FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA
WATER CONTROL MANUAL

APPENDIX E – PART III
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

PREVIOUS EDITION – JULY 1992
REVISED EDITION – MARCH 2013

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA

NOTICE TO USERS OF THIS MANUAL

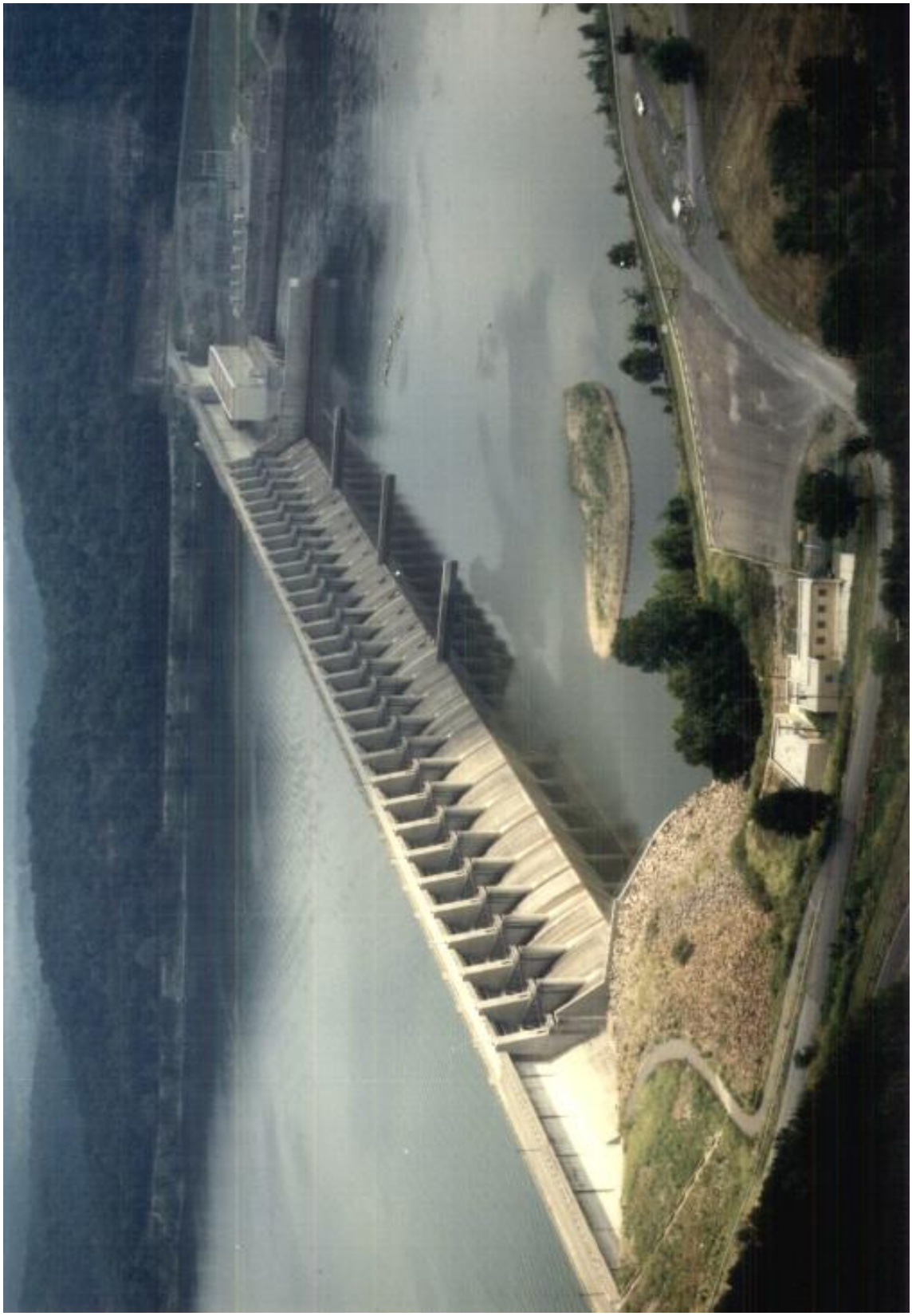
Regulations specify that this Water Control Manual be used in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the Manual current. All elevations referred to in this manual, unless noted otherwise, are in feet, NGVD29 (National Geodetic Vertical Datum 1929).

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during duty hours and at various hours during weekends and holidays, contact can be made by telephone to the Water Management Section, Tulsa District (918) 669-7085. If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, one of persons shown below. Section VII of this Manual contains detailed instructions for emergency regulations. All project personnel associated with regulation of the project must be thoroughly familiar with the procedure outlined in this section.

EMERGENCY PERSONNEL ROSTER

TITLE AND NAME	RESIDENCE TELEPHONE
Coordinator (b) (6)	(b) (6)
Backup Coordinator (b) (6)	(b) (6)
Chief, Water Management Section (b) (6)	(b) (6) (b) (6)
Chief, Hydrology-Hydraulics Branch (b) (6)	(b) (6) (b) (6)



FORT GIBSON DAM AND SPILLWAY

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PERTINENT DATA

LOCATION:

Fort Gibson Dam is located in Wagoner County, OK at R.M. 7.7 on the Grand (Neosho) River, about 5 miles north of the town of Fort Gibson and 12 miles northeast of Muskogee, OK. Fort Gibson Lake is located in Wagoner, Mayes, and Cherokee Counties, Oklahoma.

DRAINAGE AREA:

12,492 square-mile drainage area upstream of the dam site.
Uncontrolled drainage area of 959 square miles downstream of Markham Ferry Reservoir.
One inch of runoff = 666,240 acre-feet.

DAM:

Type: Concrete gravity and earth-fill
Length: 2,990 feet
Elevation: 593.0 feet, NGVD29.
Max Height: 110 feet
Top Width: 22 feet (clear roadway)

DIKES:

Number and Location: Seven on right bank of reservoir between Wagoner, OK and dam
Type: Rolled earth-fill
Maximum height above original ground surface: 20 feet
Total Length: 21,678 feet

SPILLWAY:

Location: Valley
Type: Gate controlled, concrete, gravity, ogee weir.
Crest Elevation: 547.0 feet, NGVD29
Length: 1,490 feet gross, 1,200 feet net overflow length
Control: 30 – 40’ X 35’ tainter gates
Hoists: Individual electric-motored

LAND:

	Guide Contour Elev.	Area (acres)
Fee Simple	585.0 + Backwater	72,358
Easement	Varies	688

OUTLET WORKS:

Type and Size: 10 – 5’8” X 7’0” rectangular sluices
Invert Elevation: 502.0 feet, NGVD29
Location: Through spillway weir
Control: Hydraulic, vertical lift gates Emergency closure by bulkhead at entrance

DISCHARGE – WATER SUPPLY:

Location: Through right abutment
Type: 48 inch diameter pipe
Entrance Centerline Elev: 538.0 feet, NGVD29.

POWER FEATURES:

Capacity: 45,000 kW.
Number of units: 4
Penstock Invert Elevation: 512.0 feet, NGVD29.

Feature	Elevation Feet, NGVD29	Lake area (acres) (1)	Lake Capacity			Spillway Capacity (c.f.s) 30 gates	Outlet Works Capacity (c.f.s.) 10 sluices
			Accumulative (acre-feet) (1)	Runoff (inches)	Incremental (acre-feet)		
Top of dam	593.0	67,800	1,929,700		645,300		
Top of gates and flood control pool	582.0	51,000	1,284,400	1.93	919,200	961,930	21,000
Top of conservation pool	554.0	19,000	365,200	0.55	53,900	73,020	16,900
Top of inactive pool	551.0	16,950	311,300	0.47	62,900	30,750	16,400
Spillway crest	547.0	14,500	247,800	0.37	-	0	15,700
Flood control storage	554.0 - 582.0	-	919,200	1.38	-	-	
Power drawdown (pondage)	551.0 - 554.0	-	53,900	0.08	-	-	
Streambed	483.0	-	-	-	-	-	

(1) Based on 1941 survey, 1951 rating.

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I - INTRODUCTION

1-01. Authorization. This manual is submitted in accordance with ER 1110-2-240 and prepared in accordance with EM 1110-2-3600 and ER 1110-2-8156.

1-02. Purpose and Scope. The purpose of this manual is to document the plan of water control; to present detailed information to higher authority; and to give guidance to personnel who will become concerned with, or responsible for, regulation of the lake during the life of the project.

1-03. Related Manuals. This manual is Appendix E, Part III, to the Arkansas River Basin Water Control Master Manual. Other related manuals important to the regulation of Fort Gibson Lake are:

Appendix E - Part I Pensacola Reservoir (Grand Lake)
Appendix E - Part II Markham Ferry Reservoir (Lake Hudson)
Appendix G - Tenkiller
Appendix J – Wister
Appendix L -- Oologah
Appendix M - Keystone
Appendix O - Part I Council Grove
Appendix O - Part II Marion
Appendix O - Part III John Redmond
Appendix S - Navigation System

The locations of existing and authorized projects in Tulsa District are shown on Plate 1-1. Design memoranda important to the regulation of Fort Gibson Lake are shown in Table 1-1. Supplementary Pertinent Data are given in Exhibit A of this manual.

1-04. Project Owner. Fort Gibson Lake is owned by the U.S. Government.

1-05. Operating Agency. The U.S. Army Corps of Engineers is the operating agency for Fort Gibson Lake. The Lake Manager, Fort Gibson Lake, operating through the Operations Project Manager, Northern Area, and the Operations Division, Tulsa District, has the responsibility for project operations. The project will be manned 24 hours a day when the lake level is above elevation 578.0 feet, National Geodetic Vertical Datum of

1929 (NGVD29). Between elevations 575.0 feet through 578.0 feet, the project will be manned every day. Below elevation 575.0 feet the project will be manned for the normal 5-day work week. However, when the project is in a flood control regulation, operation personnel will closely monitor the project and the downstream river reaches. The project has been furnished a list of the Water Management Section personnel to contact when necessary. Power is scheduled by the Southwestern Power Administration (SWPA).

The Lake Manager will furnish the Water Management Section a list of project personnel, giving their office and home telephone numbers and addresses.

TABLE 1-1

PERTINENT REPORTS AND DESIGN MEMORANDA
FOR FORT GIBSON DAM AND LAKE

Memorandum No.	Title	Date Submitted
1	Definite Project Report	Feb 1942
1A	Analysis of Design	Mar 1946
1B	Public Use and Access Facilities	Sep 1961
	Feasibility Report on Expansion of Powerhouse	Apr 1977
1C	Master Plan (Revised)	Sep 1987
	Navigation - Memorandum for Assistant Secretary of the Army(Civil) on Statutory Authorities in the Arkansas River Basin	12 Oct 1989
	Drought Contingency Plan for Wister, Tenkiller, and Fort Gibson Lakes	Updated 31 Jan 2005
	Operation and Maintenance Manual, Volume II, Fort Gibson Lake, Flood Emergency Plan	28 Jul 2011

1-06. Regulating Agencies. The regulating agency for Fort Gibson Lake is the Corps of Engineers, with the lake's regulation being the responsibility of the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District. Regulation of Ft. Gibson Lake's

hydropower releases are coordinated with SWPA, which is the responsible federal agency for marketing hydroelectric power and energy from the project. SWPA schedules hydropower releases from the project on a daily basis in coordination with the Water Management Section.

II - DESCRIPTION OF PROJECT

2-01. Location. Fort Gibson Dam is located at River Mile 7.7 on the Grand (Neosho) River about 5 miles north of the Town of Fort Gibson, and about 12 miles northeast of the City of Muskogee in Wagoner County, Oklahoma. The lake is located in Wagoner, Mayes, and Cherokee Counties, Oklahoma. The project location is shown on Plate 2-1.

2-02. Purpose. Fort Gibson Lake is a multi-purpose project for flood control, regulation of flows on the Grand (Neosho) River, water supply, hydropower, recreation, navigation, and other beneficial uses including fish & wildlife. The project was designed and is regulated to provide for maximum flood protection on the Grand (Neosho) and Arkansas Rivers when operated in conjunction with the Arkansas River Basin System. Navigation was confirmed as a project purpose in the 12 Oct 1989 Memorandum for Assistant Secretary of the Army (Civil) on Statutory Authorities in the Arkansas River Basin.

2-03. Physical Components.

a. Embankment. The dam embankment, from left abutment to right abutment, is comprised of: an earth embankment section 63 feet in length; a concrete, gravity, non-overflow section 460 feet in length; the powerhouse intake structure with a total length of 318 feet; the spillway section with a total length of 1,490 feet; a concrete, gravity, non-overflow section 285 feet in length; and an earth embankment section 374 feet in length. Total length of the structures, including the spillway, is 2,990 feet and maximum height above the streambed is 110 feet. A roadway extends across the top of the structures. Seven rolled earth-fill dikes are located on the west side of the lake between Wagoner, Oklahoma, and the dam and have a total length of 21,678 feet and a maximum height of 20 feet. Dike locations are shown on Plate 2-2. A plan view of the dam is shown on Plate 2-3.

b. Spillway. The spillway section is a gated concrete, gravity ogee weir which extends across the existing river channel and a large portion of the right bank flood plain. The section has a gross length of 1,490 feet and a net over-flow length of 1,200 feet. Flows over the spillway are controlled by thirty 40' wide x 35' high tainter gates operated by individual electric-motored hoists. The concrete slab stilling basin has a six-foot high stepped end sill. A section through the spillway is shown on Plate 2-3.

c. Outlet Works, The outlet works consist of ten 5'8" x 7'0" rectangular sluices located through the spillway weir. Flows through the sluices are controlled by means of hydraulically operated cast-iron slide gates. Emergency closure of the sluices can be accomplished using a bulkhead lowered by a hoist into frames provided at the sluice entrances. A section of the spillway showing the outlet works is shown on Plate 2-3.

d. Hydroelectric Power. The powerhouse contains four 11,250-kilowatt (kW) generators. A concrete penstock provides water for each power unit. Flow through each penstock is controlled by two 14'6" x 20'2$^{1/4}$" caterpillar type gates. The gates are

controlled by individual electric-motored hoists. The powerhouse is located between the spillway and the left abutment. A typical intake section through the powerhouse is shown on Plate 2-3.

e. Water Quality Facilities. There are no physical water quality facilities built into the project. However, small temporary releases are occasionally made to alleviate dissolved oxygen deficiency or pollution downstream.

f. Water Supply. A 48-inch diameter pipe is located through the right abutment of the dam for municipal water supply for the City of Muskogee, Oklahoma. The water supply pipe is controlled by a double-disc gate valve. The entrance centerline elevation is 538.0 feet.

g. Sedimentation and Degradation Ranges. A combination range and contour survey method is used for measuring sediment deposition in Fort Gibson Lake. Thirty-four (34) sediment ranges are located in and upstream of the lake area, with their ends marked with permanent monuments. Sediment surveys are periodically made by District personnel or by contract for the purpose of computing sediment deposition and updated lake area and lake capacity data. The original sediment survey was accomplished in 1941 with updates occurring in 1949 and 1950. The locations of the sediment ranges are shown on Plate 2-4.

Eight (8) degradation ranges are located downstream of Fort Gibson Dam to provide information on the downstream channel condition. All ranges are located on the Grand (Neosho) River. The downstream-most degradation range is located at River Mile 3.9. The degradation ranges downstream of Fort Gibson Dam are shown on Plate 2-5.

2-04. Related Control Facilities. There are seven (7) dikes in the flood control pool of Fort Gibson Lake. Dikes one and two are near Mallard Bay and Wahoo Bay, respectively. Dikes three, eight, and nine are near the State Waterfowl Refuge. Dike 10 is near the city of Wagoner and Dike 11 is 1.6 miles north of Wagoner. The dikes provide protection by containing the flood control pool of Fort Gibson Lake within desired limits.

2-05. Real Estate Acquisition. The lake taking line for Fort Gibson Lake was a blocked perimeter based on elevation 585.0 feet, or to the elevation of the envelope curve of backwater effects on a full pool, whichever was higher. The envelope curve of backwater effects used as a guide to purchase land upstream to the vicinity of State Highway 33 (approximate route of today's US Highway 412) was that of a flood with a peak discharge of 400,000 cubic feet per second (c.f.s.) on a full flood control pool. The envelope curve used as a guide to purchase land upstream of State Highway 33 (about current US Highway 412) was that of a flood with a peak discharge of 200,000 c.f.s. on a full flood control pool. The amount taken in fee was 72,358 acres. Additionally, 688 acres of easement were taken. The envelope curve of backwater effects is shown on Plate 2-6.

2-06. Public Facilities. There are twenty-six (26) public use areas and concession sites at Fort Gibson Lake. Facilities provided at these areas consist of roads, parking areas, trails, boat-launching ramps, picnic areas, water and sanitary facilities. Facilities provided by private interests, the Cities of Hulbert and Pryor, and the State of Oklahoma, supply foods and refreshments, bait, fishing and hunting supplies, marinas, lodging facilities, air fields and a golf course. The public use areas are shown on Plate 2-7.

III - HISTORY OF PROJECT

3-01. Authorization. Fort Gibson Lake was authorized by the Flood Control Act approved 18 Aug 1941. It was incorporated in the Arkansas River multiple-purpose plan by the River and Harbor Act of 24 Jul 1946 (Project Document - H.D. 107, 76th Congress, 1st Session).

3-02. Planning and Design.

a. House Document No. 798. A report entitled "Control of Floods in the Alluvial Valley of the Lower Mississippi River" was published as House Document No. 798, 71st Congress, 3rd Session. This report was a review of the projects included in the Flood Control Act approved by Congress, 15 May 1928, for flood control and navigation of the Mississippi River in its alluvial valley. It considered a system of reservoirs in the Arkansas River Basin, but was unfavorable for their construction.

b. "308" Report. A report on the Grand (Neosho) River, Kansas, Oklahoma, Missouri and Arkansas, dated 19 Jun 1931, was included in the comprehensive report "Arkansas River and Tributaries" published in 1936 as House Document No. 308, 74th Congress, 1st Session. This report discussed flood control in the Grand (Neosho) River Basin, together with other benefits which would be derived from the controlled storage of flood waters, by means of levees, flood-control reservoirs, channel rectifications, flood control and power reservoirs. The report stated that the water resources of the Grand (Neosho) River for the development of hydroelectric power could be utilized to the best advantage by the construction of a three-reservoir system in the lower reaches of the valley. The report further stated that development of power by the three-reservoir system was economically feasible, but in the absence of a ready power market, there could be no economic justification for its construction at that time. The report also considered operation of the system for the dual purpose of power development and flood control. The flood control and incidental benefits, which would accrue to the three-reservoir system, were not commensurate with the cost of the projects at that time. The report recommended that there be no participation by the United States in the control of floods in the Grand (Neosho) River watershed.

c. House Document No. 259. Pensacola, Markham Ferry and Fort Gibson Reservoirs were mentioned as part of a system of lakes considered in the "Comprehensive Report on Reservoirs in Mississippi River Basin", dated 15 Dec 1934, and published as House Document No. 259, 74th Congress, 1st Session. This report was unfavorable for construction and operation of the reservoir system entirely at Federal expense.

d. Flood Control Committee Document No. 4. This report entitled "Flood Control and Power Projects in the Arkansas Basin", dated 1935, was an economic report on the power possibilities of Pensacola Dam, and an analysis of the applicable power market. This report was favorable for the project.

e. Preliminary Examination Report. This report, entitled "Preliminary Examination Report, Pensacola, Markham Ferry and Fort Gibson Reservoirs, Grand (Neosho) River, Oklahoma", dated 21 Sep 1937, indicated that the three-reservoir system offered possibilities of development for flood control; development of hydroelectric power; or development as a dual-purpose project. The report recommended that there be further investigations of the three-reservoir system.

f. House Document No. 107. A survey report on "Pensacola, Markham Ferry and Fort Gibson Reservoirs, on Grand (Neosho) River, Oklahoma", was published as House Document No. 107, 76th Congress, 1st Session. This report recommended that the three-reservoir system be constructed at Federal expense for the combined purpose of flood control and water power.

g. Survey Report. This report was authorized by the Flood Control Acts approved 22 Jun 1936, and 28 Aug 1937, and by a Resolution adopted 13 Apr 1938, by the Committee on Flood Control of the House of Representatives. This survey report on flood control, Grand (Neosho) River and tributaries, Oklahoma, Kansas, Missouri and Arkansas, was prepared by the Tulsa District and forwarded to higher authority on 4 Sep 1941. The Southwestern Division (SWD) Office, Dallas, Texas, by first endorsement dated 24 Jan 1942, concurred, in general, with the recommendations of Tulsa District. In addition to other recommendations for the control of floods and the development of hydroelectric power in the Grand (Neosho) River valley, this report recommended that the plan for the Fort Gibson Reservoir, as reported in House Document No. 107, be revised to provide 906,000 acre-feet of flood control storage, and that the proposed power generating facilities at the Fort Gibson Dam site be increased.

h. Definite Project Report - Fort Gibson Dam and Reservoir. A Definite Project Report (DPR) for Fort Gibson Reservoir was published by the Corps of Engineers in Feb 1942. The report recommended that the reservoir contain 922,000 acre-feet of flood control storage and 365,000 acre-feet of power storage, in order to fully develop the lower Grand (Neosho) River Valley in general accord with the plan for the three-reservoir system recommended in House Document No. 107. The DPR was approved by the Office, Chief of Engineers on 3 Mar 1942.

i. Design Memoranda. Several design memoranda have been prepared by the Corps of Engineers subsequent to the construction of Fort Gibson Lake. These reports cover access roads, recreational facilities, construction of stop logs for powerhouse intake and construction of Ordnance Works levee. Design documents and memorandums that are currently available at Tulsa District are listed in Table 1-1.

3-03. Construction. A resume of construction activities for Fort Gibson Dam and Lake is given in Table 3-1.

TABLE 3-1

RESUME OF CONSTRUCTION ACTIVITIES

Activity	Date
Construction began	May 1946 [1]
Date of closure	6 Jun 1949
Final storage began	1 Oct 1952
Conservation pool filled	Mar 1953

[1] Construction of access road and field office began in 1942. Remainder of construction was delayed due to World War II.

3-04. Related Projects. Fort Gibson Lake is an integral unit of the multi-purpose plan for flood control, generation of hydroelectric power, navigation and other beneficial water uses in the Arkansas River basin in Kansas, Arkansas and Oklahoma. In particular, Fort Gibson Lake is operated in conjunction with Council Grove, Markham Ferry (Hudson Lake), and Grand Lake and Marion and John Redmond Reservoirs to control flooding on the Grand (Neosho) River. Also included in this system are completed projects in the Verdigris, Walnut, Canadian, North Canadian, Caney, Illinois and Poteau River Basins.

3-05. Modification to Regulations. – None.

3-06. Principle Regulation Problems. Fort Gibson, Grand (Pensacola) and Markham Ferry (Hudson) Lakes are operated as a unit for maximum flood control benefits on the lower Grand (Neosho) River and as a unit of a system for maximum flood control benefits on the Arkansas River from Muskogee, Oklahoma, to Van Buren, Arkansas. Flood releases from each lake in the system are made in accordance with predicted runoff from the uncontrolled area downstream and the predicted volume of inflow into the lake, each lake making its proportionate release in accordance with the predicted allowable release for the downstream control points. The proportionate release from each lake will be determined by the ability of each lake to store the predicted inflow and the ability of each lake to evacuate the stored floodwaters at channel capacity.

As Fort Gibson Lake elevation rises into the flood control pool zone, the following issues occur; (1) at elevation 556.1 feet, some flap gates on dikes must be closed manually, (2) at elevation 557.0 feet, access roads, beaches, wildlife and agricultural leases become flooded, (3) at elevation 558.0 feet, some boat ramps become flooded, (4) at elevation 559.0 feet, picnic, camping sites and parking lots become flooded, and (5) at elevation 560.0 feet, State Highway 80 closes.

Lake release rates of 70,000 c.f.s. or greater erode public use area roads downstream of the dam. High discharges on the Arkansas River create a backwater effect on the Grand (Neosho) River which reduces channel capacity to approximately 70,000 c.f.s.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Grand (Neosho) River rises in the Flint Hill region in Morris County, east central Kansas, near the town of Parkerville (river mile 470.0), and flows in a southeasterly direction for approximately 347 miles, then in a southerly and southwesterly direction to its confluence with the Arkansas River (Arkansas River mile 459.5) near Fort Gibson, Oklahoma. The basin rises from an elevation of about 483 feet on the valley floor at Fort Gibson Dam to over 1,450 feet in the headwater area in Kansas. The average fall of the Grand (Neosho) River is about two feet per mile, varying from approximately 11 feet per mile in the upper reaches to about one foot per mile in the middle reaches. The valley is from one to four miles wide and the river channel varies in width from 50 feet in the upper reaches to about 400 feet in the lower reaches. The banks are generally stable and vary in height from 15 to 30 feet. The total drainage area above the Fort Gibson Dam site is approximately 12,492 square miles, which is over 99 percent of the entire watershed. Approximately 959 square miles of drainage area lie between the Fort Gibson Dam and Markham Ferry Dam (river mile 47.4). Streambed profiles for the Grand (Neosho) River are shown on Plate 4-1.

The principal tributaries are Rock Creek, Allen Creek, Cottonwood River, Big Creek, Deer Creek, Owl Creek, Flat Rock Creek, Lightning Creek, Cherry Creek, Labette Creek, Spring River, Elk (Cowskin) River, Big Cabin Creek, Spavinaw Creek, Pryor Creek, Chouteau Creek, Spring Creek, and Fourteen Mile Creek, all of which enter the main stem above Fort Gibson Dam. The Grand (Neosho) River and its tributaries drain an area about 260 miles in length, with a maximum width of about 90 miles near the Kansas-Oklahoma state line (river mile 164.4) with-a minimum width of approximately 20 miles immediately downstream from the point at which the Cottonwood River enters the main stem (river mile 382.8). It comprises a total area of 12,520 square miles, of which 6,220 square miles are in Kansas, 2,930 are in Oklahoma, 2,960 are in Missouri and 410 are in Arkansas.

The Cottonwood River, the principal tributary in Kansas and the second largest tributary of the Grand (Neosho) River, rises in east central Kansas near Marion, Kansas and joins the main stem near Emporia, Kansas (river mile 382.8). The watershed of the Cottonwood River is about 70 miles long and averages about 26 miles in width and drains an area of approximately 1,908 square miles. Spring River, the largest tributary of the Grand (Neosho) River, rises near Aurora, Missouri, and joins the main stem at river mile 130.6, near Wyandotte, Oklahoma. The watershed of the Spring River is about 60 miles in length, averages about 45 miles in width, and drains an area of about 2,581 square miles. The third largest tributary of the Grand (Neosho) River, the Elk River, rises near Seligman, Missouri, and joins the main stem at river mile 113.6, near Grove, Oklahoma. The watershed of the Elk River is about 48 miles long, averages about 21 miles in width, and drains an area of about 1,033 square miles.

4-02. Topography. The watershed varies from rolling to rough hill country and its extreme eastern portion is located in the rugged area of the Boston Mountains of the

Ozark uplift. The upper reaches of the basin are located in the Flint Hill region, which extends across Kansas from north to south. The valley slopes are gentle with woods and brush bordering the stream banks.

4-03. Geology and Soils. Fort Gibson Lake is located in the Interior Lowlands physiographic province. The overburden in the floodplain area across the dam axis has a fairly uniform depth of approximately 30 feet and consists of varying amounts of gravel, sand, silt, and clay. Bedrock strata are moderately hard, dense limestone, coarse-grained shales which grade into fine sandstones, and clayey to silty shales.

4-04. Sediment. The drainage basin above Fort Gibson Lake contributes relatively little sediment because of good ground cover and a clay type soil. The sediment inflow is further reduced by Grand Lake (Pensacola Dam) and Lake Hudson (Markham Ferry Dam) upstream. The original 34 sedimentation ranges and the area-capacity table were completed in Sep 1950. Since then the lake has not been re-surveyed, and no new sedimentation survey is scheduled.

4-05. Climate. The climate of the Grand (Neosho) River watershed is characterized by moderate winters and comparatively long summers with relatively high temperatures. Summer rains generally occur as thunderstorms with very intense rainfall of short duration and limited areal coverage. The winter rains are generally of low intensity but cover a large area and are of considerably longer duration. The Gulf of Mexico is the source of much of the precipitation which falls on the basin.

Basin average rainfall was computed for the period of record 1930-2010 by examining average monthly and annual rainfall records as shown in Table 4-1. Climatic characteristics for the basin are shown in the following tabulation:

a. Temperature. Pryor Gage Period of Record (1926 – 2011)

Mean annual	58.8 degrees F
Maximum in basin upstream of Fort Gibson Lake Pryor, OK (14 Jul 1954)	113 degrees F
Minimum in basin upstream of Fort Gibson Lake Pryor, OK (14 Jan 2009)	-28 degrees F

b. Precipitation. (Average in basin upstream of Fort Gibson Lake)

Mean Annual (Period of record 1930 – 2010, from Annual Report)	41.54 inches
Maximum annual (2008)	61.42 inches
Minimum annual (1963)	21.31 inches

Percent during growing season (Apr through Oct)	60.2 %
Annual Snowfall	0 to 13.5 inches
Mean Annual	7.9 inches

Runoff from snowfall is not excessive and has not been a factor of importance in contributing to floods. The average monthly and annual rainfall and runoff data are shown in Table 4-1. The locations of precipitation and stream gaging stations are shown on Plate 5-1.

TABLE 4-1

AVERAGE MONTHLY AND ANNUAL RAINFALL
AND RUNOFF UPSTREAM OF FORT GIBSON DAM

Month	Average Rainfall (inches) [1]	Percent of Average Annual Rainfall	Average Runoff [2] [3]		Percent of Average Annual Runoff
			(acre-feet)	(inches)	
Jan	1.97	4.74	372,880	0.56	5.77
Feb	2.29	5.51	411,460	0.62	6.37
Mar	3.26	7.85	662,460	0.99	10.25
Apr	4.17	10.04	841,280	1.26	13.02
May	5.37	12.93	953,470	1.43	14.76
Jun	4.96	11.94	893,460	1.34	13.83
Jul	2.95	7.10	528,970	0.79	8.19
Aug	3.18	7.66	265,340	0.40	4.11
Sep	4.37	10.52	318,260	0.48	4.93
Oct	3.70	8.91	403,830	0.61	6.25
Nov	3.09	7.44	424,990	0.64	6.58
Dec	2.23	5.37	384,070	0.58	5.94
TOTAL	41.54	100.00	6,460,500	9.70	100.00

(1) Period of record – 1930 – 2010 (from Annual Report).
(2) Period of record - Jan 1923 through Dec 2010 (from Annual Report).
(3) Drainage area upstream of Fort Gibson Dam is 12,492 square miles, of which approximately 959 are intervening area below Lake Hudson.

c. Evaporation. Following the construction of the Fort Gibson Project, evaporation data was collected from an evaporation pan on site. In 1996, Tulsa District migrated from physical evaporation measurements to using an empirical formula, based on meteorology data collected on site. The formula incorporates electronically collected data for solar radiation, wind speed, air temperature and relative humidity. Average monthly evaporation figures are shown in Table 4-2, for the period Jan 1980 through Dec 2010.

TABLE 4-2

ESTIMATED MONTHLY
EVAPORATION (Fort Gibson Lake)
Jan 1980 – Dec 2010

Month	Evaporation
	Normal
Jan	1.92
Feb	2.42
Mar	4.30
Apr	5.86
May	6.69
Jun	7.76
Jul	9.45
Aug	8.68
Sep	6.06
Oct	4.38
Nov	2.82
Dec	1.92
Annual Total	**62.26**

(1) National Weather Service Class "A" pan until 1996. Empirical estimate of pan evaporation since 1996.

d. Wind. The prevailing wind is from a southerly direction, with the greatest wind movements occurring in the spring months. A study of available wind velocity data indicated that for 1-minute and 1-hour durations, the highest wind velocities that can reasonably be expected are 75 and 53 miles per hour.

4-06. Storms and Floods. Most of the flood-producing storms over the watershed above the Fort Gibson Lake have been from 5 to 10 days duration and have occurred in the spring and fall months. Thunderstorms and the remnants of hurricanes are the types of storms that produce most high runoff events in the basin. The maximum storm over the entire watershed above Fort Gibson Dam during the 87 year period of record was 9.08 inches from 7 to 11 May 1943. Storms with an average precipitation of 3 inches or more over the drainage areas above the dam site are shown in Table 4-3, located in the Supplemental Tables Section. Over the period of record, about 60.2 percent of the rainfall occurred during the months of Apr through Sep for those years. The basin average rainfall was computed from available published records which do not necessarily show the actual center of intense storms over small areas. Because of this, and since antecedent rainfall, season of the year, and many other factors influence storm runoff, floods have frequently followed periods of relatively small amounts of recorded rainfall. Conversely, longer storms of greater amounts of recorded rainfall may cause only minor flooding. Major floods at the Muskogee, Oklahoma, and Van Buren, Arkansas, gages are shown in Table 4-4.

4-07. Runoff Characteristics. The upper portion of the Grand (Neosho) River drainage area lies in the Flint Hills, a region characterized by steep broken hills which are devoid of trees except along the streams. The thin, rather impervious soil cover and the steep slopes of the tributary streams are conducive to rapid concentration of runoff in the main stem and major tributaries. This part of the drainage area produces flashy flood flows on the main stem, which are decreased by valley storage in passing through the central portion of the valley, unless augmented by heavy rainfall over that portion of the watershed. Long periods of very low flow have been observed on the main stem in Kansas, and at infrequent intervals, short periods of zero flow have been recorded. On the Cottonwood River, main tributary of the Grand (Neosho) River above Iola, Kansas, drainage is well developed and due to the comparatively large channel capacities in the upper reaches of the river, floods of large magnitude are relatively infrequent, though high flows in the Cottonwood contribute heavily to flood flows in the Grand (Neosho) River. Spring and Elk Rivers, the main tributaries entering the stream in the lower reaches, have their source in the Ozark Mountains of southwestern Missouri and northwestern Arkansas. The runoff from the drainage areas of these tributaries is very rapid and they contribute a major portion of the flood flows in the lower portion of the main stem. As these streams are fed by springs, they produce most of the flow in the lower reaches during summer months, so that very low flows are less frequent in this portion of the river than in the upper reaches.

For the intervening area between Markham Ferry Dam and Fort Gibson Dam, hydrologic studies indicate the time from the most intense rainfall to peak inflow into Fort Gibson Lake is about 15 hours; however, this time is highly dependent on the storm pattern and its location over the basin. Pertinent stream gages in the upper Grand (Neosho) River Basin include Commerce, Quapaw, and Tiff City, Missouri. Other gages on the upper Grand are Burlington, Iola, and Parsons. These are discussed in more detail in the Grand Lake (Pensacola Dam) Water Control Manual. Storm studies indicate that depending on antecedent rainfall, 1 inch of rainfall generally was needed to

satisfy initial losses before significant runoff begins. Pertinent data for stream gaging stations used for regulation of Fort Gibson Lake are shown on Table 4-5. Estimated monthly and annual flows past Fort Gibson Dam are shown in Table 4-6, located in the Supplemental Tables Section. The inflow volume frequency by months is shown in Table 4-7. The flow duration curve is shown on Plate 4-2.

TABLE 4-4

TOP TWENTY ANNUAL PEAK STAGES AT STREAM GAGES
Ranking Determined by Stage Height When Available

Muskogee Gage			Van Buren Gage		
DATE	FLOW (c.f.s.)	STAGE	DATE	FLOW (c.f.s.)	STAGE
21 May1943	700,000	48.20	12 May 1943	850,000	38.00
6 Oct 1986	375,000	39.60	17 Apr 1945	650,000	(2)
May 1898	384,000 (1)	39.50	28 May 1957	510,000	35.97
26 May 1957	366,000	39.03	2 Nov 1941	485,000	(2)
31 Oct 1941	304,000	37.23	19 Jun 1935	418,000	34.10
18 Apr 1945	326,000	36.65	7 Oct 1959	418,000	32.55
6 Oct 1926	325,000	36.50	13 May 1950	402,000	30.90
Jun 1923	295,000 (1)	34.70	5 May 1990	401,000	401.75 (3)
7 Oct 1959	286,000	34.00	19 Feb 1938	375,000	32.71
21 Apr 1941	248,000	32.72	9 Oct 1986	357,000	400.32 (3)
9 May 1961	295,000	32.70	25 Jun 1948	330,000	30.61
7 Jul 2007	176,000	31.62	22 May 1949	323,000	29.03
15 May 1929	249,000	31.50	16 May 1929	315,000	29.00
15 Apr 1927	248,000	31.40	22 Apr 1941	311,000	30.58
17 Jul 1951	240,000	31.40	15 Jun 1995	294,000	397.05 (3)
9 Jun 1935	243,000	30.80	2 Oct 1945	287,000	29.42
10 Jun 2008	153,000	30.72	11 May 1993	267,000	396.87 (3)
1 Oct 1945	231,000	30.67	13 Dec 1946	262,000	27.80
24 Jun 1948	224,000	30.25	25 Nov 1973	259,000	397.72 (3)
7 Nov 1974	186,000	29.75	6 Jul 1951	250,000	26.76

Flood Stage = 28.0 feet
Period of Record = 6 Oct 1926 -- Present
With break from 1986-2004
Slightly different location
From 2005 -- Present

Flood Stage = 22.0 feet
Period of Record is
3 Oct 1927 – Present

(1) Estimated Peak Flow
(2) Data Not Available
(3) Lock & Dam No. 13 Pool Elevation

Note: Annual Peak Flows are the highest flow during a given water year (1 Oct to 30 Sep of following calendar year).

4-08. Water Quality. The most recent water quality data available for Fort Gibson Lake were collected by the Oklahoma Water Resources Board (OWRB), between Oct 2006 and Jul 2007 and have been published in the 2011-2012 Oklahoma Lakes Report, "Beneficial Use Monitoring Program by the OWRB". Generally, surface water quality in Fort Gibson Lake ranges from moderately to severely impacted primarily due to elevated nutrient (nitrogen and phosphorous) concentrations within the lake. Plate 4-3 shows the water quality sampling locations in and downstream of the lake.

4-09. Channel and Flooding Characteristics. The regulating channel capacity of the Grand (Neosho) River below Fort Gibson Lake is about 100,000 c.f.s. During times of high flow on the Arkansas River, which causes a backwater effect on the Grand (Neosho) River, channel capacity is diminished to about 70,000 c.f.s. Regulating channel capacity on the Arkansas River at Muskogee, Oklahoma, is 120,000 c.f.s., and at Van Buren, Arkansas, is 150,000 c.f.s. The Grand (Neosho) River channel downstream of Fort Gibson Lake is about 400 to 500 feet wide and has generally stable banks that vary in height from 15 to 30 feet. The overbank varies from 2000 to 3000 feet in width, until it joins the Arkansas River overbank. Below its confluence with the Grand (Neosho) River, the Arkansas River channel is stabilized and protected from shifting for navigation purposes. The overbank varies from one to several miles wide. The discharge rating curve at the Van Buren, Arkansas, gage is shown on Plate 4-4. Crest travel times for the Grand (Neosho) and the Arkansas River basins are shown on Plate 4-5. This is a simplified diagram and should be used as a guide only, as the crest travel time depends on the magnitude of the flood and antecedent flows.

4-10. Upstream Structures. Located upstream of Fort Gibson Lake are 5 major multi-purpose flood control projects: Marion and John Redmond Reservoirs, Council Grove Lake and Grand (Pensacola Dam) Lake, and Lake Hudson (Markham Ferry Dam). The flood control storage is about 1,495,970 acre-feet. These projects are operated as a system with Fort Gibson Lake in the multi-purpose plan for flood control, hydropower, navigation and allied water uses on the Arkansas River and its tributaries. There are also numerous National Resource Conservation Services (NRCS) single and multi-purpose flood retarding structures located in the Grand (Neosho) River Basin. These structures combine for a total of 25,147 acre feet of storage which includes 3,652 acre-feet of sediment storage.

TABLE 4-5

PERTINENT DATA FOR GAGING STATIONS
Ranking Determined by Stage Height When Available

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD29)	FLOOD STAGE (ft.) (1)	DRAINAGE AREA (sq. mi.) (2)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	FLOW (c.f.s.)
Muskogee, OK	Arkansas River	457.8	471.38	28.0	96,674	21 May 1943	48.20	700,000
Van Buren, AR	Arkansas River	308.9	372.36	22.0	22,241	12 May 1943	38.00	850,000

STATION	STREAM	2nd LARGEST FLOOD OF RECORD			3rd LARGEST FLOOD OF RECORD			PERIOD OF RECORD
		DATE	STAGE (ft.)	FLOW (c.f.s.)	DATE	STAGE (ft.)	FLOW (c.f.s.)	(FLOW AND / OR STAGE)
Muskogee, OK	Arkansas River	6 Oct 1986	39.60	375,000	May 1898	39.50	384,000	6 Oct 1926 to 30 Sep 1987; 2005 – present (4)
Van Buren, AR	Arkansas River	17 Apr 1945	(3)	650,000	28 May 1957	35.97	510,000	3 Oct 1927 to present

(1) Regulating Flood Stages
(2) Contributing Drainage Area
(3) Data Not Available
(4) Slightly Different Location

TABLE 4-7

INFLOW VOLUME FREQUENCY
(1923-2010)

Frequency Of Occurrence (years)	Monthly Inflow in Thousands of Acre-Feet											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	355	302	467	553	643	641	410	163	325	395	420	375
5	590	448	1,084	1,334	1,422	1,409	610	388	456	598	612	594
10	909	583	1,561	2,009	2,122	2,027	1,115	569	763	986	1,128	961
25	1,430	1,340	2,238	3,067	3,353	3,174	2,223	874	1,388	2,219	2,226	1,585
50	1,792	1,600	3,195	3,819	4,199	3,926	2,668	1,095	1,790	2,647	3,188	2,079
100	2,228	1,859	4,565	4,687	5,396	5,389	3,522	1,375	2,225	3,090	4,558	2,674

4-11. Downstream Structures. Structures in the Arkansas River Basin below Fort Gibson Lake include Tenkiller Ferry Lake on the Illinois River with a drainage area of 1,610 square miles; Eufaula Lake on the North Canadian River with a drainage area of 47,522 square miles; Wister Lake on the Poteau River with a drainage area of 993 square miles and the McClellan-Kerr Arkansas River Navigation System on the Arkansas River. All of these structures are regulated by the Corps of Engineers.

4-12. Economic Data.

a. Population. The population of counties traversed by the Grand (Neosho) River above and below Fort Gibson Dam and larger cities in the basin are shown in Table 4-8.

b. Agriculture. Principal crops grown in the region are wheat, soybeans, sorghums, and hay. A small percentage is devoted to corn and oats. Beef cattle production is the principal livestock. Fort Gibson Dam is approximately 8 miles from the confluence of the Grand (Neosho) River with the Arkansas River and Verdigris River. As such, the crop acreages below Fort Gibson Dam are insignificant. Production and annual value of the major crops in the Arkansas River floodplain below Fort Gibson Dam are shown in Table 4-9.

c. Industry. Health care and social assistance is the largest industry in the region, followed by manufacturing and retail trade. The primary manufacturing industries in the area are located in Muskogee, Oklahoma and are involved with paper and fabricated metal manufacturing. Tables 4-10A, -10B, and -10C display the major industries in the town of Fort Gibson and Cherokee and Muskogee counties along with corresponding data on number of establishments, sales, annual payroll, and employees.

d. Flood Damages. The estimated average annual flood damages prevented by Fort Gibson Dam on the Grand (Neosho) River are presented in Table 4-11 while the top five flood events, in terms of flood damages prevented, to pass through Fort Gibson Dam are presented in Table 4-12. Plate 4-6 shows the Structural Loss and Area curve for the area from the Verdigris River confluence to the Illinois River Confluence on the Arkansas River.

TABLE 4-8

POPULATION OF COUNTIES AND CITIES
NEAR OF FORT GIBSON LAKE

County	Major Cities	U.S. Census Population			% Change (2000-2010)
		1990	2000	2010	
Wagoner		47,883	57,491	73,085	27.12
	Wagoner	6,894	7,669	7,982	11.24
Cherokee		34,049	42,521	45,733	24.88
	Ft. Gibson	3,359	4,054	4,331	20.69
Muskogee		68,078	69,451	71,278	2.02
	Muskogee	37,708	38,310	40,015	1.60
1990 Census, 2000 Census, *2007 or 2008 Population Estimates http://factfinder.census.gov/					

TABLE 4-9

ANNUAL VALUE OF CROPS
DOWNSTREAM OF FORT GIBSON DAM

Crops	Grand River to Illinois River		Illinois River to Fort Smith, AR		Total	
	Acres	Value ($)	Acres	Value ($)	Acres	Value ($)
Alfalfa	3,320	797,312	9,680	2,324,693	13,000	3,122,005
Wheat	12,810	1,707,825	37,330	4,976,824	50,140	6,684,650
Soybeans	11,680	1,660,896	34,020	4,837,644	45,700	6,498,540
Vegetables	1,280	849,439	3,710	2,475,439	4,990	2,475,439
Other Crops	750	441,842	2,180	1,287,418	2,930	1,287,418
Total	**29,840**	**5,457,315**	**86,920**	**15,902,018**	**116,760**	**20,068,051**

Yield Rates from Oklahoma State University Crop Enterprise Budgets 2009
2009 Current Normalized Prices; Acres maintained are from the Jul 1992 Ft. Gibson WCM

TABLE 4-10A

2002 ECONOMIC CENSUS FOR FORT GIBSON, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing*	6	D	D	a
42	Wholesale trade	3	D	D	a
44-45	Retail trade	15	20,257	1,567	107
51	Information	3	N	D	b
53	Real estate & rental & leasing	2	D	D	a
54	Professional, scientific, & technical services	4	D	D	a
56	Administrative & support & waste management & remediation service	4	448	238	13
62	Health care & social assistance	13	D	D	e
71	Arts, entertainment, & recreation	1	D	D	a
72	Accommodation & food services	8	4,266	1,343	163
81	Other services (except public administration)	8	D	D	a
31-33	Manufacturing*	6	D	D	a

Source: U.S. Bureau of the Census, 2002 Economic Census, * 2006 County Business Patterns

Key to Table:

a = 0 – 19 employees

b = 20 to 99 employees

D = Withheld to avoid disclosing data for individual companies; data are included in higher totals

e = 250 – 499 employees

N = Not available or not comparable

TABLE 4-10B

2002 ECONOMIC CENSUS FOR CHEROKEE COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing*	21	N	8,769	429
42	Wholesale trade	18	70,704	2,857	194
44-45	Retail trade	133	282,171	24,311	1,714
51	Information	7	N	1,472	52
53	Real estate & rental & leasing	31	32,231	4,448	296
54	Professional, scientific, & technical services	44	8,795	2,468	133
56	Administrative & support & waste management & remediation service	28	8,357	2,617	121
61	Educational services	5	D	D	b
62	Health care & social assistance	88	108,705	57,043	1,834
71	Arts, entertainment, & recreation	14	4,008	1,532	101
72	Accommodation & food services	82	32,425	8,355	987
81	Other services (except public administration)	39	12,159	2,421	214

Source: U.S. Bureau of the Census, 2007 Economic Census, * 2008 County Business Patterns

Key to Table:
b = 20 – 99 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
N = Not available or not comparable

TABLE 4-10C

2002 ECONOMIC CENSUS FOR MUSKOGEE COUNTY, OK

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000's)	Annual Payroll ($1,000's)	Number of Employees
31-33	Manufacturing	78	1,185,528	184,242	4,867
42	Wholesale trade*	81	332,276	29,674	1,139
44-45	Retail trade	316	655,782	61,118	3,475
51	Information	28	N	13,146	424
53	Real estate & rental & leasing	61	30,471	6,246	287
54	Professional, scientific, & technical services	93	42,764	16,274	604
56	Administrative & support & waste management & remediation service	74	46,258	24,114	1,069
61	Educational services	4	D	D	a
62	Health care & social assistance	201	330,642	145,783	5,551
71	Arts, entertainment, & recreation	19	22,379	3,706	291
72	Accommodation & food services	134	70,746	19,603	2,151
81	Other services (except public administration)	99	32,390	9,089	493

Source: U.S. Bureau of the Census, 2007 Economic Census,
* 2008 County Business Patterns
Key to Table:
a = 0 – 19 employees
D = Withheld to avoid disclosing data for individual companies; data are included in higher totals
N = Not available or not comparable

TABLE 4-11

AVERAGE ANNUAL FLOOD DAMAGES PREVENTED

Average Annual Flood Damages Prevented by Fort Gibson Lake		
Years in Operation	**Cumulative Damages (2008 $ 1,000's)**	**Average Annual Damages (2008 $ 1,000's)**
58	348,932	6,016

TABLE 4-12

TOP FIVE FLOOD EVENTS
DOWNSTREAM OF FORT GIBSON DAM

Top Five Flood Events		
Year	**Damages Prevented ($ 1,000's)**	**Damages Prevented (2008 $1,000's)**
1975	6,457	24,258
1974	6,454	26,551
2002	21,640	27,505
1960	2,754	27,770
1993	24,633	39,290

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

a. Facilities. The Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, the National Weather Service (NWS), and the U.S. Geological Survey (USGS) cooperate to collect data and maintain a reliable communication network. All pertinent stream gage and rainfall stations are shown on Plate 5-1. The drainage area above Fort Gibson is 12,492 square miles, 11,533 square miles of which is controlled by upstream lakes. The Muskogee, Oklahoma, and Van Buren, Arkansas, gages on the Arkansas River are key stations for regulation purposes.

Important stream gages used to forecast inflows into the Grand Lake (Pensacola Dam), Lake Hudson (Markham Ferry), and Fort Gibson Lake system are Burlington, Iola, Chanute, Parsons, Kansas, and the Commerce, Oklahoma, gages on the Grand (Neosho) River; Joplin and Waco, Missouri, and Quapaw, Oklahoma, gages on the Spring River; Tiff City, Missouri, on the Elk River; and Big Cabin, Oklahoma, on Big Cabin Creek. Pertinent data for these gages can be found in Section V of the Pensacola Reservoir, Grand River, Oklahoma, Water Control Manual.

At Fort Gibson Lake, a tipping bucket rain gage is located on the roof of the elevator tower east of the powerhouse on the left bank. Pool elevation records are provided by a float gage in a wet well located on floor five of the elevator tower. Automated stream gaging stations are equipped with automated rain gages that provide precipitation data transmitted along with stage data. Tailwater readings are provided by a float gage in a wet well located in the powerhouse generator bay. Both gages are read continuously in the control room of the powerhouse.

Two staff gages for pool elevation readings are located on the upstream side of the powerhouse intake structure. There are three staff gages for tailwater readings. One is located on the east side of the power house training wall, and the other two are located on the east and west end walls of the main spillway.

b. Reporting. The reporting procedures for precipitation and stream gaging stations are on a cooperative basis with the NWS and the USGS. The reporting of data from pool elevation and stream gaging stations has been automated by using Data Collection Platforms (DCP's) that record data hourly and transmit the data every hour or when a threshold value is exceeded. The data are transmitted via Geostationary Operational Environmental Satellite (GOES) to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. The data are then transmitted to a domestic satellite (DOMSAT) that passes the data to the Tulsa District's Receive Only Terminal (DROT). The data from the NOAA computer facility may also be transferred via the Internet. When received, the river stage is converted to flow and lake elevation is converted to storage. All the data are then stored in a database on the Tulsa District Water Control Data System (WCDS)

for access when needed. DCP's also report rainfall data in the same way. In addition to the DCP data, observer rainfall data are collected and stored in the computer system for use in forecasting. Observers telephone the NWS offices in their region and the NWS then encodes the data into a Standard Hydrologic Exchange Format (SHEF). The data are then transferred to the WCDS by electronic data transmission from the Arkansas-Red Basin River Forecast Center. Once the data are received, they are decoded and handled similarly to the DCP data. Informative display of all data is possible by using several versatile computer programs developed for use on the WCDS. Table 5-1 contains a list of automated stream gage and rainfall stations. Detailed instructions on reporting criteria are presented in Exhibit B, Standing Instructions to Lake Manager.

c. Maintenance. Maintenance and repair of stream gages are the responsibility of the administering agency. Both the Corps of Engineers and the USGS have stream-gaging equipment in the Grand (Neosho) River Basin. The Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the responsibility for the equipment placed by the Corps of Engineers.

5-02. Water Quality Stations.

a. Facilities. USGS water quality station #07193500, mentioned in previous manual (1992) was discontinued in 2 Dec 1992. Active USACE sampling locations are shown on Plate 4-3. Water quality monitoring under the Tulsa District Water quality monitoring program occurs on ten (10) year rotations. It is anticipated that Fort Gibson water quality will be sampled in FY16 or FY17. Water quality samples are also taken on an as-needed basis to in response to specific needs and requests.

b. Reporting. Water quality reports will be prepared in accordance with ER 1110-2-8154. Water quality reports are maintained in the Planning Division at the Tulsa District Office.

c. Maintenance. Maintenance and repair of the water quality stations are the responsibility of the Tulsa District and are shown in Table 5-2.

TABLE 5-1

AUTOMATED GAGES

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID	LATITUDE NORTH (Deg Min Sec)	LONGITUDE WEST (Deg Min Sec)
Automated Stream Gages						
Pryor Creek near Pryor, OK	USGS	PRYO	07192000	PYRO2	36 18 27	95 20 50
Spring Creek near Locust Grove, OK	USGS	LOGR	07192100	LCGO2	36 08 54	95 09 30
Big Cabin Creek near Big Cabin, OK	USGS	BCAB	07191000	BGCO2	36 34 06	95 09 06
Arkansas River at Muskogee, OK	USGS	MUSK	07194500	MKGO2	35 46 10	95 17 55
Automated Pool Gages						
Arkansas River at Webbers Falls L&D	USGS	WEBB	07194550	WFLO2	35 33 16	95 10 02
Lake Hudson (Markham Ferry Dam)	USGS	HUDS	07191400	MFDO2	36 13 54	95 11 35
Fort Gibson Lake Dam	USGS	FGIB	07193000	GIBO2	35 52 16	95 13 42
Automated Rainfall Gages						
Arkansas River at Muskogee, OK	USGS	MUSK	07194500	MKGO2	35 46 10	95 17 55
Pryor Creek near Pryor, OK	USGS	PRYO	07192000	PYRO2	36 18 27	95 20 50
Spring Creek near Locust Grove, OK	USGS	LOGR	07192100	LCGO2	36 08 54	95 09 30
Arkansas River at Webbers Falls L&D	USGS	WEBB	07194550	WFLO2	35 33 16	95 10 02
Verdigris River at Newt Graham L&D	USGS	NEWT	07178620	INLO2	36 03 28	95 32 05
Verdigris River at Chouteau L&D	USGS	CHOU	07178660	WAGO2	35 51 56	95 22 13

TABLE 5-1 (continued)

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID	LATITUDE NORTH (Deg Min Sec)	LONGITUDE WEST (Deg Min Sec)
Automated Rainfall Gages (continued)						
Lake Hudson (Markham Ferry Dam)	USGS	HUDS	07191400	MFDO2	36 13 54	95 11 35
Flint Creek near Kansas, OK	USGS	KANS	07196000	KNSO2	36 11 54	94 42 30
Verdigris River near Claremore, OK	USGS	CLAR	07176000	CLRO2	36 18 26	95 41 51
Verdigris River at Oologah Lake Dam	USGS	OOLO	07171300	OOLO2	36 25 18	95 04 42
Arkansas River at Haskell, OK	USGS	HASK	07165570	HSKO2	35 49 22	95 38 38
Illinois River near Tahlequah, OK	USGS	TAHL	07196500	TALO2	35 55 17	94 55 15
Baron Fork River near Eldon, OK	USGS	ELDN	07197000	ELDO2	35 55 16	94 50 18
Illinois River near Chewey, OK	USGS	CHEW	07196090	CWYO2	36 06 15	94 46 57
Caney River near Ramona, OK	USGS	RAMO	07175500	RAMO2	36 30 30	95 50 36
Caney River near Collinsville, OK	USGS	COLL	07175550	CVLO2	36 23 40	95 48 40
Big Cabin Creek near Big Cabin, OK	USGS	BCAB	07191000	BGCO2	36 34 06	95 09 06
Mesonet Gages						
5 miles S of Adair	N/A	POSO2	N/A	POSO2	36 22 08	95 16 16
3.1 miles SSE of Inola	N/A	INSO2	N/A	INSO2	36 08 32	95 27 02
4 miles N of Tahlequah	N/A	TQSO2	N/A	TQSO2	35 58 20	94 59 12
1.8 miles WNW of Claremore	N/A	CLSO2	N/A	CLSO2	36 19 16	95 38 46

TABLE 5-1 (continued)

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID	LATITUDE NORTH (Deg Min Sec)	LONGITUDE WEST (Deg Min Sec)
Mesonet Gages (continued)						
2.5 miles W of Clarksville	N/A	PESO2	N/A	PESO2	35 49 32	95 33 35
5 miles SSE of Haskell	N/A	HSSO2	N/A	HSSO2	35 44 52	95 38 25
7 miles NNW of Marble City	N/A	TKSO2	N/A	TKSO2	35 40 48	94 50 56
5 miles WNW of Westville	N/A	WVSO2	N/A	WVSO2	36 00 39	94 38 41
2 miles NE of Bixby	N/A	BXSO2	N/A	BXSO2	35 57 46	95 51 58
3 miles SE of Delaware	N/A	NTSO2	N/A	NTSO2	36 44 37	95 36 28
4 miles NW of Skiatook	N/A	SKSO2	N/A	SKSO2	36 24 55	96 02 13
7 miles E of Centralia	N/A	VNSO2	N/A	VNSO2	36 46 31	95 13 15
4 miles N of Jay	N/A	JYSO2	N/A	JYSO2	36 28 55	94 46 58

TABLE 5-2

WATER QUALITY STATIONS

Primary Station Code	Location Description	Type	Operating Agency	Reporting or Non-Reporting	Period of Record	Frequency of Analysis	Latitude (North)	Longitude (West)
07193500	Grand (Neosho) River downstream of Ft. Gibson Dam, nr Ft. Gibson, OK	Physical / chemical	USGS	Non-Reporting	1952-1992	As necessary	35 51 10	95 13 44
OKN0003	Thalweg at dam buoy line	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	35 52 13	95 13 49
OKN0004	Thalweg in 14-mile creek arm near the Wildwood Park boat ramp	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	35 54 55	95 13 43
OKN0005	Thalweg at mouth of Long Bay	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	35 57 51	95 18 02
OKN0006	Thalweg at mouth of Flat Rock Creek	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	36 02 12	95 18 50
OKN0007	Thalweg at mouth of Spring Creek	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	36 06 48	95 15 27
OKN0008	Thalweg at highway 412 bridge	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	36 10 36	95 16 32
OKN0009	Thalweg downstream of low-water dam	Physical / chemical	USACE	Non-Reporting	1979-present	10 years or As Needed	36 12 49	95 14 43

5-03. Sediment Stations.

a. Facilities. The Corps has established 34 sedimentation ranges upstream of Fort Gibson Dam and 8 degradation ranges downstream of Fort Gibson Dam to be used for sedimentation measurements. These ranges are surveyed periodically to compute sediment deposition and new lake area/capacity data. The ranges are shown on Plates 2-4 and 2-5.

b. Reporting. Sediment survey updates that have occurred since the original survey that was completed in 1941 are 1949 and 1950.

c. Maintenance. Maintenance on the sediment ranges is performed by the Tulsa District.

5-04. Recording Hydrologic Data. Hydrologic information is recorded as it is received by the Water Management Section as follows:

a. Stages and Discharges. The raw data that the Water Management computer retrieves from the central computer are stored as they are received. These raw data are then sorted by station and stored again. Several computer programs convert the raw data into stage/pool elevation data and the corresponding flow/storage values as determined from rating curves. These processed data are then stored in two databases. To prevent the databases from filling, they are periodically archived on tape for permanent storage. Stream flow measurements made by the USGS are reported to the Hydrology and Hydraulics Section. The measurements are entered into the database for storage.

b. Precipitation. Precipitation data from the DCP stations and the project are combined with NWS observer precipitation data that can then be used by computer programs for plotting distribution, determining basin rainfall, and forecasting runoff (see Section VI).

c. Water Quality Data. Water quality data have not been recorded with regularity for Fort Gibson Lake.

5-05. Communication Network. Wire facilities at the Fort Gibson Lake Project Office consist of local and long-distance telephone service. Radio communication is by a VHF-FM fixed station (call signal WUI-316) capable of reaching local mobile stations, the Tulsa District, stations on the local loop of the District and other stations on the north and south loop of the District via repeater relay. Maintenance of the telephone lines is the responsibility of the company leasing the lines to the Government. The District radio technician makes quarterly inspections of the project's fixed equipment and makes repairs as conditions warrant. To alert the public of impending gate changes, warning horns are located on the conduit gate tower, on the downstream end of the conduit, and on the spillway. Control buttons for these devices are found on the gate control panels.

5-06. Communication with Project.

a. Water Management Section with Project Office. Instructions for the storage and release of water from the lake will be communicated by the Water Management Section to the responsible project operating personnel for the implementation of the provisions set forth in Section IX of this manual. This communication will normally be made by telephone, but could on occasion be made by VHF-FM radio, call sign WUI-316. The reports by the project office, described in paragraph 5-07. and Exhibit B of this manual, will be communicated directly to the Water Management Section. Should communication between the project and the District Office be disrupted, the Lake Manager will, on his own initiative, direct regulation of the lake according to emergency regulations as required in Section VII and Exhibit B of this manual. A chart, "Organization For Flood Control Regulation" is shown on Plate 5-2.

b. Between Project Office and Others. Communications between project personnel and other Federal, State, and local agencies will be sufficient to facilitate the coordination described in Section IX of this manual.

5-07. Project Reporting Instructions. Hydrologic data items affecting release of water, confirmation of change in releases as instructed, complaints, operating machinery failure, or out-of service times for maintenance shall be reported to the Water Management Section as they occur.

The following data should be included in the daily report to the Water Management Section from all flood control storage projects with hydropower. Data are typically reported by telephone, fax, or email. Data collected will be reviewed and input into the Water Management Section's data base before 10 a.m. and published to the lake data morning report located at http://www.swt-wc.usace.army.mil/old_resvrept.htm by 10 a.m. See Plate 5-3 for lake data reporting details.

a. As of 8 a.m. Each Weekday.

1) Pool elevations at 12 noon, 4 p.m., and 12 midnight of the previous day and the current 8 a.m. pool elevation and tailwater elevation (if available).

2) The total precipitation amounts for the previous 24-hour period (7 a.m. to 7 a.m. time period).

3) The current wind direction and wind speed (Beaufort scale).

4) Water supply withdrawal or release for previous day (if available).

5) The average power discharge in day second feet (d.s.f.) for the previous 24-hour period (midnight to midnight).

6) The net power generation in megawatt-hours (mWh) for the previous 24-hour period (midnight to midnight.)

7) The total discharge in d.s.f. for the previous 24-hour period (midnight to midnight).

8) The 8 a.m. instantaneous power discharge in c.f.s.

9) The 8 a.m. instantaneous total discharge in c.f.s.

10) The total hourly discharge in c.f.s for the previous 24-hour period (midnight to midnight).

11) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation (and tailwater elevation if necessary) when the change was made.

b. As of 8 a.m. Each Monday.

1) The same data from the weekend as required in 5-07.a. above.

2) The current pool elevation readings from the pool gage, the recording chart or tape, the shaft encoder or data logger, and the wire weight or staff gage. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

c. Weekends and Holidays.

1) Daily reports are not required to be submitted on weekends and holidays except during flood periods.

d. During Flood Periods.

1) During flood periods, weekend and holiday reports should include the same data as required in 5-07.a. above as well as the 8 a.m. pool elevation from the pool gage.

2) In addition to the data in 5-07.a., 5-07.b., and 5-07.c. above, additional reports of lake elevations may be requested by Water Management Section personnel.

5-08. Warnings. It is the responsibility of the Lake Manager to initiate a warning to the Tulsa District and local law enforcement agencies if emergency situations develop. He/she has the responsibility to properly recognize emergency situations and to seek assistance from supervisory offices, if time permits. They must be knowledgeable of

conditions that constitute an emergency such as a dam failure possibility. The downstream population should be notified as early as possible of a potential problem. Initial notification by project personnel will include (listed by priority), Chief of Operations, Chief of Operations Technical Support, Chief of Engineering and Construction, Chief of Emergency Management, as set forth in the Operations and Maintenance Manual Volume II, Fort Gibson Lake, Flood Emergency Plan, dated 28 Jul 2011. The Fort Gibson Lake project personnel have compiled a list of downstream contacts for use in emergency situations.

5-09. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. The initial transition to flood releases or vice versa may require gate changes every hour. When floodwater has significantly risen into the flood control pool, gate changes can be expected two or more times daily. Only under the most unusual circumstances will changes be ordered more frequently than once every two (2) hours. Frequency of gate changes during low flow operations will generally be less than once a day.

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are necessary in predicting stream flow upstream and downstream of Fort Gibson Lake to determine if and when releases should be made.

a. Role of Corps of Engineers. Hydrologic forecasts are made by the Water Management Section, Tulsa District, for use in the regulation of lakes for flood control and other authorized purposes and for the benefit of Corps of Engineers' construction projects and flood control activities. As distinguished from the NWS, who furnishes weather and flood forecasts to the public, the Tulsa District furnishes information on current and forecasted lake levels and lake releases, along with technical advice. The Water Management Section (lake levels recording), telephone number (918) 669-7521, is listed in the Tulsa telephone directory to provide the public a means of obtaining current lake information, such as pool levels and discharges. General news releases are made by the Public Affairs Office which is kept fully informed of the hydrologic situation as appropriate. Further discussion of the role of the Corps of Engineers in hydrologic forecasts is presented in Section V of the Arkansas River Basin Water Control Master Manual.

b. Role of Other Agencies. The NWS, Tulsa, Oklahoma, is the official agency making flood forecast information available to the public. This information is distributed by the NWS Automation of Field Operations and Services (AFOS) network to subscribing government agencies and the various news media. The NWS issues routine scheduled reports containing the following forecasts:

(1) Weather forecasts (daily, severe weather, and 5-day extended).

(2) National weather summaries and additional details for the five south-central states (four times daily).

(3) Quantitative precipitation forecasts (four times daily – one 24-hour and one 48-hour quantitative precipitation forecast and two 6-hour quantitative precipitation forecasts).

(4) Three-day river stage forecasts (when available).

(5) Rainfall required to produce bank full stages (weekly).

(6) Urgent priority messages such as severe weather warnings, watches, forecasts and statements, and instructions from Civil Defense during emergency conditions are transmitted immediately, regardless of scheduled traffic. Unscheduled traffic, including the following, is sent when appropriate.

(a) Damage reports.
(b) Road information and winter weather conditions.
(c) River and flood warning bulletins, forecasts, and statements.
(d) Thirty-day forecast.

(7) Percent chance of precipitation (twice daily).

6-02. Flood Conditions Forecasts.

a. Requirements. Flood condition forecasts are necessary whenever substantial rainfall has occurred on the basin upstream or downstream of Fort Gibson Dam. Personnel in the Water Management Section have developed a flood-forecasting model for Fort Gibson Lake. This model was calibrated to historical flood events. Basin subdivisions contained in the forecasting model are presented on Plate 6-1. To use this model the following data are required:

(1) Rainfall for stations listed in Table 5-1.

(2) Fort Gibson Lake pool elevation for time of forecast.

(3) Flood hydrographs for gages listed in Table 5-1.

(4) Releases from Fort Gibson Lake, including projected releases, from time of forecast until the end of the forecast period.

b. Methods. Inflow forecasts are made using a slightly modified HEC-1 computer program. Precipitation data are received from the NWS observers, the DCPs by the water control computer, the Oklahoma Mesonet, and also the NWS Stage III digital radar. The average precipitation over the project basin is computed by a computer program called VIEWRAIN. The VIEWRAIN program takes the DCP data and plots isohyetal maps of 24-hour rainfall. The VIEWRAIN program also computes the basin and subbasin average rainfalls for input into the HEC-1 forecasting model. The HEC-1 program uses the hourly DCP rainfalls to distribute the subbasin average rainfalls. Beginning loss rates are chosen based upon historical storm reproductions. Rainfall excess is computed by subtracting the applicable losses from the incremental rainfall amounts. One-hour unit hydrographs are computed using Snyder's coefficients or are entered directly into the data file for each subarea. Flood hydrographs are computed by applying the rainfall excess to the unit hydrographs. Computed flood hydrographs are compared with observed flood hydrographs for gages listed in Table 5-1. Loss rates are adjusted and the HEC-1 model is rerun until the computed and observed hydrographs converge. Calibrated loss rates are applied to un-gaged subareas and flood hydrographs are combined and routed to compute an inflow hydrograph. Using projected releases from Fort Gibson Lake, the inflow hydrograph is routed through the lake to determine elevations. Flood control releases are projected based upon conditions on the Arkansas River System and following procedures described in section

V of the Arkansas River Basin Water Control Master Manual. The unit hydrograph for the area downstream of Lake Hudson is presented on Plate 6-2. A sample inflow computation is shown on Plate 6-3.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be requested by Project personnel to predict pool levels during fish spawning season, special recreation events, and water supply. Forecasts may also be requested for water quality.

b. Methods. Forecasts for conservation purposes during non-flood periods would rely largely on statistical interpretation of historical data. The flow duration curve, Plate 4-2, and the peak inflow probability curve, Plate 4-3, would be considered with NWS forecasts in making conservation forecasts during non-flood periods.

6-04. Long-Range Forecasts.

a. Requirements. The regulatory decision involved in evacuating stored floodwater, sustaining yield during low flow periods, and maintaining constant or slowly changing pool levels for conservation purposes is dependent on accurate estimates of the water volume that will pass through the lake.

b. Methods. Reliable methods for long range runoff forecasts are not presently available. The NWS publishes an "Average Monthly Weather Outlook" semi-monthly, which may be used as an estimate of the trend of the weather but should not be given too much weight for one forecast, especially for a specific point. The NWS forecasts described in paragraph 6-01.b. are more useful in a shorter range.

6-05. Drought Forecasts. Droughts can be forecast when runoff is dependent upon snowmelt by measuring snow pack in the mountains. However, on projects where runoff is a result of a rainfall event, as in the Tulsa District, no techniques are available at this time to forecast droughts.

VII – WATER CONTROL PLAN

7-01. General Objectives. The primary objectives of the Fort Gibson Lake project are flood control, hydropower and navigation. Fort Gibson Lake will be operated as a unit in a multiple-purpose system for optimal flood control providing benefits on the Grand (Neosho) and Arkansas River basins. Flood releases from Fort Gibson Lake will be made in accordance with the predicted runoff from the uncontrolled area downstream, the allowable stage for the downstream control points, the predicted volume of inflow into the lake, and the proportion of available storage remaining in the various lakes in the system. All of the flood control storage will be used to provide optimal benefits, categorized as method A in paragraph 3-3c(2)(b) of EM1110-02-3600, dated 30 Nov 1987.

7-02. Major Constraints. The channel capacity immediately downstream from the Fort Gibson Dam is about 100,000 c.f.s. During times of high flow on the Arkansas River, which causes a backwater effect on the Grand (Neosho) River, channel capacity is reduced to about 70,000 c.f.s. The capacity of the spillway and sluices at the top of flood control pool (elevation 582.0 feet) is 981,930 c.f.s. The invert of the sluices is at elevation 502.0 feet, which is the lowest elevation water can be released from the dam. A major constraint is to monitor the recession of the flood waters on the Grand (Neosho) River downstream of Fort Gibson Dam and the Arkansas River so as to coincide releases from the dam with the natural recession of the rivers to below bank full. The limiting non-damaging flow on the Arkansas River just downstream of the mouth of the Grand (Neosho) River at Muskogee, Oklahoma, is about 120,000 c.f.s. (stage of 28.0 feet). Limiting non-damaging flow at Van Buren, Arkansas, is about 150,000 c.f.s. (stage of 22.0 feet). Another operating constraint is that no surcharge storage is available in the lake.

7-03. Overall Plan for Water Control.

a. General. Fort Gibson Lake is regulated as a unit in a multipurpose system for the benefit of water resources in the Arkansas River basin. Development of these water resources is discussed in the Arkansas River Basin Water Control Master Manual, while the specific purposes of each of the various projects are detailed in the appropriate Exhibit.

b. System Regulation. Fort Gibson Lake is regulated in a system with Grand Lake (Pensacola Dam) and with Lake Hudson (Markham Ferry) for control of floods on the Grand (Neosho) River downstream from the Fort Gibson Dam and in the total Arkansas River system for control of floods on the Arkansas River to Van Buren, Arkansas. When the floodwaters are being accumulated in the system, each lake shall be regulated to retain equivalent flood control capabilities, as much as possible, with priority for releases, as shown on curve "C" Plate 7-57 of the Arkansas River Basin Water Control Master Manual, given to the lake with the least amount of flood storage available and considering predicted inflow into the lake and conditions downstream. Section 7 of the Arkansas River Basin Water Control Master Manual provides detailed

information on the Arkansas River System operation. This essentially means that Fort Gibson Lake can make flood releases when the system has available channel capacity. In addition, Fort Gibson Lake is regulated for fish and wildlife, navigation and hydropower. The project is regulated to obtain maximum benefits downstream of the project.

c. Grand Lake, Lake Hudson, and Fort Gibson Lake Subsystem Regulations. The system regulation plan discussed in the previous paragraph is used in determining a release schedule for Fort Gibson Lake. This release schedule is then used as the evacuation rate for the total flood control storage (storage volume plus inflow) in Grand Lake (Pensacola Dam), Lake Hudson (Markham Ferry Dam), and Fort Gibson Lake. Once the release schedule for Fort Gibson is set as described above, a release schedule for Lake Hudson and Grand Lake would be determined that will strive to equalize the flood control storage in the three projects. The releases as determined by the Arkansas River System regulation for Fort Gibson Lake is not reduced solely to achieve a balance among the three lakes. When a reasonable subsystem balance is achieved, releases from Lake Hudson and Grand Lake are at a rate which will continue the balance and empty the subsystem at approximately the same time.

7-04. Standing Instructions to Lake Manager. During flood periods the lake is regulated in accordance with the normal regulations for flood control operations as directed in subparagraph 7-05.a. and Exhibit B of this manual. Instructions for the storage and discharge of floodwater will be issued by the Water Management Section. In the event communication with the Tulsa District is disrupted, the lake regulation will become the responsibility of the Lake Manager and will be regulated in accordance with subparagraph 7-05.b. and Exhibit B of this manual. In addition, the Lake Manager will immediately make every effort to re-establish communications with the Tulsa District. The Lake Manager will make daily observations of the weather station and pool level data and report those observations as directed in paragraph 5-07. and repeated in Exhibit B. Should an emergency situation occur, in which communication is not lost, such as inoperable gates, a drowning accident, excessive trash in gates, a broken buoy line, or power outage, the Water Management Section will be notified immediately.

7-05. Flood Control.

a. Normal Flood Control Regulations. Fort Gibson Lake will be regulated for optimal flood reductions on the Grand (Neosho) River from the dam to its confluence with Arkansas River and from that point in conjunction with flood control releases from Keystone Lake and other systems on the Arkansas River. The regulations as shown in Table 7-1 will govern releases from Fort Gibson Lake. During flood control regulation the spillway gates generally are operated in a uniform setting with no more than 1 foot difference in opening of the gates within each segment of stilling basin. Generally, a difference of 2 feet in gate opening is allowed between one set of gates within a segment of the stilling basin and the adjacent set of gates and stilling basin.

TABLE 7-1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
554.0 – 582.0 & forecasted not to exceed 582.0	Rising	Releases will not exceed 100,000 c.f.s. downstream of the dam, or that flow which when combined with intervening flow downstream shall not exceed a 22-foot stage at the Van Buren Gage unless superseded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual. Releases will be made in such a manner as to balance, as much as practical the percentage of the flood control storage used in Grand Lake, Lake Hudson, and Fort Gibson Lake.
554.0 – 582.0 & forecasted to exceed 582.0	Rising	Releases will be made to reduce as much as practical the flood damage downstream of the dam and to limit the pool elevation to 582.0 feet. Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter, may be used as a guide to determine releases.
582.0 or above	Rising	Spillway gates will be operated to maintain the pool at elevation 582.0 feet, or until all the gates are fully open.
582.0 or above	Falling	The maximum gate opening attained shall be held until the pool recedes to elevation 582.0 feet.
582.0 – 554.0	Falling	Releases will not exceed 100,000 c.f.s. and will be made in such a manner as to balance, as much as practical, the percent of flood control storage utilized in the 3-lake system. Evacuation of the flood control storage in this system will be governed by the provisions of Chapter 7 of the Arkansas River Basin Water Control Master Manual.

b. Emergency Flood Control Regulations. When communication with the Tulsa District is disrupted, the Lake Manager will, on his or her own initiative, direct regulation of the lake in accordance with the schedule shown in Table 7-2 until communication is restored. In addition, the Lake Manager will make every effort to re-establish communication with the Tulsa District. The spillway gates will be operated at a uniform opening as discussed in paragraph 7-05.a.

c. Constraints. The regulation schedules provide that the channel capacity of 100,000 c.f.s. immediately downstream of the dam is not to be exceeded insofar as practicable. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossings and low-lying farmland. The significance of the stages or discharges is shown on the curves at the control point (see Plate 4-6).

d. Operational Curves. The "Spillway Gate Regulation Schedule - Inflow Parameter" is shown on Plate 7-1. The "Inflow vs. Rate-of-Rise Nomograph" is shown on Plate 7-2. The spillway rating curves for partial and full gate openings (one gate) are shown on Plate 7-3. The sluice rating curves are shown on Plate 7-4. The tail-water rating curve is shown on Plate 7-5. The evaporation curves are shown on Plate 7-6. Elevation versus area and capacity data are compiled in Table 7-3, shown in the Supplemental Tables Section. The Elevation vs. Area and Capacity curves are shown on Plate 7-7. Rating curves used by the Water Management Section are adjusted for changing conditions and are maintained in current status.

7-06. Recreation. Although recreation was not included as an authorized project purpose, there are several recreation areas, and it is considered a project purpose even if not authorized. There is no storage or releases specifically designated for recreation. Requests for special releases will be considered as the situation warrants. When special releases would impact the conservation pool, the request will be coordinated with SWPA. All recreation area access roads are constructed above the top of the conservation pool, elevation 554.0 feet. The access roads begin to be affected by flood waters at elevation 557.0 feet. Most recreation area access roads are impassable when the pool reaches elevation 560 feet. Camping and picnic areas begin to be affected at elevation 558.0 feet. At elevation 560.0 feet, all camping and picnic areas are affected by high water. Some private access roads are also affected by high water. Oklahoma State Highway 80 is closed at elevation 560.0 feet, affecting traffic from Hulbert and the dam site to the east side of the lake. Locations of the public use facilities are outlined in paragraph 2-06. of this manual and shown on Plate 2-7. Recreational features at the project include camping, picnicking, and swimming, boating, hiking and fishing.

7-07. Water Quality.

a. General. Fort Gibson Lake has no storage allocated to water quality. However, small, temporary water quality releases will be made as needed to respond to low dissolved oxygen problems downstream, which usually occur in summer.

TABLE 7-2

EMERGENCY FLOOD CONTROL
REGULATION SCHEDULE FOR FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA

LAKE STAGE	POOL CONDITIONS	REGULATION
554.0 – 582.0	Rising	Maintain current releases until communication is restored or 12 hours have elapsed. If communication is not restored after 12 hours or the pool rises to elevation 577.0 feet during the 12 hour waiting period, begin releases in accordance with Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter. Releases shall be adjusted every 2 hours using the previous 6-hour time interval to compute the inflow. Plate 6-3 shows a sample inflow computation, and Plate 7-2 is a nomograph for computing inflow. At no time shall releases be reduced if the pool is rising. If the pool is above 577.0 feet, the releases shall not be less than indicated by the minimum discharge curve on Plate 7-1.
582.0 or above	Rising	Spillway gates will be opened as necessary to maintain the pool at elevation 582.0 feet, or until all the gates are fully opened.
582.0 or above	Falling	The maximum gate opening attained shall be held until the pool recedes to elevation 582.0 feet.
582.0 – 577.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 100,000 c.f.s. whichever is greater.
577.0 – 571.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 60,000 c.f.s. whichever is greater.
571.0 – 564.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 40,000 c.f.s. whichever is greater.

TABLE 7-2 (continued)

LAKE STAGE	POOL CONDITIONS	REGULATION
564.0 – 554.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 20,000 c.f.s. whichever is greater.
Near 554.0	Falling	Releases shall be gradually reduced to equal inflow by the time the pool recedes to elevation 554.0 feet.

b. Present Regulation Procedure for Water Quality. Except for emergencies, water quality and water supply releases shall not be made that will reduce the pool elevation in Fort Gibson Lake below elevation 554.0 feet. Additional releases shall be made as necessary to alleviate or respond to emergency conditions such as fish kills and flow augmentation for pollution abatement or aesthetics.

7-08. Fish and Wildlife. Fish and wildlife is included as an authorized project purpose pursuant to Public Law 85-624; however, no storage or releases are specifically provided in the project. However, low flow releases are occasionally made on an "as-needed" basis as described in paragraph, 7-07. to the benefit of fish and wildlife. Management of the fish and wildlife resources will be under the direction of the Oklahoma Department of Wildlife Conservation.

7-09. Water Supply.

a. General. Water supply is not a project purpose. Therefore, Fort Gibson Lake does not have water supply storage. However, several entities purchase water from the Grand River Dam Authority (GRDA). Storage for these water supply purchases resides upstream in Pensacola and Markham Ferry Reservoirs. Cherokee County Rural Water Districts (RWD) No.1, No. 3 and No. 9 have contracted for a water volume not to exceed 394.0 million gallons per year. Cherokee RWD No. 11 (formerly Lost City Water Company) has contracted for a water volume not to exceed 800,000 gallons per day (g.p.d.). Wagoner County RWDs No. 1, No. 2, No. 7 and No. 9 have contracted for a water volume not to exceed 59.01 million gallons per month. Hulbert Public Works Authority has contracted for a water volume not to exceed 12.2 million gallons per month. Tri-B Nursery in Tahlequah, Oklahoma, has been granted water supply not to exceed 5.4 million gallons per month. Sugar Tree Nursery has been granted 1 million gallons per month. Lake Crest Property Owners Association has contracted for water volume not to exceed 50,000 g.p.d. (however, they do not take water). Beggs Water Company has contracted for water supply not to exceed 15 million gallons per month. The Oklahoma Ordnance Works Authority has contracted for the maximum volume per

volume per day which can be passed through the 48” water line plus 20 million gallons per day (m.g.d.). The town of Fort Gibson is granted water supply not to exceed 1.543 c.f.s. The City of Muskogee water supply releases (not to exceed 5 c.f.s.) are made through the 48" diameter pipe located through the right abutment of the spillway. This supply point replaces a previous supply point downstream of the dam which is now inundated by the navigation system. The City of Wagoner has been granted water supply not to exceed 2 c.f.s.

b. Regulation Procedure for Water Supply. Withdrawals for municipal and industrial water supply can be made from the lake or released through a 48-inch water supply pipe. Water withdrawal from storage will be metered and read by the User and reported to the Water Supply Specialist by the 5th day of the month following usage.

c. Accounting Procedure for Water Supply. Accounting procedures for conservation storage in multipurpose projects have been developed by Tulsa District and approved by the Southwestern Division (SWD) to regulate the withdrawal of water from lakes by each water supply user. No accounting is necessary where all conservation storage is contracted for by one user or when the Corps is not the contracting agency. In this case, GRDA administers water supply contracts for the entire Grand (Neosho) River basin and bears responsibility for water supply storage.

7-10. Water Rights.

a. General. The Oklahoma Legislature has judicially vested water rights of 1.543 c.f.s. to the town of Fort Gibson, Oklahoma; 2.0 c.f.s. to the City of Wagoner, Oklahoma; and 5.0 c.f.s. to the City of Muskogee, Oklahoma. The Oklahoma Water Resources (OWRB) has not issued water rights on the Grand (Neosho) River downstream of Fort Gibson Lake. However, there are water rights holders downstream on the Arkansas River in the amount of 264,844 acre-feet/year. Table 7-4, located in the Supplemental Tables Section, lists the active water rights holders on the Arkansas River, between the Grand (Neosho) River confluence and the Oklahoma/Arkansas state border.

b. Regulation Procedure for Water Rights. Releases from inflow to satisfy downstream water rights will be made at the request of the OWRB. The OWRB will inform the Water Management Section as to the amount and time distribution of the required release. No withdrawal from storage in the lake will be made for downstream water rights.

7-11. Hydroelectric Power. The storage in Fort Gibson Lake between elevations 551.0 feet and 554.0 feet has been authorized for hydroelectric power generation. Fort Gibson Dam has four 11,250 kW generators for a total nameplate capacity of 45,000 kW. The discharge from the four turbines at full power is about 10,900 c.f.s. at elevation 554.0 feet. The turbines are used in conjunction with the spillway and outlet works for flood control releases. Flood control releases of 10,900 c.f.s. or less are made through the turbines, if operable. When above elevation 554.0 feet, the Water Management Section will notify Southwester Power Administration of the daily outflow volume

required through the turbine. The release of water from the power pondage (below elevation 554.0 feet) will be for the production of hydroelectric power as required by Southwester Power Administration.

7-12. Navigation. Fort Gibson Lake is regulated for flood control in conjunction with the other lakes in the navigation system to help provide a tapered recession of flows along the Arkansas River navigation channel. The coordinated regulation of the lake is discussed in Chapter 7 of the Arkansas River Basin Water Control Master Manual (updated in 2007).

7-13. Sedimentation. There are no regulation procedures for sediment at this time.

7-14. Drought Contingency Plans. The Drought Contingency Plan for the Lower Grand River, including Fort Gibson Lake, updated 31 Jan 2005, was prepared by the Water Management Section.

7-15. Flood Emergency Action Plans. A Flood Emergency Action Plan is outlined in the document "Operation and Maintenance Manual, Volume II, Fort Gibson Lake, Flood Emergency Plan, Updated 28 Jul 2011. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life as a result of uncontrolled releases of water due to failure, or severe damage to the dam appurtenant works.

7-16. Deviation From Normal Flood Control Regulation. Deviation from normal flood control regulation of the lake is occasionally necessary. Prior approval for a deviation is obtained from SWD, except as noted in subparagraph 7-16.a. shown below. Deviation requests fall into the following categories:

a. Emergencies. The water control plan is subject to temporary modification by the Corps if found necessary in time of emergency. Request for and actions on such modifications may be made by the fastest means of communication available. Also, the Lake Manager may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to avoid serious hazards. The Lake Manager may deviate from the water control plan whenever necessary to protect the safety of the dam. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing as soon as possible to the Water Management Section and shall include justification for the action. Continuation of the deviation will require the express approval of SWD. A written confirmation showing the deviation and conditions will be furnished by the Water Management Section to SWD.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulations of the lake, although they are not considered emergencies. Construction accounts for the major portion of the incidents and include utility stream crossings, bridge work, and major construction contracts. Changes in releases are sometimes necessary for maintenance and inspec-

tion. Requests for changes of release rates are generally from a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions of the lakes, and possible alternative measures. In the interest of maintaining good public relations, the requests are complied with providing there are no adverse effects on the overall operation of the project (or projects) for the authorized purposes. Approval for these minor deviations will normally be obtained by the Water Management Section from SWD by telephone or email. SWD is normally advised by telephone of these minor deviations with written follow-up to confirm the deviation.

c. Unplanned Major Deviations. There are unplanned instances that create a temporary need for major deviations from the normal regulation plan and may be considered, but are not, emergencies. Flood control releases account for the major portion of these incidents and typical examples include project pre-releases or exceeding downstream channel capacity, incidents that have a short window of opportunity in an effort to minimize damages or optimize benefits. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. Each request is analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to upstream watershed conditions, potential flood threat, and condition of the lake, and alternative measures that can be taken. Approval for these major deviations normally will be obtained from SWD by telephone or email. Written confirmation explaining the deviation and its cause will be furnished to the Division water control manager.

d. Planned Deviations. Advance approval of SWD is required prior to any deviation from the plan of regulation prescribed or approved by the Corps in the interest of flood control, except in emergency conditions provided for in subparagraph 7-16.a. Each condition will be analyzed on its own merits. When conditions appear to warrant a prolonged deviation from the approved plan, the Water Management Section will investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigation and evaluations have been conducted to the extent deemed necessary by the SWD water control manager.

7-17. Rate of Release Change. The increase and decrease in releases from the lake shall be accomplished in a manner which minimizes damage to the lake area and downstream channel as shown in Table 7-5. Every reasonable precaution will be made to eliminate, if possible, bank sloughing, undercutting, excessive erosion, and danger to human and animal lives. Situations will arise which will not allow an orderly increase and/or decrease in releases. Examples of these situations are the making of large flood releases as described in paragraph 7-05., and drowning which may occur downstream of the dam.

TABLE 7-5

RELEASE RATE CHANGES
INCREASING RELEASES TO CHANNEL CAPACITY [1]

Current Release Range (c.f.s.)	Maximum Increase (c.f.s.)	Minimum Time Between Changes (hours)
0 – 100,000	15,000	2

DECREASING RELEASES BELOW CHANNEL CAPACITY [1]

Current Release Range (c.f.s.)	Maximum Decrease (c.f.s.)	Minimum Time Between Changes (hours)
100,000 - 0	15,000	2

[1] See paragraph 7-05.a. for releases that will exceed channel capacity and also decrease in releases above channel capacity

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The effects of emergency flood control regulations (communication between Tulsa District and the Fort Gibson Project Office is disrupted) on the Spillway Design Flood and the Standard Project Flood and examples of the normal and emergency regulations of a historical major flood are presented in the following paragraphs. The floods were selected to show the effects of the flood control regulations for Fort Gibson Lake on a variety of possible flood conditions.

8-02. Flood Control.

a. Probable Maximum Flood. The Probable Maximum Storm (PMS) was centered over the drainage basin to be critical for Grand Lake (Pensacola Dam). This was done to achieve consistency of the Probable Maximum Flood (PMF) for lakes located in the lower Grand (Neosho) River system that include: Grand Lake (Pensacola Dam), Lake Hudson (Markham Ferry Dam), and Fort Gibson Lake. The PMF was generated by applying the Probable Maximum Precipitation (PMP) from Hydrometeorological Report No. 52 to a HEC-1 hydrologic runoff model that combines the Fort Gibson Lake intervening drainage area and the Lake Hudson intervening drainage area. Releases from Pensacola Dam were input, combined with the intervening area runoff and operated through the system. When the beginning elevations of Fort Gibson, Lake Hudson, and Grand Lake were at top of conservation pool, the flood volume at Fort Gibson was 3,352,000 acre-feet with a peak inflow of 613,000 c.f.s. With starting elevations at the top of the flood control pool, the volume was 4,148,000 acre-feet, and the peak inflow was 645,000 c.f.s. (these volumes are accurate for the span of time covered by the operational hydrographs and do not represent total flood volume.) Fort Gibson Lake was operated under normal regulations until 12 hours prior to the peak inflow. Beginning at this time increment, emergency regulations were used. When routed through the lake on a full flood control pool the resulting maximum release was 645,000 c.f.s. and the maximum pool elevation was 582.0 feet. Plate 8-1 shows the operational hydrographs for the PMF routed through Fort Gibson Lake by emergency regulations on both an empty and full flood control pool.

b. Spillway Design Flood. The Spillway Design Flood (SDF) was developed during the original design of the project. The flood was based upon an average rainfall of 10.6 inches occurring in 72 hours over the Grand River basin. Operation of Grand Lake (Pensacola Dam) and Lake Hudson (Markham Ferry Dam) was such that the peak inflows were intensified. The flood has a volume of 5,022,000 AF with a peak inflow of 926,000 c.f.s. The flood was routed through Fort Gibson Lake on full and empty flood control pools using emergency regulations. The full pool regulation resulted in a maximum discharge of 925,000 c.f.s. and a maximum pool elevation of 582.0 feet. Plate 8-2 shows the operational hydrographs for this flood routed by emergency regulations on both an empty and full flood control pool.

c. Standard Project Flood. The Standard Project Flood (SPF) was considered to be one half of the SDF. The resulting flood has a volume of 2,511,000 acre-feet with a peak inflow of 463,000 c.f.s. The flood was routed through Fort Gibson Lake on full and empty flood control pools using emergency regulations. The full pool regulation resulted in a peak discharge of 462,000 c.f.s. at the peak pool elevation of 582.0 feet. Plate 8-3 shows the operational hydrographs for this flood routed by emergency regulations on both an empty and full flood control pool.

d. Flood of Sep - Oct 1986. This flood was the result of a stalled cold front followed by the remnants of a hurricane that resulted in an intervening area basin average rainfall of 9.53 inches from 27 Sep to 2 Oct 1986. The inflow came in two peaks, the first on 1 Oct at 280,000 c.f.s. with no releases being made. The second peak occurred on 5 Oct with an inflow of 142,000 c.f.s. The flood had a volume of 4,567,000 acre-feet and the peak release was 122,700 c.f.s., with a peak pool elevation of 582.02 feet. This flood is the flood of record for the Fort Gibson Lake drainage basin. The flood was routed through Fort Gibson Lake using emergency regulations and assuming that Grand Lake (Pensacola Dam) and Lake Hudson (Markham Ferry Dam) were also operated using emergency regulations. The result was a peak discharge of 137,000 c.f.s. at a peak pool elevation of 582.0 feet. Plate 8-4 shows the operational hydrographs for Fort Gibson Lake for both actual and emergency regulations.

8-03. Recreation Twenty-six (26) public use areas have been developed around the lake. Some access roads and beaches start being inundated at elevation 557.0 feet and by elevation 559.0 feet picnic sites, camping sites and parking lots become flooded.

8-04. Water Quality. Water quality releases are made as needed to respond to low dissolved oxygen problems downstream, which usually occur during the summer.

8-05. Fish and Wildlife. Fort Gibson Lake replaced the existing stream fishery with an improved reservoir-type fishery. The impoundment provides an excellent fishery and, being located in a scenic area, attracts fishermen from a widespread area. The downstream fishery is improved by releases from the lake. Minimum releases required for water quality also aid the downstream fishery in periods of low flow. Waterfowl habitat has increased and the lake provides hunting opportunities for these species. There have been some losses of squirrel and deer habitat. However, because of the vast acreage of these habitat types in the general area, the minor loss does not have significant effect on the hunting of these species in the area. The lake provides a greater diversification of fish and wildlife habitat and specific losses are replaced by wildlife management of the lake perimeter lands.

8-06. Water Supply. Water supply is not a project purpose, however several entities purchase water from GRDA. The quality of water in the Grand (Neosho) River is considered good, requiring only conventional treatment to be suitable for domestic and industrial use. While the water supply outlet is in the right abutment of the Fort Gibson

dam, the storage for the water supply agreements reside with GRDA in Markham Ferry and Pensacola reservoirs, and therefore water supply releases have no major effects on Fort Gibson Lake.

8-07. Hydroelectric Power. During normal operations, releases will be made primarily through the turbines to maintain the pool at elevation 554.0 feet. The conservation storage from elevation 551.0 feet to 554.0 feet is allocated to hydroelectric power generation. The generation of power during hot, dry periods will not typically draw the pool significantly below the top of the conservation pool (elevation 554.0 feet), since the power generation is essentially run-of-river.

8-08. Navigation. The coordination of releases from Fort Gibson Lake with other lakes (discussed in Chapter VII of the Arkansas River Basin Water Control Master Manual) will significantly benefit navigation along the Kerr-McClellan Navigation system by providing a tapered recession of flows along the system. The controlled recession will enable navigation to continue while shoals are removed from the navigation channel. Another benefit from Fort Gibson Lake is sediment storage that will reduce the incidence of shoaling in the navigation system.

8-09. Frequencies.

a. Peak Inflow Probability. Estimated natural flows taken from RIVERWARE run 2011-01 at the dam site for the period Jan 1940 through Dec 2008 were used to compute the maximum annual peak inflow probability. The inflow probability was derived in accordance with Bulletin 17B, "Guidelines for Determining Flood Flow Frequency," dated Sep 1981, with SWD requirements as stated in DF dated 22 Aug 1979. The peak inflow probability curve is shown on Plate 8-5.

b. Pool Elevation Duration and Probability. The pool elevation hydrographs resulting from the Arkansas River system routing of the computed flows at the dam site were used to compute maximum and minimum annual pool elevations which were converted to partial duration series. The computations were made using the general procedures presented in ER 1110-2-1450, dated 10 Oct 1962. The annual series was converted to a partial duration series by Langbein's conversion table described in "Transactions American Geophysical Union," Volume 30, Dec 1949. Plate 8-6 shows the pool elevation probability curve and Plate 8-7 shows the pool elevation duration curve. Plates 8-8 through 8-14 show pool elevations from operational hydrographs for the period of record Jan 1940 through Dec 2011.

c. Key Control Points. The discharge rating curve at Van Buren, Arkansas, which is used in the regulation of Fort Gibson Lake, is shown on Plate 4-4.

8-10. Other Studies.

a. Examples of Regulation. Studies are in progress to improve the forecasting techniques presented in Section VI of this manual. Computer programs have been developed to forecast inflows into the lake, the resulting pool elevations, and the effects of

releases at the downstream gage. Use of these programs has greatly shortened the reaction time in preparing regulation schedules.

b. Channel and Floodway Improvement. Channelization projects exist below Fort Gibson Lake along the Arkansas River with the majority related to the Arkansas River navigation system. Ground and aerial reconnaissance are made as required to determine if revised channel capacities and maximum discharge limits are warranted.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. Fort Gibson Lake is a Corps of Engineers project, with Tulsa District prescribing and directing the flood control releases. Operation and Maintenance, as well as regulation of the conservation storage, is the responsibility of the Corps of Engineers. Project reporting instructions and an organization chart are presented in Section V, and project regulating instructions are presented in Section VII of this manual.

(1) Responsibilities and Duties During Normal Operations. The Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the following responsibilities and duties under general supervision of the Engineering and Construction Division.

(a) Routine regulation of lakes and distribution of routine data.

(b) Investigations and refinement of regulation procedures.

1). Analysis of past floods.

2). Reconnaissance to determine channel capacities.

3). Improvement of forecasting techniques.

4). Plan and coordinate the hydrologic reporting network with the NWS and the USGS.

(c) Train personnel in flood control duties.

1). Make periodic visits to projects by the Water Management Section personnel to familiarize themselves with regulation facilities, become acquainted with the operating personnel, discuss emergency regulation procedures with operating personnel, and provide the background for improving facilities and methods.

2). Instruct personnel of the Hydrology-Hydraulics Branch in flood control procedures to supplement the Water Management Section 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 emergencies, the Water Management Section is responsible for the following:

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

(b) Performing or obtaining lake forecasts.

(c) Presentation of storm and flood analysis to the District Commander and other interested Tulsa District personnel.

(d) When necessary, furnish personnel to help project operating personnel in flood regulations.

(e) Regulation of lakes according to flood control regulation schedules.

(f) Furnish information to higher authority.

1). Provide initial reports to SWD and the Office of the Chief of Engineers by telephone.

2). Provide hydrologic data for situation reports.

(g) Furnish information to the Reservoir Information Control Center (RICC). The duties of the Lake Manager under flood conditions are set forth in Section VII of this manual. The details of the overall procedures of the Tulsa District under emergency conditions are set forth in Tulsa District Supplement A, Natural Disaster Activities, to ER 500-1-1.

(3) Assignment of Personnel. During non-flood periods, the Water Management Section accomplishes the routine regulation of the lake. However, during flood periods, assistance of other personnel may be required to maintain effective regulation of the lake. Plate 5-2 shows the organization of the Water Management Section during a major flood. The area and size of the flood will determine the number of people engaged in each activity.

(4) Provision for 24-hour Alert. The NWS and project personnel are provided with a list of names, addresses, and telephone numbers of key personnel of the Engineering Division with instructions to provide warning if unusual conditions occur. Responsible personnel will be on duty at Tulsa District 24 hours a day whenever basin and/or project conditions warrant and during

flood emergencies. Responsible personnel will be on duty at the project or on call at all times.

(5) Role of Lake Manager. The Lake Manager will regulate the lake during flood periods according to instructions issued by personnel of the Water Management Section. The instructions follow the "Normal Regulations for Flood Control," included in Section VII. If the Lake Manager loses communication with the Tulsa District, he/she will immediately attempt to reestablish communication with Tulsa District while following the instructions outlined in the Section "Emergency Regulations for Flood Control" included in Section VII and Exhibit B of this manual. The Lake Manager will make daily observations as directed in paragraph 5-07.

b. Other Federal Agencies. The NWS and the USGS cooperate with the Water Management Section, Hydrology-Hydraulics Branch, Tulsa District, to accumulate rainfall and stream flow data. The Environmental Protection Agency (EPA), together with the State of Oklahoma, establishes the standards for water quality releases. SWPA cooperates with the Corps of Engineers to market hydropower produced by the project.

c. State Agencies. Management of the fish and wildlife resources of the Fort Gibson project is the responsibility of the Oklahoma Department of Wildlife Conservation.

d. Private Organizations. Presently, there are no privately owned flood control protection facilities at Fort Gibson Lake whose regulation is coordinated with the Corps of Engineers.

9-02. Interagency Coordination. Cooperative arrangements with other Federal agencies, State agencies and local interests are discussed in the following subparagraphs.

a. Local Press and Corps Bulletins. The Corps of Engineers, the NWS, and the USGS coordinate in forecasting flood stages, stream flow, and pool elevations. The NWS is officially responsible for issuing flood warnings to the public. This information will be supplemented by the Corps of Engineers bulletins from the Public Affairs Office (PAO) on observed conditions and with technical advice to enable local interests, within the limits of their capabilities, to obtain optimal flood protection and to perform rescue and relief functions. The Corps of Engineers further assists in flood control through the office of the Emergency Operations Manager, who furnishes sandbags and other necessary equipment based on equipment on hand and need. To facilitate the distribution of these data, the RICC is in operation when conditions warrant.

b. National Weather Service. The Tulsa District and the NWS's Arkansas-Red Basin River Forecast Center exchange hydrometeorological data and reports to prevent duplication of effort in obtaining and distributing data. This exchange of data is

discussed in greater detail in Section VI of this manual. The NWS is the responsible agency for issuing public forecasts of stream stages.

c. U.S. Geological Survey. The Corps of Engineers and the USGS cooperate in a program for the construction, maintenance, and operation of stream gaging stations throughout the Tulsa District. During floods, the Corps of Engineers and the USGS coordinate field activities to maximize the number of stream discharge measurements.

d. Southwestern Power Administration. Close coordination is maintained between the Tulsa District and SWPA. Tulsa District provides SWPA with daily inflow forecasts to Fort Gibson Lake. SWPA provides Tulsa District with daily power generation schedule forecasts. SWPA plans and holds monthly coordination meetings with representatives of SWD and the various Corps Districts with hydropower projects in this region. Current issues relating to hydropower operations are discussed and power allocations for each project for the coming month are established.

e. Other Federal, State, or local agencies. Tulsa District exchanges information with State government officials, the State Department of Transportation, State Highway Patrol, and others during flood emergencies. Tulsa District also coordinates with State agencies concerning fish and wildlife throughout normal operations.

9-03. Interagency Agreements. Exhibit C is a Memorandum of Understanding (MOU) between The US Department of Energy (via SWPA) and the Corps of Engineers detailing hydropower operations at Keystone Lake, dated 23 Jul 1980.

9-04. Commissions, River Authorities, Compacts, and Committees.

The GRDA operates Grand Lake (Pensacola Dam) and Lake Hudson (Markham Ferry) on the Grand (Neosho) River. Arkansas River Basin compacts have been established between the states of Arkansas and Oklahoma, and also between Kansas and Oklahoma. The major purposes of these compacts are:

a. To promote interstate comity between Arkansas and Oklahoma and between Kansas and Oklahoma.

b. To provide for an equitable apportionment of the waters of the Arkansas River between Arkansas and Oklahoma and between Kansas and Oklahoma, and to promote the orderly development thereof.

c. To provide an agency for administering the water apportionment agreed to in the compacts.

d. To encourage the maintenance of an active pollution abatement program in each of the three states and to seek the further reduction of both natural and manmade pollution in the waters of the Arkansas River Basin.

e. To facilitate the cooperation of the water administration agencies of Arkansas and Oklahoma and Kansas and Oklahoma in the total development and management of the water resources of the Arkansas River Basin.

9-05. Reports.

a. Daily Reports. In accordance with Tulsa District policy, this report is prepared following procedures outlined by the Water Management Section on a daily basis, except Saturday, Sunday, and holidays, to cover a period of 24-hours. The report provides data for use by personnel, whose work requires knowledge about the regulation of lakes, field investigations, stream gaging, and construction of flood control projects affected by releases from lakes, answering public inquiries, and preparing public releases. The report includes information on pool elevation, flood control storage, releases, inflow and rainfall. The report is completed and dispatched from the Hydrology-Hydraulics Branch by 10:00 a.m. daily under normal conditions.

b. Monthly Lake Reports. The Water Management Section prepares monthly reports in accordance with EM 1110-2-3600 and ER 1110-2-240. These reports are records for all flood control, navigation, and multiple-purpose storage lakes under supervision of or of direct interest to the Tulsa District. Supplemental information on the regulation of the lakes, such as explanation of deviations from approved schedules, is added as a note on the reports or as an attachment. These tabulations are promptly prepared each month and maintained in such form as to be readily available for transmittal to the Chief of Engineers or others, upon request. The monthly lake reports are also available on the Tulsa District Web Page from 1994 to the present at http://www.swt-wc.usace.army.mil/FGIBcharts.html.

c. Flood Situation Reports. The Water Management Section provides daily information to the Readiness and Security Branch for situation reports during floods in accordance with ER 500-1-1 and OM 500-1-6. The report contains various types of information about the floods. Pertinent data specifically required for lakes are as follows: name of lake, lake stage, predicted maximum stage, rates of inflow and outflow in c.f.s., percent of flood control storage used to date and at predicted maximum stage, and any special information particularly pertinent to the flood situation.

d. Post Flood Reports. This report is prepared according to ER 500-1-1 and OM 500-1-6 when practicable after a flood that has caused major damages. The report describes flood emergency operations by the Corps of Engineers and others. Included in summary form are: available hydrologic information, damage estimates, and other engineering data as are considered essential for flood control and flood plain studies or in the review of possible claims against the United States for damages. The Tulsa District Planning Division personnel, using information compiled and prepared by the Water Management Section, prepare the report. The report should be completed within approximately three months of the time of flooding, including a statement of final damages.

e. Annual Reports. The Water Management Section prepares this report. The report contains a summation of the general conditions of the river basins and the individual projects in the Tulsa District for the preceding fiscal year. The report also presents the activities and accomplishments of the Water Management Section for the past year. The report is forwarded to the SWD Water Management Section for inclusion in the SWD's annual report.

f. Summary of Reports. Table 9-1 is a summary of the reports required in the regulation of the lakes in the Tulsa District.

TABLE 9-1

TABULATION OF REPORTS

Name of Report	**When Required**	**Regulation Requiring Reporting**
Daily Report	Daily, except Saturday, Sunday, and holidays	Tulsa District Policy
Monthly Lake Report	Monthly	ER 1110-2-3600 EM 1110-2-240
Flood Situation Report	During Floods	OM 500-1-6 ER 500-1-1
Post flood Report	Following a flood causing major damage	OM 500-1-6 ER 500-1-1
Annual Report	Annually	ER 1110-2-1400

FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA
WATER CONTROL MANUAL
APPENDIX E, PART III
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

SUPPLEMENTAL TABLES

TABLE 4-3

MAJOR STORMS
JAN 1923 THROUGH DEC 2010
GRAND (NEOSHO) RIVER BASIN
UPSTREAM OF FORT GIBSON DAM

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
9-11 Jun 1923	4.14	14-18 Feb 1938	6.12
13-20 Sep 1923	3.00	26-30 Mar 1938	3.74
12-16 Oct 1923	5.73	7-11 Jun 1938	3.39
25-30 Apr 1924	3.82	16-17 Aug 1938	3.41
12-21 Aug 1926	3.52	2-5 Sep 1940	3.17
4-6 Sep 1926	4.31	20-26 Nov 1940	5.10
25-30 Sep 1926	6.28	14-20 Apr 1941	7.86
7-21 Apr 1927	8.36	6-10 Jun 1941	4.82
31 May – 5 Jun 1927	4.63	30 Sep – 7 Oct 1941	5.38
17-21 Jun 1927	3.67	14-17 Oct 1941	4.54
29 Jul – 4 Aug 1927	5.40	29-31 Oct 1941	6.06
23 Sep – 2 Oct 1927	7.95	6-9 Apr 1942	3.68
20-23 Apr 1928	3.68	24-28 Apr 1942	4.51
14-22 May 1928	4.41	8-18 Jun 1942	6.43
4-5 Aug 1928	3.00	7-11 May 1943	9.08
8-13 May 1929	5.06	15-20 May 1943	4.32
9-14 Oct 1929	3.11	4-10 Jun 1943	5.36
13-18 May 1930	3.00	8-14 Jun 1944	5.29
2-5 Aug 1931	3.92	24-31 Aug 1944	3.56
11-14 Oct 1931	5.06	11-16 Apr 1945	8.26
21-29 Nov 1931	3.98	8-12 Jun 1945	3.33
23-24 Dec 1932	5.32	23-30 Sep 1945	8.11
12-15 May 1933	3.76	7-17 May 1946	3.24
1-4 Sep 1933	4.36	8-16 Apr 1947	3.00
1-3 Sep 1934	3.74	20-26 Jun 1947	3.92
19-22 Nov 1934	3.00	21-28 Jun 1948	9.68
10-12 Mar 1935	3.70	7-15 Aug 1948	6.36
21-25 Mar 1935	3.08	23-28 Jan 1949	3.00
14-19 May 1935	3.07	15-21 May 1949	6.97
13-21 Jun 1935	5.49	8-14 Jun 1949	3.62
25-27 Sep 1935	3.33	13-19 Sep 1949	3.74
16-28 Sep 1936	8.14	7-11 May 1950	8.08
5-8 Oct 1936	3.70	17-22 Jul 1950	3.02
5-10 Sep 1937	3.67	29 Jul – 2 Aug 1950	3.78

TABLE 4-3 (continued)

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
14-21 Feb 1951	5.12	10-13 Oct 1969	5.90
29-30 Jun 1951	3.20	29-30 Apr 1970	4.00
7-13 Jul 1953	3.23	28 May – 5 Jun 1970	4.20
30 Apr – 2 May 1954	4.99	1-3 Sep 1970	3.70
18-22 Mar 1955	3.55	21-22 Sep 1970	3.00
20-28 May 1955	3.13	5-9 Oct 1970	3.60
14-15 May 1956	3.79	22-28 Oct 1970	4.30
16-30 Apr 1957	6.77	15-20 Sep 1971	3.00
12-18 May 1957	3.72	2-3 Oct 1971	3.30
21-25 May 1957	7.64	23-28 Jun 1972	3.70
30 May – 6 Jun 1957	3.23	21 Oct 1972	3.20
9-15 Jun 1957	3.53	30 Oct – 1 Nov 1972	5.70
11-15 Sep 1957	3.13	14-15 Apr 1973	3.00
22-23 Jul 1959	3.42	30 May – 5 Jun 1973	6.00
24-26 Sep 1959	5.26	4-8 Sep 1973	3.30
30 Sep – 5 Oct 1959	7.71	24-27 Sep 1973	3.60
4-6 May 1960	3.71	23-26 Oct 1973	4.60
18-20 May 1960	3.25	6-9 Jun 1974	6.70
22-25 Jul 1960	6.15	1-3 Sep 1974	4.10
4-9 May 1961	5.43	27 Oct – 4 Nov 1974	7.70
13-17 Jul 1961	7.76	17-18 Sep 1975	4.30
3-10 Sep 1962	3.88	17-21 Apr 1976	4.30
4-10 Mar 1964	3.00	17-20 Jun 1980	3.30
3-6 Apr 1964	3.00	28 Jul – 3 Aug 1981	5.05
12-18 Jun 1964	4.90	12-18 Oct 1981	5.01
25-30 Aug 1964	4.30	12-17 May 1982	3.68
15-19 Nov 1964	3.00	28 May – 4 Jun 1982	3.59
2-8 Apr 1965	3.80	17-21 Oct 1983	4.51
19-22 Sep 1965	3.40	14-21 Oct 1984	4.14
17-24 Apr 1966	3.90	13-16 Dec 1984	3.30
9-14 Aug 1966	3.60	30 Dec -- 1 Jan 1985	3.16
9-15 Apr 1967	3.90	21-24 Feb 1985	3.79
24-29 Jun 1967	3.30	2-7 Jun 1985	4.99
27 Jan – 2 Feb 1968	4.40	11-15 Oct 1985	3.99
16-23 Apr 1968	3.90	12-20 Nov 1985	5.33
24-26 Jun 1968	3.70	27 Sep – 2 Oct 1986	9.53
10-15 Aug 1968	3.60	29 Mar – 2 Apr 1988	3.23
22-24 Mar 1969	3.00	15-20 Sep 1988	3.45
8-15 Jun 1969	3.50	26-30 Jan 1989	4.06

TABLE 4-3 (continued)

Storm Dates	Average Basin Rainfall (inches)	Storm Dates	Average Basin Rainfall (inches)
13-16 Feb 1989	3.16	13-16 Sep 1998	5.76
16-23 May 1989	4.38	1-7 Oct 1998	4.31
11-14 Jun 1989	4.82	22-27 Apr 1999	5.49
16-19 Jul 1989	3.60	16-25 Jun 1999	6.48
10-16 Sep 1989	3.65	10 Nov 1999	6.21
22-23 Nov 1989	3.80	20-29 Jun 2000	6.47
17-20 Jan 1990	4.26	10-13 Oct 2001	4.40
11-16 Mar 1990	5.42	13-15 Aug 2002	3.74
14-21 Apr 1990	4.89	14-18 May 2003	3.36
17-21 Sep 1990	4.71	29 Aug – 3 Sep 2003	6.11
20-26 May 1991	4.06	3-5 Mar 2004	3.23
24 Oct – 1 Nov 1991	7.19	20 Apr – 2 May 2004	3.34
10-15 Feb 1992	3.43	1-5 Jul 2004	3.56
14-21 May 1992	3.05	30 Oct – 4 Nov 2004	4.53
27 May – 4 Jun 1992	3.22	2-6 Jan 2005	3.77
6-16 Jun 1992	4.08	20 Apr – 2 May 2006	3.14
8-11 Sep 1992	3.00	7-12 May 2007	3.44
13-17 Dec 1992	6.38	10-24 Jun 2007	5.58
6-13 May 1993	5.17	18-19 Mar 2008	4.97
13-16 Sep 1993	5.11	8-10 Apr 2008	5.57
12-17 Nov 1993	3.23	9-10 Jun 2008	4.09
26 Apr – 8 May 1994	3.44	13-24 Jun 2008	4.51
7 Jul – 2 Aug 1994	7.85	9-11 Jul 2008	3.17
7-8 Aug 1994	3.75	10-12 Aug 2008	4.69
4-6 Nov 1994	3.00	11-14 Sep 2008	3.29
7-8 May 1995	3.51	30 Apr – 6 May 2009	6.10
20-27 Jul 1995	3.21	9-11 Sep 2009	3.15
24-29 Sep 1996	5.46	5-10 Oct 2009	4.39
7-23 Aug 1997	7.09	2-10 Jul 2010	3.42
4-10 Jan 1998	3.84		

TABLE 4-6

FORT GIBSON DAM SITE MONTHLY INFLOWS
(Acre-Feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1923	21,780	259,000	371,500	74,500	746,000	2,000,000	217,500	20,600	64,490	671,000	524,500	906,700	5,877,570
1924	186,800	610,600	472,800	420,700	937,900	1,018,000	535,200	583,300	193,900	128,800	136,000	149,300	5,373,300
1925	369,600	290,400	212,200	469,000	208,600	157,600	66,490	60,250	107,200	127,800	228,100	68,000	2,365,240
1926	134,600	131,000	172,500	455,800	142,600	345,200	98,600	154,000	1,436,000	1,925,000	462,200	491,300	5,948,800
1927	672,400	441,900	753,800	4,280,000	858,000	1,362,000	476,900	1,704,000	294,100	1,168,000	286,100	390,100	12,687,300
1928	226,300	481,200	532,600	968,800	388,500	3,250,000	585,200	778,400	129,400	108,700	670,700	621,600	8,741,400
1929	749,500	319,000	440,600	2,271,000	2,841,000	1,373,000	571,400	141,400	72,590	102,700	80,250	69,600	9,032,040
1930	202,600	635,800	139,900	105,900	892,000	641,400	83,440	43,470	252,600	90,530	94,760	320,000	3,502,400
1931	91,500	162,400	205,500	317,900	393,800	168,800	129,400	161,600	46,690	82,200	662,100	307,500	2,729,390
1932	523,300	243,200	165,400	146,100	97,200	592,800	477,600	88,780	34,050	31,340	36,400	531,400	2,967,570
1933	354,300	148,800	203,900	742,200	1,376,000	186,700	88,360	126,300	212,600	197,200	132,200	169,900	3,938,460
1934	134,800	51,000	77,700	262,200	218,700	83,200	19,950	10,110	247,000	196,400	483,400	208,900	1,993,360
1935	304,700	270,700	1,000,000	295,900	1,342,000	4,139,000	363,000	84,300	121,500	250,700	685,700	429,300	9,286,800
1936	133,400	99,510	90,480	58,540	275,100	85,580	70,670	9,230	383,400	604,200	437,900	121,200	2,369,210
1937	1,093,000	815,900	493,800	514,300	377,000	1,347,000	222,300	123,200	273,100	54,540	37,390	68,600	5,420,130
1938	112,200	695,600	515,400	833,300	1,379,500	1,901,000	215,200	129,400	60,830	29,910	50,090	36,390	5,958,820
1939	35,340	87,610	123,100	165,200	871,100	446,300	145,600	84,600	19,190	14,860	19,770	22,400	2,035,070
1940	20,100	28,600	39,750	299,600	295,300	178,800	135,200	140,500	151,500	36,160	215,800	251,900	1,793,210
1941	763,500	439,100	160,000	2,125,000	183,700	1,371,000	136,400	182,900	1,012,000	3,663,700	2,104,800	465,200	12,607,300
1942	233,200	501,900	342,900	1,604,900	593,100	1,477,000	409,000	236,100	876,600	492,600	717,800	909,500	8,394,600
1943	480,900	260,500	355,700	527,900	5,996,000	1,494,000	271,900	79,030	67,510	175,300	65,690	98,390	9,872,820
1944	116,000	343,100	1,422,000	2,072,000	1,556,000	786,600	197,200	364,500	225,200	631,100	115,700	713,900	8,543,300
1945	142,600	324,900	2,004,000	3,674,000	1,443,000	1,200,000	809,100	351,900	1,287,000	1,068,000	158,000	91,100	12,553,600
1946	888,600	722,700	407,300	321,800	748,800	600,700	167,700	51,960	73,080	37,230	423,500	533,200	4,976,570

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1947	139,500	69,210	467,300	2,461,000	1,084,000	830,400	275,200	61,970	54,310	26,500	35,760	56,160	5,561,310
1948	62,020	97,950	932,200	235,000	533,600	1,969,000	2,077,000	1,084,000	177,500	49,590	124,900	66,800	7,409,560
1949	921,800	1,499,000	721,000	532,700	1,423,000	884,400	660,400	103,700	260,600	285,600	83,400	143,200	7,518,800
1950	654,800	307,600	265,200	152,400	1,454,000	713,600	1,624,000	1,424,000	784,100	371,400	82,580	56,540	7,890,220
1951	92,670	1,067,000	554,400	400,300	739,200	1,188,000	4,280,000	364,600	1,280,000	378,400	1,088,000	317,200	11,749,770
1952	340,100	652,300	894,200	734,300	317,500	141,300	70,030	151,900	37,160	12,290	37,620	32,740	3,421,440
1953	40,970	42,470	295,800	521,100	306,100	88,590	79,300	42,480	27,550	43,750	16,670	16,370	1,521,150
1954	26,540	27,990	41,510	110,600	551,200	132,800	23,920	39,830	26,760	492,700	68,400	94,990	1,637,240
1955	212,900	291,400	429,700	197,400	421,700	508,900	219,900	79,710	90,940	262,500	22,050	24,300	2,761,400
1956	31,400	40,960	35,550	73,980	314,600	270,100	117,800	51,530	21,810	20,730	29,600	48,000	1,056,060
1957	40,010	129,800	248,500	1,705,000	3,278,000	2,719,000	405,500	88,840	81,850	67,430	109,410	86,830	8,960,170
1958	83,550	100,530	1,421,750	699,480	646,900	390,380	2,255,000	282,810	311,870	76,820	162,570	54,760	6,486,420
1959	110,370	258,320	460,000	348,330	643,760	152,800	783,900	67,050	205,380	2,154,000	309,220	292,700	5,785,830
1960	320,800	360,960	869,200	700,810	1,009,900	326,220	139,170	210,690	105,770	188,260	311,150	358,100	4,901,030
1961	85,020	214,790	628,330	1,013,400	4,429,600	566,460	469,860	246,510	1,505,000	502,180	1,283,300	453,940	11,398,390
1962	413,060	565,980	611,440	370,240	203,090	759,060	186,210	44,380	1,055,370	562,780	173,920	171,780	5,117,310
1963	196,030	57,410	342,400	57,180	54,490	96,010	142,220	161,030	133,470	10,080	2,320	4,680	1,257,320
1964	13,060	7,320	19,340	81,420	26,850	988,380	171,310	212,200	165,780	61,390	220,120	94,570	2,061,740
1965	121,400	75,530	285,880	1,388,150	281,680	902,600	498,400	153,590	593,860	362,190	49,670	97,140	4,810,090
1966	188,830	299,590	158,510	232,250	406,120	183,100	136,300	211,020	156,590	54,540	41,880	74,050	2,142,780
1967	60,330	38,810	29,780	177,220	77,520	680,520	1,012,690	354,680	215,450	533,450	581,380	344,370	4,106,200
1968	431,470	827,530	828,440	826,030	559,070	643,560	456,850	460,210	158,060	175,300	677,810	764,120	6,808,450
1969	840,790	751,840	631,540	1,010,840	825,650	855,330	892,610	281,460	349,770	459,770	236,200	215,330	7,351,130
1970	141,090	85,430	189,910	804,510	1,736,670	988,370	233,390	138,930	426,970	621,320	315,090	198,910	5,880,590
1971	532,100	416,880	412,790	22,860	234,180	722,700	598,900	289,070	110,530	276,800	141,320	998,210	4,756,340
1972	380,610	148,060	134,000	174,730	464,240	47,040	360,850	157,820	209,140	361,530	1,615,240	638,550	4,691,810
1973	1,487,280	1,008,160	2,626,640	2,812,780	1,777,100	1,147,840	343,560	230,340	447,340	1,152,750	1,539,630	2,004,460	16,577,880
1974	885,900	816,480	1,853,980	652,780	639,690	2,014,460	200,940	204,550	596,790	437,770	2,311,250	927,920	11,542,510

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1975	652,760	1,080,740	1,775,100	999,890	422,210	1,027,980	461,900	227,750	341,860	189,710	70,090	243,270	7,493,260
1976	272,330	67,410	271,270	626,510	589,710	438,020	1,701,260	200,200	176,480	75,330	39,470	85,440	4,543,430
1977	29,390	41,460	160,540	85,250	161,290	1,059,880	946,220	381,060	564,990	520,210	895,910	217,740	5,063,940
1978	133,310	286,560	1,134,620	1,564,850	951,810	544,940	226,900	163,250	150,410	57,500	52,500	80,700	5,347,350
1979	80,900	243,100	801,000	701,700	539,000	728,100	764,900	430,800	209,800	17,500	326,280	456,790	5,299,870
1980	109,390	285,520	476,830	772,170	215,460	155,310	139,930	125,810	107,110	18,250	11,700	12,500	2,429,980
1981	8,330	15,470	40,560	35,700	97,980	302,670	424,990	277,960	147,550	191,780	628,560	245,670	2,417,220
1982	382,420	774,740	604,360	284,030	665,650	1,430,740	486,550	196,170	66,390	45,420	75,370	444,500	5,456,340
1983	256,070	659,110	533,750	1,933,880	1,905,520	821,360	352,660	154,510	28,960	147,570	330,840	454,410	7,578,640
1984	171,370	245,160	1,681,590	1,998,350	804,500	473,650	115,830	81,720	46,610	288,200	361,590	952,260	7,220,830
1985	1,410,840	1,565,160	2,122,120	1,159,740	1,106,780	1,591,740	437,950	503,010	595,240	887,470	2,712,790	1,655,400	15,748,240
1986	346,120	508,760	394,310	1,093,090	728,130	401,260	234,640	155,350	583,640	3,784,070	918,050	623,110	9,770,530
1987	516,690	973,790	1,966,810	769,790	528,694	491,700	306,250	135,270	146,680	78,050	524,730	1,738,710	8,177,164
1988	1,042,110	407,210	969,520	1,895,110	224,130	72,850	126,350	70,260	88,070	127,640	352,070	303,670	5,678,990
1989	453,220	502,020	741,620	329,650	257,060	551,010	265,490	397,880	602,970	126,940	78,150	81,720	4,387,730
1990	162,170	570,840	2,286,350	1,413,820	2,433,720	1,794,050	294,580	206,480	85,090	42,900	27,440	109,260	9,426,700
1991	760,462	274,016	122,181	419,008	415,537	106,710	49,190	30,704	35,861	49,487	199,378	549,123	3,011,657
1992	251,900	366,545	304,462	424,264	102,942	879,471	1,509,123	799,140	376,363	122,737	1,633,983	2,744,132	9,515,062
1993	1,465,980	940,160	1,188,100	1,200,600	2,277,620	1,788,300	1,515,170	916,360	1,774,410	989,750	472,070	487,140	15,015,660
1994	253,090	392,530	933,220	2,440,860	1,318,810	192,990	286,310	182,480	105,820	136,862	1,615,065	400,171	8,258,208
1995	590,488	280,269	472,073	904,278	2,811,810	3,040,706	1,124,149	380,435	63,075	20,232	13,091	17,455	9,718,061
1996	102,944	47,902	62,024	145,192	410,188	403,741	186,151	227,646	276,639	238,516	1,335,124	741,522	4,177,589
1997	170,591	691,408	1,061,014	714,229	428,248	582,534	571,159	286,031	147,205	147,939	121,638	721,250	5,643,246
1998	1,426,980	366,233	1,279,080	1,041,744	645,262	146,948	318,292	338,762	367,870	1,969,675	1,578,995	809,050	10,288,891
1999	367,900	790,068	1,190,993	1,703,331	2,463,904	1,658,900	1,208,586	131,506	84,795	58,493	17,256	420,105	10,095,837
2000	115,341	183,275	674,588	225,028	757,959	1,197,439	591,281	198,548	40,820	29,614	87,869	28,067	4,129,829
2001	291,173	1,182,148	1,088,132	323,504	81,719	766,810	116,578	199,140	94,314	228,992	122,717	179,207	4,674,434
2002	140,132	364,165	306,843	371,405	1,935,014	835,041	250,116	118,264	27,659	17,851	16,165	36,119	4,418,774

TABLE 4-6 (continued)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
2003	57,323	74,877	296,732	304,963	723,878	375,576	126,845	135,909	339,774	31,141	89,952	324,699	2,881,669
2004	431,312	312,699	1,695,099	1,037,569	981,733	505,098	1,218,861	350,038	52,166	51,412	680,350	712,077	8,028,414
2005	1,785,249	637,398	386,088	454,122	449,858	1,060,181	578,190	365,857	372,600	55,062	18,387	20,133	6,183,125
2006	17,951	13,924	15,868	39,571	759,333	150,944	36,992	87,631	22,215	15,273	31,240	83,107	1,274,049
2007	334,121	317,955	408,403	671,960	1,439,228	2,058,278	1,817,332	670,423	336,005	156,359	36,001	345,873	8,591,938
2008	496,768	795,879	2,208,231	2,578,451	2,023,765	2,157,949	1,152,215	659,216	921,832	520,570	224,036	185,656	13,924,568
2009	261,723	529,595	415,147	1,183,009	2,425,325	921,435	449,699	398,485	1,046,395	1,820,218	807,285	364,428	10,622,744
2010	619,407	797,089	1,136,030	683,078	1,221,539	793,698	948,510	256,724	348,243	34,215	80,231	66,248	6,985,012
MIN	8,330	7,320	15,868	22,860	26,850	47,040	19,950	9,230	19,190	10,080	2,320	4,680	1,056,060
MAX	1,785,249	1,565,160	2,626,640	4,280,000	5,996,000	4,139,000	4,280,000	1,704,000	1,774,410	3,784,070	2,712,790	2,744,132	16,577,880
MEAN	372,883	411,465	662,463	841,284	953,473	893,461	528,974	265,335	318,263	399,804	421,428	381,282	6,450,116

TABLE 7-3
ELEVATION - AREA - CAPACITY DATA
FT GIBSON LAKE, OKLAHOMA
ORIGINAL 1941 SURVEY, 1951 RATING

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
490	0.000	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
491	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.034	0.036	0.038
	0.010	0.013	0.016	0.019	0.022	0.025	0.028	0.031	0.034	0.037
492	0.040	0.042	0.044	0.046	0.048	0.050	0.052	0.054	0.056	0.058
	0.040	0.045	0.050	0.055	0.060	0.065	0.070	0.075	0.080	0.085
493	0.060	0.062	0.064	0.066	0.068	0.070	0.072	0.074	0.076	0.078
	0.090	0.097	0.104	0.111	0.118	0.125	0.132	0.139	0.146	0.153
494	0.080	0.082	0.084	0.086	0.088	0.090	0.092	0.094	0.096	0.098
	0.160	0.169	0.178	0.187	0.169	0.205	0.214	0.223	0.232	0.241
495	0.100	0.102	0.104	0.106	0.108	0.110	0.112	0.114	0.116	0.118
	0.250	0.261	0.272	0.283	0.294	0.305	0.316	0.327	0.338	0.349
496	0.120	0.122	0.124	0.126	0.128	0.130	0.132	0.134	0.136	0.138
	0.360	0.373	0.386	0.399	0.412	0.425	0.438	0.451	0.464	0.477

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
497	0.140	0.142	0.144	0.146	0.148	0.150	0.152	0.154	0.156	0.158
	0.490	0.505	0.520	0.535	0.550	0.565	0.580	0.595	0.610	0.625
498	0.160	0.162	0.164	0.166	0.168	0.170	0.172	0.174	0.176	0.178
	0.640	0.657	0.674	0.691	0.708	0.725	0.742	0.759	0.776	0.793
499	0.180	0.182	0.182	0.186	0.188	0.190	0.192	0.194	0.196	0.198
	0.810	0.829	0.848	0.867	0.886	0.905	0.924	0.943	0.962	0.981
500	0.200	0.208	0.216	0.224	0.232	0.240	0.248	0.256	0.264	0.272
	1.000	1.024	1.048	1.072	1.096	1.120	1.144	1.168	1.192	1.216
501	0.280	0.288	0.296	0.304	0.312	0.320	0.328	0.336	0.344	0.352
	1.240	1.272	1.304	1.336	1.368	1.400	1.432	1.464	1.496	1.528
502	0.360	0.368	0.376	0.384	0.392	0.400	0.408	0.416	0.424	0.432
	1.560	1.600	1.640	1.680	1.720	1.760	1.800	1.840	1.880	1.920
503	0.440	0.448	0.456	0.464	0.472	0.480	0.488	0.496	0.504	0.512
	1.960	2.008	2.056	2.104	2.152	2.200	2.248	2.296	2.344	2.392
504	0.520	0.528	0.536	0.544	0.552	0.560	0.568	0.576	0.584	0.592
	2.440	2.496	2.552	2.608	2.664	2.720	2.776	2.832	2.888	2.944

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
505	0.600	0.608	0.616	0.624	0.632	0.640	0.648	0.656	3.032	0.672
	3.000	3.064	3.128	3.192	3.256	3.320	3.384	3.448	3.512	3.576
506	0.680	0.688	0.696	0.704	0.712	0.720	0.728	0.736	0.744	0.752
	3.640	3.712	3.784	3.856	3.928	4.000	4.072	4.144	4.216	4.288
507	0.760	0.768	0.776	0.784	0.792	0.800	0.808	0.816	0.824	0.832
	4.360	4.440	4.520	4.600	4.680	4.760	4.840	4.920	5.000	5.080
508	0.840	0.848	0.856	0.864	0.872	0.880	0.888	0.896	0.904	0.912
	5.160	5.248	5.336	5.424	5.512	5.600	5.688	5.776	5.864	5.952
509	0.920	0.928	0.936	0.944	0.952	0.960	0.968	0.976	0.984	0.992
	6.040	6.136	6.232	6.328	6.424	6.520	6.616	6.712	6.808	6.904
510	1.000	1.015	1.030	1.045	1.060	1.075	1.090	1.105	1.120	1.135
	7.000	7.108	7.215	10.333	7.430	7.538	7.645	7.753	7.860	7.968
511	1.150	1.165	1.180	1.195	1.210	1.225	1.240	1.255	1.270	1.285
	8.075	8.198	8.320	8.443	13.098	8.688	8.810	8.933	9.055	9.178

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
512	1.300	1.315	1.330	1.345	1.360	1.375	1.390	1.405	1.420	1.435
	9.300	9.438	9.575	9.713	9.850	9.988	10.125	10.263	10.400	10.538
513	1.450	1.465	1.480	1.495	1.510	1.525	1.540	1.555	1.570	1.585
	10.675	10.828	10.980	11.133	11.285	11.438	11.590	11.743	11.895	12.048
514	1.600	1.615	1.630	1.645	1.660	1.675	1.690	1.705	1.720	1.735
	12.200	12.368	12.535	12.703	12.870	13.038	13.205	13.373	13.540	13.708
515	1.750	1.774	1.798	1.822	1.846	1.870	1.894	1.918	1.942	1.966
	13.875	14.062	14.249	14.436	14.623	14.810	14.997	15.184	15.371	15.558
516	1.990	2.014	2.038	2.062	2.086	2.110	2.134	2.158	2.182	2.206
	15.745	15.956	16.167	16.378	16.589	16.800	17.011	17.222	17.433	17.644
517	2.230	2.254	2.278	2.302	2.326	2.350	2.374	2.398	2.422	2.446
	17.855	18.090	18.325	18.560	18.795	19.030	19.265	19.500	19.735	19.970
518	2.470	2.494	2.518	2.542	2.566	2.590	2.614	2.638	2.662	2.686
	20.205	20.464	20.723	20.982	21.241	21.500	21.759	22.018	22.277	22.536
519	2.710	2.734	2.758	2.782	2.806	2.830	2.854	2.878	2.902	2.926
	22.795	23.078	23.078	23.644	23.927	24.210	24.493	24.776	25.059	25.342

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
520	2.950	2.990	3.030	3.070	3.110	3.150	3.190	3.230	3.270	3.310
	25.625	25.940	26.255	26.570	26.885	27.200	27.515	27.830	28.145	28.460
521	3.350	3.390	3.430	3.470	3.510	3.550	3.590	3.630	3.670	3.710
	28.775	29.130	29.485	29.840	30.195	30.550	30.905	31.260	31.615	31.970
522	3.750	3.790	3.830	3.870	3.910	3.950	3.990	4.030	4.070	4.110
	32.325	32.720	33.115	33.510	33.905	34.300	34.695	35.090	35.485	35.880
523	4.150	4.190	4.230	4.270	4.310	4.350	4.390	4.430	4.470	4.510
	36.275	36.710	37.145	37.580	38.015	38.450	38.885	39.320	39.755	40.190
524	4.550	4.590	4.630	4.670	4.710	4.750	4.790	4.830	4.870	4.910
	40.625	41.100	41.575	42.050	42.525	43.000	43.475	43.950	44.425	44.900
525	4.950	4.984	5.018	5.052	5.086	5.120	5.154	5.188	5.222	5.256
	45.375	45.887	46.399	46.911	47.423	47.935	48.447	48.959	49.471	49.983
526	5.290	5.324	5.358	5.392	5.426	5.460	5.494	5.528	5.562	5.596
	50.495	51.041	51.587	52.133	52.679	53.225	53.771	54.317	54.863	55.409

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
527	5.630	5.664	5.698	5.732	5.766	5.800	5.834	5.868	5.902	5.936
	55.955	56.535	57.115	57.695	58.275	58.855	59.435	60.015	60.595	61.175
528	5.970	6.004	6.684	6.072	6.106	6.140	6.174	8.384	6.242	6.276
	61.755	62.369	62.983	63.597	64.211	64.825	65.439	66.053	66.667	67.281
529	6.310	6.344	6.378	6.412	6.446	6.480	6.514	6.548	6.582	6.616
	67.895	68.543	69.191	69.839	70.487	71.135	71.783	72.431	73.079	73.727
530	6.650	6.689	6.728	6.767	6.806	6.845	6.884	6.923	6.962	7.001
	74.375	75.060	75.744	76.429	77.113	77.798	78.482	79.167	79.851	80.536
531	7.040	7.079	7.118	7.157	7.196	7.235	7.274	7.313	7.352	7.391
	81.220	81.944	82.667	83.391	84.114	84.838	85.561	86.285	87.008	87.732
532	7.430	7.469	7.508	7.547	7.586	7.625	7.664	7.703	7.742	7.781
	88.455	89.218	89.980	90.743	91.505	92.268	93.030	93.793	94.555	95.318
533	7.820	7.859	7.898	7.937	7.976	8.015	8.054	8.093	8.132	8.171
	96.080	96.882	97.683	98.485	99.286	100.088	100.889	101.691	102.492	103.294
534	8.210	8.249	8.288	8.327	8.366	8.405	8.444	8.483	8.522	8.561
	104.095	104.936	105.776	106.617	107.457	108.298	109.138	109.979	110.819	111.660

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
535	8.600	8.639	8.678	8.717	8.756	8.795	8.834	8.873	8.912	8.951
	112.500	113.380	114.259	115.139	116.018	116.898	117.777	118.657	119.536	120.416
536	8.990	9.928	10.866	11.804	12.742	13.680	14.618	15.556	16.494	17.432
	121.295	122.214	123.132	124.051	124.969	125.888	126.806	127.725	128.643	129.562
537	9.380	9.419	9.458	9.497	9.536	9.575	9.614	9.653	9.692	9.731
	130.480	131.438	132.395	133.353	134.310	135.268	136.225	137.183	138.140	139.098
538	9.770	9.809	9.848	9.887	9.926	9.965	10.004	10.043	10.082	10.121
	140.055	141.052	142.048	143.045	144.041	145.038	146.034	147.031	148.027	149.024
539	10.160	10.199	10.238	10.277	10.316	10.355	10.394	10.433	10.472	10.511
	150	151.056	152.091	153.127	154.162	155.198	156.233	157.269	158.304	159.340
540	10.550	10.600	10.650	10.700	10.750	10.800	10.850	10.900	10.950	11.000
	160.375	161.455	162.535	163.615	164.695	165.775	166.855	167.935	169.015	170.095
541	11.050	11.108	12.258	11.223	11.280	11.338	11.395	11.453	11.510	11.568
	171.175	172.309	173.443	174.576	175.710	176.844	177.978	179.112	180.245	181.379

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
542	11.625	11.683	11.740	11.798	11.855	11.913	11.970	12.028	12.085	12.143
	182.513	183.704	184.895	186.087	187.278	188.469	189.660	190.851	192.043	193.234
543	12.200	12.258	12.315	12.373	12.430	12.488	12.545	12.603	12.660	12.718
	194.425	195.674	196.923	198.171	199.420	200.669	201.918	203.167	204.415	205.664
544	12.775	12.833	12.890	12.948	13.005	13.063	13.120	13.178	13.235	13.293
	206.913	208.219	209.525	210.832	212.138	213.444	214.750	216.056	217.363	218.669
545	13.350	13.408	13.465	13.523	13.580	13.638	13.695	13.753	13.810	13.868
	219.975	221.339	222.703	224.066	225.430	226.794	228.158	229.522	230.885	232.249
546	13.925	13.983	14.040	14.098	14.155	14.213	14.270	14.328	14.385	14.443
	233.613	235.034	236.455	237.877	239.298	240.719	242.140	243.561	244.983	246.404
547	14.500	14.558	14.615	14.673	14.730	14.788	14.845	14.903	14.960	15.018
	247.825	249.304	250.783	252.261	253.740	255.219	256.698	258.177	259.655	261.134
548	15.075	15.133	15.190	15.248	15.305	15.363	15.420	15.478	15.535	15.593
	262.613	264.149	265.685	267.222	268.758	270.294	271.830	273.366	274.903	276.439
549	15.650	15.715	15.780	15.845	15.910	15.975	16.040	16.105	16.170	16.235
	277.975	279.638	281.300	282.963	284.625	286.288	287.950	289.613	291.275	292.938

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
550	16.300	16.365	16.430	16.495	16.560	16.625	16.690	16.755	16.820	16.885
	294.600	296.270	297.940	299.610	301.280	302.950	304.620	306.290	307.960	309.630
551	16.950	17.015	17.080	17.145	17.210	17.275	17.340	17.405	17.470	17.535
	311.300	313.020	314.740	316.460	318.180	319.900	321.620	323.340	325.060	326.780
552	17.600	17.670	17.740	17.810	17.880	17.950	18.020	18.090	18.160	18.230
	328.500	330.300	332.100	333.900	335.700	337.500	339.300	341.100	342.900	344.700
553	18.300	18.370	18.440	18.510	18.580	18.650	18.720	18.790	18.860	18.930
	346.500	348.370	350.240	352.110	353.980	355.850	357.720	359.590	361.460	363.330
554	19.000	19.080	19.160	19.240	19.320	19.400	19.480	19.560	19.640	19.080
	365.200	367.130	369.060	370.990	372.920	374.850	376.780	378.710	380.640	382.570
555	19.800	19.880	19.960	20.040	20.120	20.200	20.280	20.360	20.440	20.520
	384.500	386.500	388.500	390.500	392.500	394.500	396.500	398.500	400.500	402.500
556	20.600	20.675	20.750	20.825	20.900	20.975	21.050	21.125	21.200	21.275
	404.500	406.590	408.680	410.770	412.860	414.950	417.040	419.130	421.220	423.310

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
557	21.350	21.425	21.500	21.575	21.650	21.725	21.800	21.875	21.950	22.025
	425.400	427.560	429.720	431.880	434.040	436.200	438.360	440.520	442.680	444.840
558	22.100	22.180	22.260	22.340	22.420	22.500	22.580	22.660	22.740	22.820
	447.000	449.240	451.480	453.720	455.960	458.200	460.440	462.680	464.920	467.160
559	22.900	22.980	23.060	23.140	23.220	23.300	23.380	23.460	23.540	23.620
	469.400	471.720	471.720	471.720	471.720	471.720	471.720	471.720	471.720	471.720
560	23.700	23.790	23.880	23.970	24.060	24.150	24.240	24.330	24.420	24.510
	492.600	495.000	497.400	499.800	502.200	504.600	507.000	509.400	511.800	514.200
561	24.600	24.690	24.780	24.960	24.960	25.050	25.140	25.230	25.320	32.790
	516.600	519.100	521.600	524.100	526.600	529.100	531.600	534.100	536.600	539.100
562	25.500	25.595	25.690	25.785	25.880	25.975	26.070	26.165	26.260	26.355
	541.600	544.190	546.780	549.370	551.960	554.550	557.140	559.730	562.320	564.910
563	26.450	26.545	26.640	26.735	26.830	26.925	27.020	27.115	27.210	27.305
	567.500	570.180	572.860	575.540	578.220	580.900	583.580	586.260	588.940	591.620
564	27.400	27.500	27.600	27.700	27.800	27.900	28.000	28.100	28.200	28.300
	594.300	597.080	599.860	602.640	605.420	608.200	610.980	613.760	616.540	619.320

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
565	28.400	28.500	28.600	28.700	28.800	28.900	29.000	29.100	29.200	29.300
	622.100	624.980	627.860	630.740	633.620	636.500	639.380	642.260	645.140	648.020
566	29.400	29.515	29.630	29.745	29.860	29.975	30.090	30.205	30.320	30.435
	650.900	653.890	656.880	659.870	662.860	665.850	668.840	671.830	674.820	677.810
567	30.550	30.665	30.780	30.895	31.010	31.125	31.240	31.355	31.470	31.585
	680.800	683.910	687.020	690.130	693.240	696.350	699.460	702.570	705.680	708.790
568	31.700	31.815	31.930	32.045	32.160	32.275	32.390	32.505	32.620	32.735
	711.900	715.120	718.340	721.560	724.780	728.000	731.220	734.440	737.660	740.880
569	32.850	32.965	33.080	33.195	33.310	33.425	33.540	33.655	33.770	33.885
	744.100	747.440	750.780	754.120	757.460	760.800	764.140	767.480	770.820	774.160
570	34.000	34.140	34.280	34.420	34.560	34.700	34.840	34.980	35.120	35.260
	777.500	780.960	784.420	787.880	791.340	794.800	798.260	801.720	805.180	808.640
571	35.400	35.540	35.680	35.820	35.960	36.100	36.240	36.380	36.520	36.660
	812.100	815.680	819.260	822.840	826.420	830.000	833.580	837.160	840.740	844.320

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
572	36.800	36.935	37.070	37.205	37.340	37.475	37.610	37.745	37.880	38.015
	847.900	851.630	855.360	859.090	862.820	866.550	870.280	874.010	877.740	881.470
573	38.150	38.285	38.420	38.555	38.690	38.825	38.960	39.095	39.230	39.365
	885.200	889.060	892.920	896.780	900.640	904.500	908.360	912.220	916.080	919.940
574	39.500	39.640	39.780	39.920	40.060	40.200	40.340	40.480	40.620	40.760
	923.800	927.810	931.820	935.830	939.840	943.850	947.860	951.870	955.880	959.890
575	40.900	41.040	41.180	41.320	41.460	41.600	41.740	41.880	42.020	42.160
	963.900	968.050	972.200	976.350	980.500	984.650	988.800	992.950	997.100	1001.250
576	42.300	42.445	42.590	42.735	42.880	43.025	43.170	43.315	43.460	43.605
	1005.400	1009.690	1013.980	1018.270	1022.560	1026.850	1031.140	1035.430	1039.720	1044.010
577	43.750	43.895	44.040	44.185	44.330	44.475	44.620	44.765	44.910	45.055
	1048.300	1052.740	1057.180	1061.620	1066.060	1070.500	1074.940	1079.380	1083.820	1088.260
578	45.200	45.345	45.490	45.635	45.780	45.925	46.070	46.215	46.360	46.505
	1092.700	1097.270	1101.840	1106.410	1110.980	1115.550	1120.120	1124.690	1129.260	1133.830
579	46.650	46.795	46.940	47.085	47.230	47.375	47.520	47.665	47.810	47.955
	1138.400	1143.130	1147.860	1152.590	1157.320	1162.050	1166.780	1171.510	1176.240	1180.970

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
580	48.100	48.245	48.390	48.535	48.680	48.825	48.970	49.115	49.260	49.405
	1185.700	1190.560	1195.420	1200.280	1205.140	1210.000	1214.860	1219.720	1224.580	1229.440
581	49.550	49.695	49.840	49.985	50.130	50.275	50.420	50.565	50.710	50.855
	1234.300	1239.310	1244.320	1249.330	1254.340	1259.350	1264.360	1269.370	1274.380	1279.390
582	51.000	51.140	51.280	51.420	51.560	51.700	51.840	51.980	52.120	52.260
	1284.400	1289.550	1294.700	1299.850	1305.000	1310.150	1315.300	1320.450	1325.600	1330.750
583	52.400	52.540	52.680	52.820	52.960	53.100	53.240	53.380	53.520	53.660
	1335.900	1336.190	1336.480	1336.770	1337.060	1337.350	1337.640	1337.930	1338.220	1338.510
584	53.800	53.940	54.080	54.220	54.360	54.500	54.640	54.220	54.920	55.060
	1338.800	1349.230	1359.660	1370.090	1380.520	1390.950	1401.380	1411.810	1422.240	1432.670
585	55.200	55.340	55.480	55.620	55.760	55.900	56.040	56.180	56.320	56.460
	1443.100	1448.650	1454.200	1459.750	1465.300	1470.850	1476.400	1481.950	1487.500	1493.050
586	56.600	56.750	56.900	57.050	57.200	57.350	57.500	57.650	57.800	57.950
	1498.600	1504.270	1509.940	1515.610	1521.280	1526.950	1532.620	1538.290	1543.960	1549.630

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
587	58.100	58.250	58.400	58.550	58.700	58.850	59.000	59.150	59.300	59.450
	1555.300	1561.105	1566.910	1572.715	1578.520	1584.325	1590.130	1595.935	1601.740	1607.545
588	59.600	59.760	59.920	60.080	60.240	60.400	60.560	60.720	60.880	61.040
	1613.350	1619.345	1625.340	1631.335	1637.330	1643.325	1649.320	1655.315	1661.310	1667.305
589	61.200	67.480	61.520	61.680	61.840	62.000	62.160	62.320	62.480	62.640
	1673.300	1679.475	1685.650	1691.825	1698.000	1704.175	1710.350	1716.525	1722.700	1728.875
590	62.800	69.240	63.120	63.280	63.440	63.600	63.760	63.920	64.080	64.240
	1735.050	1741.375	1747.700	1754.025	1760.350	1766.675	1773.000	1779.325	1785.650	1791.975
591	64.400	64.560	64.720	64.880	65.040	65.200	65.360	65.520	65.680	65.840
	1798.300	1804.780	1811.260	1817.740	1824.220	1830.700	1837.180	1843.660	1850.140	1856.620
592	66.000	66.180	66.360	66.540	66.720	66.900	67.080	67.260	67.440	67.620
	1863.100	1869.760	1876.420	1883.080	1889.740	1896.400	1903.060	1909.720	1916.380	1923.040
593	67.800	67.980	68.160	68.340	68.520	68.700	68.880	69.060	69.240	69.420
	1929.700	1936.520	1943.340	1950.160	1956.980	1963.800	1970.620	1977.440	1984.260	1991.080
594	69.600	69.765	69.930	70.095	70.260	70.425	70.590	70.755	70.920	71.085
	1997.900	2004.900	2011.900	2018.900	2025.900	2032.900	2039.900	2046.900	2053.900	2060.900

TABLE 7-3 (continued)
ELEVATION - AREA - CAPACITY DATA

AREA IN 1000'S OF ACRES
CAPACITY IN 1000'S OF ACRE-FEET

ELEVATION NGVD29	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
595	71.250	71.415	71.580	71.745	71.910	72.075	72.240	72.405	72.570	72.735
	2067.900	2075.080	2082.260	2089.440	2096.620	2103.800	2110.980	2118.160	2125.340	2132.520
596	72.900	73.075	73.250	73.425	73.600	73.775	73.950	74.125	74.300	74.475
	2139.700	2147.040	2154.380	2161.720	2169.060	2176.400	2183.740	2191.080	2198.420	2205.760
597	74.650	74.825	75.000	75.175	75.350	75.525	75.700	75.875	76.050	76.225
	2213.100	2220.600	2228.100	2235.600	2243.100	2250.600	2258.100	2265.600	2273.100	2280.600
598	76.400	76.580	76.760	76.940	77.120	77.300	77.480	77.660	77.840	78.020
	2288.100	2295.790	2303.480	2311.170	2318.860	2326.550	2334.240	2341.930	2349.620	2357.310
599	78.200	78.380	78.560	78.740	78.920	79.100	79.280	79.460	79.640	79.820
	2365.000	2372.790	2380.580	2388.370	2396.160	2403.950	2411.740	2419.530	2427.320	2435.110
600	80.000									
	2442.900									

TABLE 7-4

STREAM WATER RIGHTS FOR GRAND RIVER WATERSHED
DOWNSTREAM ON THE MAIN STEM OF THE ARKANSAS RIVER TO THE ARKANSAS BORDER
AS OF 19 JUL 2011

			Diversion Point Legals									
PERMIT #	PURPOSE	ENTITY NAME	1/4	1/4	1/4	SEC	TWP	RNG	COUNTY	AMT(af/yr)	DATE FILED	DATE ISSUED
19220033	Public Supply	Tulsa Metropolitan Utility Auth			SE	15	22N	21E	Mayes	181,000.0	3 Jul 1922	28 Dec 1922
19320029	Public Supply	Pryor, City of				12	20N	19E	Mayes	542.0	18 Feb 1932	14 Apr 1932
19320030	Public Supply	Muskogee, City of	NW	SW	NE	09	15N	19E	Muskogee	21,720.0	28 Feb 1932	4 Apr 1932
19320032	Public Supply	Vinita, City of		SW	SW	02	23N	21E	Craig	3,620.0	8 Apr 1932	8 Apr 1932
19320034	Public Supply	Wagoner, City of		SW	NW	20	18N	19E	Wagoner	2,896.0	14 Apr 1932	25 Nov 1939
19350064	Public Supply	Fort Gibson, City of				02	15N	19E	Muskogee	1,117.0	4 Mar 1935	24 Apr 1935
19490067	Public Supply	Pryor, City of				12	20N	19E	Mayes	1,840.0	27 Apr 1949	30 Jun 1949
19540544	Irrigation	(b) (6)			NW	13	10N	24E	Le Flore	93.0	28 Aug 1954	10 Aug 1965
19560165	Recreation, Fish, Wildlife	Tourism & Recreation, Dept of				35	17N	20E	Cherokee	400.0	23 Feb 1956	11 Mar 1956
19630212	Irrigation	Werschky, Carl & Sue, dba C W Farms	S2	S2	S2	27	10N	26E	Le Flore	288.0	17 Jul 1963	9 Jun 1964
19660098	Irrigation	(b) (6)		SE	SE	29	12N	21E	Muskogee	180.0	23 Feb 1966	12 Apr 1966
19660457	Irrigation	(b) (6)			S2	25	15N	19E	Muskogee	180.0	26 Jul 1966	13 Sep 1966
19740510	Irrigation	(b) (6)	SW	NW	SW	18	10N	27E	Le Flore	60.0	31 Dec 1974	8 Apr 1975
19750026	Industrial	Georgia-Pacific Consumer ProductsLP			NW	34	15N	19E	Muskogee	15,842.0	14 Apr 1975	10 Jun 1975
19760120	Public Supply	Fort Gibson, City of	NW	NW	SE	02	15N	19E	Muskogee	4,560.0	27 Sep 1976	11 Jan 1977
19790033	Industrial	Mineral Solutions Inc	NW	NE	SW	25	16N	19E	Cherokee	95.0	12 Mar 1979	12 Jun 1979
19800200	Irrigation	(b) (6)	SE	SE	NE	13	12N	20E	Muskogee	600.0	10 Dec 1980	10 Mar 1981
19810036	Irrigation	(b) (6)	SW	SE	NW	25	15N	19E	Muskogee	120.0	13 Feb 1981	12 May 1981
19820110	Recreation, Fish, Wildlife	U S Fish & Wildlife Service	SW	NE	NW	07	11N	22E	Sequoyah	40.0	17 Aug 1982	14 Dec 1982
19830023	Commercial	Mineral Solutions Inc	NW	NE	SW	25	16N	19E	Cherokee	48.0	8 Apr 1983	12 Jul 1983

TABLE 7-4 (continued)

PERMIT #	PURPOSE	ENTITY NAME	Diversion Point Legals 1/4	1/4	1/4	SEC	TWP	RNG	COUNTY	AMT(af/yr)	DATE FILED	DATE ISSUED
19830052C	Irrigation	J B Sheffield Irrevocable Trust	SW	NW	NE	19	12N	21E	Muskogee	164.0	30 Aug 1983	26 Aug 1994
19830052D	Irrigation	(b) (6)	SW	NW	NE	19	12N	21E	Muskogee	391.0	30 Aug 1983	26 Aug 1994
19830052E	Irrigation	(b) (6)	SW	NW	NE	19	12N	21E	Muskogee	32.5	30 Aug 1983	13 Dec 1983
19830052F	Irrigation	(b) (6)	SW	NW	NE	19	12N	21E	Muskogee	97.5	30 Aug 1983	13 Dec 1983
19830058	Irrigation	(b) (6)	SE	NE	SE	19	12N	21E	Muskogee	150.0	12 Sep 1983	10 Jan 1984
19830075	Irrigation	(b) (6)	SE	NE	NE	13	12N	20E	Muskogee	500.0	6 Dec 1983	13 Mar 1984
19850051	Irrigation	(b) (6)	NE	SE	SE	19	12N	21E	Muskogee	172.0	11 Oct 1985	11 Mar 1986
19860004	Irrigation	Sloan Farms, Inc	SW	NW	NE	19	12N	21E	Muskogee	450.0	15 Jan 1986	13 May 1986
19860008	Irrigation	(b) (6)	NW	NW	SE	02	12N	20E	Muskogee	320.0	31 Jan 1986	13 May 1986
19900034	Recreation, Fish, Wildlife	U S Fish & Wildlife Service	SE	SE	SW	10	11N	22E	Sequoyah	1,000.0	6 Nov 1990	6 Nov 1990
19910002	Irrigation	(b) (6)	SW	SE	NE	19	12N	21E	Muskogee	54.0	14 Jan 1991	6 May 1991
19910031	Irrigation	(b) (6)	SE	NW	SE	33	11N	27E	Le Flore	610.0	12 Apr 1991	10 Sep 1991
19910052	Irrigation	(b) (6)	SE	NE	SE	12	10N	26E	Sequoyah	320.0	23 Sep 1991	23 Sep 1991
19920017	Irrigation	(b) (6)	SW	SE	NW	10	10N	24E	Le Flore	309.0	21 Apr 1992	15 Sep 1992
19940004	Irrigation	(b) (6)	NW	NW	SE	02	12N	20E	Muskogee	195.0	26 Jan 1994	14 Jun 1994
19970023	Irrigation	Werschky dba C W Farms, Carl & Sue	SW	SW	SE	27	10N	26E	Le Flore	762.0	1 Dec 1997	10 Mar 1998
19980053	Irrigation	Werschky, Carl & Sue, dba C W Farms	SW	SW	SE	27	10N	26E	Le Flore	360.0	14 Dec 1998	13 Apr 1999
19990044	Irrigation	(b) (6)	SE	SE	NE	28	11N	22E	Haskell	13.5	17 Dec 1999	14 Mar 2000
20000036	Irrigation	(b) (6)	NW	NW	SW	11	10N	24E	Le Flore	300.0	20 Sep 2000	9 Jan 2001
20010012	Irrigation	(b) (6)	SE	SE	SE	13	10N	24E	Le Flore	257.0	5 Jun 2001	9 Oct 2001
20020013	Irrigation	(b) (6) , dba C W Farms	SW	SW	SE	27	10N	26E	Le Flore	157.0	11 Mar 2002	9 Jul 2002
20030024	Irrigation	Gamble, Eloise P & Ralph C Revocable Trusts	SW	NW	NE	19	10N	25E	Le Flore	173.0	25 Jun 2003	13 Jul 2004

TABLE 7-4 (continued)

			Diversion Point Legals									
PERMIT #	PURPOSE	ENTITY NAME	1/4	1/4	1/4	SEC	TWP	RNG	COUNTY	AMT(af/yr)	DATE FILED	DATE ISSUED
20050004	Irrigation	(b) (6)	SE	SE	SE	13	10N	24E	Le Flore	214.0	28 Feb 2005	10 May 2005
20050027	Irrigation	(b) (6)	NE	NW	SE	12	12N	20E	Muskogee	100.0	19 Dec 2005	14 Mar 2006
20060046	Industrial	Georgia-Pacific Consumer ProductsLP	NW	NW	NW	34	15N	19E	Muskogee	19,593.0	17 Aug 2006	13 Feb 2007
20060061	Irrigation	(b) (6)	SW	NE	SW	33	12N	21E	Muskogee	46.0	30 Oct 2006	8 May 2007
20070037	Irrigation	(b) (6)	SW	SE	SE	13	10N	26E	Sequoyah	1,200.0	12 Jul 2007	9 Oct 2007
20070056	Irrigation	(b) (6)	SE	NW	NW	12	12N	20E	Muskogee	148.0	26 Dec 2007	14 May 2008
20080003	Irrigation	Rose Real Estate a partnership	NW	NE	SW	20	10N	25E	Le Flore	441.0	11 Feb 2008	14 May 2008
20090011	Irrigation	(b) (6)	NW	NW	NW	10	15N	19E	Muskogee	1,073.0	21 Apr 2009	14 Jul 2009
									TOTAL	264,843.5		

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

FORT GIBSON LAKE

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

FORT GIBSON LAKE

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EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
FORT GIBSON LAKE

1 - GENERAL INFORMATION

Other names for project	None
Location	(State of Oklahoma) Grand (Neosho) River Basin, Grand (Neosho) River, river mile 7.7.
Type of Project	Dam and Lake
Objectives of Regulation	Multipurpose - Flood control, fish and wildlife, water quality, recreation, power and navigation, and stream-flow aesthetics.
Project Owner	US Government
Operating Agency	US Army Corps of Engineers. The normal working hours of operation for weekdays are 7:00 a.m. to 4:30 p.m. Working hours for weekends, holidays and nights vary. Working hours under flood emergency conditions are 24 hours.
Regulating Agency	US Army Corps of Engineers.
Water Supply Agreements	Commercial Agreements: Grand River Dam Authority (GRDA) has water supply agreements with the following users: Rural Water Districts #1, #3, and #9 in Cherokee County for a total of 394.0 million gallons per year, and with Rural Water Districts #1, #2, #7, and #9 in Wagoner County for a total of 59.01 million gallons per month. RWD #11 Cherokee County (formerly Lost City Water Company) for 800,000 gallons per day (g.p.d.). Town of Fort Gibson for 1.543 c.f.s., City of Muskogee for 5 cubic feet per second (c.f.s.), City of Wagoner for 2 c.f.s.

Water Supply Agreements (continued)	Hulbert Public Works Authority dated 15 Aug 1984 for 12.2 million gallons per month. Tri-B Nursery, Tahlequah, OK for 5.4 million gallons per month. Sugar Tree Nursery for 1 million gallons per month. Lake Crest Property Owners Association, Inc., dated 1 May 1972, for 50,000 g.p.d. (do not take water). Beggs Water Company for 15 million gallons per month. Water supply outlet is in right abutment of Fort Gibson dam, although GRDA provides water supply storage in Pensacola and Markham Ferry reservoirs Oklahoma Ordnance Works Authority for maximum available volume per day from the 48” line plus 20 m.g.d. There are several short-term raw-water contracts for dust control and landscaping on the Cherokee Turnpike. There are numerous other small water supply agreements which exist with individual land owners.
Water rights	The Oklahoma Legislature has judicially-vested water rights to the Town of Fort Gibson for 1.543 c.f.s.; to the city of Wagoner for 2.0 c.f.s.; and to the City of Muskogee for 5.0 c.f.s. The Oklahoma Water Resources Board (OWRB) has issued water rights on the Arkansas River below Fort Gibson Lake. The OWRB will inform the Water Management Section as to the amount and time distribution of

	releases required to satisfy downstream water rights. Releases will be made from inflow, not storage.
Code of Federal Regulations, Title 33 (applies to Section 7 Project)	Does not apply
Federal power distributing and marketing	Southwestern Power Administration (SWPA)
Other inter-agency agreement	None
Project cost through 2009	$ 56,184,927.36
Closure date	Jun 1949
Special project features	Dikes – 21,678 feet long, located between the City of Wagoner and the dam.
Other	None

2 - LAKE INFORMATION

ELEVATIONS, AREAS, AND STORAGES

Feature	Elevation (feet, NGVD29)	Area (acres)	Storage (acre-feet) (1)	Runoff (inches) (2)
Top of dam	593.0	67,800	1,929,700	_
Top of gates and flood control pool	582.0	51,000	1,284,400	1.93
Top of conservation pool	554.0	19,000	365,200	0.55
Top of inactive pool	551.0	16,950	311,300	0.47
Spillway crest	547.0	14,500	247,800	0.37
Flood control storage	554.0-582.0	-	919,200	1.38
Power drawdown (pondage)	551.0-554.0	-	53,900	0.08
Streambed	483.0	-	-	-

(1) Based on 1950 sediment survey.
(2) Drainage area is 12,492 square miles.

MAJOR FLOODS PAST DAMSITE

Date	Peak flow (c.f.s.)	Volume (acre-feet)	Runoff (inches) (1)
20 May – 8 Jun 1957	280,000	3,285,000	4.93
1 May – 2 Jun 1961	200,000	3,546,000	5.32
26 Sep – 10 Oct 1986	280,000	4,567,000	6.85
6 - 24 May 1993	88,249	1,602,270	2.40
10 Jun – 11 Jul 2007	104,022	2,150,410	3.23

(1) One inch of runoff = 666,240 acre-feet.

Real estate taking for land fee title	Fee simple title has been acquired to land required for construction of the dam and for operation and maintenance purposes in the area designated as the dam site and public-use area. In the reservoir area, the acquisition guideline is elevation 585.0 feet, NGVD29. The fee purchase limits in the main body of the lake generally encompass the acquisition guideline with a minimum distance of 300 feet measured horizontally from the top of the flood control pool, elevation 582.0 feet. This contains 72,358 acres.
Real estate taking for Easement	Flowage easements were obtained in some extreme upper reaches (elevation varies) encompassing 688 acres.
Range of clearing	Elevation varies.
Pool elevation corresponding to discharge capability of maximum non-damaging flow rate downstream	Non-damaging channel capacity immediately downstream of Fort Gibson Dam is estimated at 100,000 c.f.s. This flow rate can be discharged when the lake level is at elevation 556.0 feet and above.
Reservoir length at top of conservation pool	39.7 miles
Reservoir length at top of flood pool	47.9 miles
Shoreline length at top of conservation pool	225 miles
Safety aspects, possibly requiring warning	At elevation 556.1 feet, some flap gates on dikes must be manually closed. At elevation 557.0 feet, access roads, beaches, wildlife and agricultural leases become flooded. At elevation 558.0 feet, some boat ramps become flooded. At elevation 559.0 feet, picnic and camping sites and parking lots become flooded. At elevation 560.0 feet, State Highway 80 must be closed.

Emergency drawdown	The outlet works facilities will provide emergency drawdown capacity capable of lowering the pool from the top of conservation pool, elevation 554.0 feet to elevation 551.0 feet, within 0.5 days.

3 – HYDROLOGY

Drainage area	12,492 square miles

Probable Maximum Flood

Maximum water surface elev. (full pool)	582.0 feet, NGVD29
Peak inflow (into full pool)	645,000 c.f.s.
Peak inflow (natural channel flow)	613,000 c.f.s.
Total storm runoff (into full pool)	6.23 inches
Volume (into full pool)	4,148,000 acre-feet
Maximum outflow (full pool)	645,000 c.f.s.
Duration of flood	9 days

Spillway Design Flood

Maximum water surface elev. (full pool)	582.0 feet, NGVD29
Peak inflow (into full pool)	926,000 c.f.s.
Peak inflow (natural channel flow)	
Total storm runoff (into full pool)	7.54 inches
Volume (into full pool)	5,022,000 acre-feet
Maximum outflow	925,000 c.f.s.
Duration of flood	9 days

Standard Project Flood

Maximum water surface elev. (full pool)	582.0 feet, NGVD29
Peak inflow (into full pool)	463,000 c.f.s.
Total storm runoff	3.77 inches
Volume (into full pool)	2,511,000 acre-feet
Maximum outflow	462,000 c.f.s.
Duration of flood	7 days

Climate	Moderate
One inch of runoff	666,240 acre-feet
Storm types	Mainly thunderstorms
Flood Seasons	Primary flood period Mar through Jun with a secondary flood period of Sep through Nov; however, floods have occurred in every month of the year.
Low flow season	Aug, Dec through Feb; however, low flow can occur at any time of the year.
Minimum daily inflow	Period 1940 through 2010 zero flow has occurred on many occasions.
Minimum monthly inflow	2,320 acre-feet in Nov 1963.
Minimum annual inflow and year	1,056,060 acre-feet in 1956
Average annual inflow	6,450,120 acre-feet (1923-2011)
Maximum annual inflow and year	16,577,880 acre-feet 1973 from records (1923-2011)
Maximum monthly inflow and date	5,996,000 acre-feet in May 1943
Maximum daily inflow and date	308,200 day second feet in May 1943
Maximum instantaneous inflow and date	420,000 c.f.s. on 21 May 1943
Maximum flood volume and date	5,070,00 acre-feet, flood of 7 May-2 Jun 1943
Name and location of key stream flow stations	Muskogee, Oklahoma, Arkansas River (river mile 457.8) Van Buren, AR, Arkansas River (river mile 353.4).
Type of hydro-meteorological data recorded at dam site	Maximum and minimum temperatures, recording and standard rainfall measurements, wind speed and direction, pool elevations (recording), and tailwater stages (recording and staff).

Number of precipitation stations used in hydrologic forecasting inflow	Eighteen recording, 23 Mesonet.
Number of sediment ranges	34
Number of degradation ranges	8

4 – EMBANKMENT

Location	Grand (Neosho) River, river mile 7.7.
Purpose	Flood control, fish and wildlife, water quality, recreation and power and navigation and stream flow aesthetics.
Type	Non-overflow concrete gravity and rolled earth-fill embankment
Type of fill	Rolled earth fill with impervious core
Slope Protection	Riprap on upstream face; crushed rock on downstream face.
Height	110 feet above streambed
Length	2,990 feet
Top Elevation	593.0 feet, NGVD29
Design Flood	Spillway Design Flood developed in original project design.
Freeboard	11 feet between design flood peak and top of dam (582.0 feet – 593.0 feet), 5 feet between top of flood control pool and dike overtopping (582.0 feet – 587.0 feet).

Used for Roadway	Yes, State Highway 251A, a 22-foot wide double bituminous surfaced roadway across the embankment and spillway.
Elevation of stream bed	483.0 feet, NGVD29

5 – DIKES

Number and location	Seven on west side of reservoir.
Purpose	Protection of agricultural lands and rural and urban structures from pool elevation rises.
Type	Rolled earth-fill, non-overflow
Height	20 feet.
Length	21,678 feet
Top elevation	Varies from 587.0 feet to 587.5 feet

6 – SPILLWAY

Location	Across the original river channel and the major portion of the right bank flood plain.
Type	Gated concrete gravity, ogee weir
Crest Elevation	547.0 feet, NGVD29
Net overflow length	1,200 feet
Number and size of gates	Thirty, 40’ wide X 35’ high.
Type of gates	Tainter

Top of gate elevation	582.0 feet, NGVD29
Induced surcharge	None
Design head	35 feet
Maximum discharge capacity	961,930 c.f.s. at 582.0 feet, NGVD29
Bridge deck elevation	593.0 feet, NGVD29
Type of energy dissipater	Stilling basin
Time required to open and close all gates	Gates raise and lower separately or together at the rate of 1.8 feet per minute with stops every 1 foot from closed to fully open.
Type of emergency closure	Bulkheads are provided for tainter gates and penstocks.
Spillway activation	The tainter gates, except for periodic maintenance, are activated only during flood conditions, all discharges including low flow requirements are released through the powerhouse.

7 - OUTLET FACILITIES

a. FLOOD CONTROL SLUICES

Location	Through intermediate piers in spillway
Number and size and gates	10 rectangular, 5’8” wide x 7’0” high
Purpose	Flood control
Type of service gates	Hydraulically operated cast iron slide gates
Conduit length	85.0 feet
Entrance invert elevation	502.0 feet, NGVD29

Exit invert elevation	500.0 feet, NGVD29
Discharge at pertinent elev.	Spillway crest (547.0) 15,700 c.f.s. Top of flood control pool (elev. 582.0 feet) 21,000 c.f.s. Top of conservation pool (elev. 554.0 feet) 16,900 c.f.s. Bottom of conservation pool (elev. 551.0 feet) 16,400 c.f.s.
Minimum pool elevation inoperative	502.0 feet, NGVD29
Minimum time required to open/close gates	The service gates will open or close at the rate of 1.6 foot per minute
Type emergency closure	Bulkhead lowered by a hoist into frames provided at the sluice entrances.
Type energy dissipater	Tetrahedral deflector.

b. WATER SUPPLY

Purpose	Water supply
Location	Through right abutment
Type of outlet	Circular
Size of outlet	48-inch diameter pipe
Type of gate	Double-disc gate valve
Entrance centerline elevation	538.0 feet, NGVD29

8 – HYDROELECTRIC POWER FACILITIES

Location	Near left abutment
Type	Peaking
Installed capacity	45,000 kilowatts
Number, type and capacity	Four 11,250 kilowatt Francis units
Power online date	Sep 1953
Load factor	Depends on upstream operation of Pensacola and Markham Ferry Reservoirs
Number and size of penstocks	Four, 18-foot diameter
Turbine discharge	Top of conservation pool; 2,450 c.f.s. with one unit running, 10,900 c.f.s. with all four units running
Design head (net head)	63.5 feet (from previous manual, cannot be verified)
Maximum gross head for power	88.0 feet
Average net head	
Conservation pool full	59.0 feet
Conservation pool empty	56.0 feet
Minimum flow required for generation	2,000 c.f.s. (from previous manual, cannot be verified)
Draw down	3.0 feet
Minimum head	35.0 feet (from previous manual, cannot be verified)
Critical drawdown	Aug 1956 to Jan 1957

Minimum peaking capability	6,000 kW (one unit)
Dependable capacity	45,000 kW
Average annual energy	191,000,000 kWh
Specific hydroelectric storage	53,900 acre-feet
Critical tail-water elevation	530.0 feet, NGVD29 (from previous manual, cannot be verified)
Constraints	Plant is essentially run-of-river and requires inflows from intervening area or upstream projects for generation water.

9 - CONTROL POINTS

a. MUSKOGEE GAGE

Location	On U.S. Highway 62 bridge, 3.5 miles NE of Muskogee, Oklahoma, at river mile 457.8 on the Arkansas River.
Purpose of gage	Used by Corps of Engineers to provide stage and precipitation data and serve as a control point for flood releases from Fort Gibson Lake and other upstream reservoirs and determination of benefits.
Channel and floodplain description	The channel is well defined, and fairly straight in the vicinity of the gage; the flood plain is broad with trees, cultivated crops and some rural development.
Uncontrolled drainage area	96,674 square miles, of which 12,541 are non-contributing.
Treatment of uncontrolled runoff	Contributes to flood control target flows

Target flow rate	Bank full stage 28.0 feet, 120,000 c.f.s. (current rating).
Time of crest travel	Fort Gibson Dam to Muskogee gage -2 hours.
Monitoring provisions	Water surface elevation is recorded by electronic logger. The gage can be polled by satellite platform.
Channel usage	Navigation, water supply, fishing and fish spawning.

b. VAN BUREN, AR

Location	Near left bank of upstream side of U.S. Highway 64 bridge at Van Buren, AR, at navigation mile 300.4 on the Arkansas River
Purpose of gage	Provide stage data and serve as a control point for flood releases from upstream projects
Channel and flood plain	The channel is will defined and fairly straight at the description gage. The left bank is high and the right bank is a combined levee and floodwall that protects the properties on the right bank
Drainage Area	150,483 sq. mi., of which 22,241 sq. mi. are non-contributing
Target Flow Rate	Bank full stage is 22.0 ft., approximately 150,000 c.f.s. at present
Time of Crest Travel	Fort Gibson Dam to Van Buren gage is approximately 36 hours
Monitoring Provisions	Water surface elevation is recorded by a sutron data collection platform
Zero of Gage	380.24 ft, NVGD29
Channel usage	Navigation, water supply, fishing and fish spawning

EXHIBIT B

STANDING INSTRUCTIONS TO LAKE MANAGER

FORT GIBSON LAKE

EXHIBIT B

STANDING INSTRUCTIONS TO LAKE MANAGER

FORT GIBSON LAKE

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EXHIBIT B
STANDING INSTRUCTIONS TO LAKE MANAGER
FORT GIBSON LAKE

I - GENERAL

1. Operation. The lake will be regulated in accordance with the normal regulations for flood control as directed in Section VII of this Manual or Paragraph II-1.a. of this Exhibit. Instructions for the storage and discharge of floodwater will be issued by the Water Management Section. In the event communications with the Tulsa District are disrupted, the lake will be regulated in accordance with the schedule of emergency regulations for flood control (see Section VII of this Manual or paragraph II-1.b. of this Exhibit). In addition, the Lake Manager will immediately make every effort to re-establish communications with the Tulsa District.

2. Project Reporting Instructions. Hydrologic data items affecting release of water, confirmation of change in releases as instructed, complaints, operating machinery failure, or out-of service times for maintenance shall be reported to the Water Management Section as they occur.

The following data should be included in the daily report to the Water Management Section (Hydrology-Hydraulics Branch, Tulsa District) from all flood control storage projects with hydropower. Data is typically reported by telephone, fax, or email. Data collected will be reviewed and input into the Water Management Section's data base before 10 a.m. and published to the lake data morning report located at http://www.swt-wc.usace.army.mil/old_resvrept.htm by 10 a.m. See Plate 5-3 for lake data reporting details.

a. As of 8 a.m. Each Weekday.

1) Pool elevations at 12 noon, 4 p.m., and 12 midnight of the previous day and the current 8 a.m. pool elevation and tailwater elevation (if available).

2) The total precipitation amounts for the previous 24-hour period (7 a.m. to 7 a.m. time period).

3) The current wind direction and wind speed (Beaufort scale).

4) Water supply withdrawal or release for previous day (if available).

5) The average power discharge in day second feet (d.s.f.) for the previous 24-hour period (midnight to midnight).

6) The net power generation in megawatt hours (mWh) for the previous 24-hour period (midnight to midnight.)

7) The total discharge in day second feet (d.s.f.) for the previous 24-hour period (midnight to midnight).

8) The 8 a.m. instantaneous power discharge in c.f.s.

9) The 8 a.m. instantaneous total discharge in c.f.s.

10) The total hourly discharge in c.f.s. for the previous 24-hour period (midnight to midnight).

11) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation (and tailwater elevation if necessary) when the change was made.

b. As of 8 a.m. Each Monday.

1) The same data from the weekend as required in I - 2.a. above.

2) The current pool elevation readings from the pool gage, the recording chart or tape, the shaft encoder or data logger, and the wire weight or staff gage. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

c. Weekends and Holidays.

1) Daily reports are not required to be submitted on weekends and holidays except during flood periods.

d. During Flood Periods.

1) During flood periods, weekend and holiday reports should include the same data as required in I - 2.a. above as well as the 8 a.m. pool elevation from the pool gage.

2) In addition to the data in I - 2.a., I - 2.b., and I - 2.c. above, additional reports of lake elevations may be requested by Water Management Section personnel.

3. Reporting Unusual Events. Events or conditions not normally encountered in the routine operation of the dam and lake which might endanger the dam or necessitate temporary or permanent revision of the operating procedures such as settlement, movement, or cracking of the earth embankment or abutments; unusual change in seepage rates, or development of new seepage areas; mechanical malfunction or failure; structural settlement, movement, cracking, or vibration; landslides, rockslides, or indications of an impending movement; or an occurrence indicating any degree of jeopardy to the safety of the dam, or to the safety of the public shall be reported promptly to the Water Management Section, Hydrology-Hydraulics Branch.

4. Warnings. It is the responsibility of the Lake Manager and project personnel authorized to make gate changes to maintain a list in current status of residents and/or property which might be endangered or inconvenienced by large and/or prolonged releases. If damaging releases are expected to occur, notification will be made by telephone, or oral warning by Corps employees. Notification will be made in accordance with the Tulsa District supplements to ER 500-1-1. This would include media such as radio, television, telephone, citizens band radio, use of law enforcement and civil defense agencies and their communication system, National Guard and reserve units, supplemented by oral warning by Corps employees. Studies have been made to determine the possible downstream flood conditions that could exist in the event of a maximum spillway release or failure of the dam at maximum pool. Approximate water surface profiles and flooded area maps giving the results of these studies are kept in the Ft. Gibson Lake Operation and Maintenance Manual, Volume II, Flood Emergency Plan. In every case, when a gate change is made a horn is blown to give warning to people immediately downstream of Fort Gibson Dam.

5. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Management Section at any time. When the floodwaters have significantly risen into the flood control pool, gate changes can be expected two or three times daily. When the pool level is at or above the top of the flood control pool, gate changes may occur every hour. Only under the most unusual circumstances will changes be ordered more frequently than once every hour. Frequency of gate changes during low flow operation will generally be less than once a day.

II - REGULATION PROCEDURES

1. Regulating River Stages and Discharges. The regulation schedules provide that the channel capacity of 100,000 c.f.s is not to be exceeded insofar as practicable. Floodwaters will be released as rapidly as practicable with consideration given to minimizing flooding of low-water crossing and low-lying farmland. Factors considered in the determination of releases are: maximum inflow into the reservoir during a rise, general climatic conditions, season of the year with respect to the probability of floods, status of crops in low-lying farmlands, and maximum non-damaging stages or discharges.

a. Normal flood control regulations. Under normal procedures, instruction for storage and release of water for conservation and flood control will be issued by the district office Water Management Section (in accordance with Table B-1). Implementation of the instructions is to be confirmed back to the Water Management Section as soon as the required action is completed. Instructions originating from any other source should not be processed. Fort Gibson Lake will be regulated for optimal flood reductions on the Grand (Neosho) River from the dam to its confluence with Arkansas River and from that point in conjunction with flood control releases from Keystone Lake and other systems on the Arkansas River.

b. Emergency flood control regulations. Should communication with Tulsa District be disrupted, the Lake Manager will, on his or her own initiative, direct regulation of the lake in accordance with the rules of regulation shown in Table B-2 until communication is restored. In addition, the Lake Manager will immediately make every effort to reestablish communication with Tulsa District. The spillway gates will be operated at a uniform opening.

2. During Emergency Events. The Lake Manager may temporarily deviate from the current release rates in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of dam, or to avoid serious hazards to life. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Water Management Section and shall include justification for the action. Continuation of the deviation will require the express approval of the Water Management Section and the Southwestern Division (SWD).

TABLE B -1

NORMAL FLOOD CONTROL REGULATION SCHEDULE
FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA

LAKE STAGE (feet)	POOL CONDITIONS	REGULATION
554.0 – 582.0 & forecasted not to exceed 582.0	Rising	Releases will not exceed 100,000 c.f.s. downstream of the dam, or that flow which when combined with intervening flow downstream shall not exceed a 22-foot stage at the Van Buren Gage, unless superceded by the requirements in Chapter 7 of the Arkansas River Basin Water Control Master Manual. Releases will be made in such a manner as to balance, as much as practical the percentage of the flood control storage utilized in Grand Lake, Lake Hudson, and Fort Gibson Lake.
554.0 – 582.0 & forecasted to exceed 582.0	Rising	Releases will be made to reduce as much as practical the flood damage below the dam and to limit the pool elevation to 582.0 feet. Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter, may be used as a guide to determine releases.
582.0 or above	Rising	Spillway gates will be operated to maintain the pool at elevation 582.0 feet or until all the gates are fully open.
582.0 or above	Falling	The maximum gate opening attained shall be held until the pool recedes to elevation 582.0 feet.
582.0 – 554.0	Falling	Releases will not exceed 100,000 c.f.s. and will be made in such a manner as to balance, as much as practical, the percent of flood control storage utilized in the 3-lake system. Evacuation of the flood control storage in this system will be governed by the provisions of Chapter 7 of the Arkansas River Basin Water Control Master Manual.

TABLE B – 2

EMERGENCY FLOOD CONTROL
REGULATION SCHEDULE FOR FORT GIBSON LAKE
GRAND (NEOSHO) RIVER, OKLAHOMA

LAKE STAGE (feet)	POOL CONDITIONS	REGULATION
554.0 – 582.0	Rising	Maintain current releases until communication is restored or 12 hours have elapsed. If communication is not restored after 12 hours or the pool rises to elevation 577.0 feet during the 12 hour waiting period, begin releases in accordance with Plate 7-1, Spillway Gate Regulation Schedule, Inflow Parameter. Releases shall be adjusted every 2 hours using the previous 6-hour time interval to compute the inflow. Plate 6-3 shows a sample inflow computation, and Plate 7-2 is a nomograph for computing inflow. At no time shall releases be reduced if the pool is rising. If the pool is above 577.0 feet the releases shall not be less than indicated by the minimum discharge curve on Plate 7-1.
582.0 or above	Rising	Spillway gates will be opened as necessary to maintain the pool at elevation 582.0 feet or until all the gates are fully opened.
582.0 or above	Falling	The maximum gate opening attained shall be held until the pool recedes to elevation 582.0 feet.
582.0 – 577.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 100,000 c.f.s., whichever is greater.
577.0 – 571.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 60,000 c.f.s., whichever is greater.
571.0 – 564.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 40,000 c.f.s., whichever is greater.

TABLE B – 2 (continued)

LAKE STAGE (feet)	POOL CONDITIONS	REGULATION
564.0 – 554.0	Falling	Every 2 hours adjust the discharge to equal the previous 6-hour inflow or 20,000 c.f.s., whichever is greater.
Near 554.0	Falling	Releases shall be gradually reduced to equal inflow by the time the pool recedes to elevation 554.0 feet.

EXHIBIT C

MEMORANDUM OF UNDERSTANDING

CORPS OF ENGINEERS & SOUTHWESTERN POWER ADMINISTRATION

CONTRACT NUMBER
DE-(AM)75-80SW00058

COPY

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 WITNESS 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	Norfork 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	Robert S. Kerr

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 75242-0216

REPLY TO ATTENTION OF

October 30, 1986

SWPA OFFICIAL COPY

From/Date: SD 11/03/86		
Assigned to:	ORG	DATE
No Action Req.	INITIAL	DATE
Copies to:		
SURNAME	DATE	Route Code
W	11/5	100
	11/6	101
	11-7	~~300~~
	11/13	330

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

Department of Energy
Southwestern Power Administration
Post Office Box 1619
Tulsa, Oklahoma 74101

OCT 23 1986

Major General Jerome B. Hilmes
Division Engineer
Southwestern Division
U.S. Army Corps of Engineers
1114 Commerce Street
Dallas, TX 75242-0216

Dear General Hilmes:

In accordance with the meeting between our staffs in Dallas yesterday, it was recommended you and I delay signing the Operating Arrangement on Monday, October 27, 1986, as previously scheduled. A customer has expressed concerns about some operational criteria that appear to be in conflict with provisions in his power sales contract. Southwestern Power Administration, Little Rock District Corps of Engineers, and this particular customer have previously scheduled a meeting next week in Arkansas where this issue among others will be discussed and hopefully resolved. If we are successful, I would anticipate signing the Operational Arrangement in the near future. I will contact you to arrange a convenient time for that signing.

Sincerely,

Ronald H. Wilkerson

Ronald H. Wilkerson
Administrator

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

EXHIBIT "B"

OPERATING ARRANGEMENT

TABLE OF CONTENTS

TABLES

Exhibit "B"

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 documentated 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 pre-pared 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

Reservoir	Allowable Daily Release Volume (DSF)	Energy (MWH) (1)
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)	Discha. (DSF)
Beaver1/	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 Ferry2/	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

1/ Minimum generation is based on 3,000 DSF.

TABLE 4

MAXIMUM DRAWDOWN
RATES IN CONSERVATION POOL

Project	Maximum Drawdown Per Week (ft)	Maximum Drawdown In Any Consecutive 4-Week Period (ft)
Beaver	2.0	6.0
Norfork	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

PROJECT	TIME	
	NORMAL	EMERGENCY
FORT WORTH DISTRICT		
Sam Rayburn	20 Minutes	5 Minutes
Whitney	20 Minutes	5 Minutes
LITTLE ROCK DISTRICT		
Beaver	10 Minutes	5 Minutes
Bull Shoals	10 Minutes 1/	5 Minutes
Table Rock	10 Minutes 2/	5 Minutes
Norfork	10 Minutes	5 Minutes
Greers Ferry	10 Minutes	5 Minutes
Dardanelle	10 Minutes	5 Minutes
Ozark	10 Minutes	5 Minutes
TULSA DISTRICT		
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 3/	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

TITLE	DATE
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 Norfork 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

Norfork (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 Administration

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

EXHIBIT D

OPERATING PLAN FOR SOUTHWESTERN DIVISION (SWD) CORPS OF ENGINEERS (COE) HYDROPOWER

OPERATING PLAN

TABLE OF CONTENTS

ENCLOSURES

OPERATING PLAN

(Reservoir Regulation and Power Scheduling)

1. Purpose To outline processes and procedures for coordination of operations, maintenance, regulation of our power plant generation equipment and schedules. The goal is to operate projects within the authorized purposes. This document does not supersede any information or requirements, contained in water control manuals (see Table 6 for list of manuals and latest revisions), or other legal determinations. Also this document does not supersede or replace the 1986 Operating Arrangement between the Corps of Engineers (COE) and Southwestern Power Administration (SWPA).

2. Activities. SWD and SWPA activities include:

2.1 Activities of SWD:

2.1.1 The regulation of SWD District projects in accordance with authorized purposes and in accordance with approved water control plans and approved deviations.

2.1.2 The daily operation and maintenance of electric generation equipment and project facilities, including scheduling of outages at each SWD power plant.

2.1.3 The determination of hourly, daily and monthly water release requirements at SWD projects.

2.1.4 The preservation of project integrity.

2.2 Activities of SWPA:

2.2.1 The marketing and transmission of surplus (in excess of project requirements) power.

2.2.2 The preparation of monthly estimates of generation requirements for each SWD project.

2.2.3 The hourly, daily and monthly scheduling of power plants to meet system requirements.

2.2.4 To contract for the sale of power and energy generated at SWD projects.

2.3 SWD and SWPA will consult on load and resource requirements.

3. Procedures.

3.1 Power Allocations and Monthly Meetings.

3.1.1 A monthly hydropower meeting will be held by SWPA 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 or in person.

3.1.2 SWD may furnish SWPA recommended monthly available energy along with maximum and minimum energy quantities for their projects for the following month. Development of recommended monthly hydropower energies will consider the individual project rule curve, projected reservoir condition, water quality, endangered species, fish and wildlife and any authorized reservoir uses. This information will be provided formally via email prior to the monthly hydropower meeting.

3.1.3 SWPA will furnish SWD its anticipated energy needs for the following month from SWD projects. These monthly hydropower needs will consider SWPA system guide curve, load requirements, the condition of the interconnected reservoir system, projected reservoir conditions, available capacity, inflow trends and the ability to obtain energy from other sources. This information will be available to each SWD district via email prior to the monthly hydropower meeting.

3.1.4 During the monthly operational meeting, both SWPA and each SWD District will agree on the proposed generation (hydropower allocation) at each SWD project. The agreed upon releases will be documented in the final monthly operations meeting minutes prepared by SWPA which will be transmitted via email.

3.2 Operation.

3.2.1 General.

3.2.1.1 SWPA will schedule the monthly hydropower production in accordance with the monthly agreement. However, in event of special conditions or unforeseen events, SWPA may schedule hydropower production differently than specified in monthly agreement, provided that these changes are arranged with the responsible SWD District Office prior to scheduling.

3.2.1.2 Operation of SWD projects for hydropower operations within approved regulations will be handled between SWPA and the appropriate SWD District Office. Occasionally SWD will become involved in regional and special day-to-day operations described herein.

3.2.1.3 Power plant system controller shall begin or adjust generation in accordance with SWPA schedule as requested. The power plant system controller 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 controller will commence generation to the requested limits in a manner consistent with the system needs (normally across the hour in a ten-minute period). If the request exceeds the limits or violates the conditions previously established, the power plant system controller will advise the dispatcher as to what generation is available from the power plant.

3.2.1.4 Daily, SWD District Offices will make available to SWPA 4-day forecast of inflow, pool elevations and any limiting constraints for each project.

3.2.1.5 If it is determined that a turbine is operating in a rough zone, either the load will be changed or the unit will be shutdown to prevent damage to equipment. Power Plant System controller will contact the SWPA Dispatcher to facilitate the reliability of the bulk power system.

3.2.1.6 Notification of all scheduled and unscheduled outages shall be made using the attached unit un-availability for (Form 2) or revision thereto. The report shall be used to notify SWPA, internal Corps Offices and SWD. Notifications will be given when unit is removed and returned to service.

3.2.2 Flood Risk Management Operations.

3.2.2.1 During flood risk management operations, SWD H&H District Offices will furnish to SWPA a statement of flood control objectives for the next four days relative to individual pool regulations and planned release volumes. The release schedule will be furnished via email.

3.2.2.2 SWPA will plan its generation schedule consistent with flood releases.

3.2.2.3 SWD District Offices will coordinate daily if necessary with SWPA and provide required releases. The firm power hydropower releases are listed in Table 1. Generation may be limited to less than that shown in Table 1 for conditions described in para 3.2.4.5

3.2.2.4 SWPA will reschedule generation between projects and/or obtain other resources to meet its needs to effect any changes in project releases required by SWD District Offices for flood risk management needs to the extent possible. In the event SWPA is unable to reschedule generation or obtain sufficient resources to meet its needs,

SWPA may declare a power emergency in accordance with Section 3.2.4.3 Declared Power Emergency.

3.2.3 Conservation Operation.

3.2.3.1 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.

3.2.3.2 SWPA will be responsible for daily hydropower operations to meet 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.

3.2.3.3 SWPA will furnish SWD a weekly statement of their generation plans and objectives relative to pool manipulations. 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.

3.2.3.4 Release schedules by SWPA and the Districts will consider project and system curves, pool zone criteria, drawdown limits, current and projected pool conditions, downstream needs, and the needs of other authorized uses of the project.

3.2.3.5 Table 4 shows maximum drawdown rates within the conservation pool for applicable Corps projects.

3.2.4 Special Operations

3.2.4.1 General. Normally, special operations will be coordinated by SWD Districts and SWPA. These operations will be documented in the minutes of the monthly hydropower meeting. If these special operations arise after the scheduled monthly meeting the SWD District will email the completed special operations form (Form 1) to SWPA. SWD Districts will coordinate with SWD those special operations which have significant impacts on SWPA. SWD Districts will notify SWPA of the special operating limits which are necessary for the operation of its projects. SWPA will be notified of planned special operations by email using the special operations form. SWD Districts will notify SWPA as soon as each special operating schedule is determined.

3.2.4.2 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

modification from previously agreed to schedules. These situations (short term emergencies) typica1ly 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 will be coordinated prior to scheduling with the appropriate SWD District Office. When the required response does not permit prior coordination, the power plant system controller 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 project to respond to a generation change under normal and emergency conditions.

3.2.4.3 Declared Power Emergency. It is recognized that SWPA has an obligation to its customers, the Southwest Power Pool (SPP), and various regulatory bodies to adhere to mandatory reliability standards and requirements in an effort to minimize power system disturbances. In the event of a declared power emergency, the power plant system controller can make limited excursions beyond normal operation limits provided that equipment rating is not exceeded. For all operations, either normal or emergency, the power plant system controller shall operate his equipment in accordance with the listed criteria below.

(a) 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.

(b) Would not conflict with the statutory requirements for the operation of said projects with regard to authorized purposes.

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

(d) Would not infringe upon the vested property rights of third parties.

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

3.2.4.4 Short Term Emergency. Short term emergencies requiring a reduction in releases such as for drowning, imminent loss of life, 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 by the power plant system controller to SWPA, and District H&H staff at the earliest possible time. Depending on circumstances, initial notification by power plant system controller may be by telephone and then followed up with an email.

3.2.4.5 Flood Constraints. SWD has the responsibility to minimize flooding to the extent possible by the regulation of Federal projects. Hydropower generation may be constrained during flood periods to prevent reservoir releases from adding to downstream damages. For any changes to scheduled generation, the District H&H staff will notify SWPA and power plant system controller. The actual request for generation load change will be confirmed and initiated by the SWPA dispatcher to the power plant system controller.

3.2.5 Generation Scheduling. Request for actual generation at a power plant will be given to the power plant system controller by the SWPA dispatcher or dispatcher designated in writing by SWPA. To the maximum extent possible, these requests will conform to the weekly schedules.

3.2.6 Generating Equipment Maintenance Schedule. The planned routine outage schedule will be prepared by SWD Districts and will be furnished to SWPA by February 1. The Planned routine outages should avoid the agreed to seasonal power peak load periods when practical. Changes to the scheduled outages should be provided to SWPA prior to the monthly scheduled operational meeting or as soon as practical. SWPA requests for rescheduling during the course of the year due to unanticipated load requirements or water conditions shall be transmitted to SWD Districts via email. Changes to the schedule initiated by a District during the course of the year will be coordinated with SWPA.

3.2.7 Unplanned Outages. The Districts will notify SWPA as soon as possible in the event of forced outages.

3.2.8 Switching Activities. Switching operations which affect the high-voltage transmission system or the availability of a unit will be coordinated with SWPA.

TABLE 1

FIRM POWER RELEASES

RESERVOIR	ALLOWABLE VOLUME (DSF)	DAILY RELEASE ENERGY (MWH) (1)
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 the power pool.

TABLE 2

WATER RELEASE REQUIREMENTS FOR INSTREAM FLOW NEEDS

Project	Period of Time in Effect	Forecast Air Temperature (Degrees Fahrenheit)							
		90 or Below		91 - 95		96 - 104		105 & 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
Broken Bow	Jan - Dec	Maintain 100 CFS from re-regulation structure.							

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.
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

1/ Minimum generation is based on 3,000 DSF.

TABLE 4

MAXIMUM DRAWDOWN RATES IN CONSERVATION POOL

PROJECT	MAXIMUM DRAWDOWN PER WEEK (FT)	MAXIMUM DRAWDOWN IN ANY CONSECUTIVE 4-WEEK PERIOD (FT)
BEAVER	2.0	6.0
NORFORK	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 CHANGES IN GENERATION

PROJECT	TIME	
	NORMAL	EMERGENCY
FORT WORTH DISTRICT		
SAM RAYBURN	10 minutes	5 minutes
WHITNEY	10 minutes	5 minutes
LITTLE ROCK DISTRICT		
BEAVER	10 minutes	5 minutes
BULL SHOALS	10 minutes 1/	5 minutes
TABLE ROCK	10 minutes 2/	5 minutes
NORFORK	10 minutes	5 minutes
GREERS FERRY	10 minutes	5 minutes
DARDANELLE	10 minutes	5 minutes
OZARK	10 minutes	5 minutes
TULSA DISTRICT		
BROKEN BOW	10 minutes	5 minutes
DENISON	10 minutes	5 minutes
EUFAULA	10 minutes	5 minutes
FORT GIBSON	10 minutes	5 minutes
KEYSTONE	10 minutes	5 minutes
ROBERT S. KERR	10 minutes 3/	5 minutes
TENKILLER FERRY	10 minutes	5 minutes
WEBBERS FALLS	10 minutes	5 minutes

Notes:

General. Indicated Emergency Start Up and Loading times assume the power plant 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 ½ hour between third and fourth units or a lag of one hour if third and fourth are started simultaneously.

TABLE 6

WATER CONTROL MANUALS

TITLE	DATE
Lake Regulation Manual, Broken Bow Lake	Feb 2000
Lake Texoma Water Control Manual,	Apr 1993
Reservoir Regulation Manual for Eufaula Reservoir	Jan 1994
Reservoir Regulation Manual for Pensacola, Markham Ferry and Fort Gibson Reservoirs	Nov 1992
Reservoir Regulation Manual for Keystone Reservoir	Jan 1990
Reservoir Regulation Manual, Robert S. Kerr Lock And Dam Reservoir	Dec 1998
Lake Regulation Manual, Tenkiller Ferry Lake	Mar 1977
Reservoir Regulation Manual, Webbers Falls Lock And Dam	Dec 1997
Sam Rayburn Reservoir Water Control Manual	Jan 1982
Whitney Lake Water Control Manual	Apr 1975
Dam B Reservoir (R.D. Willis)	Mar 1956
Reservoir Regulation Manual for Greers Ferry Reservoir	Mar 1963 Revised Nov 1966
Reservoir Regulation Manual for Beaver Lake	Oct 1998
Reservoir Regulation Manual for Table Rock,	Mar 1963
Bull Shoals, and Norfork Reservoirs	Revised Oct 1966
Regulation Manual for Ozark L&D and Pool No. 13	Oct 1974
Regulation Manual for Lake Dardanelle and Pool No. 9	Feb 1976
Arkansas River Master Water Control Manual	Oct 1980 Revised Oct 2007, (- Chapter 7)

FORM 1

Special Hydropower Operations Request
Southwestern Power Administration

Project: Date prepared:

Submitter
Name/District:
Phone: Cell Email:

Purpose:

Units affected/Proposed
Operation:

From: hours Month: Day:
To: hours Month: Day:

On-site contact
Person(s):
Agency/Organization:
Phone Number:
Cell Phone Number:

Comments:

Emailed to:

FORM 2

CORPS OF ENGINEERS (TULSA) **UNIT UNAVAILIBILITY REPORT**	
STATION:	
UNITS	TYPE OF OUTAGE:
GDFO: Generator Delayed Forced Outage. GFO: Generator Forced Outage. GSO: Generator Scheduled Outage. NGDF: Non-Generator Delayed Forced Outage. NGFO: Non-Generator Forced Outage NGSO: Non-Generator Scheduled Outage	
RELAYS OPERATED:	
BREAKERS TRIPPED:	
ESTIMATED TIME TO RETURN TO SERVICE: HRS.	
REPAIRS OR CORRECTIONS MADE	

RESTORED	DATE	TIME:
TOTAL UNAVAILABLE TIME: HOURS MINUTES		
POWER PLANT:		

Name

Signature **Date**

Title

PLATES AND DRAWINGS

FORT GIBSON LAKE

US ARMY CORPS OF ENGINEERS
TULSA DISTRICT

U.S. Representative — U.S. Senator

KANSAS

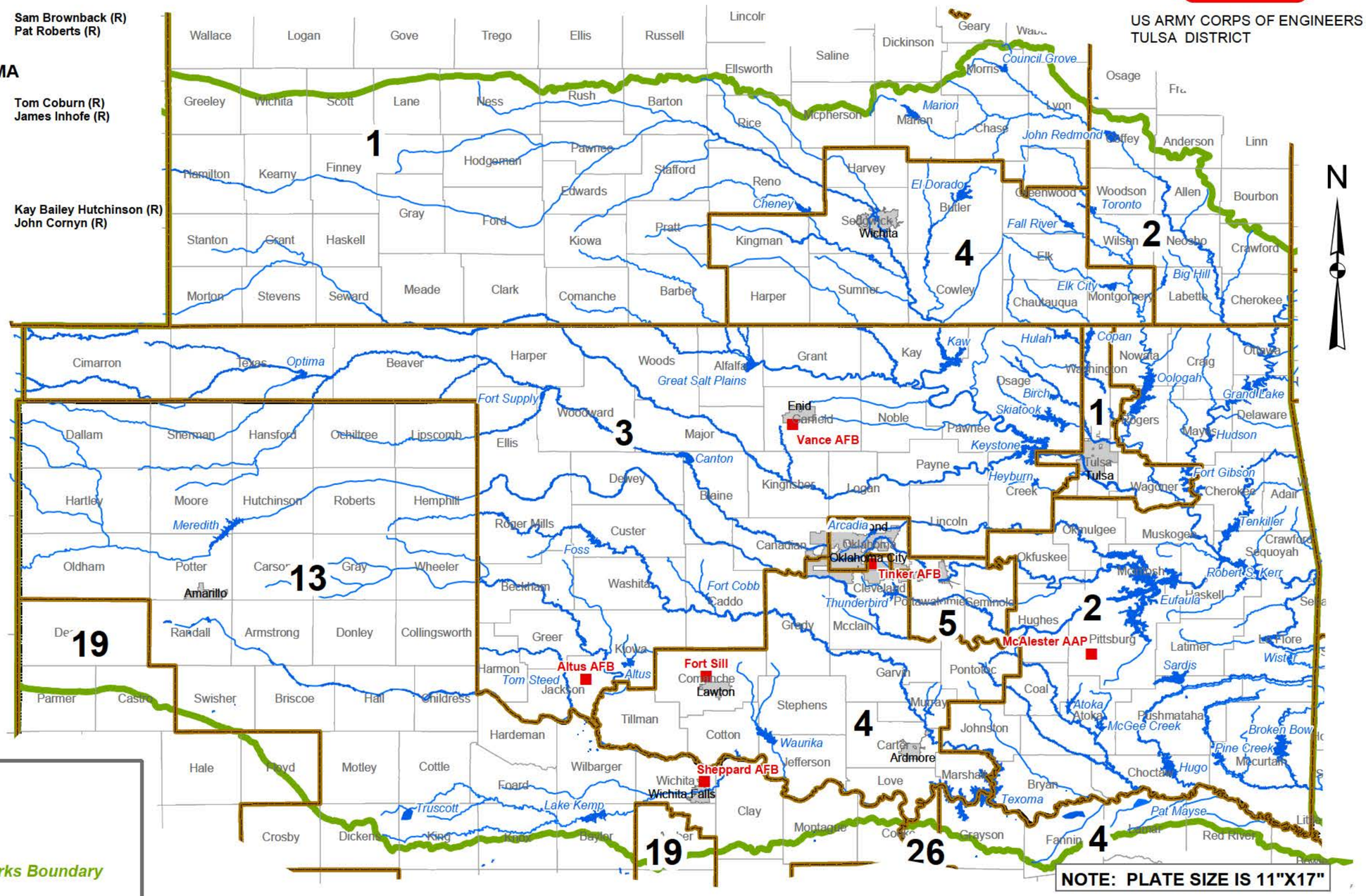
U.S. Representative	U.S. Senator
1 Jerry Moran (R)	Sam Brownback (R)
2 Lynn Jenkins (R)	Pat Roberts (R)
4 Todd Tiahirt (R)	

OKLAHOMA

U.S. Representative	U.S. Senator
1 John Sullivan (R)	Tom Coburn (R)
2 Dan Boren (D)	James Inhofe (R)
3 Frank Lucas (R)	
4 Tom Cole (R)	
5 James Lankford (R)	

TEXAS

U.S. Representative	U.S. Senator
4 Ralph M. Hall (R)	Kay Bailey Hutchinson (R)
13 Mac Thornberry (R)	John Cornyn (R)
19 Randy Neugebauer (R)	
26 Michael C. Burgess (R)	



Lakes

Military Installations

Tulsa District Civil Works Boundary

111th Congressional Boundaries

PLATE 1 - 1

Nowata County
Washington County
Craig County
Oologah Lake
Grand Lake
Watershed Boundary
Rogers County
Adair
Delaware County
Claremore
Mayes County
Lake Hudson
Pryor
Benton County
Choteau
Tulsa
Tulsa County
Verdigris River
Grand (Neosho) R.
Ft. Gibson Lake
Cherokee County
Wagoner County
Wagoner
Tahlequah
Arkansas River
Okmulgee County
66
44
69
20
4
412
82
51

KANSAS
OKLAHOMA
TEXAS
Fort Gibson Lake Basin
Tulsa
Oklahoma City
FORT GIBSON LAKE

VICINITY MAP

N

OKLAHOMA
ARKANSAS

0 5 10 Miles

NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED — GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

PROJECT LOCATION AND VICINITY MAP

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 1

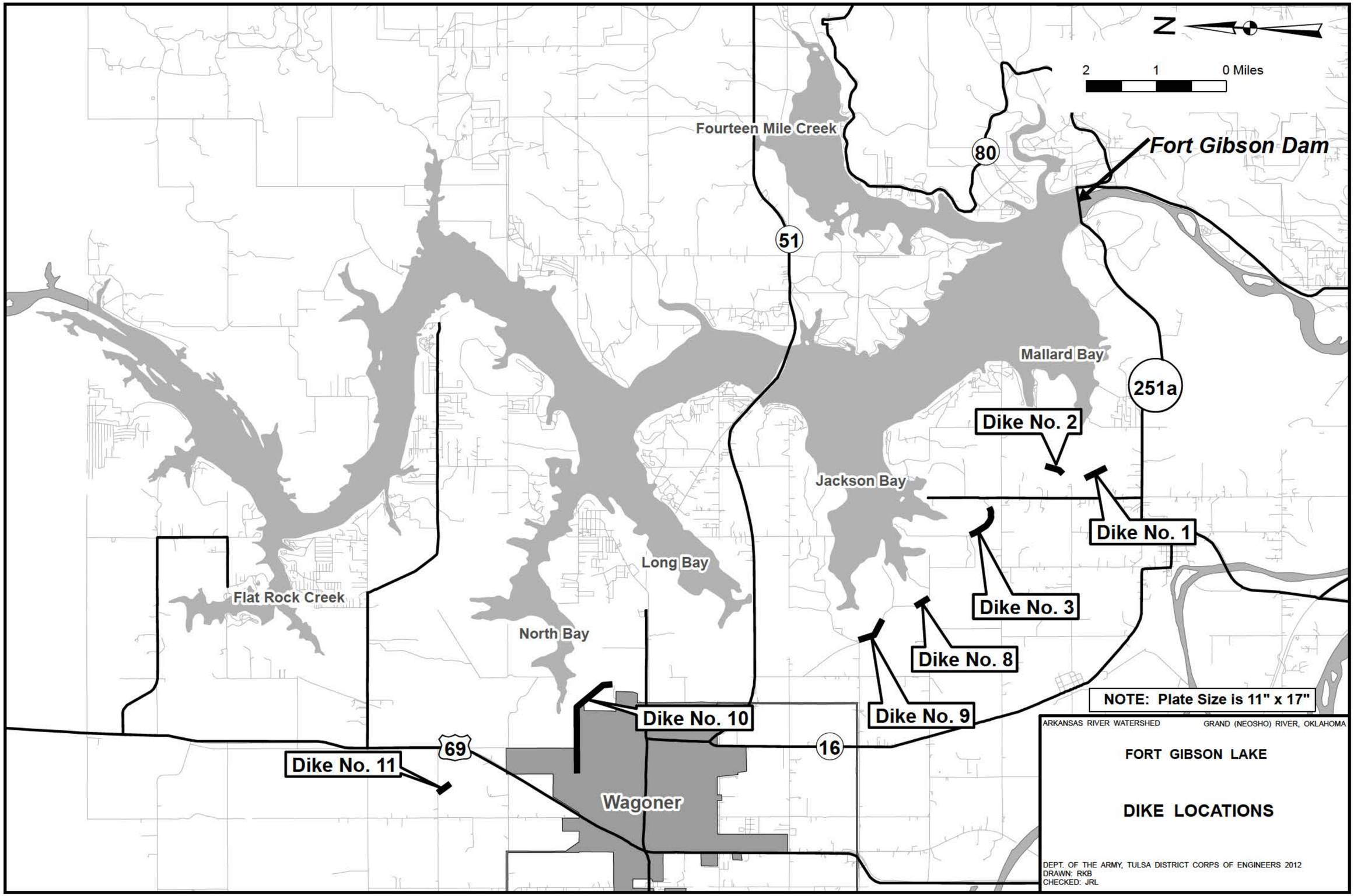

N
2
1
0 Miles
Fourteen Mile Creek
80
Fort Gibson Dam
51
Mallard Bay
251a
Dike No. 2
Jackson Bay
Dike No. 1
Long Bay
Dike No. 3
Flat Rock Creek
North Bay
Dike No. 8
Dike No. 9
NOTE: Plate Size is 11" x 17"
Dike No. 10
69
16
Dike No. 11
Wagoner
ARKANSAS RIVER WATERSHED
GRAND (NEOSHO) RIVER, OKLAHOMA
FORT GIBSON LAKE
DIKE LOCATIONS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2012
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 2

(b) (7)(F)

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

GENERAL PLAN AND SECTIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

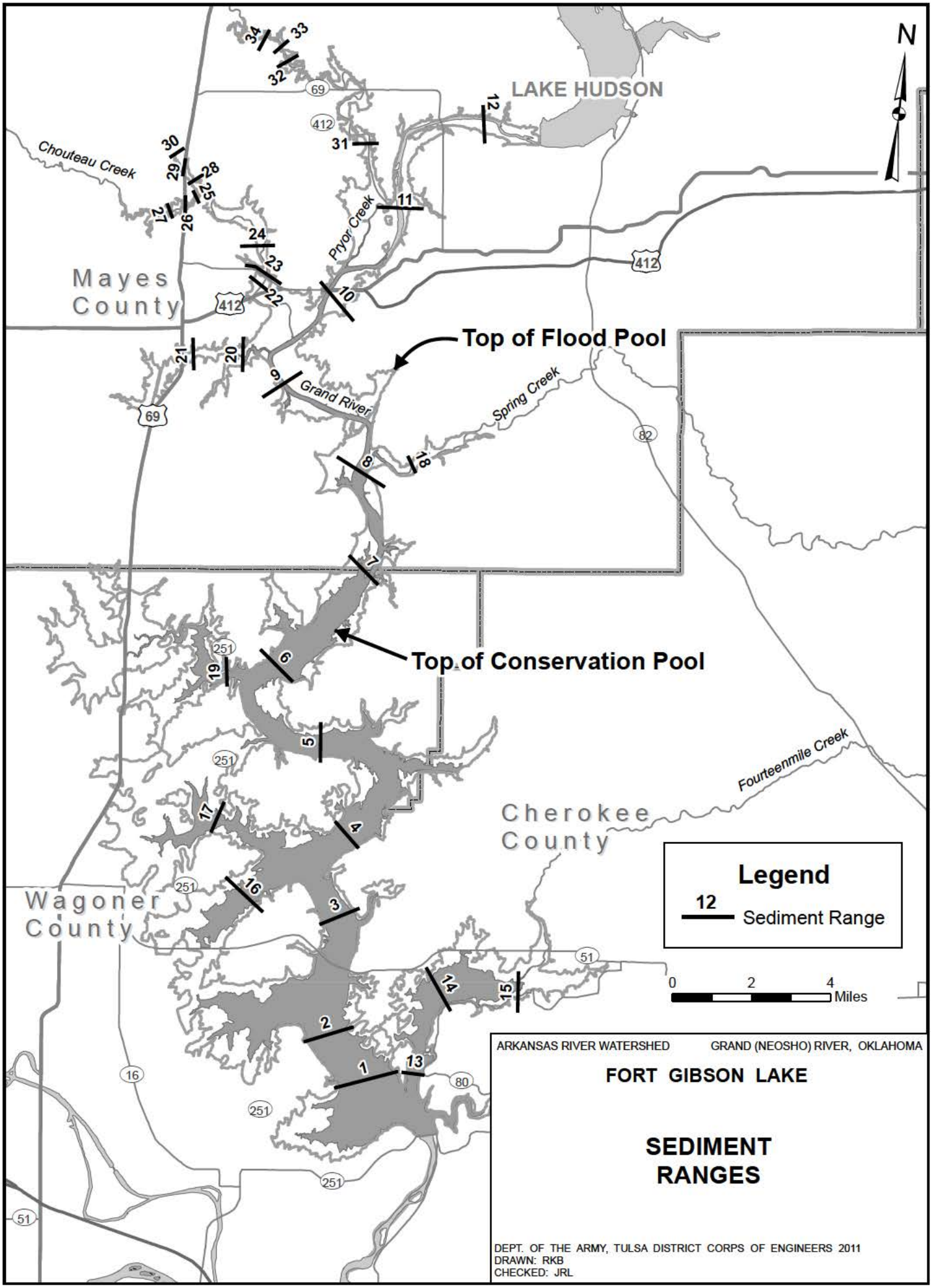

N
LAKE HUDSON
Chouteau Creek
Pryor Creek
Mayes County
Top of Flood Pool
Grand River
Spring Creek
Top of Conservation Pool
Fourteenmile Creek
Cherokee County
Wagoner County
Legend
12
Sediment Range
0 2 4
Miles
ARKANSAS RIVER WATERSHED
GRAND (NEOSHO) RIVER, OKLAHOMA
FORT GIBSON LAKE
SEDIMENT RANGES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 4

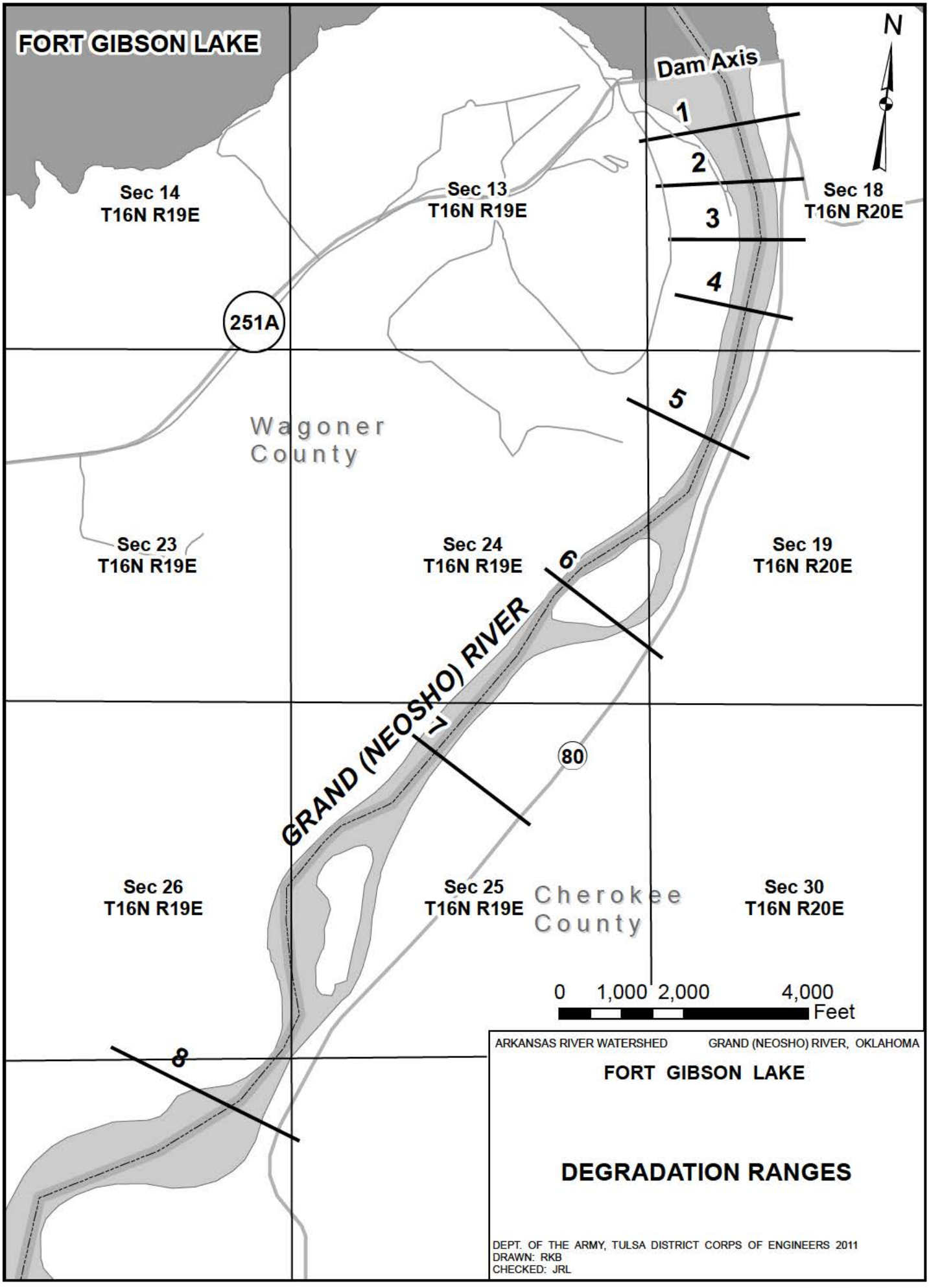
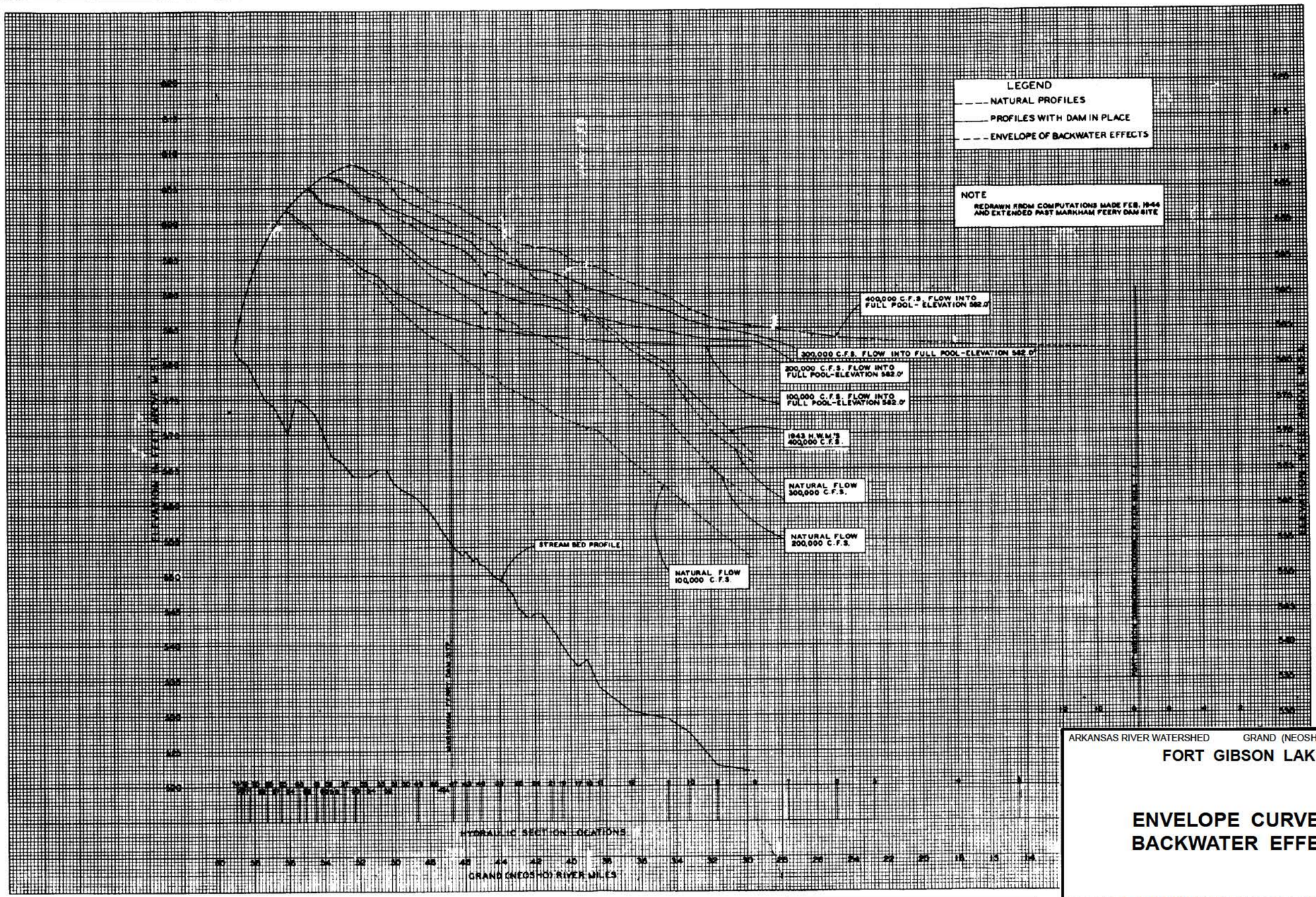

FORT GIBSON LAKE
Dam Axis
N
1
2
3
4
5
6
7
8
Sec 14
T16N R19E
Sec 13
T16N R19E
Sec 18
T16N R20E
251A
Wagoner
County
Sec 23
T16N R19E
Sec 24
T16N R19E
Sec 19
T16N R20E
GRAND (NEOSHO) RIVER
80
Sec 26
T16N R19E
Sec 25
T16N R19E
Cherokee
County
Sec 30
T16N R20E
0 1,000 2,000 4,000
Feet
ARKANSAS RIVER WATERSHED
GRAND (NEOSHO) RIVER, OKLAHOMA
FORT GIBSON LAKE
DEGRADATION RANGES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 2 - 5



ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

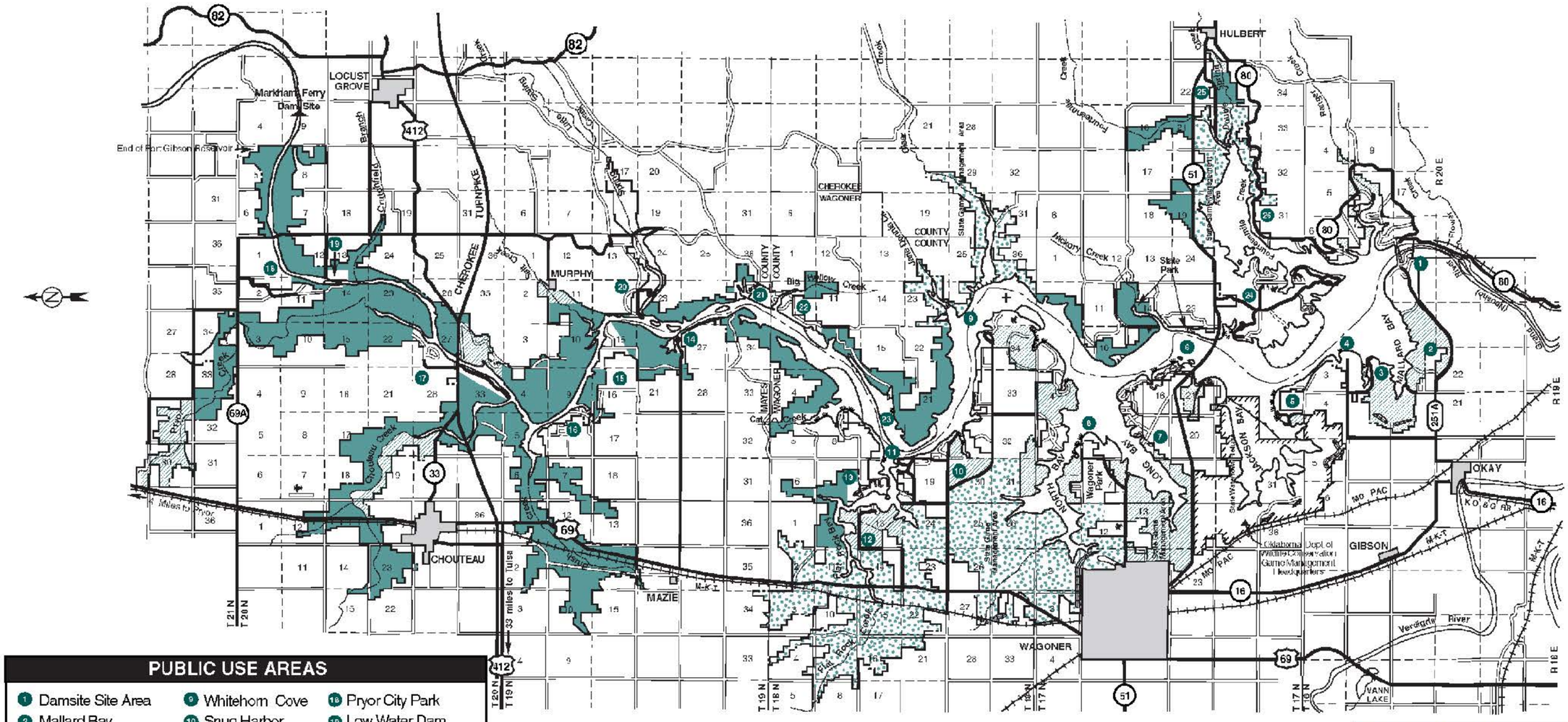
ENVELOPE CURVE OF BACKWATER EFFECTS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

NOTE: Plate Size is 11" x 17"

FORT GIBSON LAKE

PUBLIC HUNTING AREA



PUBLIC USE AREAS

1. Damsite Site Area
2. Mallard Bay
3. Wahoo Bay
4. Sequoyah State Park (Bay Area)
5. Jackson Bay
6. Taylor Ferry
7. Long Bay Landing
8. Wagoner City Park
9. Whitehorn Cove
10. Snug Harbor
11. Rocky Point
12. Blue Bill Point
13. Flat Rock Creek
14. Three Finger Bay
15. Mission Bend
16. Mazie Landing
17. Chouteau Bend
18. Pryor City Park
19. Low Water Dam
20. Spring Creek
21. Earbob Ferry
22. Big Hollow
23. Big Bend
24. Sequoyah State Park
25. Hulbert Landing
26. Wildwood

LEGEND

- Paved Road
- Improved Road
- Project Boundary
- Brush Rows
- Uncleared
- Corps Areas Open For Hunting
- State Areas Open For Hunting
- See Restrictions

Scale of Miles: 1 0 1 2

RESERVOIR DATA
Power pool El. 554.0
225 approx. shoreline miles at El. 554.0
Total project land & water acreage 72249

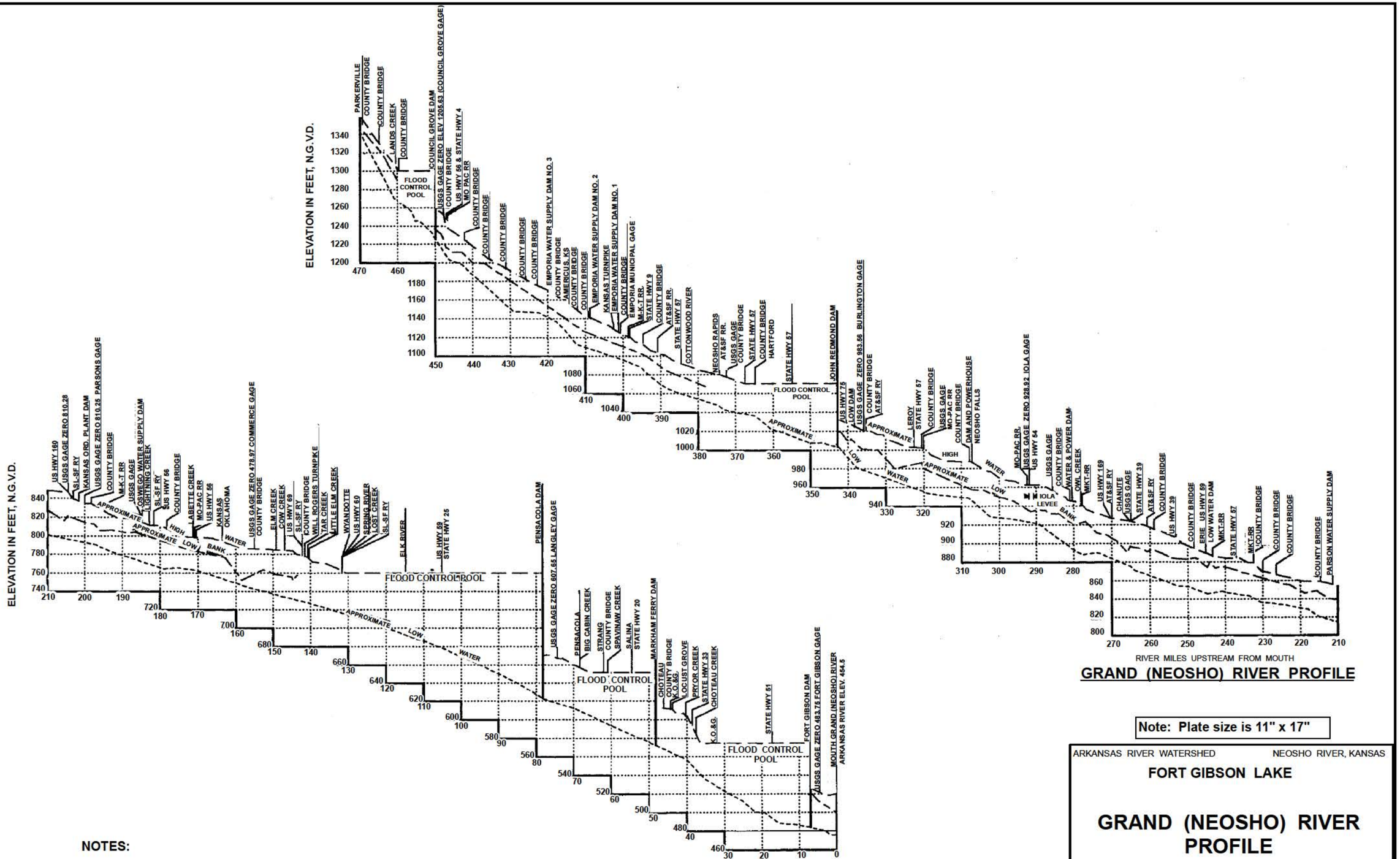
NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

PUBLIC USE AREAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL



NOTES:

NO DATA AVAILABLE FROM R.M. 469.7 TO SOURCE (R.M. 482)

Note: Plate size is 11" x 17"

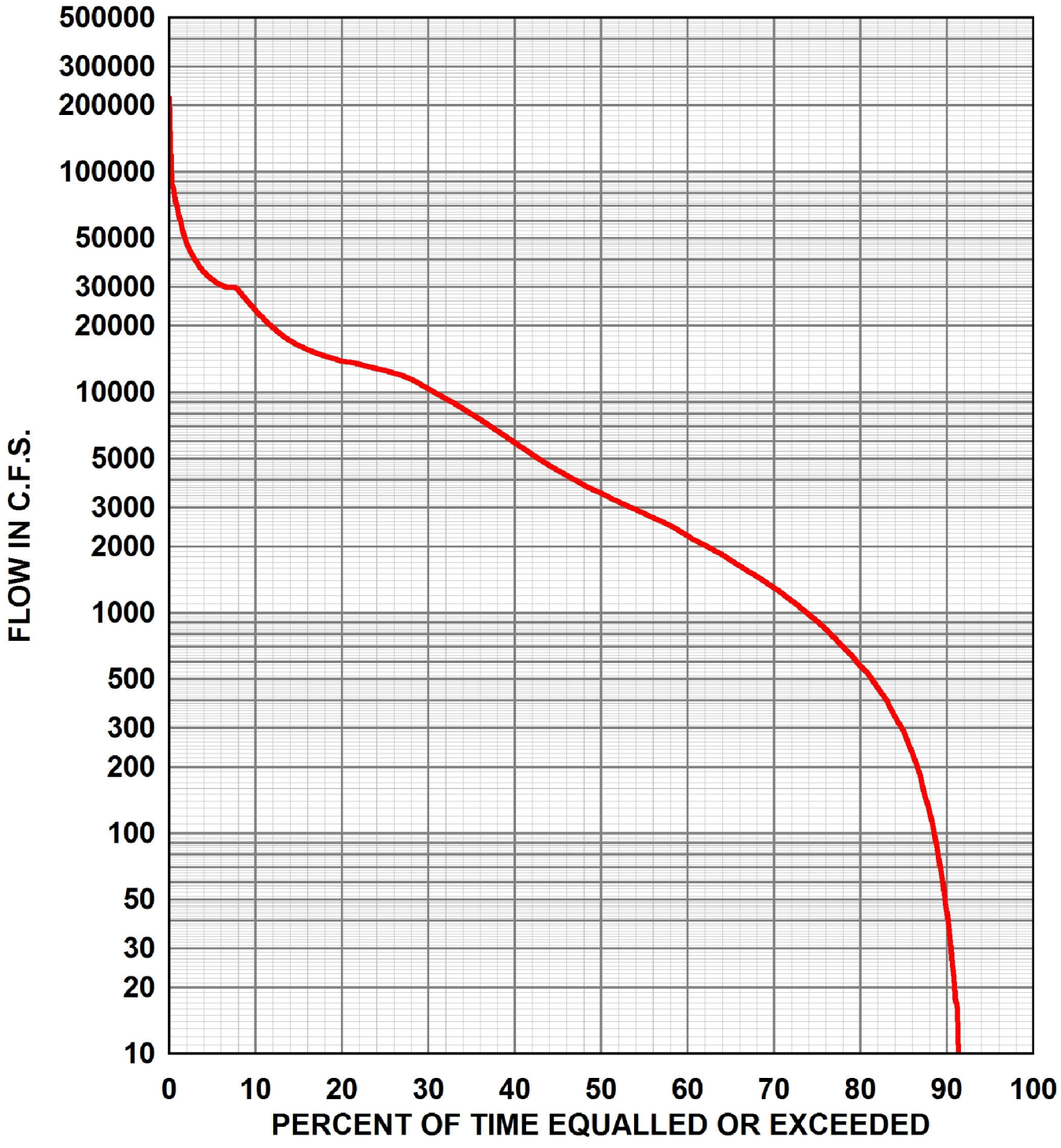
ARKANSAS RIVER WATERSHED — NEOSHO RIVER, KANSAS

FORT GIBSON LAKE

GRAND (NEOSHO) RIVER PROFILE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 1



NOTE:
BASED ON PERIOD OF RECORD
JAN 1940 THRU DEC 2008

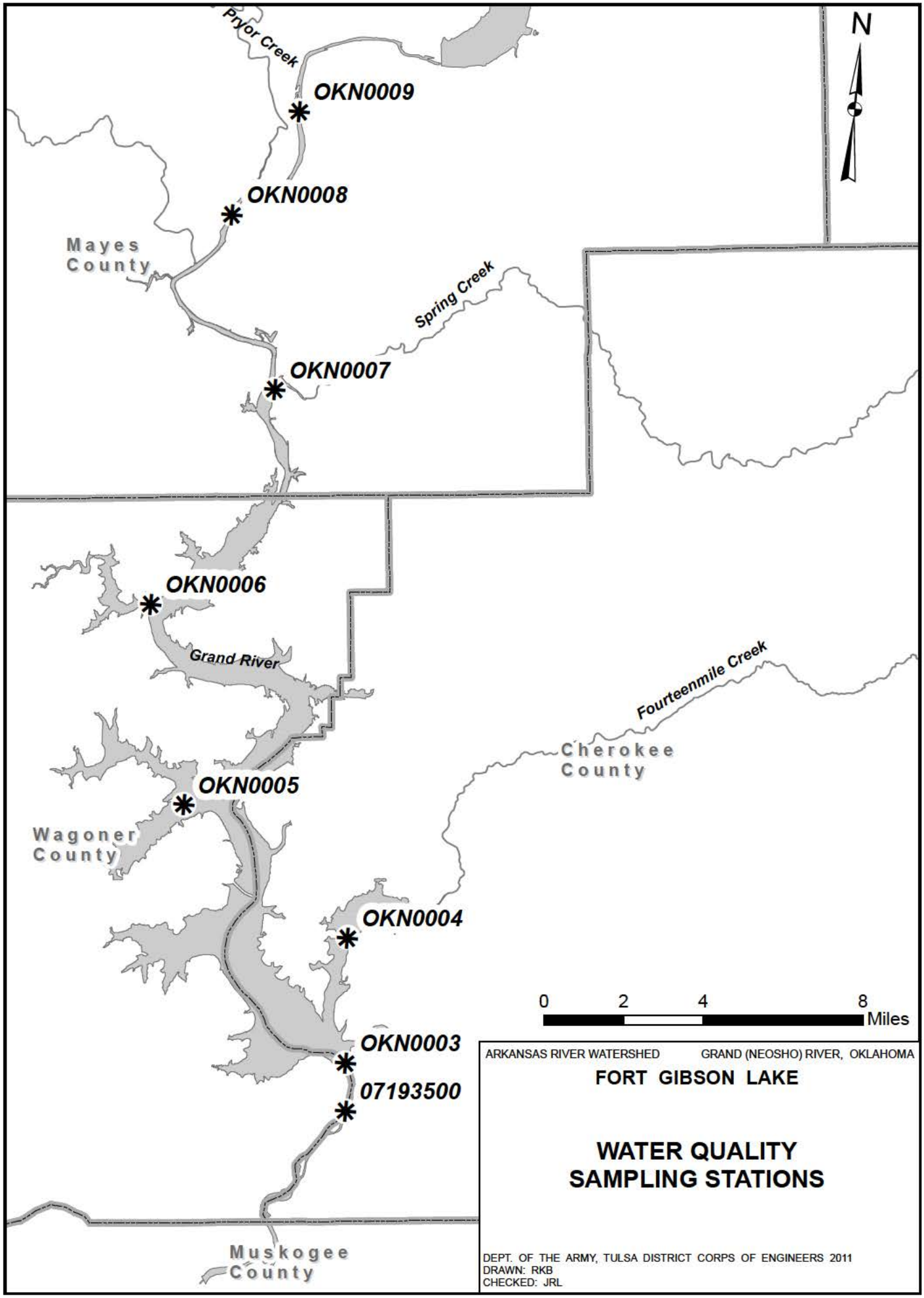
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

FLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 2



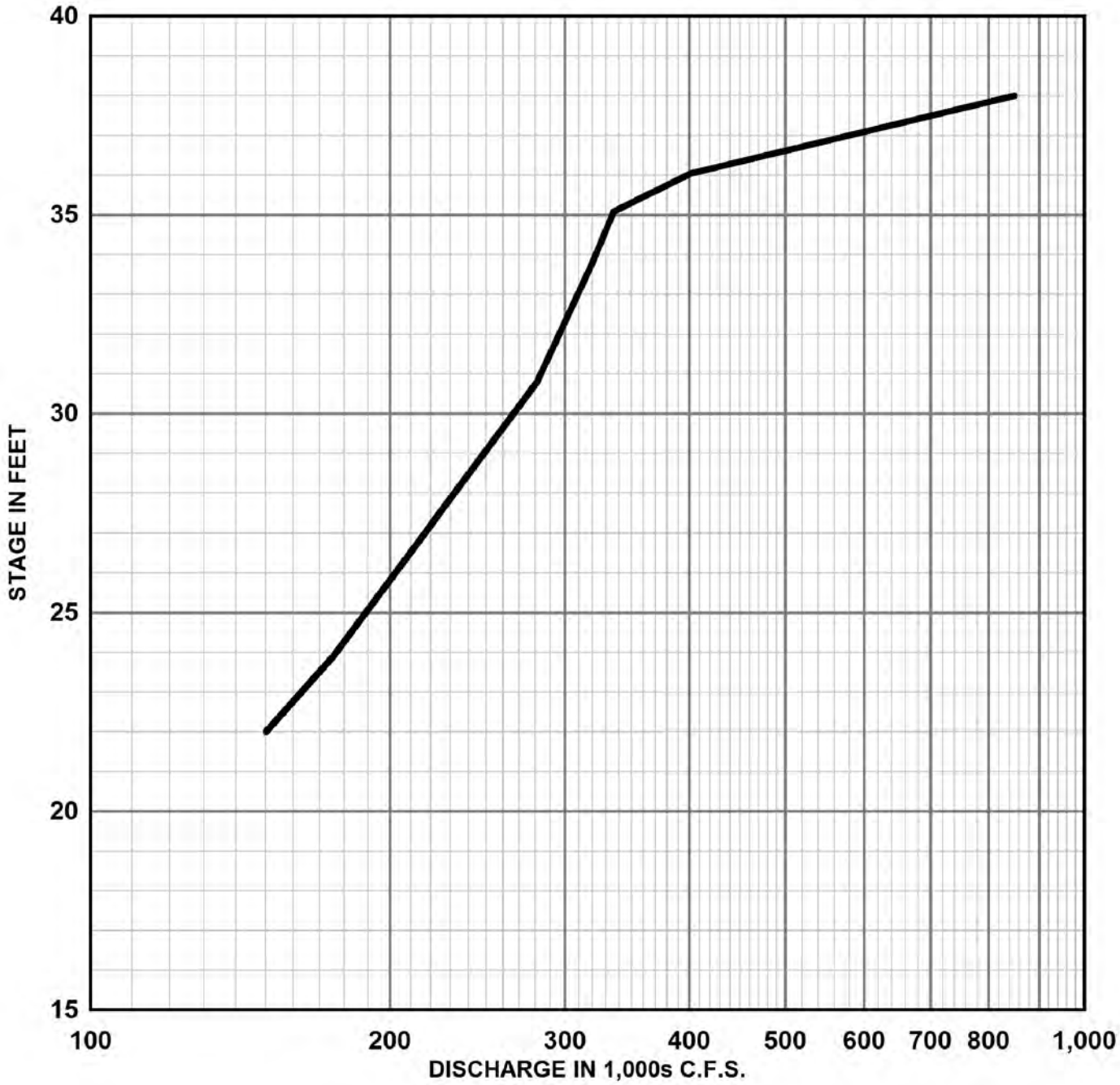
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

WATER QUALITY SAMPLING STATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 3



ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

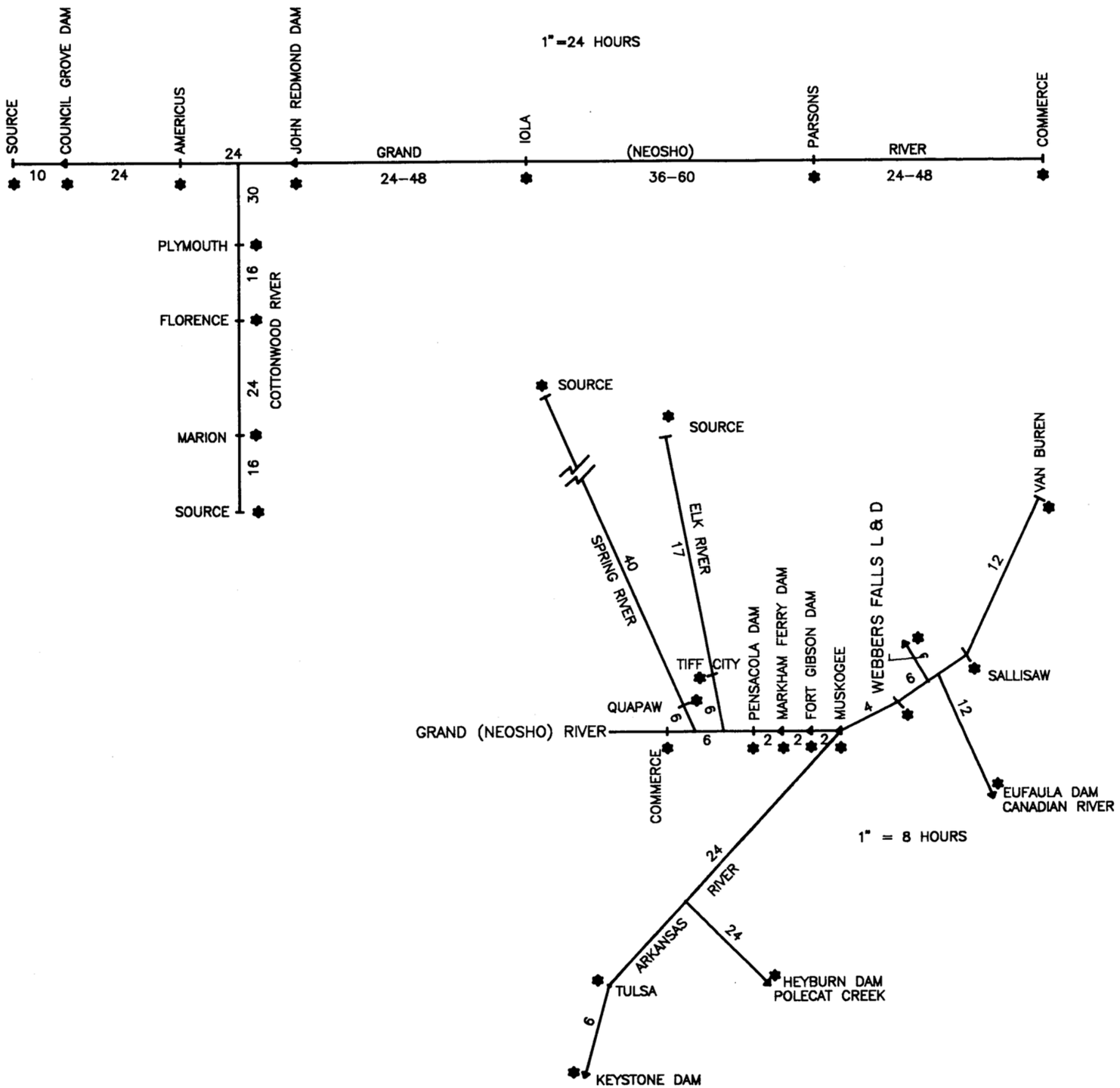
FORT GIBSON LAKE

DISCHARGE RATING CURVE

VAN BUREN, ARKANSAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 4



NOTE:

1. TIME OF TRAVEL IN HOURS FOR LARGE RISES IS SHOWN: *24*
2. TIME SHOWN ABOVE UPSTREAM STATION IS AVERAGE TIME TO CREST AFTER BEGINNING OF RUNOFF.

NOTE: Plate Size is 11" x 17"

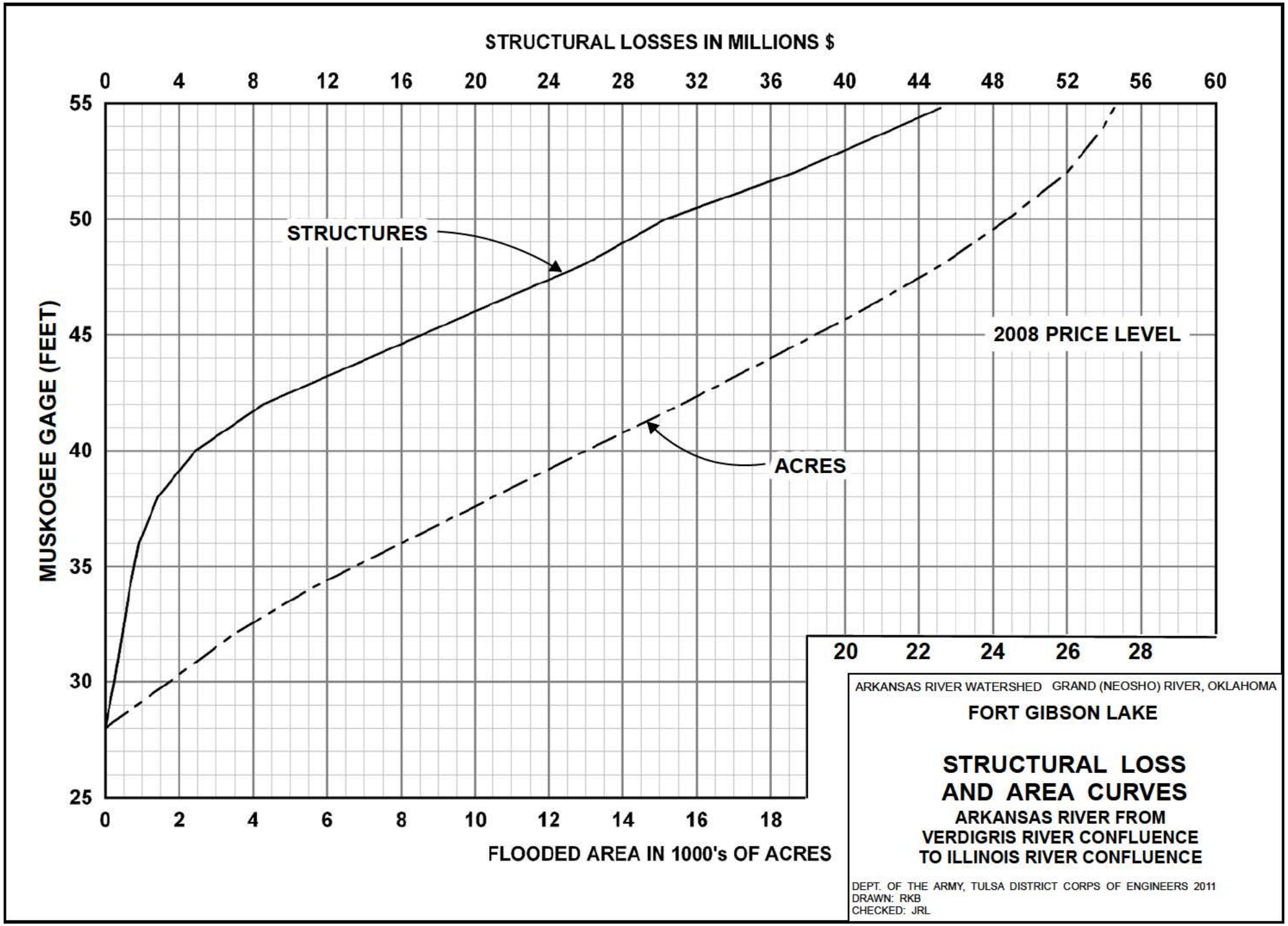
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

TIME OF CREST TRAVEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 5



ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

STRUCTURAL LOSS AND AREA CURVES

ARKANSAS RIVER FROM VERDIGRIS RIVER CONFLUENCE TO ILLINOIS RIVER CONFLUENCE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 4 - 6

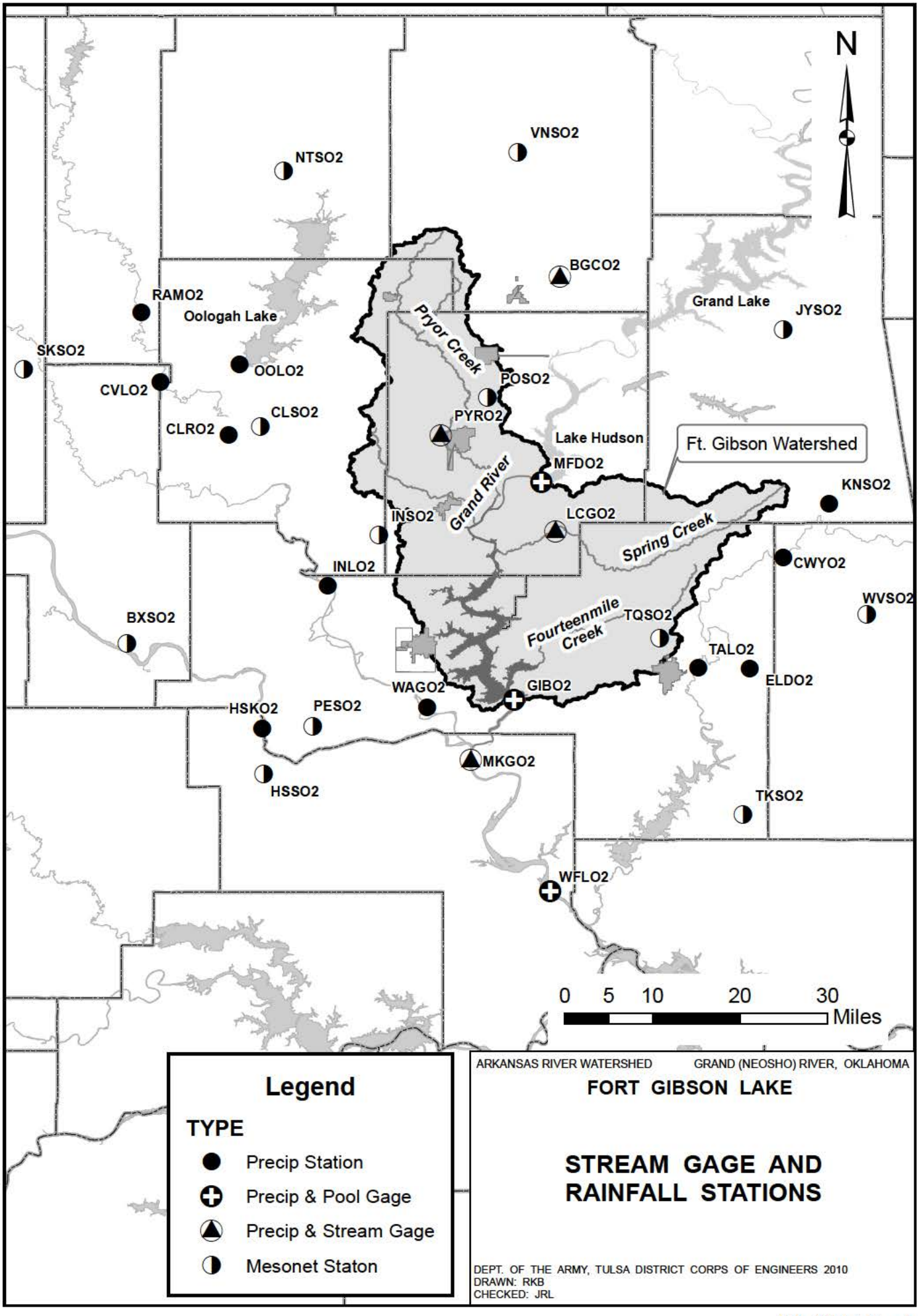
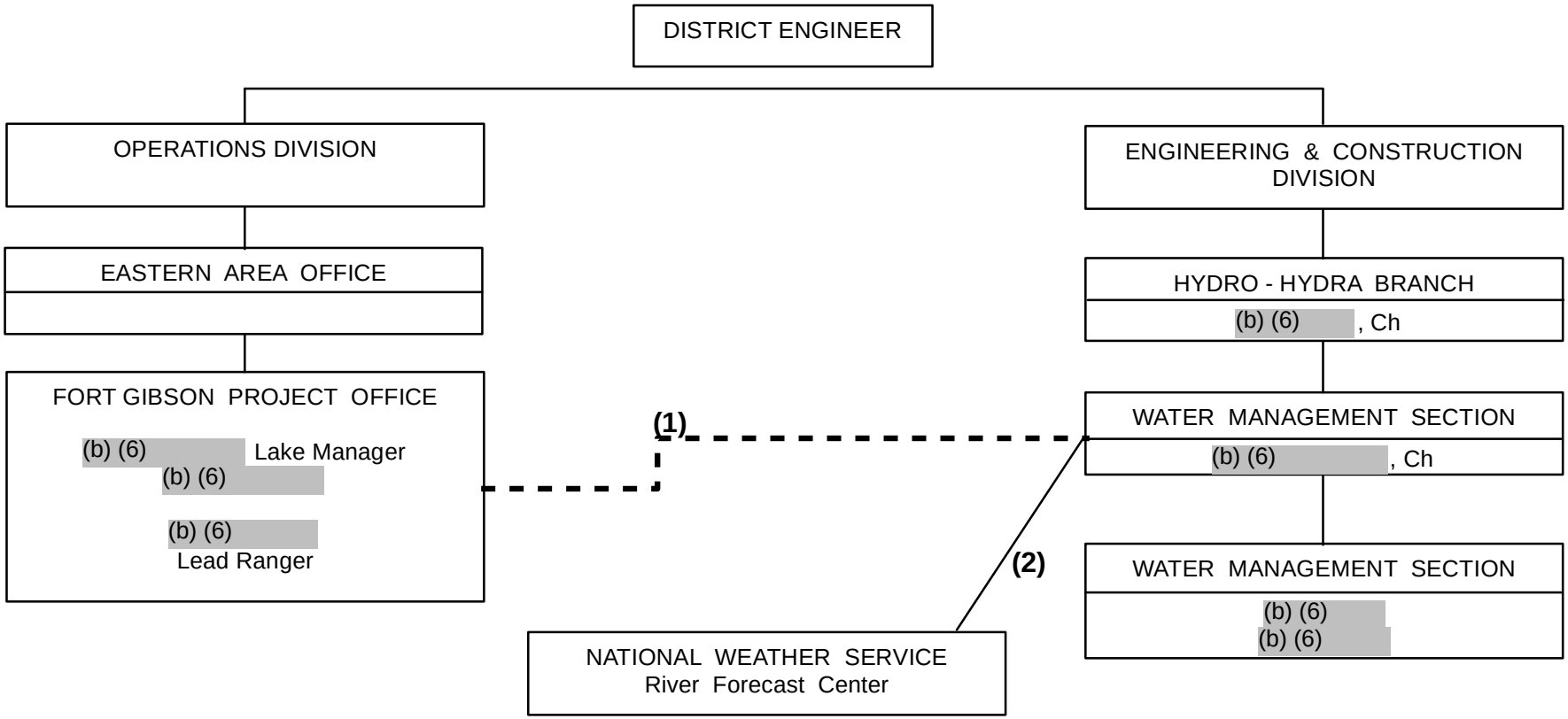

N
VNSO2
NTSO2
BGCO2
RAMO2
Oologah Lake
Grand Lake
JYSO2
Pryor Creek
SKSO2
OOLO2
POSO2
CVLO2
CLSO2
PYRO2
CLRO2
Lake Hudson
Ft. Gibson Watershed
MFDO2
KNSO2
Grand River
INSO2
LCGO2
Spring Creek
CWYO2
INLO2
WVSO2
BXSO2
Fourteenmile Creek
TQSO2
TALO2
ELDO2
WAGO2
GIBO2
HSKO2
PESO2
MKGO2
HSSO2
TKSO2
WFLO2
0 5 10 20 30
Miles
Legend
TYPE
Precip Station
Precip & Pool Gage
Precip & Stream Gage
Mesonet Staton
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA
FORT GIBSON LAKE
STREAM GAGE AND RAINFALL STATIONS
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 5 - 1

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN FORT GIBSON PROJECT OFFICE AND THE WATER MANAGEMENT SECTION FOR TRANSMISSION OF RESERVOIR DATA, REGULATIONS AND INSTRUCTIONS.

2. PRECIPITATION AND STREAM GAGE DATA ARE SHARED BY THE NATIONAL WEATHER SERVICE, RIVER FORECAST CENTER.

ARKANSAS RIVER WATERSHED — GRAND NEOSHO RIVER, OKLAHOMA

FORT GIBSON LAKE

ORGANIZATION FOR FLOOD CONTROL REGULATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RAB
CHECKED: JRL

PLATE 5 - 2

PROJECT **SKIA # 42** **LAKE DATA** **DATE :**

LINE #	ITEM		TIME									
1	POOL ELEVATION		12N									
2	POOL ELEVATION		4PM									
3	POOL ELEVATION		12M									
4	POOL ELEVATION		8AM									
5	TAILWATER ELEVATION		8AM									
6	24 HR AVG POWER DISCHARGE		12M									
7	24 HR AVG TOTAL DISCHARGE		12M									
8	NET POWER GENERATION		12M									
9	GEN#1 HRS OF USE		12M									
	GEN#2 HRS OF USE		12M									
	GEN#3 HRS OF USE		12M									
	GEN#4 HRS OF USE		12M									
10	INSTANTANEOUS POWER DISCHARGE		8AM									
11	INSTANTANEOUS TOTAL DISCHARGE		8AM									
12/13	LAKE	WEATHER	8AM									
14	TOTAL PRECEDING 6 HR PRECIPITATION ENDING AT		1PM									
			7PM									
			1AM									
			7AM									
15	TOTAL 24 HOUR PRECIPITATION		7AM									
16	COMMENTS ON PRECIP. DIST.											
17	EVAPORATION 24 HOURS		8AM									
18/19	WIND DIRECTION AND VELOCITY		8AM		B-		B-		B-		B-		B-		B-		B-
20	WATER SUPPLY											
21	GATE SETTINGS NO. TYPE AND OPENING		8AM									
22	GATE CHANGES	DATE TIME										
23	POOL ELEVATION											
24	FROM	GATE SETTING										
25	TO	GATE SETTING										
26	GATE CHANGES	DATE TIME										
27	POOL ELEVATION											
28	FROM	GATE SETTING										
29	TO	GATE SETTING										
30	GATE CHANGES	DATE TIME										
31	POOL EVEVATION											
32	FROM	GATE SETTING										
33	TO	GATE SETTING										

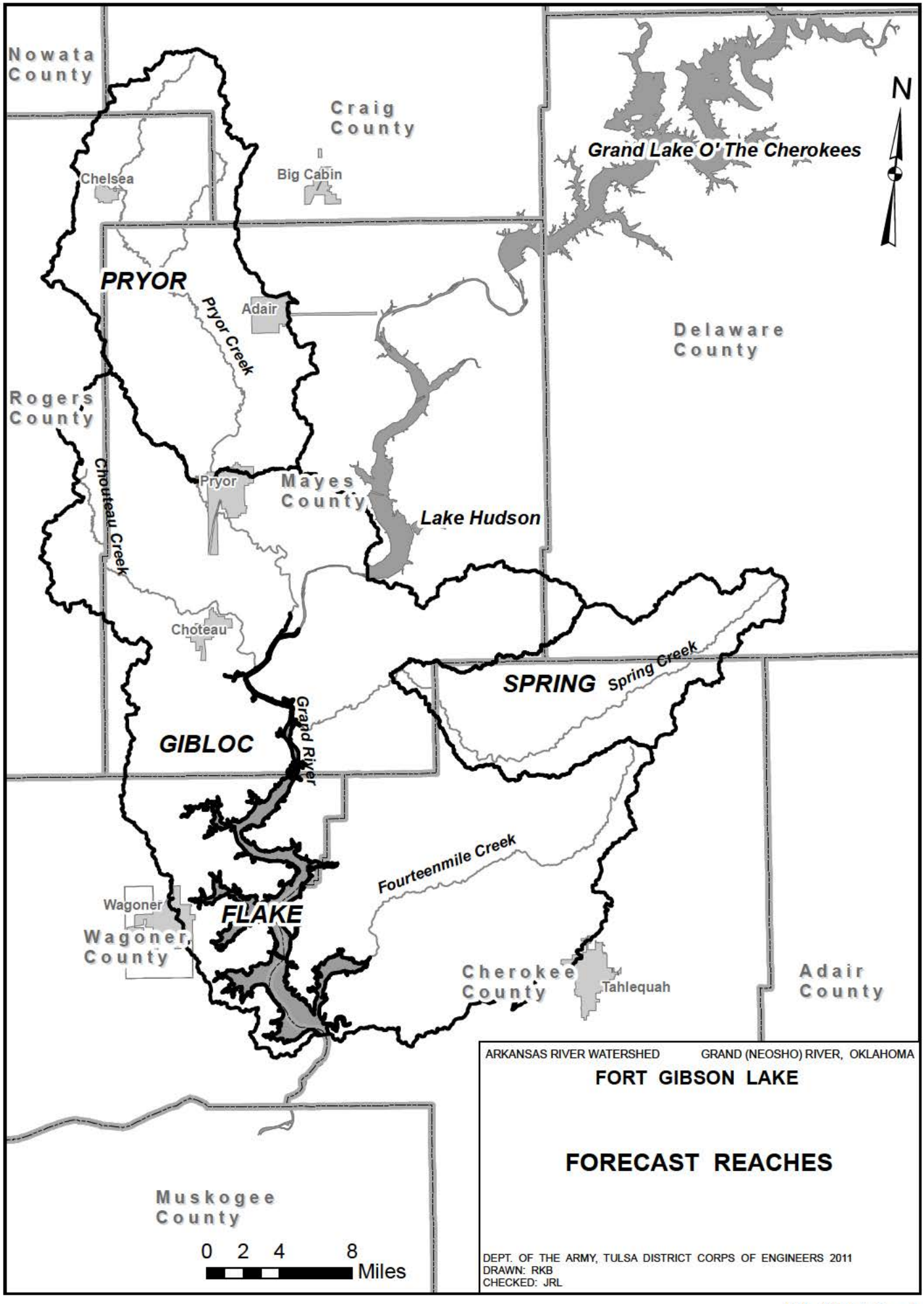
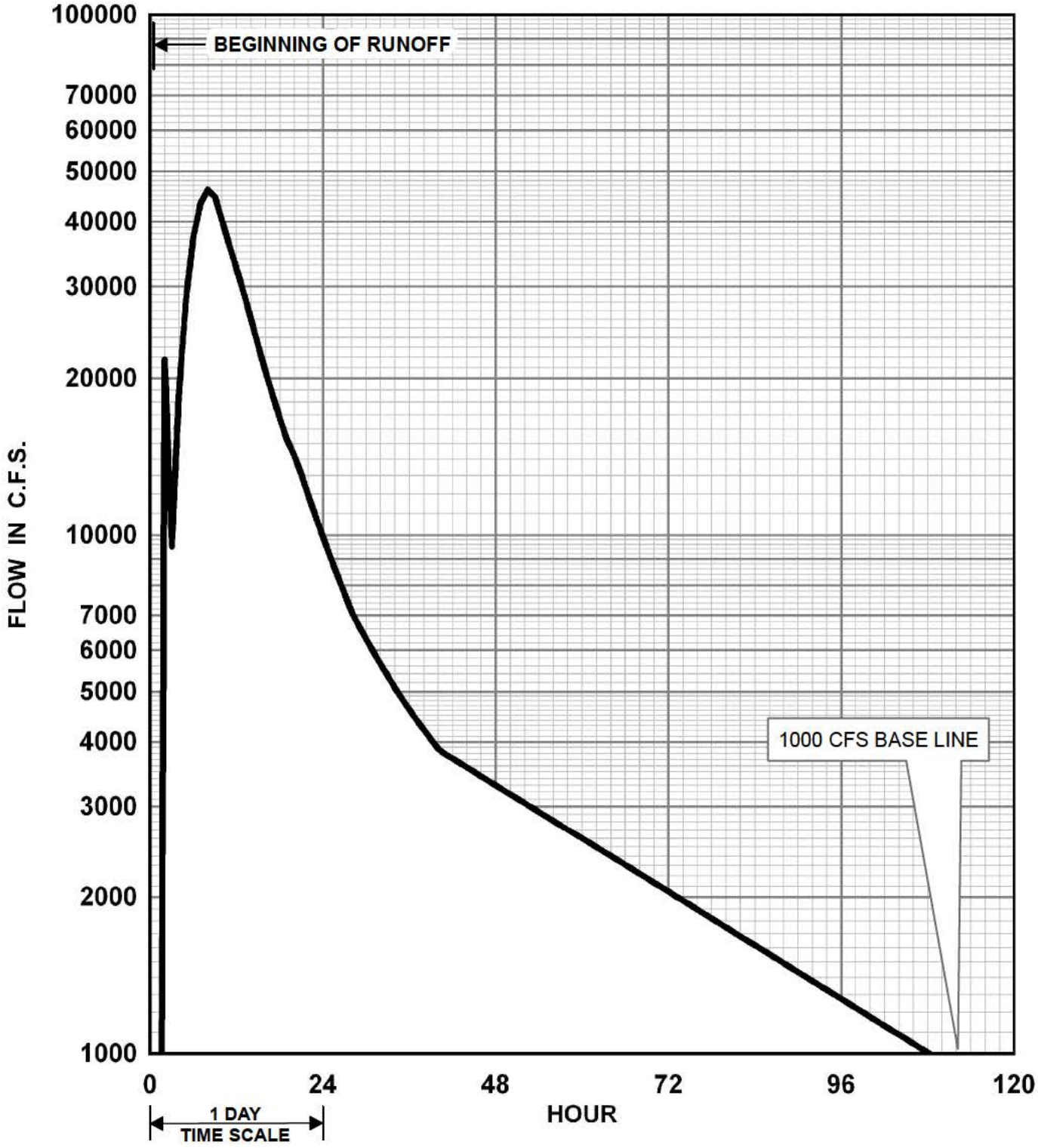

Nowata County
Craig County
Grand Lake O' The Cherokees
N
Chelsea
Big Cabin
PRYOR
Pryor Creek
Adair
Delaware County
Rogers County
Chouteau Creek
Pryor
Mayes County
Lake Hudson
Choteau
SPRING
Spring Creek
Grand River
GIBLOC
Fourteenmile Creek
Wagoner
FLAKE
Wagoner County
Cherokee County
Tahlequah
Adair County
Muskogee County
0 2 4 8
Miles
ARKANSAS RIVER WATERSHED
GRAND (NEOSHO) RIVER, OKLAHOMA
FORT GIBSON LAKE
FORECAST REACHES
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 1



DRAINAGE AREA = 960 SQ. MI.
1" RUNOFF = 51,170 AC.FT.
PEAK FLOW = 46,120 C.F.S.

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

UNIT HYDROGRAPH FOR AREA DOWNSTREAM OF LAKE HUDSON DAM AND UPSTREAM OF FORT GIBSON DAM

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 2

SWD Form 156
25 Nov 52

FORT GIBSON RESERVOIR

DISCHARGE AND INFLOW COMPUTATION

Computed by Date OCTOBER 1986 Checked by Date Book No.

Date	Time	Pool Elevation	Storage (1000 A.F.)	Storage 1000 A.F.	Storage c.f.s.	Gates Operating No. & Type	Gates Operating Opening	Discharge in c.f.s. Instantaneous Flood Control	Instantaneous Power	Instantaneous Total	Average Flood Control	Average Power	Average Evap.	Average Total	Inflow
10/1	2400	575.70	992.8								---	11,100			
													.201		
10/2	0800	577.93	1089.6	8/96.8				0	11,100	11,100	0	11,100			
	1200	579.02	1139.3	4/49.7	4/100200										
	1600	577.86	1179.0	4/39.7	4/119100	0		0	11,100	11,100					
						10TG	1'	10090	11,100	21,190					
	1700	580.11			FROM	10TG	1'	10090	11,100	21,190					
					TO	20TG	1'	20240	11,100	31,340					
	1800	580.31			FROM	20TG	1'	20240	11,100	31,340					
					TO	20TG	1 1/2'	30860	11,100	41,960					
	1900	580.45			FROM	20TG	1 1/2'	30860	11,100	41,960					
					TO	20TG	2'	41580	11,100	52,680					
				2/11.6	2/69600						2/41600	11,100			2/122300
	2000	580.55	1212.2	4/33.2	4/99600						4/31600	11,100			4/142300
	2200	580.75	1224.4	6/45.4	6/91600	20TG	2'	41700	11,100	52,800	6/42100	11,100			6/144800
	2330	580.90			FROM	20TG	2'	41880	11,100	42,380					
					TO	19TG	2 1/2'	50521	11,100	51,021					
10/2	2400	580.94	1231.4								11432	500		11932	24/131668
													.201		
			(1)	(2)	(3)			(4)			(5)		(6)		(7)

(1) RESERVOIR CAPACITY TABLE.

(2) SUBTRACT STORAGE AT BEGINNING OF PERIOD FROM STORAGE AT END OF PERIOD. IF POOL IS RISING, CHANGE IN STORAGE IS POSITIVE (+), IF FALLING NEGATIVE (-).

(3) $\frac{\text{CHANGE IN STORAGE (A.F.) x 12}}{\text{NO. OF HOURS IN PERIOD}}$ = CHANGE IN STORAGE IN C.F.S.

(4) FROM DISCHARGE RATING CURVES.

(5) AVERAGE DISCHARGE DURING PERIOD.

(6) PAN EVAPORATION APPLIED TO EVAPORATION CURVES.

(7) INFLOW = CHANGE IN STORAGE (D.F.S) + AVERAGE DISCHARGE + EVAPORATION.

NOTE: DURING FLOOD PERIODS EVAPORATION IS USUALLY NEGLECTED IN PRELIMINARY INFLOW CALCULATIONS. NUMBER OF HOURS FOR THE INFLOW PERIOD IS INDICATED BY 4/

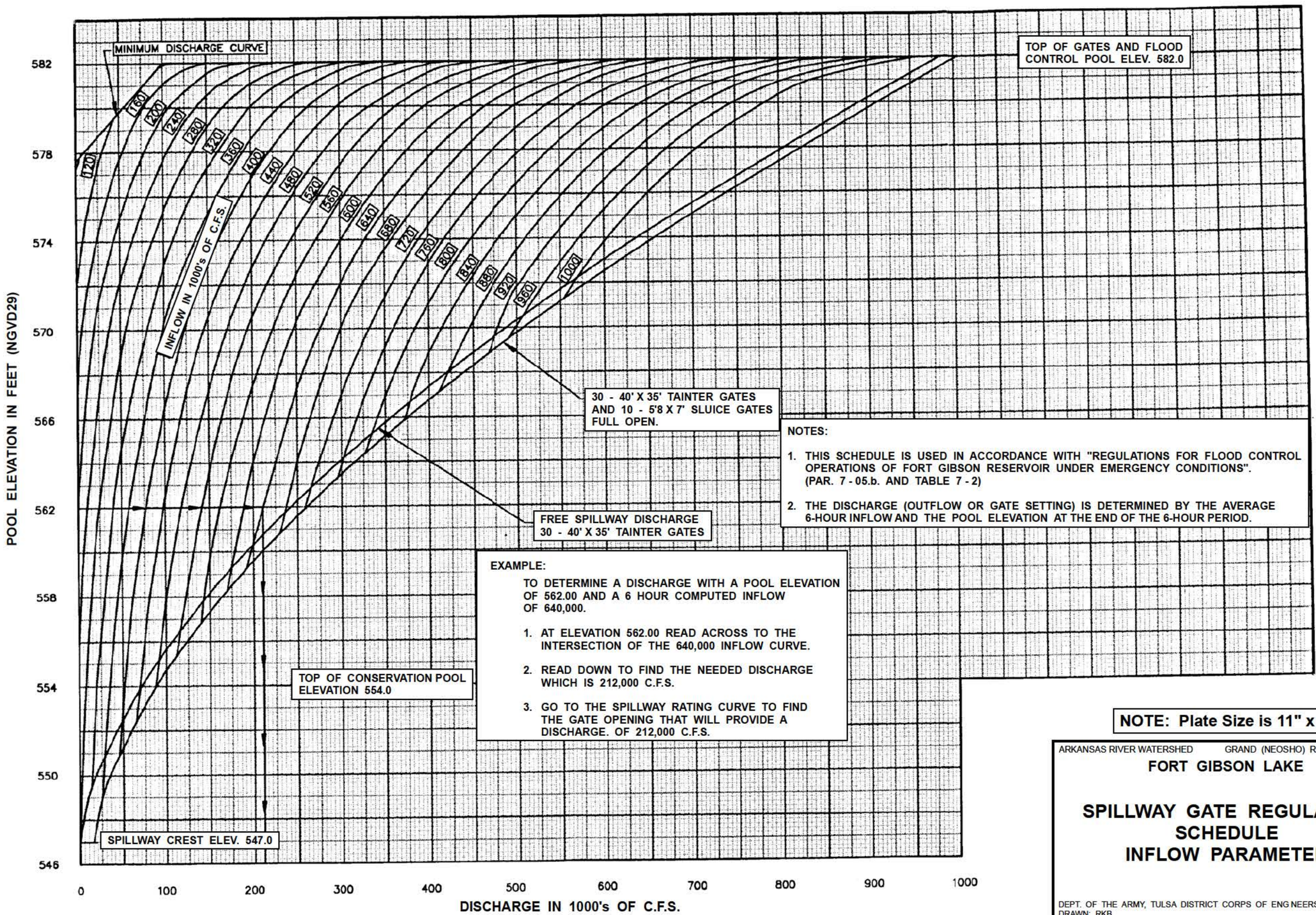
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

SAMPLE DISCHARGE AND INFLOW COMPUTATION

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 6 - 3



NOTES:

1. THIS SCHEDULE IS USED IN ACCORDANCE WITH "REGULATIONS FOR FLOOD CONTROL OPERATIONS OF FORT GIBSON RESERVOIR UNDER EMERGENCY CONDITIONS". (PAR. 7 - 05.b. AND TABLE 7 - 2)
2. THE DISCHARGE (OUTFLOW OR GATE SETTING) IS DETERMINED BY THE AVERAGE 6-HOUR INFLOW AND THE POOL ELEVATION AT THE END OF THE 6-HOUR PERIOD.

EXAMPLE:

TO DETERMINE A DISCHARGE WITH A POOL ELEVATION OF 562.00 AND A 6 HOUR COMPUTED INFLOW OF 640,000.

1. AT ELEVATION 562.00 READ ACROSS TO THE INTERSECTION OF THE 640,000 INFLOW CURVE.
2. READ DOWN TO FIND THE NEEDED DISCHARGE WHICH IS 212,000 C.F.S.
3. GO TO THE SPILLWAY RATING CURVE TO FIND THE GATE OPENING THAT WILL PROVIDE A DISCHARGE. OF 212,000 C.F.S.

NOTE: Plate Size is 11" x 17"

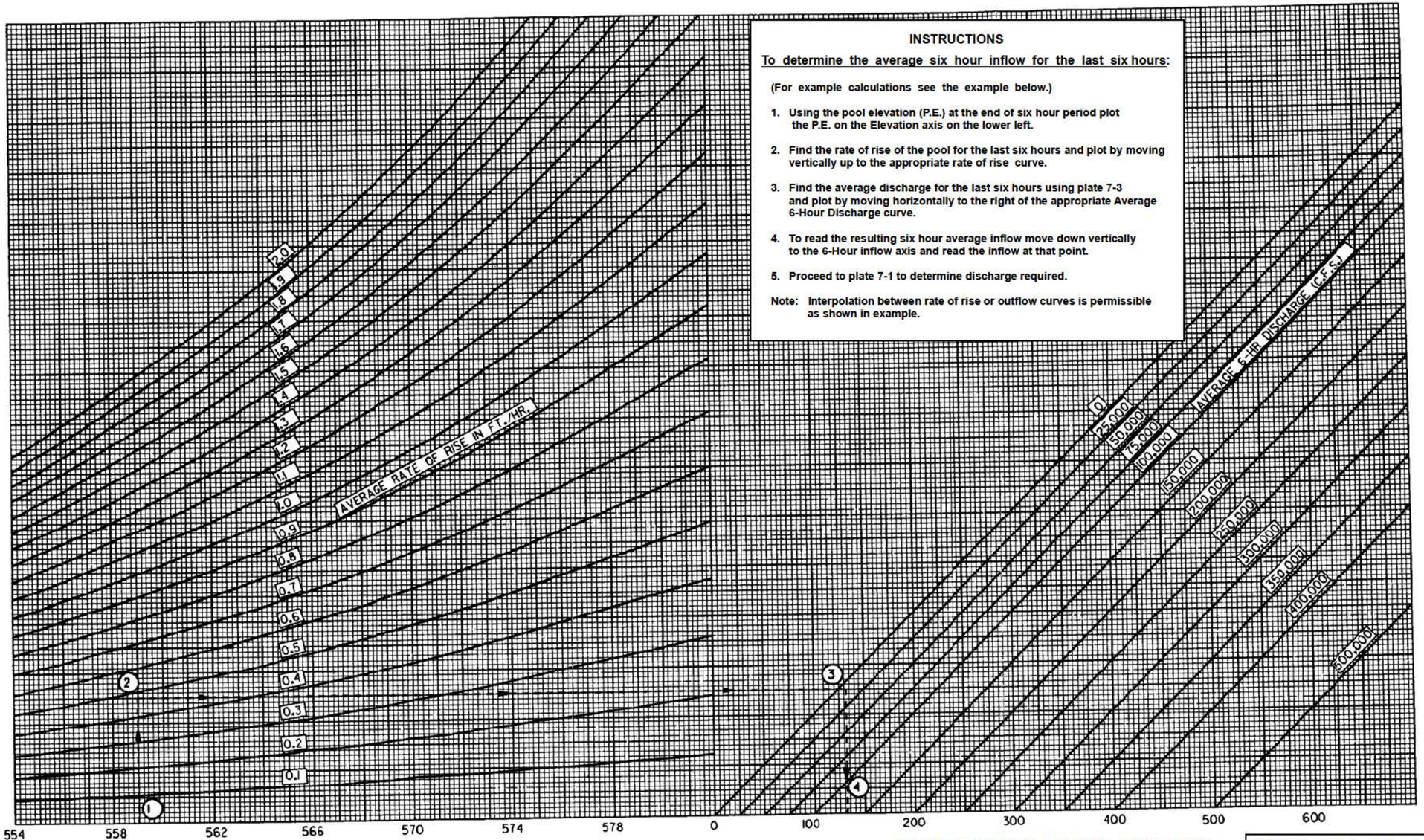
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

SPILLWAY GATE REGULATION SCHEDULE INFLOW PARAMETER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 1



INSTRUCTIONS

To determine the average six hour inflow for the last six hours:

(For example calculations see the example below.)

1. Using the pool elevation (P.E.) at the end of six hour period plot the P.E. on the Elevation axis on the lower left.
2. Find the rate of rise of the pool for the last six hours and plot by moving vertically up to the appropriate rate of rise curve.
3. Find the average discharge for the last six hours using plate 7-3 and plot by moving horizontally to the right of the appropriate Average 6-Hour Discharge curve.
4. To read the resulting six hour average inflow move down vertically to the 6-Hour inflow axis and read the inflow at that point.
5. Proceed to plate 7-1 to determine discharge required.

Note: Interpolation between rate of rise or outflow curves is permissible as shown in example.

NOTE: Plate Size is 11" x 17"

EXAMPLE CALCULATION

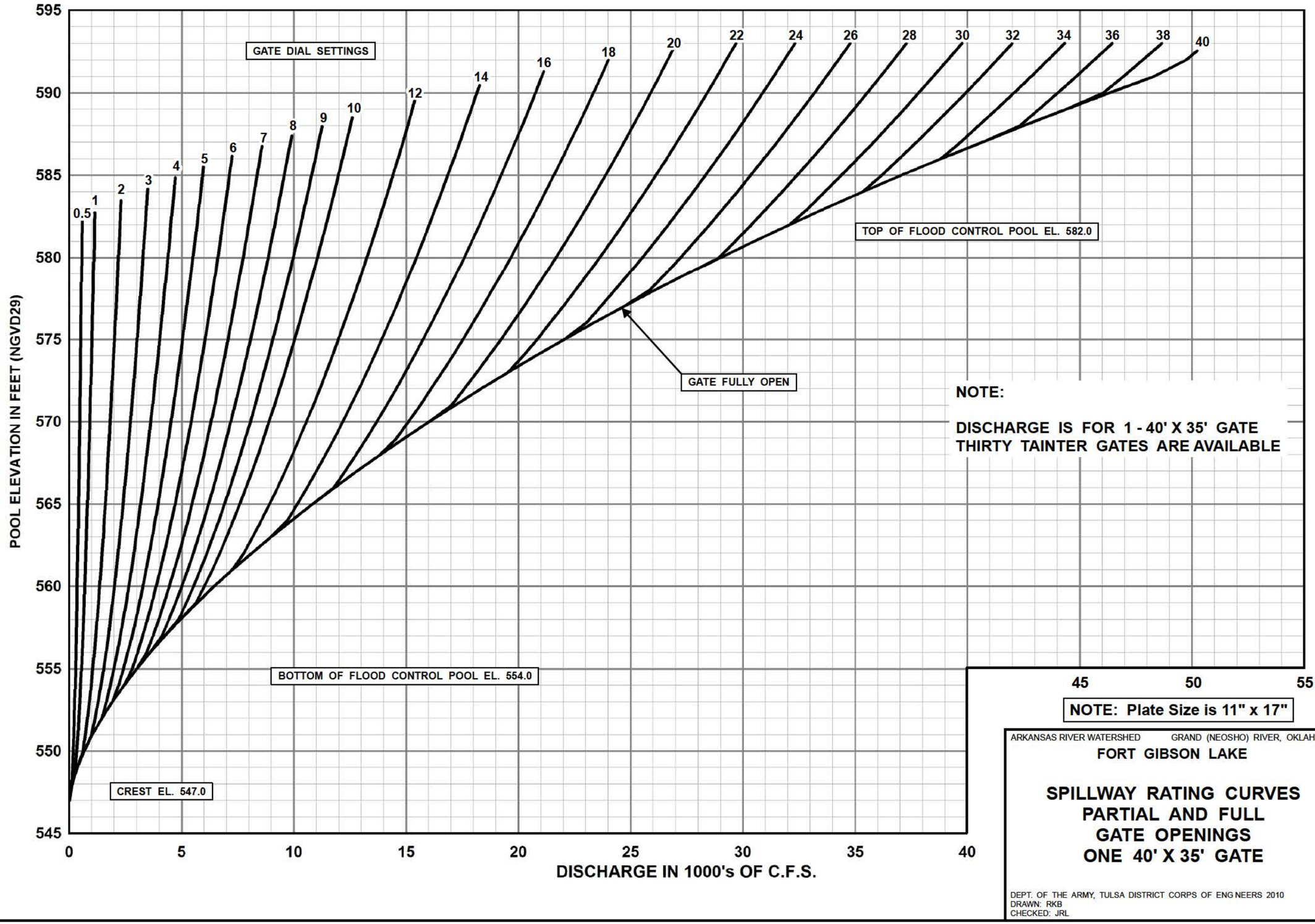
1. The current pool elevation is 559 ft. Find this on the pool elevation axis (1.).
2. Six hours ago it was 556.14 ft. The average rate of rise for this six hours is: (559-556.14) / 6hrs. = 0.48 ft. per hour. Move up vertically from (1.) to find the rate of rise on the rate of rise curves (2.).
3. Six hours ago the discharge was 4,800 C.F.S., four hours ago it was changed to 9,000 C.F.S., and two hours ago it was changed to 4,200 C.F.S. The average discharge for the last six hours is [2 hr. (4,800 C.F.S.) + 2 hrs. (9,000 C.F.S.) + 2 hrs. (4,200)] / 6 = 6,000 C.F.S. Move horizontally to read this six hour average discharge on the Outflow curves (3.).
4. From (3.) read down vertically that the inflow for the last six hours is 132,000 C.F.S. (4.).

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

INFLOW VS. RATE OF RISE NOMOGRAPH

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL



NOTE:

DISCHARGE IS FOR 1 - 40' X 35' GATE
THIRTY TAINTER GATES ARE AVAILABLE

NOTE: Plate Size is 11" x 17"

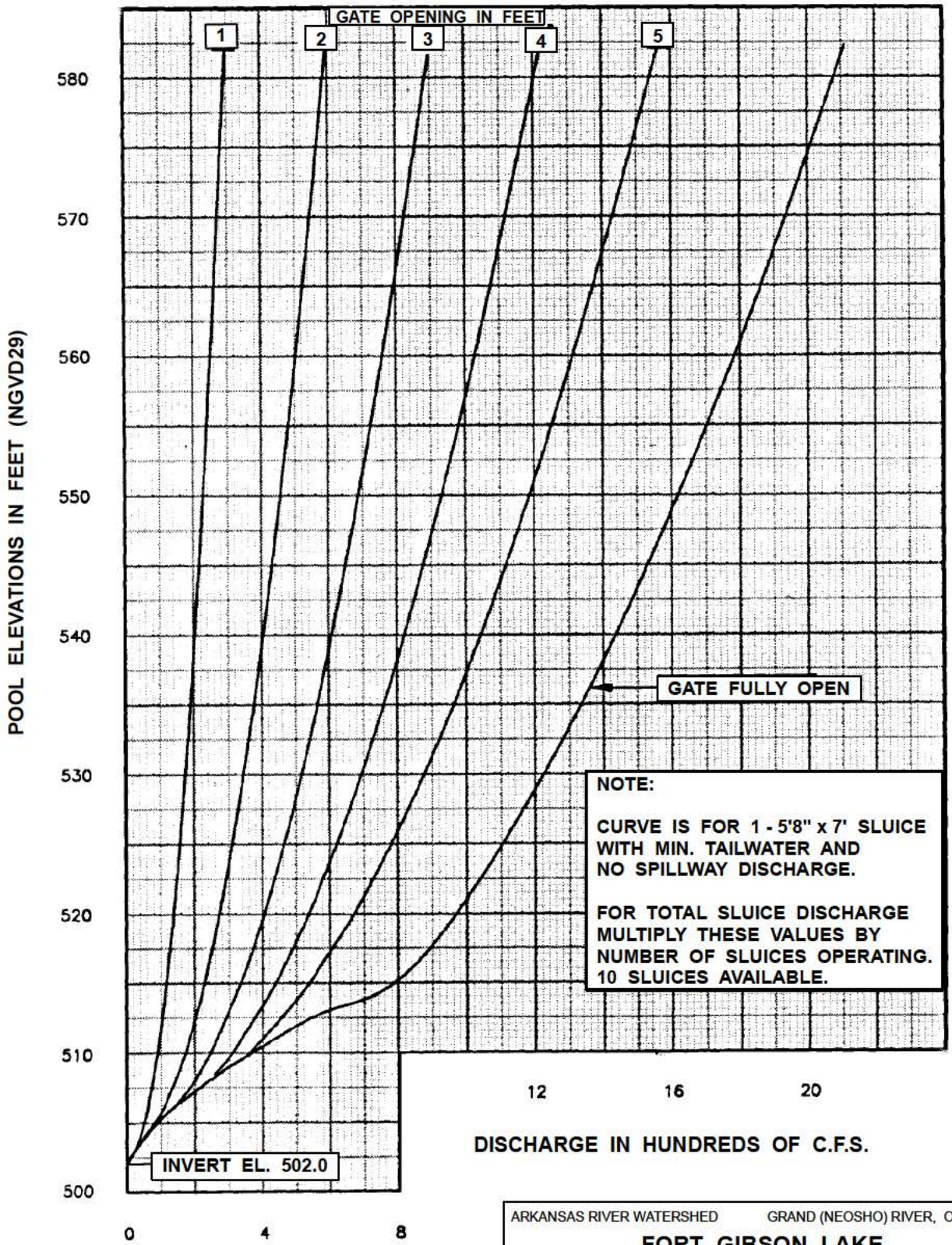
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

SPILLWAY RATING CURVES PARTIAL AND FULL GATE OPENINGS ONE 40' X 35' GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 3



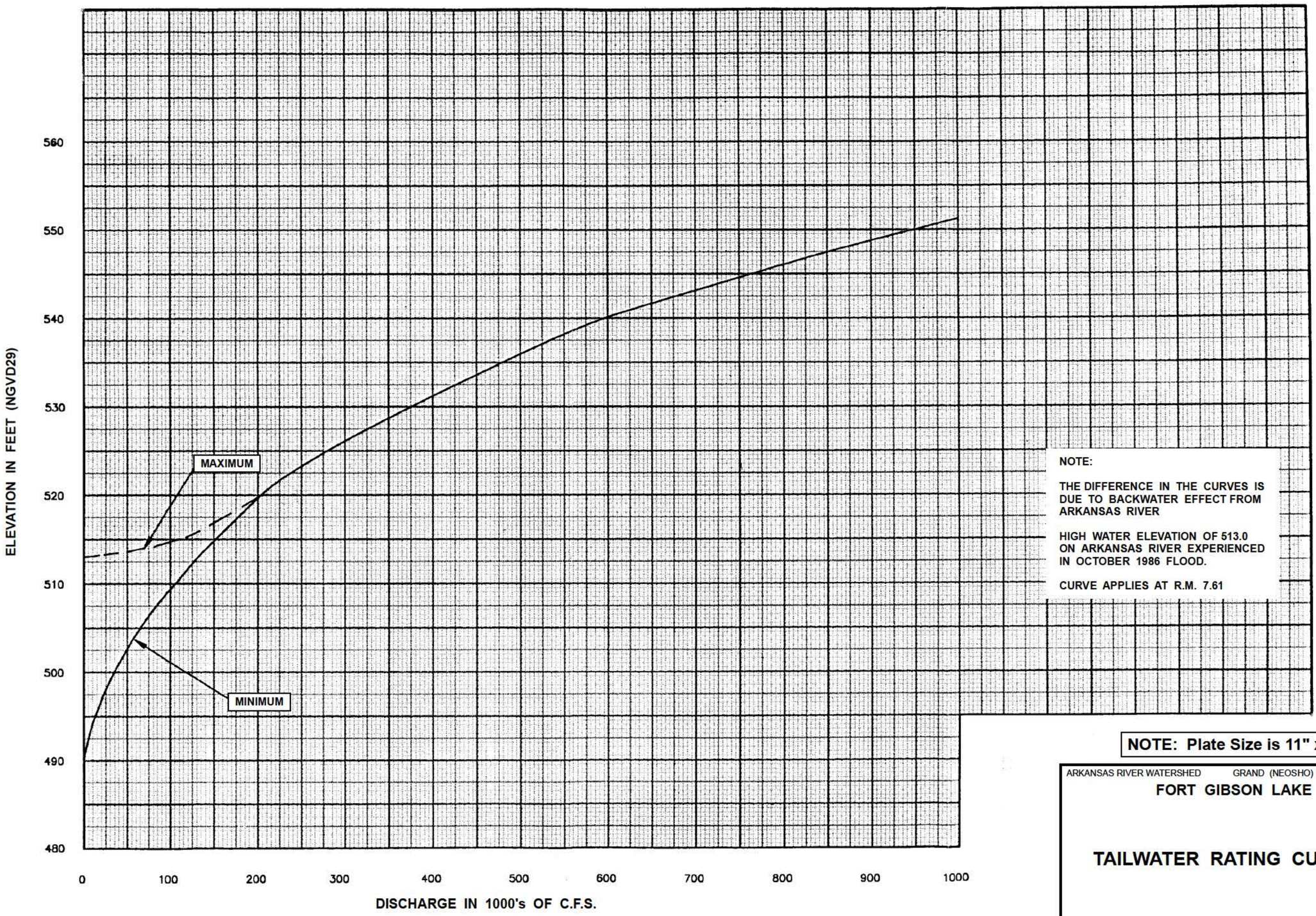
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

SLUICE RATING CURVE PARTIAL AND FULL GATE OPENINGS ONE 5'- 8" X 7' SLUICE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 4



NOTE:

THE DIFFERENCE IN THE CURVES IS DUE TO BACKWATER EFFECT FROM ARKANSAS RIVER

HIGH WATER ELEVATION OF 513.0 ON ARKANSAS RIVER EXPERIENCED IN OCTOBER 1986 FLOOD.

CURVE APPLIES AT R.M. 7.61

NOTE: Plate Size is 11" x 17"

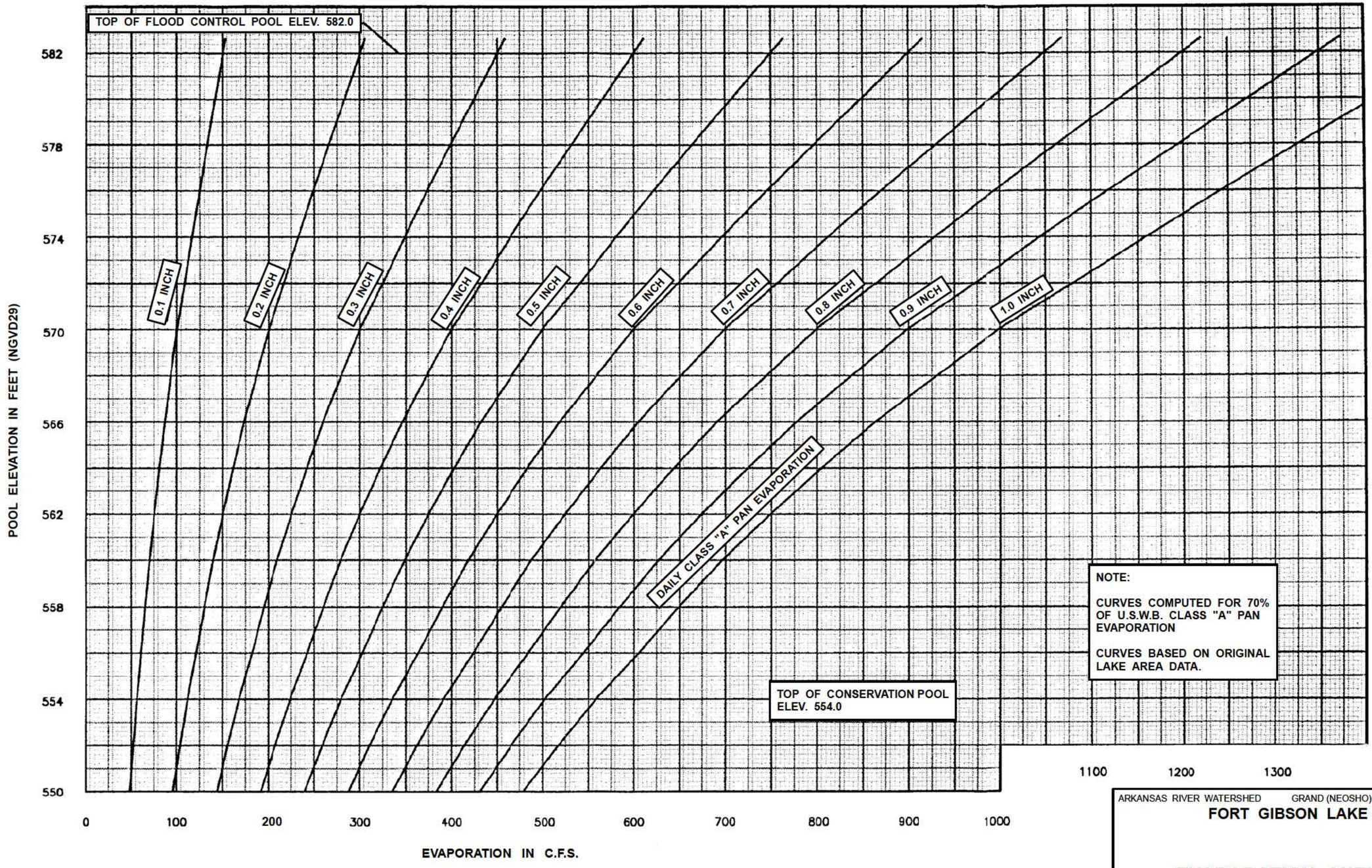
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

TAILWATER RATING CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 5



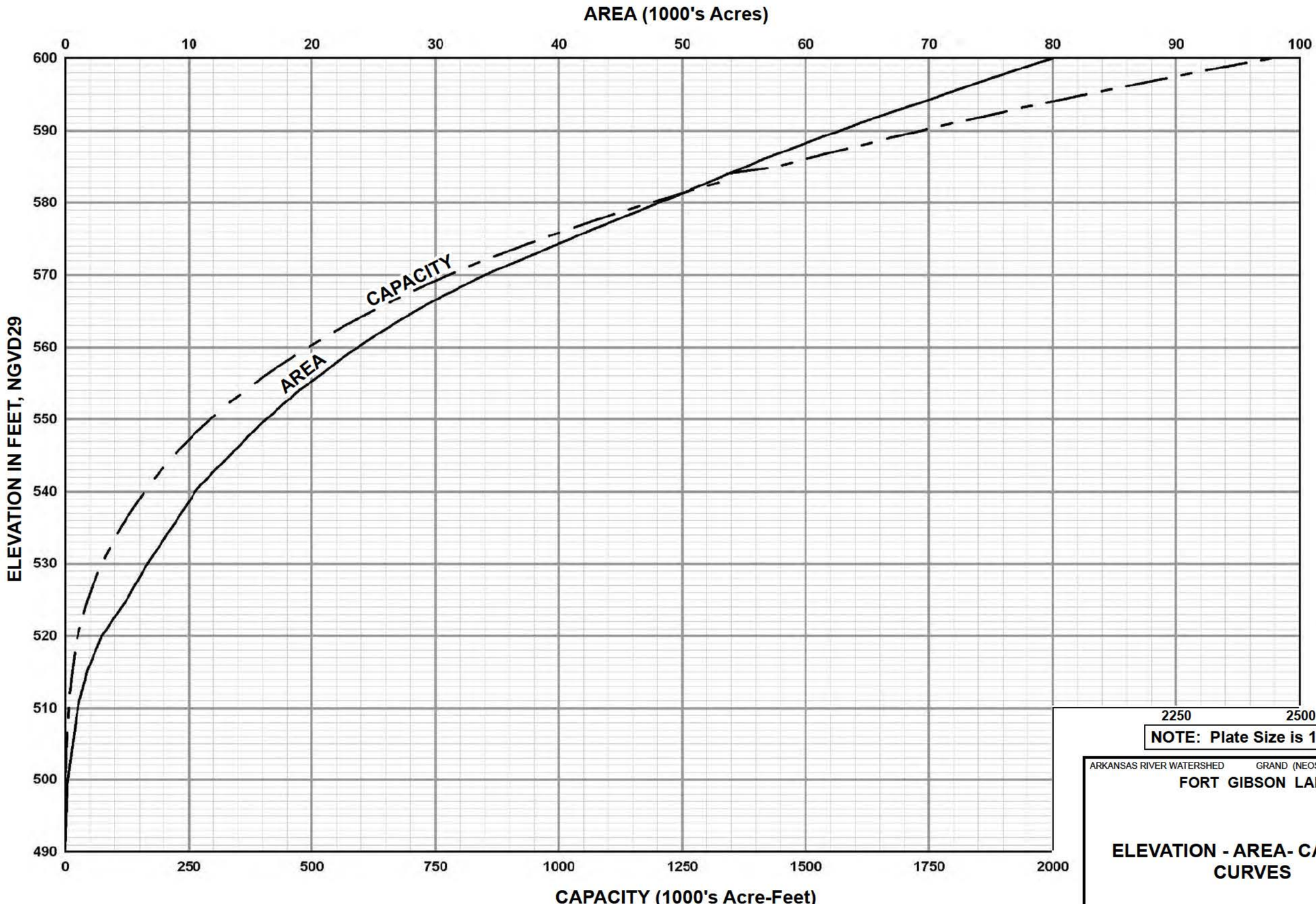
NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL



NOTE: Plate Size is 11" x 17"

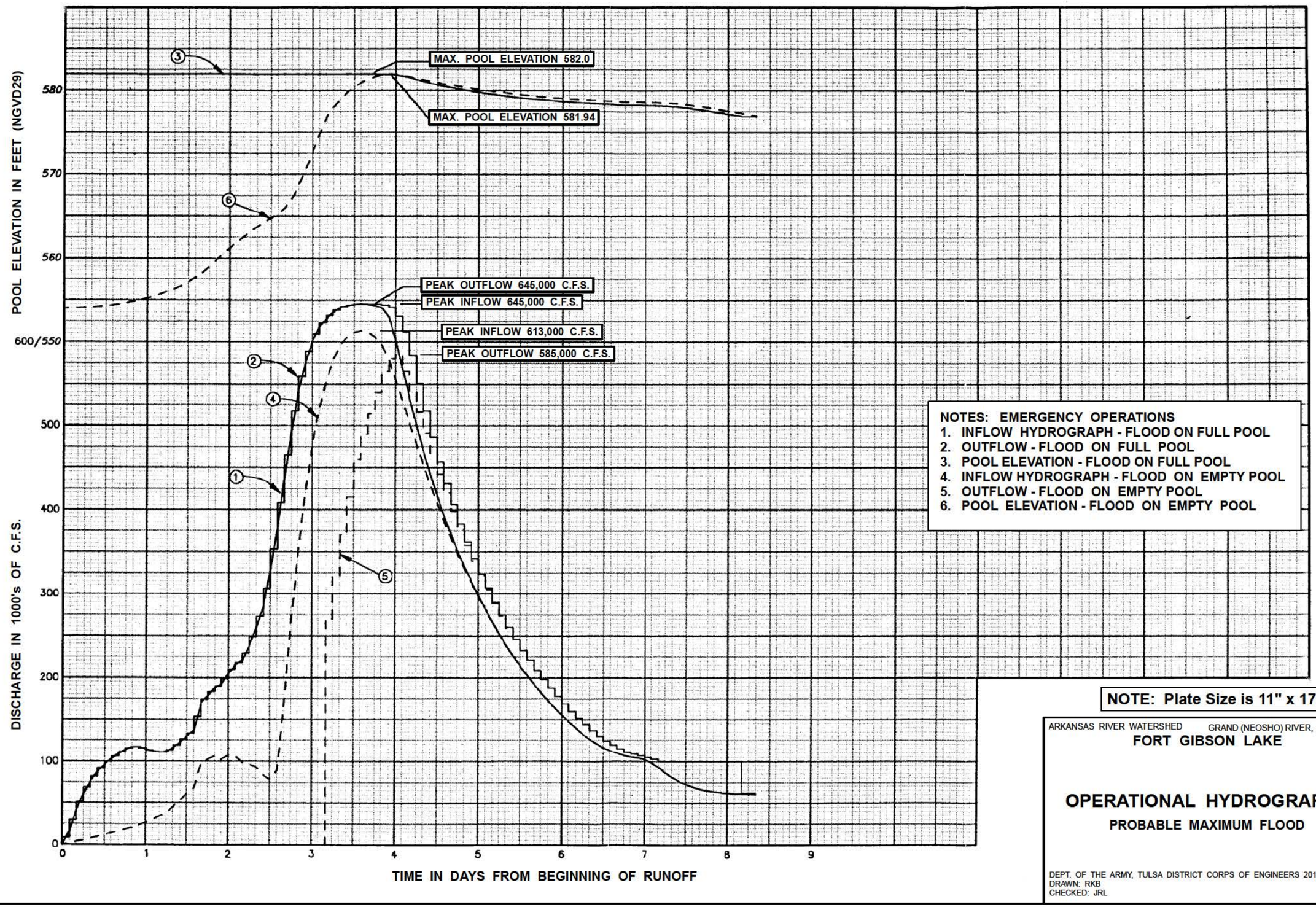
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

ELEVATION - AREA- CAPACITY CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 7 - 7



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH - FLOOD ON FULL POOL
2. OUTFLOW - FLOOD ON FULL POOL
3. POOL ELEVATION - FLOOD ON FULL POOL
4. INFLOW HYDROGRAPH - FLOOD ON EMPTY POOL
5. OUTFLOW - FLOOD ON EMPTY POOL
6. POOL ELEVATION - FLOOD ON EMPTY POOL

NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

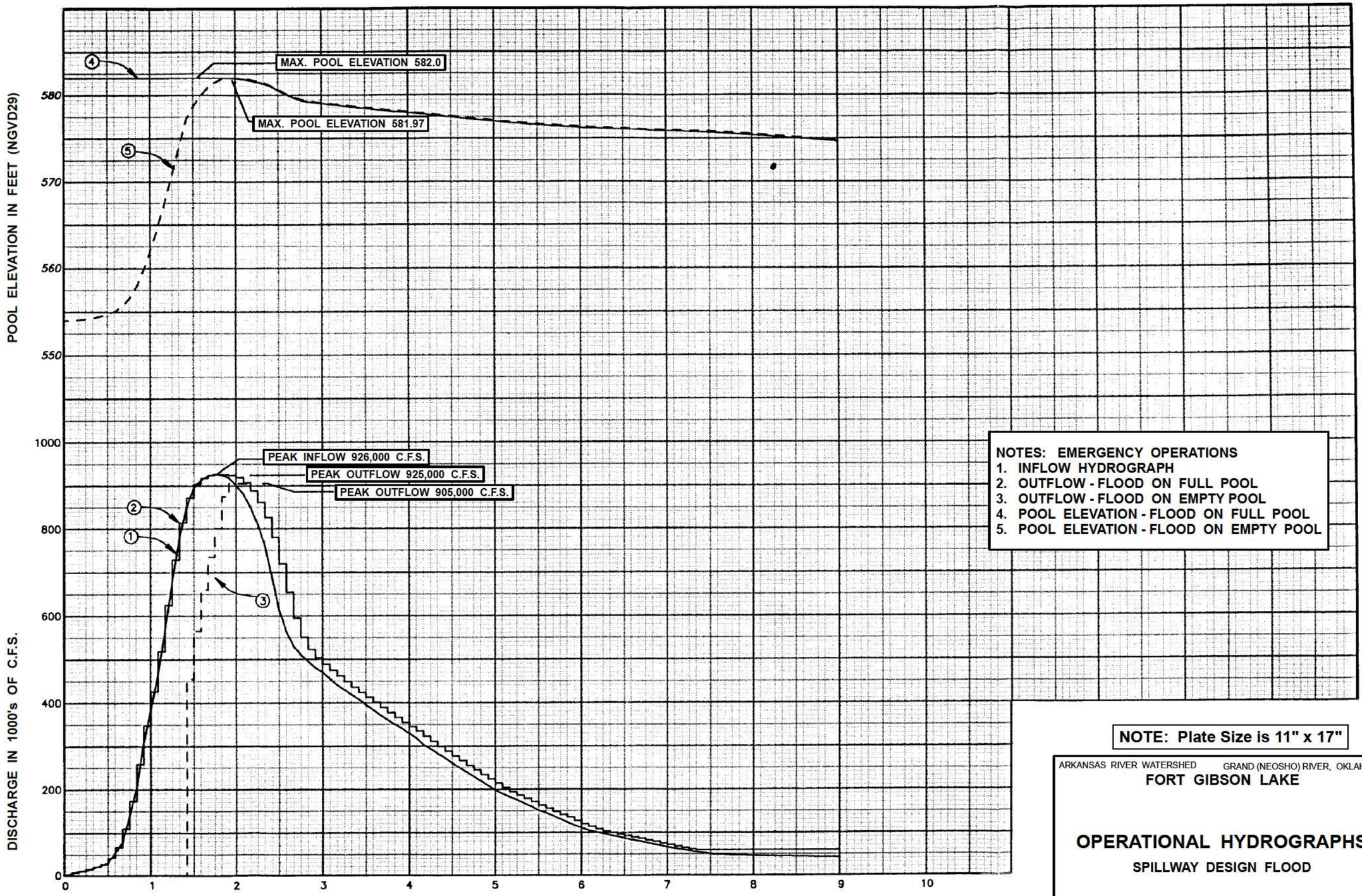
FORT GIBSON LAKE

OPERATIONAL HYDROGRAPHS

PROBABLE MAXIMUM FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 1



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH
2. OUTFLOW - FLOOD ON FULL POOL
3. OUTFLOW - FLOOD ON EMPTY POOL
4. POOL ELEVATION - FLOOD ON FULL POOL
5. POOL ELEVATION - FLOOD ON EMPTY POOL

NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

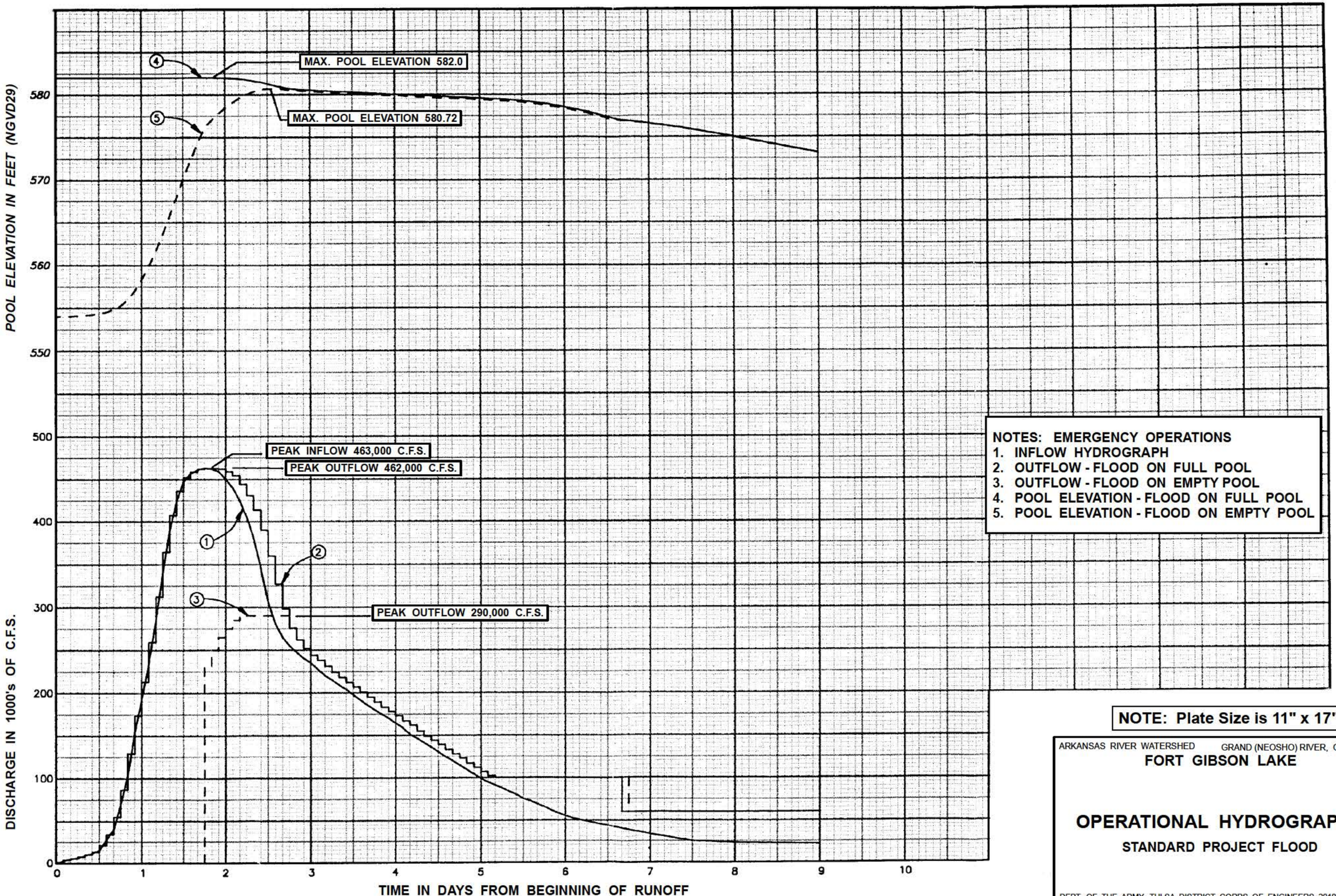
FORT GIBSON LAKE

OPERATIONAL HYDROGRAPHS

SPILLWAY DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 2



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH
2. OUTFLOW - FLOOD ON FULL POOL
3. OUTFLOW - FLOOD ON EMPTY POOL
4. POOL ELEVATION - FLOOD ON FULL POOL
5. POOL ELEVATION - FLOOD ON EMPTY POOL

NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

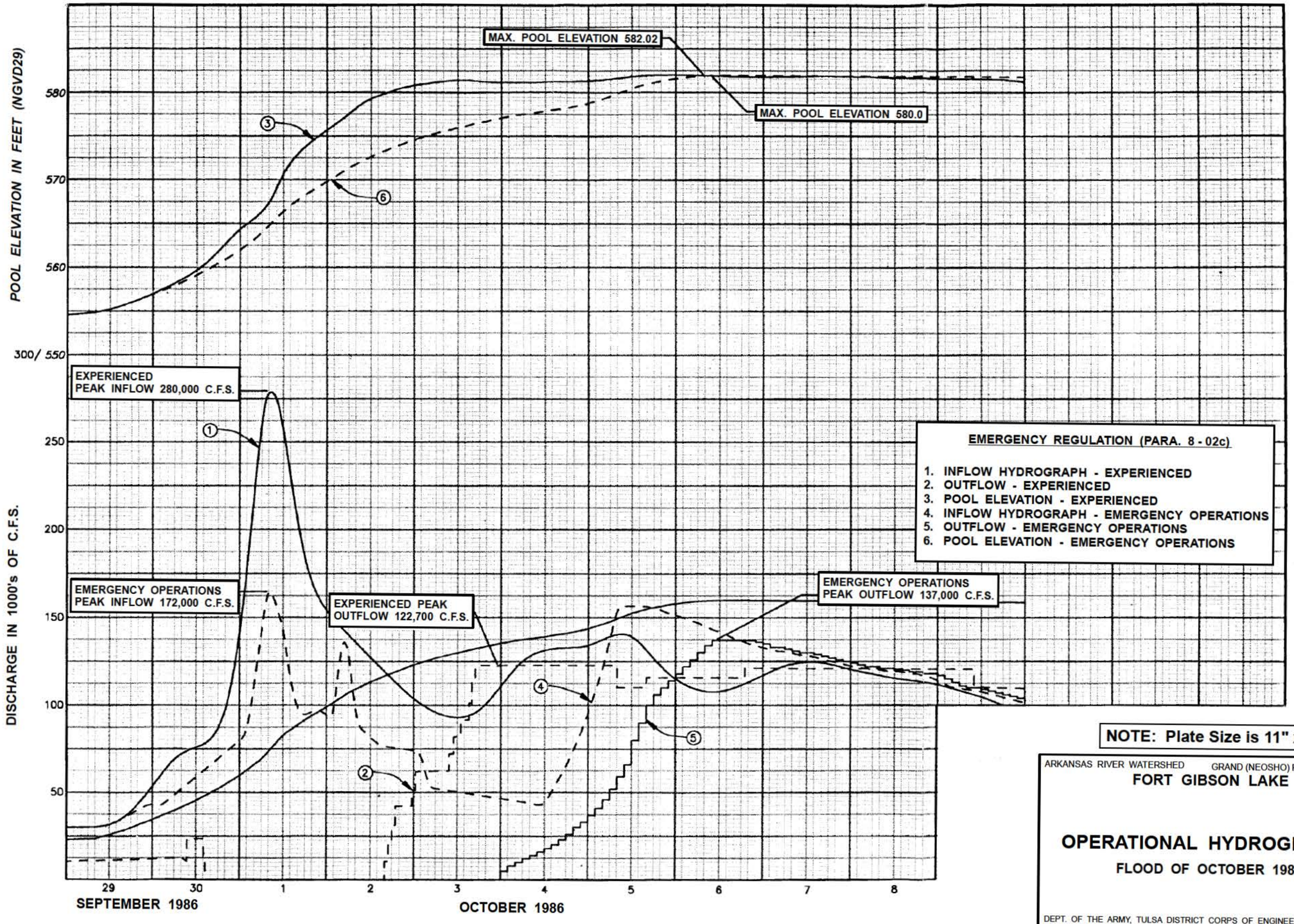
FORT GIBSON LAKE

OPERATIONAL HYDROGRAPHS

STANDARD PROJECT FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 3



EMERGENCY REGULATION (PARA. 8 - 02c)

1. INFLOW HYDROGRAPH - EXPERIENCED
2. OUTFLOW - EXPERIENCED
3. POOL ELEVATION - EXPERIENCED
4. INFLOW HYDROGRAPH - EMERGENCY OPERATIONS
5. OUTFLOW - EMERGENCY OPERATIONS
6. POOL ELEVATION - EMERGENCY OPERATIONS

NOTE: Plate Size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

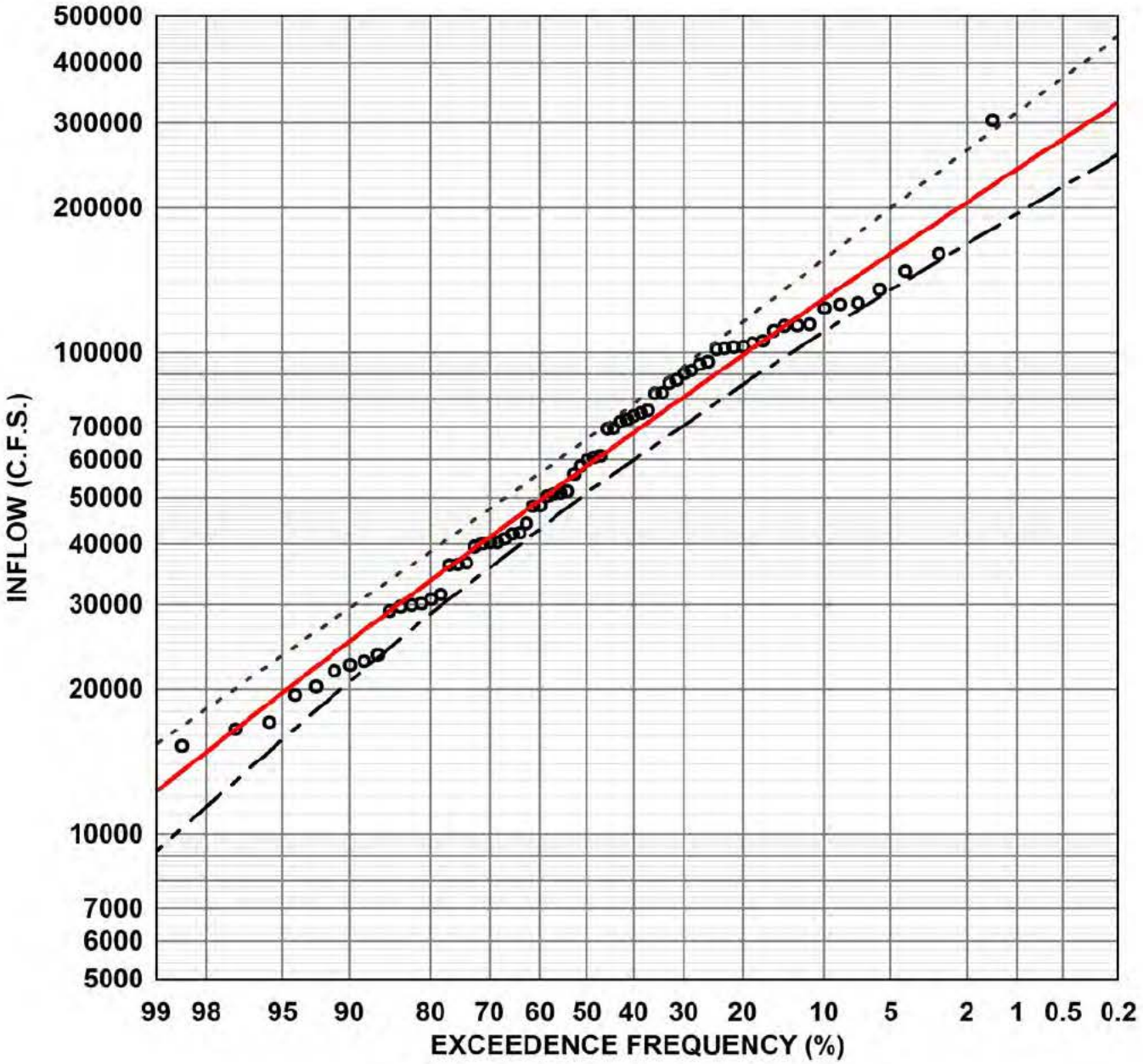
FORT GIBSON LAKE

OPERATIONAL HYDROGRAPHS

FLOOD OF OCTOBER 1986

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 4



NOTE:

1. **BASED ON ANNUAL PEAK INFLOWS FOR PERIOD OF RECORD JAN 1940 THROUGH DEC 2008**
2. **BULLETIN NO. 17B "GUIDELINES FOR DETERMINING FLOOD FLOW FREQUENCY" WAS USED.**

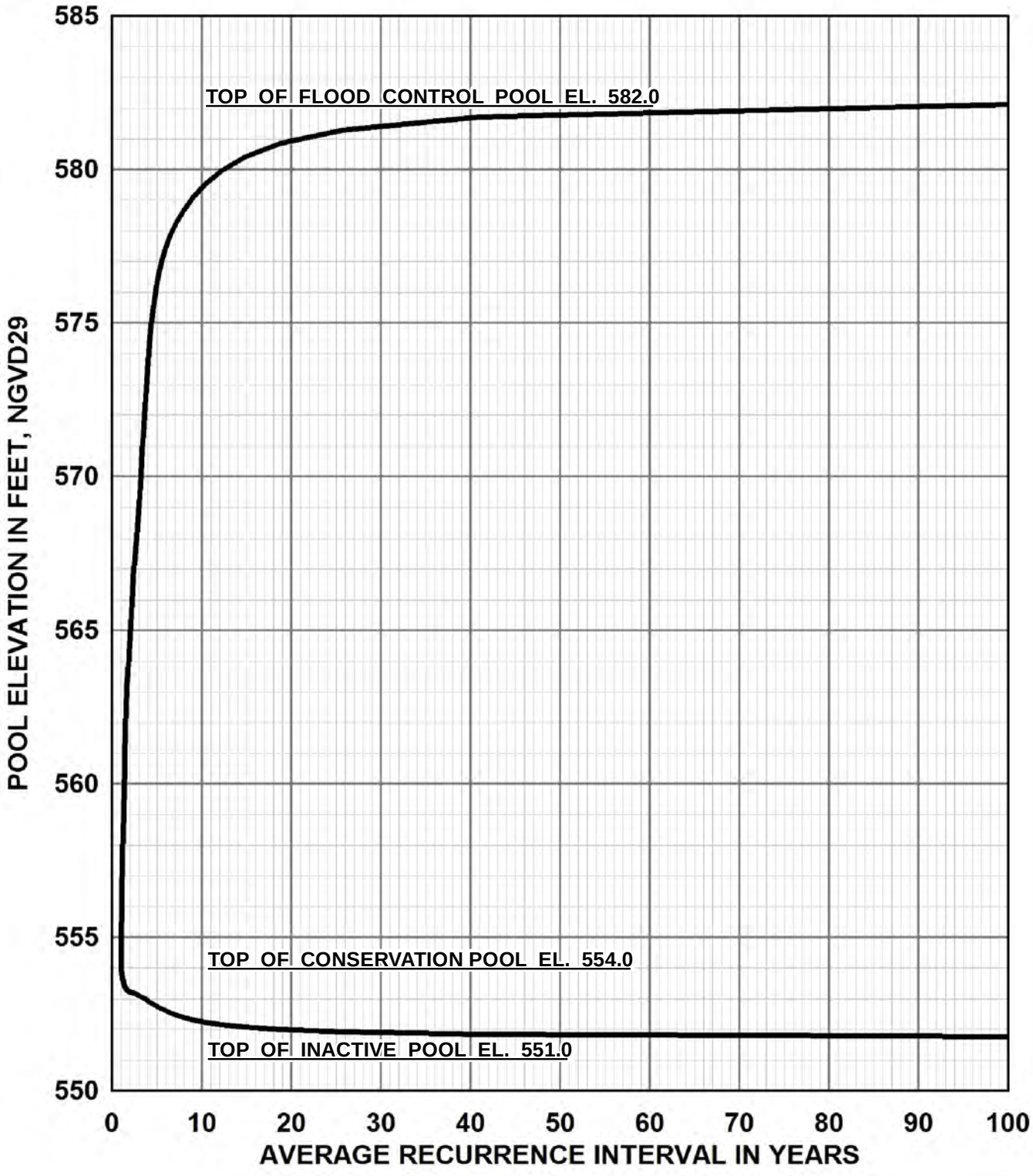
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

PEAK INFLOW PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 5



ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

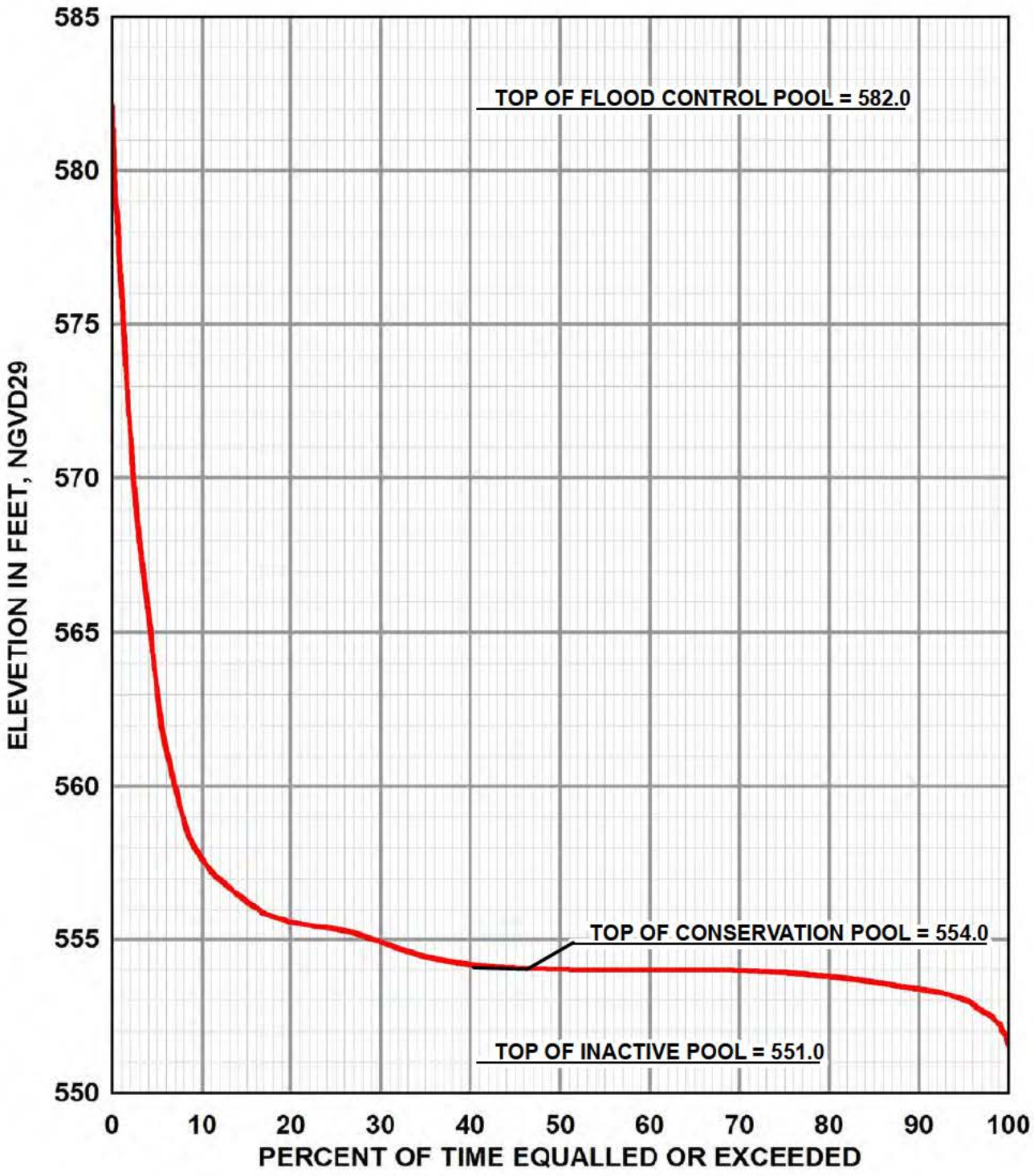
FORT GIBSON LAKE

POOL ELEVATION PROBABILITY CURVE

NOTE:

CURVE IS BASED ON RIVERWARE RUN FOR THE PERIOD OF RECROD JAN 1940 THRU DEC 2008 AND DOES NOT NECESSARILY REPRESENT ACTUAL UTILIZATION OF POWER PONDAGE.

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL



NOTE:

BASED ON PERIOD OF RECORD 1940 TO 2008 FROM RIVERWARE COMPUTER RUN

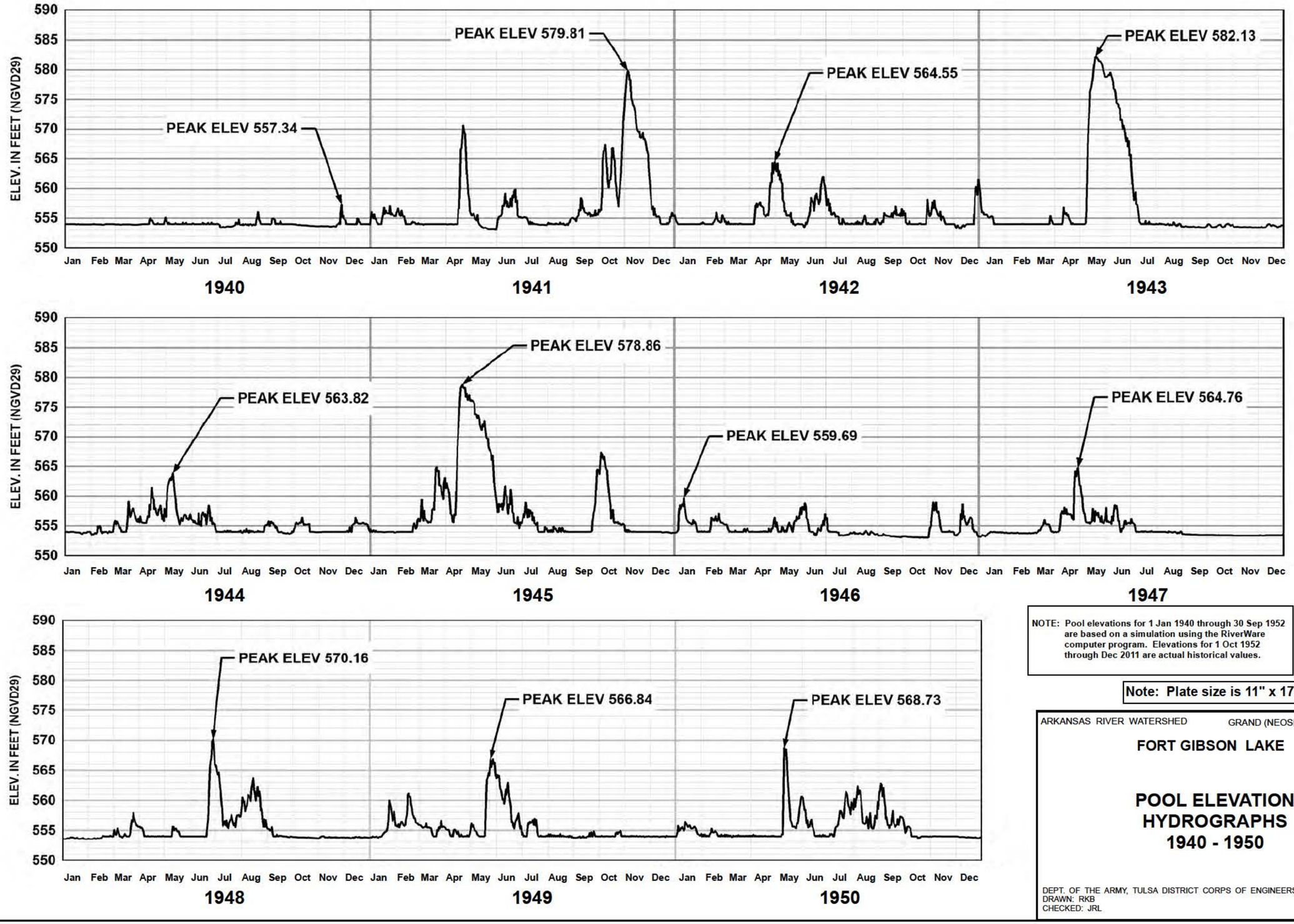
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

POOL ELEVATION DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL

PLATE 8 - 7



NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

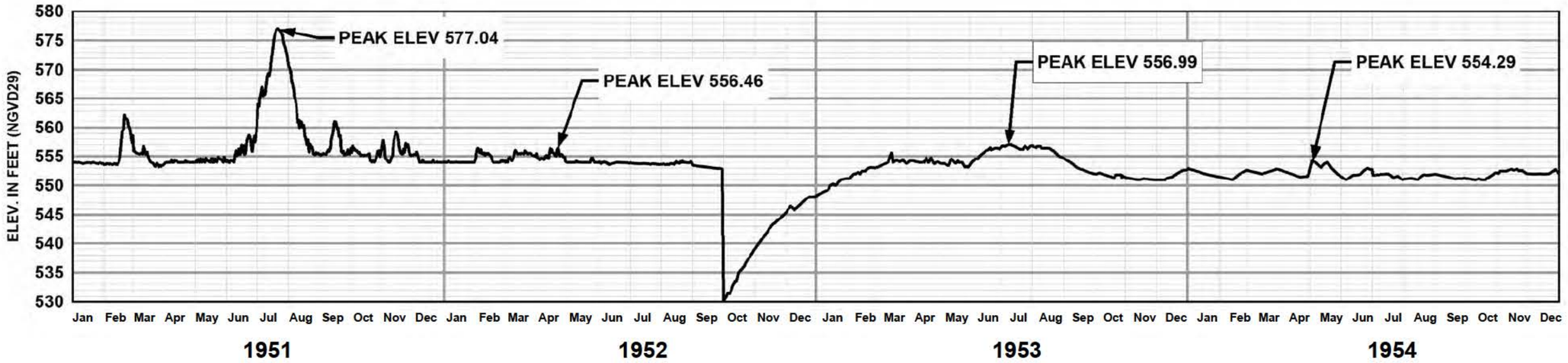
Note: Plate size is 11" x 17"

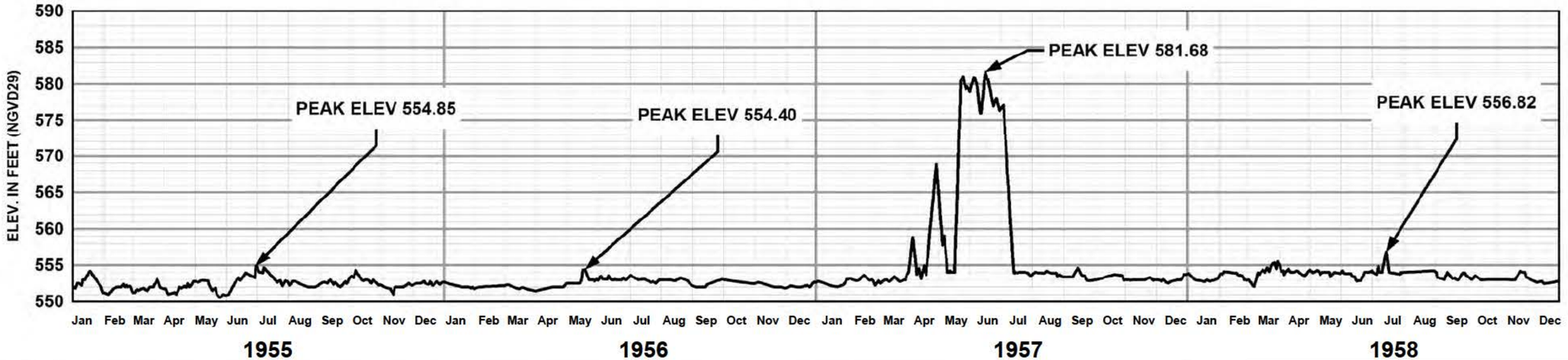
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

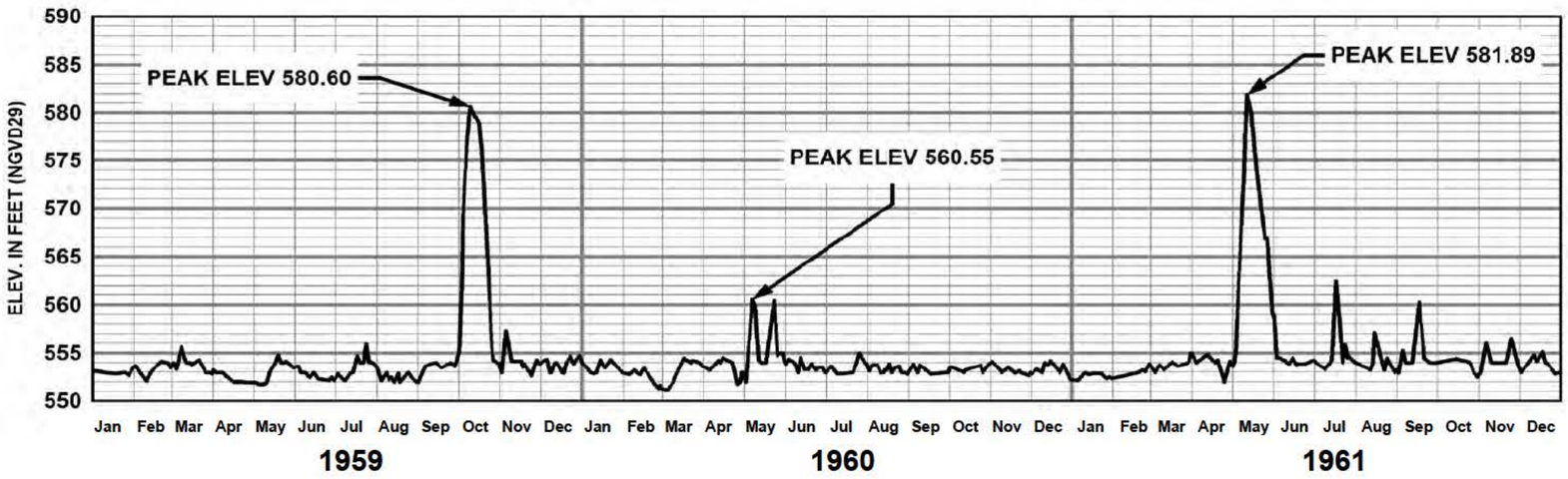
FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1940 - 1950

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL







NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

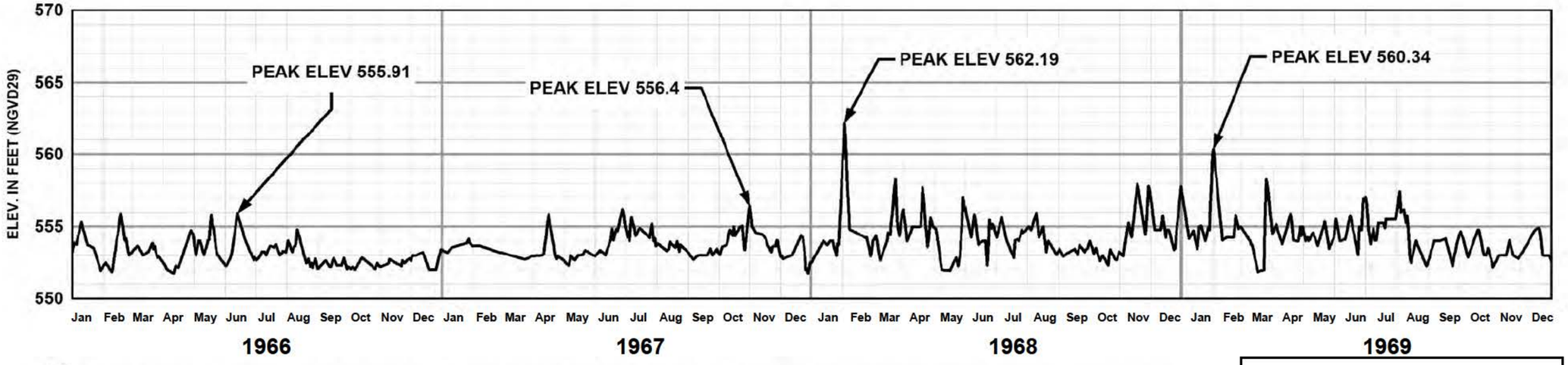
Note: Plate size is 11" x 17"

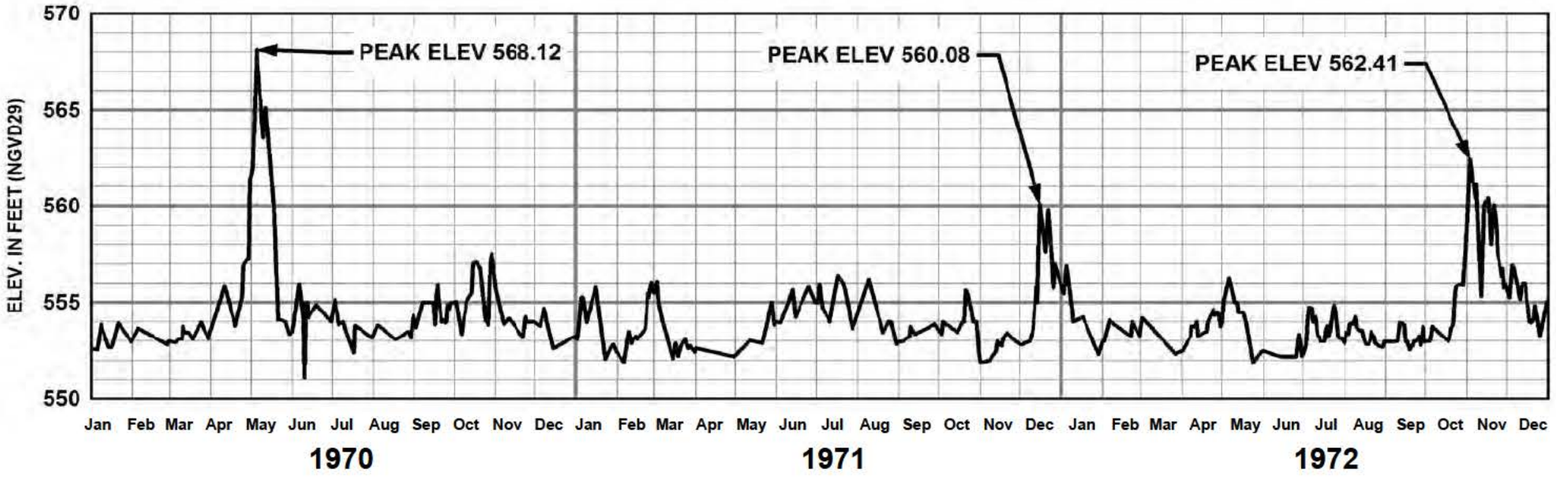
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1951 - 1961

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL





NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

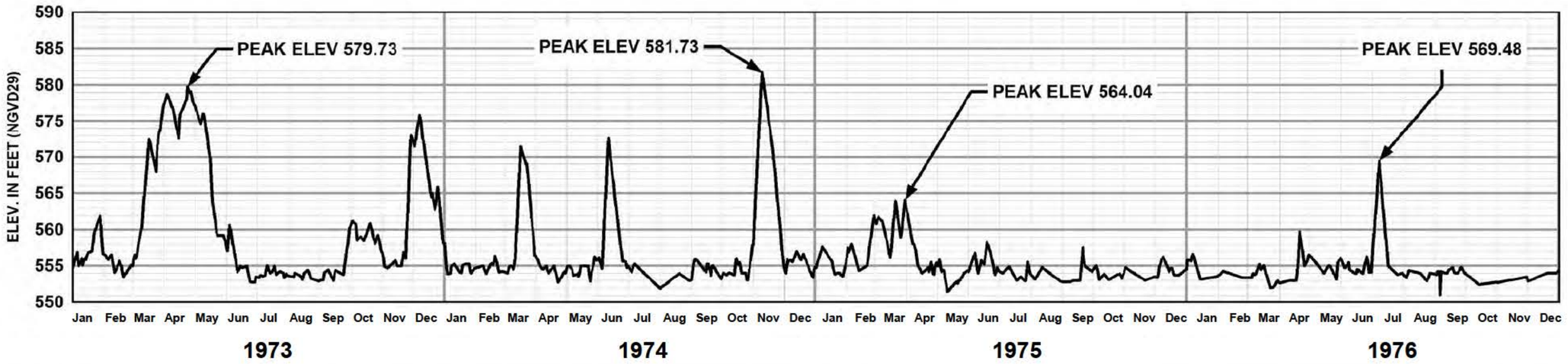
Note: Plate size is 11" x 17"

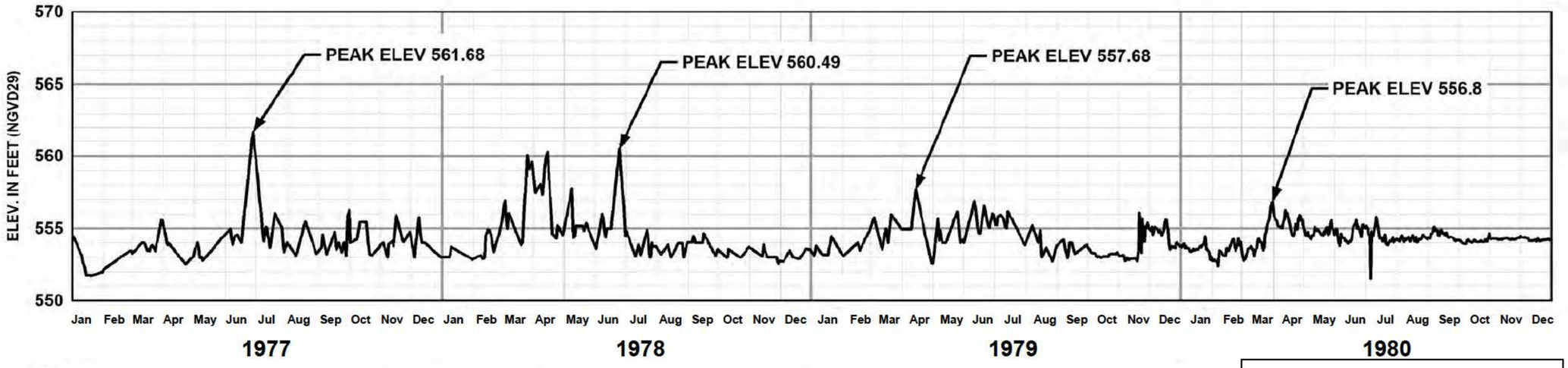
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

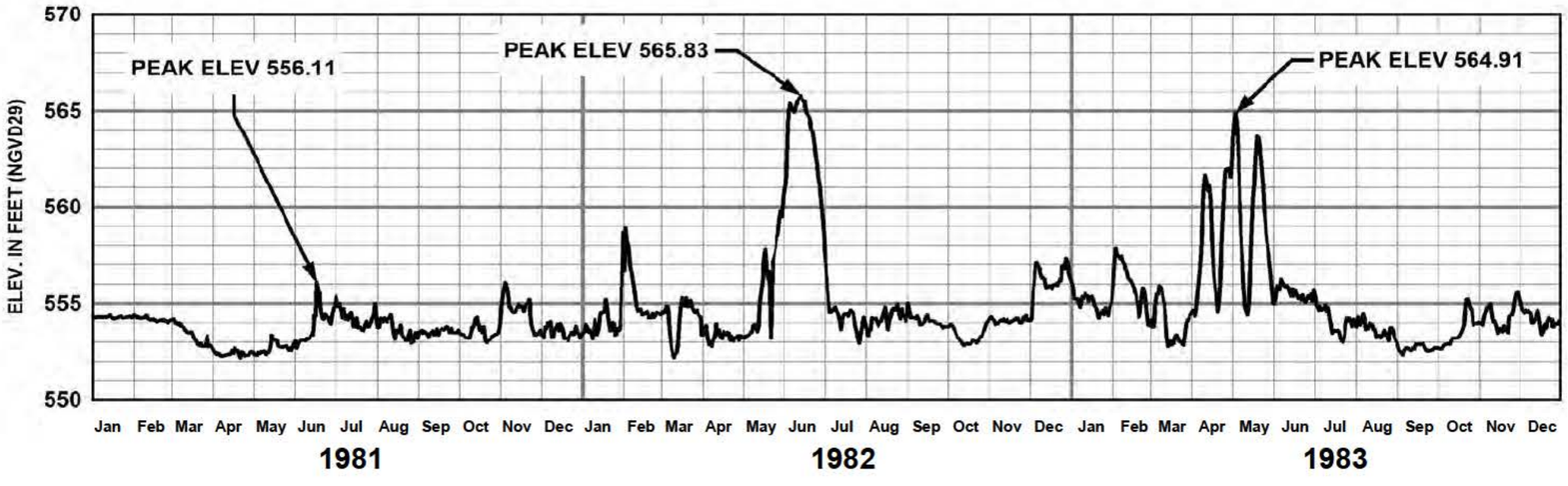
FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1962 - 1972

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL







NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

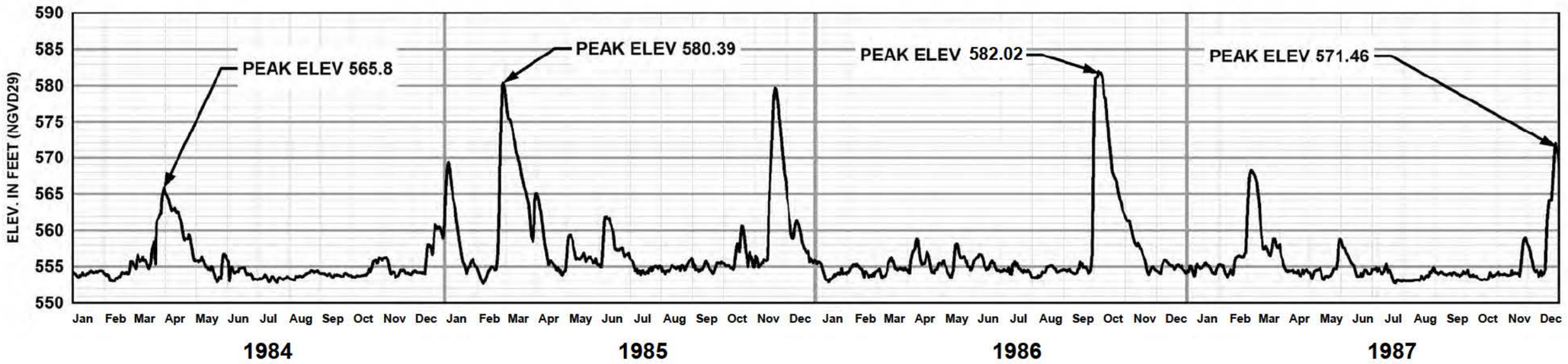
Note: Plate size is 11" x 17"

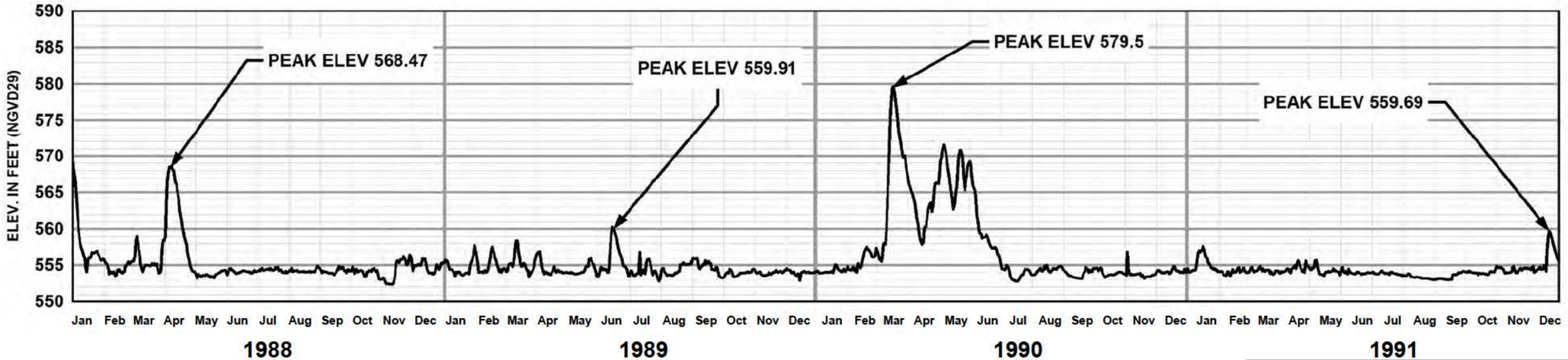
ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

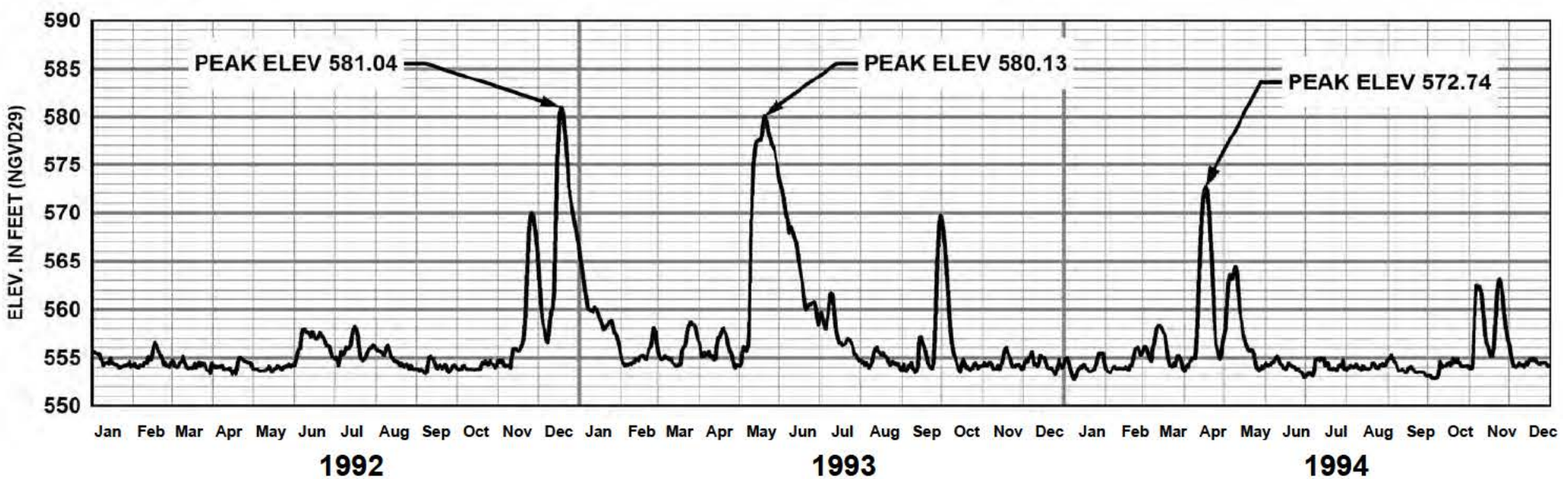
FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1973 - 1983

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL







NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

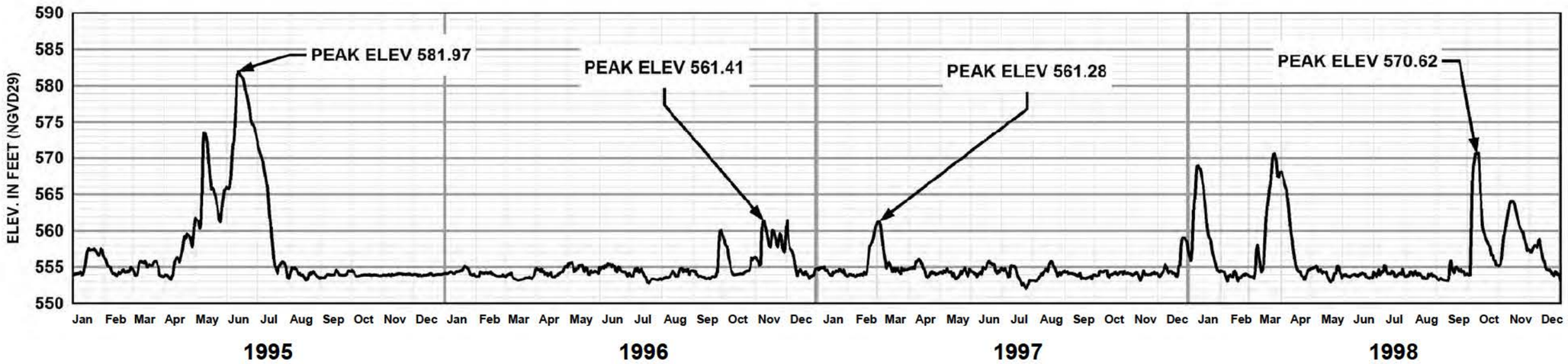
Note: Plate size is 11" x 17"

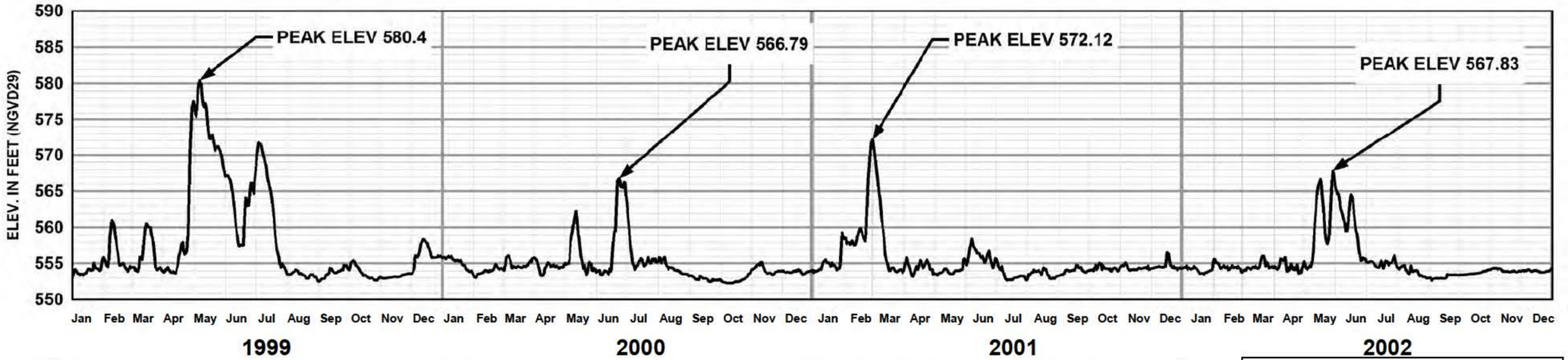
ARKANSAS RIVER WATERSHED — GRAND (NEOSHO) RIVER, OKLAHOMA

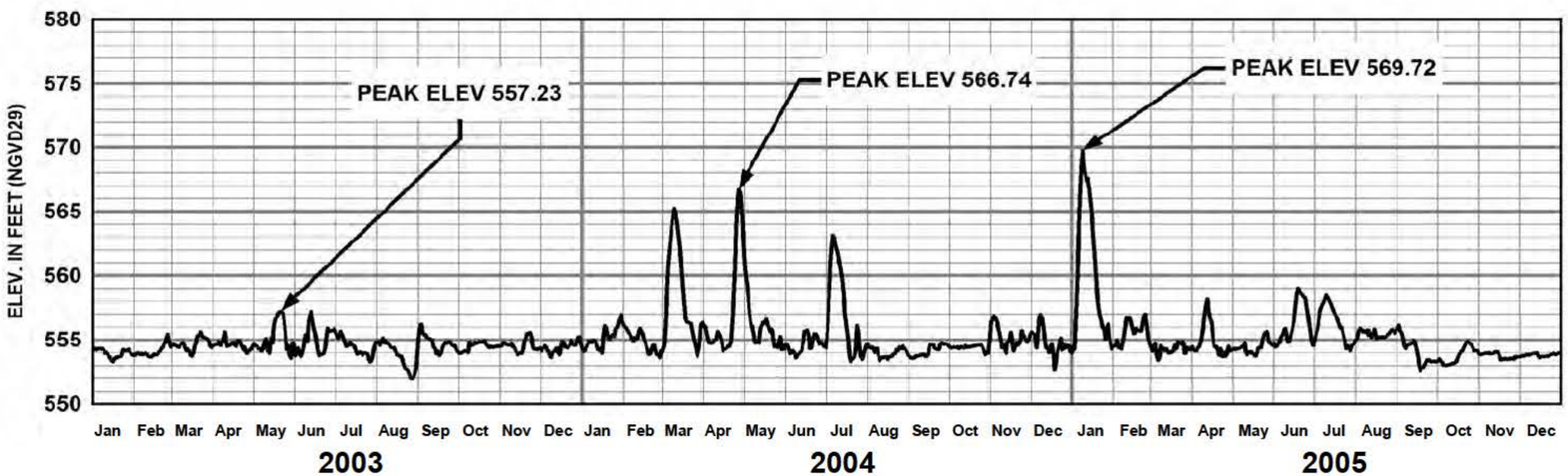
FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1984 - 1994

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL







NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

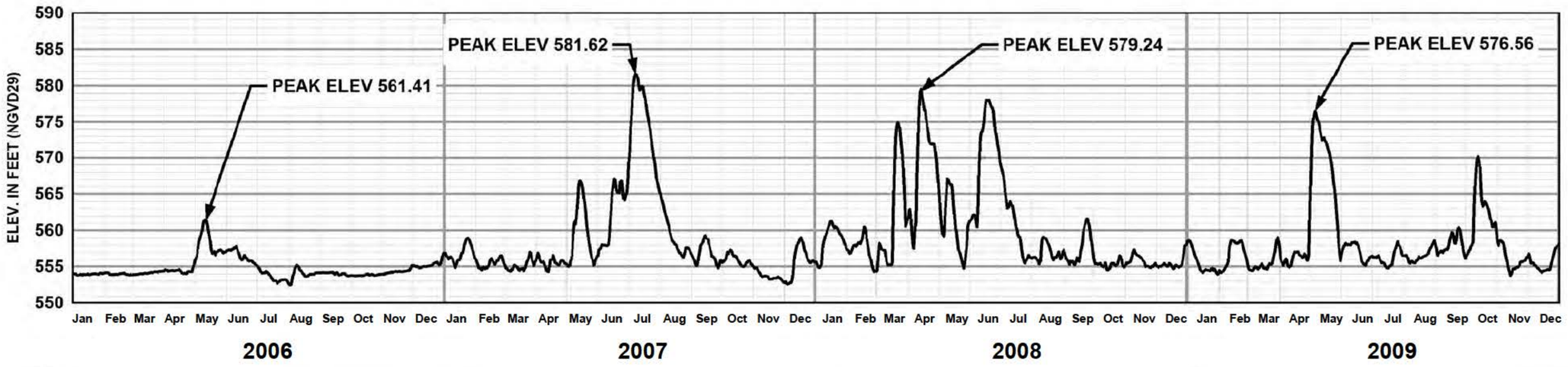
Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 1995 - 2005

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL



NOTE: Pool elevations for 1 Jan 1940 through 30 Sep 1952 are based on a simulation using the RiverWare computer program. Elevations for 1 Oct 1952 through Dec 2011 are actual historical values.

Note: Plate size is 11" x 17"

ARKANSAS RIVER WATERSHED GRAND (NEOSHO) RIVER, OKLAHOMA

FORT GIBSON LAKE

POOL ELEVATION HYDROGRAPHS 2006 - 2011

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2010
DRAWN: RKB
CHECKED: JRL