

**OOLOGAH LAKE
VERDIGRIS RIVER, OKLAHOMA**

**WATER CONTROL MANUAL
APPENDIX L
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN**

**ORIGINAL EDITION - JANUARY 1962
REVISED EDITION - SEPTEMBER 1996**

**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 looseleaf form, and only those sections, or parts of it, 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, NGVD (National Geodetic Vertical Datum).

EMERGENCY REGULATION ASSISTANCE PROCEDURES

If unusual conditions arise during duty hours and at various hours during weekends and holidays, contact can be made by telephone to the Water Control Section, Tulsa District Office (918) 669-7103, or the District VHF-FM radio (call signal WUI-3, Hydrology). If the above office cannot be contacted, assistance can be achieved by contacting, in the order listed, a person shown below. Chapter 7 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 chapter. A separate copy of this chapter has been provided to the project office and must be displayed on the bulletin board at all times.

EMERGENCY PERSONNEL ROSTER CORPS OF ENGINEERS PERSONNEL

Title and Name	Telephone
Project Coordinator, Office	(b) (6)
(b) (6)	(b) (6)
Backup Coordinator, Office	(b) (6)
(b) (6)	(b) (6)
Backup Coordinator, Office	(b) (6)
(b) (6)	(b) (6)
Backup Coordinator, Office	(b) (6)
(b) (6)	(b) (6)
Chief, Water Control Section, Office	(b) (6)
(b) (6)	(b) (6)
Natural Disaster Specialist	(b) (6)
Readiness Branch	(b) (6)



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PERTINENT DATA OOLOGAH LAKE

LOCATION: Verdigris River at mile 90.2, 22 miles northeast of Tulsa, Oklahoma.

DRAINAGE AREA: 4,339 square miles above the dam, 2,353 square miles of uncontrolled area below upstream lakes.

DAM: Type: Earthfill
Length: 4,000 feet (including spillway).
Top of Dam: 687.0 feet, NGVD.
Max. Height: 137 feet above streambed.
Crest Width: 36 feet

DIKE: Location: About one-half mile east of spillway.
Type: Earthfill.
Crest Elevation: 685.0 feet, NGVD.
Crest Width: 12 feet
Length: 3,330 feet

SPILLWAY: Location: In saddle about 2 miles east of main embankment.
Type: Gate controlled, concrete, gravity, ogee weir.
Number, size, and type of gates: 7 -40' x 21' tainter gates
Crest Elevation: 640.0 feet, NGVD.
Length: 328 feet gross and 280 feet net

OUTLET WORKS: Location: Through main embankment
Type and Size: 2 - 19' Diameter cut-and-cover circular conduit.
Invert Elevation: 565.0 feet, NGVD.
Control: 4 - 9' X 19' Vertical lift gates with gate hoists.
Low Flow Pipe, Number, Size and Type: 1 - 48" Diameter, butterfly valve

WATER SUPPLY: Location: In the intake structure.
Type: 1 - 66" conduit
Invert Elevation: 565.0 feet, NGVD

LAND ACQUISITION:

	Guide Contour Elevation (feet NGVD)	Area (acres)
Fee Simple	Blocked perimeter to 655	50,150
Easement	Blocked perimeter to 664	15,119

ELEVATIONS, AREAS, AND STORAGES:

Feature	Elevation (feet NGVD)	Lake Area ⁽¹⁾ (acres)	Lake Capacity			Outlet Works and Spillway Capacity (cfs)
			Accumulative ⁽¹⁾ (Acre-feet)	Incremental (Acre-feet)	Runoff ⁽²⁾ (inches)	
Top of Dam	687.0	112,402	3,857,292	929,862	7.41	---
Maximum Pool	678.25	92,160	2,927,430	1,015,915	8.10	264,700
Top of Surcharge Pool	666.0	72,118	1,911,515	352,236	2.81	160,200
Top of Flood Control Pool	661.0	67,117	1,559,279	942,589	7.51	92,400
Spillway Crest	640.0	33,400	616,690	64,455	0.51	30,800
Top of Conservation Pool	638.0	31,043	552,235	545,300	4.35	30,300
Top of Inactive Pool	592.0	880	6,935	6,935	0.06	13,000
Flood Control Storage	638.0-661.0	---	1,007,060	---	8.02	---
Conservation Storage	592.0-638.0	---	545,300 ⁽³⁾	---	4.35	---
Streambed at Dam	550.0	---	---	---	---	---

- (1) Based on 1977 sedimentation survey.
- (2) One inch of runoff equals 125,493 acre-feet, based upon 2,353 square miles of uncontrolled area.
- (3) Includes 342,600 acre-feet for water supply (154 mgd yield), 168,000 acre-feet for navigation (81.3 mgd yield), and 34,700 acre-feet for sediment storage.

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WATER CONTROL MANUAL
APPENDIX L
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN

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 part of Appendix L to Arkansas River Basin Water Control Master Manual. The following is a list of other related manuals in this District:

Appendix A - Great Salt Plains
Appendix B - Heyburn
Appendix C - Toronto (Part I), Fall River (Part II) and Elk City (Part III)
Appendix D - Hulah
Appendix E - Pensacola, Markham Ferry (Lake Hudson), and Fort Gibson
Appendix F - Birch
Appendix G - Tenkiller
Appendix H - Fort Supply, Optima, and Canton
Appendix J - Wister
Appendix K - Big Hill
Appendix M - Keystone
Appendix N - Eufaula
Appendix O - Council Grove, Marion, and John Redmond
Appendix P - Norman
Appendix Q - Sanford
Appendix R - Cheney

Appendix S - W.D. Mayo Lock Dam (Part II)
Robert S. Kerr Lock and Dam
and Reservoir (Part III)
Webbers Falls Lock and Dam (Part IV)
Chouteau Lock and Dam (Part V)
Newt Graham Lock and Dam (Part VI)
Appendix T - Kaw
Appendix U - El Dorado
Appendix W - Copan
Appendix Y - Skiatook
Appendix Z - Arcadia

The locations of existing and authorized projects in the Tulsa District are shown on Plate 1-1. Design memorandums important to the regulation of Oologah Lake are: Operation and Maintenance Manual Vol. I; Operation and Maintenance Manual, Vol. II, Flood Emergency Plan; and Drought Contingency Plan for Lower Verdigris River, Oklahoma, Appendix DCP-2 to Water Control Master Manual, Arkansas River Basin.

1.04. Project Owner. Oologah Lake is owned by the U.S. Government.

1.05. Operating Agency. The Corps of Engineers is the operating agency for Oologah Lake. The Project Manager, Oologah Lake, operating through the Operations Division, Tulsa District, has the responsibility for project operations. The project is placed under 24-hour surveillance when the lake level is above elevation 658.0. Below elevation 658.0, the project will be manned during normal work hours each day through the recreational season. When the recreation season is over, the project will be manned for the normal 5-day week. However, when the project is in flood control regulation, operating personnel will closely monitor the project and the downstream river reaches. A list of reservoir regulation personnel to contact during emergencies has been furnished to the project office. The Project Manager will furnish the Water Control Section a list of project personnel with their office and home telephone numbers and addresses. The Project Manager resides as close to the project as is considered prudent to carry out his or her official duties.

1.06. Regulation Agencies. The Corps of Engineers is the regulatory agency for Oologah Lake. The regulation is the responsibility of the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District.

II - DESCRIPTION OF PROJECT

2-01. Location. Oologah Lake is located at mile 90.2 on the Verdigris River, approximately 22 miles northeast of Tulsa in Rogers and Nowata Counties, Oklahoma. The project location is shown on plate 2-1. Supplementary pertinent data for Oologah Lake is given in Exhibit A.

2-02. Purpose. Oologah Lake is a multipurpose project for flood control, water supply, recreation, navigation, and fish and wildlife. The project was designed to provide maximum flood protection on the Lower Verdigris and Arkansas Rivers when operated in conjunction with the Arkansas River Basin System.

2-03. Physical Components.

a. Embankment. The embankment is a rolled, earthfilled structure consisting of random fill with an impervious core. The crest of the embankment is at elevation 687.0 and has a maximum height of 137 feet above streambed. The embankment has a crest length of 4000 feet and width of 36 feet with 24 feet of roadway paving for public access. A cutoff trench with a bottom width of 25 feet is provided for the full length of the embankment. The upstream slope of the embankment is protected by 24-inch riprap on backing material and the downstream slope is grass covered. The non-overflow dike has a top elevation of 685.0, crest width of 12 feet, and an average height of 25 feet. The general plan and cross-section of the structure are shown on plate 2-2.

b. Spillway. The spillway is a gated, concrete, gravity, ogee weir type structure with a gross length of 328 feet, a net overflow length of 280 feet, and a crest elevation of 640.0. The structure is located in a saddle approximately two miles east of the main embankment. Flows over the spillway are controlled by seven 40 feet by 21 feet tainter gates operated by individual electric power hoists. The rate of travel for each gate is approximately one foot of arc per minute. An emergency diesel powered generating unit is located in the generator building to provide electricity in case normal electric service is interrupted. The spillway plan is shown on plate 2-2.

c. Outlet works. The outlet works consist of two 19-foot diameter conduits placed on firm rock, on the right side of the old river channel. The intake structure is provided with four 9' x 19' broom-type gates, two for each conduit, and has provision for emergency gates and stoplogs. The gates hoists will lift the gates at a speed of one-half foot per minute. Low-flow releases are provided by a 48-inch diameter bypass sluice located in the dividing pier between conduits and discharging into the left conduit. The stilling basin is equipped with two rows of staggered baffles and a tapered end sill. A diesel-powered generator is provided for emergency use in the event of power failure. A section of the outlet works is shown on plates 2-2 and 2-3.

d. Sedimentation and Degradation. Forty-five sediment ranges have been established in the lake and five degradation ranges are located on the river below Oologah Dam. The ends of these ranges are marked with permanent monuments with known horizontal and vertical survey control data. The locations of the sedimentation and degradation ranges are shown on plate 2-4.

e. Water Supply. The water supply facility consists of an 84-inch diameter conduit that transitions to a 66-inch conduit and is located in a wet well on the right side of the intake structure. The invert elevation of the water supply conduit is 565.0. The wet well has two intake gates with invert elevations at 586.833 and 612.0.

2-04. Related Control Facilities. None.

2-05. Real Estate Acquisition. The fee taking line for Oologah Lake is a blocked perimeter encompassing elevation 655.0, which is approximately the 10-year frequency pool elevation. Flowage easements were acquired in the flat pool area above the fee taking line to elevation 664.0. In the upper reaches the flowage easement is based on the elevation of the envelope curve of backwater effects of the 50-year flood after 50 years of sedimentation. The envelope curves of backwater effects for the Verdigris River are shown on plate 2-5. There are 50,150 acres in fee simple title and 15,119 (including easement below the spillway) acres in easement.

2-06. Public Facilities. The Corps of Engineers maintains ten parks and one access point on Oologah Lake. A public overlook and picnic area is located on the upstream side of the left abutment. The public use areas are shown on plate 2-6.

III - HISTORY OF PROJECT

3-01. Authorization. Oologah Lake was authorized for construction by the Flood Control Act approved 28 June 1938 (Committee Document No. 1, 75th 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 in 1931 as House Document No. 798, 1st Congress, 3rd session. It considered a system of reservoirs in the Arkansas River Basin, one of which was the Oologah Reservoir. The report was unfavorable to the construction of such a system by the Federal Government at that time.

b. House Document No. 259. In the "Comprehensive Report on Reservoirs in the Mississippi River Basin," dated 15 December 1934, the Oologah Reservoir was considered as one of a system of reservoirs for the control of floods in the Arkansas River Basin. The report was unfavorable to the construction and operation of such a reservoir system by the Federal Government at that time.

c. House Document No. 308. The survey report "Arkansas River and Tributaries" published in 1936 as House Document No. 308, 74th Congress, 1st session, discussed Oologah Reservoir as part of a plan for controlling floods on the Verdigris River. The report was unfavorable to the participation by the Federal Government in the control of floods in the Verdigris River Basin at that time.

d. Committee Document No. 1. The Oologah Reservoir was included in a system of reservoirs recommended for the control of floods in the Arkansas River Basin in the report "Comprehensive Flood Control Plan for the Ohio and Lower Mississippi Rivers," dated 6 April 1937, and published as Committee Document No. 1, 75th Congress, 1st session. The report was favorable to participation by the Federal Government in the construction, maintenance, and operation of such a system of reservoirs. The general plan of improvement recommended by this published document was subsequently approved by the Flood Control Act of 1938.

e. Questionnaire Report. A questionnaire report, submitted on a form entitled "Flood Control Reservoir Data," dated 27 September 1937, considered a reservoir at the Oologah site for the purpose of flood control or generation of hydroelectric power. The site was not considered feasible for the development of a dual purpose project. The study indicated the flood control project could be justified but the power project could not. The report was preliminary in nature and was based upon data then readily available.

f. Preliminary Examination Report. The "Preliminary Examination Report on Flood Control, Verdigris River, Kansas, and Oologah Reservoir, Oklahoma," dated 21 January 1938, considered a reservoir at the Oologah site and found that, based on the preliminary data then available, such a reservoir had possibilities for the economical development of a flood control project. The report recommended that further investigations as to the potentialities of the Oologah Reservoir be made.

g. House Document No. 758. A survey report on Oologah Reservoir as combined with and included in the "Survey Report on Arkansas River and Tributaries, Arkansas and Oklahoma," dated 31 December 1943, was published as House Document No. 758, 79th Congress, 2nd session. The recommended plan provided Oologah Reservoir with storage for flood control, hydroelectric power, navigation, and other conservation uses. It provided for an earth embankment, two concrete non-overflow sections, a gate controlled concrete spillway, and powerhouse and power generating facilities. The general plan of improvement recommended in this report was approved by the River and Harbor Act of 24 July 1946.

h. Definite Project Report. This report was submitted to the Chief of Engineers by letter dated 15 May 1944. Studies made for this report indicated that a two-stage plan of development was economically feasible. The initial development would include flood control and conservation storage, and the ultimate development would include storage for flood control, conservation, and hydroelectric power. As hydroelectric power was not an authorized feature of the Oologah project at that time, the report provided that the recommendation for the installation of power as the ultimate development would be dependent upon further congressional approval for that purpose. The plan recommended in the definite project report was essentially the same as that recommended in House Document No. 758. The definite project report was tentatively approved by the Office, Chief of Engineers, in 5th Indorsement dated 22 November 1945, subject to additional studies and pending agreement with the Federal Power Commission on the provision for future power.

i. Letter Report Dated 1 September 1950. Revised spillway design storm criteria adopted at a conference attended by representatives of the Office, Chief of Engineers, Southwestern Division, and Tulsa District necessitated major changes in the definite project plan. Details of the revised plan, together with data on the spillway design storm, were presented in A Tulsa District letter dated 1 September 1950, subject: Revised Plan of Development, Oologah Dam and Reservoir, Verdigris River, Oklahoma. Major differences in this plan from the plan recommended by the definite project report were to increase the height of the dam from elevation 674.0 to elevation 687.0 and change the location of the spillway from the channel of the stream to a saddle about 2 miles east of the left abutment. An outlet works would be located in the stream channel. The Office, Chief of Engineers, concurred in general with the plan, subject to additional studies.

j. Public Law 93-251. The River and Harbor Act of 24 July 1946 was amended by the Secretary of the Army to reassign the storage provided in Oologah Lake for hydroelectric power production to municipal and industrial water supply and to make such storage available for such purposes under the Water Supply Act of 1958.

K. Analysis of Design. A series of analysis of design and design memorandums have been prepared in connection with planning for Oologah Lake. These reports cover the planning of structural features of the plan, relocation of roads and utilities, and real estate.

3-03. Construction. Oologah Lake was constructed in two stages. The initial development was for the construction of the main embankment and outlet works, an uncontrolled saddle spillway at the site of the final gated spillway, and an emergency overflow area at the site of the final dike embankment. The initial top of conservation pool was elevation 608.0, with a top of flood control pool at elevation 651.0. The final stage of development was the construction of the gated spillway and the dike embankment. The final development resulted in a conservation pool elevation of 638.0 and a flood control pool elevation of 661.0. A resume' of construction activities is presented in Table 3-1.

TABLE 3-1

RESUME' OF CONSTRUCTION ACTIVITIES

<u>Activity</u>	<u>Date</u>
Construction began	July 1950
Placed on standby basis	October 1951
Construction resumed	December 1955
Date of diversion	6 June 1961
Storage began (initial development)	15 May 1963
Conservation pool filled (initial development)	4 April 1964
Storage began (final development)	13 January 1971
Conservation pool filled (final development)	29 July 1972

3-04. Related Projects. Oologah Lake is a component of multipurpose Arkansas River Basin flood control and navigation system. Included in this system are completed projects in the Verdigris, Walnut, Canadian, North Canadian, Grand, Caney, Illinois, and Poteau River Basins. Other projects either under construction or authorized are

located in the Arkansas, Walnut, Verdigris, and Grand River Basins. The Arkansas River system is operated for the control of floods, navigation, and other beneficial uses.

3-05. Modification to Regulations. The regulation of Oologah Lake has been modified to coincide with the present Arkansas River System Operating Plan as Discussed in the Arkansas River Basin Water Control Master Manual.

3-06. Principal Regulation Problems. Flooding and inundation of access roads to recreation areas occurs when the pool reaches elevation 642.0. Twenty-four hour flood surveillance at the dam begins at elevation 658.0. During the October 1986 flood operation, the lake was allowed to raise above the top of the flood control pool to minimize downstream flooding. This operation required that flood releases be made through the tainter gates instead of the conduit. This release caused considerable erosion on private land in which the Corps of Engineers had only a flood easement. When the pool elevation receded to the top to the flood control pool, the conduit gates could not be opened because of the pressure against the gates caused by the high tailwater. Also, releases greater than 20,000 cfs cause considerable damage to the riprap in the outlet channel.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Verdigris River rises in the Flint Hills of Chase County, Kansas, and flows generally southeast from the vicinity of Madison to Neodesha, Kansas, and then in a southerly direction to its confluence with the Arkansas River, about 5 miles northeast of Muskogee, Oklahoma. The river basin is roughly elliptical in shape, with a total area of 8,303 square miles, of which 4,339 square miles are above the Oologah Dam and is divided as follows: 3,354 square miles in Kansas and 985 square miles in Oklahoma. The principal tributaries are the Fall and Elk Rivers that enter from the right bank in Kansas and the Caney River and Bird Creeks that enter from the right bank in Oklahoma downstream from Oologah Dam. The Verdigris River navigation system extends from the Arkansas River upstream about 50 miles to the Tulsa-Rogers County Port of Catoosa. Considerable channel widening and straightening along with construction of Newt Graham and Chouteau Locks and Dams have improved the water carrying capability of the channel considerably. The valley floor varies from approximate elevation 510.0 near its confluence with the Arkansas River and the mouth of the main stem to approximate elevation 1000.0 in the upper reaches of the basin. The slope of the river near its source averages about 3.7 feet per mile and the navigation channel has a total rise of 42 feet in 50 miles. Stream profiles of the Verdigris River and its principal tributaries are shown on plates 4-1 through 4-3.

4-02. Topography. The greater portion of the Verdigris River watershed is an undulating plain; however, the western boundary, formed by the Flint Hills in Kansas and the Osage Hills in Oklahoma, is rough and broken, with elevations rising to 1600 feet, NGVD. The valley side slopes are relatively steep, with most of the valley proper in cultivation or pasture land. Wooded areas are prevalent along the channel and in the river bottom in the lower reaches of the stream. The channel is well defined, but winds and contains many sharp bends in its course through the valley.

4-03. Geology and Soils. Oologah Lake is in the Cherokee Plains subdivision of the Prairie Plains physiographic province. The bedrock strata are shale and limestone of Pennsylvanian age.

4-04. Sediment. The Verdigris River basin consists of silts and clays with scattered outcroppings of sandstone and limestone rock. The well-defined stream with its heavily vegetated overbanks allow for very little bank erosion. The sediment inflow to the lake is lower than other reservoirs in the Verdigris basin. This reduction in sediment is due to almost 50 percent of the watershed being controlled by upstream reservoirs. The total drainage area upstream of Oologah Dam is 4,339 square miles, 1,986 square miles of which are controlled by upstream reservoirs. The average annual sediment deposit is 660 acre-feet. The 50-year design sediment accumulation for the lake is 33,500 acre-feet, and as of the 1977 resurvey, 24,260 acre-feet of sediment storage

remains. The area and capacity data of the lake have been updated using the last sedimentation resurvey conducted in 1977. The storage lost to sediment since impoundment is 9,240 acre-feet with the deposition occurring as follows: 0.23 percent in the flood pool, 67.49 percent in the conservation pool and 32.28 percent in the inactive pool.

4-05. Climate. The climate in the Verdigris River Basin is characterized by moderate winters and long summers with high temperatures. Rainfall usually occurs as high intensity, local thunderstorms occurring primarily in the late spring and early fall months. These storms are frequently accompanied by high winds, hail, and occasional tornadoes. Climatic characteristics for the basin are:

a. Temperature

(from recorded data at Nowata, Oklahoma)

Mean annual	59.3 degrees F
Maximum recorded (July 1954)	117 degrees F
Minimum recorded (January 1977)	-10 degrees F

b. Precipitation

(average for the drainage basin above Oologah Dam)

Mean annual (Jan. 1930 thru Dec. 1995)	39.22 inches
Maximum annual (1973)	55.88 inches
Minimum annual (1952)	22.27 inches
Percent during growing season (April through September)	66.5 percent

c. Snow

(from recorded data at Nowata, Oklahoma)

Mean annual	11.9 inches
Maximum month (January 1979)	23.0 inches
Minimum annual (several years)	0.0 inches

The average monthly and annual rainfall and runoff data are shown in Table 4-1.

TABLE 4-1
AVERAGE MONTHLY AND ANNUAL RAINFALL AND RUNOFF
ABOVE OOLOGAH DAM

Month	Average rainfall (1) (inches)	Percent of average annual rainfall	Average runoff		Percent of average annual runoff
			(acre-feet)	(2) (3) (inches)	
January	1.37	3.5	100,740	0.44	4.9
February	1.43	3.6	106,230	0.46	5.2
March	3.58	9.1	213,020	0.92	10.4
April	3.79	9.7	299,330	1.29	14.6
May	5.09	13.0	318,570	1.38	15.5
June	5.14	13.1	310,800	1.34	15.2
July	3.55	9.1	158,490	0.68	7.7
August	3.34	8.5	57,220	0.25	2.8
September	4.64	11.8	105,520	0.46	5.1
October	3.06	7.8	138,780	0.60	6.8
November	2.59	6.6	143,830	0.62	7.0
December	1.64	4.2	99,350	0.43	4.8
Total	39.22	100.0	2,051,880	8.87	100.0

(1) Period of record - January 1930 through December 1995.

(2) Contributing drainage area above Oologah Lake = 4,339 square.

(3) Period of record - January 1923 through December 1995.

d. Evaporation. The estimated monthly evaporation at Oologah Lake is shown in Table 4-2.

TABLE 4-2
AVERAGE MONTHLY PAN EVAPORATION
OOLOGAH LAKE

Evaporation (inches) (1)	
January	1.86
February	2.61
March	5.40
April	7.26
May	8.16
June	9.03
July	10.85
August	10.04
September	7.23
October	5.64
November	3.25
December	1.92
TOTAL INCHES PER YEAR	73.25

(1) National Weather Service Class "A" pan.

e. Wind. The prevailing wind is from the south with the greatest wind movement occurring in the spring months. Wind velocity data show the highest wind speed that can reasonably be expected at the dam site is 53 miles per hour.

4-06. Storms and Floods. Most major storms in the Oologah Lake drainage basin have occurred in April through June and September through November. Thunderstorms and the remnants of hurricanes are the type of storms that produce most high runoff events in the basin. The largest storm in the 67 years of records was the September 26 to October 5, 1986 storm that produced an average of 10.65 inches of rainfall over the basin. This storm was the combination of a stalled cold front and the remnant of a hurricane. Time of year and antecedent soil moisture condition are major factors that determine the runoff from a given storm. Thus, some lesser rainfall storms have resulted in runoff as great as or greater than storms of higher rainfall. Major storms in the basin are listed in Table 4-3. Major floods recorded at the Claremore gage are listed in Table 4-4.

TABLE 4-3
MAJOR STORMS – JANUARY 1923 THROUGH DECEMBER 1995
OOLOGAH LAKE

Inclusive Dates	Average Basin Rainfall (inches)	Inclusive Dates	Average Basin Rainfall (inches)
8-11 Jun 1923	4.36	20-26 Jun 1969	3.99
3-5 Sep 1926	4.87	9-13 Oct 1969	5.57
7-21 Apr 1927	8.04	17-21 Oct 1971	3.91
16-21 Jun 1927	4.05	20-22 Oct 1972	3.45
23 Sep-3 Oct 1927	6.15	21-27 Sep 1973	5.80
16-25 Jun 1928	4.15	8-10 Mar 1974	5.10
16-17 Nov 1928	4.16	3-8 Jun 1974	4.88
9-15 Jun 1930	4.60	30 Oct-4 Nov 1974	7.10
18 May-17 Jun 1935	12.25	1-3 Jul 1976	5.60
14-19 Jul 1937	5.32	19-20 Nov 1979	4.31
18-23 May 1938	4.24	11-17 Oct	3.56
2-18 Aug 1940	4.56	11-16 May 1982	3.10
19-26 Nov 1940	4.25	16-21 Oct 1983	5.67
13-20 Apr 1941	4.60	20-23 Feb 1985	4.76
1-10 Sep 1941	6.41	3-6 Jun 1985	3.16
28 Sep-31 Oct 1941	11.36	11-15 Nov 1985	4.48
15-25 Jun 1942	5.82	12-13 Jul 1986	3.16
Sep 1942	4.98	25 Sep-4 Oct 1986	10.65
6-11 May 1943	5.71	22 May 1987	3.50
13-20 May 1943	6.89	13-20 Sep 1988	4.69
8-11 Apr 1944	4.16	7-13 Jun 1989	4.22
11-16 Apr 1945	5.05	11-17 Jul 1989	3.47
24 Sep-Oct 1945	10.14	11-16 Mar 1990	4.52
8-16 Apr 1947	4.85	10 Apr- 6 May 1990	5.43
20-29 Jun 1948	5.88	15-21 May 1990	3.43
10-15 Jul 1948	4.63	17-22 Sep 1990	3.45
20 Jun-14 Jul 1951	12.40	24 Oct-2 Nov 1991	3.52
9-25 May 1957	7.63	18-26 Nov 1992	3.50
9-18 Jun 1957	5.08	13-17 Dec 1992	3.37
12-18 Jul 1959	5.98	28 Apr-13 May 1993	5.67
30 Sep-5 Oct 1959	6.84	23-27 Sep 1993	4.71
1-9 May 1961	8.94	9-15 Apr 1994	5.73
14-22 Sep 1962	4.84	26 Apr-16 May 1994	6.38
14-19 Nov 1964	4.49	13-22 Jul 1994	3.48
1-6 Apr 1964	3.89	7-9 May 1995	3.24
1-15 Jun 1965	3.89	31 May-6 Jun 1995	3.23
9-12 Jun 1967	3.33	8-11 Jun 1995	4.55
7-14 Jun 1969	3.19	1-7 Aug 1995	4.46

TABLE 4-4
FLOODS FOR PERIOD OF RECORD AT CLAREMORE GAGE
(Flood Stage 35.0 Feet)

Month	day	Year	stage (feet)	Discharge (cfs)	Month	day	year	stage (feet)	discharge (cfs)
Jun		1935	46.20	64200	Apr	26	1947	38.29	32300
Jun	13	1937	41.20	38700	May	24	1947	35.56	28800
Oct	11	1937	41.20	38700	Jun	27	1948	46.41	61000
Mar	31	1938	38.12	34600	Jul	15	1948	37.91	30400
May	29	1938	42.10	39900	Jul	23	1948	44.80	50400
Apr	22	1941	44.46	48200	Aug	15	1948	36.15	28600
Jun	14	1941	44.30	45100	Jan	25	1949	37.78	30000
Sep	12	1941	38.58	29400	Feb	17	1949	39.03	31000
Oct	8	1941	45.83	52800	May	21	1949	38.58	30800
Oct	18	1941	39.88	31600	Jul	23	1950	40.13	37200
Nov	2	1941	46.60	64200	Jul	6	1951	46.95	74900
Apr	12	1942	41.41	34900	Jul	20	1951	44.16	51900
Apr	23	1942	42.82	38300	May	4	1954	38.12	32900
Jun	26	1942	43.63	41300	May	22	1957	43.96	47500
May	13	1943	46.55	68000	Jun	5	1957	41.98	37900
May	21	1943	55.05	182000	Jun	15	1957	46.51	68500
Apr	13	1944	47.23	85200	Jun	25	1957	38.36	35800
Apr	30	1944	41.47	36600	Jul	25	1959	43.53	47200
Oct	1	1944	35.10	28200	Oct	5	1959	45.76	60500
Oct	7	1944	41.40	36400	Oct	15	1959	36.40	33900
Dec	10	1944	38.37	32200	May	7	1960	35.78	33000
Mar	16	1945	37.54	30400	May	11	1961	50.06	116000
Mar	29	1945	38.10	32800	May	23	1961	35.10	35200
Jul	1	1945	37.14	30100	Aug	15	1961	35.25	32700
Oct	4	1945	46.98	73000	Sep	19	1961	38.45	36600
Jan	7	1946	38.90	31800	Oct	12	1986	44.99	78400
Apr	20	1947	44.51	53000					

Flows have been regulated by Hulah Lake since 1951, Oologah Lake since 1963, and Copan Lake since April 1983.

4.07. Runoff Characteristics. The general shape of the 4,339 square mile Verdigris River drainage basin above Oologah Dam is elliptical, approximately 100 miles long and 45 miles wide. Generally the storms common to the drainage basin are not of uniform intensity. Floods above Independence, Kansas, generally peak faster than those on the Lower Verdigris. This is partly due to the steep slopes, impervious shallow soils, the synchronized flood flows from the Upper Verdigris, Fall, and Elk Rivers and the sluggish flow of water in the lower portions of the Verdigris and Caney Rivers. In the reach between Independence, Kansas, and Oologah Lake, the

overflow area widens and there are no major tributaries. The river bottoms in this reach are intensively farmed, with many small levees (both natural and man-made). When overtopped, the storage behind these levees causes significant retardation of flows as the flood passes downstream. Below Oologah Dam, the heavily wooded overbanks attenuate peak flows and prolong flood duration. Base flow in the Verdigris River is moderately low, and periods of zero flow have been observed. The time from beginning of runoff to peak flow into Oologah Lake is about 36 hours. However, this time is highly dependent on the storm pattern and time of year significant runoff begins. Pertinent data for stream gaging stations in the basin are shown in Table 4-5. The estimated monthly and annual flows at the Oologah dam site for the period 1923 through 1989 are shown on Table 4-6. These flows are modified by Toronto, Fall River, Elk City, and Big Hill Lakes. The monthly inflow volume frequency is shown on Table 4-7. Flow duration curves (inflow and outflow) are shown on plate 4-4.

TABLE 4-5
PERTINENT DATA FOR STREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.)	FLOOD STAGE (ft.)	BANK FULL CAPACITY (cfs)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	DISCHARGE (cfs)
Independence, KS	Verdigris River	194.3	716.63	30.0	20,000	05-19-43	47.60	114,000
Lenapah, OK	Verdigris River	144.6	644.89	30.0	32,400	05-20-43	40.44	137,000
Claremore, OK	Verdigris River	76.0	536.62	35.0	51,900	05-21-43	55.05	182,000
Van Buren, AR	Arkansas River	308.9	372.36	22.0	105,000	05-12-43	38.0	850,000

STATION	STREAM	2ND LARGEST FLOOD OF RECORD			3RD LARGEST FLOOD OF RECORD			PERIOD OF RECORD
		DATE	STAGE (ft.)	DISCHARGE (cfs)	DATE	STAGE (ft.)	DISCHARGE (cfs)	(FLOW AND/OR STAGE)
Independence, KS	Verdigris River	04-17-45	47.28	117,000	05-06-61	47.03	110,000	OCT 1921-Present
Lenapah, OK	Verdigris River	05-08-61	39.78	121,000	07-03-51	38.66	94,800	OCT 1938-Present
Claremore, OK	Verdigris River	05-11-61	50.06	116,000	04-13-44	47.23	85,200	OCT 1935-Present
Van Buren, AR	Arkansas River	04-17-45	38.1	650,000	05-28-57	35.97	510,000	OCT 1945-Present

TABLE 4-6
ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
OOLOGAH LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1923	4200	4100	40800	33300	186700	654500	58400	3800	34800	199800	97200	162300	1479900
1924	32100	124100	322600	169400	204700	153400	90500	245300	138000	94400	156200	40300	1771000
1925	166400	76300	32500	199600	111100	32600	6700	7000	62100	4300	213000	18700	930300
1926	43300	26200	29200	298000	48700	63300	2900	8600	379800	811000	43200	75800	1830000
1927	82100	76300	159400	1703000	125900	298100	52100	495500	96300	933800	37000	67700	4127200
1928	97200	167000	276600	302800	115000	764600	134200	67500	14200	6900	289500	263000	2498500
1929	347100	84000	124500	986800	1069000	508100	262300	22400	5500	4600	8900	5400	3428600
1930	11000	116100	5500	75800	646000	385300	15100	3600	151800	15700	47900	88800	1562600
1931	18600	38300	87600	171800	226700	224800	49100	38000	42600	6400	426700	107100	1437700
1932	239700	105000	50400	51900	39700	215000	86500	6200	380	3100	1300	57600	856780
1933	33900	15100	71100	227900	297800	25800	3900	77300	99600	22300	20600	78700	974000
1934	55200	6400	9800	154300	195300	15200	820	3000	140500	68800	200800	41200	891320
1935	97600	71700	132000	49800	545800	1473000	99800	9000	9400	44300	252600	125400	2910400
1936	39700	12100	13500	8500	107700	70700	29600	460	139100	391300	101600	25600	939860
1937	198100	113600	107700	150400	101800	369000	185100	34900	45200	2100	870	1800	1310570
1938	5000	46800	178100	201700	744200	427900	33800	48700	12900	910	1700	1000	1702710
1939	1900	1800	5900	52000	196100	68600	9100	1300	570	0	0	0	337270
1940	0	260	340	79700	92900	35900	35600	56500	85400	1800	117100	52400	557900
1941	241800	186600	38300	527000	58900	570200	27700	47000	381200	0	0	0	2078700
1942	54500	145100	137500	727200	199500	619300	75900	68000	415300	176000	78000	218800	2915100
1943	106100	87100	90100	48200	2166000	566100	61700	6900	12900	74100	4400	24800	3248400
1944	35300	68400	456700	1154000	410600	118600	23600	50600	113100	366000	22100	321900	3140900
1945	42700	51300	586200	1105000	226200	145900	238900	11300	337300	603300	20200	13100	3381400
1946	295500	141500	158200	123900	77200	16200	6100	560	9600	3600	86000	28200	946560
1947	11900	4400	118600	970500	461000	251800	50600	5300	8600	1300	2500	11300	1897800
1948	5800	6800	180300	87000	64200	597000	1097000	187200	6200	2700	55300	6800	2296300
1949	368200	507700	222800	234100	405400	352500	265100	44100	40600	62000	12300	12000	2526800
1950	36300	30000	25000	27800	189500	252100	446500	251900	120100	35400	6200	6000	1426800
1951	6400	45800	39200	91300	461900	547400	1845000	209600	454900	74800	274800	73100	4124200
1952	92100	64300	393000	268100	55400	19100	2800	1600	870	500	1400	1500	900670
1953	1100	1200	12000	20000	44100	5900	6100	1300	8100	1300	5500	4000	110600
1954	1300	1700	1700	50700	250000	18800	1200	200	100	89700	2200	1800	419400
1955	22400	14600	21100	8700	196200	76100	6200	400	4800	76900	420	470	428290
1956	810	1000	540	730	4400	33700	11000	260	30	160	1000	690	54320
1957	500	4400	3800	153200	757700	1123000	68600	6100	11400	22900	50600	17300	2219500
1958	26800	52300	750100	342000	188900	73600	458400	24000	85400	8200	34300	12600	2056600
1959	16400	33300	46600	129100	224300	29000	677000	73500	39300	1024500	49700	46000	2388700
1960	94900	154500	343100	254000	274000	183400	13600	68200	12300	66400	105900	118100	1688400
1961	153500	196700	245900	432900	1765000	183100	208800	135200	856300	385100	774700	312700	5649900

TABLE 4-6 (CONT'D)
ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
OOLOGAH LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1962	151700	193700	178900	81400	24100	139700	29300	2500	348500	159100	26800	43900	1379600
1963	101100	16600	150300	24900	20100	34700	8700	4900	1300	1200	1600	1400	366800
1964	2200	2800	4900	89800	19900	144200	960	26900	6200	1600	284600	96300	680360
1965	68200	32900	96400	626500	78300	588800	24700	6200	242800	13300	3400	14600	1796100
1966	13100	25800	37400	28600	71300	37300	4900	7900	4200	2500	940	1500	235440
1967	4900	5800	5500	40100	55000	300200	258100	43600	167000	166100	180800	53600	1280700
1968	105300	37900	201300	197900	179000	132900	85600	195500	8900	84000	349600	201000	1778900
1969	188800	140000	342900	410500	407200	965100	223900	9900	51300	349800	84900	77200	3251500
1970	47000	20300	81100	744300	357600	412900	19400	2600	113000	79300	13800	19800	1911100
1971	176200	129100	126400	20300	48800	181000	99500	21500	41700	161600	25300	426000	1457400
1972	16900	58200	19000	71900	99700	11400	233600	55000	90200	156300	459800	192300	1464300
1973	642100	322000	1298200	717500	585100	99500	68900	18900	203700	25800	442000	577900	5001600
1974	378200	224100	1050100	183300	333200	608400	50300	37500	286200	207600	1181200	318600	4858700
1975	308200	519300	516200	281100	194600	602700	89100	41500	21000	13000	15900	30500	2633100
1976	10100	11000	67000	103400	203600	52800	1030600	12200	11500	17800	5100	570	1525670
1977	2200	14400	18400	27400	234200	550600	416400	157200	286200	140600	553900	61200	2462700
1978	33500	161000	399700	387800	390800	166800	32300	9800	4900	1200	14900	840	1603540
1979	54700	63600	221700	189600	121400	441800	166000	40800	4000	7600	228800	42500	1582500
1980	26700	97900	270400	376700	78200	20100	5800	11200	10400	8900	1200	6300	913800
1981	2000	6200	8500	25700	58600	92700	66900	28700	43400	45200	122800	39700	540400
1982	87900	159400	174300	32200	366700	728000	159900	44700	16400	11800	24900	139000	1945200
1983	96000	316500	236100	969600	416400	134700	50400	2500	4200	132600	39100	40100	2438200
1984	33200	96400	670800	716000	388300	430400	15500	10800	6400	45000	39100	290400	2742300
1985	292500	639900	774000	211300	318200	712200	53900	309900	202300	519100	856400	275900	5165600
1986	86500	104900	74600	246100	421700	101900	151800	27300	310100	1839700	469000	285800	4119400
1987	203200	565000	673000	146000	336000	265000	62200	35600	22000	6300	140200	407700	2862200
1988	249100	66900	463400	1061200	57400	6700	26400	6600	37100	5100	54500	30000	2064400
1989	42500	44300	138800	95400	270700	591300	71800	98100	318200	101500	96300	7900	1876800
1990	97800	151500	968100	264900	634900	452300	8120	37100	14740	11900	20690	30250	2692300
1991	73670	25390	14930	90900	133990	83350	1160	5040	16820	10940	38490	182100	676780
1992	52910	109200	118110	155440	49190	310910	535280	306640	73290	16510	634310	778710	3140500
1993	551310	368730	352360	319730	996000	560030	258050	41510	320350	78170	100900	75270	4022410
1994	42640	111670	97960	979540	798350	15800	71440	21060	19020	22671	382915	50877	2613943
1995	24000	28761	181490	261822	971221	1143686	441497	173715	19240	635	2033	8787	3256887
MEAN	100736	106233	213021	299328	318565	310801	158489	57221	105522	138778	143834	99349	2051878
MAXIMUM	642100	639900	1298200	1703000	2166000	1473000	1845000	495500	856300	1839700	1181200	778710	5649900
MINIMUM	0	260	340	730	4400	5900	820	200	30	0	0	0	54320

TABLE 4-7
INFLOW VOLUME FREQUENCY
(1923-1989)

Frequency of occurrence (years)	Monthly Inflow in Thousands of Acre-Feet											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	43	50	95	168	198	175	54	19	37	36	44	44
5	162	167	345	443	550	499	202	78	166	191	211	211
10	298	292	560	692	730	720	369	147	330	400	436	290
25	476	447	790	973	1050	960	587	239	556	670	758	481
50	772	694	1080	1380	1550	1280	946	394	954	1170	1340	813

Flows Modified by Toronto, Fall River, Elk City, and Big Hill Lakes

4-08. Water Quality. The water in Oologah Lake is suitable for municipal water supply and recreation. Total hardness is usually greater than 130 mg/l classifying it as moderately hard. Total alkalinity values are usually about 100 mg/l indicating the lake is well buffered against drastic changes in pH. Conductivity readings of around 300 MICROMHOS/CM shows fairly high concentrations of ionized salts. Sulfates and chlorides appear to be the major salts.

Turbidity levels are extremely high for various reasons. The lake receives a great deal of runoff from agricultural lands. This runoff contributes large amounts of silt to the lake. In addition, the lake above the Winganon Bridge is very shallow, and wind and wave action keep soil in suspension. The lake covers many plugged and unplugged oil wells. In addition, strip-mining operations for coal are found on the eastern side of the lake. These potential contaminant sources do not appear to have caused any significant water quality problems within the lake.

4-09. Channel and Floodway Characteristics. The regulating channel capacity on the Verdigris River below Oologah dam is estimated to be 30,000 cfs and 42,000 cfs at Claremore, Oklahoma. Rating curves for Independence, and Lenapah gages on the Verdigris River are shown on plates 4-5, and 4-6. Rating curves for the Caney River near Ramona and the Verdigris River near Claremore are shown on plates 4-7, and 4-8. Rating curves used by Reservoir Control Section are adjusted to changing conditions and are kept current. The channel from Oologah Dam to the Port of Catoosa is heavily tree-lined which helps stabilize the banks against erosion from high flows. The channel reach from the Port of Catoosa to the Arkansas River has been improved as a part of the navigation system. This reach has stable channel banks and a capacity of about 79,000 cfs as compared with the 30,000 - 42,000 cfs capacity of the natural upstream reach. Crest time of travel from

Oologah Dam to Van Buren, Arkansas, is about 60 hours. A simplified diagram showing crest travel time is shown on plate 4-9. Travel time varies with the size of the flood; therefore, this diagram should be used as a guide only.

4-10. Upstream Structures. Operational structures upstream of Oologah Dam are Elk City Lake in Kansas on the Elk River; Big Hill Lake in Kansas on Big Hill Creek; Fall River Lake in Kansas on the Fall River; and Toronto Lake in Kansas on the Verdigris River.

4-11. Downstream Structures. Structures downstream of Oologah Lake in the Verdigris River Basin include the following: Hulah and Copan Lakes on the Caney River; Skiatook and Birch Lakes on Bird Creek; and McClellan-Kerr Navigation System on the Verdigris and Arkansas Rivers.

4-12. Economic Data.

a. Population. The population of the Oklahoma counties and cities in the Verdigris River Basin is shown in Table 4-8.

TABLE 4-8
POPULATION OF OKLAHOMA COUNTIES AND CITIES
IN THE VERDIGRIS RIVER BASIN - 1960 to 1986

County & City	U.S. Census Population			
	1960	1970	1980	1986
Osage County	32,441	29,750	39,327	41,100
Pawhuska	(5,414)	(4,238)	(4,771)	(4,760)
Barnsdall	(1,663)	(1,579)	(1,501)	(NA)
Washington County	42,347	42,277	48,113	44,900
Bartlesville	(27,893)	(29,683)	(34,568)	(30,010)
Dewey	(3,994)	(3,958)	(3,545)	(3,780)
Nato County	10,848	9,773	11,486	11,000
Nato	(4,163)	(3,679)	(4,270)	(4,110)
Craig County	16,303	14,722	15,014	15,100
Rogers County	20,614	28,425	46,436	55,700
Claremore	(6,639)	(9,084)	(12,085)	(16,290)
Chelsea	(1,170)	(1,622)	(1,754)	(NA)
Tulsa County	346,038	401,663	470,593	517,000
Tulsa	(261,685)	(331,638)	(360,919)	(393,750)
Collinsville	(2,526)	(3,009)	(3,556)	(4,170)
Wagoner County	15,673	22,163	41,801	50,400
TOTAL, All Counties	484,264	548,773	672,770	735,200

b. Industry. The chief industry in the Verdigris River Basin below the Kansas-Oklahoma State line is agriculture and its related industries. The production of mineral commodities in the basin also is significant, with petroleum, stone, and natural gas among the most important followed by coal, cement, and clay. Other industries found in the watershed include the manufacture of zinc products, clothing, brick, and tile, paint, and oil field equipment. The Oklahoma portion of the McClellan-Kerr Arkansas River Navigation System was completed in December 1970. Principal commodities moved on the navigation system are grains, such as soybeans, peanuts, and wheat; iron and steel products; chemicals; coal; petroleum products; and sand and gravel.

c. Agriculture. The principal agricultural crops grown in the Verdigris River Basin below the Kansas-Oklahoma State line are wheat, soybeans, sorghum, pecans, and alfalfa. The raising of beef cattle has become an important industry in the basin. Production and annual value of crops in the flood plain below Oologah Dam are shown in Table 4-9.

TABLE 4-9
ACRES, AND ANNUAL VALUE OF PRINCIPAL CROPS
IN VERDIGRIS RIVER FLOOD PLAIN BELOW OOLOGAH DAM
(Crops Distribution Survey of August 1987)
(1989 Current Normalized Prices)

Crops	From Oologah Dam to mouth of Caney River		From Mouth of Caney River to mouth of Bird Creek		From Mouth of Bird Creek to confluence with Arkansas River		Total	
	Acres	Value \$	Acres	Value \$	Acres	Value \$	Acres	Value \$
Soybeans	60	5,500	-	-	330	30,270	390	35,770
Wheat	50	3,820	62	4,740	470	35,930	582	44,490
Sorghum (Wheat)	-	-	-	-	40	4,970	40	4,970
Corn	-	-	-	-	10	770	10	770
Oats	-	-	-	-	20	650	20	650
Pecans	-	-	-	-	520	41,310	520	41,310
Alfalfa	-	-	19	4,270	30	6,740	49	11,010
Hay	110	10,930	74	7,120	360	34,670	544	52,720
Pasture	13,550	689,420	5,925	301,460	48,650	2,475,300	68,125	3,466,180
Total	13,770	709,670	6,080	317,590	50,430	2,630,610	70,280	3,657,870

d. Flood Damages. The estimated annual damages, damages prevented, and residual damages for the 6-project Verdigris system and existing and authorized projects in the Arkansas River Basin are shown in Table 4-10. These values are based on January 1990 prices for structures and 1989 current normalized prices for crops. Structural loss and area curves are shown on plates 4-10 through 4-12.

TABLE 4-10

DAMAGES, DAMAGES PREVENTED, AND RESIDUAL DAMAGES
(January 1990 Prices for Structures and 1989 Current
Normalized Prices for Crops)

Reach & Item	Estimated Average Annual		
	Damages \$	Damages Prevented \$	Residual Damages \$
Verdigris River			
Structures	2,108,000	2,048,000	60,000
Crops	932,000	722,000	210,000
Subtotal (1)	3,040,000	2,770,000	270,000
Arkansas River			
Structures	9,250,000	8,270,000	980,000
Crops	1,589,000	1,340,000	249,000
Subtotal (2)	10,839,000	9,610,000	1,229,000
Totals			
Structures	11,358,000	10,318,000	1,040,000
Crops	2,521,000	2,062,000	459,000
GRAND TOTAL	13,879,000	12,380,000	1,499,000

(1) Total is for 6-project Verdigris system. Benefits to Oologah Lake are \$1,412,000 for structures, \$415,000 for crops, and a total of \$1,827,000.

(2) Total is for all existing and authorized projects. Benefits to Oologah Lake are \$887,000 for structures, \$378,000 for crops, and a total of \$1,265,000.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological stations.

a. Facilities. The Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office; the National Weather Service (NWS); and the U.S. Geological Survey (USGS) cooperate to collect data and maintain a reliable communication network. All pertinent reporting observation stations are shown on plate 5-1. Pool elevation data are provided by a recorder over a 24-inch floatwell located in the gate control structure on the top floor (operating deck) of the stair tower. The float well is connected to the lake by two 3-inch intakes at elevations 587.0 and 592.0. The recorder drives a counter indicator that is located in the project office and a shaft encoder wired to a transmitting type data collection platform. Staff gages are located on the upstream side of the access bridge as a backup for the graphic recorder. Tailwater records are provided by a recorder located over a floatwell in a concrete shelter about 800 feet below the dam at the cableway and on the right bank of the stream.

All stream gaging stations are automated gages consisting of floatwells or bubble gages geared to digital recorders and data collection platforms. Stream gages on the mainstem Verdigris River used in forecasting inflows to Oologah Lake are: Verdigris River near Altoona, Kansas; Verdigris River at Independence, Kansas; and Verdigris River near Lenapah, Oklahoma. Also, used in forecasting inflows is the Fall River at Fredonia gage located below Fall River Lake. The gages designated for regulation are found on the Verdigris River near Claremore, Oklahoma, and the Arkansas River near Van Buren, Arkansas.

Automated stream gaging stations are equipped with automated rain gages that provide precipitation data transmitted along with stage data. The NWS also maintains a network of local observer stations throughout the district (see plate 5-1). A weather station at the project office has equipment for monitoring precipitation, evaporation, wind speed and direction, and temperature.

b. Reporting. The reporting procedures for precipitation and stream gaging stations are on a cooperative basis with the NWS and the USGS. Hydrometeorological data collected by project personnel at Oologah Lake will be included in the daily report to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7103 or VHF-FM radio, call signal WUI-3 Hydrology). The reporting of data from pool elevation and stream gaging stations has been automated by using data collection platform's (DCP's) which record data hourly and transmits the data every four hours or when a threshold value is exceeded. The data is transmitted via GOES satellite to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. The data is then transmitted to a domestic satellite (DOMSAT) which in turn passes the data on to the Tulsa District's Receive Only Terminal (DROT). The data from the NOAA

computer facility may also be transferred by using telephone modems. When received, the river stage is converted to flow and lake elevation is converted to storage. All the data are then stored in a data base on the Tulsa District (WCDS) for access when needed. DCP's also report rainfall data in the same way. Besides DCP data, observer rainfall data is collected and stored in the computer system for use in forecasting. Observers phone the NWS offices in this region and the NWS then encodes the data into a Standard Hydrologic Exchange Format (SHEF). This data is then transferred to the (WCDS) using telephone modems and a dedicated phone line to the Tulsa River Forecast Center. Once the data is received, it is 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 paragraph 1b of Exhibit C, Standing Instructions to Project Manager.

c. Maintenance. Maintenance and repair of the weather station instrumentation are the responsibility of the NWS. 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 Verdigris River Basin. The Hydraulic Engineering Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the responsibility for the equipment owned by the Corps of Engineers.

TABLE 5-1
AUTOMATED GAGES

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID
<u>Automated Stream Gages</u>				
Verdigris River near Coyville, Kansas	USGS	COYV	07166000	CYVK1
Verdigris River near Altoona, Kansas	USGS	ALTO	07166500	ATOK1
Verdigris River at Independence, Kansas	USGS	INDP	07170500	IDPK1
Verdigris River near Lenapah, Oklahoma	USGS	LENA	07171000	LEPO2
Verdigris River near Claremore, Oklahoma	USGS	CLAR	07176000	CLRO2
Fall River at Fredonia, Kansas	USGS	FRED	07169500	FRNK1
<u>Automated Pool Gages</u>				
Toronto Lake	COE	TORO	07165900	TRLK1
Fall River Lake	COE	FALL	07168000	FLLK1
Elk City Lake	COE	ELKC	07170050	ECLK1
Big Hill Lake	COE	BIGH	07170695	BIGK1
Oologah Lake	COE	OOLO	07176000	OOL02
<u>Automated Rainfall Gages Used in the Oologah Lake Forecast Model</u>				
Cherryvale, Kansas	USGS	CHER	07170700	CHRK1
Chanute, Kansas	COE	CHAU	07183200	CNUK1
Parsons, Kansas	USGS	PARS	07183500	PPFK1
Bartlesville, Oklahoma	USGS	BART	07174500	BVLO2
Ramona, Oklahoma	USGS	RAMO	07175500	RAMO2
Copan Lake, Oklahoma	COE	COPA	07174300	CPLO2
Big Hill Lake, Kansas	COE	BIGH	07170695	BIGK1
Elk City Lake, Kansas	COE	ELKC	07170050	ECLK1
Fall River Lake, Kansas	COE	FALL	07168000	FLLK1
Fredonia, Kansas	USGS	FRED	07169500	FRNK1
Big Cabin, Oklahoma	USGS	BCAB	07191000	BGCO2
Altoona, Kansas	USGS	ALTO	07166500	ATOK1
Claremore, Oklahoma	USGS	CLAR	07176000	CLRO2
Coyville, Kansas	USGS	COYV	07166000	CYVK1
Independence, Kansas	USGS	INDP	07170500	IDPK1
Lenapah, Oklahoma	USGS	LENA	07171000	LEPO2
Oologah Lake, Oklahoma	COE	OOLO	07176000	OOL02
Toronto Lake, Kansas	COE	TORO	07165900	TRLK1
Virgil, Kansas	USGS	VIRG	07165750	VGLK1
Iola, Kansas	USGS	IOLA	07183000	IOLK1
Commerce, Oklahoma	USGS	COMM	07185000	COMO2
Pensacola Lake, Oklahoma	USGS	PENS	07190000	PENO2
Spavinaw Lake, Oklahoma	USGS	SPAV	07191300	SPAO2
Collinsville, Oklahoma	COE	COLL	07175550	CVLO2
Hulah Lake, Oklahoma	COE	HULA	07172500	HULO2
Elk Falls, Kansas	USGS	ELKF	07169800	ELFK1
Climax, Kansas	USGS	CLIM	07167500	CMXK1
Sedan, Kansas	USGS	SEDA	07173300	SDNK1

5-02. Water Quality Stations.

a. Facilities. No water quality stations are currently in operation on the Verdigris River. Water quality samples from the lake are taken in periodic intervals from sites selected by the Environmental Analysis Section, Tulsa District, to establish the chemical and biological quality of the water. These data are reported directly to the Tulsa District Office.

b. Reporting. Water quality samples taken by Corps of Engineers personnel will be reported directly to the Tulsa District Office.

c. Maintenance. No permanent facilities exist to maintain.

5-03. Sediment Stations.

a. Facilities. The Corps of Engineers has established 44 sedimentation ranges above Oologah Dam used for sedimentation measurements (paragraph 2-03d). These ranges are surveyed periodically to compute sediment deposition and new lake area/capacity data.

b. Reporting. Sediment surveys are made approximately once every ten years.

c. Maintenance. Maintenance on the sediment ranges is performed by the Corps of Engineers.

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

a. Stages and Discharges. The raw data that the water control computer retrieves from the central computer are stored as it is 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. Streamflow 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 chapter VI).

c. Water Quality Data. Water quality data from Oologah Lake are recorded by the Environmental Analysis Section, Tulsa District, and entered into the STORET system for access by other agencies.

5-05. Communication Network. Wire facilities at Oologah Lake consist of local and long distance telephone service. Radio Communication is by a VHF-FM fixed station (call signal WUI-321) capable of reaching local mobile stations, the Tulsa District Office, 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. Regulating Office with Project Office. Instructions for the storage and release of water from the lake will be communicated by the Water Control Section to the responsible project operating personnel for the implementation of the provisions set forth in Chapter IX of this manual. This communication will normally be made by telephone but could on occasion be made by VHF-FM radio. The reports by the project office, described in paragraph 5-07 and Exhibit C of this manual, will be communicated directly to the Water Control Section. Should communication between the project and the District Office be disrupted, the Project Manager will, on his own initiative, direct regulation of the lake according to emergency regulations as required in Chapter VII and Exhibit C of this manual. A chart, "Organization Chart - Oologah Lake" 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 Chapter IX of this manual.

5-07. Project Reporting Instructions. Most of the daily lake data from Oologah Lake (see plate 5-3) will be obtained from the WCDS database. Weather data and other data collected by the Oologah Lake Project will be submitted to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7103 or VHF-FM radio, call signal WUI-3). The Water Control Section office is manned from 7:00 a.m. to 4:30 p.m. daily and various hours on weekends and holidays. Data for nonworking days will be read and submitted the following workday. Should unusual conditions arise during nonworking hours, one of the persons listed on page i should be contacted. The following data should be included in the daily report.

a. As of 8:00 a.m. Each Weekday.

- (1) The current lake clarity and weather condition.
- (2) The total precipitation amounts for the previous 24-hour periods (7:00 a.m. to 7:00 a.m.) including the amounts for the 6-hour periods ending at 1:00 p.m., 7:00 p.m., 1:00 a.m., and 7:00 a.m., and the starting and ending times.
- (3) The pan evaporation, in inches, for the previous 24-hour period (7:00 a.m. to 7:00 a.m.) or for the period since the last evaporation reading was taken.
- (4) The current wind direction and wind speed (Beaufort scale).
- (5) Water supply withdrawal or release for previous day (if available).
- (6) 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 8:00 a.m. Each Monday.

- (1) The same data as required in 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.
- (3) The current tailwater elevation if available.

c. Weekends and Holidays.

- (1) Daily reports are not required on weekends and holidays except during flood periods.
- (2) During flood periods, weekend and holiday reports should include the same data as required in a. above plus the 8:00 a.m. pool elevation from the pool gage.

d. During Flood Periods. Besides the data in a. and b. above, additional reports of lake elevations may be requested by the Water Control Section personnel during flood periods.

e. Rainfall Reports. Rainfall reports will be made as follows:

(1) At 8:00 a.m. all precipitation that occurred during the preceding 24 hours (7:00 a.m. to 7:00 a.m.) as shown on plate 5-3 (covered by routine report on working days).

(2) At 1:00 p.m. when 0.50 inch or more of precipitation has occurred since 7:00 a.m. and no 1:00 p.m. report was made, or if it has continued to rain since 7:00 a.m.

(3) At 7:00 p.m. when 0.50 inches or more precipitation has occurred since 7:00 a.m. and no 1:00 p.m. report was made, or if it has continued to rain since reporting at 1:00 p.m.

(4) Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period six hours or less. During nonworking hours, the report should be made to one of the persons listed on page i.

5-08. Warnings. It is the responsibility of the Project Manager and project personnel authorized to make gate changes, to maintain a list in current status of residents and/or property owners who would be endangered or inconvenienced by large and/or prolonged releases. This list will be attached to the Project Manager's file copy of this manual. If damaging releases are expected to occur, notification will be made by telephone or oral warning by the Corps employees. Notification will be made according to the Tulsa District supplements to ER-500-1-1. This would include radio, television, telephone, Citizen Band radio, use of law enforcement and Civil Defense agencies and their communication systems, National Guard and Reserve Units, supplemented by oral warning from Corps employees in Government vehicles. Studies have been made to determine the possible downstream flood conditions that could exist in case 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 can be found in the Oologah Dam, Operation and Maintenance Manual, Volume II, dated October 1982. Always when a gate change is made a horn is blown to give warning to people immediately downstream who are within hearing distance of the horn blast.

5-09. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Control Section anytime. The initial transition from low flow releases 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 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.

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are necessary to plan releases, project pool elevations, and inform the public.

a. Role of Corps of Engineers. The responsibility for hydrologic forecasts lies with personnel in the Water Control Section, Tulsa District. Hydrologic forecasts are made either by the project regulators in the Water Control Section or by the forecasters in the Forecasting Section. Forecasts are used to aide in the regulation of lakes for flood fighting activities and other authorized purposes. Also, forecasts are used to benefit Corps of Engineers construction projects and inform interested citizens. In contrast, the Corps of Engineers furnishes to the public current lake levels, current releases, forecasted lake levels, other available information on observed conditions, and technical advice. The Water Control Section (lake levels), telephone number 669-7521, is listed in the Tulsa telephone directory to provide the public a means of receiving 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 is presented in Section V of the Water Control Master Manual for the Arkansas River Basin.

b. Role of Other Agencies. The NWS is responsible for providing warnings and forecasts for severe storms and flooding to the public. This information is distributed by NWS Automation of Field Operations and Services (AFOS) network to subscribing Government agencies and the various news media. The NWS issues routine scheduled reports through AFOS containing the following forecasts:

- (1) Weather forecasts (daily, severe weather, and 5-day extended).
- (2) Quantitative precipitation forecasts are made daily for first six-hour, second six-hour, day one 24-hour, and day two 24-hour rainfall totals.
- (3) Three-day river stage forecasts, when available.
- (4) Rainfall required to produce bankfull stages (weekly).
- (5) Damage reports.
- (6) River and flood warning bulletins, forecasts, and statements.
- (7) Thirty-day forecast.
- (8) Percent chance of precipitation (twice daily).

6-02. Flood Condition Forecasts.

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

- (1) Rainfall for stations listed in Tables 5-1.
- (2) Oologah Lake pool elevation for time of forecast.
- (3) Flood hydrographs for gages listed in Table 5-1.
- (4) Projected releases from Toronto, Fall River, and Elk City Lakes.

b. Methods. Inflow forecasts are made using computer program 723-X6-L2010 (HEC-1). Precipitation data is received from the NWS and the DCP's by the water control computer. The average precipitation over the project basin is computed by a computer program called RAIN. The RAIN program takes the DCP data and plots isohyetal maps of 24-hour rainfall. The RAIN 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. Two 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 rerun until the computed and observed hydrographs converge. Calibrated loss rates are applied to ungaged subareas and flood hydrographs are combined and routed, along with releases from Toronto, Fall River, and Elk City Lakes, to compute an inflow hydrograph. Using projected releases from Oologah 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. Sample input and output files using one inch of runoff are presented in Tables 6-1 and 6-2, respectively, on pages T6-1 to T6-7. Unit hydrographs are presented on Plates 6-2, 6-3, and 6-4.

6-03. Conservation Purpose Forecasts.

a. Requirements. Conservation forecasts may be required to predict pool levels during fish spawning season, special recreation events, and water supply. Forecasts may also be required 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 4-4; and the peak inflow probability curve, plate 8-4; 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 reservoir.

b. Methods. Reliable methods for long range runoff forecasts are not presently available. The NWS publishes an "Average Monthly Weather Outlook" semimonthly 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 6-01b are more useful in a shorter range.

6-05. Drought Forecasts. Droughts can be forecast when runoff is dependent upon snow melt 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 authorized purposes of Oologah Lake include recreation, fish and wildlife, flood control, water supply, and navigation. However, Oologah Lake is only authorized to be regulated for flood control, water supply, and navigation. Although water quality is not an authorized project purpose, releases may occasionally be made to improve the quality of the water below the dam. Oologah Lake will be operated as a unit in a multiple-purpose system for optimum flood control providing benefits in the Arkansas River Basin. Flood releases from Oologah Lake will be made considering 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 optimum benefits, described as method A in paragraph 3-3c(2)(b) of EM 1110-02-3600, November 1987.

7-02. Major Constraints. Significant structural problems exist at the Oologah project that effect the regulation of Oologah Lake. Releases greater than 20,000 cfs cause considerable damage to the stilling basin and riprap in the outlet channel. Efforts to remedy these problems have included three modifications to the stilling basin and outlet channel due to damage from releases above 20,000 cfs and have been performed since initial construction of the project. However, the problems still exist and future solutions will be addressed. The flows on the Verdigris River below Oologah Lake are regulated to 30,000 cfs as presented in the Arkansas River Basin Water Control Master Manual, dated July 1980. To obtain a release of 30,000 cfs, releases must be made from the Oologah spillway when lake levels exceed elevation 645.0. Releases from the spillway cause considerable erosion on privately owned land along the spillway channel and when flows transition back to the main Verdigris channel. The spillway channel flows into the main channel at a 90-degree angle and has eroded thousands of acre-feet of earth from the right bank of the main channel. Also, when the gates are open and the pool elevation reaches 655.0, the elevation of the main service deck, water flows over the top of the conduit gates and causes excessive vibrations that damage the gates. Therefore, the conduit gates are closed when the lake elevation reaches 655.0 (all necessary releases are made through the spillway) and remain closed until the lake level falls below elevation 655.0 or rises above elevation 666.0. Flooding and inundation of access roads to recreation areas occurs when the pool reaches elevation 642.0. Twenty-four hour flood surveillance at the dam begins at elevation 658.0. The Oologah Dam spillway can discharge 92,400 cfs at the top of the flood control pool (elevation 661.0), without using the outlet works. The invert of the outlet works is at elevation 565.0 which is the lowest elevation from which water can be released from the dam. The recession of floodwaters on the lower Arkansas River is to be monitored to keep releases from the dam combined with the natural recession of the river to below bankfull stage. The limiting non-damaging flow at the Claremore gage on the Verdigris River is about 42,000 cfs (stage of 35 feet). A navigation taper as

described in paragraph 7-03 of the Arkansas River Basin Water Control Master Manual is to be followed.

7-03. Overall Plan for Water Control.

a. General. Oologah 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 appendix. The Soil Conservation Service has a program of soil and water conservation, flood prevention, and channel improvements within the upper reaches of the Verdigris River watershed; however, they do not significantly affect Oologah's flood operation. Toronto, Fall River, Elk City, and Big Hill Lakes all influence the operation of Oologah Lake.

b. System Regulation. Oologah Lake will be regulated in a system with the Verdigris River Lakes for control of floods on the Verdigris River from Oologah Dam to Muskogee, Oklahoma and in the total Arkansas River system for control of floods on the Arkansas River from Muskogee, Oklahoma, to Van Buren, Arkansas. When flood storage in each lake in the system is above 30 percent full and floodwaters are being accumulated, each lake will be regulated to retain equivalent flood control capabilities, as much as possible. Priority for releases, as shown on plate 7-54 of the Arkansas River Basin Water Control Master Manual, will be given to the lakes with the least amount of flood storage available, considering predicted inflow into the lake and conditions downstream. Section VII of the Arkansas River Basin Water Control Master Manual provides detailed information on the Arkansas River System operation. The computer program Taper will be used as a guide to determine releases from reservoirs in the Arkansas River System. In addition, Oologah Lake will be regulated for water supply, and navigation.

c. Upper Verdigris Subsystem Regulation. The Arkansas River system regulation plan discussed in the previous paragraph will be used in determining a release schedule for Oologah Lake. This release schedule is determined by using the Taper program that includes projected inflows and storages to balance the Arkansas River System. Inflows into Oologah Lake are computed from local runoff and releases from Toronto, Fall River, Big Hill, and Elk City Lakes. The outlet works at Big Hill Lake consists of an uncontrolled drop inlet structure and cannot be balanced with the other projects. Toronto, Fall River, Elk City, and Oologah Lakes will be regulated as a subsystem and balanced according to plate 7-54 of the Arkansas River Basin Water Control Master Manual. From this plate, when all lakes are above 30 percent full, each lake will be balanced equally. Below 30 percent full, the projects will be unbalanced and Toronto, Fall River, and Elk City Lakes will be empty when Oologah is 20 percent

full. Table 7-1 will be used as a guide in determining Oologah Lake releases if the releases are not controlled by the Arkansas River system regulation plan.

7-04. Standing Instructions to Project Manager. During flood periods, the lake will be regulated following the normal regulations for flood control operation as directed in subparagraph 7-05a. Instructions for the storage and discharge of floodwater will be issued by the Water Control Section. In the event communication with the Tulsa District Office is disrupted, the lake regulation will become the responsibility of the Project Manager and will be regulated according to subparagraph 7-05b and exhibit C of this manual. In addition, the Project Manager will immediately attempt to reestablish communications with the Tulsa District Office. The Project Manager will make daily observations of the weather station and lake conditions and report those observations as directed by the Water Control Section. Should an emergency occur in which communication is not lost, such as an inoperable gate, drowning accident, excessive trash in gates, broken buoy line, or power outage, the Water Control Section will be notified immediately.

7-05. Flood Control.

a. Normal Regulation for Flood Control Operations. Oologah Lake will be regulated for optimum flood reductions on the Verdigris from the dam to its confluence with the Arkansas River and with the existing system of lakes on the Arkansas River and tributaries from the confluence to Van Buren, Arkansas. The following regulations, as shown in Table 7-1, will govern releases from Oologah Lake. During flood control regulation the tainter gates and conduit gates are to be operated at uniform settings with a no more than a 1-foot difference in opening between gates of like type.

TABLE 7-1
NORMAL FLOOD CONTROL REGULATION SCHEDULE
OOLOGAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
638.0 and Below	--	Releases are made to maintain elevation 638.0, to meet downstream low-flow requirements defined in paragraph 7-07, or to meet navigation demands defined in paragraph 7-11.
638.0 to 641.0 and forecasted not to exceed 641.0	Rising	Releases, when combined with intervening flow downstream, will not exceed 30,000 cfs below the dam, a 35-foot stage (42,000 cfs) at the Claremore gage, or a 22-foot stage at the Arkansas River at Van Buren gage. Regulated releases may be made at less than the maximum rate permissible. Releases will be modified to meet target discharges specified by the requirements in Chapter 7 of the Arkansas River Master Manual for the operation of the Arkansas River System.
641.0 to 661.0 and forecasted not to exceed 661.0	Rising	Releases, when combined with intervening flow downstream, will not exceed 30,000 cfs below the dam, a 35-foot stage (42,000 cfs) at the Claremore gage, or a 22-foot stage at the Arkansas River at Van Buren gage. Releases will be modified to meet target discharges specified by the requirements in Chapter 7 of the Arkansas River Master Manual for the operation of the Arkansas River System. Below elevation 645.0 releases will be impeded due to operational constraints (See Par. 7-02.).

TABLE 7-1 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
661.0 to 666.0 or forecasted to exceed 661.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 666.0, if possible. Plate 7-1, Spillway Gate Regulation Schedule Inflow Parameter, will be used as a guide for determining releases so that the lake will not rise beyond the induced surcharge limits. Elevation 666.0 will be maintained, if possible, by opening the spillway gates as necessary to pass inflow or until the gates are fully opened. Releases will be made by operating all the spillway gates at uniform openings.
Above 666.0	Rising	The spillway gates and conduit gates will be maintained fully opened and held in such position.
Above 666.0	Falling	The spillway gates and conduit gates will be maintained fully opened and held in such position until the pool elevation recedes to elevation 666.0.
666.0 to 661.0	Falling	The maximum gate opening attained will be held until the pool level recedes an amount sufficient to permit lowering the spillway gates one-half foot without lowering the discharge below inflow. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates will be maintained at all times. This regulation will be repeated until the lake level recedes to elevation 661.0.

TABLE 7-1 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
661.0 to 638.0	Falling	If the maximum release rate was smaller than 30,000 cfs, releases will not exceed 30,000 cfs or target discharges specified in Chapter 7 of the Arkansas River Basin Water Control Master Manual, whichever is less. If the maximum release rate exceeded 30,000 cfs, releases will be made equal to the previous 4-hour inflow or 30,000 cfs, whichever is greater. Releases much lower than 30,000 cfs may be made when lake levels are in the lower portion of the flood pool while still evacuating the flood storage in a reasonable time. Target discharges specified by the Arkansas River Basin Water Control Master Manual will always supersede any other designated discharges.

b. Emergency Flood Control Regulations. When communication with the Tulsa District Office is disrupted, the Project Manager will, on his own initiative, direct regulation of the lake according to the schedule shown on Table 7-2 until communication is restored.

In addition, the Project Manager will make every effort to reestablish communication with the Tulsa District Office. Plate 7-2 will be used by the project manager during emergency flood operations to determine the 4-hour inflow. Using this inflow, a release will be determined from plate 7-1. Plate 7-10 has been included to meet EM 1110-2-3600 requirements and should only be used as a last alternative. The spillway gates will be operated at uniform openings as discussed in paragraph 7-05a. The conduit gates will be closed at elevation 655.0 and remain closed until all spillway gates are open and the lake level exceeds elevation 666.0 or is determined to exceed elevation 666.0.

TABLE 7-2
EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
OOLOGAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
Below 638.0	Rising	Continue the releases being made at the time of communication failure.
638.0 to 666.0	Rising	If the lake level is below elevation 656.5, maintain current releases until communication is restored. If, after 12 hours, communication has not been restored, or the pool is above or rises to elevation 656.5 anytime within the 12-hour period, determine inflows following plate 7-2 (Inflow Nomograph) and go on to plate 7-1 (Spillway Gate Regulation Schedule-Inflow Parameter) to determine required releases. Use the minimum discharge curve for emergency operations to determine the minimum release. The rate of rise of the lake and the average discharge will be computed every 2 hours for the preceding 4 hours. The determined releases will be increased by operating all the spillway gates at uniform openings until all gates are fully open. After the spillway gates have been fully opened and the pool is still rising, the conduit gates will be raised at uniform openings until the lake stops rising or the conduit gates are fully open. Never when the lake is rising will releases be decreased. If after the 12-hour delay, the lake level becomes static and releases are less than 1000 cfs, then releases will be increased to 1000 cfs immediately.
Above 666.0	Rising	The spillway gates and conduit gates will be maintained fully opened and held in such position.

TABLE 7-2 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
Above 666.0	Falling	The spillway gates and conduit gates will be maintained fully opened and held in such position until the pool elevation recedes to elevation 666.0.
666.0 - 661.0	Falling	The maximum spillway gate opening attained will be held until the lake level recedes an amount sufficient to permit lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise, set the gates back to the previous opening. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates will be maintained at all times. This operation will be repeated until the lake level reaches elevation 661.0 or the release is 30,000 cfs.
661.0 - 640.0	Falling	If the maximum release rate exceeded 30,000 cfs, releases will be adjusted by lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise, set the gates back to the previous opening. This operation will be repeated until the the release is 30,000 cfs. If the maximum release was much lower than 30,000 cfs this release will be maintained until the lake level reaches 640.0.
640.0 - 638.0	Falling	Begin a gradual reduction of the release rate (not to exceed 5,000 per 3-hr period) so that releases are equal to inflow (the pool is steady) at elevation 638.0.

c. Constraints. Significant structural problems exist at the Oologah project that effect the regulation of Oologah Lake. Releases greater than 20,000 cfs cause considerable damage to the riprap in the outlet channel. The flows on the Verdigris River below Oologah Lake are regulated to 30,000 cfs as presented in the Arkansas River Basin Water Control Master Manual, dated July 1980. To obtain a release of

30,000 cfs releases must be made from the Oologah spillway. Due to roller bearing and structural problems, the conduit gates will be operated in the following way:

- Below a discharge of 2000 cfs, use only 2 gates (one from each conduit).
- Operate with maximum of 1 gate foot difference between open gates.
- The conduit gates will be closed at elevation 655.0.

If the 30,000 cfs release must be exceeded then the stage-damage curves shown on Plates 4-10 thru 4-12 should be used as a guide in determining the effects. Floodwater will be released as soon as possible while the flooding of low-lying farmland is kept to a minimum.

7-06. Recreation. Although recreation is a project purpose, Oologah Lake is only authorized to make regulated releases for flood control, water supply, and navigation. Requests for special releases will be considered as the situation warrants. All recreation area access roads are constructed above the top of the conservation pool, elevation 638.0. The access roads begin to be affected by flood waters at elevation 640.0. All recreation area roads, except the overlook and Hawthorn Bluff, are impassable when the pool reaches 652.5. Some private access and county roads are also affected by high water. Public facilities are listed in paragraph 2-06 of this manual and shown on plate 2-6. Recreational features at the project include camping, picnicking, swimming, boating, hiking and fishing. Management of the fish and wildlife resources will be under the direction of the Oklahoma Department of Wildlife Conservation (ODWC).

7-07. Water Quality. Oologah Lake has no storage allocated to water quality. Leakage around the conduit gates is usually sufficient to maintain water quality for the downstream fishery. Occasionally, an emergency water quality release may be requested by (ODWC) or Oklahoma Department of Environmental Quality. The lake storage from which the release will be made and the rate of release will be determined on a case-by-case basis.

7-08. Fish and Wildlife. Although fish and wildlife is a project purpose, no storage is authorized for that purpose. However, low flow releases are occasionally requested on an "as-needed" basis to relieve oxygen deficiency of fish trapped in the stilling basin. Management of the fish and wildlife resources will be under the direction of the (ODWC).

7-09. Water Supply.

a. General. Oologah Lake has a water supply storage of 342,600 acre-feet with a dependable yield of 154 MGD. Table 7-3 shows the water supply users and their contracted storage. Copies of the water supply contracts are kept on file in the Hydrology-Hydraulics Branch. Exhibit B contains one complete copy of a surplus

contract and one complete copy of a storage contract. The remaining contracts in Exhibit B are presented without those sections that are identical to sections already given in the complete contracts.

b. Regulation Procedure for Water Supply. Water supplied to the city of Tulsa, the city of Collinsville, and the Public Service Company of Oklahoma (PSO) is supplied through the 66-inch conduit in the wet well on the right side of the intake structure. The invert elevation of the water supply pipe is 565.5. All other water supply users take water directly from the lake.

TABLE 7-3
WATER SUPPLY CONTRACTS
OOLOGAH LAKE

USER NAME	CONTRACT APPROVAL DATE	CONTRACT TYPE	USER STORAGE (ACRE-FEET)
Rogers County RWD #4	07/05/85	Storage	1590
Public Service Co of Oklahoma	05/08/85	Storage	20990
Rogers County RWD #3	02/08/85	Storage	5960
Consolidated RWD #1	03/07/85	Storage	200
City of Collinsville	06/26/85	Storage	6670
Tulsa Metropolitan Water Authority	02/08/85	Storage	285450
City of Claremore	09/19/88	Storage	445
Washington County RWD #3	09/22/92	Storage	4170
Town of Chelsea	04/02/82	Storage	1530
Not Under Contract	----	Storage	15595

c. Accounting Procedures for Conservation Storage. Accounting procedures for conservation storage have been developed to regulate the withdrawal by each water supply user. Inflows, after deductions for downstream water rights and losses, are applied to the storage account of the user in proportion to his contracted storage. When a user has 50 percent or less of contracted storage remaining, the contracting officer will advise the user frequently throughout the critical period. Should the storage of a user become depleted, no additional withdrawal from storage will be made without an additional contract. The computer program "WSACCT" can be used to determine each water user's remaining storage. Plate 7-4 gives an example of output from the accounting program.

d. Regulation Procedure for Water Rights. The Oklahoma Water Resources Board (OWRB) has issued water rights on the Verdigris River below Oologah Lake. These water rights locations and amounts are shown in Table 7-4. Releases from inflow to satisfy downstream water rights will be made at the request of the OWRB. The OWRB will inform the Water Control 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 unless the water-right holder has contracted storage available in the lake.

TABLE 7-4
WATER RIGHTS FOR THE VERDIGRIS RIVER
FROM THE MOUTH TO OOLOGAH DAM

<u>User</u>	<u>Point Of Diversion</u>	<u>Authorized Amount (ac-ft/yr)</u>
Yonkipin Assoc.	SE SE SE 08 20N 15EIM	86
Mid-Western Nurseries	27 16N 18 EIM	600
(b) (6)		12
(b) (6)		92
Big Lake Club	SW 14 21N 16 EIM	1,000
City of Broken Arrow	W2 3S 19N 16 EIM	15,185
Town of Okay	S2 NW 20 16N 19 EIM	33
City of Coweta	SW SW 06 17N 17 EIM	258
Rogers Co. RWD #5	SW SW 27 21N 15 EIM	1,500
Verdigris Valley Farms	NW 23 19N 16 EIM	25
(b) (6)		11
Rogers Co. RWD #3	SE NE SW 03 21N 15 EIM	1400
Wagoner Co. RWD #5	NW SW NE 36 18N 16 EIM	889
(b) (6)		30
PSO	24 19N 16 EIM	24,950
City of Broken Arrow	NE SW SW 19N 16 EIM	12,042
(b) (6)		1
(b) (6)		55
(b) (6)		4,322
Verdigris Valley Farms	W2 NW S3 14 19N 16 EIM	946
City of Coweta	NE NW NW 12 17N 16 EIM	2,712
(b) (6)		40
Verdigris Valley Sod Farms	S2 SE NW 23 23 22N 15 E1M	85
Dept. of Wildlife Conservation	N2 SW NW 02 22N 15 E1M	120
Dept. of Wildlife Conservation	NW NW SE 26 17N 17E1	100
(b) (6)		992
Verdigris Valley Ranch	NE 28 21 N 15 E1M	260
Columbia Property Co.	32 20N 16E1	325
(b) (6)		267
(b) (6)		180
Wagoner Co. RWD #4	SE SE NW 35 19N 16E1	4500
(b) (6)		12
TOTAL		73,030

7-10. Hydroelectric Power. Oologah Lake has no hydroelectric power units and installation of hydroelectric power is not being considered at this time.

7-11. Navigation. Oologah Lake has 168,000 acre-feet of navigation storage in the conservation pool to provide minimum flow requirements for navigation during drought periods. This storage will yield 126 cfs (81.3 MGD). Also, Oologah Lake will be regulated for flood control with the other reservoirs in the navigation system to help provide a tapered recession of flows along the Arkansas River navigation channel. This tapered recession helps move sedimentation through the navigation system, keeping the channel open, and reduces dredging maintenance costs. The coordinated regulation of the reservoirs is discussed in Chapter VII of the Arkansas River Basin Water Control Master Manual.

7-12. Drought Contingency Plans. The Tulsa District Office has prepared drought contingency plans for the individual projects. The plan for Oologah Lake is contained in Drought Contingency Plan for Lower Verdigris River, Oklahoma, Appendix DCP-2 to Water Control Master Manual, Arkansas River Basin. A copy of the plan can be found in the Water Control Section. The plan establishes a Corps Drought Management Committee and an Interagency Drought Management Committee to conserve stored water and to identify surplus water available during drought conditions. In addition, the project has established specific sites around the lake where water can be withdrawn and transported for domestic and livestock uses.

7-13. Flood Emergency Action Plans. A Flood Emergency Plan has been prepared by the Tulsa District Office and is outlined in the Operations and Maintenance Manual, Volume II, for Oologah Dam, dated October 1982. A copy of the plan can be found at the Oologah Lake Project Office and in the Tulsa District Office. The manual outlines the procedures to be used to protect the public from possible property damage or loss of life from uncontrolled releases of water due to failure or severe damage to the dam or appurtenant works.

7-14. Deviation from Normal Regulation. The District Commander is occasionally requested to deviate from normal regulation of the lakes. Prior approval is obtained from the Southwestern Division Office (SWD) for the subsequent action, except as noted in subparagraph a, below. Deviation requests usually fall into the following categories:

a. Emergencies. Emergency deviations require immediate action with no time in which to seek approval from Southwestern Division (SWD). These emergencies include drownings, accidents, operating facility failure, and pollution. SWD will be informed and a written confirmation describing the deviation will be furnished as soon as possible.

b. Unplanned Minor Deviations. Unplanned instances create temporary needs for minor deviations from the normal regulation of the lake, although they are not considered emergencies. Construction such as utility stream crossings, bridge work, and major construction contracts, account for most of the unplanned deviations. Also, deviations are sometimes necessary for maintenance and inspection. Requests for changes of release rates are generally for a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threats, conditions of the lake, and possible alternative measures. To maintain good public relations, the requests are usually granted, provided there are no adverse effects on the overall regulation of the project (or projects) for optimum benefits to the authorized and useful purposes. Approval for minor deviations will normally be obtained from SWD by telephone. A written confirmation showing the deviation and conditions will be furnished to CESWD-ED-WR (Form SWD 898).

c. Planned Deviations. Other instances include anticipated or planned deviations. Each condition would be analyzed on its merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be presented by letter, telephone, facsimile or E-mail to Southwestern Division along with Tulsa District recommendations for review or approval.

7-15. Rate of Release Change. The increase and decrease in releases from the lake will be accomplished in a way that reduces damage to the reservoir area and downstream channel. As shown on Table 7-5, every reasonable precaution will be made to eliminate bank sloughing, undercutting, excessive erosion, and danger to human and animal lives, if possible. Situations will arise which will not allow an orderly increase and/or decrease in releases. Examples of these situations are large flood releases, as described in paragraph 7-05, drownings that occur downstream of the dam, and heavy rains occurring downstream while making flood releases.

TABLE 7-5
RELEASE RATE CHANGES

Increasing Releases to Channel Capacity

Current release range (cfs)	Maximum increase (cfs)	Minimum time between changes (hours) (1)
30,000	5,000	2

Decreasing Release Below Channel Capacity

Current release range (cfs)	Maximum decrease (cfs)	Minimum time between changes (hours) (1)
30,000	5,000	3

(1) A maximum of 3 gate changes per day.

7-16. Operating 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 are shown on Plate 7-3. The evaporation curves are shown on Plate 7-5. The low flow rating curve is shown on Plate 7-6. Rating curves for the conduit are shown on plates 7-7 and 7-8. The tailwater rating curve is shown on Plate 7-9. Elevation versus area and capacity data are compiled in Table 7-6 on pages T7-1 through T7-7. Rating curves used by the Water Control Section are adjusted for changing conditions and are maintained in current status.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The effects of the normal flood control regulations on the original spillway design flood, original standard project flood, and a major flood are presented in the following paragraphs. The floods were selected to show the effects of the flood control regulations for Oologah Lake on a variety of possible flood conditions.

8-02. Flood Control.

a. Spillway Design Flood. The spillway design flood was generated by increasing the May 6-12, 1943 precipitation by 34 percent and transposing it over the drainage area above Oologah. Inflow into Oologah was modified by Toronto, Fall River, and Elk City Lakes. The flood has 15.87 inches of runoff, 3,671,600 acre-feet of volume, and a peak inflow of 473,000 cfs. The flood, routed through Oologah on a full flood control pool by emergency regulations, resulted in a peak release of 265,100 cfs at the maximum pool elevation of 678.25. Plate 8-1 shows the operational hydrographs for the spillway design flood routed through Oologah Lake by emergency regulations on both empty and full flood control pools.

b. Standard Project Flood. The standard project flood was considered to be one-half the spillway design flood. This flood has a volume of 1,835,800 acre-feet and a peak inflow of 236,500 cfs. The flood, routed through Oologah Lake on a full flood pool, resulted in a peak release of 172,200 cfs at the maximum pool elevation of 667.54. Plate 8-2 shows the operational hydrographs for this flood routed by emergency regulations.

c. Flood of October 1986. This flood was the result of a stalled cold front followed by the remnants of a hurricane that resulted in basin average rainfall of 10.65 inches from September 26 to October 5. The flood had a volume of 2,144,000 acre-feet with a peak inflow into Oologah Lake of 97,500 cfs. This flood is the flood of record for the Oologah Lake drainage basin. Plate 8-3 shows the operational hydrographs for Oologah Lake for both experienced and emergency regulations.

8-03. Recreation. Low-lying areas begin to be affected and access roads to recreation areas begin to be inundated at elevation 640.0. All recreation areas except Hawthorn Bluff and the overlook are closed at elevation 652.5. Recreation activities are also affected by releases for water supply and navigation during drought periods which causes the pool to be fall below normal.

8-04. Water Quality. Oologah Lake, overall, has good water quality that would not be significantly altered during flood control operations. Small releases have occasionally been made during the summer through the low flow outlet to increase the dissolved oxygen in the stilling basin to prevent fish kills.

8-05. Fish and Wildlife. Oologah Lake provides an improved fishery over the natural river, allowing some species of sport fish to flourish in contrast to previous natural river conditions. Some wildlife habitat was inundated due to impoundment; however, wildlife management of lake perimeter lands strives to replace these losses.

8-06. Water Supply. The quality of water in the Oologah Lake is considered good, requiring only conventional treatment to be suitable for domestic and industrial use. During drought periods of minimum or no inflow, the water supply demand will cause the pool to be fall below normal.

8-07. Hydroelectric Power. Although hydropower is not a project purpose, incidental benefits may accrue to downstream hydropower projects because of the leveling effect on flows due to the flood control operation of Oologah Lake.

8-08. Navigation. The coordination of releases from Oologah Lake with other reservoirs (discussed in Chapter VII of the Arkansas River Basin Water Control Master Manual) will significantly benefit navigation along the McClellan-Kerr Navigation system by providing a tapered recession of flows along the system. This controlled recession will enable navigation to continue while shoals are removed from the navigation channel. The 168,000 acre-feet of navigation storage will provide flows during drought periods to help meet the minimum requirements for navigation.

8-09. Drought Contingency Plans. A drought contingency plan for the Lower Verdigris River basin was approved March 1990. This plan identifies water uses and needs within the basin and outlines steps which can be taken to alleviate the problems encountered during a drought. The document provides a basic reference for the Tulsa District Corps of Engineers during a climatologically-induced water shortage in the Verdigris River basin.

8-10. Emergency Action Plans. The Flood Emergency Plan is outlined in the Operations and Maintenance Manual, Volume II, for Oologah Dam, dated October 1982. The purpose of the manual is to specify procedures to protect the public from possible property damage or loss of life because of uncontrolled releases of water due to failure or severe damage to the dam or appurtenant works.

8-11. Frequencies.

a. Peak Inflow Probability. Annual peak mean daily inflows for Oologah Lake, modified by Toronto, Fall River, Elk City, and Big Hill Lakes, were determined using the SUPER program, a period of record routing computer model, for the period 1940 to 1995. Linear regression techniques were used to develop a regression equation correlating peak discharges to peak mean daily flows for the Verdigris River near Lenapah, Oklahoma gage during the period of record 1966 to 1993. This regression

equation was used to compute peak discharges from peak mean daily flows obtained from SUPER. Using these computed peak discharges, a peak inflow probability curve for Oologah Lake was generated. This probability curve was developed according to Bulletin 17B guidelines for Determining Flood Flow Frequency, September 1981 with SWD requirements as stated in a DF dated August 22, 1979. The Peak Inflow Probability Curve is presented in Plate 8-4.

b. Pool Elevation Duration and Frequency. The SUPER period of record routing computer model, for the period 1940 to 1995, was used to calculate the maximum and minimum pool elevation frequency relationships. The two elevation frequency relationships were combined to produce the Pool Elevation Probability Curve presented on plate 8-5. SUPER was also used to determine the Pool Elevation Duration Curve displayed on plate 8-6.

c. Key Control Points. Discharge rating curves used in the regulation of Oologah Lake are shown on plates 4-5 and 4-8.

8-12. 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 downstream gages. Use of these programs has greatly shortened the reaction time in preparing regulation schedules.

b. Channel and Floodway Improvement. A flood insurance study has been made for Rogers and Wagoner Counties. The Verdigris River is covered by this study. This report includes profiles of the 500-, 100-, 50-, and 10-year floods. Channelization projects exist below Oologah Lake with the majority related to the Arkansas River navigation system. Ground and aerial reconnaissance are made as required to decide if a revision of regulating stages is warranted.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organizations.

a. Corps of Engineers. Oologah Lake is owned by the U.S. Government. The Tulsa District of the Corps of Engineers is the operating agency. Oologah Lake is the responsibility of the Project Manager, operating through the Operations Division, Tulsa District Office. Project reporting instructions and an organization chart are presented in Chapter V. Project regulating instructions are presented in Chapter VII of this manual.

(1) Responsibilities and Duties During Normal Operations. The Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office, 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 National Weather Service and the U.S. Geological Survey.

(c) Train personnel in flood control duties.

1. Periodic visits to projects by personnel of the section 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 Control Section during flood emergencies, when necessary.

(d) Prepare reports on lake regulation.

1. Recurring reports.

2. Water control manuals.

3. Postflood reports.

(2) Responsibilities and Duties During Flood Emergencies. During flood emergencies, the Water Control Section is responsible for the following:

(a) Evaluation of current hydrologic and meteorologic data.

(b) Performing or obtaining reservoir forecasts.

(c) Presentation of storm and flood analysis to the District Commander and other interested 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. Initial reports to the Southwestern Division 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. The duties of the project operating personnel under flood conditions are set forth in Chapter 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, instructions for the routine regulation of the lake are accomplished by the Water Control Section. 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 Control 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 National Weather Service (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 are on duty at the Tulsa District Office 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 Project Manager. The Project Manager will regulate the lake according to instructions issued by personnel of the Water Control Section. The instructions follow the "Normal Regulations for Flood Control," included in Chapter VII. If the Project Manager loses communication with the District Office, he will immediately attempt to reestablish communication with the District Office while following the instructions outlined in the section "Emergency Regulations for Flood Control" included in Chapter VII and paragraph 3 of Exhibit C. The Project Manager will make daily observations as directed in paragraph 5-07.

b. Other Federal Agencies. The NWS and the U.S. Geological Survey (USGS) cooperate with the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office, to accumulate rainfall and streamflow data.

c. State Agencies. Management of the fish and wildlife resources of the Oologah 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 Oologah Lake whose regulation is coordinated with the Corps of Engineers.

9-02. Interagency Coordination. Cooperative arrangements with other Federal and State agencies and local interests are discussed in Section X of the Water Control Master Manual, Arkansas River Basin, Tulsa District, dated July 1980. Further coordination is shown in the following subparagraphs.

a. Local Press and Corps Bulletins. The Corps of Engineers, the NWS, and USGS coordinate in forecasting flood stages, streamflow, 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 on observed conditions and with technical advice to enable local interests, within the limits of their capabilities, to obtain optimum flood protection and to perform rescue and relief functions. The Corps of Engineers further assists in flood fighting, through the office of the Emergency Operations Manager, who furnishes sandbags and other necessary equipment based on equipment on hand and need.

b. National Weather Service. The Tulsa District Office and the Tulsa River Forecast Center, NWS, exchange hydrometeorologic data and reports to prevent duplication of effort in obtaining and distributing data. This exchange of data is discussed in greater detail in Chapter VI of this manual. The National Weather Service 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. Power Marketing Agency. Presently, power is not a project purpose.

e. Other Federal, State, or Local Agencies. The Tulsa District Office exchanges information with state and local government officials, the State Highway Department, Oklahoma State Highway Patrol, and others during flood emergencies. The Tulsa District also coordinates with federal and state fish and wildlife agencies throughout normal operation.

9-03. Interagency Agreements. Presently, there are no agreements with respect to lake regulations.

9-04. Commissions, River Authorities, Compacts, and Committees. There are no commissions or a river authority on the Verdigris River. Arkansas River Basin compacts have been established between the States of Arkansas and Oklahoma and the States of Kansas and Oklahoma and the Arkansas River Coordination Committee. The major purposes of these compacts are:

a. To promote interstate comity between the States of Arkansas and Oklahoma and the States of Kansas and Oklahoma.

b. To provide for an equitable apportionment of the waters of the Arkansas River between the States of Arkansas and Oklahoma and the States of 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 simplify the cooperation of the water administration agencies of the States of Arkansas and Oklahoma and the States of Kansas and Oklahoma in the total development and management of the water resources of the Arkansas River Basin.

The Arkansas River Basin Coordinating Committee is made up of State and Federal agencies interested in the water resources development within the Arkansas River Basin. The committee meets as required to discuss the previous year's activities and to exchange information and ideas to serve specific project purposes better.

9-05. Reports.

a. Morning Reports. This report is prepared following TDR 1130-2-12 by the Water Control Section daily, 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 reservoirs, field investigations, stream gaging, and construction of flood control projects affected by releases from reservoirs, 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 Control 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 Office. Supplemental information on the regulation of the reservoirs, 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.

c. Flood Situation Reports. The Water Control 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 reservoirs are as follows: name of reservoir, reservoir stage, predicted maximum stage, rates of inflow and outflow in cfs, 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 had 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 or possible claims against the United States for damages. The report is prepared by the District Office Planning Division personnel, using information compiled and prepared by the Water Control Section. The report should be completed within approximately three months of the time of flooding, including a statement of final cost.

e. Annual Reports. This report is prepared by the Water Control Section. The report contains a summation of the general conditions of the river basins and the individual projects in the District for the preceding fiscal year. The report also presents the activities and accomplishments of the Water Control Section for the past year. The report is forwarded to the SWD Water Control Section for inclusion in the Division'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
Morning Report	Daily, except Saturday, Sunday, and holidays	TDR 1130-2-12
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
Postflood Report	Following a flood Causing major damage	OM 500-1-6 ER 500-1-1
Annual Report	Annually	ER 1110-2-1400

TABLES

TABLE 6-1

OOLOGAH LAKE HEC-1 FORECAST MODEL

ID OOLOGAH LAKE FORECAST COOK OCT 1981
ID VERDIGRIS RIVER SUBSYSTEM
ID MODIFIED FOR DSS ZREAD AND ZWRITE DEC84 BSM
ID MODIFIED FOR TOTDSS RELEASES SEPTEMBER 1989 MAD
ID MODIFIED FOR UPDATED ELEV-CAPACITY TABLE OCT90 MAD
ID MODIFIED FOR USE ON THE NETWORK MAY 1991 MAD
ID MODIFIED FOR DRAG & DROP APR 1992 MAD
*DIAGRAM
*FREE
IT 120 05SEP96 0800 100
IO 5
VSINDPEN LENPAH OOL-IN OOLOUT RELESE
VV 2.11 2.11 2.11 7.11 2.11
VSALTONA FREDNA LENLOC OOLLOC
VV 2.11 2.11 5.11 5.11
VSTRONTO FALRIV ELKCTY OOLLOC
VV 2.11 2.11 2.11 2.11
* *****
KKTRONTO TORONTO RELEASES
* :PLOT-MACRO: TORO
BA 730
ZR=QI A=POSITIVE B=TORO C=FLOW-RES OUT F=OBS
* *****
KK ALTNA TORONTO RELEASES ROUTED TO ALTOONA
RM 4 36 .3
* *****
KKATLOC ALTOONA LOCAL RUNOFF
BA 408
* B BASEFLOW FOR ALL SUBAREAS ABOVE THE LOCAL AREA
BF 0 -.1 1.02
* L LOSS RATE CARD FOR ALTOONA SUB-AREA
LU 0 0
PB 0
ZR=PI A=VERDIGRIS B=ATLOC C=PRECIP-INC F=ADJUST
US 24 .6
* *****
KKALTONA COMBINED FLOWS AT ALTOONA
* :PLOT-MACRO: ALTO
HC 2
ZW A=VERDIGRIS B=ALTO C=FLOW-LOC CUM F=CALC
* *****
KK RIND ALTOONA FLOWS ROUTED TO INDEPENDENCE
RM 2 20 .3
* *****
KKFALRIV FALL RIVER RELEASES
* :PLOT-MACRO: FALL
BA 585

TABLE 6-1 (CONT'D)

ZR=QI A=POSITIVE B=FALL C=FLOW-RES OUT F=OBS

* *****

KK FRDN FALL RIVER RELEASES ROUTED TO FREDONIA

RM 3 12 .3

* *****

* KK FREDN LAG 6 HOURS

* RT 0 0 3

* *****

KKFRELOC FREDONIA LOCAL RUNOFF

BA 242

* B BASEFLOW FOR ALL SUBAREAS ABOVE THE LOCAL AREA

BF 0 -.1 1.02

* L LOSS RATE CARD FOR FREDONIA SUB-AREA

LU 0 0

PB 0

ZR=PI A=VERDIGRIS B=FRELOC C=PRECIP-INC F=ADJUST

US 13 .6

* *****

KKFREDNA COMBINED FLOWS AT FREDONIA

* :PLOT-MACRO: FRED

HC 2

ZW A=FALL RIVER B=FRED C=FLOW-LOC CUM F=CALC

* *****

KK RIND2 FREDONIA FLOWS ROUTED TO INDEPENDENCE

RM 2 22 .3

* *****

KKELKCTY ELK CITY RELEASES

* :PLOT-MACRO: ELKC

BA 634

ZR=QI A=POSITIVE B=ELKC C=FLOW-RES OUT F=OBS

* *****

KK RIND3 ELK CITY RELEASES ROUTED TO INDEPENDENCE

RM 1 12 .3

* *****

KKINDLOC INDEPENDENCE LOCAL RUNOFF

BA 293

BF 0 -.1 1.03

* L LOSS RATE FOR INDEPENDENCE SUB-AREA

LU 0 0

PB 0

ZR=PI A=VERDIGRIS B=INDLOC C=PRECIP-INC F=ADJUST

US 14 .65

* *****

KKINDPEN COMBINED FLOWS AT INDEPENDENCE

* :PLOT-MACRO: INDP

HC 4

ZW A=VERDIGRIS B=INDP C=FLOW-LOC CUM F=CALC

* *****

KK LENPA INDEPENDENCE FLOWS ROUTED TO LENAPAH

RM 3 22 .3

TABLE 6-1 (CONT'D)

* *****

KKLENLOC LENAPAH LOCAL RUNOFF

BA 747

* L LOSS RATE FOR LENAPAH SUB-AREA

LU 0 0

PB 0

ZR=PI A=VERDIGRIS B=LENLOC C=PRECIP-INC F=ADJUST

US 16 .55

* *****

KKLENPAH COMBINED FLOWS AT LENAPAH

* :PLOT-MACRO: LENA

HC 2

ZW A=VERDIGRIS B=LENA C=FLOW-LOC CUM F=CALC

* *****

KKLENOOL LAG 12 HOURS (MAY NEED THIS KK GROUP TO LAG FROM 12 TO 24 HRS)

RM 2 12 .3

* *****

KKOOLLOC OOLOGAH LOCAL RUNOFF

BA 686.3

* L OOLOGAH LAKE LOCAL AREA RUNOFF

LU 0 0

* B BASEFLOW FOR LOCAL AREA

BF 0 -.05 1.02

PB 0

ZR=PI A=VERDIGRIS B=OOLOC C=PRECIP-INC F=ADJUST

US 15 0.75

* *****

KKOOLLAK OOLOGAH LAKE SURFACE

BA 76.7

LU 0 0

BF 0 -.01 1.15

PB 0

ZR=PI A=VERDIGRIS B=OOLOC C=PRECIP-INC F=ADJUST

UI 24755

* *****

KKOOL-IN COMBINED INFLOW INTO OOLOGAH LAKE

HC 3

ZW A=VERDIGRIS B=OOLO C=FLOW-RES IN F=CALC

* *****

KKRELESE OOLOGAH RELEASES

BA 1

ZR=-QI A=POSITIVE B=OOLO C=FLOW-RES OUT F=OBS

* *****

KKNET-IN NET INFLOW

HC 2

* *****

KKOOLOUT OOLOGAH INFLOW ROUTED THRU LAKE

* :PLOT-MACRO: OOLO

* R OOLOGAH LAKE

RS 1 ELEV 637.00

TABLE 6-1 (CONT'D)

SV 6935 19797 32546 51540 79847 118268 166795 229296 344011 552219
SV835308 1182658 1559279 3089510
SE 592 600 604 608 612 616 620 624 630 638
SE 646 654 661 680
SQ 0 0
SE 630 680
ZW A=VERDIGRIS B=OOLO C=ELEV F=CALC
ZZ

TABLE 6-2

OOLOGAH LAKE
HEC-1 FORECAST MODEL SAMPLE SUMMARY OUTPUT

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK	TIME OF	AVERAGE FLOW FOR			BASIN	MAXIMUM	TIME OF
		FLOW	PEAK	6-HOUR	24-HOUR	72-HOUR			
				MAXIMUM PERIOD			AREA	STAGE	MAX STAGE
HYDROGRAPH AT	TRONTO	0	2.00	0	0	0	730.00		
ROUTED TO	ALTNA	0	2.00	0	0	0	730.00		
HYDROGRAPH AT	ATLOC	6784	26.00	6664	5740	3356	408.00		
2 COMBINED AT	ALTONA	6784	26.00	6664	5740	3356	1138.00		
ROUTED TO	RIND	5441	44.00	5403	4996	3270	1138.00		
HYDROGRAPH AT	FALRIV	0	2.00	0	0	0	585.00		
ROUTED TO	FRDN	0	2.00	0	0	0	585.00		
HYDROGRAPH AT	FRELOC	7280	16.00	6870	4952	2254	242.00		
2 COMBINED AT	FREDNA	7280	16.00	6870	4952	2254	827.00		
ROUTED TO	RIND2	4516	36.00	4479	3969	2220	827.00		
HYDROGRAPH AT	ELKCTY	0	2.00	0	0	0	634.00		
ROUTED TO	RIND3	0	2.00	0	0	0	634.00		
HYDROGRAPH AT	INDLOC	8850	16.00	8540	6110	2715	293.00		
4 COMBINED AT	INDPEN	11152	36.00	11094	10433	7740	2892.00		
ROUTED TO	LENPA	10402	58.00	10372	9932	7483	2892.00		
HYDROGRAPH AT	LENLOC	16775	18.00	16338	12831	6504	747.00		
2 COMBINED AT	LENPAH	17118	20.00	16672	15196	12763	3639.00		
ROUTED TO	LENOOL	15025	34.00	14968	14476	12504	3639.00		
HYDROGRAPH AT	OOLLOC	22407	18.00	21605	15399	6341	686.30		
HYDROGRAPH AT	OOLLAK	24755	4.00	8365	2143	716	76.70		
3 COMBINED AT	OOL-IN	28496	20.00	27802	23841	17482	4402.00		
HYDROGRAPH AT	RELESE	0	2.00	0	0	0	1.00		
2 COMBINED AT	NET-IN	28496	20.00	27802	23841	17482	4403.00		
ROUTED TO	OOLOUT	0	2.00	0	0	0	4403.00	641.24	198.00

TABLE 6-2 (CONT'D)

PER	DAY	MON	STATION	INDPEN	LENPAH	OOO-IN	OOOOUT	RELEASE
			HRMN	FLOW	FLOW	FLOW	STAGE	FLOW
1	5	SEP	800	0	0	0	637	0
2	5	SEP	1000	0	0	0	637	0
3	5	SEP	1200	493	666	25882	637	0
4	5	SEP	1400	1729	2503	4245	637	0
5	5	SEP	1600	3278	5071	7918	637	0
6	5	SEP	1800	4945	7980	12078	637	0
7	5	SEP	2000	6544	11007	16660	637	0
8	5	SEP	2200	7807	13677	21037	637	0
9	6	SEP	0	8677	15628	24557	638	0
10	6	SEP	200	9096	16851	27113	638	0
11	6	SEP	400	9037	17118	28496	638	0
12	6	SEP	600	8975	16468	28075	638	0
13	6	SEP	800	9216	15673	26560	638	0
14	6	SEP	1000	9597	15169	25133	638	0
15	6	SEP	1200	10016	14830	23767	638	0
16	6	SEP	1400	10409	14565	22426	639	0
17	6	SEP	1600	10756	14328	21151	639	0
18	6	SEP	1800	11022	14109	19981	639	0
19	6	SEP	2000	11152	13909	18935	639	0
20	6	SEP	2200	11133	13735	18014	639	0
21	7	SEP	0	10971	13595	17210	639	0
22	7	SEP	200	10686	13493	16514	639	0
23	7	SEP	400	10301	13424	15915	639	0
24	7	SEP	600	9841	13376	15406	639	0
25	7	SEP	800	9408	13333	15063	639	0
26	7	SEP	1000	8933	13280	14875	639	0
27	7	SEP	1200	8419	13191	14713	639	0
28	7	SEP	1400	7892	13052	14576	640	0
29	7	SEP	1600	7369	12860	14456	640	0
30	7	SEP	1800	6861	12612	14341	640	0
31	7	SEP	2000	6376	12309	14219	640	0
32	7	SEP	2200	5917	11954	14078	640	0
33	8	SEP	0	5486	11588	13909	640	0
34	8	SEP	200	5084	11213	13699	640	0
35	8	SEP	400	4710	10793	13446	640	0
36	8	SEP	600	4365	10338	13161	640	0
37	8	SEP	800	4045	9858	12845	640	0
38	8	SEP	1000	3750	9362	12496	640	0
39	8	SEP	1200	3477	8859	12114	640	0
40	8	SEP	1400	3226	8358	11701	640	0
41	8	SEP	1600	2995	7863	11259	640	0
42	8	SEP	1800	2782	7381	10794	640	0
43	8	SEP	2000	2585	6915	10312	640	0
44	8	SEP	2200	2405	6468	9819	641	0
45	9	SEP	0	2234	6042	9320	641	0
46	9	SEP	200	2077	5638	8823	641	0
47	9	SEP	400	1933	5257	8331	641	0
48	9	SEP	600	1803	4900	7849	641	0
49	9	SEP	800	1685	4565	7381	641	0
50	9	SEP	1000	1580	4252	6930	641	0
51	9	SEP	1200	1485	3960	6498	641	0
52	9	SEP	1400	1399	3687	6086	641	0
53	9	SEP	1600	1321	3434	5696	641	0

TABLE 6-2 (CONT'D)

		STATION	INDPEN	LENPAH	OOO-IN	OOOOUT	RELEASE
			FLOW	FLOW	FLOW	STAGE	FLOW
PER	DAY	MON	HRMN				
54	9	SEP	1800	1251	3198	5326	641
55	9	SEP	2000	1186	2980	4978	641
56	9	SEP	2200	1127	2779	4651	641
57	10	SEP	0	1072	2593	4344	641
58	10	SEP	200	1021	2422	4058	641
59	10	SEP	400	974	2265	3790	641
60	10	SEP	600	930	2122	3541	641
61	10	SEP	800	889	1990	3309	641
62	10	SEP	1000	850	1869	3095	641
63	10	SEP	1200	813	1759	2896	641
64	10	SEP	1400	778	1657	2713	641
65	10	SEP	1600	745	1564	2544	641
66	10	SEP	1800	714	1478	2388	641
67	10	SEP	2000	684	1399	2245	641
68	10	SEP	2200	655	1325	2112	641
69	11	SEP	0	628	1257	1990	641
70	11	SEP	200	602	1194	1878	641
71	11	SEP	400	577	1135	1774	641
72	11	SEP	600	554	1080	1678	641
73	11	SEP	800	531	1029	1590	641
74	11	SEP	1000	509	980	1507	641
75	11	SEP	1200	489	935	1431	641
76	11	SEP	1400	469	892	1360	641
77	11	SEP	1600	450	851	1293	641
78	11	SEP	1800	432	813	1231	641
79	11	SEP	2000	414	777	1173	641
80	11	SEP	2200	397	742	1118	641
81	12	SEP	0	381	710	1066	641
82	12	SEP	200	366	678	1018	641
83	12	SEP	400	351	649	972	641
84	12	SEP	600	337	621	928	641
85	12	SEP	800	323	594	887	641
86	12	SEP	1000	310	568	848	641
87	12	SEP	1200	298	544	811	641
88	12	SEP	1400	286	520	776	641
89	12	SEP	1600	274	498	742	641
90	12	SEP	1800	263	477	710	641
91	12	SEP	2000	253	457	680	641
92	12	SEP	2200	243	437	651	641
93	13	SEP	0	233	419	623	641
94	13	SEP	200	224	401	596	641
95	13	SEP	400	215	384	571	641
96	13	SEP	600	206	368	547	641
97	13	SEP	800	198	352	524	641
98	13	SEP	1000	190	338	502	641
99	13	SEP	1200	182	323	481	641
100	13	SEP	1400	175	310	461	641
MAX			11152	17118	28496	641	0
MIN			0	0	0	637	0
AVE			3323	5832	8503	640	0

TABLE 6-2 (CONT'D)

			STATION	ALTONA	FREDNA	LENLOC	OOLLOC
			HRMN	FLOW	FLOW	EXCESS	EXCESS
PER	DAY	MON					
1	5	SEP	800	0	0	0	0
2	5	SEP	1000	0	0	0	0
3	5	SEP	1200	157	394	1	1
4	5	SEP	1400	588	1453	0	0
5	5	SEP	1600	1200	2900	0	0
6	5	SEP	1800	1916	4509	0	0
7	5	SEP	2000	2703	5957	0	0
8	5	SEP	2200	3538	6915	0	0
9	6	SEP	0	4399	7280	0	0
10	6	SEP	200	5194	6876	0	0
11	6	SEP	400	5840	5984	0	0
12	6	SEP	600	6323	5127	0	0
13	6	SEP	800	6641	4393	0	0
14	6	SEP	1000	6784	3764	0	0
15	6	SEP	1200	6711	3225	0	0
16	6	SEP	1400	6352	2764	0	0
17	6	SEP	1600	5849	2368	0	0
18	6	SEP	1800	5382	2029	0	0
19	6	SEP	2000	4953	1739	0	0
20	6	SEP	2200	4557	1490	0	0
21	7	SEP	0	4194	1276	0	0
22	7	SEP	200	3859	1094	0	0
23	7	SEP	400	3551	937	0	0
24	7	SEP	600	3268	803	0	0
25	7	SEP	800	3007	718	0	0
26	7	SEP	1000	2767	690	0	0
27	7	SEP	1200	2546	663	0	0
28	7	SEP	1400	2343	638	0	0
29	7	SEP	1600	2156	613	0	0
30	7	SEP	1800	1984	589	0	0
31	7	SEP	2000	1826	566	0	0
32	7	SEP	2200	1680	544	0	0
33	8	SEP	0	1546	523	0	0
34	8	SEP	200	1423	503	0	0
35	8	SEP	400	1309	483	0	0
36	8	SEP	600	1205	464	0	0
37	8	SEP	800	1109	446	0	0
38	8	SEP	1000	1020	429	0	0
39	8	SEP	1200	939	412	0	0
40	8	SEP	1400	864	396	0	0
41	8	SEP	1600	795	381	0	0
42	8	SEP	1800	732	366	0	0
43	8	SEP	2000	676	352	0	0
44	8	SEP	2200	650	338	0	0
45	9	SEP	0	625	325	0	0
46	9	SEP	200	600	313	0	0
47	9	SEP	400	577	300	0	0
48	9	SEP	600	555	289	0	0
49	9	SEP	800	533	278	0	0
50	9	SEP	1000	512	267	0	0
51	9	SEP	1200	492	256	0	0
52	9	SEP	1400	473	246	0	0
53	9	SEP	1600	455	237	0	0

TABLE 6-2 (CONT'D)

			STATION	ALTONA	FREDNA	LENLOC	OOLLOC
			HRMN	FLOW	FLOW	EXCESS	EXCESS
PER	DAY	MON					
54	9	SEP	1800	437	228	0	0
55	9	SEP	2000	420	219	0	0
56	9	SEP	2200	404	210	0	0
57	10	SEP	0	388	202	0	0
58	10	SEP	200	373	194	0	0
59	10	SEP	400	359	187	0	0
60	10	SEP	600	345	180	0	0
61	10	SEP	800	331	173	0	0
62	10	SEP	1000	319	166	0	0
63	10	SEP	1200	306	159	0	0
64	10	SEP	1400	294	153	0	0
65	10	SEP	1600	283	147	0	0
66	10	SEP	1800	272	142	0	0
67	10	SEP	2000	261	136	0	0
68	10	SEP	2200	251	131	0	0
69	11	SEP	0	241	126	0	0
70	11	SEP	200	232	121	0	0
71	11	SEP	400	223	116	0	0
72	11	SEP	600	214	112	0	0
73	11	SEP	800	206	107	0	0
74	11	SEP	1000	198	103	0	0
75	11	SEP	1200	190	99	0	0
76	11	SEP	1400	183	95	0	0
77	11	SEP	1600	176	92	0	0
78	11	SEP	1800	169	88	0	0
79	11	SEP	2000	162	85	0	0
80	11	SEP	2200	156	81	0	0
81	12	SEP	0	150	78	0	0
82	12	SEP	200	144	75	0	0
83	12	SEP	400	139	72	0	0
84	12	SEP	600	133	69	0	0
85	12	SEP	800	128	67	0	0
86	12	SEP	1000	123	64	0	0
87	12	SEP	1200	118	62	0	0
88	12	SEP	1400	114	59	0	0
89	12	SEP	1600	109	57	0	0
90	12	SEP	1800	105	55	0	0
91	12	SEP	2000	101	53	0	0
92	12	SEP	2200	97	51	0	0
93	13	SEP	0	93	49	0	0
94	13	SEP	200	90	47	0	0
95	13	SEP	400	86	45	0	0
96	13	SEP	600	83	43	0	0
97	13	SEP	800	80	41	0	0
98	13	SEP	1000	77	40	0	0
99	13	SEP	1200	74	38	0	0
100	13	SEP	1400	71	37	0	0
			MAX	6784	7280	1	1
			MIN	0	0	0	0
			AVE	1389	909	0	0

OOLOGAH LAKE, OKLAHOMA
 BASED ON 1 MAY 1977 RESURVEY

TABLE 7-6
 ELEVATION-AREA-CAPACITY

STATION FILE NO. 07171300
 TABLE NO. 2

AREA IN 1000'S OF AC										
ELEV	0	1	2	3	4	5	6	7	8	9
560	0.000	0.000	0.013	0.026	0.029	0.031	0.033	0.036	0.037	0.040
570	0.042	0.045	0.048	0.063	0.073	0.078	0.108	0.138	0.165	0.181
580	0.193	0.214	0.270	0.311	0.344	0.374	0.411	0.500	0.575	0.638
590	0.695	0.783	0.880	1.020	1.145	1.351	1.560	1.847	2.051	2.216
600	2.463	2.826	3.276	3.505	3.822	4.253	4.613	5.146	6.141	6.597
610	7.010	7.558	8.143	9.144	9.510	10.208	10.976	11.414	11.854	12.860
620	13.822	14.818	15.537	16.724	17.021	17.538	18.226	18.798	19.852	20.802
630	21.978	23.033	24.230	25.227	25.848	26.464	27.528	29.367	31.043	32.250
640	33.400	34.242	35.231	36.363	37.586	38.699	39.593	40.329	41.239	42.057
650	42.977	44.242	45.651	46.912	48.294	49.558	50.882	52.572	54.028	55.296
660	56.579	67.117	69.147	70.468	71.205	71.799	72.118	72.314	72.597	73.428
670	73.516	86.170	86.831	87.872	88.447	89.097	90.099	90.463	92.003	92.632
680	92.933	108.954	110.470	111.142	111.305	111.532	111.712	112.402	112.862	113.914
690	114.407	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

CAPACITY IN 1000'S OF ACRE-FEET										
ELEV	0	1	2	3	4	5	6	7	8	9
560	0.000	0.000	0.007	0.026	0.054	0.084	0.116	0.150	0.187	0.225
570	0.266	0.310	0.356	0.412	0.480	0.555	0.648	0.771	0.923	1.096
580	1.283	1.486	1.728	2.019	2.346	2.705	3.098	3.553	4.091	4.697
590	5.364	6.103	6.934	7.884	8.967	10.215	11.670	13.374	15.323	17.456
600	19.796	22.440	25.491	28.882	32.545	36.583	41.016	45.895	51.539	57.908
610	64.711	71.995	79.846	88.489	97.816	107.675	118.267	129.462	141.096	153.453
620	166.794	181.114	196.292	212.422	229.295	246.574	264.456	282.968	302.293	322.620
630	344.010	366.516	390.147	414.876	440.413	466.569	493.565	522.013	552.218	583.864
640	616.689	650.510	685.247	721.044	758.018	796.161	835.307	875.268	916.052	957.700
650	1000.217	1043.826	1088.773	1135.054	1182.657	1231.583	1281.803	1333.530	1386.830	1441.492
660	1497.430	1559.278	1627.410	1697.217	1768.054	1839.556	1911.514	1983.730	2056.186	2129.198
670	2202.670	2282.513	2369.014	2456.365	2544.525	2633.297	2722.895	2813.176	2904.409	2996.726
680	3089.509	3190.452	3300.164	3410.970	3522.194	3633.612	3745.234	3857.291	3969.923	4083.311
690	4197.472	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

OOLOGAH LAKE, OKLAHOMA
 BASED ON 1 MAY 1977 RESURVEY

TABLE 7-6 (CONT'D)
 ELEVATION-AREA-CAPACITY

STATION FILE NO. 07171300
 TABLE NO. 2

CAPACITY IN 1000'S OF ACRE-FEET

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
560	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
561	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.004	0.005
562	0.007	0.008	0.009	0.011	0.013	0.015	0.017	0.019	0.021	0.024
563	0.026	0.029	0.031	0.034	0.037	0.039	0.042	0.045	0.048	0.051
564	0.054	0.057	0.059	0.062	0.065	0.068	0.071	0.074	0.077	0.081
565	0.084	0.087	0.090	0.093	0.096	0.099	0.103	0.106	0.109	0.112
566	0.116	0.119	0.122	0.126	0.129	0.132	0.136	0.139	0.143	0.147
567	0.150	0.154	0.157	0.161	0.165	0.168	0.172	0.176	0.179	0.183
568	0.187	0.190	0.194	0.198	0.202	0.205	0.209	0.213	0.217	0.221
569	0.225	0.229	0.233	0.237	0.241	0.245	0.249	0.254	0.258	0.262
570	0.266	0.270	0.275	0.279	0.283	0.287	0.292	0.296	0.301	0.305
571	0.310	0.314	0.319	0.323	0.328	0.332	0.337	0.342	0.347	0.351
572	0.356	0.361	0.366	0.371	0.376	0.382	0.388	0.393	0.399	0.405
573	0.412	0.418	0.424	0.431	0.438	0.444	0.451	0.458	0.465	0.472
574	0.480	0.487	0.494	0.502	0.509	0.517	0.524	0.532	0.540	0.547
575	0.555	0.563	0.571	0.580	0.589	0.598	0.607	0.617	0.627	0.637
576	0.648	0.659	0.670	0.682	0.694	0.706	0.718	0.731	0.744	0.757
577	0.771	0.785	0.799	0.814	0.828	0.843	0.859	0.874	0.890	0.906
578	0.923	0.939	0.956	0.973	0.990	1.007	1.024	1.042	1.060	1.078
579	1.096	1.114	1.132	1.150	1.169	1.188	1.206	1.225	1.244	1.263
580	1.283	1.302	1.322	1.341	1.361	1.382	1.402	1.423	1.444	1.465
581	1.486	1.508	1.530	1.553	1.576	1.600	1.625	1.650	1.675	1.701
582	1.728	1.755	1.783	1.811	1.839	1.868	1.897	1.927	1.957	1.988
583	2.019	2.050	2.081	2.113	2.146	2.178	2.211	2.244	2.278	2.312
584	2.346	2.381	2.415	2.451	2.486	2.522	2.558	2.594	2.631	2.668
585	2.705	2.743	2.781	2.819	2.858	2.897	2.936	2.976	3.016	3.057
586	3.098	3.139	3.182	3.225	3.269	3.314	3.360	3.407	3.455	3.504
587	3.553	3.603	3.655	3.706	3.759	3.812	3.867	3.921	3.977	4.033
588	4.091	4.148	4.207	4.266	4.326	4.386	4.447	4.509	4.571	4.634
589	4.697	4.761	4.826	4.891	4.957	5.023	5.090	5.158	5.226	5.294

TABLE 7-6 (CONT'D)
OOLOGAH LAKE, OKLAHOMA
BASED ON 1 MAY 1977 RESURVEY

ELEVATION-AREA-CAPACITY

STATION FILE NO. 07171300
TABLE NO. 2

CAPACITY IN 1000'S OF ACRE-FEET										
ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
590	5.364	5.434	5.504	5.576	5.649	5.722	5.796	5.872	5.948	6.025
591	6.103	6.181	6.261	6.342	6.424	6.506	6.590	6.674	6.760	6.847
592	6.934	7.023	7.113	7.204	7.297	7.392	7.487	7.584	7.683	7.783
593	7.884	7.987	8.091	8.196	8.302	8.410	8.519	8.629	8.740	8.853
594	8.967	9.082	9.200	9.319	9.441	9.565	9.691	9.819	9.949	10.081
595	10.215	10.351	10.489	10.629	10.772	10.916	11.063	11.212	11.362	11.515
596	11.670	11.828	11.988	12.151	12.317	12.486	12.658	12.832	13.010	13.190
597	13.374	13.559	13.747	13.937	14.129	14.323	14.519	14.716	14.916	15.119
598	15.323	15.529	15.736	15.945	16.156	16.369	16.583	16.799	17.016	17.235
599	17.456	17.679	17.904	18.132	18.362	18.595	18.830	19.068	19.308	19.551
600	19.796	20.044	20.295	20.551	20.810	21.072	21.339	21.609	21.882	22.159
601	22.440	22.725	23.014	23.308	23.607	23.909	24.217	24.529	24.845	25.166
602	25.491	25.820	26.151	26.484	26.820	27.158	27.498	27.840	28.185	28.532
603	28.882	29.234	29.589	29.947	30.309	30.674	31.042	31.413	31.787	32.164
604	32.545	32.929	33.318	33.711	34.108	34.510	34.916	35.326	35.741	36.159
605	36.583	37.010	37.440	37.875	38.313	38.754	39.199	39.648	40.100	40.556
606	41.016	41.480	41.949	42.423	42.903	43.389	43.879	44.375	44.877	45.383
607	45.895	46.415	46.944	47.484	48.033	48.592	49.162	49.741	50.330	50.929
608	51.539	52.155	52.776	53.401	54.031	54.666	55.305	55.949	56.597	57.250
609	57.908	58.569	59.235	59.905	60.579	61.258	61.940	62.627	63.317	64.012
610	64.711	65.415	66.124	66.839	67.559	68.285	69.016	69.752	70.494	71.242
611	71.995	72.754	73.518	74.289	75.065	75.847	76.635	77.429	78.229	79.034
612	79.846	80.665	81.494	82.334	83.183	84.042	84.912	85.791	86.680	87.580
613	88.489	89.405	90.325	91.249	92.176	93.107	94.041	94.980	95.921	96.867
614	97.816	98.771	99.732	100.701	101.676	102.658	103.648	104.644	105.647	106.658
615	107.675	108.700	109.732	110.772	111.820	112.875	113.938	115.009	116.087	117.173
616	118.267	119.367	120.471	121.580	122.693	123.810	124.932	126.058	127.188	128.323
617	129.462	130.606	131.754	132.906	134.063	135.224	136.390	137.560	138.734	139.913
618	141.096	142.287	143.487	144.698	145.918	147.149	148.390	149.640	150.901	152.172
619	153.453	154.744	156.044	157.354	158.674	160.003	161.342	162.691	164.049	165.417

TABLE 7-6 (CONT'D)
OOLOGAH LAKE, OKLAHOMA
BASED ON 1 MAY 1977 RESURVEY

ELEVATION-AREA-CAPACITY

STATION FILE NO. 07171300
TABLE NO. 2

CAPACITY IN 1000'S OF ACRE-FEET										
ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
620	166.794	168.181	169.578	170.986	172.403	173.830	175.267	176.714	178.170	179.637
621	181.114	182.599	184.092	185.592	187.099	188.613	190.134	191.663	193.199	194.741
622	196.292	197.851	199.423	201.006	202.601	204.208	205.827	207.458	209.101	210.756
623	212.422	214.096	215.773	217.453	219.135	220.821	222.510	224.202	225.896	227.594
624	229.295	230.999	232.709	234.424	236.144	237.870	239.600	241.336	243.077	244.823
625	246.574	248.331	250.095	251.866	253.644	255.429	257.221	259.019	260.825	262.637
626	264.456	266.282	268.113	269.950	271.792	273.641	275.495	277.354	279.220	281.091
627	282.968	284.853	286.749	288.655	290.572	292.499	294.437	296.385	298.344	300.313
628	302.293	304.283	306.283	308.291	310.310	312.338	314.375	316.422	318.479	320.545
629	322.620	324.706	326.804	328.914	331.035	333.168	335.313	337.470	339.638	341.818
630	344.010	346.213	348.427	350.651	352.886	355.131	357.387	359.653	361.930	364.218
631	366.516	368.825	371.146	373.479	375.825	378.182	380.551	382.932	385.325	387.730
632	390.147	392.575	395.013	397.461	399.919	402.387	404.865	407.352	409.850	412.358
633	414.876	417.401	419.933	422.472	425.016	427.567	430.124	432.687	435.256	437.831
634	440.413	443.001	445.595	448.195	450.802	453.414	456.033	458.658	461.289	463.926
635	466.569	469.221	471.883	474.556	477.240	479.934	482.639	485.355	488.081	490.818
636	493.565	496.327	499.107	501.906	504.723	507.559	510.413	513.285	516.176	519.085
637	522.013	524.958	527.920	530.898	533.893	536.906	539.934	542.980	546.043	549.122
638	552.218	555.328	558.450	561.585	564.731	567.890	571.061	574.243	577.438	580.645
639	583.864	587.095	590.337	593.591	596.856	600.133	603.421	606.721	610.032	613.355
640	616.689	620.033	623.386	626.747	630.116	633.494	636.881	640.275	643.679	647.090
641	650.510	653.939	657.378	660.827	664.286	667.755	671.233	674.722	678.220	681.728
642	685.247	688.775	692.315	695.867	699.430	703.004	706.589	710.186	713.794	717.413
643	721.044	724.686	728.341	732.008	735.687	739.378	743.082	746.797	750.525	754.266
644	758.018	761.782	765.558	769.344	773.142	776.950	780.770	784.601	788.443	792.296
645	796.161	800.035	803.918	807.811	811.712	815.622	819.541	823.469	827.406	831.352
646	835.307	839.270	843.240	847.218	851.203	855.195	859.195	863.202	867.217	871.238
647	875.268	879.305	883.352	887.407	891.472	895.546	899.629	903.721	907.822	911.932
648	916.052	920.180	924.316	928.460	932.613	936.773	940.942	945.119	949.305	953.498
649	957.700	961.910	966.129	970.358	974.596	978.843	983.099	987.365	991.640	995.923

TABLE 7-6 (CONT'D)
 OOLOGAH LAKE, OKLAHOMA
 BASED ON 1 MAY 1977 RESURVEY

ELEVATION-AREA-CAPACITY

STATION FILE NO. 07171300
 TABLE NO. 2

CAPACITY IN 1000'S OF ACRE-FEET										
ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
650	1000.217	1004.521	1008.837	1013.167	1017.509	1021.863	1026.230	1030.610	1035.003	1039.408
651	1043.826	1048.257	1052.703	1057.162	1061.636	1066.123	1070.625	1075.141	1079.671	1084.215
652	1088.773	1093.344	1097.928	1102.525	1107.134	1111.756	1116.390	1121.037	1125.697	1130.369
653	1135.054	1139.752	1144.464	1149.190	1153.929	1158.683	1163.450	1168.231	1173.026	1177.835
654	1182.657	1187.493	1192.341	1197.202	1202.076	1206.962	1211.861	1216.773	1221.697	1226.634
655	1231.583	1236.546	1241.521	1246.510	1251.512	1256.528	1261.556	1266.598	1271.653	1276.721
656	1281.803	1286.900	1292.013	1297.144	1302.291	1307.455	1312.636	1317.835	1323.049	1328.281
657	1333.530	1338.795	1344.074	1349.367	1354.675	1359.998	1365.335	1370.687	1376.054	1381.435
658	1386.830	1392.239	1397.661	1403.096	1408.543	1414.003	1419.475	1424.960	1430.458	1435.969
659	1441.492	1447.028	1452.577	1458.139	1463.713	1469.300	1474.901	1480.514	1486.140	1491.778
660	1497.430	1503.140	1508.956	1514.877	1520.904	1527.036	1533.274	1539.617	1546.065	1552.619
661	1559.278	1566.000	1572.742	1579.504	1586.287	1593.090	1599.913	1606.757	1613.621	1620.505
662	1627.410	1634.331	1641.266	1648.213	1655.174	1662.148	1669.136	1676.136	1683.150	1690.177
663	1697.217	1704.268	1711.325	1718.391	1725.463	1732.543	1739.631	1746.725	1753.827	1760.937
664	1768.054	1775.177	1782.307	1789.442	1796.583	1803.730	1810.883	1818.043	1825.208	1832.379
665	1839.556	1846.737	1853.922	1861.110	1868.301	1875.495	1882.693	1889.893	1897.097	1904.304
666	1911.514	1918.727	1925.942	1933.158	1940.377	1947.598	1954.820	1962.045	1969.271	1976.500
667	1983.730	1990.963	1998.199	2005.437	2012.678	2019.922	2027.169	2034.419	2041.672	2048.927
668	2056.186	2063.449	2070.722	2078.002	2085.291	2092.588	2099.893	2107.207	2114.529	2121.859
669	2129.198	2136.541	2143.885	2151.230	2158.576	2165.923	2173.271	2180.619	2187.969	2195.319
670	2202.670	2210.085	2217.626	2225.294	2233.089	2241.010	2249.057	2257.232	2265.532	2273.959
671	2282.513	2291.133	2299.760	2308.394	2317.034	2325.681	2334.334	2342.994	2351.661	2360.334
672	2369.014	2377.702	2386.401	2395.110	2403.829	2412.559	2421.300	2430.050	2438.812	2447.583
673	2456.365	2465.155	2473.951	2482.753	2491.560	2500.373	2509.192	2518.016	2526.847	2535.683
674	2544.525	2553.373	2562.227	2571.088	2579.955	2588.829	2597.710	2606.597	2615.490	2624.390
675	2633.297	2642.211	2651.136	2660.071	2669.016	2677.970	2686.935	2695.910	2704.895	2713.890
676	2722.895	2731.906	2740.922	2749.941	2758.963	2767.990	2777.020	2786.053	2795.090	2804.131
677	2813.176	2822.229	2831.299	2840.384	2849.484	2858.600	2867.731	2876.877	2886.039	2895.216
678	2904.409	2913.612	2922.822	2932.038	2941.260	2950.489	2959.724	2968.965	2978.212	2987.466
679	2996.726	3005.991	3015.259	3024.529	3033.803	3043.080	3052.360	3061.642	3070.928	3080.217

TABLE 7-6 (CONT'D)
 OOLOGAH LAKE, OKLAHOMA
 BASED ON 1 MAY 1977 RESURVEY
 ELEVATION-AREA-CAPACITY
 STATION FILE NO. 07171300
 TABLE NO. 2

CAPACITY IN 1000'S OF ACRE-FEET										
ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
680	3089.509	3098.882	3108.416	3118.109	3127.964	3137.978	3148.152	3158.487	3168.982	3179.637
681	3190.452	3201.355	3212.273	3223.207	3234.155	3245.119	3256.097	3267.091	3278.100	3289.125
682	3300.164	3311.214	3322.271	3333.335	3344.406	3355.483	3366.567	3377.658	3388.755	3399.859
683	3410.970	3422.085	3433.202	3444.320	3455.440	3466.562	3477.685	3488.809	3499.936	3511.064
684	3522.194	3533.325	3544.459	3555.595	3566.734	3577.875	3589.017	3600.163	3611.310	3622.460
685	3633.612	3644.766	3655.922	3667.080	3678.239	3689.401	3700.564	3711.729	3722.895	3734.064
686	3745.234	3756.409	3767.590	3778.779	3789.974	3801.176	3812.385	3823.602	3834.825	3846.054
687	3857.291	3868.534	3879.781	3891.032	3902.289	3913.550	3924.815	3936.085	3947.360	3958.639
688	3969.923	3981.215	3992.517	4003.829	4015.152	4026.486	4037.830	4049.184	4060.549	4071.925
689	4083.311	4094.705	4106.104	4117.508	4128.916	4140.330	4151.749	4163.171	4174.600	4186.033

EXHIBITS

EXHIBIT A

Supplementary Pertinent Data

Oologah Lake

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA
OOLOGAH LAKE

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1. GENERAL INFORMATION

Other names for Projects	None
Location	Arkansas River Basin, Verdigris River, river mile 90.2, State of Oklahoma.
Type of Project	Dam and Lake
Objectives of regulation	Multipurpose - Flood control, water supply, navigation, fish and wildlife, recreation and streamflow aesthetics
Project Owner	U.S. Government
Operating Agency	U.S. Army Corps of Engineers. The working hours of operation for weekdays are 7:00 a.m. to 4:30 p.m.; working hours for weekends, holidays, and nights vary but generally are the same as weekdays; working hours during flood emergency conditions are 24 hours a day.
Regulating agency	U.S. Army Corps of Engineers
Water supply contracts	Currently, there are nine contracts totaling 327,005 acre-feet. The remaining 15,595 acre-feet are not under contract.
Water rights	Water rights have been granted in the Verdigris River basin between Oologah Dam and the Arkansas River in the amount of 73,030 acre-feet. Releases may be required from Oologah Lake to meet some of these water rights.
Project cost	\$46,655,000
Closure date	The project was placed in operation on May 15, 1963. The construction for ultimate development was completed and final storage began January 13, 1971.

2. LAKE INFORMATION

ELEVATIONS, AREAS, AND STORAGES:

Feature	Elevation (feet NGVD)	Lake Area ⁽¹⁾ (acres)	Lake Capacity			Outlet Works and Spillway Capacity (cfs)
			Accumulative ⁽¹⁾ (Acre-feet)	Incremental (Acre-feet)	Runoff ⁽²⁾ (inches)	
Top of Dam	687.0	112,402	3,857,292	929,862	7.41	---
Maximum Pool	678.25	92,160	2,927,430	1,015,915	8.10	264,700
Top of Surcharge Pool	666.0	72,118	1,911,515	352,236	2.81	160,200
Top of Flood Control Pool	661.0	67,117	1,559,279	942,589	7.51	122,500
Spillway Crest	640.0	33,400	616,690	64,455	0.51	30,800
Top of Conservation Pool	638.0	31,043	552,235	545,300	4.35	30,300
Top of Inactive Pool	592.0	880	6,935	6,935	0.06	13,000
Flood Control Storage	638.0-661.0	---	1,007,060	---	8.02	---
Conservation Storage	592.0-638.0	---	545,300 ⁽³⁾	---	4.35	---
Streambed at Dam	550.0	---	---	---	---	---

(1) Based on 1977 sedimentation survey.

(2) One inch of runoff equals 125,493 acre-feet, based upon 2,353 square miles of uncontrolled area.

(3) Includes 342,600 acre-feet for water supply (154 mgd yield), 168,000 acre-feet for navigation (81.3 mgd yield), and 34,700 acre-feet for sediment storage.

MAXIMUM FLOODS PAST THE DAM SITE

Date	Peak Flow (cfs)	Volume (Acre-feet)	Runoff (inches)(1)
May 8 - Jun 2, 1943	138,000	2,179,000	9.42
Sep 26 - Oct 21, 1986	97,500	2,144,000	9.26
Jun 20 - Jul 25, 1951	63,500	1,936,000	8.37
May 1 - Jun 15, 1995	80,000	1,905,000	8.23
May 17 - Jun 26, 1957	38,000	1,719,000	7.43
Apr 9 - 29, 1927	65,500	1,501,000	6.49
May 1 - 14, 1961	123,000	1,186,000	5.12

(1) One inch of runoff equals 231,413 acre-feet, based upon 4,339 square miles of total drainage area.

Real estate taking line	The fee taking line is semi-blocked for fee title perimeter to elevation 655.0 and contains 50,150 acres
Real estate taking line	Flowage easements were acquired for easement in the flat pool area above the fee taking line to elevation 664.0. In the upper reaches the flowage easement is to the elevation of the backwater envelope curve for a 50-year flood after 50 years of sedimentation. This contains 15,119 acres.
Range of clearing	Lower limit - elevation 608.0 Upper limit - above Winganon bridge, elevation 641.0; below Winganon bridge, 638.0.
Pool elevation corresponding to discharge capability of maximum nondamaging flow rate downstream	The nondamaging channel capacity immediately below Oologah Dam is estimated to be 30,000 cfs. This flow rate can be discharged when the lake level is at elevation 636.0 and above.
Reservoir length at top of conservation pool	35 miles
Shoreline length at top of conservation pool	209 miles
Safety aspects, possibly requiring warning	Some campsites and access roads will be inundated at elevation 740.0 (about 1-yr flood frequency). At elevation 652.5 (about 5-yr flood frequency), all access roads to recreation areas would be inundated. The Project Manager will make every effort to inform campsite users when roads and campsites are closed. When water is released for flood control purposes, a horn will sound.

Emergency drawdown

Oologah Lake has 7 - 40' x 21' tainter gates with a spillway crest at elevation 740.0. The dam also has two 19' diameter conduits, controlled by four 9' x 19' vertical lift gates, with an invert elevation of 565.0. All water in the reservoir can be emptied through the conduits. The minimum time required to empty when the water level is at the top of the conservation pool is 12 days. The total time required to empty the lake from the top of the flood pool would be 21 1/2 days. The times required to empty given above are based on no inflow.

3. HYDROLOGY

Drainage area

The total drainage area above Oologah Lake is 4,339 square miles. The uncontrolled drainage area below the upstream lakes is 2,353 square miles.

Spillway design flood

Max. water surface elevation	678.25
Peak inflow (into full pool)	473,000 cfs
Total storm runoff (into full pool)	15.87 inches
Volume (into full pool)	3,671,600 acre-feet
Maximum outflow (full flood control pool at beginning of spillway design flood)	265,100 cfs
Flood duration	14 days

Standard Project Flood

Maximum water surface elevation	667.54
Peak inflow (into full pool)	236,500 cfs
Total runoff (natural channel flow)	7.93 inches
Volume (natural channel flows)	1,835,800 acre-feet
Maximum outflow (full flood control pool at beginning of standard project flood)	172,200 cfs
Flood duration	14 days
Climate	Moderate
One inch runoff	231,413 acre-feet for 4,339 square miles and 125,493 acre-feet for the uncontrolled area of 2,353 square miles.
Storm types	Primarily thunderstorms
Flood season	Primary flood period March through July with a secondary period September through November; however, floods are possible in any month of the year.
Low flow season	Primarily August, September, December through February; however, low flow can occur at any time of the year.
Minimum daily flow*	1 cfs (numerous occurrences)
Minimum monthly flow*	61 acre-feet (December 1976)

Minimum annual flow*	49,429 acre-feet (1956)
Average annual flow*	2,100,983 acre-feet
Maximum daily flow*	100,206 cfs (October 6, 1986)
Maximum instantaneous flow	123,000 cfs (May 10, 1986)
Maximum monthly flow*	1,646,908 acre-feet (May 1943)
Maximum annual flow*	5,460,238 acre-feet
Maximum flood volume	2,179,000 acre-feet (8 May-2 June 1943)

* (Based on 1940-1986 period of record with Toronto, Fall River, and Elk City lakes in operation from SUPER RUN A88X01.)

Name and location of key streamflow stations	Independence and Lenapah gages are located on the Verdigris River above Oologah Dam at river miles 194.3 and 144.6, respectively. The Claremore gage is on the Verdigris River below Oologah Dam at river mile 76.0. The Van Buren gage is on the Arkansas River below Oologah Dam at river mile 308.9.
Type of hydrometeorologic data recorded at damsite	Maximum and minimum air temperature, recording and standard rainfall gages, evaporation pan, anemometer, pool elevation (recording and staff) and tailwater elevation (recording and staff).
Number of precipitation stations used in hydrologic forecasting of Oologah Lake	33 recording and 1 non-recording.
Number of sediment ranges	44
Number of degradation ranges	5

4. EMBANKMENTS

Location	Verdigris River at river mile 90.2
Purpose	Protection of agriculture lands and rural and urban structures, against loss of life and property, water supply, navigation, recreation, and fish and wildlife.
Type	Nonoverflow embankment
Type of fill	Rolled earthfill with impervious earth core
Slope protection	Riprap upstream and grassed on downstream
Height	137 feet above streambed
Length	4,000 feet
Top elevation	687.0 feet
Design flood	May 6-12, 1943 storm increased 34 percent.
Freeboard	8.75 feet above maximum pool elevation
Used for roadway	Yes, Oklahoma Highway 88 crosses the embankment and spillway with a 24-foot wide asphalt roadway
Elevation of streambed	550.0

5. SPILLWAY

Location	2 miles east of main embankment
Type	Gated controlled spillway, gravity ogee weir
Crest elevation	640.0
Net overflow length	280 feet

Number, type, and size gates	7 - 40' x 21' tainter gates operated by individual electric powered hoists.
Top of gate elevation	661.0
Induced surcharge	5 feet
Design head	28 feet
Maximum discharge capacity	232,600 cfs
Type energy dissipator	None
Time required to open/close tainter gates	Gates raise or lower separately at a rate of 1 foot per minute.
Type emergency closure	Diesel powered generating unit is located at project.
Spillway activation	The tainter and conduit gates, except for periodic maintenance, are activated only during flood conditions. During normal conditions, all discharges including low flow requirements are released through the low flow conduit.

6. NONOVERFLOW DIKE

Location	1/2 mile east of spillway
Type	Nonoverflow rolled earth levee
Type of fill	Impervious random fill with an impervious core.
Slope protection	Grass on lake side and grass on downstream side
Height (maximum)	30 feet
Length	3,330 feet

Top elevation	685.0
Design flood	Same as main embankment
Freeboard	6.75 feet

7. OUTLET FACILITIES

a. Conduit

Location	Through main embankment
Purpose	Flood control releases
Type of outlet	Two circular conduits
Number and size of gates	4 - 9' x 19' gates
Type of service gates	Hoist operated tractor gates
Entrance invert elevation	565.0
Discharge at pertinent elevations	Bottom of conservation pool (592.0) - elevation 13,000 cfs
	Top of conservation pool (638.0) - 30,300 cfs
	Top of flood control pool (661.0) - 35,000 cfs (tainter gates closed)
	Top of maximum pool (678.25) - 32,100 cfs (tainter gates open)
Minimum pool elevation when inoperative	565.0
Minimum time required to open or close service gates	Average time is 78 minutes from completely closed to completely opened positions for all four gates.

Type of emergency closure	One auxiliary gate operated by gantrycrane.
Type energy dissipator	Two rows of baffle blocks in tandem arrangement with a sloped endsill.

b. Low flow

Location	Dividing pier between conduits
Type and site of outlet	Circular 48-inch conduit
Type of gate	48" butterfly valve
Entrance invert elevation	574.5
Capacity at top of conservation pool	550 cfs

c. Water supply

Location	In the intake structure
Number, type and size outlet	One 66" circular conduit
Type service gate	Slide gate
Entrance invert elevation	565.0

8. CONTROL POINTS

a. Claremore gage

Location	At river mile 76.0 on the Verdigris River, near left bank on downstream side of bridge on State Highway 20, west of Claremore
Purpose	Measure stage and serve as control point for flood releases from Oologah Lake

Channel description	Channel banks are high and covered with vegetation. Streambed is rock.
Drainage area	6,534 square miles
Target flow rate	Operating stage is 35 feet, 42,000 cfs (current rating)
Time of crest travel from Oologah Dam to gage	Approximately 6 hours
Description of equipment	Water-stage recorder with a sutron DCP
Zero of gage	Elevation 538.62

b. Van Buren Gage (Arkansas River)

Location	At river mile 308.7 on Arkansas River, in Dam No. 13 control house on right bank
Purpose	Provide river stage data for flood control
Channel description	Channelized and stabilized
Drainage area	150,547 square miles of which 22,241 is probably noncontributing
Target flow rate	Bankfull stage is 22.0 feet, 105,000 cfs (current rating)
Time of water travel from Oologah dam to gage	48 hours (approximate)
Description of equipment	Water-stage recorder with a Sutron DCP
Zero of gage	Elevation 372.36

EXHIBIT B

WATER SUPPLY CONTRACTS

OOLOGAH LAKE

WATER STORAGE CONTRACT
 BETWEEN THE UNITED STATES OF AMERICA
 AND
 RURAL WATER DISTRICT NO. 3, WASHINGTON COUNTY, OKLAHOMA
 FOR
 WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this 1st day of May, 19 92, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and RURAL WATER DISTRICT NO. 3, WASHINGTON COUNTY, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, pursuant to Public Law 761, 75th Congress, 3d Session approved 28 June 1938, as amended by the River and Harbor Act approved 24 July 1946, (Public Law 525, 79th Congress, 3d Session) and Section 79 of the Water Resources Development Act of 1974 (Public Law 93-251), approved 7 March 1974 the Government has constructed and is operating and maintaining Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and,

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 U.S.C. 390b-f, et seq.); and,

WHEREAS, the User is empowered to contract with the Government and is vested with all necessary powers of accomplishment of the purposes of this contract;

NOW THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

a. Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

b. Rights of User.

(1) The User shall have the right to utilize an undivided 0.817 percent (estimated to contain 4,170 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 National Geodetic Vertical Datum, which usable conservation storage space is estimated to

contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1c and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 U.S.C. 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

c. Rights Reserved. The Government reserves the right to control and use all storage in this Project in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

d. Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

e. Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless the Contracting Officer determines that such surveys are unnecessary or funds are not available to perform the surveys. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project including municipal and industrial water supply. The total available remaining storage space in the

Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reservoir storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Project by the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with

written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1c. The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

a. Project Investment Costs.

(1) The User shall repay to the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "B" attached to and made a part of this contract, constitutes the entire actual amount of investment costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance will be the coupon rate as determined by the Secretary of the Treasury on the basis set forth in the Water Supply Act of 1958, Title III of PL 85-500. For the ultimate development stage of the Project, construction of which was initiated in Fiscal Year 1967 this interest rate is 3.225 percent. The User shall repay:

1.217 percent of the total Project joint-use construction costs,	\$ 124,365
Interest during construction,	\$ <u>10,443</u>
Total amount of Project investment costs allocated to the User	\$ 134,808

(2) The Project investment costs allocated to the storage space indicated in Article 1(b)(1) as being provided for present demand is \$134,808, on the basis of the costs presented in Exhibit "B". The amount of the Project investment costs allocated to the storage for present demand shall be paid within the life of the Project in not to exceed 30 years from the date the first contract for water supply storage space in the Project was approved by the Secretary of the Army, 2 April 1982. The payments shall be made in equal consecutive annual installments, the first of which shall be due and payable within 30 days after the User is notified by the Contracting Officer of the approval of this contract by the Secretary of the Army. Annual installments thereafter will be due and payable on the anniversary date of the date of notification. Except for the first payment

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
TOWN OF CHELSEA, OKLAHOMA
FOR
WATER STORAGE SPACE IN OOLAGAH LAKE

/s/ 2 Apr 82

THIS CONTRACT, entered into this ____ day of 80 APR 30 19__, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and the TOWN OF CHELSEA, OKLAHOMA, (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, pursuant to Public Law 761, 75th Congress, 3d Session approved 28 June 1938, as amended by the River and Harbor Act approved 24 July 1946, (Public Law 525, 79th Congress, 3d Session) and Section 79 of the Water Resources Development Act of 1974 (Public Law 93-251), approved 7 March 1974 the Government has constructed and is operating and maintaining Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

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

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

NOW, THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.300 percent (estimated to contain 1,530 acre-feet after adjustment for sediment deposits) of the total storage space in the Project between elevations 638.0 feet above mean sea level and 592.0 feet above mean sea level, which total storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for future demand or need for municipal and

industrial water supply. 43.79 percent (an estimated 670 acre-feet) of the space which User has a right to utilize is designated as Storage Space No. 1 and 56.21 percent (an estimated 860 acre-feet) is designated as Storage Space No. 2.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appliances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges herein granted.

(c) Rights Reserved. The Government reserves the right to maintain at all times minimum downstream releases through the gates or spillway of the dam to meet established water rights. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life or property, including the right not to make downstream releases during such periods of time as is deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5.

The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost of the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. Prior to the construction of any facilities for withdrawal of water, the User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. The User shall furnish to the Government monthly statements of all such withdrawals. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay to the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amount which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the Project was initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For the Project, this interest rate is 3.225 percent. The User shall repay:

0.105 percent of the total Project joint-use construction costs	\$45,527
Interest during construction	<u>\$ 3,848</u>
Total amount of Project investment costs allocated to water supply	\$49,375

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
RURAL WATER DISTRICT NO. 3, ROGERS COUNTY, OKLAHOMA
FOR
WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this 84 SEP 25, 1984, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and RURAL WATER DISTRICT NO. 3, ROGERS COUNTY, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress, 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation of 661.0 feet above mean sea level; and

WHEREAS, there is now in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-65-1909, approved on 26 January 1966, which authorizes the User to utilize 300 acre-feet of storage to provide a dependable yield of 300 acre-feet per year in the initial stage of development of the Oologah Lake as a source of municipal and industrial water supply; and

WHEREAS, the existing contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modification in quantity, elevation and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time, and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251), approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-1); and

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

NOW, THEREFORE, upon approval of this contract by the Secretary of the Army, Contract No. DA-34-066-CIVENG-65-1909 is hereby terminated, and the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 1.167 percent (estimated to contain 5,960 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply. 10.067 percent (an estimated 600 acre-feet, designated as Storage Space No. 1, initial stage development), is provided by the existing contract and 89.933 percent (an estimated 5,360 acre-feet, designated as Storage Space No. 2, ultimate stage development) is for use beginning on 1 February following the approval of this contract.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights reserved. The Government reserves the right to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

CONDITIONAL
TRANSFER AND ASSIGNMENT OF A CONTRACT BETWEEN THE
UNITED STATES OF AMERICA
AND RURAL WATER DISTRICT NO. 3, ROGERS COUNTY, OKLAHOMA
FOR WATER STORAGE SPACE IN OOLOGAH LAKE

WITNESSETH THAT:

WHEREAS, Rural Water District No. 3, Rogers County, Oklahoma (hereinafter called the "User"), entered into Contract No. DACW56-83-C-0019 with the United States of America on 25 September 1984 for water supply storage space in Oologah Lake; and

WHEREAS, said contract will be part of the security for Farmers Home Administration (hereinafter called "FmHA") loans to Rural Water District No. 3, Rogers County, Oklahoma; and

WHEREAS, Article 10 of said contract provides for transfer or assignment of the contract subject to the approval of the Secretary of the Army or his duly authorized representative; and

WHEREAS, said contract can be assigned to FmHA in accordance with financial arrangements upon agreement by said agency to assume all the responsibilities of the contract terms and approval of the Secretary of the Army or his duly authorized representative as provided in said contract.

NOW, therefore, in consideration of the total sum of \$1,886,300, the receipt whereof is hereby acknowledged, and any subsequent amounts loaned not exceeding 15 percent, the User does hereby transfer and assign unto FmHA, its successors and assigns, all of its right, title and interest in and to the said Contract No. DACW56-83-C-0019 with the United States of America dated 25 September 1984.

This transfer and assignment is intended as a conditional transfer and assignment to secure the payment of certain promissory notes of even date herewith for \$810,600, \$46,000, and \$1,029,700, due 40 years from dates of loans closing, made to FmHA, or order, payable at monthly intervals, with 4 1/8, 4 1/2, and 5 percent, respectively, interest per annum, and executed by the User.

If the User shall pay or cause to be paid to FmHA, its successors and assigns, the total sum of money in the above-described notes, together with the interest thereon according to the terms and tenor of said notes, then these presents shall be wholly discharged and void. If said sums of money or any part thereof is not paid when due, FmHA, its successors or assigns, may elect to declare the whole sum and interest thereon due and payable at once and proceed to collect said debt including attorney's fees, and to foreclose this conditional transfer and assignment and shall become entitled to all rights and interests in and under said contract.

The User hereby waives notice of election to declare the whole debt due as above and also benefit of stay, valuation or appraisement laws.

FmHA hereby agrees to assume all of the responsibilities of the User and abide by all the terms and provisions of said contract if and when this conditional agreement shall become absolute, including the requirements of approval of the Secretary of the Army or his duly authorized representative for all subsequent assignments in accordance with Article 10 of the contract.

The conditional agreement shall become effective upon approval of the Secretary of the Army or his duly authorized representative.

FARMERS HOME ADMINISTRATION

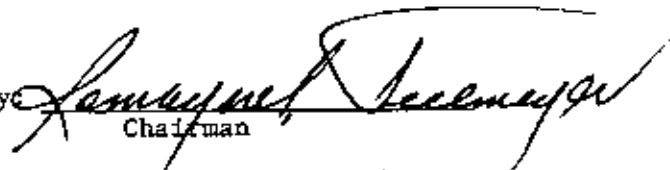
RURAL WATER DISTRICT NO. 3
ROGERS COUNTY, OKLAHOMA

flb By:


LARRY E. STEPHENSON
State Director

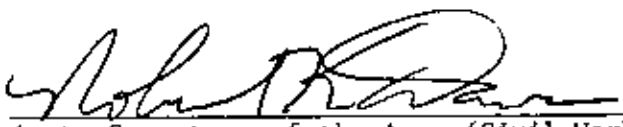
Date: November 26, 1984

By:


Chairman

Date: 19 Nov 84

APPROVED:


Acting Asst. Secretary of the Army (Civil Works)

Date: 8 FEB 1985

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government such share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location,

and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the initial and ultimate development stage of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For initial development stage of the Project, this interest rate is 2.544 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

0.408 percent of the total Project joint-use construction costs	\$177,770.00
Interest during construction	\$ 14,930.00
Subtotal	\$192,700.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-65-1909 thru 1 February 1985	\$ -2,570.97
Total remaining unpaid amount of Project investment costs	\$190,129.03

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into Storage Space Numbers 1 and 2 defined herein as follows:

Storage Space No. 1 - 600 acre-feet (initial development)	\$ 16,819.03
Storage Space No. 2 - 5,360 acre-feet (ultimate development)	\$173,310.00
Total	\$190,129.03

(2) The Project investment costs allocated to the Storage Space No. 1, 600 acre-feet of storage space for present use (initial development)

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
TULSA METROPOLITAN WATER AUTHORITY
FOR
WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this 12 day of DEC, 1984, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and THE TULSA METROPOLITAN WATER AUTHORITY, a public trust, (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation 661.0 feet above mean sea level; and,

WHEREAS, there has been in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-57-330, dated 4th day of December 1956, which authorizes the User to utilize 38,000 acre-feet of storage in the initial stage of development of the Oologah Lake as a source of municipal and industrial water supply. Modification No. 1, thereto, dated 1st day of December 1961, incorporates the provisions of the Water Supply Act of 1958 to defer payment on storage until time of use, and provides for commencing payments on the existing 84-inch water supply conduit as a separate item; and

WHEREAS, the prior contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modifications in quantity, elevation, and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time; and

WHEREAS, Contract No. DA-34-066-CIVENG-57-330 and Modification No. 1, thereto, which expired on 29 July, 1972 under their own terms pursuant to Article 5, has been continued on a year to year basis by mutual agreement of the parties; and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251), approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-f); and

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

NOW, THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 55.905 percent (estimated to contain 285,450 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet above mean sea level and 592.0 feet above mean sea level, which total conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights Reserved. The Government reserves the right to control and use any future water supply storage or any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the

Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space and the water supply conduit in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay to the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage and the water supply conduit right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal years in which construction of the initial and ultimate development stages of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For the initial development stage of the Project, this interest rate is 2.5 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

100 percent of the construction cost of specific water supply outlet works	\$ 365,000.00
19.546 percent of the total Project joint-use construction costs	\$8,514,330.00
Interest during construction	\$ 741,517.00
Subtotal	\$9,620,847.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-57-330 thru 29 May 1977	- \$ 53,519.69
Total remaining unpaid amount of Project investment costs	\$9,567,327.31

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into the water supply conduit and increments of storage space defined herein as follows:

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
RURAL WATER DISTRICT NO. 1, NOWATA COUNTY, OKLAHOMA
FOR
WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this _____ day of 10 JAN 1986 19____, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and RURAL WATER DISTRICT NO. 1, NOWATA COUNTY, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress, 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation of 661.0 feet above mean sea level; and

WHEREAS, there is now in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-64-2016, approved on 22 September 1964, which authorizes the User to utilize 100 acre-feet of storage to provide a dependable yield of 100 acre-feet per year in the initial stage of development of the Oologah Lake as a source of municipal and industrial water supply; and

WHEREAS, the existing contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modification in quantity, elevation and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time; and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251), approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-f); and

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

NOW, THEREFORE, upon approval of this contract by the Secretary of the Army, Contract No. DA-34-066-CIVENG-64-2016 is hereby terminated, and the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.039 percent (estimated to contain 200 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply. 50.00 percent (an estimated 100 acre-feet, designated as Storage Space No. 1, initial stage development) of the space which user has a right to utilize is provided by the existing contract and 50.00 percent (an estimated 100 acre-feet, designated as Storage Space No. 2, ultimate stage development) is for use beginning on 1 May following the approval of this contract.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights reserved. The Government reserves the right to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government such share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the

construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the initial and ultimate development stages of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For initial development stage of the Project, this interest rate is 2.50 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

0.0137 percent of the total Project joint-use construction costs	\$ 5,968.00
Interest during construction	<u>\$ 502.00</u>
Subtotal	\$ 6,470.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-64-2016 thru 1 May 1985	<u>\$ -1,089.39</u>
Total remaining unpaid amount of Project investment costs	\$ 5,380.61

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into Storage Space Numbers 1 and 2 defined herein as follows:

Storage Space No. 1 - 100 acre-feet (initial development)	\$ 2,145.61
Storage Space No. 2 - 100 acre-feet (ultimate development)	<u>\$ 3,235.00</u>
Total	\$ 5,380.61

CONTRACT BETWEEN THE UNITED STATES OF AMERICA

AND

THE PUBLIC SERVICE COMPANY OF OKLAHOMA

FOR

WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this 25 MAR 1985 day of 19, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and THE PUBLIC SERVICE COMPANY OF OKLAHOMA (hereinafter called the "User"); WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress, 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation of 661.0 feet above mean sea level; and

WHEREAS, there is now in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-58-265, approved on 1 August 1958, which authorizes the User to utilize 5,000 acre-feet of storage space in the initial stage of development of the Project as a source of cooling water for a thermal electric plant located in the vicinity of the Project; and

WHEREAS, the existing contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modification in quantity, elevation and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time; and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251),

approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-f); and

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

NOW, THEREFORE, upon approval of this contract by the Secretary of the Army, Contract No. DA-34-066-CIVENG-58-265 is hereby terminated, and the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 4.111 percent (estimated to contain 20,990 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for industrial water supply. 23.821 percent (an estimated 5,000 acre-feet, designated as Storage Space No. 1, initial stage development) of the space which User has a right to utilize is provided by the existing contract and 76.179 percent (an estimated 15,990 acre-feet, designated as Storage Space No. 2, ultimate stage development) is for use beginning on 1 July following the approval of this contract.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights reserved. The Government reserves the right to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government such share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the initial and ultimate development stages of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For initial development stage of the Project, this interest rate is 2.5 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

1.437 percent of the total Project joint-use construction costs	\$626,090.00
Interest during construction	<u>\$ 52,570.00</u>
Subtotal	\$678,660.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-58-265 thru 30 June 1985	<u>\$-49,869.52</u>
Total remaining unpaid amount of Project investment costs	\$628,790.48

- *

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into Storage Space Numbers 1 and 2 defined herein as follows:

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
CITY OF COLLINSVILLE, OKLAHOMA
FOR
WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this ____ day of 04 APR 1985, 19__, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and THE CITY OF COLLINSVILLE, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress, 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation of 661.0 feet above mean sea level; and

WHEREAS, there is now in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-58-266, approved on 1 August 1958, which authorizes the User to utilize 500 acre-feet of storage in the initial stage of development of the Oologah Lake as a source of municipal and industrial water supply; and

WHEREAS, the existing contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modification in quantity, elevation and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time; and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251), approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-f); and

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

NOW, THEREFORE, upon approval of this contract by the Secretary of the Army, Contract No. DA-34-066-CIVENG-58-266 is hereby terminated, and the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 1.306 percent (estimated to contain 6,670 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply. 7.496 percent (an estimated 500 acre-feet, designated as Storage Space No. 1, initial stage development) of the space which the User has a right to utilize is provided by the existing contract and 92.504 percent (an estimated 6,170 acre-feet, designated as Storage Space No. 2, ultimate stage development) is for use beginning on 2 April following the approval of this contract.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights reserved. The Government reserves the right to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no

representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government such share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring

devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the initial and ultimate development stages of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For initial development stage of the Project, this interest rate is 2.5 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

0.457 percent of the total Project joint-use construction costs	\$198,950.00
Interest during construction	\$ 16,700.00
Subtotal	\$215,650.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-58-266 thru 2 April 1985	\$ -4,781.25
Total remaining unpaid amount of Project investment costs	\$210,868.75

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into Storage Space Numbers 1 and 2 defined herein as follows:

Storage Space No. 1 - 500 acre-feet (initial development)	\$ 11,378.75
Storage Space No. 2 - 6,170 acre-feet (ultimate development)	\$199,490.00
Total	\$210,868.75

(2) The Project investment costs allocated to the Storage Space No. 1, 500 acre-feet of storage space for present use (initial development)

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
RURAL WATER DISTRICT NO. 4, ROGERS COUNTY, OKLAHOMA
FOR
WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this _____ day of 12 APR 1985, 19____, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and RURAL WATER DISTRICT NO. 4, ROGERS COUNTY, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Act of Congress approved 28 June 1938 (Public Law 761, 75th Congress, 3d Session), as amended by the River and Harbor Act approved 24 July 1946 (Public Law 525, 79th Congress, 3d Session), authorized the construction, operation, and maintenance of the Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the Project has been operating under the initial stage of development, defined as top of flood control pool at elevation 651.0 feet above mean sea level, and is now operated under the ultimate stage of development, defined as top flood control pool at elevation of 661.0 feet above mean sea level; and

WHEREAS, there is now in full force and effect between the parties hereto Contract No. DA-34-066-CIVENG-66-68, approved on 16 February 1966, which authorizes the User to utilize 300 acre-feet of storage to provide a dependable yield of 300 acre-feet per year in the initial stage of development of the Oologah Lake as a source of municipal and industrial water supply; and

WHEREAS, the existing contract provides that, upon change from the initial stage of development of the Project, the User shall have the prior right, subject to any required approval of appropriate State authorities, to negotiate a new contract for use of storage space then available for water supply purposes, with the new contract providing for appropriate modification in quantity, elevation and annual payment; and further provides that, in determining the allocable charges to be specified in the new contract, due consideration will be given to the amount of reimbursement which has already been made to the Government at that time; and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply by Section 79 of the Water Resources Development Act of 1974 (PL 93-251), approved 7 March 1974, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 390b-f); and

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

NOW, THEREFORE, upon approval of this contract by the Secretary of the Army, Contract No. DA-34-066-CIVENG-66-68 is hereby terminated, and the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.312 percent (estimated to contain 1,590 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply. 18.868 percent (an estimated 300 acre-feet, designated as Storage Space No. 1, initial development) of the space which User has a right to utilize is provided by the existing contract and 81.132 percent (an estimated 1,290 acre-feet, designated as Storage Space No. 2, ultimate development) is for use beginning on 1 May following the approval of this contract.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 USC 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights reserved. The Government reserves the right to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project, including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with state laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government such share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the

User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Project Investment Costs.

(1) The User shall repay the Government, at the times and with interest on the unpaid balance as hereinafter specified, the amounts stated below which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the entire actual amount of the construction costs, including interest during construction, allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest during construction and interest on the unpaid balance was determined by the Secretary of the Treasury as of the beginning of the fiscal year in which construction of the initial and ultimate development stage of the Project were initiated, on the basis set forth in the Water Supply Act of 1958, as amended. For initial development stage of the Project, this interest rate is 2.544 percent, and for the ultimate development stage it is 3.225 percent. The User shall repay:

0.109 percent of the total Project joint-use construction costs	\$ 47,420.00
Interest during construction	\$ 3,980.00
Subtotal	\$ 51,400.00
Less credit for payments on principal made under Contract No. DA-34-066-CIVENG-66-68 thru 1 May 1985	\$ -2,911.28
Total remaining unpaid amount of Project investment costs	\$ 48,488.72

The entire Project investment cost allocated to water supply to be paid under this contract will be divided into Storage Space Numbers 1 and 2 defined herein as follows:

Storage Space No. 1 - 300 acre-feet (initial development)	\$ 6,788.72
Storage Space No. 2 - 1,290 acre-feet (ultimate development)	\$ 41,700.00
Total	\$ 48,488.72

CONTRACT BETWEEN THE UNITED STATES OF AMERICA

AND

CITY OF CLAREMORE, OKLAHOMA

FOR

WATER STORAGE SPACE IN OOLOGAH LAKE

THIS CONTRACT, entered into this 4th day of June, 1988, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and the CITY OF CLAREMORE, OKLAHOMA (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, pursuant to Public Law 761, 75th Congress, 3d Session approved 28 June 1938, as amended by the River and Harbor Act approved 24 July 1946, (Public Law 525, 79th Congress, 3d Session) and Section 79 of the Water Resources Development Act of 1974 (Public Law 93-251), approved 7 March 1974 the Government has constructed and is operating and maintaining Oologah Lake on the Verdigris River, Oklahoma, (hereinafter called the "Project"); and

WHEREAS, the User desires to contract with the Government for the use of storage included in the Project for municipal and industrial water supply, and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 U.S.C. 390b-f); and

WHEREAS, the User is empowered to contract with the Government and is vested with all necessary powers for accomplishment of the purposes of this contract;

NOW, THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, has designed and constructed the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.087 percent (estimated to contain 445 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 638.0 feet National Geodetic Vertical Datum and 592.0 feet National Geodetic Vertical Datum, which usable conservation storage space is estimated to contain 510,600 acre-feet after adjustment for sediment deposits. This storage space

is to be used to impound water for present demand or need for municipal and industrial water supply.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in accordance with the provisions of 10 U.S.C. 2669 and other such authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights Reserved. The Government reserves the right to control and use any future water supply storage and/or any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the Contracting Officer, the findings of such survey indicate any Project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and

described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation, and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location, and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

EXHIBIT C

STANDING INSTRUCTIONS TO PROJECT MANAGER

OOLOGAH LAKE

EXHIBIT C
STANDING INSTRUCTIONS TO PROJECT MANAGER
OOLOGAH LAKE

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
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I - GENERAL

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	b. Data Reporting Instructions	C-1
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	e. Frequency of Gate Changes	C-4

II - REGULATION PROCEDURES

1	Regulating River Stages and Discharges	C-5
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EXHIBIT C

STANDING INSTRUCTIONS TO PROJECT MANAGER

OOLOGAH LAKE

I. GENERAL

1. Instructions. Detailed instructions to the project personnel at Oologah Lake are presented below.

a. Operation. During flood periods, the lake will be regulated following the normal regulations for flood control operation as directed in subparagraph 7-05a. Instructions for the storage and discharge of floodwater will be issued by the Water Control Section. In the event communication with the Tulsa District Office is disrupted, the lake regulation will become the responsibility of the Project Manager and will be regulated according to subparagraph 7-05b of this manual or paragraph 3 of section II of this exhibit. In addition, the Project Manager will immediately attempt to reestablish communications with the Tulsa District Office. The Project Manager will make daily observations of the weather station and lake conditions and report those observations as directed by the Water Control Section. Should an emergency occur in which communication is not lost, such as an inoperable gate, drowning accident, excessive trash in gates, broken buoy line, or power outages, the Water Control Section will be notified immediately.

b. Data Reporting Instructions. Most of the daily lake data from Oologah Lake (see plate 5-3) will be obtained from the WCDS database. Weather data and other data collected by the Oologah Lake Project will be submitted to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7103 or VHF-FM radio, call signal WUI-3 Hydrology). The Water Control Section office is manned from 7:00 a.m. to 4:30 p.m. daily and various hours on weekends and holidays. Data for nonworking days will be read and submitted the following workday. Should unusual conditions arise during nonworking hours, one of the persons listed on page i should be contacted. The following data should be included in the daily report.

(1) As of 8:00 a.m. Each Weekday.

a. The current lake clarity and weather condition.

b. The total precipitation amounts for the previous 24-hour periods (7:00 a.m. to 7:00 a.m.) including the amounts for the 6-hour periods ending at 1:00 p.m., 7:00 p.m., 1:00 a.m., and 7:00 a.m., and the starting and ending times.

c. The pan evaporation in inches for the previous 24-hour period (7:00 a.m. to 7:00 a.m.) or for the period since the last evaporation reading was taken.

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

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

f. Report 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.

(2) As of 8:00 a.m. Each Monday.

a. The same data as required in a. above.

b. Report 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 Monday, then these readings can be taken on the next day that weather permits.

c. The current tailwater elevation if available.

(3) Weekends and Holidays.

a. Daily reports are not required on weekends and holidays except during flood periods.

b. During flood periods, weekend and holiday reports should include the same data as required in a. above plus the 8:00 a.m. pool elevation from the pool gage.

(4) During Flood Periods. Besides the data in a. and b. above, additional reports of lake elevations may be requested by the Water Control Section personnel during flood periods.

(5) Rainfall Reports. Rainfall reports will be made as follows:

a. At 8:00 a.m. all precipitation that occurred during the preceding 24 hours (7:00 a.m. to 7:00 a.m.) as shown on plate 5-3 (covered by routine report on working days).

b. At 1:00 p.m. when 0.50 inch or more of precipitation has occurred since 7:00 a.m. and no 1:00 p.m. report was made, or if it has continued to rain since 7:00 a.m.

c. At 7:00 p.m. when 0.50 inches or more precipitation has occurred since 7:00 a.m. and no 1:00 p.m. report was made, or if it has continued to rain since reporting at 1:00 p.m.

d. Report at once the occurrence of 2.00 inches or more of precipitation that occurs during a period six hours or less. During nonworking hours, the report should be made to one of the persons listed on page i.

c. Reporting Unusual Events. Events or conditions not normally encountered in the routine operation of the dam and lake that might endanger the dam or require temporary or permanent revision of the operating procedures such as a 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 indication of an impending movement; or an occurrence showing any degree of jeopardy to the safety of the dam or to the safety of the public will be reported promptly to the Water Control Section, Hydrology-Hydraulics Branch.

d. Warnings. It is the responsibility of the Project Manager and project personnel authorized to make gate changes, to maintain a list in current status of residents and/or property owners who would be endangered or inconvenienced by large and/or prolonged releases. This list will be attached to the Project Manager's file copy of this manual. If damaging releases are expected to occur, notification will be made by telephone or oral warning by the Corps employees. Notification will be made according to the Tulsa District supplements to ER-500-1-1. This would include radio, television, telephone, Citizen Band radio, use of law enforcement and Civil Defense agencies and their communication systems, National Guard and Reserve Units, supplemented by oral warning from Corps employees in Government vehicles. Studies have been made to determine the possible downstream flood conditions that could exist in case 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 can be found in the Oologah Dam, Operation and Maintenance Manual, Volume II, dated October 1982. Always when a gate change is made a horn is blown to give warning to people immediately downstream who are within hearing distance of the horn blast.

e. Frequency of Gate Changes. During flood periods, gate changes may be directed by the Water Control Section anytime. The initial transition from low flow releases 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 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 30,000 cfs is not to be exceeded as far as practicable. Floodwaters will be released as rapidly as practicable with consideration given to reducing flooding of low-water crossings and low-lying farmland. Factors considered in the determination of releases are: the season of the year with respect to the probability of floods, status of crops in low-lying farmlands, and minimum stages or discharges.
2. Normal Regulation of Flood Control Operations Oologah Lake will be regulated for optimum flood reductions on the Verdigris from the dam to its confluence with the Arkansas River and with the existing system of lakes on the Arkansas River and tributaries from the confluence to Van Buren, Arkansas. The following regulations, as shown in Table 7-1, will govern releases from Oologah Lake. During flood control regulation the tainter gates and conduit gates are to be operated at uniform settings with a no more than a 1-foot difference in opening between gates of like type.
3. Emergency Flood Control Regulations When communication with the Tulsa District Office is disrupted, the Project Manager will, on his own initiative, direct regulation of the lake according to the schedule shown on Table C-2 until communication is restored. In addition, the Project Manager will make every effort to reestablish communication with the Tulsa District Office. Plate 7-2 will be used by the project manager during emergency flood operations to determine the 4-hour inflow. Using this inflow, a release will be determined from plate 7-1. Plate 7-10 has been included to meet HQUSACE requirements and should only be used as a last resort. Use of this plate will direct releases to be made which are much greater than necessary. The spillway gates will be operated at uniform openings as discussed in paragraph 2.
4. During Emergency Events. The Project 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 the dam or to avoid serious hazards to life. Such actions will be immediately reported by the fastest means of communication available. Actions will be confirmed in writing the same day to the Water Control Section and will include justification for the action. Continuation of the deviation will require the express approval of the Water Control Section.

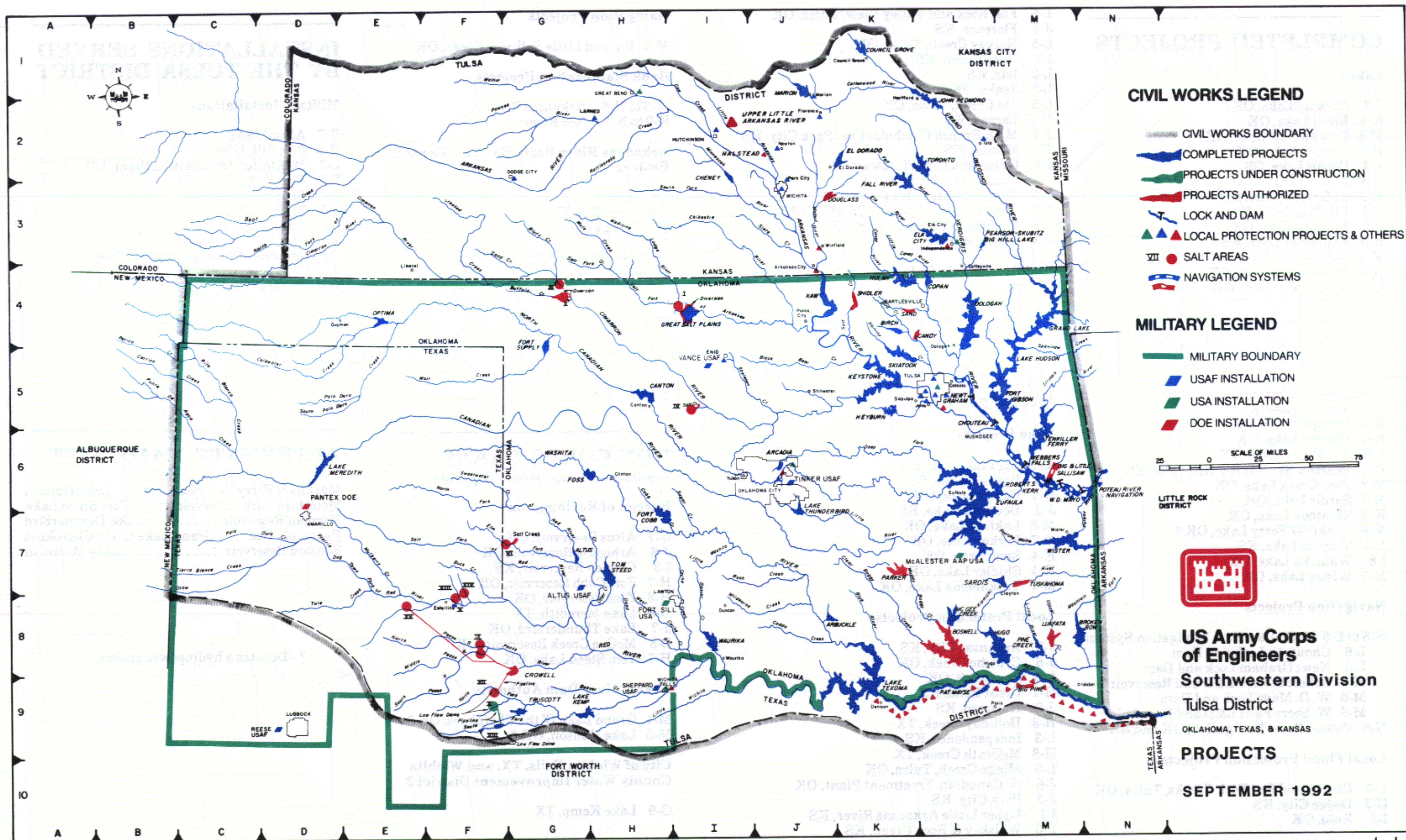
TABLE C-2
EMERGENCY FLOOD CONTROL REGULATION SCHEDULE
OOLOGAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
Below 638.0	Rising	Continue the releases being made at the time of communication failure.
638.0 to 666.0	Rising	If the lake level is below elevation 656.5, maintain current releases until communication is restored. If, after 12 hours, communication has not been restored, or the pool is above or rises to elevation 656.5 anytime within the 12-hour period, determine inflows following plate 7-2 (Inflow Nomograph) and go on to plate 7-1 (Spillway Gate Regulation Schedule-Inflow Parameter) to determine required releases. The rate of rise of the lake and the average discharge will be computed every 4 hours for the preceding 4 hours. Never when the lake is rising will releases be decreased. If after the 12-hour delay, the lake level becomes static and releases are less than 1000 cfs, then releases will be increased to 1000 cfs immediately.
666.0 or above	Rising	Releases will be increased by raising the spillway gates in one foot increments to maintain the lake at elevation 666.0 or until all gates are fully open. After the spillway gates have been fully opened and the pool is still rising, the conduit gates will be raised in 2 foot increments until the lake stops rising or the conduit gates are fully open.
666.0 or above	Falling	Maximum gate openings attained will be maintained until the lake level recedes to elevation 666.0.

TABLE C-2 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
666.0 - 661.0	Falling	The maximum spillway gate opening attained will be held until the lake level recedes an amount sufficient to permit lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise, set the gates back to the previous opening. A margin of not less than one-fourth foot between the lake level and the top of the spillway gates will be maintained at all times. This operation will be repeated until the lake level reaches elevation 661.0 or the release is 30,000 cfs.
661.0 - 640.0	Falling	If the maximum release rate exceeded 30,000 cfs, releases will be adjusted by lowering the spillway gates one-half foot without causing the pool to rise. If the pool begins to rise, set the gates back to the previous opening. This operation will be repeated until the release is 30,000 cfs. If the maximum release was much lower than 30,000 cfs this release will be maintained until the lake level reaches 640.0.
640.0 - 638.0	Falling	Begin a gradual reduction of the release rate (not to exceed 5,000 per 3-hr period) so that releases are equal to inflow (the pool is steady) at elevation 638.0.

PLATES



COMPLETED PROJECTS

Lakes

J-6 Arcadia Lake, OK
K-4 Birch Lake, OK
M-8 Broken Bow Lake, OK *
H-5 Canton Lake, OK
L-4 Copan Lake, OK
K-1 Council Grove Lake, KS
K-2 El Dorado Lake, KS
L-3 Elk City Lake, KS
L-6 Eufaula Lake, OK
K-3 Fall River Lake, KS *
M-5 Fort Gibson Lake, OK *
G-4 Fort Supply Lake, OK
I-4 Great Salt Plains Lake, OK
K-5 Heyburn Lake, OK
M-8 Hugo Lake, OK
K-4 Hulah Lake, OK and KS
L-2 John Redmond Dam and Reservoir, KS
J-4 Kaw Lake, OK
K-5 Keystone Lake, OK *
K-9 Lake Texoma, OK and TX *
J-2 Marion Lake, KS
L-5 Oologah Lake, OK
E-4 Optima Lake, OK
L-9 Pat Mayse Lake, TX
L-3 Pearson-Skubitz Big Hill Lake, KS
M-8 Pine Creek Lake, OK
M-7 Sardis Lake, OK
K-5 Skiatook Lake, OK
M-6 Tenkiller Ferry Lake, OK *
L-2 Toronto Lake, KS
I-8 Waurika Lake, OK
M-7 Wister Lake, OK

Navigation Projects

N-6 to L-5 McClellan-Kerr Navigation System
L-6 Chouteau Lock and Dam
L-5 Newt Graham Lock and Dam
M-6 Robert S. Kerr L&D and Reservoir *
M-6 W. D. Mayo Lock and Dam
M-6 Webbers Falls L&D and Reservoir *
N-6 Poteau River Navigation, OK and AR

Local Flood Protection Projects

L-5 Cherry and Red Fork Creeks, Tulsa, OK
G-2 Dodge City, KS
I-5 Enid, OK

L-5 Flat Rock and Valley View, Tulsa, OK
J-2 Florence, KS
L-5 Haikey Creek, Tulsa, OK
I-2 Hutchinson, KS
L-2 Iola, KS
L-5 Jenks, OK
L-5 Joe Creek, Tulsa, OK
N-2 Larned, KS
J-3 Main Branch Chisholm Crk, Park City, KS
J-2 Marion, KS
J-6 Oklahoma City Floodway, OK
J-2 Sand Creek, Newton, KS
L-5 Tulsa & West Tulsa Levee, OK
J-3 West Branch Chisholm Creek, Wichita, KS
J-3 Wichita & Valley Center, KS
J-3 Winfield, KS

Red River Basin Chloride Control Projects

F-8 Area V, Estelline Springs
F-9 Area VIII & Truscott Brine Lake

OTHER AUTHORIZED PROJECTS

Lake Projects

M-9 Big Pine Lake, TX
L-8 Boswell Lake, OK
K-4 Candy Lake, OK
J-3 Douglass Lake, KS
M-8 Lukfata Lake, OK
K-7 Parker Lake, OK
K-4 Sand Lake, OK
K-4 Shidler Lake, OK
M-7 Tuskahoma Lake, OK

Local Protection Projects

J-3 Arkansas City, KS
J-6 Crutcho Creek, OK
L-5 Fry Creek, OK
H-1 Great Bend, KS
J-2 Halstead, KS
H-8 Holliday Creek, TX
L-3 Independence, KS
H-8 McGrath Creek, TX
L-5 Mingo Creek, Tulsa, OK
J-6 N. Canadian Treatment Plant, OK
J-3 Park City, KS
I-1 Upper Little Arkansas River, KS
L-3 Whiskey & Rock Creek, KS

Navigation Projects

M-6 Big and Little Sallisaw Creek, OK

Bank Stabilization Projects

M-6 to N-6 Arkansas River
K-9 to N-9 Red River

Arkansas River Basin Chloride Control Project

I-4 Area I
G-4 Area II & III
I-5 Area IV

Red River Basin Chloride Control Project

G-7 Area VI
F-9 Area VII
F-8 Area IX
F-9 Area X
F-8 Area XIII
F-8 Area XIV
E-8 Area XV

NON-CORPS LAKES

(Corps of Engineers manages the flood control operations.)

Bureau of Reclamation

G-7 Altus Reservoir, OK
J-8 Arbuckle Reservoir, OK
I-3 Cheney Reservoir, KS
H-7 Fort Cobb Reservoir, OK
H-6 Foss Reservoir, OK
D-6 Lake Meredith, TX
J-7 Lake Thunderbird, OK
L-8 McGee Creek Reservoir, OK
H-7 Tom Steed Lake, OK

Grand River Dam Authority

M-4 Grand Lake O' the Cherokees, OK *
M-5 Lake Hudson, OK *

City of Wichita Falls, TX, and Wichita County Water Improvement District 2

G-9 Lake Kemp, TX

INSTALLATIONS SERVED BY THE TULSA DISTRICT

Military Installations

G-7 Altus USAF
H-8 Fort Sill, USA
L-7 McAlester Ammunition Plant, USA
D-9 Reese USAF
H-9 Sheppard USAF
J-6 Tinker USAF
I-5 Vance USAF

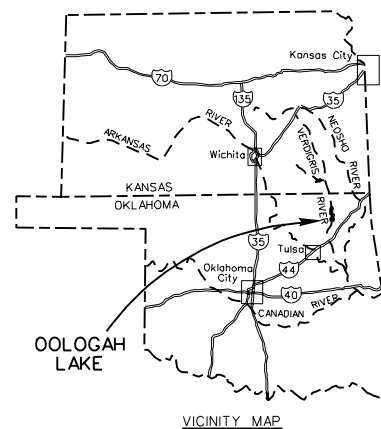
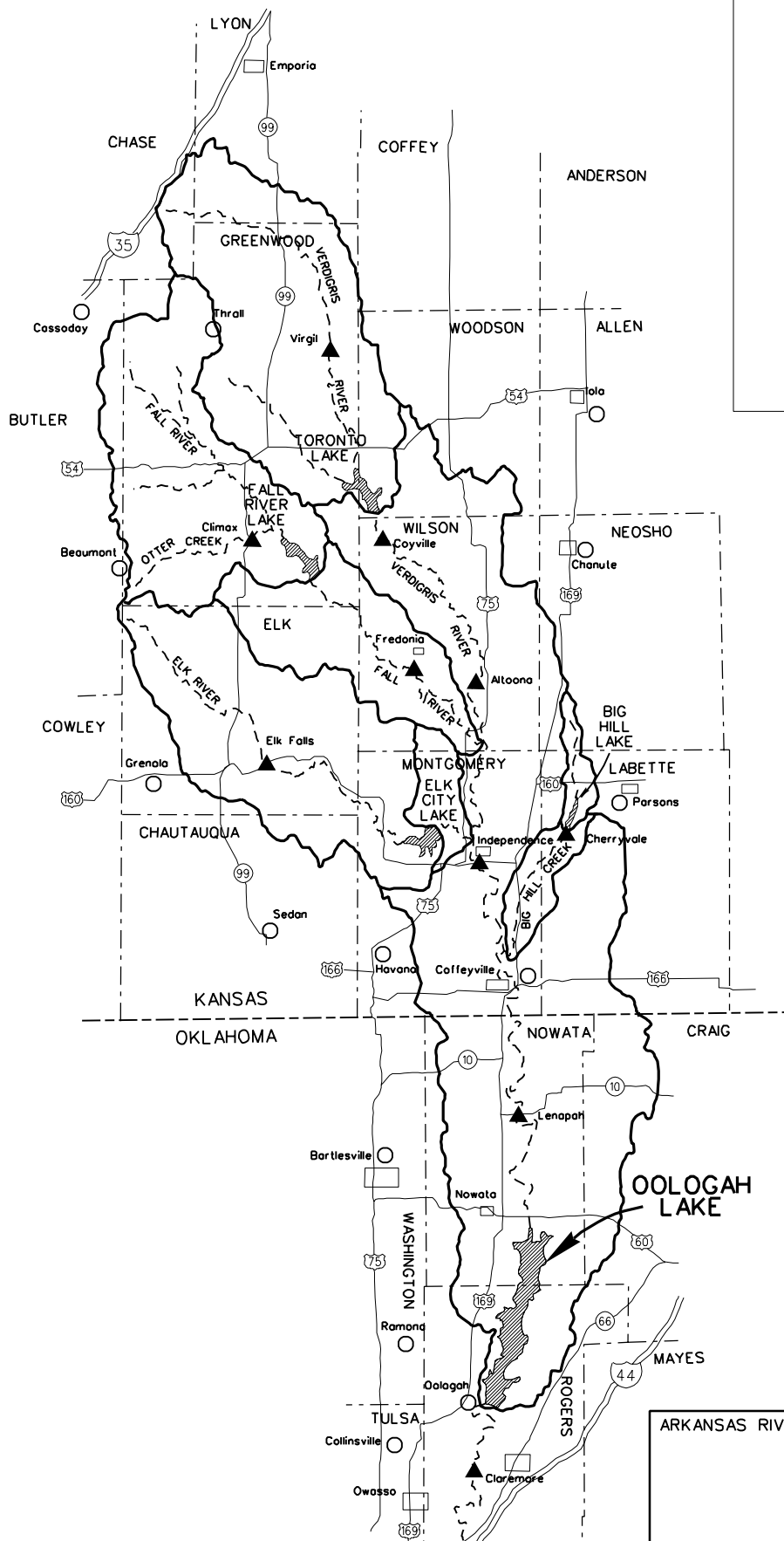
Department of Energy Installation

D-6 Pantex, TX

ALTERNATE NAME LIST

Markham Ferry Reservoir Lake Hudson
Mountain Park Reservoir Tom Steed Lake
Norman Reservoir Lake Thunderbird
Pensacola Res ... Grand Lake O' the Cherokees
Sanford Reservoir Lake Meredith

* - Denotes a hydropower project.



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

PROJECT LOCATION AND VICINITY MAP

(b) (7)(F)

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

GENERAL PLAN & SECTION

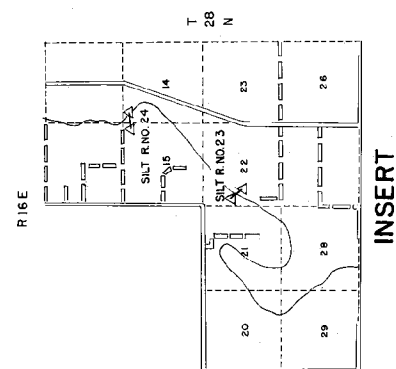
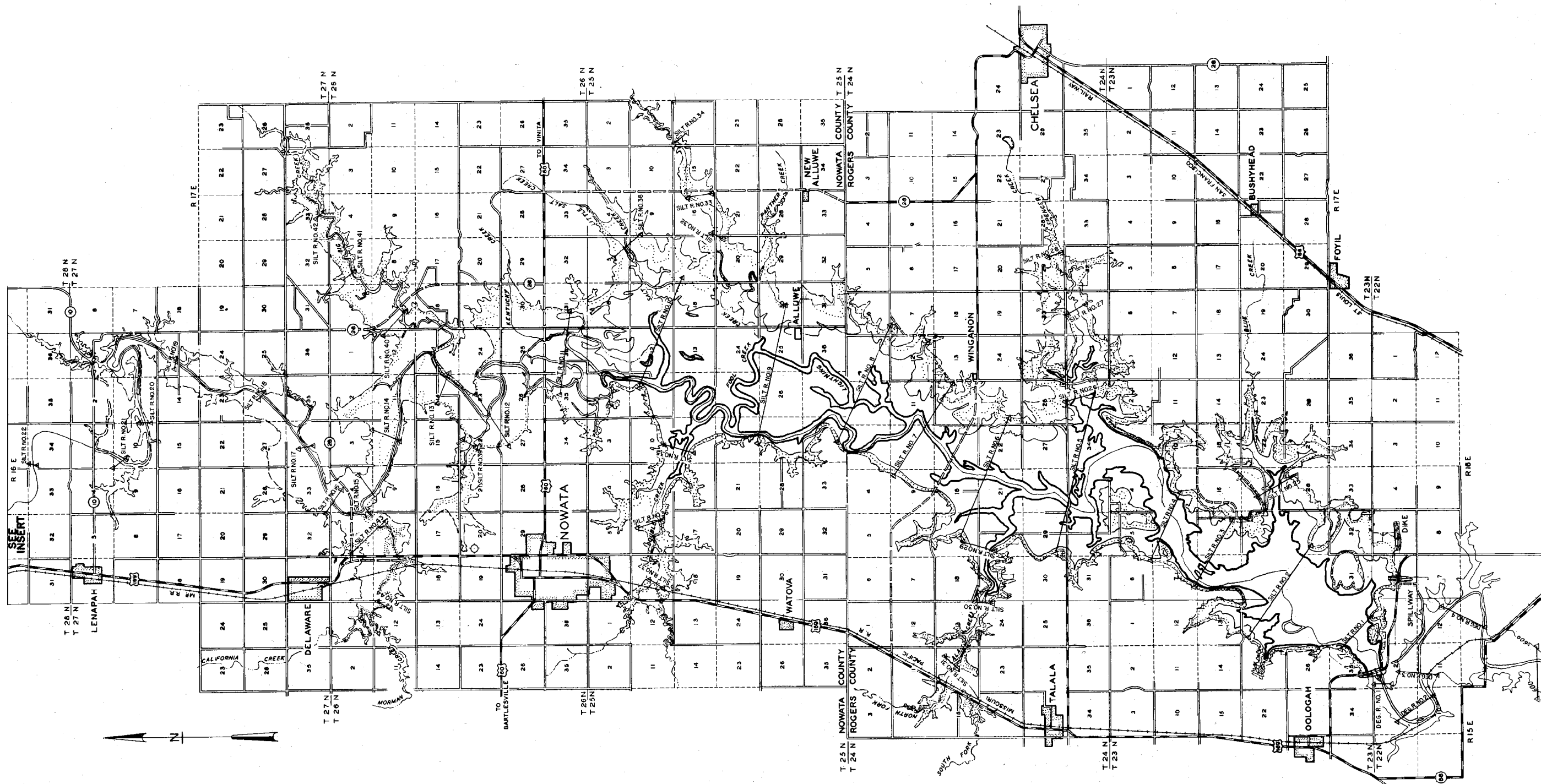
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1995
DRAWN: SKG
CHECKED: GDE

(b) (7)(F)

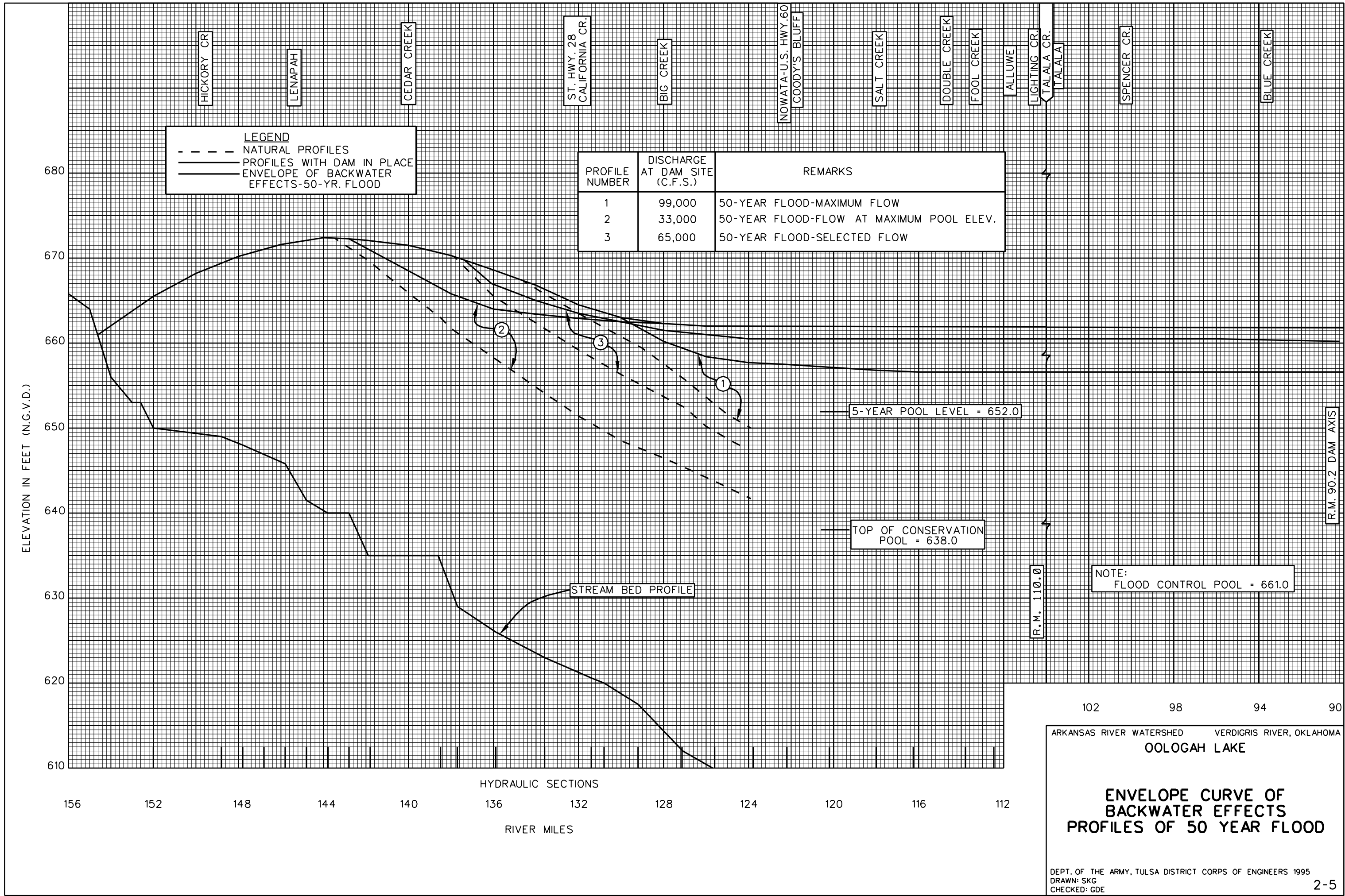
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

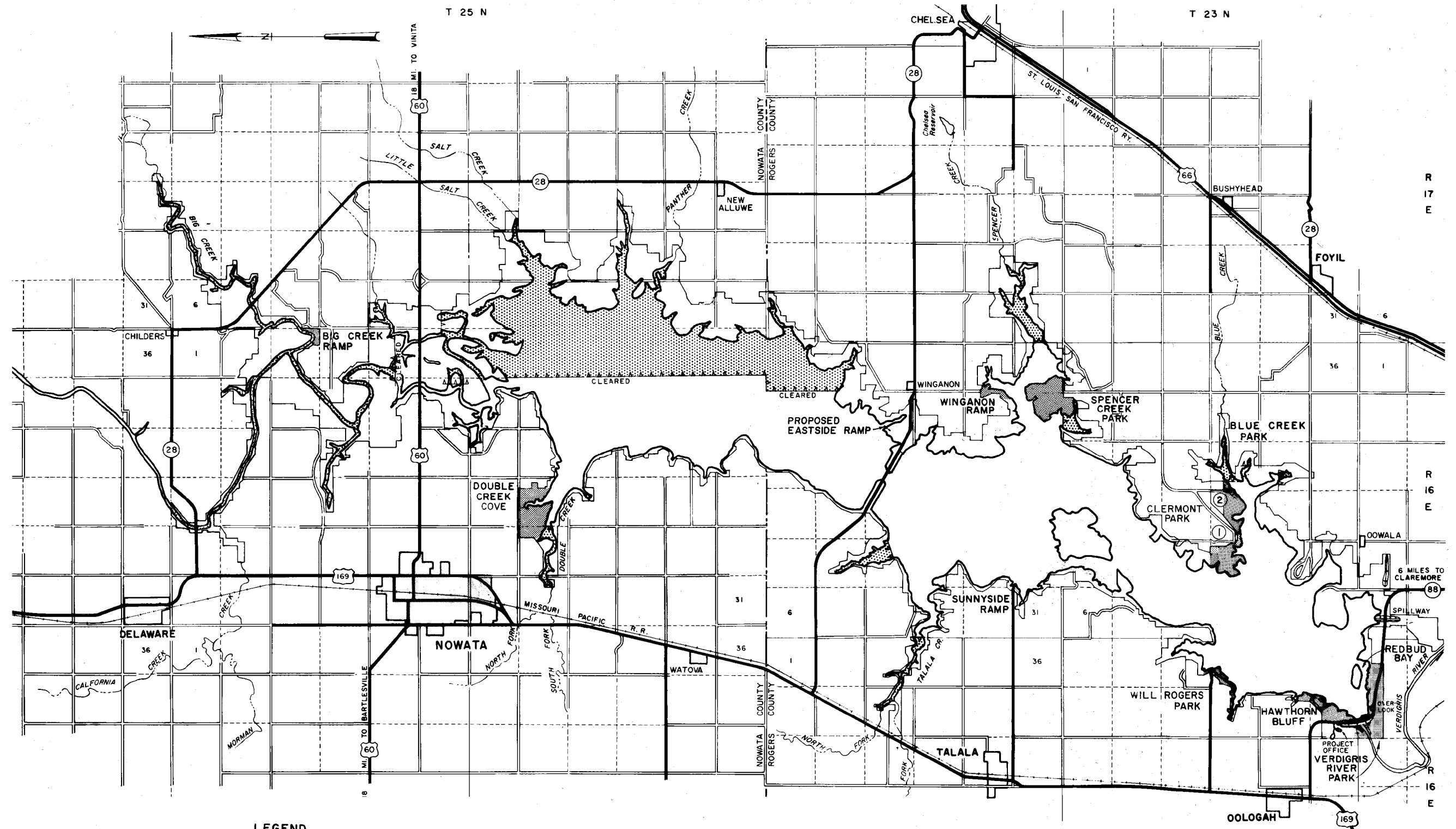
SECTION VIEW
OUTLET WORKS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: SKG
CHECKED: GDE



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE
SEDIMENTATION AND DEGRADATION RANGES





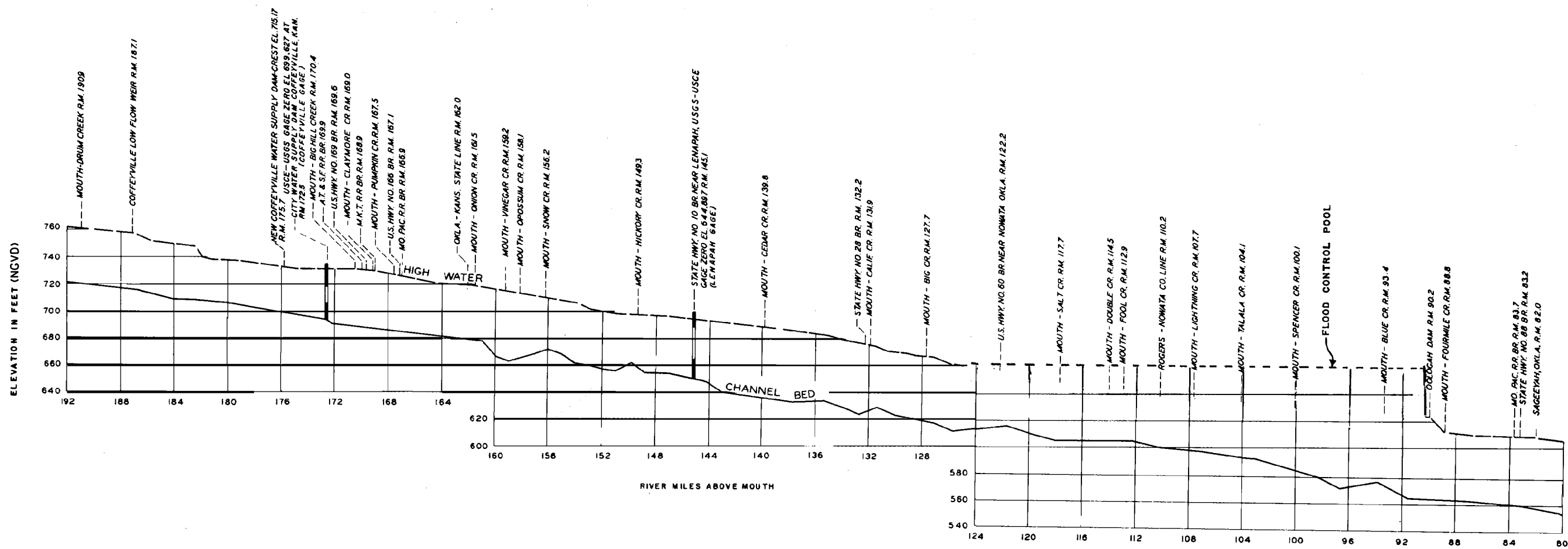
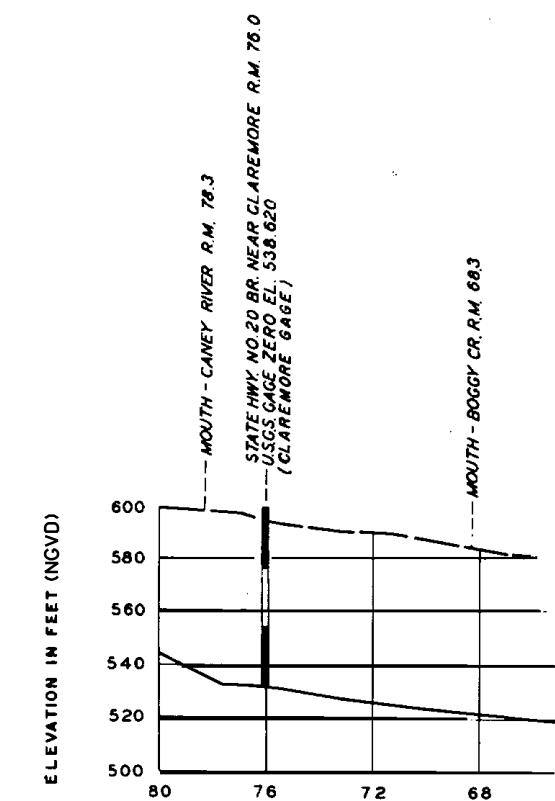
LEGEND

- | | | | |
|--|---|--|---|
| | DIVIDED HIGHWAY | | CONSERVATION POOL EL. 638.0 |
| | PAVED ROADS | | FLOOD CONTROL POOL EL. 661.0 |
| | GRAVEL ROADS | | 209 SHORE LINE MILES AT EL. 638.0 |
| | PROJECT BOUNDARY | | 29,500 APPROXIMATE ACRES AT CONSERVATION POOL |
| | PUBLIC USE AREAS | | |
| | AREA NOT CLEARED OF TIMBER AND OBSTRUCTIONS | | |

SCALE OF MILES
0 1 2

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

PUBLIC USE AREAS

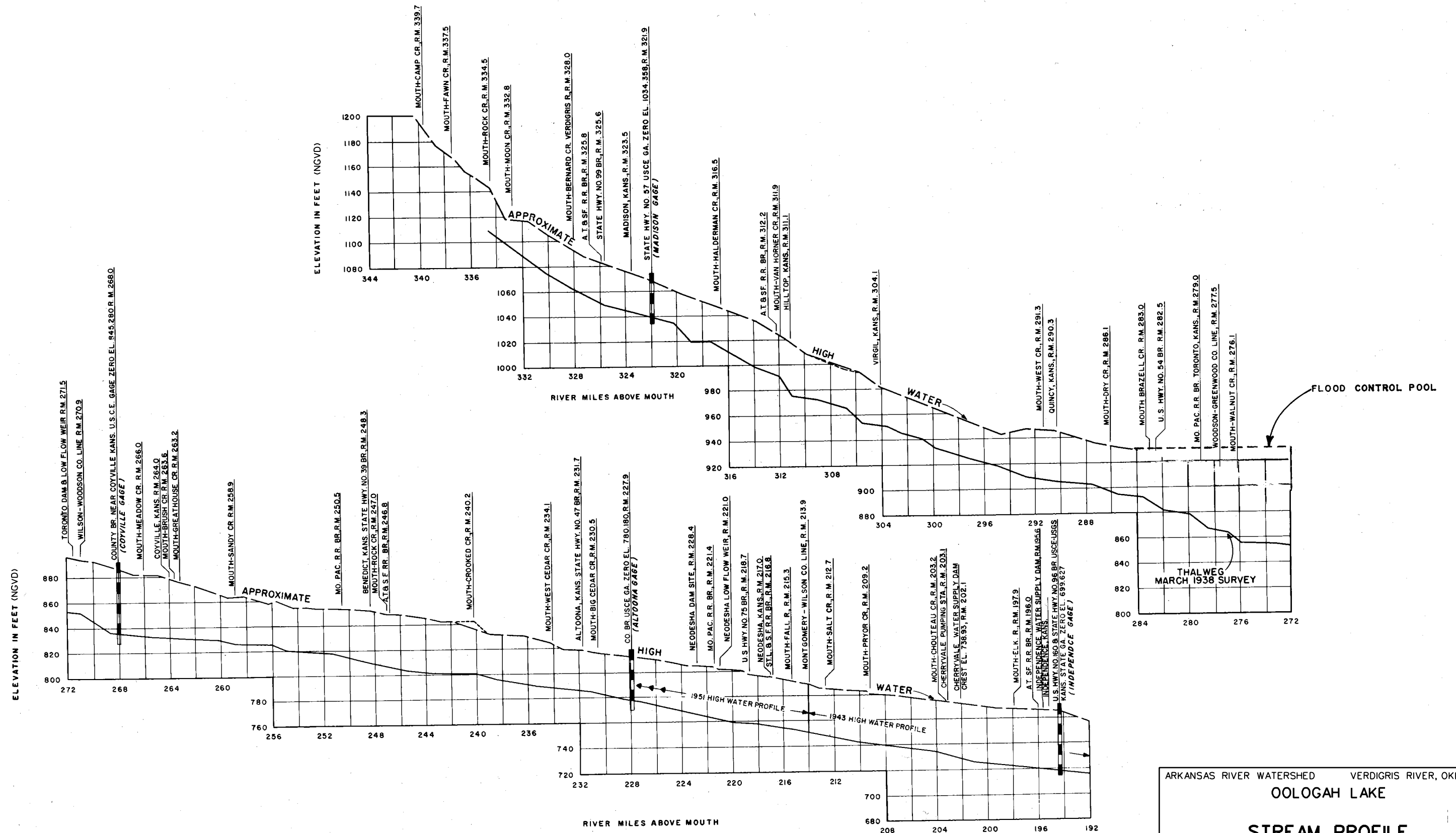


ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

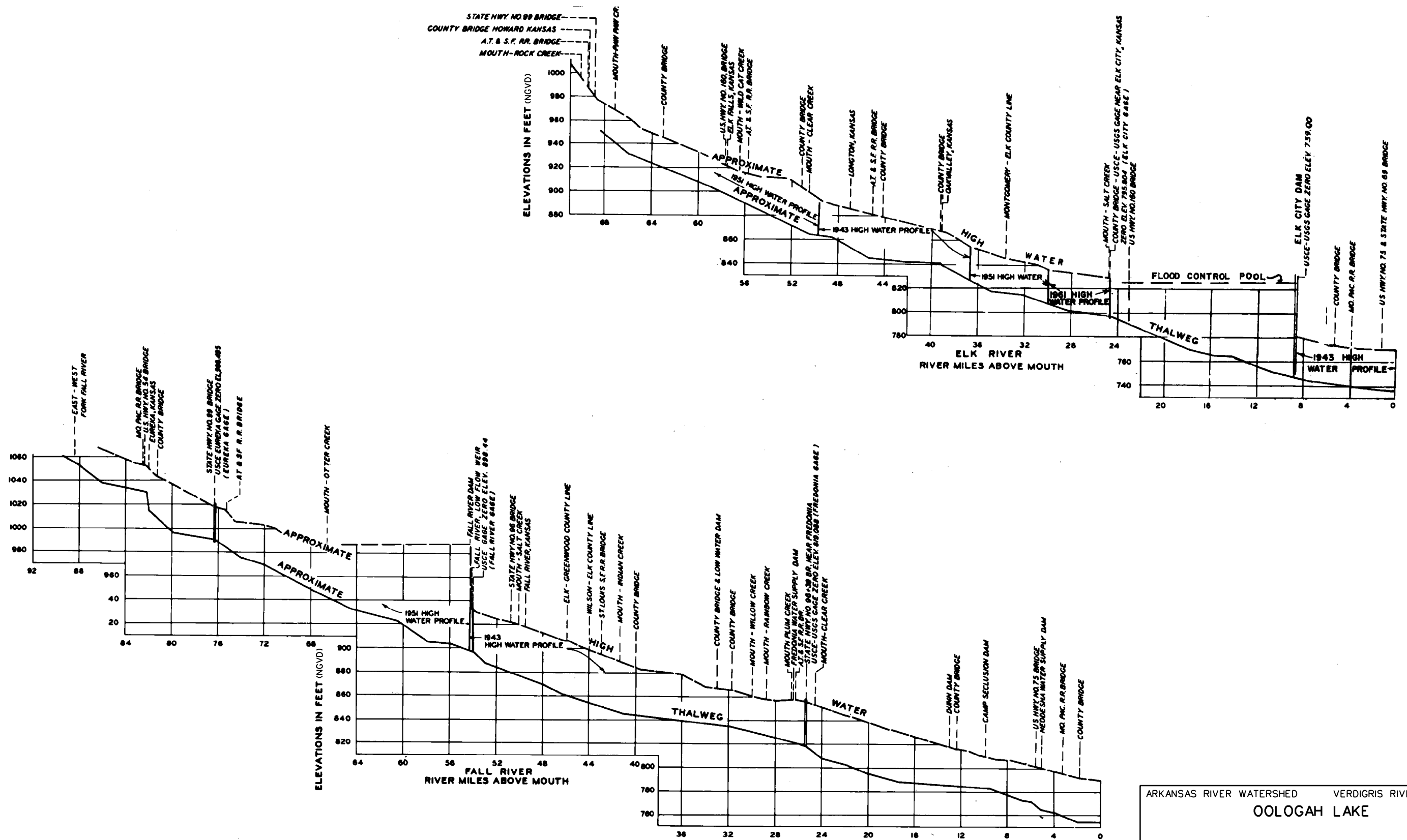
OOLOGAH LAKE

STREAM PROFILE VERDIGRIS RIVER

PLATE 1 OF 2



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE
STREAM PROFILE
VERDIGRIS RIVER
 PLATE 2 OF 2



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

STREAM PROFILE FALL RIVER & ELK RIVER

DISCHARGE IN 1000'S CFS

35
30
25
20
15
10
5
0

0

20

40

60

80

100

INFLOW CONDITIONS

OUTFLOW CONDITIONS

PERCENT OF TIME EQUALLED OR EXCEEDED

NOTE:

CURVE IS BASED UPON PERIOD
OF RECORD JANUARY 1940 THRU
DECEMBER 1993 FROM SUPER RUN
A95X09.

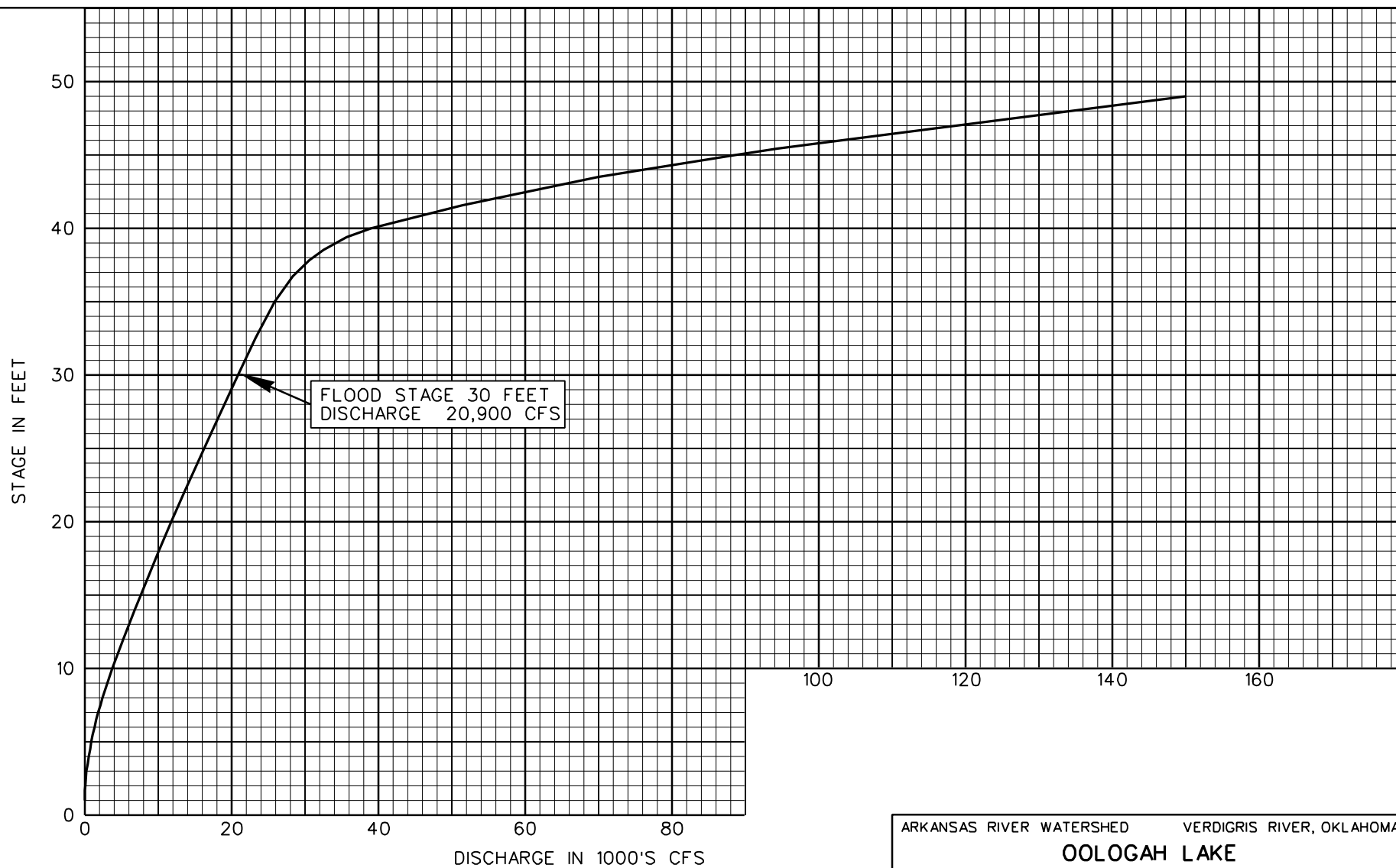
ARKANSAS RIVER WATERSHED

VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

FLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.

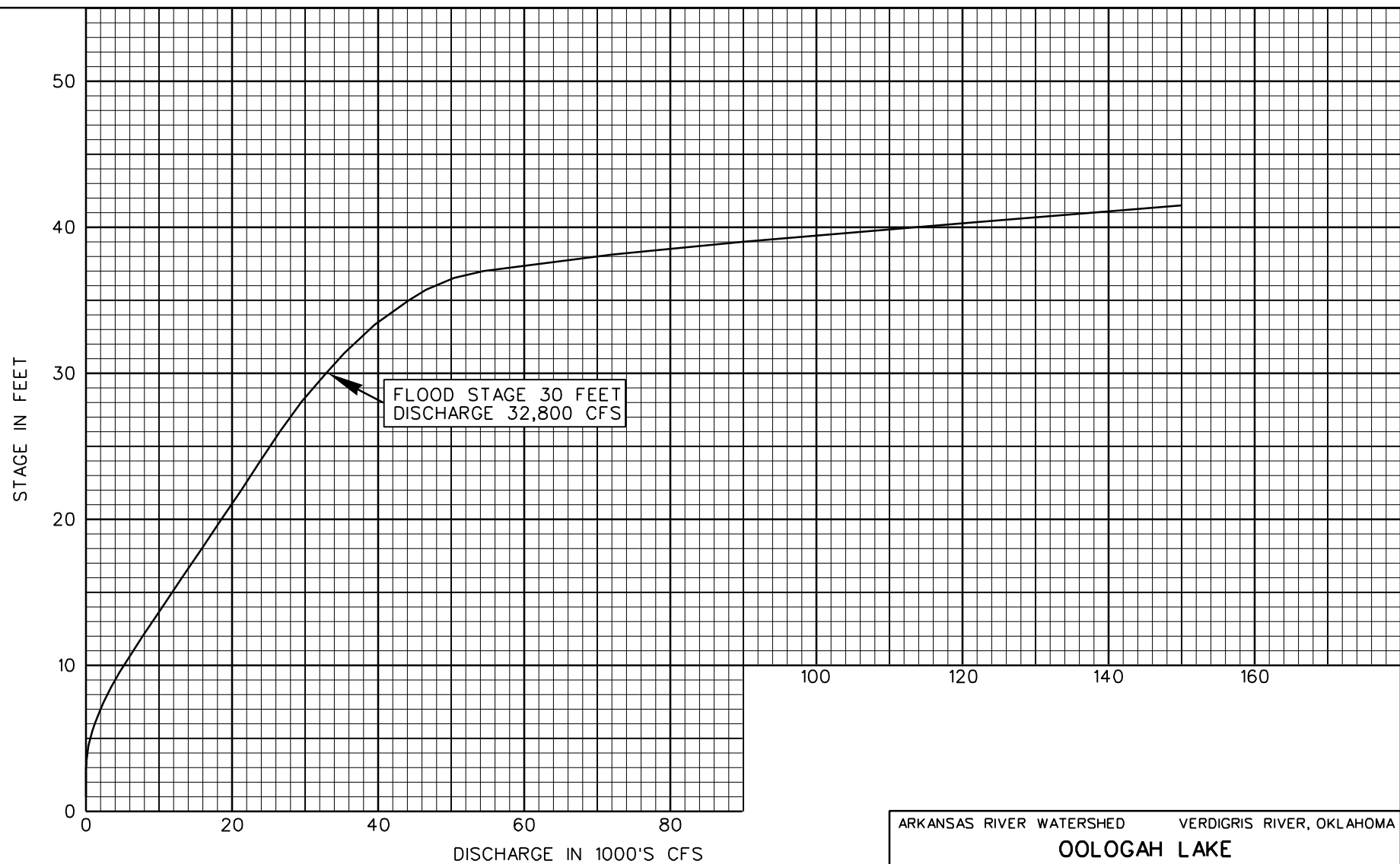


NOTE:
 CURVE IS BASED UPON RATING CURVE
 NUMBER 17, DATED OCTOBER 1, 1990
 AND SHIFT CURVE DATED DECEMBER 2, 1992.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

DISCHARGE RATING CURVE
 VERDIGRIS RIVER AT
 INDEPENDENCE, KANSAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1994
 DRAWN: G.D.E.
 CHECKED: R.W.B.

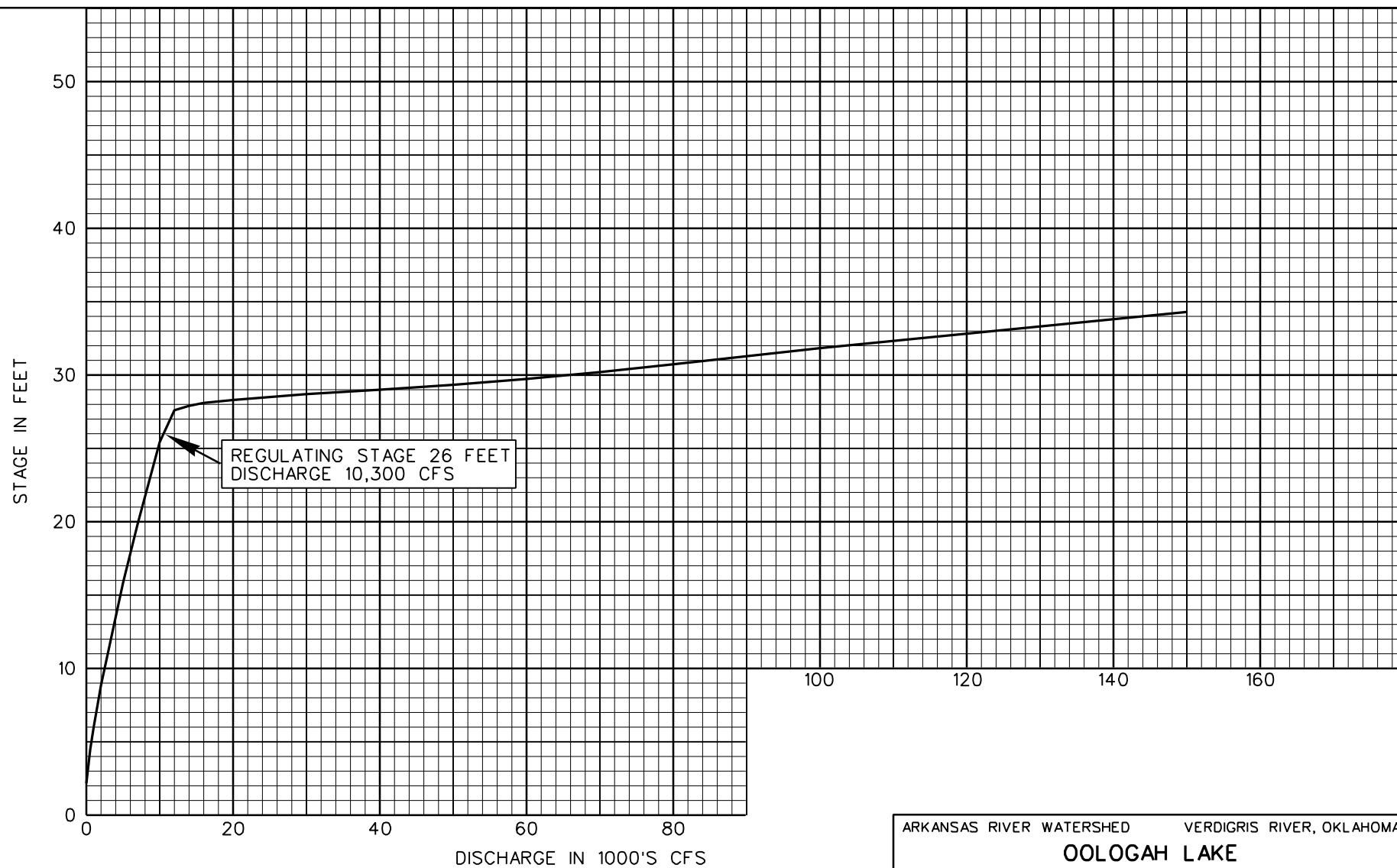


NOTE:
 CURVE IS BASED UPON RATING CURVE
 NUMBER 17, DATED OCTOBER 1, 1990
 AND SHIFT CURVE DATED OCTOBER 7, 1993.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

DISCHARGE RATING CURVE
 VERDIGRIS RIVER NEAR
 LENAPAH, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1994
 DRAWN: G.D.E.
 CHECKED: R.W.B.



NOTE:
CURVE IS BASED UPON RATING CURVE
NUMBER 26, DATED OCTOBER 1, 1994
AND SHIFT CURVE DATED JUNE 14, 1996.

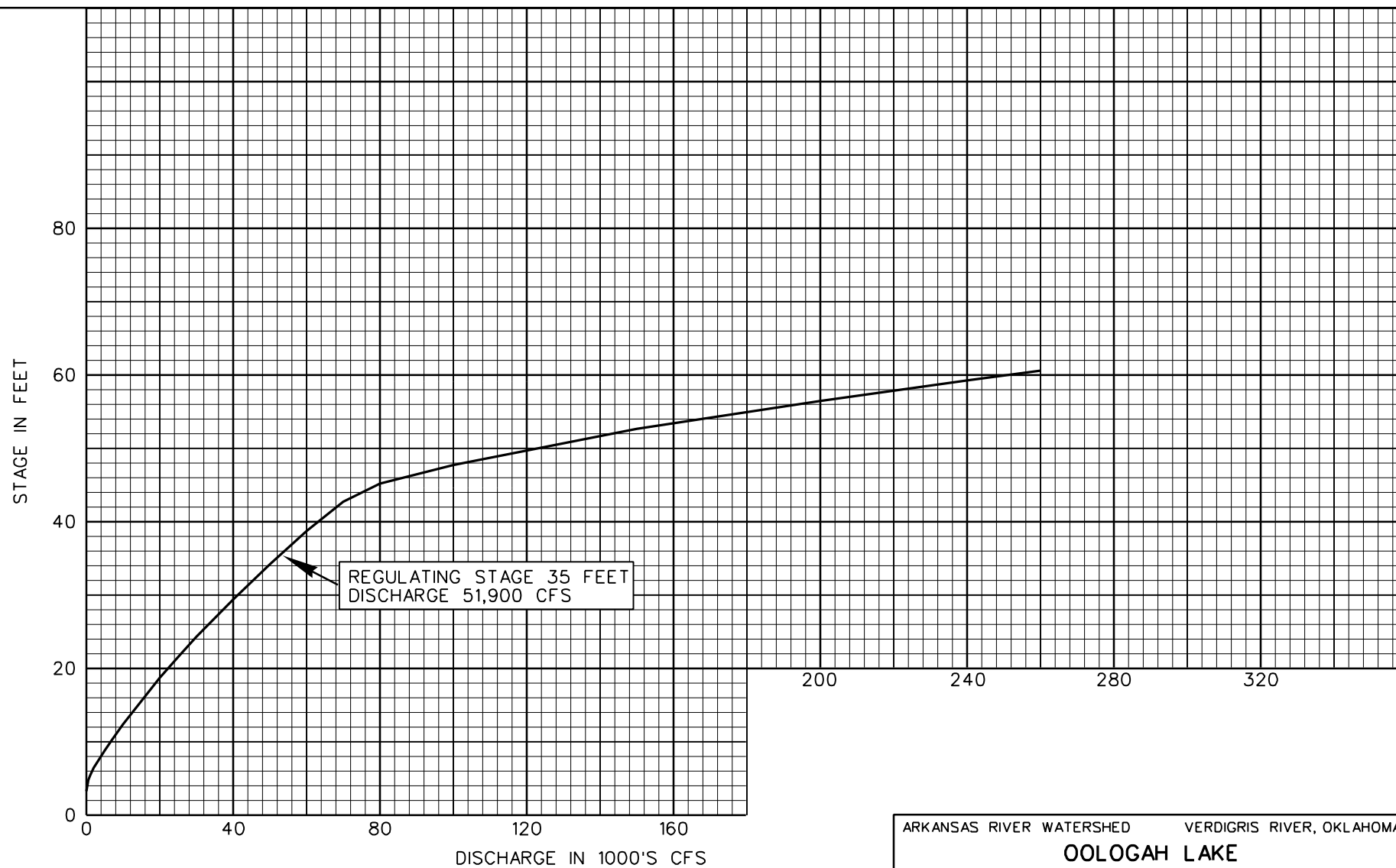
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

DISCHARGE RATING CURVE

CANEY RIVER NEAR
RAMONA, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.

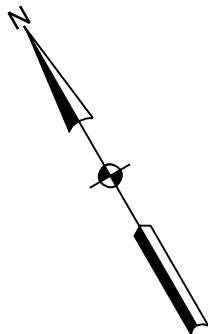


NOTE:
 CURVE IS BASED UPON RATING CURVE
 NUMBER 18, DATED OCTOBER 1, 1993
 AND SHIFT CURVE DATED SEPTEMBER 1, 1994.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

DISCHARGE RATING CURVE
 VERDIGRIS RIVER NEAR
 CLAREMORE, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
 DRAWN: G.D.E.
 CHECKED: R.W.B.

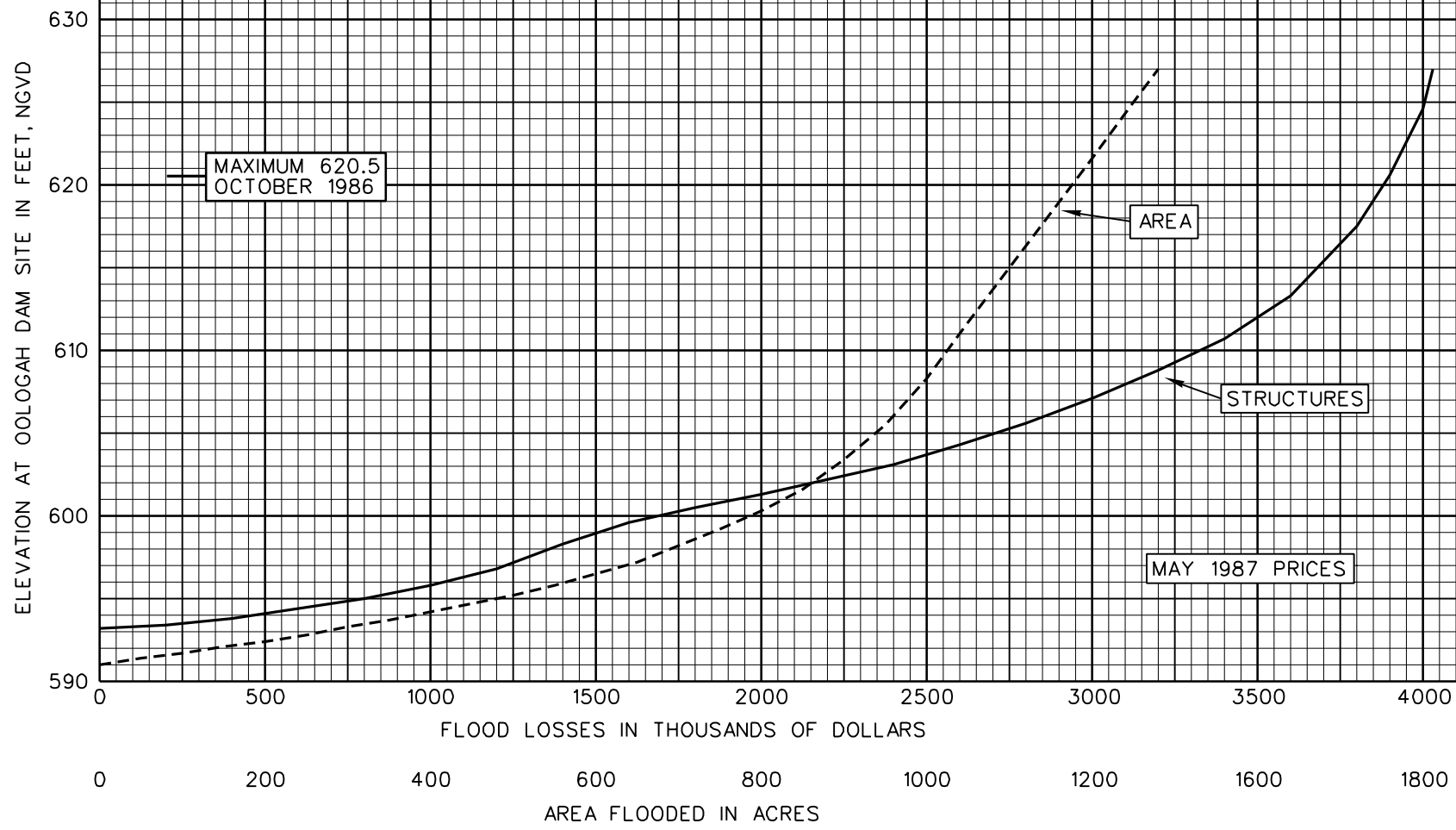


1. TIME OF TRAVEL IN HOURS
FOR LARGE RISES IS SHOWN:

2. TIME SHOWN ABOVE UPSTREAM STATION IS AVERAGE TIME TO CREST AFTER BEGINNING OF RUNOFF.

TIME OF CREST TRAVEL

4-9

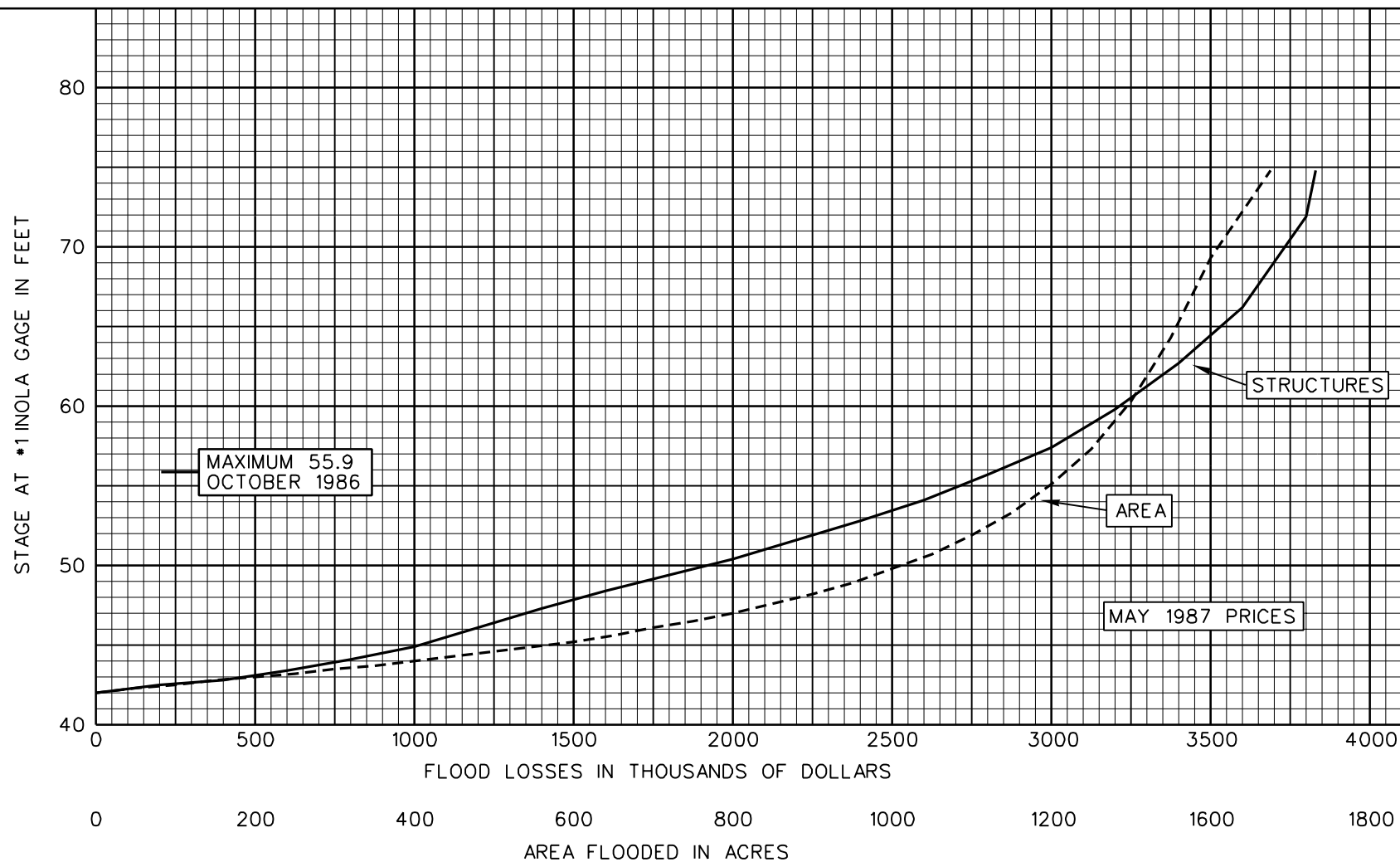


ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

**STRUCTURAL LOSS AND
AREA CURVES**

VERDIGRIS RIVER FROM
OOLOGAH DAM TO
CANEY RIVER CONFLUENCE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

STRUCTURAL LOSS AND AREA CURVES

VERDIGRIS RIVER FROM
CANEEY RIVER CONFLUENCE
TO BIRD CREEK CONFLUENCE

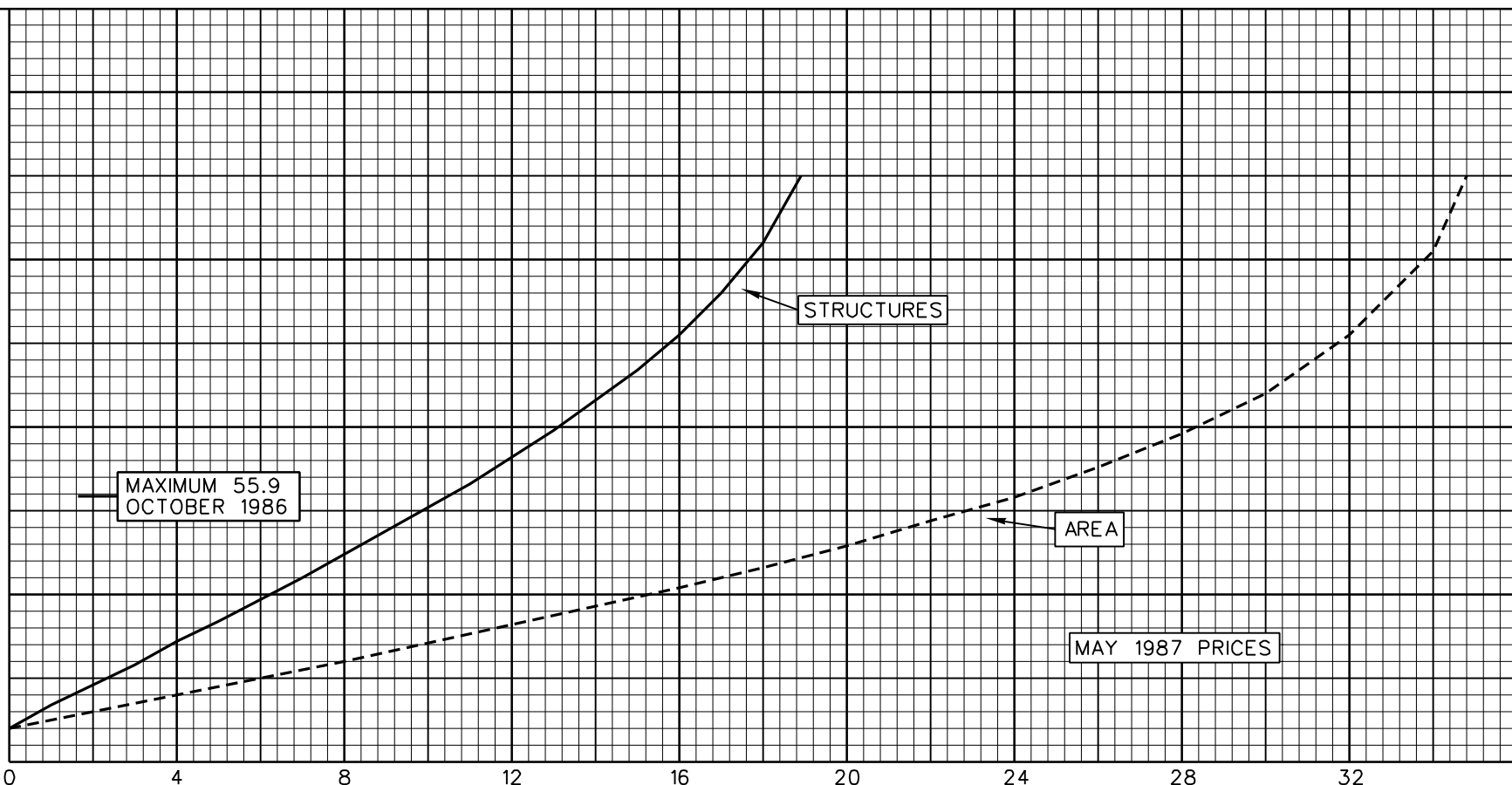
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996

DRAWN: G.D.E.

CHECKED: R.W.B.

STAGE AT #2 INOLA GAGE IN FEET

80
70
60
50
40



FLOOD LOSSES IN MILLIONS OF DOLLARS

0 1000 2000 3000 4000 5000 6000 7000 8000

AREA FLOODED IN ACRES

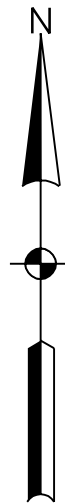
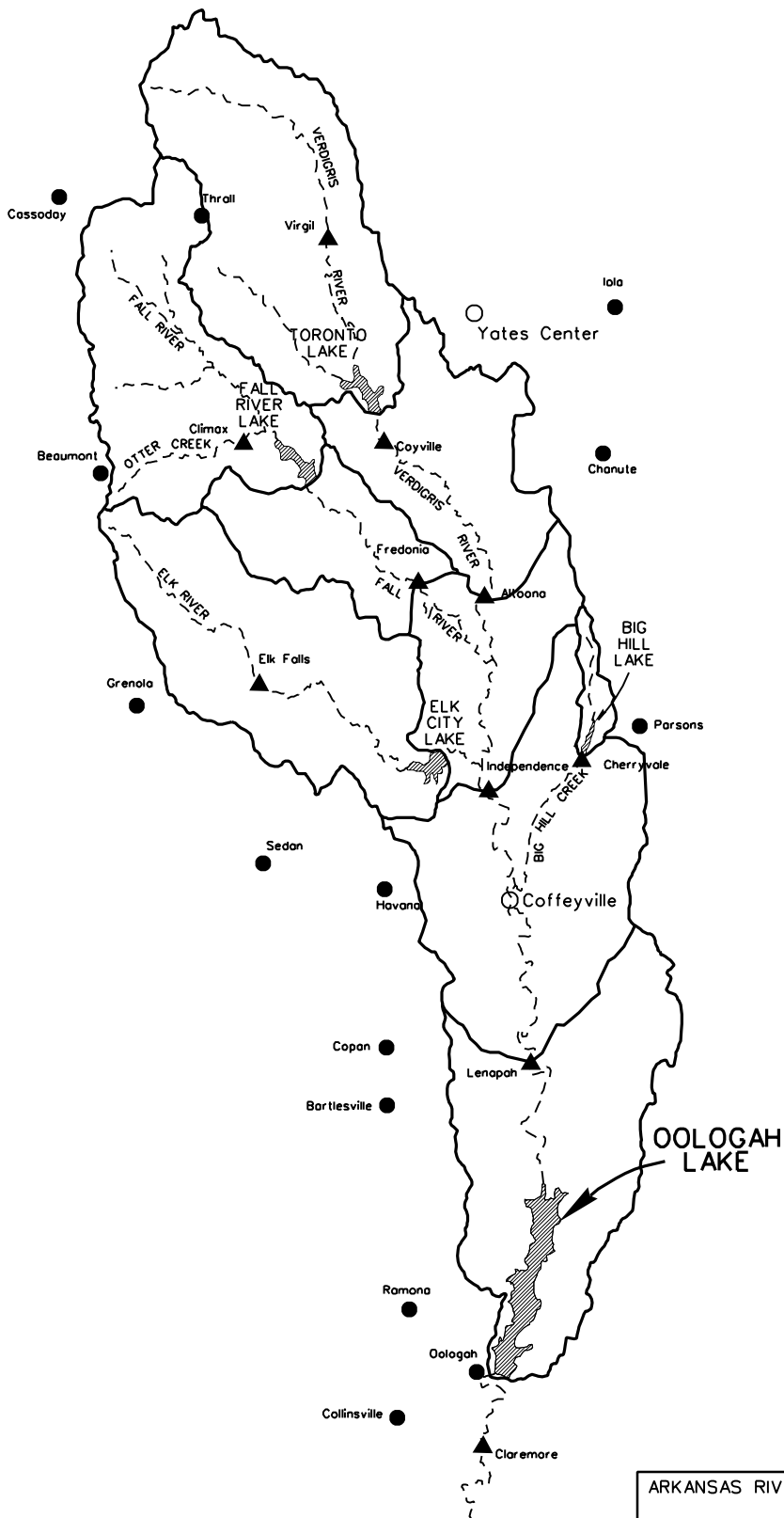
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

STRUCTURAL LOSS AND AREA CURVES

VERDIGRIS RIVER FROM
BIRD CREEK CONFLUENCE
TO ARKANSAS RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



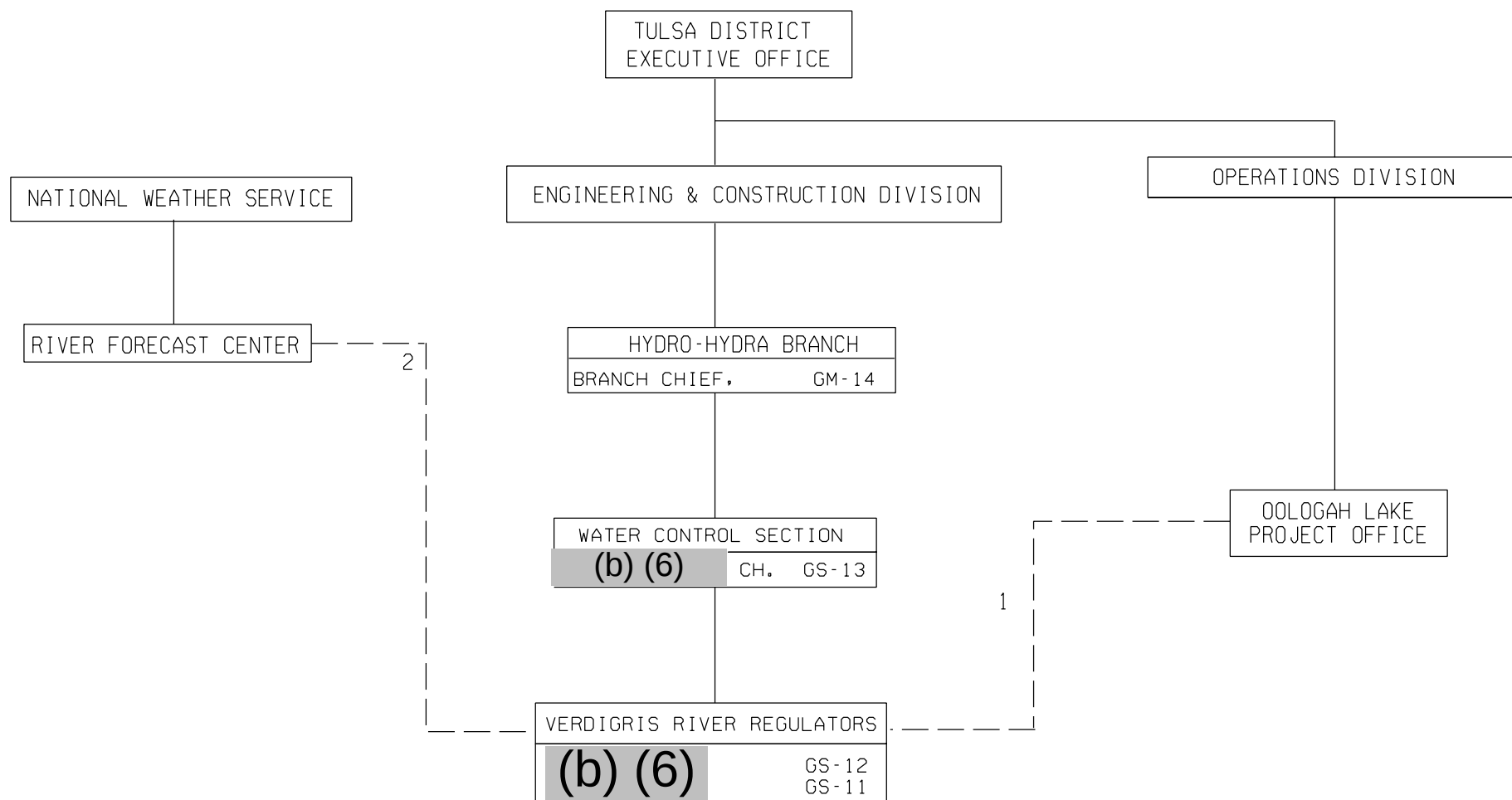
LEGEND

- RECORDING PRECIPITATION STATIONS
- OBSERVER PRECIPITATION STATIONS
- ▲ RECORDING STREAM GAGING AND PRECIPITATION STATIONS

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

RECORDING RAINFALL AND STREAM GAGING STATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



1. DIRECT COMMUNICATIONS ARE MAINTAINED BETWEEN THE LAKES AND THE RESERVOIR CONTROL SECTION FOR TRANSMISSION OF LAKE DATA AND INSTRUCTIONS.

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

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

ORGANIZATIONAL CHART

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.

LAKE DATA

26 JUNE 1991

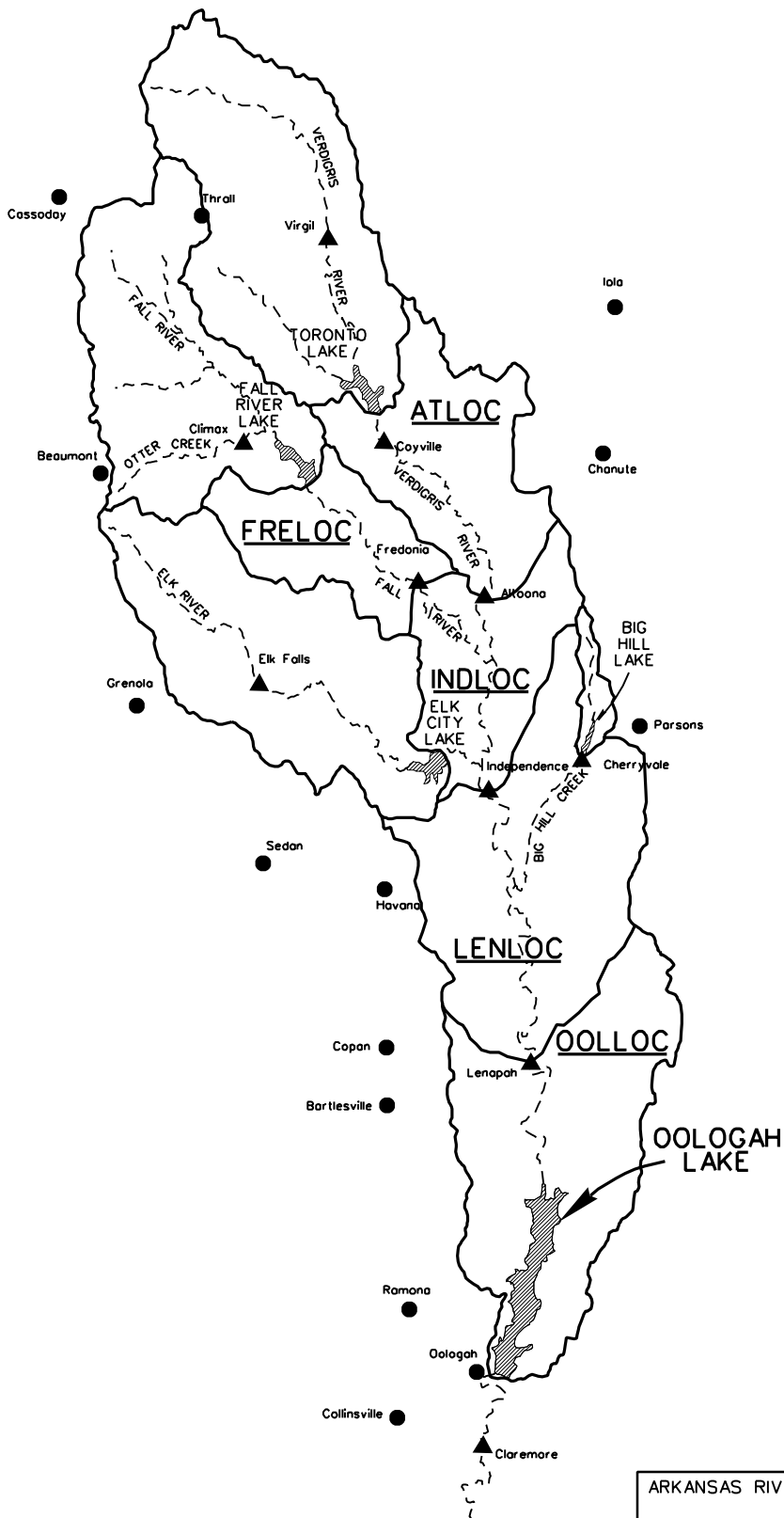
LINE NUMBER	ITEM	TIME	00LO							
1	POOL ELEVATION	12N	640.55							
2	POOL ELEVATION	4PM	640.48							
3	POOL ELEVATION	12M	640.51							
4	POOL ELEVATION	8AM	640.51							
5	TAILWATER ELEVATION	8AM	14.76							
6	24 HR AVE. POWER DISCHARGE	12M								
7	24 HR AVE. TOTAL DISCHARGE	12M								
8	NET POWER GENERATION	12M								
9	GEN#1 HRS IN USE	12M								
	GEN#2 HRS IN USE	12M								
	GEN#3 HRS IN USE	12M								
	GEN#4 HRS IN USE	12M								
10	INSTANTANEOUS POWER DISCHARGE	8AM								
11	INSTANTANEOUS TOTAL DISCHARGE	8AM	3000							
12	LAKE CONDITIONS	8AM	Ø							
13	WEATHER COND.	8AM	Ø							
14	TOTAL PRECEEDING 6 HOUR PRECIPITATION ENDING AT	1PM								
		7PM								
		1AM								
		7AM								
15	TOTAL 24 HOUR PRECIPITATION	7AM	0.0							
16	COMMENTS ON PRECIP. DIST.									
17	EVAPORATION 24 HOURS	8AM	0.23							
18	WIND DIRECTION	8AM	S							
19	WIND VELOCITY	8AM	B-1							
20	WATER SUPPLY									
21	GATE SETTINGS NO. TYPE, OPENING	8AM	4CG1.5'							
22	GATE DATE CHANGES TIME		6-25-91 1400							
23	POOL ELEVATION		640.47							
24	FROM: GATE SETTING		4CG3'							
25	TO: GATE SETTING		4CG1.5'							
26	GATE DATE CHANGES TIME									
27	POOL ELEVATION									
28	FROM: GATE SETTING									
29	TO: GATE SETTING									
30	RIVER STAGE LOW FLOW WEIR									

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

LAKE DATA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



LEGEND

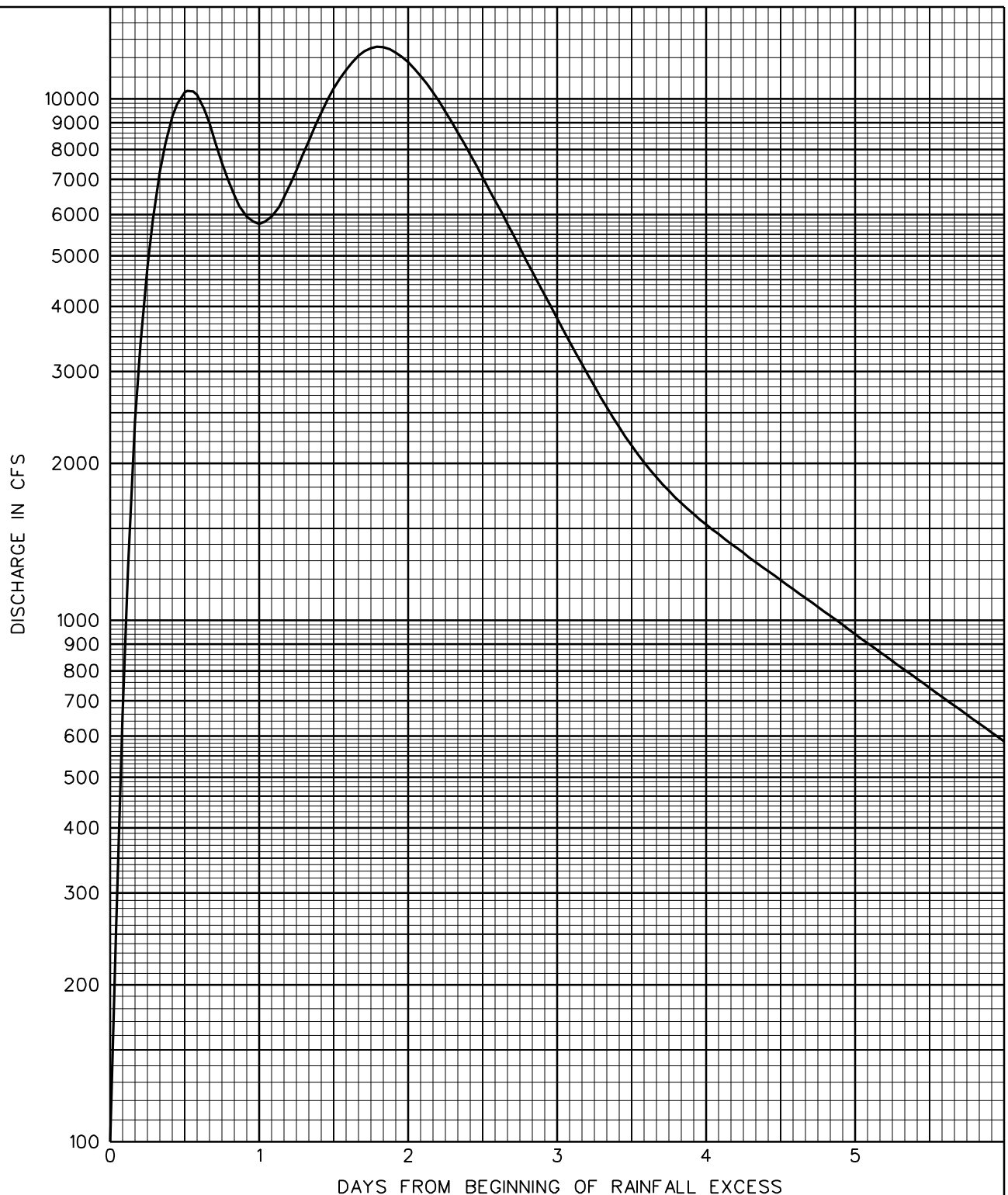
- RECORDING PRECIPITATION STATIONS
- ▲ RECORDING STREAM GAGING AND PRECIPITATION STATIONS

LENLOC - SUBAREA NAME

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

FORECAST REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



DATA BASED ON:

DRAINAGE AREA = 943 SQ. MI.
 1" RUNOFF = 50,290 AC-FT
 2 HOUR UNIT HYDROGRAPH

NOTE:

UNIT HYDROGRAPH OBTAINED BY APPLYING
 ONE INCH OF RUNOFF IN A TWO HOUR PERIOD
 TO THE SUBDIVIDED FORECAST MODEL.

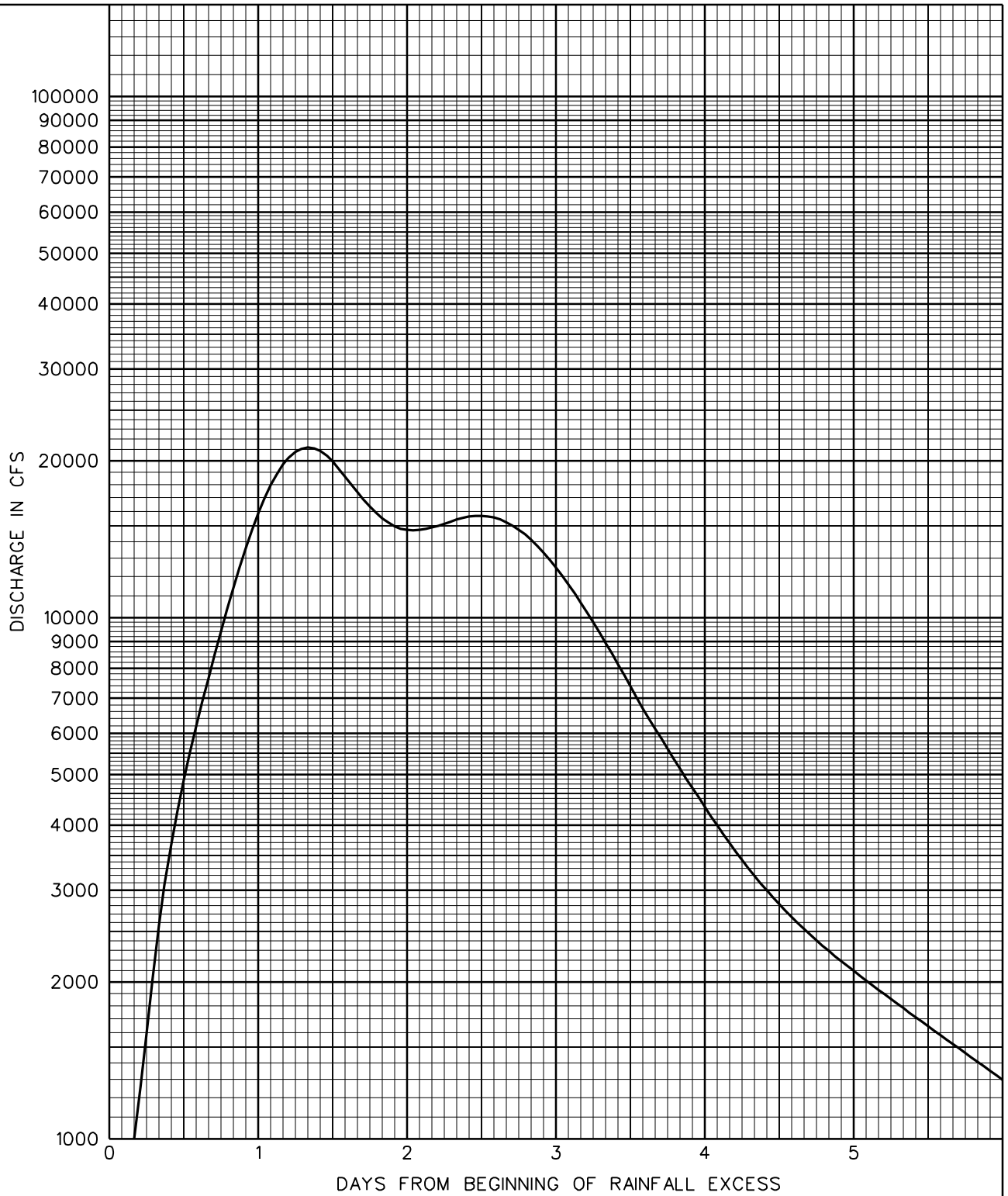
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

UNIT HYDROGRAPH

AREA BELOW FALL RIVER,
 TORONTO AND ELK CITY LAKES AND
 ABOVE THE INDEPENDENCE GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1994
 DRAWN: G.D.E.
 CHECKED: R.W.B.



DATA BASED ON:

DRAINAGE AREA = 1690 SQ. MI.
1" RUNOFF = 90,130 AC-FT
2 HOUR UNIT HYDROGRAPH

NOTE:

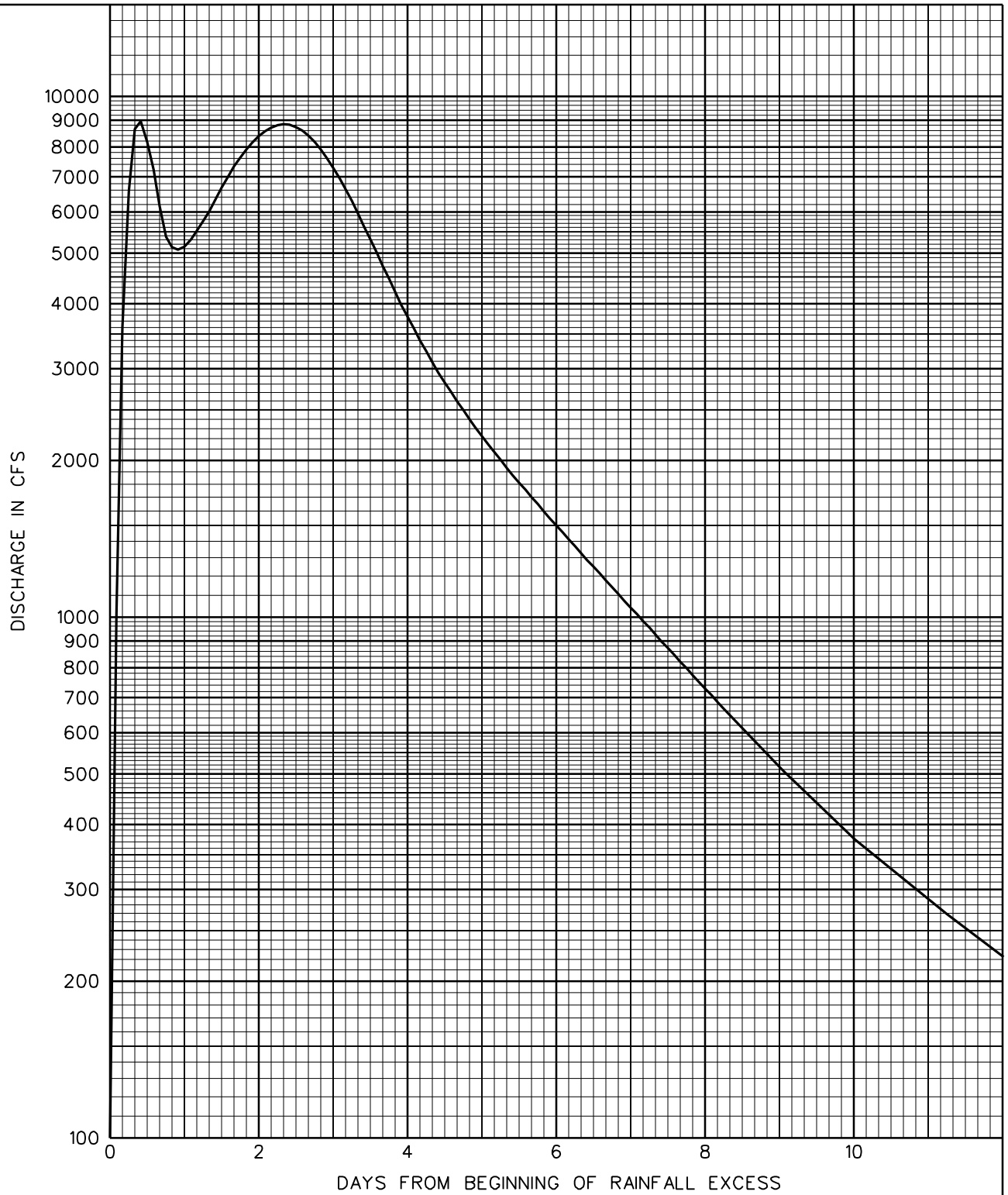
UNIT HYDROGRAPH OBTAINED BY APPLYING
ONE INCH OF RUNOFF IN A TWO HOUR PERIOD
TO THE SUBDIVIDED FORECAST MODEL.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

UNIT HYDROGRAPH

AREA BELOW FALL RIVER, TORONTO,
BIG HILL AND ELK CITY LAKES AND
ABOVE THE LENAPAH GAGE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



DATA BASED ON:

DRAINAGE AREA = 958 SQ. MI.
1" RUNOFF = 51,093 AC-FT
2 HOUR UNIT HYDROGRAPH

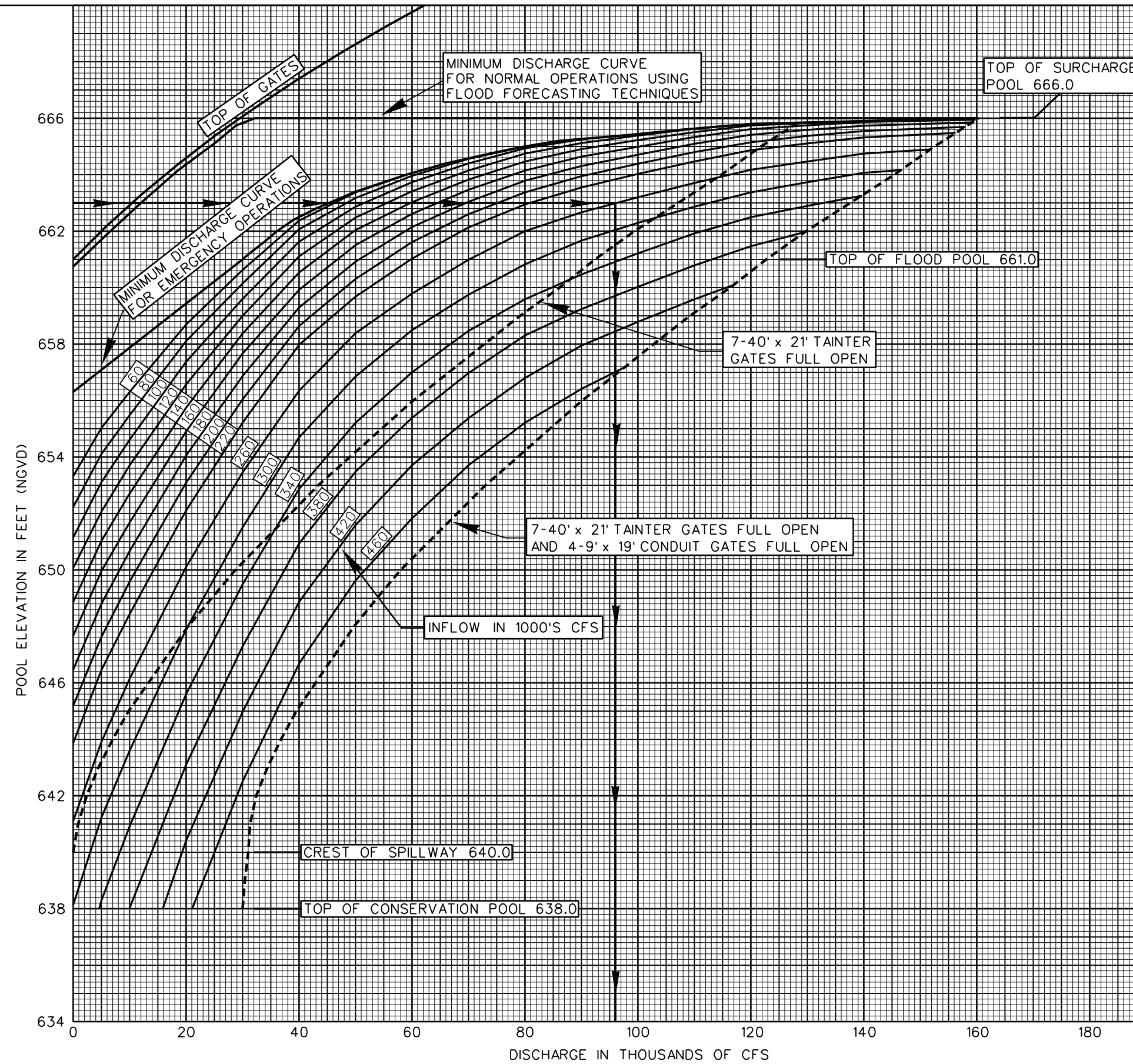
NOTE:

UNIT HYDROGRAPH OBTAINED BY APPLYING
ONE INCH OF RUNOFF IN A TWO HOUR PERIOD
TO THE SUBDIVIDED FORECAST MODEL.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

UNIT HYDROGRAPH

AREA ABOVE THE CLAREMORE GAGE
ON THE VERDIGRIS RIVER AND BELOW
HULAH, COPAN AND OOLOGAH LAKES



NOTES:

1. MINIMUM DISCHARGE CURVE FOR NORMAL OPERATIONS WILL BE USED WHEN USING FLOOD FORECASTING TECHNIQUES
2. MINIMUM DISCHARGE CURVE FOR EMERGENCY OPERATIONS WILL BE USED WHEN COMMUNICATION WITH DISTRICT OFFICE IS LOST AND PROJECT MANAGER IS OPERATING FOR EMERGENCY CONDITIONS.

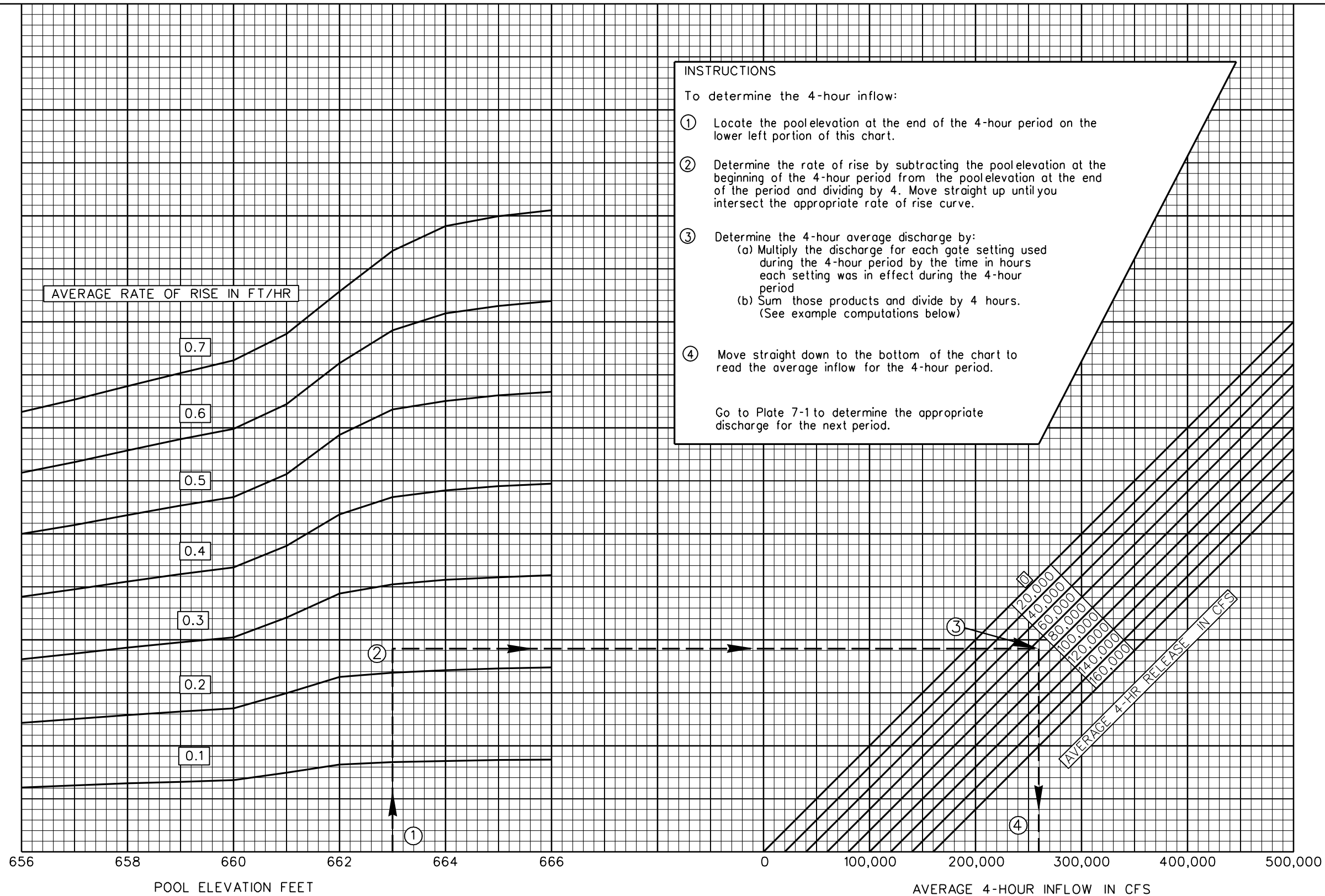
EXAMPLE:

TO DETERMINE A DISCHARGE (FOR EMERGENCY OPERATION) WITH A POOL ELEVATION OF 663.0 AND A 4 HOUR COMPUTED INFLOW OF 260,000 CFS.

1. AT ELEVATION 663.0 READ ACROSS TO THE INTERSECTION OF THE 260,000 INFLOW CURVE
2. READ DOWN TO FIND THE DISCHARGE OF 96,000 CFS.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

**SPILLWAY GATE
REGULATION SCHEDULE
INFLOW PARAMETER**



INSTRUCTIONS

To determine the 4-hour inflow:

- ① Locate the pool elevation at the end of the 4-hour period on the lower left portion of this chart.
- ② Determine the rate of rise by subtracting the pool elevation at the beginning of the 4-hour period from the pool elevation at the end of the period and dividing by 4. Move straight up until you intersect the appropriate rate of rise curve.
- ③ Determine the 4-hour average discharge by:
 (a) Multiply the discharge for each gate setting used during the 4-hour period by the time in hours each setting was in effect during the 4-hour period
 (b) Sum those products and divide by 4 hours. (See example computations below)
- ④ Move straight down to the bottom of the chart to read the average inflow for the 4-hour period.

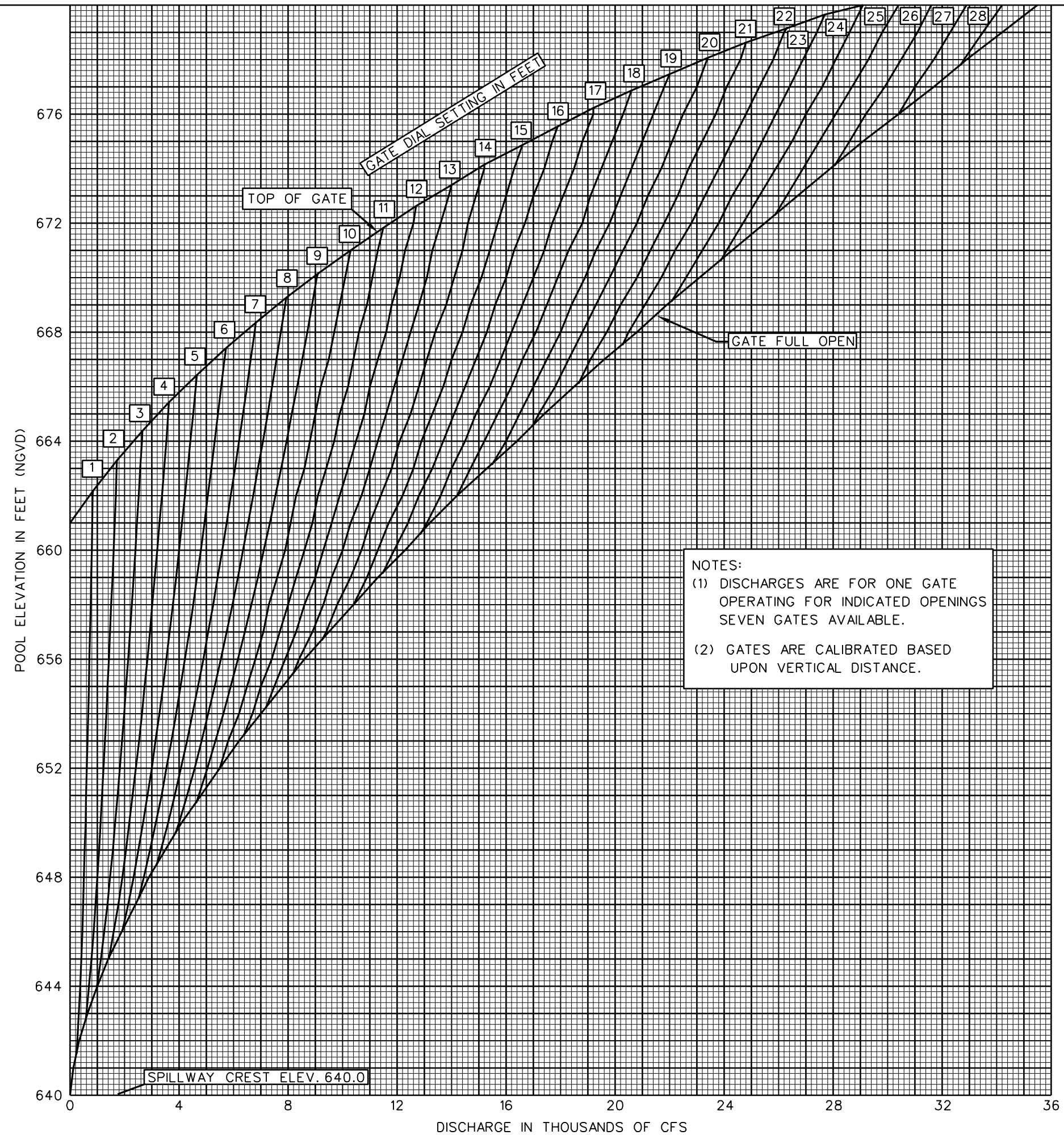
Go to Plate 7-1 to determine the appropriate discharge for the next period.

EXAMPLE COMPUTATIONS:

- ① Begin with a lake elevation of 663.00 feet. Four hours ago the elevation was 662.08 feet.
- ② Rate of rise = $(663.00 - 662.08) / 4 \text{ hrs} = 0.92 \text{ feet} / 4 \text{ hrs} = 0.23 \text{ ft/hr}$
- ③ Releases for last four hours were:

2.0 hrs at 60,000 cfs = $2.0 \times 60,000$	= 120,000 cfs
2.0 hrs at 80,000 cfs = $2.0 \times 80,000$	= 160,000 cfs
Total 4 hrs	280,000 cfs

Average release = $280,000 \text{ cfs} / 4 \text{ hrs} = 70,000 \text{ cfs}$
- ④ The resulting 4-hour inflow is 260,000 cfs.



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

SPILLWAY RATING CURVES
PARTIAL AND FULL GATE OPENINGS
1 - 40' x 21' TANTER GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1995
DRAWN: SKG
CHECKED: GDE

WATER SUPPLY STORAGE ACCOUNTING
OOLOGAH LAKE
CONSERVATION STORAGE 545300
(ALL VALUES ARE IN ACRE-FEET)
TOTAL CONSERVATION STORAGE 510600
UN-CONTRACTED STORAGE 15595
CONTRACT STORAGE USER # 1 4170, WASHINGTON COUNTY RW
CONTRACT STORAGE USER # 2 1530, TOWN OF CHELSEA
CONTRACT STORAGE USER # 3 5960, ROGERS COUNTY RWD #3
CONTRACT STORAGE USER # 4 285450, CITY OF TULSA
CONTRACT STORAGE USER # 5 200, CONSOLIDATED RWD #1
CONTRACT STORAGE USER # 6 20990, PUBLIC SERVICE OF OK
CONTRACT STORAGE USER # 7 6670, CITY OF COLLINSVILLE
CONTRACT STORAGE USER # 8 1590, ROGERS COUNTY RWD #4
CONTRACT STORAGE USER # 9 445, CITY OF CLAREMORE
CONTRACT STORAGE USER #10 168000, NAVIGATION

PERIOD MO/YR	USER	BEGINNING STORAGE	INFLOW SHARE	TOTAL LOSSES	WITH- DRAWN	ENDING STORAGE
7/84	LAKE	510610	1240	32650	14033	465167
	U-C	15595	38	1011	0	14622
	1	4170	10	267	90	3823
	2	1530	4	97	60	1376
	3	5960	14	380	200	5395
	4	285450	693	18118	12000	256025
	5	200	0	13	8	180
	6	20990	51	1333	850	18858
	7	6670	16	424	250	6012
	8	1590	4	101	60	1433
	9	455	1	29	15	412
	10	168000	408	10876	500	157032
8/84	LAKE	465167	199	25599	13626	426141
	U-C	14622	6	817	0	13811
	1	3823	2	211	85	3528
	2	1376	1	75	55	1247
	3	5395	2	295	225	4877
	4	256025	111	13978	11500	230659
	5	180	0	10	8	162
	6	18858	8	1028	890	16947
	7	6012	3	328	280	5407
	8	1433	1	78	65	1290
	9	412	0	23	18	372
	10	157032	65	8756	500	147842

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

WATER SUPPLY STORAGE ACCOUNTING

ELEVATION IN FEET (N.G.V.D.)

680
670
660
650
640
630
620
610
600

0

200

400

600

800

1000

1200

1400

1600

1800

2000

EVAPORATION IN C.F.S.

0.1"

0.2"

0.3"

0.4"

0.5"

0.6"

0.7"

0.8"

0.9"

1.0"

SPILLWAY CREST 640.0

TOP OF CONSERVATION POOL 638.0

TOP FLOOD CONTROL POOL 661.0

NOTE:
CURVES COMPUTED FOR 70%
CLASS A PAN EVAPORATION

2200

2400

2600

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

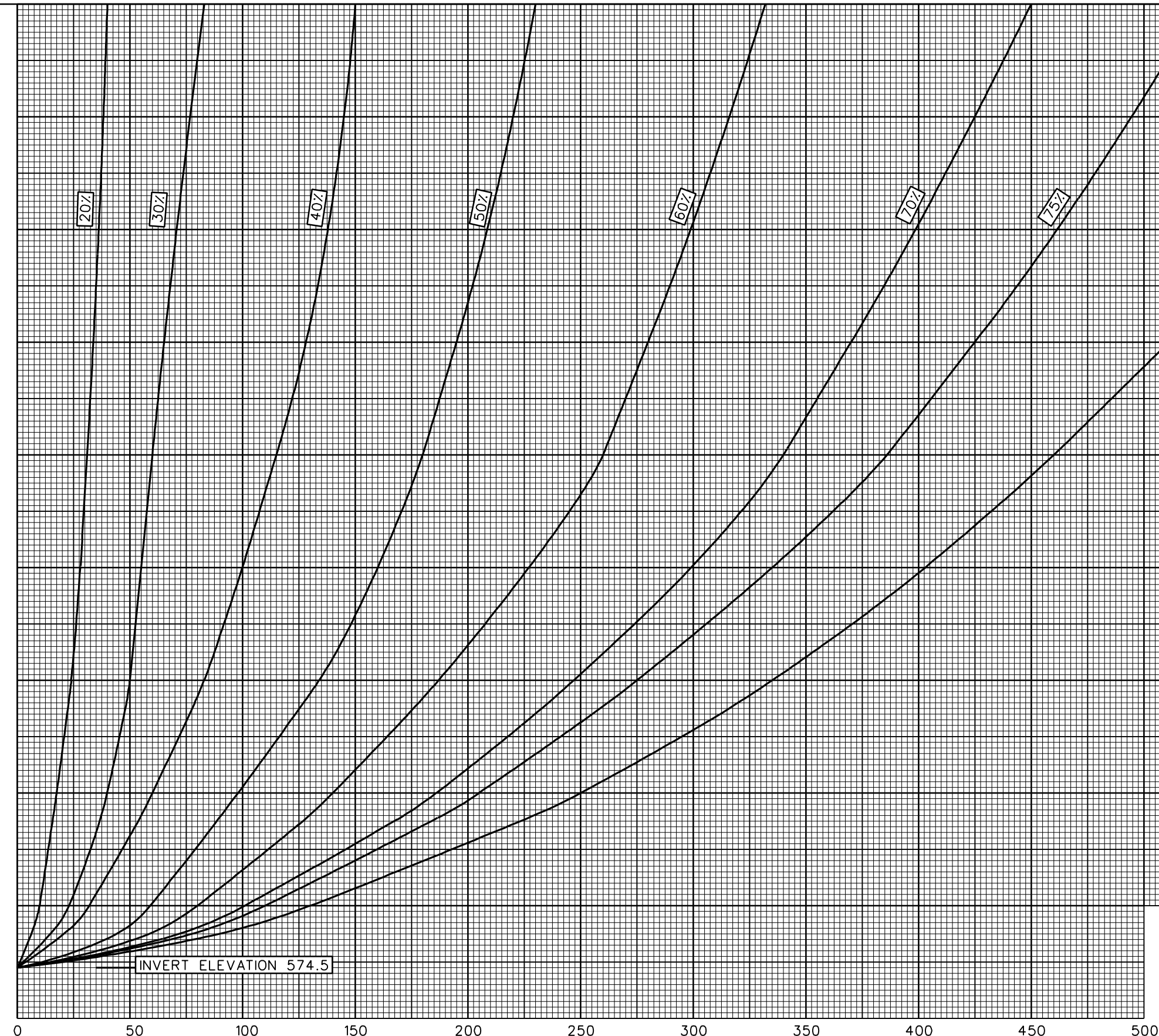
OOLOGAH LAKE

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1995
DRAWN: SKG
CHECKED: GDE

POOL ELEVATION IN FEET (N.G.V.D.)

650
640
630
620
610
600
590
580
570



20%

30%

40%

50%

60%

70%

75%

80%

TOP OF CONSERVATION POOL
ELEVATION 638.0

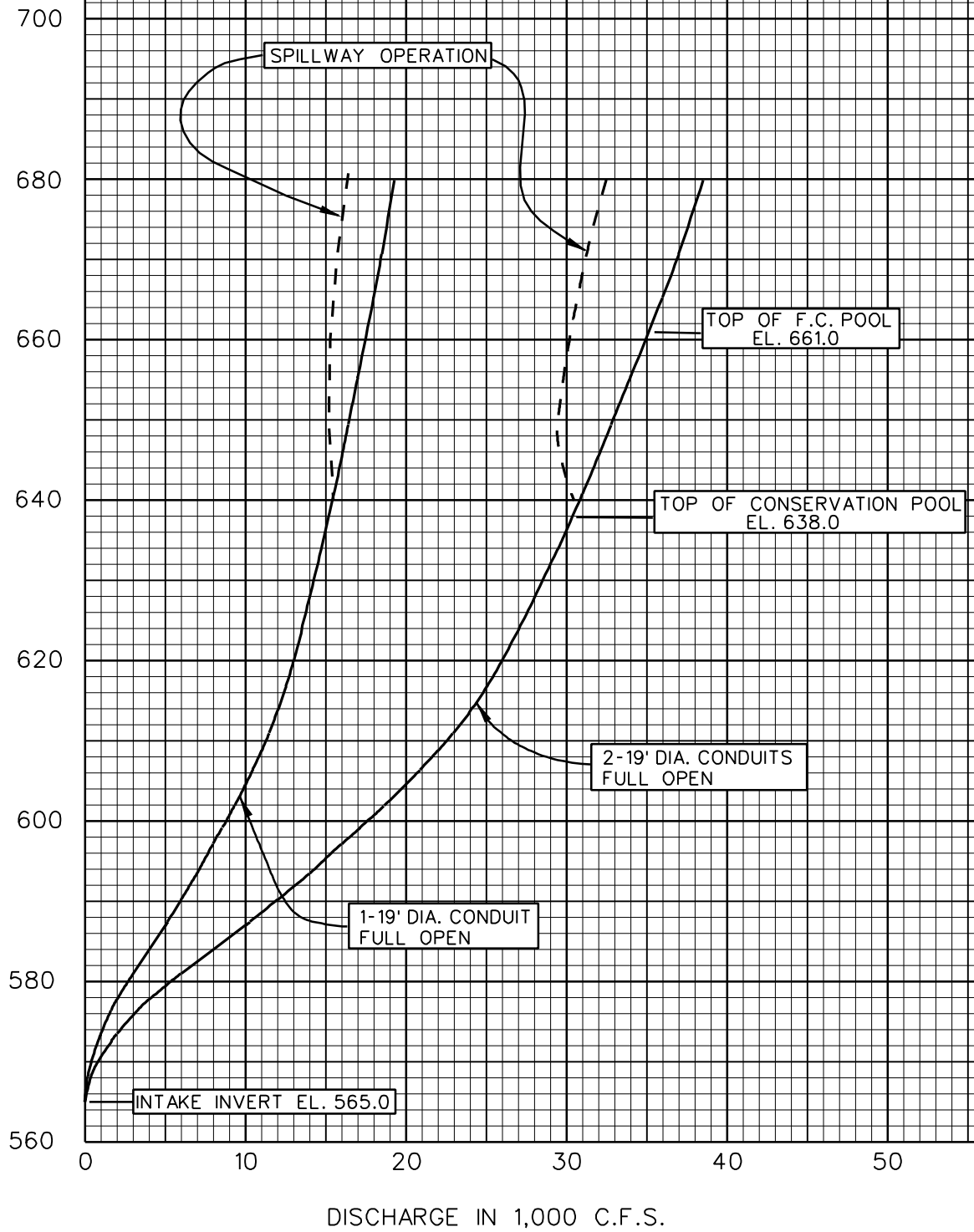
INVERT ELEVATION 574.5

DISCHARGE IN C.F.S.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

LOW FLOW RATING CURVE
48" LOW FLOW PIPE

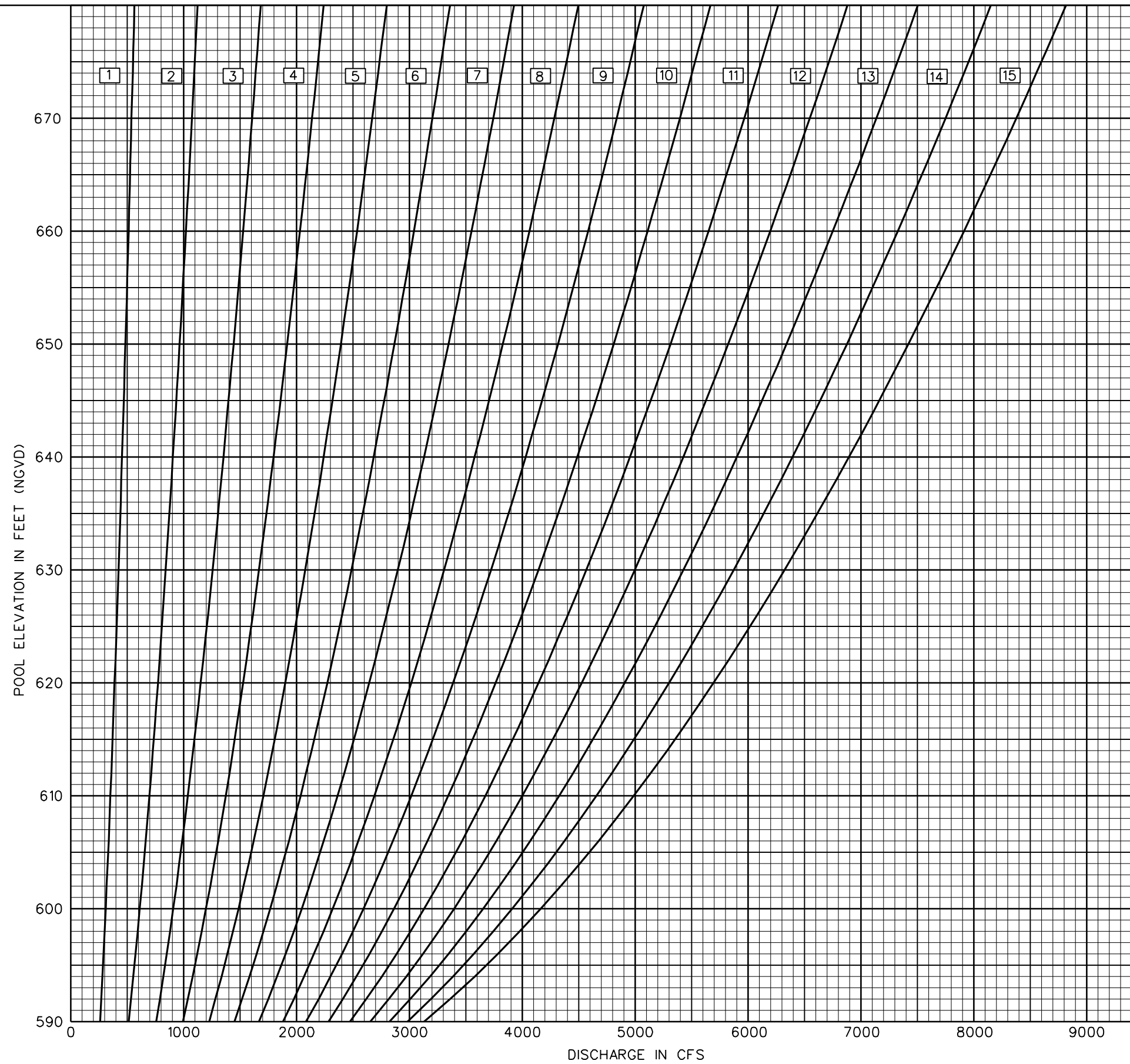
POOL ELEVATION IN FEET (N.G.V.D.)



ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

CONDUIT RATING CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: SKG
CHECKED: GDE



NOTES:

- (1) RATING FOR 1 - 9' X 19' GATE
IN 1 - 19' CONDUIT
- (2) GATE OPENING IN FEET
- (3) 4 GATES AVAILABLE

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

CONDUIT RATING CURVES
FOR PARTIAL GATE OPENINGS

ELEVATION IN FEET (NGVD)
(STAGE IN FEET)

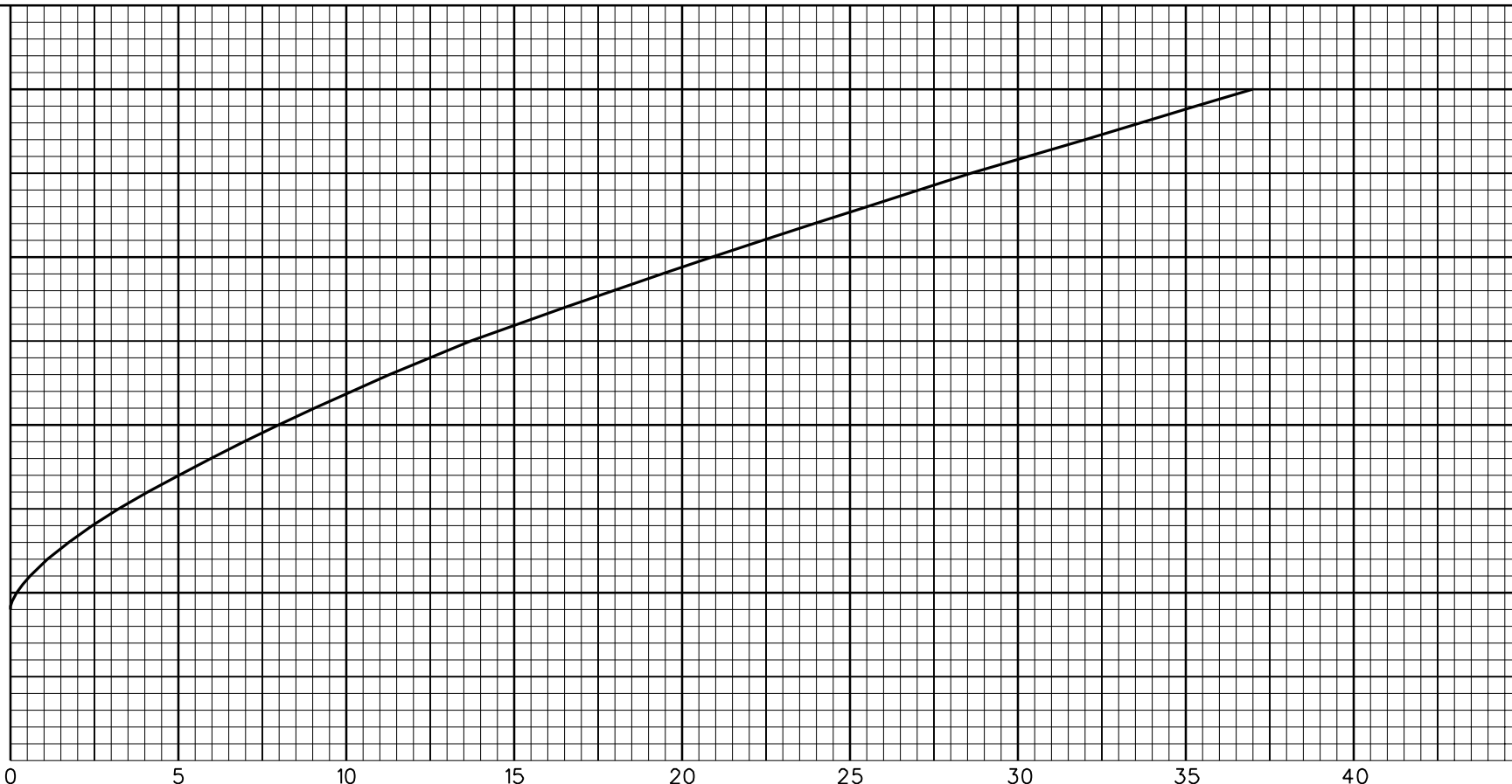
592
(40)

582
(30)

572
(20)

562
(10)

552
(0)



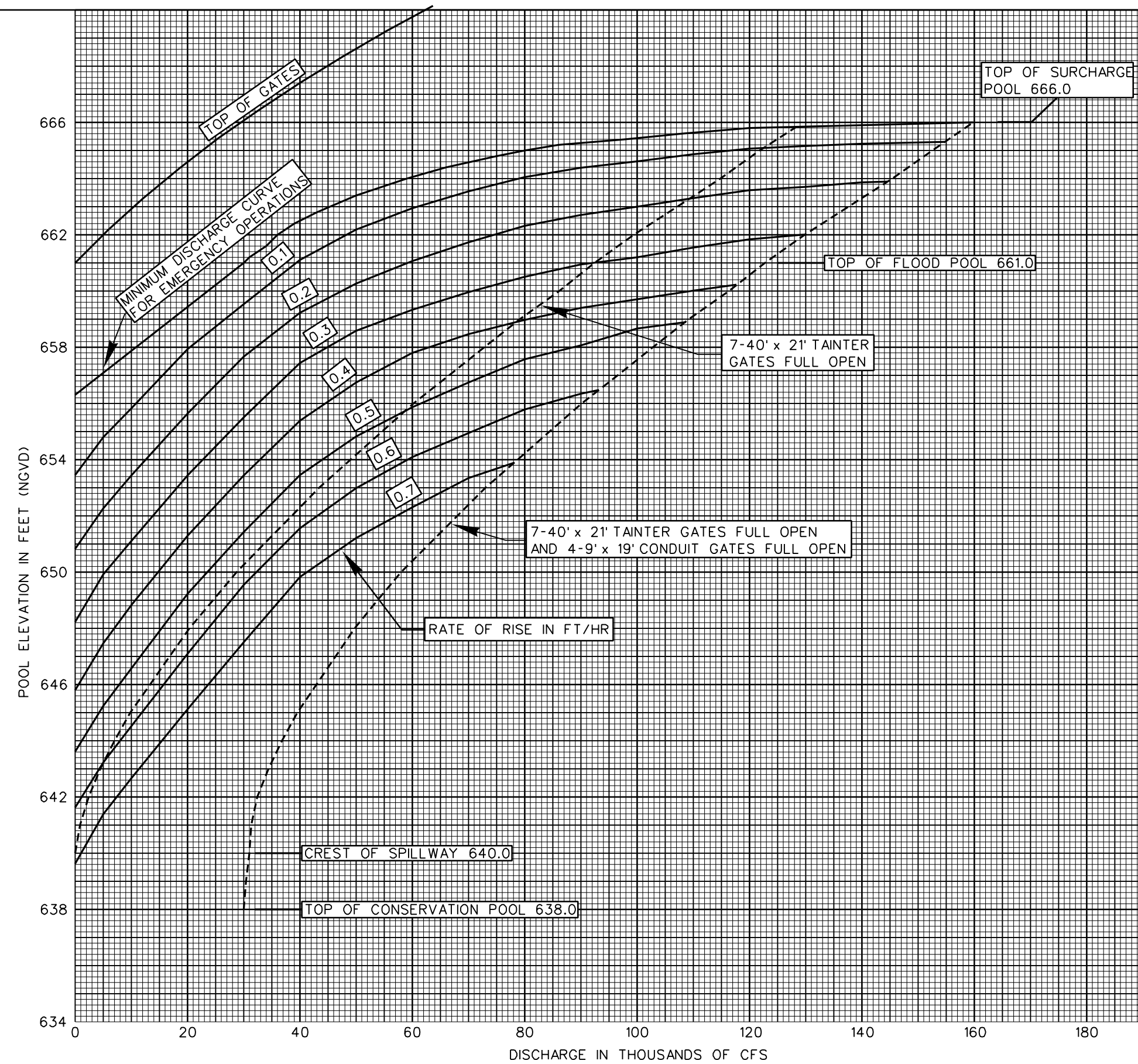
DISCHARGE IN 1000'S OF CFS

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

OOLOGAH LAKE

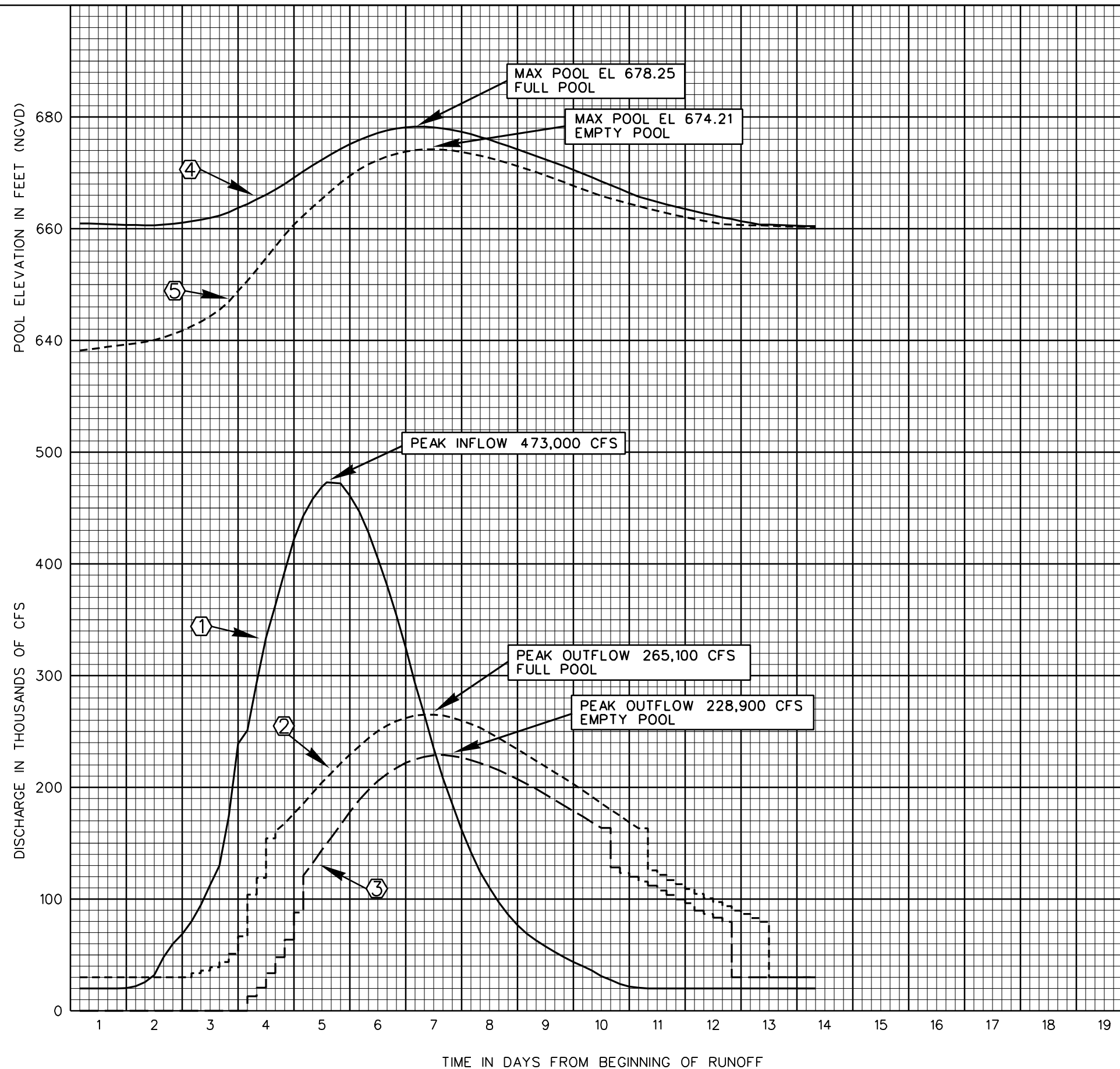
TAILWATER RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1995
DRAWN: G.D.E.
CHECKED: D.E.B.



NOTES:

1. MINIMUM DISCHARGE CURVE FOR EMERGENCY OPERATIONS WILL BE USED WHEN COMMUNICATION WITH DISTRICT OFFICE IS LOST AND PROJECT MANAGER IS OPERATING FOR EMERGENCY CONDITIONS.
2. THIS PLATE IS PRESENTED TO MEET EM 1110-2-3600 REQUIREMENTS AND SHOULD ONLY BE USED AS A LAST ALTERNATIVE.



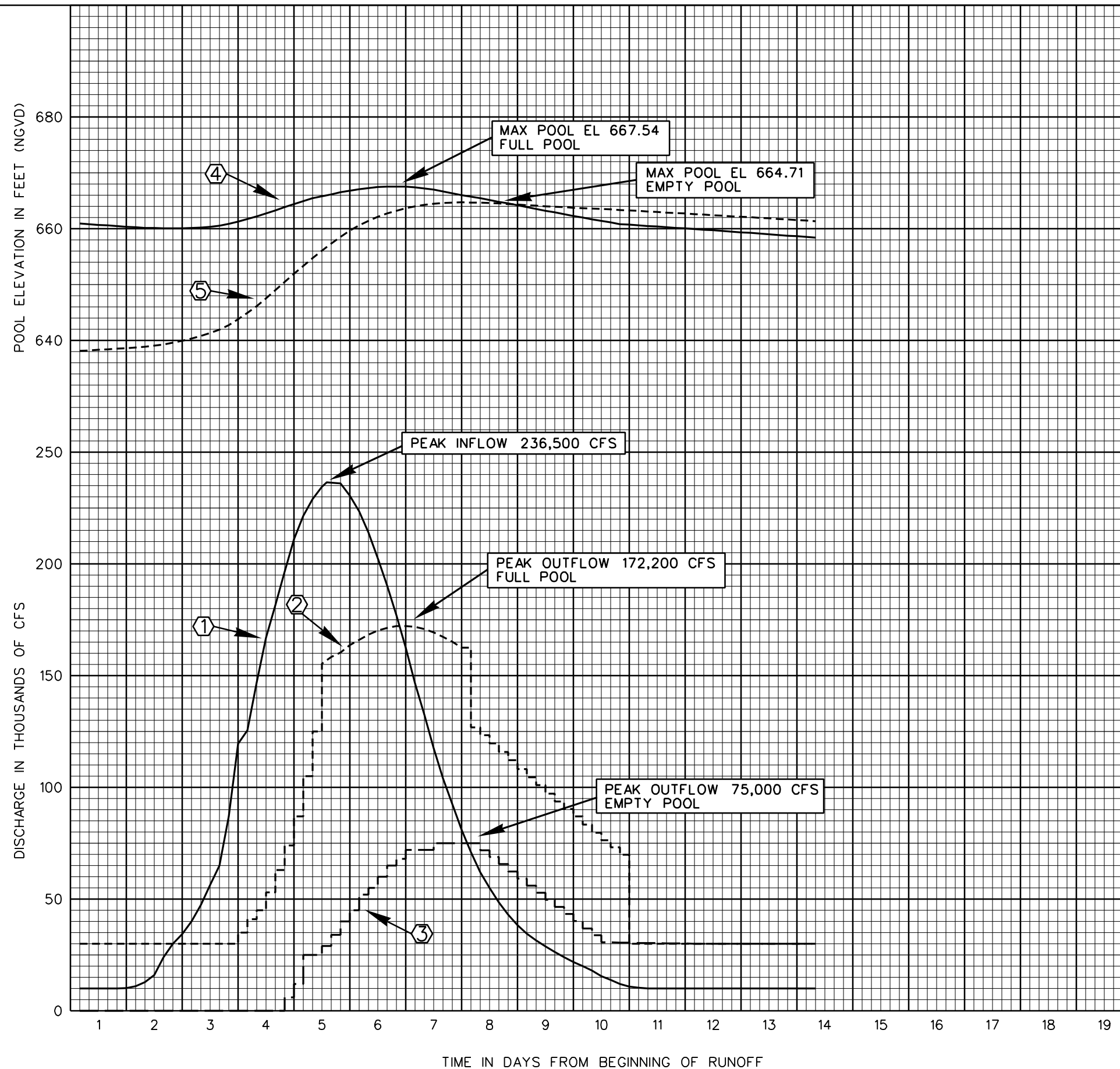
NOTES: EMERGENCY OPERATIONS

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

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

OPERATIONAL HYDROGRAPHS SPILLWAY DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



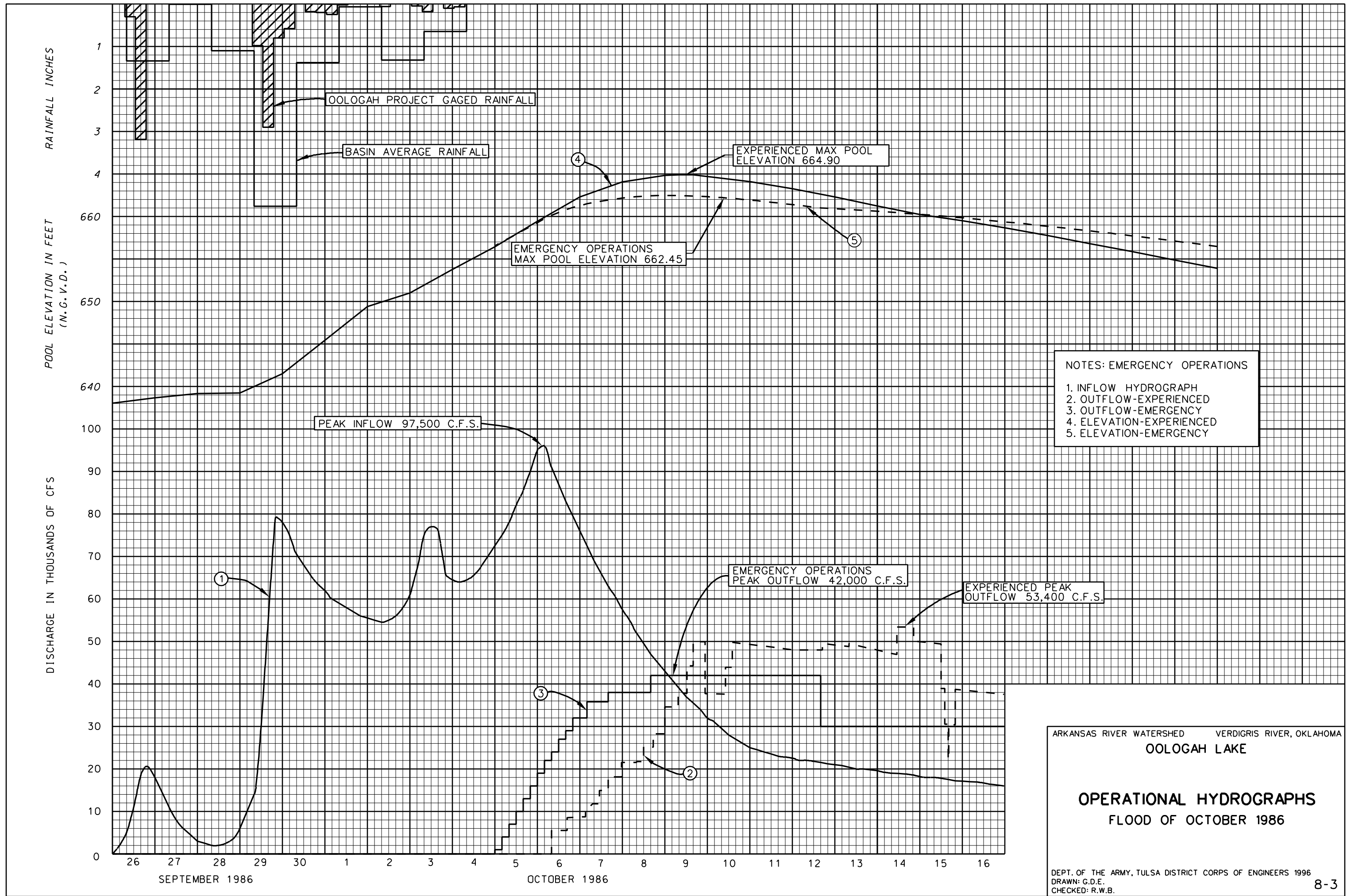
NOTES: EMERGENCY OPERATIONS

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

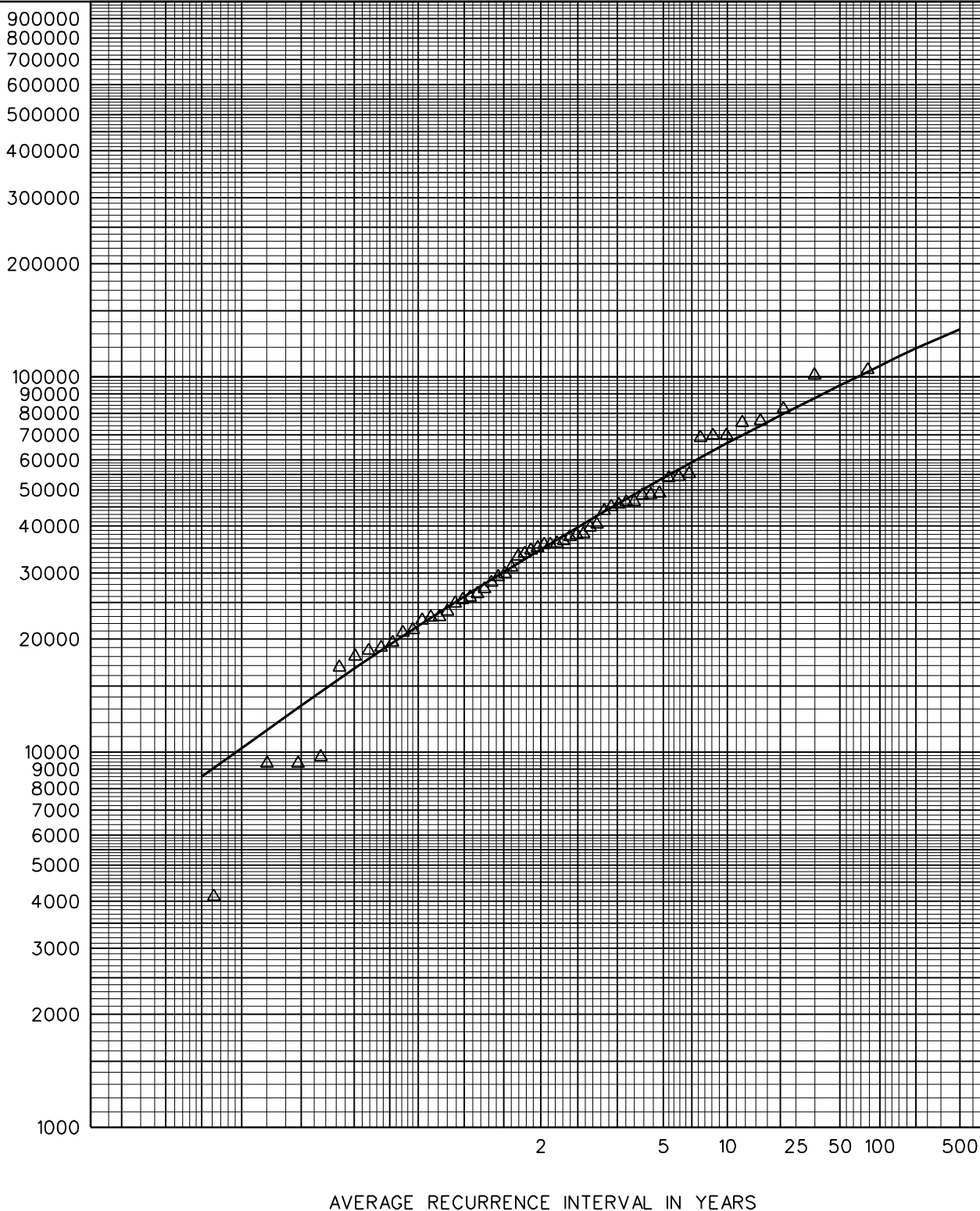
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

OPERATIONAL HYDROGRAPHS 1/2 SPILLWAY DESIGN FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



DISCHARGE IN CFS



— COMPUTED PEAK INFLOW PROBABILITY
△ HISTORICAL EVENTS

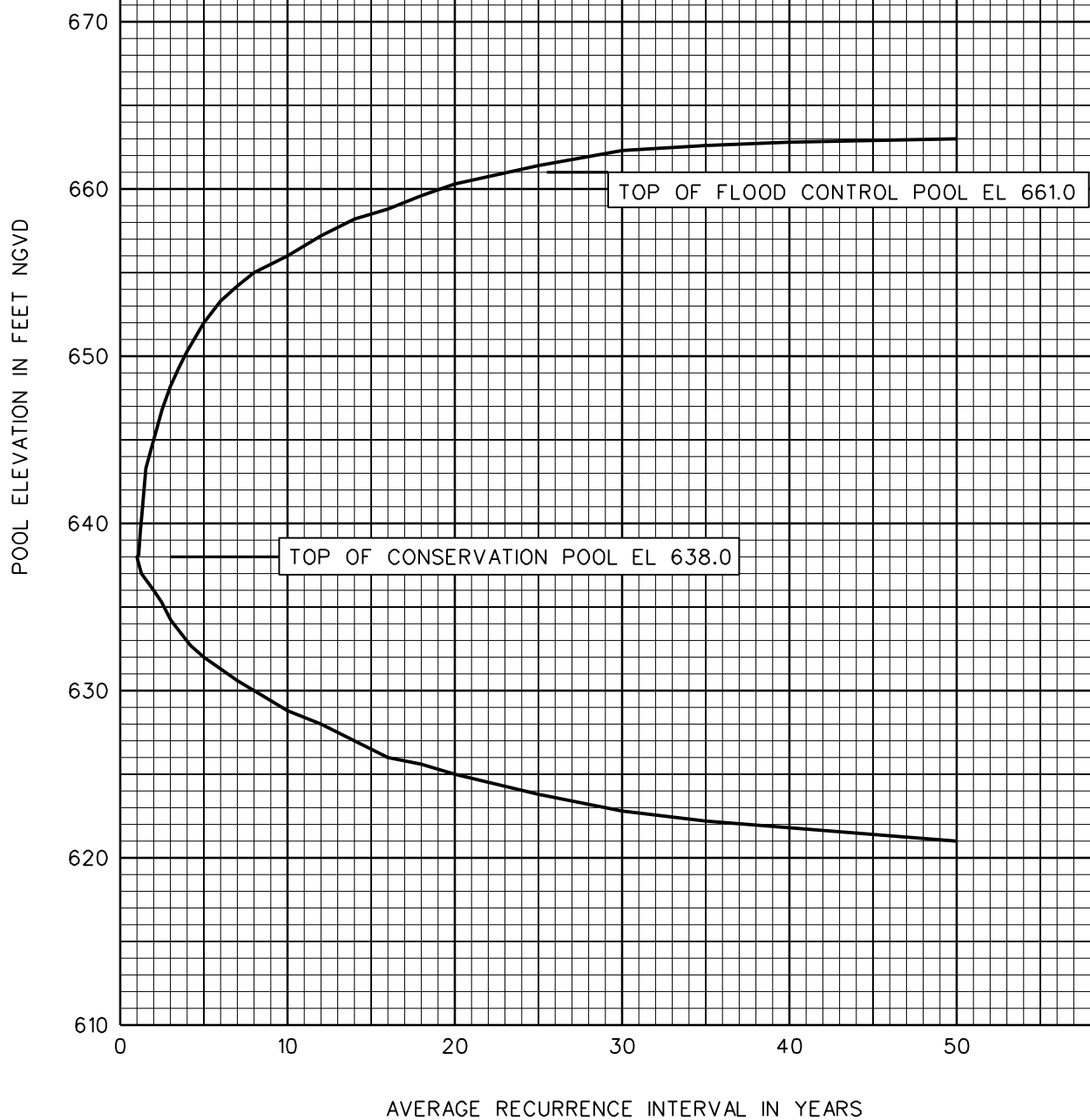
NOTE:

1. BASED ON PERIOD OF RECORD 1940 TO 1995.
2. ADOPTED SKEW COEFFICIENT OF -.40 WAS USED.
3. FLOWS MODIFIED BY OPERATION OF TORONTO, FALL RIVER AND ELK CITY LAKES.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
OOLOGAH LAKE

PEAK INFLOW
PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



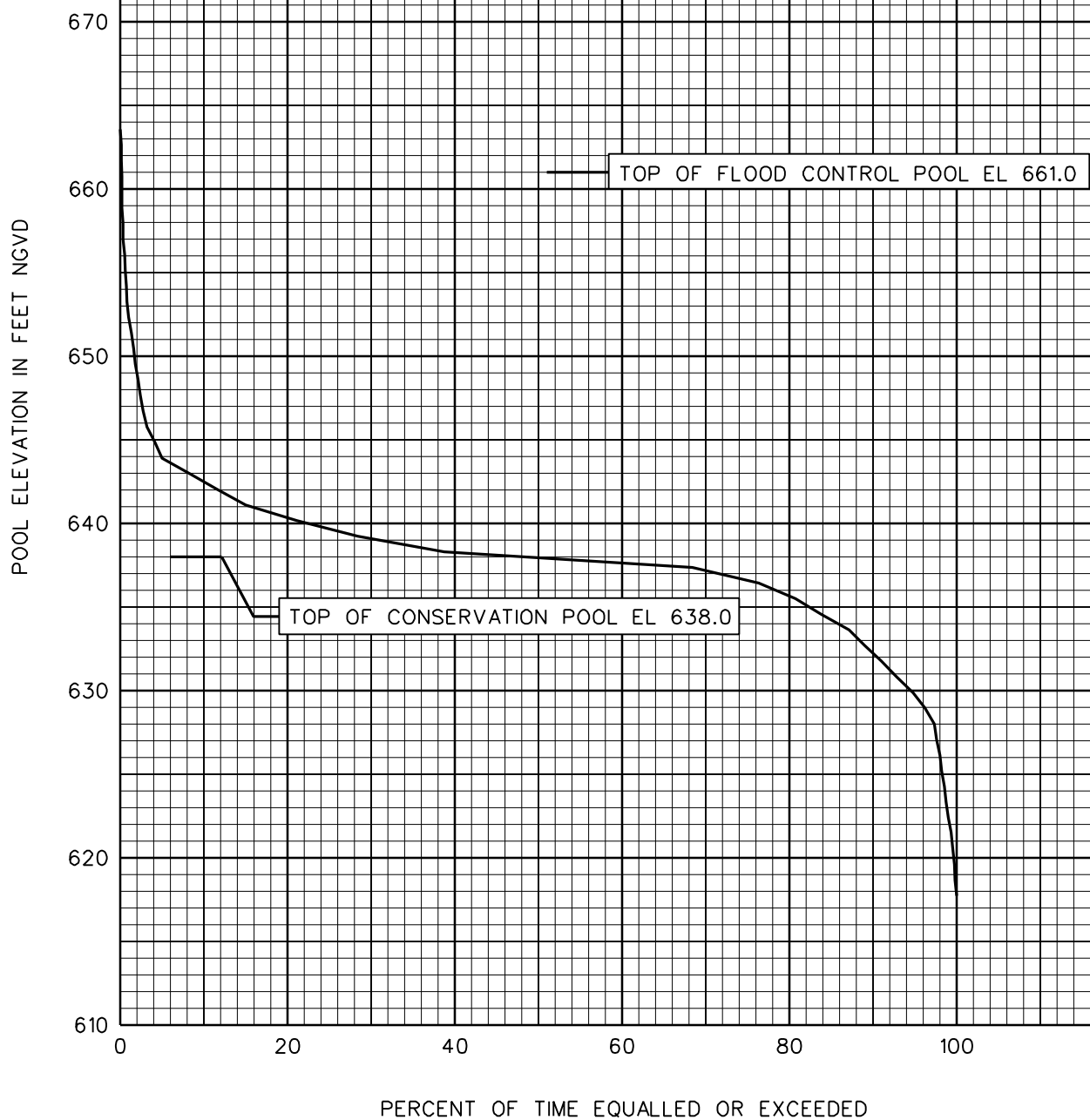
NOTE:

CURVE IS BASED UPON PERIOD
OF RECORD JANUARY 1940 THRU
DECEMBER 1993 FROM SUPER RUN
A95X09.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
Oologah Lake

**POOL ELEVATION
PROBABILITY CURVE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:

CURVE IS BASED UPON PERIOD
OF RECORD JANUARY 1940 THRU
DECEMBER 1993 FROM SUPER RUN
A95X09.

ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA
Oologah Lake

**POOL ELEVATION
DURATION CURVE**

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1996
DRAWN: G.D.E.
CHECKED: R.W.B.