HULAH LAKE
CANEY RIVER, OKLAHOMA

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

ORIGINAL EDITION - OCTOBER 1968
REVISED EDITION - FEBRUARY 1999

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be used in loose-leaf form, and only those sections, or parts 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) 669-7132, 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 procedures 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)	(918) 669-7102 (b) (6)
Backup Coordinator, Office (b) (6)	(918) 669-7132 (b) (6)
Backup Coordinator, Office (b) (6)	(918) 669-7101
Backup Coordinator, Office	(918) 669-7103 (b) (6)
Chief, Water Control Section, Office (b) (6)	(918) 669-7093 (b) (6)
Chief, Readiness & Security Branch, Office (b) (6)	(918) 669-7325 (b) (6)
Emergency Operations Manager, Office (b) (6)	(918) 669-7485 (b) (6)

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PERTINENT DATA
HULAH LAKE

LOCATION: Caney River at mile 96.2, 15 miles northwest of Bartlesville, Oklahoma.

DRAINAGE AREA: 732 square miles above the dam.

DAM:
Type: Rolled earthfill embankment
Length: 5,200 feet (including spillway).
Top of Dam: 799.5 feet, NGVD.
Max. Height: 94 feet above streambed.
Crest Width: 31 feet

DIKE:
Location: One in a saddle near right abutment of the dam.
Type: Earthfill.
Maximum Height: 30 feet
Length: 1,115 feet

SPILLWAY:
Location: Near right abutment.
Type: Gate controlled, concrete, gravity, ogee weir.
Number, size, and type of gates: 10 -40' x 25' tainter gates
Crest Elevation: 740.0 feet, NGVD.
Length: 472 feet gross and 400 feet net

OUTLET WORKS:
Location: Through intermediate piers in spillway.
Type and Size: 9 - 5' x 6.5' rectangular sluices.
Invert Elevation: 702.0 feet, NGVD.
Control: Hydraulically operated lift gates.
Low Flow Pipe, Number, Size and Type: 2 - 24" Diameter, butterfly valves

WATER SUPPLY:
Location: Through right abutment.
Type: 1 - 10" diameter, deferred (pipe blind flanged)
Invert Elevation: 712.0 feet, NGVD

LAND ACQUISITION:

	Guide Contour Elevation (feet NGVD)	Area (acres)
Fee Simple	Blocked perimeter to 769	20,676
Easement	Reserved for roadway easement	25.5

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	779.5	---	---	---	---	---
Maximum Pool	775.87	17,916	472,563	156,665	4.01	337,500
Top of Surcharge Pool	767.0	13,780	315,898	26,810	0.69	219,100
Top of Flood Control Pool	765.0	13,000	289,088	227,680	5.83	196,500
Spillway Crest	740.0	5,160	61,408	30,252	0.77	9,500
Top of Conservation Pool	733.0	3,568	31,156	31,156	0.80	8,350
Top of Inactive Pool	710.0	0	0	0	0	0
Flood Control Storage	733.0-765.0	---	257,932	---	6.61	---
Conservation Storage	710.0-733.0	---	31,156[(3)]	---	0.80	---
Streambed at Dam	685.5	---	---	---	---	---

(1) Based on 1973 sedimentation survey.
(2) One inch of runoff equals 39,040 acre-feet.
(3) Includes 19,800 acre-feet for water supply (12.4 mgd yield), 7,100 acre-feet for water quality (4.5 mgd yield), and 4,200 acre-feet for sediment reserve.

HULAH LAKE
VERDIGRIS RIVER, OKLAHOMA

WATER CONTROL MANUAL
APPENDIX D
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 Appendix D to the 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 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 L - Oologah
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, 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 Hulah 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. Hulah Lake is owned by the U.S. Government.

1.05. Operating Agency. The Corps of Engineers is the operating agency for Hulah Lake. The Project Manager, Copan/Hulah Lake Office, operating through the Oologah Resident Office and 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 663.0. Below elevation 663.0, the project office at Copan Lake will be manned during normal work hours each day through the recreational season. When the recreation season is over, the project office 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 along with office and home telephone numbers. 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 Hulah Lake. The regulation is the responsibility of the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District.

II - DESCRIPTION OF PROJECT

2-01. Location. Hulah Lake is located at mile 96.2 on the Caney River, approximately 15 miles northwest of the city of Bartlesville in Osage County, Oklahoma. The project location is shown on plate 2-1. Supplementary pertinent data for Hulah Lake is given in Exhibit A.

2-02. Purpose. Hulah Lake is a multipurpose project for flood control, water supply, water quality, navigation, recreation, and fish and wildlife. The project was designed to provide maximum flood protection on the Caney and Verdigris 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 top of the embankment is at elevation 779.5 and has a maximum height of 94 feet above streambed. The embankment is 5,200 feet long (including spillway). The dam has a top width of 31 feet with 24 feet of paved roadway for State Highway 10. The upstream slope of the embankment is protected by 18-inch riprap over 6 inches of rock spall on backing material and the downstream slope is grass covered. 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 472 feet, a net overflow length of 400 feet, and a crest elevation of 740.0. The structure is located on the right abutment of the dam. Flows over the spillway are controlled by ten 40 feet by 25 feet tainter gates operated by individual electric-powered 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 room to provide electricity in case normal electric service is interrupted. The spillway plan and section is shown on plate 2-3.

c. Outlet works. The outlet works consist of nine 5-foot by 6.5-foot sluices located through the spillway. The sluices are equipped with hydraulically operated, vertical lift gates. The gate hoists will lift the gates at a speed of one-half foot per minute. Two 24-inch low flow pipes are provided in the base of the weir. One pipe is contained in each of the second monoliths from each abutment. A section of the outlet works is shown on plates 2-3 and 2-4.

d. Sedimentation and Degradation. Thirty-one sediment ranges have been established in the lake and six degradation ranges are located on the river below Hulah 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 plates 2-5 and 2-6, respectively.

e. Water Supply. The water supply facility consists of a 10-inch diameter water supply pipe with a blind flange at the outlet end. A multilevel intake is not provided.

2-04. Related Control Facilities. None.

2-05. Real Estate Acquisition. The fee taking line for Hulah Lake is a blocked perimeter encompassing elevation 769.0. The acquisition guideline is 4 feet above the flood control pool. In the upper reaches of the reservoir, the guideline is elevation 775.0 or the envelope curve of backwater effects of the 50-year flood. The envelope curves of backwater effects are shown on plate 2-7. There are 20,676 acres in fee simple title.

2-06. Public Facilities. The Corps of Engineers maintains eight Public Use Areas on Hulah Lake. They are: (1) Dam Site, (2) Hulah Cove, (3) Caney Bend, (4) Turkey Creek, (5) Skull Creek, (6) Caney River (access point only), (7) Boulanger Landing, and (8) Pond Creek. Facilities provided at these areas consist of roads, parking areas, boat ramps, camping and picnicking facilities, walkways, sanitation facilities, potable water, and swimming areas. A total of 10,040 acres of reservoir land has been zoned for wildlife management purposes. The public use areas are shown on plate 2-8.

III - HISTORY OF PROJECT

3-01. Authorization. Hulah Lake was authorized for construction by the Flood Control Act approved 22 June 1936 (Public Law 738, 74th Congress, House Resolution 8455), in accordance with the plan outlined in House Document No. 308 (74th Congress).

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. This report was a review of the projects included in the Flood Control Act, approved by congress 15 May 1928, for flood control and navigation of the Mississippi River and its alluvial valley. Also included in the report, was a system of reservoirs in the Arkansas River Basin, one of which was the Hulah Reservoir. The report was unfavorable for the construction of such a system by the Federal Government at that time.

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

c. Concise Report. A concise report on Hulah reservoir, dated 15 February 1934, was made in compliance with directions from the office of the Chief of Engineers. This report considered a reservoir at the Hulah Dam site with 490,000 acre feet of flood control and water supply storage, based on a similar plan developed for the survey report published in the House Document No. 308. The report concluded that the project was economically feasible. This recommended plan of improvement was authorized by the Flood Control Act of 1936.

d. Definite Project Report. A report entitled “Definite Project Report, Hulah Dam and Reservoir, Caney River, Oklahoma and Kansas”, dated December 1939, was forwarded to the Office, Chief of Engineers in January 1940. Various revisions of the report and the “Analysis of Design for Construction” followed the Act.

3-03. Construction. A resume' of construction activities is presented in Table 3-1.

TABLE 3-1

RESUME' OF CONSTRUCTION ACTIVITIES

Activity	Date
Construction began	May 1946
Date of diversion	February 1950
Final storage began	September 1951
Conservation pool filled	September 1951

3-04. Related Projects. Hulah Lake is a component of the 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. In particular, Hulah Lake is operated in conjunction with Copan Lake on the Caney River, Birch and Skiatook Lakes on tributaries of Bird Creek, and Oologah Lake on the Verdigris River to regulate floods on the Verdigris River. The Arkansas River system is operated for the control of floods, navigation, and other beneficial uses.

3-05. Modification to Regulations. The regulation of Hulah 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. Since the construction of Hulah Dam, it has been determined that the channel capacity at the confluence of the Caney River and the Little Caney River is only 7000 cfs. Immediately downstream of the dam the channel capacity is only 6,500 cfs. Flooding and inundation of access roads to recreation areas occurs when the pool reaches elevation 736.0. Twenty-four hour flood surveillance at the dam begins at elevation 763.0.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Caney River watershed has a pear-shaped drainage area of 2,111 square miles, with a length of about 94 miles and a width of 23 miles. The drainage area above Hulah Dam is 732 square miles, all of which is considered to contribute to runoff. The basin ranges in elevation from about 560 feet to 1,280 feet NGVD and has an average stream slope of 4.5 feet per mile. The vegetation consists of pasture, cultivated crops, and woodlands. The stream pattern consists of one principal stream with several major tributaries on both left and right banks. The slope of the stream above Hulah Dam varies from 20 feet per mile in the headwaters to 2.6 feet per mile through the reservoir area. Slopes may vary from 2 feet per mile to 150 feet per mile on some of the tributaries. Little Caney River is the largest tributary of Caney River. It has a drainage area of 516 square miles and joins the Caney River at river mile 80.5. Sand Creek, the next largest tributary, joins the Caney River below Bartlesville at mile 63.7 and has a drainage area of about 240 square miles. Stream profiles of the Caney River are shown on plate 4-1.

4-02. Topography. The upper portion of the basin is formed by the rugged highlands of the Flint Hills in Kansas and the Osage Hills of Oklahoma. The remainder of the basin consists of rolling, undulating plains. Terrain is characterized by sandstone-capped cuestas with gentle slopes, mature streams, and valleys with broad alluvial plains. The River flows through a relatively stable channel 200 to 400 feet wide with banks 15 to 40 feet high. The channel is crooked; strewn with snags, boulders, and drift. The drainage pattern of the area is treelike with the Caney River as the main stem. Land use consists of ranching, crop production, limited timber production, and extraction of oil and gas.

4-03. Geology and Soils. Hulah Lake is in the Osage Plains Subdivision of the Interior Lowlands physiographic province. The bedrock strata are sedimentary rocks of upper Pennsylvanian age. Alluvial soil in the flood plain ranges in thickness from 10-35 feet while residual soil in the upland exists as a thin mantle.

4-04. Sediment. The Caney 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 low compared to other reservoirs in the Tulsa District. The sediment inflow is further reduced due to several U.S. Soil Conservation Service (SCS) dams upstream. The average annual sediment deposit is 281 acre-feet. The 50-year design sediment storage for the lake is 1,300 acre-feet. This storage has been filled, however, from the 1973 resurvey an additional 4,200 acre-feet of sediment storage is available in the conservation pool for sediment accumulation. The area and capacity data of the lake have been updated using the last sedimentation resurvey conducted in 1973.

4-05. Climate. The climate in the Caney 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 - Bartlesville Gage

Mean annual (1961 – 1990)	60 degrees F
Maximum recorded (July 1954)	115 degrees F
Minimum recorded (January 1949)	-15 degrees F

b. Precipitation - Bartlesville Gage

(Mean for the drainage basin above Hulah Dam)

Mean annual (Jan. 1930 - Dec. 1997)	34.93 inches
Maximum annual (1986)	58.64 inches
Minimum annual (1963)	19.84 inches
Percent during growing season (April through September)	68 percent

c. Snow – Bartlesville Gage

Mean annual	8.9 inches
Maximum annual (1948)	26.7 inches
Minimum annual (several years)	0.5 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 HULAH DAM

Month	Average rainfall (1) (inches)	Percent of average annual rainfall	Average runoff		Percent of average annual runoff
			(acre-feet)	(2) (3) (inches)	
January	1.15	3.3	11,050	0.28	3.4
February	1.25	3.6	13,860	0.36	4.4
March	2.26	6.5	29,670	0.76	9.2
April	3.38	9.7	43,270	1.11	13.4
May	5.03	14.4	51,950	1.33	16.1
June	4.68	13.4	42,260	1.08	13.1
July	3.29	9.4	26,760	0.69	8.4
August	3.28	9.4	11,230	0.29	3.5
September	4.07	11.6	25,000	0.64	7.7
October	2.88	8.2	29,540	0.76	9.2
November	2.31	6.6	24,340	0.62	7.5
December	1.35	3.9	13,130	0.34	4.1
Total	34.93	100.0	322,060	8.26	100.0

(1) Period of record - January 1930 through December 1997.
(2) Contributing drainage area above Hulah Lake = 732 square miles.
(3) Period of record - January 1918 through December 1997.

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

TABLE 4-2

AVERAGE MONTHLY PAN EVAPORATION
HULAH LAKE

	Evaporation (inches) (1)
January	1.99
February	2.83
March	4.82
April	7.05
May	7.60
June	8.76
July	10.16
August	9.71
September	7.06
October	5.35
November	3.30
December	2.33
TOTAL INCHES PER YEAR	70.96

(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 for durations of 1-minute and 1-hour, show the highest wind speeds that can reasonably be expected at the dam site to be 78 and 56 miles per hour, respectively.

4-06. Storms and Floods. Most major storms in the Hulah 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 95 years of records was the September 26 to October 1, 1986 storm that produced an average of 16.76 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 with an average precipitation of 4 inches or more over the drainage area above the damsite are listed in Table 4-3.

TABLE 4-3

MAJOR STORMS – MAY 1903 THROUGH SEPTEMBER 1998
HULAH LAKE

Inclusive Dates	Average Basin Rainfall (inches)	Inclusive Dates	Average Basin Rainfall (inches)
20-24, May 1903	5.00	10-18 Jun 1957	7.08
1-4 Jun 1904	4.42	22 Jun-1 Jul 1957	4.11
19-23 Oct 1908	6.95	4-7 Jul 1958	5.06
14-16 Sep 1915	5.31	14-17 Jul 1959	5.15
6 May 1918	4.95	20 Sep-6 Oct 1959	6.75
8-9 Apr 1922	4.06	4-9 May 1961	7.43
10-12 Jul 1922	6.64	13 Sep 1961	5.42
3-5 Sep 1926	4.53	15-19 Nov 1964	4.62
1-4 Oct 1926	7.28	9-11 Jun 1967	4.10
1-3 Aug 1927	4.16	23-27 Jun 1969	4.30
16-17 Nov 1928	4.61	11-13 Oct 1969	4.48
7-11 Jun 1930	5.13	1-4 Jul 1972	4.22
8-10 Sep 1930	4.20	9-11 Mar 1974	5.63
22-23 Nov 1931	4.28	4-8 Jun 1974	4.00
18-21 Jun 1932	4.59	14-18 Aug 1975	4.52
17 Oct 1934	5.62	2-4 Jul 1976	4.65
16-18 Sep 1936	4.57	20-21 Nov 1979	7.12
17-19 Jul 1937	4.14	17-21 Oct 1983	5.42
17-21 Jun 1942	4.02	13-16 Oct 1984	5.66
6-11 May 1943	5.21	29 Sep-1 Oct 1986	16.76
13-20 May 1943	5.01	27-29 May 1987	4.36
8-11 Apr 1944	6.35	29 Mar-2 Apr 1988	4.71
27-28 Sep 1944	5.30	15-21 Sep 1988	4.77
27-30 Sep 1945	5.29	10-13 Jun 1989	6.14
21-28 Jun1948	6.19	28 Apr-2 May 1994	4.91
11-17 Aug 1948	4.27	31May-6 Jun 1995	4.10
16-19 Jul 1950	5.63	15-21 Mar 1998	4.69
2-5 Oct 1955	4.36	12-13 Sep 1998	4.07
9-18 May 1957	4.79		

The top twenty floods recorded at the Elgin, Bartlesville, and Ramona gages are listed in Table 4-4.

TABLE 4-4

TOP TWENTY FLOODS AT GAGES

Elgin Gage			Bartlesville Gage			Ramona Gage		
DATE	DISCHARGE	STAGE	DATE	DISCHARGE	STAGE	DATE	DISCHARGE	STAGE
10-3-86	104000	42.35	10-4-86	94500	27.70	10-5-86	85600	31.16
9-13-61	62000	34.70	4-11-44	68000	24.71	9-29-86	43000	29.14
7-3-95	43200	29.64	5-19-43	54800	23.40	10-3-45	38500	30.12
4-10-44	35500	29.80	10-2-45	37200	21.32	3-11-74	38400	30.12
5-15-90	34600	27.27	3-11-74	34200	20.90	6-12-57	36700	29.69
4-28-94	32900	26.70	7-21-50	27600	19.90	6-11-95	35800	28.86
6-12-57	32500	26.40	5-11-43	25900	19.71	5-10-93	35300	28.94
6-30-51	30000	26.22	4-17-45	23600	19.18	35[1]	29000	[1]
6-22-77	29300	26.10	7-22-59	21400	18.75	11-4-74	28600	29.85
5-19-43	29000	24.51	9-30-85	21100	18.25	4-12-94	28400	28.62
9-30-86	27600	24.75	4-15-47	21000	18.65	2-23-85	28000	29.79
9-30-45	26100	25.05	4-21-42	20400	18.63	5-10-61	23400	29.52
6-7-66	25800	23.90	7-19-48	19500	18.30	7-24-59	22300	29.76
89[1]	23700	23.39	6-19-35	19100	18.30	7-23-50	21800	29.42
7-15-59	23600	22.90	8-2-50	17700	17.80	4-19-45	21600	29.28
10-13-59	23600	22.91	10-5-44	17600	17.78	4-3-88	20500	28.33
7-16-50	23400	23.28	12-7-44	17600	17.76	6-26-48	19900	29.30
6-24-69	23200	22.74	6-11-41	17500	17.85	3-13-90	19100	28.39
5-31-82	22000	22.08	3-27-45	17500	17.52	10-13-36	18000	[1]
11-2-61	21100	21.48	10-11-36	17100	17.70	4-18-47	17600	29.06
11-3-74	20900	21.36	7-2-51	17100	17.60	10-6-59	16200	29.46
4-13-47	20700	21.33	5-9-61	16600	17.45	4-17-73	16200	29.45
Flood stage 25.0 feet			Flood stage 13.0 feet			Flood stage 26.0 feet		

(1) Unavailable

4.07. Runoff Characteristics. The general shape of the 732 square mile Caney River drainage basin above Hulah Dam is elliptical. Generally the storms common to the drainage basin are not of uniform intensity. Hydrologic studies indicate the time from the most intense rainfall to peak inflow into Hulah Lake is about 18 hours. However, this time is highly dependent upon the storm pattern and its location over the basin. This is partly due to the steep slopes and impervious shallow soils in the upper portions of the Caney River basin. Base flow in the basin is moderately low and periods of zero flow have been observed. Pertinent data for stream gaging stations in the basin are shown in Table 4-5. The estimated monthly and annual flows at the Hulah dam site for the period 1923 through 1989 are shown on Table 4-6, pages T4-1 to T4-3. The monthly inflow volume frequency is shown on Table 4-7. Flow duration curves (inflow and outflow) are shown on plate 4-2.

TABLE 4-5

PERTINENT DATA FOR STREAM GAGING STATIONS

STATION	STREAM	MILES ABOVE MOUTH	GAGE ZERO (ft.,NGVD)	FLOOD STAGE (ft.)	BANK FULL CAPACITY (cfs)	MAXIMUM FLOOD OF RECORD		
						DATE	STAGE (ft.)	DISCHARGE (cfs)
Elgin, KS	Caney river	117.8	763.32	25.0	28,950	10-03-86	42.35	104,000
Bartlesville, OK	Caney River	68.7	653.33	13.0	10,500	10-04-86	27.70	94,500
Ramona, OK	Caney River	32.0	586.43	26.0	10,400	10-05-86	31.16	85,600
Claremore, OK	Verdigris River	76.0	536.62	35.0	51,900	05-21-43	55.05	182,000

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)
Elgin, KS	Caney river	09-13-61	34.70	62,000	07-03-95	29.64	43,200	MAY 1939-Present
Bartlesville, OK	Caney River	04-11-44	24.71	68,000	05-19-43	23.40	54,800	AUG 1926-Present
Ramona, OK	Caney River	09-29-86	29.14	43,000	10-03-45	30.12	38,500	AUG 1944-Present
Claremore, OK	Verdigris River	05-11-61	50.06	116,000	04-13-44	47.23	85,200	OCT 1935-Present

TABLE 4-7

INFLOW VOLUME FREQUENCY

(1918-1997)

Frequency Of Occurrence (years)	Monthly Inflow in Hundreds of Acre-Feet											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	43	43	119	220	292	190	63	27	48	48	48	42
5	154	168	434	663	782	624	302	122	290	319	296	179
10	287	347	810	1140	1280	1140	687	271	710	835	727	383
25	542	760	1520	1990	2160	2170	1660	646	1800	2300	1830	868
50	802	1270	2250	2810	3000	3270	2950	1150	3230	4410	3270	1480

4-08. Water Quality. Based on 1981 water quality investigations Hulah Lake is shallow, turbid, and mesotrophic with respect to nutrient levels. The lake rarely stratifies and dissolved oxygen concentrations near the lake bottom are sufficient to prevent water quality degradation even during “worst case” summer conditions. Phytoplankton primary productivity is probably limited by high levels of naturally occurring suspended solids and turbidity. The high turbidity detracts from the aesthetic and recreation value of the lake but does not impair water uses. Concentrations of chlorides, sulfates, and the major cations are relatively low. The pesticides chlordane and DDE have been identified in the water and fish tissues, but concentrations were below 1988 Environmental Protection Agency (EPA) and state of Oklahoma alert levels. Toxic metals have not been detected. Iron and manganese occasionally exceed EPA criteria for raw water sources but the bulk of these metals is associated with the suspended solids and can be removed by conventional water treatment processes. Hulah Lake is well suited for municipal, agricultural, and industrial water uses.

4-09. Channel and Floodway Characteristics. The regulating channel capacity on the Caney River below Hulah dam is about 6,500 cfs. The stream is winding and lined with a heavy growth of trees and brush, which can cause degradation in the channel capacity. The limiting non-damaging flow on the Caney River at the critical point downstream from the confluence with the Little Caney River is about 7,000 cfs. The channel capacities at Bartlesville and Ramona are 10,500 cfs and 10,400 cfs, respectively. The channel capacity of the Verdigris River below the confluence of the Caney River at the Claremore gage is about 42,000 cfs. Discharge rating curves for the Cedar Vale, Elgin, Hulah, Bartlesville, and Ramona gages on the Caney River are shown on plates 4-3 through 4-7. The rating curve for the Verdigris River near Claremore gage is shown on plate 4-8. Rating curves used by the Reservoir Control Section are adjusted to changing conditions and are kept current. 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. Located upstream of Hulah Lake are thirty-eight Soil Conservation Service (SCS) single and multipurpose flood retarding structures. Total flood control storage is about 39,326 acre-feet with an additional storage of about 6,467 acre-feet for sediment. Flood control releases are through uncontrolled outlet works and spillways. The total drainage area regulated by the SCS structures is 181.2 square miles.

4-11. Downstream Structures. Other related structures regulated by the Corps of Engineers in the Verdigris River Basin include the following: Copan Lake on the Little Caney River (drainage area 505 square miles); Skiatook Lake (drainage area 354 square miles) and Birch Lake (drainage area 66 square miles) on Bird Creek; Oologah Lake (drainage area 4,339 square miles) on the Verdigris River, and Newt Graham Lock and Dam (drainage area 8,030 square miles) the uppermost lock on the McClellan-Kerr Navigation System on the Verdigris and Arkansas Rivers.

4-12. Economic Data.

a. Population. The population of counties and cities within the Caney River basin is shown in Table 4-8. Although only a portion of the total county population may reside within the basin, the total population of each county is shown in the table.

TABLE 4-8

POPULATION OF OKLAHOMA AND KANSAS COUNTIES AND CITIES
IN THE CANEY RIVER BASIN - 1970 to 2000

County & City	U.S. Census Population			
	1970	1980	1990	Projected 2000
Oklahoma				
Nowata County	9,773	11,486	9,992	10,150
Nowata	3,679	4,270	3,896	4,055
Osage County	29,750	39,327	41,645	44,600
Pawhuska	4,238	4,771	3,825	3,405
Skiatook	2,930	3,596	4,910	5,920
Rogers County	28,425	46,436	55,170	61,415
Claremore	9,084	12,085	13,280	14,150
Tulsa County	401,663	470,693	503,341	559,760
Tulsa	330,350	360,919	367,302	397,335
Washington County	42,277	48,113	48,066	50,950
Bartlesville	29,683	34,568	34,252	36,150
Dewey	3,958	3,545	3,326	3,405
Kansas				
Chautauqua County	4,642	5,016	4,407	4,230
Sedan	1,555	1,579	1,306	1,254
Montgomery County	39,949	42,281	38,816	39,171
Caney	2,192	2,284	2,062	2,081
Coffeyville	15,116	15,185	12,917	13,035
Independence	10,347	10,598	9,942	10,033
Total Counties	556,479	663,252	701,437	770,276

b. Industry. The chief industry in the Caney River Basin is agriculture and its related industries. Other major manufacturers are in chemical and allied products; petroleum and allied products; concrete, stone, and clay products; meat, dairy, and poultry products; and lumber and wood products. Crude oil and natural gas are the leading minerals produced. Bituminous coal deposits underlay portions of Chautauqua and Montgomery counties in Kansas.

c. Agriculture. Agriculture is important to the economy of southeast Kansas and northeast Oklahoma. It is also the largest employer and income producer, and has the largest investment of any industry in the State of Kansas. Agriculture also ranks high in northeastern Oklahoma due to these same factors. The climate, topography, and soil of this region are suitable for diversified farming. Crops are grown in the bottomlands and the uplands are used principally for livestock grazing and hay production. The principal crops grown in the flood plain are soybeans and wheat, while alfalfa hay, corn, and sorghum are also produced. Pecan trees are found throughout the basin, especially in the bottomland areas. Bermuda pastures and wooded pastures are predominate in the flood plain. Table 4-9 displays the annual value of crops in the basin.

TABLE 4-9

ACRES, AND ANNUAL VALUE OF PRINCIPAL CROPS
IN CANEY RIVER FLOOD PLAIN BELOW HULAH DAM
(June 1998 Prices)

	Hulah dam Caney River to Little Caney River Confluence		Caney River to Sand Creek		Sand Creek to mouth of Caney River(confluence with Verdigris River)		Total	
Crops	Acres	Value $	Acres	Value $	Acres	Value $	Acres	Value $
Corn	75	$17,616	86	$20,200	634	$148,920	795	$186,737
Alfalfa	225	$67,500	258	$77,400	1902	$570,600	2385	$715,500
Soybeans	750	$150,412	860	$172,473	6340	$1,271,487	7950	$1,594,372
Sorghum	75	$10,900	86	$12,499	634	$92,145	795	$115,545
Wheat	375	$34,860	430	$39,972	3170	$294,683	3975	$369,516
Pecans	360	$216,000	850	$510,000	1820	$1,092,000	3030	$1,818,000
Pasture	3710	$510,457	10290	$1,415,798	14460	$1,989,547	28460	$3,915,802
Wooded Pasture	2230	$87,070	5140	$200,691	12040	$470,101	19410	$757,863
Total	7800	$1,094,817	18000	$2,449,034	41000	$5,929,484	66800	$9,473,337

d. Flood Damages. The estimated average annual damages along the Caney River from Hulah and Copan dams to the river's confluence with the Verdigris River with and without the operation of the projects is shown in Table 4-10. These damages, residual damages and average annual damages prevented are based on studies made in preparation of the Caney River Basin Interim Reconnaissance Study, Verdigris River Basin, Oklahoma and Kansas, dated May 1988. Price levels were updated to June 1998 prices. Structural loss and area curves are shown for the pertinent reaches below Hulah dam to the confluence of the Caney River and the Verdigris River. Plates 4-10 through 4-12 display these curves.

TABLE 4-10

AVERAGE ANNUAL FLOOD DAMAGES
Caney River below Hulah and Copan
June 1998 price levels

Item	Damages $	Damages Prevented $	Residual Damages $
Structures	$10,200,000	$7,386,000	$2,814,000
Crops	$819,000	$325,000	$494,000
Total	$11,019,000	$7,711,000	$3,308,000

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 bubble gage connected to a digital recorder and wired to a transmitting type data collection platform. This equipment is located in a gage house on the northeast portion of the dam. Elevations can also be obtained from a wire weight gage located on the dam.

All stream gaging stations are automated gages consisting of floatwells or bubble gages connected to digital recorders and data collection platforms. Stream gages on the Caney River used in forecasting inflows to Hulah Lake are Caney River near Cedar Vale, Kansas and Caney River near Elgin, Kansas. The gages designated for regulation are; the Caney River at Bartlesville, Oklahoma, the Caney River near Ramona, Oklahoma, 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).

b. Reporting. The reporting procedures for precipitation and stream gaging stations are on a cooperative basis with the NWS and the USGS. The reporting of data from pool elevation, and stream gaging stations has been automated by using data collection 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 Geostationary Operational Environmental Satellite (GOES) to a downlink and computer facility owned and operated by the National Oceanic and Atmospheric Administration (NOAA) near Washington, D.C. The data is then transmitted to a domestic satellite (DOMSAT) which in turn passes the data 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 database on the Tulsa District Water Control Data System (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 telephone 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 telephone 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 stream gages are the responsibility of the administering agency. Both the Corps of Engineers and the USGS have stream-gaging equipment in the Caney River Basin. The Hydraulic Engineering Section, Hydrology-Hydraulics Branch, Tulsa District, is charged with the responsibility for the equipment placed by the Corps of Engineers.

TABLE 5-1

AUTOMATED GAGES

Station	Operating Agency	Tulsa ID	USGS ID	SHEF ID
Automated Stream Gages				
Caney River near Cedar Vale, Kansas	USGS	CEDA	07171600	CDVK1
Caney River near Elgin, Kansas	USGS	ELGI	07172000	ELGK1
Caney River above Coon Creek at Bartlesville, Oklahoma	USGS	BART	07174400	BVLO2
Caney River near Ramona, Oklahoma	USGS	RAMO	07175500	RAMO2
Verdigris River near Claremore, Oklahoma	USGS	CLAR	07176000	CLRO2
Automated Pool Gages				
Hulah Lake	COE	HULA	07172500	HULO2
Automated Rainfall Gages Used in the Hulah Lake Forecast Model				
Arkansas City, Kansas	USGS	AARK	07146500	ARCK1
Atlanta, Kansas	COE	ATLA		ATLK1
Dexter, Kansas	COE	DEXT		DEXK1
Hardy, Oklahoma	COE	HARD		HARO2
Ponca City, Oklahoma	COE	KAWA	07148130	PCYO2
Kaw Lake, Oklahoma	COE	KAWL	07148140	KAWO2
Havana, Kansas	COE	HAVA		HVAK1
Ralston, Oklahoma	COE	RALS	07152500	RLSO2
Bartlesville, Oklahoma	USGS	BART	07174500	BVLO2
Cedar Vale, Kansas	COE	CEDA	07171600	CDVK1
Copan Lake, Oklahoma	COE	COPA	07174300	CPLO2
Grenola, Kansas	COE	GREN	07171590	GRNK1
Beaumont, Kansas	COE	BEAU	07167451	BUMK1
Birch Lake, Oklahoma	COE	BIRC	07176460	BIRO2
Hulah Lake, Oklahoma	COE	HULA	07172500	HULO2
Elgin, Kansas	USGS	ELGI	07172000	ELGK1
Sedan, Kansas	USGS	SEDA	07173300	SDNK1
Elk Falls, Kansas	USGS	ELKF	07169800	ELFK1
Winfield, Kansas	USGS	WINF	07147800	WFDK1
Ramona, Oklahoma	USGS	RAMO	07175500	RAMO2
Skiatook Lake, Oklahoma	COE	SKIA	07177400	SKLO2
Sperry, Oklahoma	USGS	SPER	07177500	SPEO2
Oologah Lake, Oklahoma	COE	OOLO	07176000	OOLO2
Collinsville, Oklahoma	COE	COLL	07175550	CVLO2
Skiatook, Oklahoma	Mesonet			SKSO2
Foraker, Oklahoma	Mesonet			PWSO2
Newkirk, Oklahoma	Mesonet			NKSO2
Copan, Oklahoma	Mesonet			CPSO2

5-02. Water Quality Stations.

a. Facilities. No water quality stations are currently in operation on the Caney 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 31 sedimentation ranges above Hulah Dam and six degradation ranges below Hulah 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 Hulah 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 the Copan/Hulah Lake Office consist of local and long-distance telephone service. Radio Communication is by a VHF-FM fixed station (call signal WUI-307) 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 – Copan/Hulah 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 Hulah Lake (see plate 5-3) will be obtained from the WCDS database. Weather data and other data collected by the Copan/Hulah Lake Project will be submitted to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7102 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, as needed. 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 total precipitation amounts for the previous 24-hour periods (7:00 a.m. to 7:00 a.m.).

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

(3) Number of water supply pumps in operation.

(4) The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation 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, data logger, and the wire weight or staff gage. If wind or weather prevents readings on Monday, then these readings can be taken on the next day that weather permits.

c. Weekends and Holidays.

(1) Daily reports are not required 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) 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 on 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 Hulah Dam, Operation and Maintenance Manual, Volume II, dated August 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 at anytime. 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. In addition, 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. Lake information can also be obtained by the public from the internet using address "www.swt-wc.usace.army.mil". 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 Hulah Dam. Personnel in the Forecasting Section have developed a flood-forecasting model for Hulah 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) Hulah Lake pool elevation for time of forecast.

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

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

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 to compute an inflow hydrograph. Using projected releases from Hulah 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 4-2; 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 snowmelt by measuring snow pack in the mountains. However, on projects where runoff is a result of a rainfall event, as in the Tulsa District, no techniques are available at this time to forecast droughts.

VII - WATER CONTROL PLAN

7-01. General Objectives. The authorized purposes of Hulah Lake include recreation, fish and wildlife, flood control, water supply, water quality, and navigation. However, Hulah Lake is only authorized to be regulated for flood control, water supply, water quality, and navigation. Hulah 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 Hulah 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, dated November 1987.

7-02. Major Constraints. The flows on the Caney River below Hulah Lake are regulated to 6,500 cfs while the sluice gates are capable of discharging 8,300 cfs at elevation 733.0 (top of conservation pool). The invert of the sluices is at elevation 702.0, which is the lowest elevation from which water can be released from the dam. The recession of floodwaters on the Caney and Little Caney Rivers below Hulah and Copan Dams must 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 downstream of the confluence of the Caney River with the Little Caney River is about 7,000 cfs. The limiting nondamaging flow at the Caney River above Coon Creek at Bartlesville is about 10,500 cfs or a stage of 13.0 feet and about 10,400 cfs or a stage of 26.0 feet at the Caney River near Ramona gage.

7-03. Overall Plan for Water Control.

a. General. Hulah 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 Caney River watershed; however, they do not significantly affect Hulah's flood operation.

b. System Regulation. Hulah Lake will be regulated in a system with the Copan Lake for control of floods on the Caney River, in a system with other lakes in the Verdigris River basin to control floods in the lower Verdigris River, 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 Arkansas River 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, Hulah Lake will be regulated for water supply, and water quality.

c. Hulah and Copan Lakes Subsystem Regulation. The Hulah and Copan Lakes system regulation plan discussed in the previous paragraph will be used in determining a release schedule for Hulah Lake. This release schedule is determined by using the Taper program that includes projected inflows and storages to balance the Arkansas River System. When the equivalent flood control storage of the two lakes is unbalanced, the lake with the highest equivalent flood control storage will be given priority to available channel capacity of the Caney River. After a balance of their flood control storage is achieved, each lake will share the channel of the Caney River proportionate to the equivalent flood control storage utilized and the limitations below each lake. Table 7-1 will be used as a guide in determining Hulah 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 observations of the weather station and lake conditions, when requested, and report those observations to 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. Hulah Lake will be regulated for optimum flood reductions, in conjunction with Copan Lake, on the Caney River from the dam to the confluence with the Verdigris River and with the existing system of lakes on the Arkansas River and tributaries to Van Buren, Arkansas. The following regulations, as shown in Table 7-1, will govern releases from Hulah Lake. During flood control regulation, the tainter gates and sluice 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

HULAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
733.0 and Below	--	Releases are made to maintain elevation 733.0, or to meet downstream low-flow requirements defined in paragraph 7-07.
733.0 to 739.0 and forecasted not to exceed 739.0	Rising	Releases, when combined with intervening flow downstream, will not exceed channel capacities. The channel capacities are currently estimated to be 6,500 cfs below the dam, 7,000 cfs downstream of the confluence of the Little Caney River, a 13-foot stage (10,500 cfs) on the Caney River above Coon Creek at Bartlesville gage, or a 26-foot stage (10,400 cfs) at the Caney River near Ramona gage. Regulated releases may be made at less than the maximum rate permissible if the rate of release is such that the flood control pool will be empty in approximately 3 days. 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.
739.0 to 765.0 and forecasted not to exceed 765.0	Rising	Releases, when combined with intervening flow downstream, will not exceed channel capacities. The channel capacities are currently estimated to be 6,500 cfs below the dam, 7,000 cfs downstream of the confluence of the Little Caney River, a 13-foot stage (10,500 cfs) on the Caney River above Coon Creek at Bartlesville gage, or a 26-foot stage (10,400 cfs) at the Caney River near Ramona 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

TABLE 7-1 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
765.0 to 767.0 or forecasted to exceed 765.0	Rising	Releases will be based on inflow forecasts and made such that the pool elevation will not exceed elevation 767.0, 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 767.0 will be maintained, if possible, by opening the spillway gates and sluice gates as necessary to pass inflow or until the gates are fully opened. Releases will be made by operating all the spillway gates and sluice gates at uniform openings.
Above 767.0	Rising	The spillway gates and sluice gates will be maintained fully opened and held in such position.
Above 767.0	Falling	The spillway gates and sluice gates will be maintained fully opened and held in such position until the pool elevation recedes to elevation 767.0.
767.0 to 765.0	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 765.0.

TABLE 7-1 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
765.0 to 733.0	Falling	If the maximum release rate was smaller than 6,500 cfs, releases will not exceed 6,500 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 6,500 cfs, releases will be made equal to the previous 2-hour inflow or 6,500 cfs, whichever is greater. Releases much lower than 6,500 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 2-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.

TABLE 7-2

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

HULAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
Below 733.0	Rising	Continue the releases being made at the time of communication failure.
733.0 to 767.0	Rising	If the lake level is below elevation 760.0, 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 760.0 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 2 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 sluice gates will be raised at uniform openings until the lake stops rising or the sluice 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 767.0	Rising	The spillway gates and sluice gates will be maintained fully opened and held in such position.

TABLE 7-2 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
Above 767.0	Falling	The spillway gates and sluice gates will be maintained fully opened and held in such position until the pool elevation recedes to elevation 767.0.
767.0 – 765.0	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 765.0 or the release is 6,500 cfs.
765.0 – 736.0	Falling	If the maximum release rate exceeded 6,500 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 6,500 cfs. If the maximum release was much lower than 6,500 cfs, this release will be maintained until the lake level reaches 736.0.
736.0 - 733.0	Falling	Begin a gradual reduction of the release rate (not to exceed 1,100 cfs per 3-hr period) so that releases are equal to inflow (the pool is steady) at elevation 733.0.

c. Constraints. The regulation schedules insure that the channel capacity immediately below the dam is not exceeded insofar as practicable. The channel capacities are currently estimated to be 6,500 cfs below the dam, 7,000 cfs downstream of the confluence of the Little Caney River, a 13-foot stage (10,500 cfs) on the Caney River above Coon Creek at Bartlesville gage, or a 26-foot stage (10,400 cfs) at the Caney River near Ramona gage. If the 6,500 cfs release must be exceeded then the stage-damage curves shown on Plates 4-10 through 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, Hulah Lake is only authorized to make regulated releases for flood control, water supply, and water quality. 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 733.0. The access roads begin to be affected by floodwaters at elevation 736.0 (skull Creek and East Turkey Creek). All recreation area roads are impassable when the pool reaches 753.0. Some private access and county roads are also affected by high water. The Bottoms Road is impassable at elevation 734.0, and another private access road is impassable at elevation 747.5. Public facilities are listed in paragraph 2-06 of this manual and shown on plate 2-8. 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. The quality of water in Caney River is considered good, and it requires minimum treatment to be suitable for municipal, agricultural, and industrial use. Hulah Lake has 7,100 acre-feet of storage allocated to water quality, based on 50-year frequency drought, and yields an average of 4.5 mgd (7.0 cfs). The average annual downstream water quality requirements at the City of Bartlesville are presented in table 7-3. Minimum releases from Hulah and Copan Lakes for water quality control will be made in accordance with monthly flow requirements presented in table 7-4. Should additional flow above the minimum be required to satisfy the requirement at Bartlesville, it will be provided by releasing about 20 percent from Hulah and 80 percent from Copan. Additional releases shall be made as necessary to alleviate or respond to emergency conditions such as fish kills and flow augmentation for pollution abatement. Water quality and water supply releases shall not be made that will reduce the pool elevation in Hulah Lake below elevation 710.0

TABLE 7-3

LOW-FLOW REQUIREMENTS

Bartlesville Gage

Period	Flows (cfs)
January – May	10
June	11
July – August	13
September – December	10

TABLE 7-4

HULAH AND COPAN LAKES
MINIMUM LOW-FLOW RELEASES
(Present)

Month	Hulah Release Rate (cfs)	Copan Release Rate (cfs)
January – May	2	5
June – August	4	8
September – December	2	5
Annual Average	2.50	5.75

7-08. Fish and Wildlife. Although fish and wildlife is a project purpose, no storage is authorized for that purpose. The low-flow releases, for water quality, should prevent most fish and wildlife problems that might occur downstream of Hulah Lake. Management of the fish and wildlife resources will be under the direction of the (ODWC).

7-09. Water Supply.

a. General. Hulah Lake has a water supply storage of 19,800 acre-feet with a dependable yield of 12.4 MGD. Table 7-5 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. Withdrawals for municipal and industrial water supply are released through two 24-inch low flow pipes into the stilling basin. The water withdrawn from the lake or the stilling basin will be metered and read by the user and reported to the Hydraulics and Hydrology Branch on a monthly basis.

TABLE 7-5

WATER SUPPLY CONTRACTS

HULAH LAKE

USER NAME	CONTRACT APPROVAL DATE	CONTRACT TYPE	USER STORAGE (ACRE-FEET)
City of Bartlesville	06/12/57	Storage	15,400
City of Bartlesville	11/04/70	Storage	2,200
Hulah Water District, Inc.	11/04/70	Storage	100
City of Bartlesville	11/12/82	Storage	2,100

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 on a monthly accounting basis. 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 Caney River below Hulah Lake. These water rights locations and amounts are shown in Table 7-6. 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 7-6

WATER RIGHTS FOR THE CANEY RIVER

FROM THE MOUTH TO HULAH DAM

User	Point Of Diversion	Authorized Amount (ac-ft/yr)
(b) (6)		43
(b) (6)		390
(b) (6)		300
(b) (6)		915
(b) (6)		80
(b) (6)		101
(b) (6)		57
(b) (6)		4
(b) (6)		280
(b) (6)		232
Bartlesville, City of	SE-NE NE 12 T26N, R12E	6000
Ken-Ada Ranches, Inc.	SW-NE NW 01 T26N, R12E	628
(b) (6)		52
(b) (6)		232
	TOTAL	9,314

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

7-11. Navigation. Hulah 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 Hulah 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

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 Hulah Dam, dated August 1982. A copy of the plan can be found at the Copan/Hulah Lakes 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 drowning, 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. In addition, 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-ETE-P (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 7-7, 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 7-7

RELEASE RATE CHANGES

Increasing Releases to Channel Capacity

Current release range (cfs)	Maximum increase (cfs)	Minimum time between changes (hours) (1)
6,500	1,100	2

Decreasing Release Below Channel Capacity

Current release range (cfs)	Maximum decrease (cfs)	Minimum time between changes (hours) (1)
6,500	1,100	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 sluice gates 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 7-8 on pages T7-1 through T7-8. 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 the October 1986 flood are presented in the following paragraphs. The floods were selected to show the effects of the flood control regulations for Hulah Lake on a variety of possible flood conditions.

8-02. Flood Control.

a. Probable Maximum Flood. The probable maximum flood was generated by applying the probable maximum precipitation from Hydrometerological Report No. 52 to an HEC-1 rainfall-runoff computer model representing the drainage area above Hulah Lake. The flood has 915,000 acre-feet of volume and a peak inflow of 430,000 cfs. The flood, routed through Hulah Lake on a full flood control pool by emergency regulations, resulted in a peak release of 338,100 cfs at the maximum pool elevation of 775.72. Plate 8-1 shows the operational hydrographs for the probable maximum flood routed through Hulah 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 probable maximum flood. This flood has a volume of 457,500 acre-feet and a peak inflow of 215,000 cfs. The flood, routed through Hulah Lake on a full flood pool, resulted in a peak release of 215,600 cfs at the maximum pool elevation of 766.96. Plate 8-2 shows the operational hydrographs for this flood routed by emergency regulations on both empty and full flood control pools.

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 16.76 inches from September 29 to October 4. The inflow came in two peaks, one on September 30 at 70,000 cfs with no release made. The second peak occurred on October 3 with an inflow of 133,000 cfs. The flood had a volume of 366,500 acre-feet, a peak release of 58,000 cfs, and a peak pool elevation of 769.42. During this flood a deviation was requested and approved to allow the pool to rise to a maximum elevation of 770.0, if necessary. This flood is the flood of record for the Hulah Lake drainage basin. Plate 8-3 shows the operational hydrographs for Hulah Lake for both experienced and emergency regulations.

8-03. Recreation. Rock bluffs, rolling hills, and the timbered creeks make the lake an area of unique appeal for recreation. Eight public use areas have been developed around the lake. Some areas start becoming inundated at elevation 736.0 and by elevation 753.0 all of the areas are affected by the water level. Recreation activities are also affected by releases for water supply and water quality during drought periods, which causes the pool to be fall below normal.

8-04. Water Quality. Hulah Lake, overall, has good water quality that would not be significantly altered during flood control operations. During dry periods before the construction of the dam, there have been periods of zero flow on the Caney River at the damsite. With the lake, however, the present low-flow requirements from 2 to 4 cfs would prevent the flow from going to zero. This results in enhanced water quality in the Caney River.

8-05. Fish and Wildlife. Hulah Lake provides an improved fishery over the natural river, allowing some species of sport fish to flourish in contrast to previous natural river conditions. The downstream fishery is improved by releases from the lake. Minimum releases required for water quality also aid the downstream fishery in periods of low flow. Waterfowl species have increased due to the enlargement of the waterfowl habitat. Some wildlife habitat was inundated due to impoundment; however, wildlife management of lake perimeter lands strives to mitigate these losses.

8-06. Water Supply. The quality of water in the Hulah 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 Hulah Lake.

8-08. Navigation. The coordination of releases from Hulah 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.

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 that 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 Hulah Dam, dated August 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 Hulah Lake were determined using the SUPER program, a computer routing model for the period of record, for the period 1940 to 1997. Linear regression techniques were used to develop a regression equation correlating peak discharges to peak mean daily flows for the Caney River near Elgin, Kansas gage during the period 1940 to 1996. 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 Hulah 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 Disposition Form dated August 22, 1979. The Peak Inflow Probability Curve is presented in Plate 8-4.

b. Pool Elevation Duration and Frequency. The SUPER model, for the period 1940 to 1997, 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 Hulah Lake are shown on plates 4-3 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 the city of Bartlesville. The Corps of Engineers completed the study in August 1988 and revised it in November of 1988. Additional portions of the Caney River were studied in the Tulsa County Flood Insurance studies in 1976 – 1980 and in the Rogers County Flood Insurance Study in 1982 – 1983. This report includes profiles of the 500-, 100-, 50-, and 10-year floods. A special Flood Hazard information Report (June 1975) was prepared for the Port of Catoosa showing profiles and the area flooded by the 100-year flood. No channelization projects exist below Hulah Lake with the exception of 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. The U.S. Government owns Hulah Lake. The Tulsa District of the Corps of Engineers is the operating agency. Hulah 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. Make periodic visits to projects by section personnel to familiarize themselves with regulation facilities, become acquainted with the operating personnel, discuss emergency regulation procedures with operating personnel, and provide the background for improving facilities and methods.

2. Instruct personnel of the Hydrology-Hydraulics Branch in flood control procedures to supplement the Water 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, hydraulic, 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. Provide 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, the Water Control Section accomplishes the routine regulation of the lake. However, during flood periods, assistance of other personnel may be required to maintain effective regulation of the lake. Plate 5-2 shows the organization of the Water 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. The Environmental Protection Agency, together with the State of Oklahoma, establishes the standards for water quality releases.

c. State Agencies. Management of the fish and wildlife resources of the Hulah 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 Hulah 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 NWS is the responsible agency for issuing public forecasts of stream stages.

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

d. Power Marketing Agency. Presently, hydropower 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. The Tulsa District also maintains an Emergency Operations Center which coordinates emergency measures and information with affected agencies and local authorities during flood events. These agencies and authorities include Federal Emergency Management Agency and local Civil Defense teams and local governments.

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 Caney River. Arkansas River Basin compacts have been established between the States of Arkansas and Oklahoma, 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. Daily 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. The monthly lake reports are also available on the Tulsa District Web Page from 1994 to the present at www.swt-wc.usace.army.mil.

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 District Office Planning Division personnel, using information compiled and prepared by the Water Control Section prepare the report. The report should be completed within approximately three months of the time of flooding, including a statement of final cost.

e. Annual Reports. The Water Control Section prepares this report. 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**
Daily 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 4-6

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
HULAH LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1918	3400	2200	10500	17500	163300	4700	3400	15400	16200	34500	46100	12800	330000
1919	2000	5500	2300	48200	18400	35900	70000	19200	390	16000	11500	2400	231790
1920	3500	2300	43400	4900	37900	3800	30800	23300	5500	40800	8100	8100	212400
1921	19900	1000	12400	24500	6000	32400	11200	22600	29200	680	660	930	161470
1922	4000	7600	29500	110700	62300	8200	248400	1200	19900	8800	16500	2200	519300
1923	2000	1900	5800	5100	24000	7500	6000	680	53400	49400	2700	3300	161780
1924	2600	3000	12100	27000	38400	31600	47800	36900	64100	8700	21900	4000	298100
1925	9200	1800	2100	25200	10900	15700	11600	10400	38800	2800	36800	1600	166900
1926	4300	2800	4000	13000	19900	9400	40600	76900	183100	262100	2200	7200	625500
1927	3900	3900	17800	152000	20200	80300	40600	117200	28700	123900	2200	12600	603300
1928	2800	4300	18900	32200	19400	148800	14100	3000	1700	42600	73000	31200	392000
1929	6000	3500	8100	80200	108100	62800	83900	11100	840	9200	6100	1500	381340
1930	7800	2700	1400	46500	70300	165100	6900	4200	137500	10400	22200	4300	479300
1931	2600	3400	18100	4300	17000	10700	39800	19500	1100	4600	211800	2300	335200
1932	7000	2100	740	1100	12000	89400	9800	250	18800	7600	480	28900	178170
1933	2500	2900	13600	20200	65700	3500	34600	103100	30700	19400	10100	14300	320600
1934	4700	2700	1300	48000	29000	12900	6300	14800	83200	162000	14000	2300	381200
1935	6400	5200	14500	3000	73000	129800	1200	5500	5300	44800	80000	10100	378800
1936	2800	1100	510	5300	27400	23500	7400	120	172100	154800	1900	9700	406630
1937	3900	3100	12100	18100	22400	69000	229500	6000	71700	300	310	660	437070
1938	890	3900	27500	23600	115200	74400	1900	1500	1400	130	240	260	250920
1939	320	280	2000	10000	10700	4000	550	20	0	0	0	0	27870
1940	0	20	50	6000	2800	23500	7000	3100	2800	0	5500	4100	54870
1941	12500	14900	7000	75400	38500	55300	870	1700	7400	109700	42800	21500	387570
1942	8000	23400	24200	128100	13200	62900	3400	7800	78900	18300	7200	23800	399200
1943	14900	10900	10200	7300	244500	35800	3000	1000	430	1400	240	1100	330770
1944	2400	2200	26600	236700	42700	10100	1200	2000	26700	49900	3700	66600	470800
1945	7400	6600	106800	137100	27000	12800	30700	940	147800	72200	3600	2200	555140
1946	25100	21700	41200	15100	5600	1400	700	310	600	50	2400	810	114970
1947	700	460	8100	156300	80400	22200	4100	570	200	60	90	160	273340
1948	200	170	3700	16800	27000	51100	110200	44400	1300	270	2100	2500	259740
1949	62400	97100	37000	27100	54100	17900	12600	1200	27200	11100	2800	2300	352800
1950	5700	3000	6100	4400	30400	67300	172800	109800	15400	2800	1600	1300	420600
1951	1600	7800	6200	18800	79500	123400	97500	4600	62200	23700	68300	18000	511600

TABLE 4-6 (Cont'd)

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
HULAH LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1952	17200	14200	80900	45300	9200	9400	1600	610	0	0	670	240	179320
1953	180	430	2200	4400	21600	7000	1500	4	1500	900	960	0	40674
1954	80	560	250	4000	47600	2900	280	950	690	15600	200	700	73810
1955	860	2600	3000	2300	75300	6900	290	450	880	22400	80	230	115290
1956	580	290	660	820	1400	3100	430	820	310	720	240	280	9650
1957	80	300	650	42100	182000	231100	10500	1600	2100	580	2800	1700	475510
1958	1600	2800	94200	80600	28900	3500	31800	2400	2200	620	910	990	250520
1959	870	1300	2900	16400	22500	7400	196300	6800	7700	176400	9700	13400	461670
1960	17100	29100	48300	30000	19500	6300	3400	6700	830	3400	2200	5700	172530
1961	1500	3900	15400	67200	252700	14100	6700	15600	164700	65000	139800	42300	788900
1962	26200	11800	10200	7200	2800	10400	2000	1400	6500	1900	1400	2900	84700
1963	11700	2700	16000	3800	3800	1700	840	790	8	510	180	0	42028
1964	460	200	610	5400	12000	6100	0	20900	3100	390	68300	17500	134960
1965	14100	8400	17600	122000	12600	18800	4800	2800	15500	300	60	1400	218360
1966	2100	6900	9300	5000	5600	66400	1300	260	40	140	140	320	97500
1967	1100	560	600	3600	3700	44700	27800	470	19400	18000	4500	5800	130230
1968	13600	5100	26400	31700	48800	15200	7100	19600	18900	21200	54000	37900	299500
1969	23400	35900	69000	75900	37600	150500	6500	1200	2100	21700	3700	410	427910
1970	3200	1900	10000	148200	14000	10300	960	220	1600	670	150	430	191630
1971	6700	7400	7000	3300	4200	4100	1900	390	14600	17700	3800	43800	114890
1972	10000	4300	2900	9400	19600	760	33900	2400	1500	5800	61400	29900	181860
1973	99300	32400	223600	92100	33200	5100	2200	510	6800	10300	31200	49100	585810
1974	32200	29100	185000	20800	62900	65100	1400	5900	5500	39500	152300	37900	637600
1975	72800	74600	81000	64100	89400	64900	2400	7200	280	780	1200	710	459370
1976	660	1000	14100	26700	18900	4600	102200	3400	320	410	300	400	172990
1977	200	1300	1800	11700	102000	102900	6300	44900	33600	7700	82900	5400	400700
1978	3200	42300	35300	41600	132600	57500	6200	380	240	700	1900	750	322670
1979	7100	8600	20800	25900	6700	22600	11500	1900	520	1200	91400	3800	202020
1980	2500	11000	54200	68500	16000	2000	110	470	440	170	0	730	156120
1981	0	210	850	780	7800	4000	850	2300	360	4900	24800	5400	52250
1982	5400	11500	27600	4300	166400	78600	5200	1400	1700	860	1400	6700	311060
1983	5500	27700	43200	94400	109200	11600	2000	230	650	26500	3200	5200	329380
1984	510	880	12300	5900	4200	970	80	830	90	77800	9800	84000	197360
1985	38900	113900	86900	61700	38000	109000	2300	4600	21000	76000	97800	24000	674100
1986	8500	7200	10400	51300	128400	82600	24000	10300	127700	332900	74400	54700	912400

TABLE 4-6 (Cont'd)

ESTIMATED MONTHLY AND ANNUAL FLOWS IN ACRE-FEET
HULAH LAKE

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1987	37000	125000	117600	19500	95000	27100	25000	6600	1600	1500	25700	73600	555200
1988	45800	10700	93100	169100	12400	1800	3100	560	14100	1200	5700	3900	361460
1989	4500	5200	45900	10100	29300	175000	7500	18200	122300	60500	14100	4800	497400
1990	25300	34800	197500	43900	112700	8000	440	1220	1370	1460	2200	630	429520
1991	1600	340	50	25930	18390	31640	800	160	1050	1000	360	22430	103750
1992	9240	15470	15160	9260	7340	69280	8410	3870	1640	230	93740	94040	327680
1993	69090	46770	50820	39270	276440	28610	16260	1170	27390	1160	12440	12610	582030
1994	6030	16900	9030	208030	46220	2300	27040	4080	1670	1388	61806	11861	396355
1995	6813	5484	74272	31548	131407	233111	125089	15551	3114	0	12	853	627254
1996	466	258	0	5405	5871	5465	0	2460	22562	18318	69899	23058	153762
1997	5703	89972	19299	71644	62619	59396	30189	3828	5296	8013	3917	65753	425629
MEAN	11054	13858	29671	43272	51950	42262	26761	11233	25000	29268	24085	13791	322204
MAXIMUM	99300	125000	223600	236700	276440	233111	248400	117200	183100	332900	211800	94040	912400
MINIMUM	0	20	0	780	1400	760	0	4	0	0	0	0	9650

TABLE 6-1

HULAH LAKE
HEC-1 FORECAST MODEL

```
ID      VERDIGRIS FORECAST MODEL
ID      UNIT HYDROGRAPHS COOK MAY,83
ID      MODIFIED BY ESTEP OCT,94
IT   120 13OCT98    1200     200      1900
*FREE
IO     3
VS CEDAL   ELGIL   CEDAL   ELGIL
VV  5.11    5.11    2.11    2.11
VSHULAIN  COPAIN  HULOUT  COPOUT
VV  2.11    2.11    7.11    7.11
* *******************************************************
* *** START COPAN MODEL ****
KK SEDAL
KM SEDAN GAGE SITE
* :PLOT-MACRO: SEDA
BA  119
* B  BASE FLOW FOR SEDA GAGE SITE
BF    0    -.25     1.01
PB 0
ZR=PI B=SEDAL C=PRECIP-INC F=ADJUST
* L  LOSS RATE FOR SEDA
LU    0       0
US    8     .68
ZW      B=SEDA C=FLOW-LOC CUM F=CALC
* *******************************************************
KKSEDANR
KM ROUTE HYDROGRAPH TO LAKE
RM     1      14      .3
* *******************************************************
KK COPAL
KM  HYDROGRAPH AT COPAN LAKE
BA 371.8
BF     0    -.25    1.02
PB  0
ZR=PI B=COPAL C=PRECIP-INC F=ADJUST
* L  LOSS RATE FOR COPAN LOCAL
LU     0       0
US    20     .60
* *******************************************************
KKCOPLAK   COPAN LAKE SURFACE
BA  14.2
BF     0    -.01    1.15
PB  0
ZR=PI B=COPAL C=PRECIP-INC F=ADJUST
LU     0       0
UI  4595
* *******************************************************
KKCOPAIN
```

TABLE 6-1 (CONT'D)

```
KM COMBINE HYDROGRAPHS FOR TOTAL INFLOW INTO COPAN LAKE
HC     3
ZW      B=COPA C=FLOW-RES IN F=CALC
* *******************************************************
KKCOPARE
KM  CALL RELEASES FROM COPAN LAKE
BA 1
ZR=-QI  B=COPA C=FLOW-RES OUT F=OBS
* *******************************************************
KKCOPDIF
KM SUBTRACT RELEASES TO PRODUCE NET INFLOW
HC 2
* *******************************************************
KKCOPOUT
KM  ROUTE NET INFLOW THROUGH COPAN LAKE
* :PLOT-MACRO: COPA
* R             COPAN LAKE
RS     1    ELEV 710
SV 6685 14220 34280 43400 65070 121800 203200 227700 338500 455400
SE  698   702   708   710   714    722    730    732  739.1    745
SQ    0     0
SE  698   745
ZW      B=COPA C=ELEV F=CALC
* *************************************************
KKCOPAON           CONDUIT RELEASES (24-HOUR VALUES)
BA 1
ZR=QI   B=COPA C=FLOW-RES OUT F=OBS
* *************************************************
KKCOPSPL           SPILLWAY+CONDUIT
HC     2
* *** END COPAN MODEL ****
* *** start hulah model ****
KK CEDAL
KM  CEDAR VALE GAGE SUBAREA (458-3)
* :PLOT-MACRO: CEDA
BA   208
* B   BASE FLOW FOR ELGIN GAGE AREA
BF     0   -0.25    1.025
PB     0
ZR=PI   B=CEDAL C=PRECIP-INC F=ADJUST
* L    LOSS RATE CARD FOR THE HULAH LAKE LOCAL SUBAREA
LU     0       0
US    11     .68
ZW  B=CEDA C=FLOW-LOC CUM F=CALC
* *******************************************************
KKCEDRVE           ROUTE COMBINED HYDROGRAPHS THROUGH AREA ELGIL
RM     2       5      .3
* *************************************************
KK ELGIL
KM   ELGIN GAGE SUBAREA (458-4)
BA   237
PB     0
```

TABLE 6-1 (CONT'D)

```
ZR=PI   B=ELGIL C=PRECIP-INC F=ADJUST
* L    LOSS RATE CARD FOR THE HULAH LAKE LOCAL SUBAREA
LU     0       0
US    10     .72
* ************************************************************
KK ELGIN           COMBINE HYDROGRAPHS AT ELGIN GAGE
* :PLOT-MACRO: ELGI
HC     2
ZW  B=ELGI C=FLOW-LOC CUM F=CALC
* ************************************************************
KK  ELGN           ROUTE COMBINED HYDROGRAPHS THROUGH AREA BUCK
RM     1       3      .3
* ************************************************************
KK HULAL           HULAH LAKE AREA
BA   274
PB     0
ZR=PI   B=HULAL C=PRECIP-INC F=ADJUST
* L    LOSS RATE CARD FOR THE HULAH LAKE LOCAL SUBAREA
LU     0       0
US    12     .72
* ************************************************************
KKHULLAK           HULAH LAKE SURFACE
BA    13
BF     0   -0.01    1.20
PB     0
ZR=PI   B=HULAL C=PRECIP-INC F=ADJUST
LU     0       0
UI  4177
* ************************************************************
KKHULAIN           COMBINE HYDROGRAPHS AT HULAH DAM (INFLOW)
KO     3
HC     3
ZW      B=HULA C=FLOW-RES IN F=CALC
* ************************************************************
KKHULARE           RELEASES (24 HOUR AVERAGE.  USE NEGATIVE VALUES)
BA     1
ZR=-QI   B=HULA C=FLOW-RES OUT F=OBS
* ************************************************************
KKHULDIF           DIFFERENCE BETWEEN INFLOW AND RELEASE
HC     2
* ************************************************************
KKHULOUT           NET INFLOW ROUTED THRU LAKE
* :PLOT-MACRO: HULA
* R          HULAH LAKE
RS     1    ELEV 733.00
SV     0   5948  31156  34834  42808  51628  61408  72308  84448  91018
SV 97918 112698 128778 146078 164588 205158 251188 289088 329808 389488
SE   710    722    733    734    736    738    740    742    744    745
SE   746    748    750    752    754    758    762    765    768    772
SQ     0       0
SE   726     772
ZW      B=HULA C=ELEV F=CALC
```

TABLE 6-1 (CONT'D)

```
* ***************************************************
KKHULAON            CONDUIT RELEASES (24-HOUR VALUES)
BA 1
ZR=QI   B=HULA C=FLOW-RES OUT F=OBS
* ***************************************************
KKHULSPL            SPILLWAY+CONDUIT
HC     2
* *** end hulah model ****
KK HUPAN            HULAH &COPAN COMBINED
HC     2
* ***************************************************************
KKBRTRT
RM     2     18     0.3
* ***************************************************************
KK BARTL            BARTLESVILLE LOCAL RUNOFF
BA   155
* B    BASE FLOW FOR BART GAGE
BF     0     -.1   1.015
* L    LOSS RATE FOR BARTL
LU     0       0
PB     0
ZR=PI   B=BARTL C=PRECIP-INC F=ADJUST
US    11    0.65
* ***************************************************************
KKBRTCON            TOTAL FLOW AT BARTLESVILLE
* :PLOT-MACRO: BART
HC     2
ZW      B=BART C=FLOW-LOC CUM F=CALC
* ***************************************************************
KKRAMOLR            COMBINED OUTFLOWS ROUTED TO RAMONA
RM     4      36      .4
* ***************************************************************
KK RAMOL            RAMONA LOCAL RUNOFF
BA   563
* B    BASE FLOW FOR RAMO GAGE
BF     0     -.2   1.015
* L    LOSS RATE FOR RAMO GAGE
LU     0       0
PB     0
ZR=PI   B=RAMOL C=PRECIP-INC F=ADJUST
US    24     .52
* ***************************************************************
KKRAMONA            COMBINED FLOWS AT RAMONA GAGE
* :PLOT-MACRO: RAMO
HC     2
ZW      B=RAMO C=FLOW-LOC CUM F=CALC
* ***************************************************************
KKCLRMRT            ROUTE TO VERDIGRIS CONFLUENCE
RM     2      22      .2
* ***************************************************************
KKCLARCR            LOCAL AREA ABOVE VERDIGRIS CONFLUENCE
BA   156
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TABLE 6-1 (CONT'D)

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PB     0
ZR=PI   B=CLARCR C=PRECIP-INC F=ADJUST
US    12     .60
* ************************************************************
KKCANVER           CANEY RIVER ABOVE VERDIGRIS RIVER
HC     2
* ************************************************************
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TABLE 7-8

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

AREA IN 1000'S OF AC

ELEV	0	1	2	3	4	5	6	7	8	9
710	0.000	0.118	0.192	0.268	0.342	0.418	0.482	0.558	0.622	0.698
720	0.798	0.918	1.068	1.228	1.438	1.648	1.908	2.168	2.428	2.688
730	2.908	3.128	3.348	3.568	3.788	3.980	4.200	4.400	4.640	4.880
740	5.160	5.440	5.760	6.060	6.400	6.740	7.060	7.380	7.740	8.000
750	8.420	8.580	9.020	9.200	9.600	9.800	10.160	10.400	10.820	11.100
760	11.560	11.840	12.240	12.460	12.820	13.000	13.420	13.780	14.040	14.620
770	14.800	15.460	15.560	16.365	16.700	17.350	18.000	18.580		

CAPACITY IN 1000'S OF ACRE-FEET

ELEV	0	1	2	3	4	5	6	7	8	9
710	0.000	0.059	0.214	0.444	0.749	1.129	1.579	2.099	2.689	3.349
720	4.097	4.955	5.948	7.096	8.429	9.972	11.750	13.788	16.086	18.644
730	21.442	24.460	27.698	31.156	34.834	38.718	42.808	47.108	51.628	56.388
740	61.408	66.708	72.308	78.218	84.448	91.018	97.918	105.138	112.698	120.568
750	128.778	137.278	146.078	155.188	164.588	174.288	184.268	194.548	205.158	216.118
760	227.448	239.148	251.188	263.538	276.178	289.088	302.298	315.898	329.808	344.138
770	358.848	373.978	389.488	405.451	421.983	439.008	456.683	474.973		

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

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
710.0	0.000	0.001	0.002	0.005	0.010	0.015	0.021	0.029	0.038	0.048
711.0	0.059	0.071	0.084	0.098	0.112	0.127	0.143	0.160	0.177	0.195
712.0	0.214	0.234	0.254	0.275	0.297	0.320	0.343	0.367	0.392	0.418
713.0	0.444	0.471	0.499	0.528	0.557	0.587	0.618	0.650	0.682	0.715
714.0	0.749	0.784	0.819	0.855	0.892	0.930	0.968	1.007	1.047	1.088
715.0	1.129	1.171	1.214	1.257	1.301	1.346	1.391	1.437	1.484	1.531
716.0	1.579	1.628	1.677	1.727	1.778	1.830	1.882	1.935	1.989	2.044
717.0	2.099	2.155	2.212	2.269	2.327	2.386	2.445	2.505	2.566	2.627
718.0	2.689	2.752	2.815	2.879	2.944	3.010	3.076	3.143	3.211	3.280
719.0	3.349	3.419	3.491	3.563	3.636	3.711	3.786	3.862	3.940	4.018
720.0	4.097	4.177	4.259	4.342	4.426	4.511	4.597	4.685	4.774	4.864
721.0	4.955	5.048	5.142	5.237	5.334	5.433	5.533	5.634	5.737	5.842
722.0	5.948	6.056	6.165	6.276	6.388	6.502	6.618	6.735	6.854	6.974
723.0	7.096	7.220	7.346	7.474	7.604	7.736	7.871	8.007	8.146	8.286
724.0	8.429	8.574	8.721	8.870	9.021	9.174	9.330	9.487	9.647	9.808
725.0	9.972	10.138	10.307	10.478	10.652	10.829	11.008	11.189	11.374	11.561
726.0	11.750	11.942	12.137	12.334	12.534	12.737	12.942	13.149	13.360	13.573
727.0	13.788	14.006	14.227	14.450	14.676	14.905	15.136	15.369	15.606	15.845
728.0	16.086	16.330	16.577	16.826	17.078	17.333	17.590	17.849	18.112	18.377
729.0	18.644	18.914	19.186	19.460	19.737	20.016	20.297	20.580	20.865	21.152
730.0	21.442	21.734	22.028	22.324	22.623	22.924	23.226	23.532	23.839	24.148
731.0	24.460	24.774	25.090	25.408	25.729	26.052	26.377	26.704	27.033	27.364
732.0	27.698	28.034	28.372	28.712	29.055	29.400	29.747	30.096	30.447	30.800
733.0	31.156	31.514	31.874	32.236	32.601	32.968	33.336	33.708	34.081	34.456
734.0	34.834	35.214	35.596	35.979	36.365	36.752	37.141	37.533	37.926	38.321
735.0	38.718	39.117	39.518	39.922	40.328	40.736	41.146	41.558	41.972	42.389
736.0	42.808	43.229	43.652	44.077	44.504	44.933	45.364	45.797	46.232	46.669
737.0	47.108	47.549	47.993	48.439	48.887	49.338	49.791	50.247	50.705	51.165
738.0	51.628	52.093	52.561	53.031	53.503	53.978	54.455	54.935	55.417	55.901
739.0	56.388	56.877	57.370	57.865	58.362	58.863	59.366	59.873	60.382	60.894

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

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
740.0	61.408	61.925	62.446	62.969	63.494	64.023	64.554	65.089	65.626	66.165
741.0	66.708	67.254	67.802	68.354	68.910	69.468	70.030	70.594	71.162	71.734
742.0	72.308	72.886	73.466	74.050	74.636	75.226	75.818	76.414	77.012	77.614
743.0	78.218	78.826	79.437	80.051	80.669	81.291	81.915	82.543	83.175	83.810
744.0	84.448	85.090	85.735	86.383	87.035	87.691	88.349	89.011	89.677	90.346
745.0	91.018	91.694	92.372	93.054	93.740	94.428	95.120	95.814	96.512	97.214
746.0	97.918	98.626	99.337	100.050	100.768	101.488	102.212	102.938	103.668	104.402
747.0	105.138	105.878	106.621	107.368	108.119	108.873	109.631	110.392	111.157	111.926
748.0	112.698	113.473	114.251	115.032	115.815	116.601	117.389	118.180	118.973	119.769
749.0	120.568	121.370	122.176	122.987	123.802	124.621	125.444	126.271	127.103	127.938
750.0	128.778	129.621	130.465	131.311	132.159	133.008	133.859	134.711	135.565	136.421
751.0	137.278	138.138	139.003	139.872	140.745	141.623	142.505	143.392	144.283	145.178
752.0	146.078	146.981	147.886	148.792	149.701	150.611	151.523	152.436	153.352	154.269
753.0	155.188	156.110	157.036	157.966	158.900	159.838	160.780	161.726	162.676	163.630
754.0	164.588	165.549	166.512	167.477	168.444	169.413	170.384	171.357	172.332	173.309
755.0	174.288	175.270	176.255	177.244	178.237	179.233	180.233	181.236	182.243	183.254
756.0	184.268	185.285	186.305	187.327	188.351	189.378	190.407	191.439	192.473	193.509
757.0	194.548	195.590	196.637	197.687	198.742	199.801	200.864	201.931	203.003	204.078
758.0	205.158	206.242	207.328	208.417	209.508	210.603	211.701	212.801	213.904	215.010
759.0	216.118	217.230	218.347	219.469	220.595	221.726	222.861	224.001	225.145	226.294
760.0	227.448	228.605	229.766	230.929	232.095	233.263	234.435	235.609	236.786	237.965
761.0	239.148	240.334	241.524	242.718	243.916	245.118	246.324	247.534	248.748	249.966
762.0	251.188	252.413	253.641	254.870	256.102	257.336	258.572	259.810	261.051	262.293
763.0	263.538	264.786	266.037	267.292	268.551	269.813	271.079	272.348	273.621	274.898
764.0	276.178	277.461	278.746	280.032	281.320	282.611	283.902	285.196	286.492	287.789
765.0	289.088	290.390	291.697	293.007	294.322	295.641	296.964	298.291	299.622	300.958
766.0	302.298	303.642	304.989	306.340	307.695	309.053	310.415	311.780	313.149	314.522
767.0	315.898	317.277	318.659	320.044	321.431	322.821	324.213	325.608	327.005	328.405
768.0	329.808	331.215	332.628	334.046	335.471	336.901	338.337	339.778	341.226	342.679
769.0	344.138	345.601	347.066	348.532	350.001	351.471	352.943	354.416	355.892	357.369

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

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
770.0	358.848	360.331	361.821	363.318	364.821	366.331	367.847	369.370	370.899	372.435
771.0	373.978	375.525	377.072	378.621	380.170	381.721	383.272	384.825	386.378	387.933
772.0	389.488	391.048	392.616	394.192	395.777	397.369	398.969	400.577	402.194	403.818
773.0	405.451	407.089	408.730	410.375	412.023	413.675	415.330	416.988	418.650	420.315
774.0	421.983	423.656	425.336	427.022	428.715	430.414	432.120	433.832	435.551	437.276
775.0	439.008	440.746	442.491	444.242	446.000	447.764	449.535	451.312	453.096	454.886
776.0	456.683	458.486	460.295	462.109	463.930	465.756	467.587	469.425	471.269	473.118

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
710.0	0.000	0.001	0.002	0.005	0.010	0.015	0.021	0.029	0.038	0.048
	0.000	0.012	0.024	0.036	0.047	0.059	0.071	0.083	0.095	0.106
711.0	0.059	0.071	0.084	0.098	0.112	0.127	0.143	0.160	0.177	0.195
	0.118	0.125	0.133	0.140	0.148	0.155	0.163	0.170	0.177	0.185
712.0	0.214	0.234	0.254	0.275	0.297	0.320	0.343	0.367	0.392	0.418
	0.192	0.200	0.207	0.215	0.222	0.230	0.238	0.245	0.253	0.261
713.0	0.444	0.471	0.499	0.528	0.557	0.587	0.618	0.650	0.682	0.715
	0.268	0.275	0.283	0.290	0.298	0.305	0.313	0.320	0.327	0.335
714.0	0.749	0.784	0.819	0.855	0.892	0.930	0.968	1.007	1.047	1.088
	0.342	0.350	0.357	0.365	0.373	0.380	0.388	0.395	0.403	0.411
715.0	1.129	1.171	1.214	1.257	1.301	1.346	1.391	1.437	1.484	1.531
	0.418	0.424	0.431	0.437	0.444	0.450	0.456	0.463	0.469	0.476
716.0	1.579	1.628	1.677	1.727	1.778	1.830	1.882	1.935	1.989	2.044
	0.482	0.490	0.497	0.505	0.512	0.520	0.528	0.535	0.543	0.551
717.0	2.099	2.155	2.212	2.269	2.327	2.386	2.445	2.505	2.566	2.627
	0.558	0.564	0.571	0.577	0.584	0.590	0.596	0.603	0.609	0.616
718.0	2.689	2.752	2.815	2.879	2.944	3.010	3.076	3.143	3.211	3.280
	0.622	0.630	0.637	0.645	0.652	0.660	0.668	0.675	0.683	0.691
719.0	3.349	3.419	3.491	3.563	3.636	3.711	3.786	3.862	3.940	4.018
	0.698	0.708	0.718	0.728	0.738	0.748	0.758	0.768	0.778	0.788
720.0	4.097	4.177	4.259	4.342	4.426	4.511	4.597	4.685	4.774	4.864
	0.798	0.810	0.822	0.834	0.846	0.858	0.870	0.882	0.894	0.906
721.0	4.955	5.048	5.142	5.237	5.334	5.433	5.533	5.634	5.737	5.842
	0.918	0.933	0.948	0.963	0.978	0.993	1.008	1.023	1.038	1.053
722.0	5.948	6.056	6.165	6.276	6.388	6.502	6.618	6.735	6.854	6.974
	1.068	1.084	1.100	1.116	1.132	1.148	1.164	1.180	1.196	1.212
723.0	7.096	7.220	7.346	7.474	7.604	7.736	7.871	8.007	8.146	8.286
	1.228	1.249	1.270	1.291	1.312	1.333	1.354	1.375	1.396	1.417
724.0	8.429	8.574	8.721	8.870	9.021	9.174	9.330	9.487	9.647	9.808
	1.438	1.459	1.480	1.501	1.522	1.543	1.564	1.585	1.606	1.627
725.0	9.972	10.138	10.307	10.478	10.652	10.829	11.008	11.189	11.374	11.561
	1.648	1.674	1.700	1.726	1.752	1.778	1.804	1.830	1.856	1.882
726.0	11.750	11.942	12.137	12.334	12.534	12.737	12.942	13.149	13.360	13.573
	1.908	1.934	1.960	1.986	2.012	2.038	2.064	2.090	2.116	2.142
727.0	13.788	14.006	14.227	14.450	14.676	14.905	15.136	15.369	15.606	15.845
	2.168	2.194	2.220	2.246	2.272	2.298	2.324	2.350	2.376	2.402
728.0	16.086	16.330	16.577	16.826	17.078	17.333	17.590	17.849	18.112	18.377
	2.428	2.454	2.480	2.506	2.532	2.558	2.584	2.610	2.636	2.662
729.0	18.644	18.914	19.186	19.460	19.737	20.016	20.297	20.580	20.865	21.152
	2.688	2.710	2.732	2.754	2.776	2.798	2.820	2.842	2.864	2.886

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
730.0	21.442	21.734	22.028	22.324	22.623	22.924	23.226	23.532	23.839	24.148
	2.908	2.930	2.952	2.974	2.996	3.018	3.040	3.062	3.084	3.106
731.0	24.460	24.774	25.090	25.408	25.729	26.052	26.377	26.704	27.033	27.364
	3.128	3.150	3.172	3.194	3.216	3.238	3.260	3.282	3.304	3.326
732.0	27.698	28.034	28.372	28.712	29.055	29.400	29.747	30.096	30.447	30.800
	3.348	3.370	3.392	3.414	3.436	3.458	3.480	3.502	3.524	3.546
733.0	31.156	31.514	31.874	32.236	32.601	32.968	33.336	33.708	34.081	34.456
	3.568	3.590	3.612	3.634	3.656	3.678	3.700	3.722	3.744	3.766
734.0	34.834	35.214	35.596	35.979	36.365	36.752	37.141	37.533	37.926	38.321
	3.788	3.807	3.826	3.846	3.865	3.884	3.903	3.922	3.942	3.961
735.0	38.718	39.117	39.518	39.922	40.328	40.736	41.146	41.558	41.972	42.389
	3.980	4.002	4.024	4.046	4.068	4.090	4.112	4.134	4.156	4.178
736.0	42.808	43.229	43.652	44.077	44.504	44.933	45.364	45.797	46.232	46.669
	4.200	4.220	4.240	4.260	4.280	4.300	4.320	4.340	4.360	4.380
737.0	47.108	47.549	47.993	48.439	48.887	49.338	49.791	50.247	50.705	51.165
	4.400	4.424	4.448	4.472	4.496	4.520	4.544	4.568	4.592	4.616
738.0	51.628	52.093	52.561	53.031	53.503	53.978	54.455	54.935	55.417	55.901
	4.640	4.664	4.688	4.712	4.736	4.760	4.784	4.808	4.832	4.856
739.0	56.388	56.877	57.370	57.865	58.362	58.863	59.366	59.873	60.382	60.894
	4.880	4.908	4.936	4.964	4.992	5.020	5.048	5.076	5.104	5.132
740.0	61.408	61.925	62.446	62.969	63.494	64.023	64.554	65.089	65.626	66.165
	5.160	5.188	5.216	5.244	5.272	5.300	5.328	5.356	5.384	5.412
741.0	66.708	67.254	67.802	68.354	68.910	69.468	70.030	70.594	71.162	71.734
	5.440	5.472	5.504	5.536	5.568	5.600	5.632	5.664	5.696	5.728
742.0	72.308	72.886	73.466	74.050	74.636	75.226	75.818	76.414	77.012	77.614
	5.760	5.790	5.820	5.850	5.880	5.910	5.940	5.970	6.000	6.030
743.0	78.218	78.826	79.437	80.051	80.669	81.291	81.915	82.543	83.175	83.810
	6.060	6.094	6.128	6.162	6.196	6.230	6.264	6.298	6.332	6.366
744.0	84.448	85.090	85.735	86.383	87.035	87.691	88.349	89.011	89.677	90.346
	6.400	6.434	6.468	6.502	6.536	6.570	6.604	6.638	6.672	6.706
745.0	91.018	91.694	92.372	93.054	93.740	94.428	95.120	95.814	96.512	97.214
	6.740	6.772	6.804	6.836	6.868	6.900	6.932	6.964	6.996	7.028
746.0	97.918	98.626	99.337	100.050	100.768	101.488	102.212	102.938	103.668	104.402
	7.060	7.092	7.124	7.156	7.188	7.220	7.252	7.284	7.316	7.348
747.0	105.138	105.878	106.621	107.368	108.119	108.873	109.631	110.392	111.157	111.926
	7.380	7.416	7.452	7.488	7.524	7.560	7.596	7.632	7.668	7.704
748.0	112.698	113.473	114.251	115.032	115.815	116.601	117.389	118.180	118.973	119.769
	7.740	7.766	7.792	7.818	7.844	7.870	7.896	7.922	7.948	7.974
749.0	120.568	121.370	122.176	122.987	123.802	124.621	125.444	126.271	127.103	127.938
	8.000	8.042	8.084	8.126	8.168	8.210	8.252	8.294	8.336	8.378

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
750.0	128.778	129.621	130.465	131.311	132.159	133.008	133.859	134.711	135.565	136.421
	8.420	8.436	8.452	8.468	8.484	8.500	8.516	8.532	8.548	8.564
751.0	137.278	138.138	139.003	139.872	140.745	141.623	142.505	143.392	144.283	145.178
	8.580	8.624	8.668	8.712	8.756	8.800	8.844	8.888	8.932	8.976
752.0	146.078	146.981	147.886	148.792	149.701	150.611	151.523	152.436	153.352	154.269
	9.020	9.038	9.056	9.074	9.092	9.110	9.128	9.146	9.164	9.182
753.0	155.188	156.110	157.036	157.966	158.900	159.838	160.780	161.726	162.676	163.630
	9.200	9.240	9.280	9.320	9.360	9.400	9.440	9.480	9.520	9.560
754.0	164.588	165.549	166.512	167.477	168.444	169.413	170.384	171.357	172.332	173.309
	9.600	9.620	9.640	9.660	9.680	9.700	9.720	9.740	9.760	9.780
755.0	174.288	175.270	176.255	177.244	178.237	179.233	180.233	181.236	182.243	183.254
	9.800	9.836	9.872	9.908	9.944	9.980	10.016	10.052	10.088	10.124
756.0	184.268	185.285	186.305	187.327	188.351	189.378	190.407	191.439	192.473	193.509
	10.160	10.184	10.208	10.232	10.256	10.280	10.304	10.328	10.352	10.376
757.0	194.548	195.590	196.637	197.687	198.742	199.801	200.864	201.931	203.003	204.078
	10.400	10.442	10.484	10.526	10.568	10.610	10.652	10.694	10.736	10.778
758.0	205.158	206.242	207.328	208.417	209.508	210.603	211.701	212.801	213.904	215.010
	10.820	10.848	10.876	10.904	10.932	10.960	10.988	11.016	11.044	11.072
759.0	216.118	217.230	218.347	219.469	220.595	221.726	222.861	224.001	225.145	226.294
	11.100	11.146	11.192	11.238	11.284	11.330	11.376	11.422	11.468	11.514
760.0	227.448	228.605	229.766	230.929	232.095	233.263	234.435	235.609	236.786	237.965
	11.560	11.588	11.616	11.644	11.672	11.700	11.728	11.756	11.784	11.812
761.0	239.148	240.334	241.524	242.718	243.916	245.118	246.324	247.534	248.748	249.966
	11.840	11.880	11.920	11.960	12.000	12.040	12.080	12.120	12.160	12.200
762.0	251.188	252.413	253.641	254.870	256.102	257.336	258.572	259.810	261.051	262.293
	12.240	12.262	12.284	12.306	12.328	12.350	12.372	12.394	12.416	12.438
763.0	263.538	264.786	266.037	267.292	268.551	269.813	271.079	272.348	273.621	274.898
	12.460	12.496	12.532	12.568	12.604	12.640	12.676	12.712	12.748	12.784
764.0	276.178	277.461	278.746	280.032	281.320	282.611	283.902	285.196	286.492	287.789
	12.820	12.838	12.856	12.874	12.892	12.910	12.928	12.946	12.964	12.982
765.0	289.088	290.390	291.697	293.007	294.322	295.641	296.964	298.291	299.622	300.958
	13.000	13.042	13.084	13.126	13.168	13.210	13.252	13.294	13.336	13.378
766.0	302.298	303.642	304.989	306.340	307.695	309.053	310.415	311.780	313.149	314.522
	13.420	13.456	13.492	13.528	13.564	13.600	13.636	13.672	13.708	13.744
767.0	315.898	317.277	318.659	320.044	321.431	322.821	324.213	325.608	327.005	328.405
	13.780	13.806	13.832	13.858	13.884	13.910	13.936	13.962	13.988	14.014
768.0	329.808	331.215	332.628	334.046	335.471	336.901	338.337	339.778	341.226	342.679
	14.040	14.098	14.156	14.214	14.272	14.330	14.388	14.446	14.504	14.562
769.0	344.138	345.601	347.066	348.532	350.001	351.471	352.943	354.416	355.892	357.369
	14.620	14.638	14.656	14.674	14.692	14.710	14.728	14.746	14.764	14.782

TABLE 7-8 (CONT'D)

HULAH LAKE, OKLAHOMA — STATION FILE NO. 07173000
BASED ON 1973 RESURVEY — TABLE NO. 3

CAPACITY [1000'S OF ACRE-FEET]
AREA [1000'S OF ACRES]

ELEV	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
770.0	358.848	360.331	361.821	363.318	364.821	366.331	367.847	369.370	370.899	372.435
	14.800	14.866	14.932	14.998	15.064	15.130	15.196	15.262	15.328	15.394
771.0	373.978	375.525	377.072	378.621	380.170	381.721	383.272	384.825	386.378	387.933
	15.460	15.470	15.480	15.490	15.500	15.510	15.520	15.530	15.540	15.550
772.0	389.488	391.048	392.616	394.192	395.777	397.369	398.969	400.577	402.194	403.818
	15.560	15.641	15.721	15.802	15.882	15.963	16.043	16.124	16.204	16.285
773.0	405.451	407.089	408.730	410.375	412.023	413.675	415.330	416.988	418.650	420.315
	16.365	16.399	16.432	16.466	16.499	16.533	16.566	16.600	16.633	16.667
774.0	421.983	423.656	425.336	427.022	428.715	430.414	432.120	433.832	435.551	437.276
	16.700	16.765	16.830	16.895	16.960	17.025	17.090	17.155	17.220	17.285
775.0	439.008	440.746	442.491	444.242	446.000	447.764	449.535	451.312	453.096	454.886
	17.350	17.415	17.480	17.545	17.610	17.675	17.740	17.805	17.870	17.935
776.0	456.683	458.486	460.295	462.109	463.930	465.756	467.587	469.425	471.269	473.118
	18.000	18.058	18.116	18.174	18.232	18.290	18.348	18.406	18.464	18.522

TABLE 6-2

HULAH 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 FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SEDAL	6456	10	5935	3272	1887	119		
ROUTED TO	SEDANR	3779	18	3664	2831	1839	119		
HYDROGRAPH AT	COPAL	7359	20	7187	5919	3314	371.8		
HYDROGRAPH AT	COPLAK	4595	2	1553	398	133	14.2		
3 COMBINED AT	COPAIN	10903	18	10713	8739	5106	505		
HYDROGRAPH AT	COPARE	0	2	0	0	0	1		
2 COMBINED AT	COPDIF	10903	18	10713	8739	5106	506		
ROUTED TO	COPOUT	0	2	0	0	0	506	717.13	398
HYDROGRAPH AT	COPAON	0	2	0	0	0	1		
2 COMBINED AT	COPSPL	0	2	0	0	0	507		
HYDROGRAPH AT	CEDAL	8289	12	7698	4936	2428	208		
ROUTED TO	CEDRVE	7586	16	7295	4852	2416	208		
HYDROGRAPH AT	ELGIL	10924	10	10351	6061	2977	237		
2 COMBINED AT	ELGIN	16086	12	15417	10627	5366	445		
ROUTED TO	ELGN	15440	16	14708	10523	5347	445		
HYDROGRAPH AT	HULAL	10623	12	10164	6516	3185	274		
HYDROGRAPH AT	HULLAK	4177	2	1411	360	121	13		
3 COMBINED AT	HULAIN	25335	14	24123	16830	8564	732		
HYDROGRAPH AT	HULARE	0	2	0	0	0	1		
2 COMBINED AT	HULDIF	25335	14	24123	16830	8564	733		
ROUTED TO	HULOUT	0	2	0	0	0	733	744.92	396
HYDROGRAPH AT	HULAON	0	2	0	0	0	1		
2 COMBINED AT	HULSPL	0	2	0	0	0	734		
2 COMBINED AT	HUPAN	0	2	0	0	0	1241		
ROUTED TO	BRTRT	0	2	0	0	0	1241		
HYDROGRAPH AT	BARTL	5960	12	5530	3589	1553	155		
2 COMBINED AT	BRTCON	5960	12	5530	3589	1553	1396		
ROUTED TO	RAMOLR	3506	44	3456	2956	1572	1396		
HYDROGRAPH AT	RAMOL	8117	24	7968	6962	4384	563		
2 COMBINED AT	RAMONA	8406	38	8360	7928	5744	1959		
ROUTED TO	CLRMRT	7443	56	7421	7108	5415	1959		
HYDROGRAPH AT	CLARCR	5105	12	4892	3349	1664	156		
2 COMBINED AT	CANVER	8170	56	8137	7837	6264	2115		

TABLE 6-2 (CONT'D)

PER	DAY	MON	STATION HRMN	CEDAL EXCESS	ELGIL EXCESS	CEDAL FLOW	ELGIL FLOW	HULAIN FLOW	COPAIN FLOW	HULOUT STAGE	COPOUT STAGE
1	13	OCT	1200	0	0	0	0	0	0	733.00	710.00
2	13	OCT	1400	1	1	589	948	4923	4599	733.11	710.07
3	13	OCT	1600	0	0	2130	3379	3329	281	733.30	710.14
4	13	OCT	1800	0	0	4151	6460	7648	1054	733.54	710.16
5	13	OCT	2000	0	0	6204	9288	13170	2590	734.01	710.22
6	13	OCT	2200	0	0	7710	10924	18797	4815	734.67	710.33
7	14	OCT	0	0	0	8289	10914	23154	7286	735.54	710.52
8	14	OCT	200	0	0	7749	9143	25335	9260	736.49	710.77
9	14	OCT	400	0	0	6398	6754	24544	10392	737.43	711.07
10	14	OCT	600	0	0	5047	4959	21826	10903	738.27	711.40
11	14	OCT	800	0	0	3981	3641	18803	10841	738.96	711.73
12	14	OCT	1000	0	0	3140	2723	15711	10399	739.54	712.05
13	14	OCT	1200	0	0	2477	2592	12823	9630	740.02	712.36
14	14	OCT	1400	0	0	2049	2467	10618	8755	740.37	712.64
15	14	OCT	1600	0	0	1951	2348	9273	7978	740.68	712.89
16	14	OCT	1800	0	0	1857	2235	8175	7287	740.94	713.13
17	14	OCT	2000	0	0	1767	2127	7311	6671	741.18	713.34
18	14	OCT	2200	0	0	1682	2025	6687	6120	741.39	713.53
19	15	OCT	0	0	0	1601	1927	6229	5627	741.58	713.71
20	15	OCT	200	0	0	1524	1834	5867	5185	741.77	713.88
21	15	OCT	400	0	0	1450	1746	5558	4787	741.94	714.02
22	15	OCT	600	0	0	1380	1662	5279	4429	742.09	714.13
23	15	OCT	800	0	0	1314	1582	5021	4106	742.23	714.23
24	15	OCT	1000	0	0	1251	1506	4777	3814	742.37	714.32
25	15	OCT	1200	0	0	1190	1433	4546	3550	742.49	714.41
26	15	OCT	1400	0	0	1133	1364	4327	3311	742.62	714.49
27	15	OCT	1600	0	0	1078	1298	4118	3180	742.73	714.56
28	15	OCT	1800	0	0	1026	1236	3920	3073	742.84	714.64
29	15	OCT	2000	0	0	977	1176	3731	2972	742.94	714.71
30	15	OCT	2200	0	0	930	1119	3551	2875	743.04	714.77
31	16	OCT	0	0	0	885	1066	3380	2782	743.14	714.84
32	16	OCT	200	0	0	842	1014	3217	2694	743.23	714.90
33	16	OCT	400	0	0	802	965	3062	2609	743.31	714.97
34	16	OCT	600	0	0	763	919	2914	2528	743.39	715.03
35	16	OCT	800	0	0	726	875	2774	2450	743.47	715.08
36	16	OCT	1000	0	0	691	832	2640	2375	743.55	715.14
37	16	OCT	1200	0	0	658	792	2513	2303	743.62	715.19
38	16	OCT	1400	0	0	626	754	2392	2233	743.68	715.25
39	16	OCT	1600	0	0	596	718	2277	2166	743.75	715.30
40	16	OCT	1800	0	0	567	683	2167	2101	743.81	715.35
41	16	OCT	2000	0	0	540	650	2063	2039	743.86	715.40
42	16	OCT	2200	0	0	514	619	1963	1978	743.92	715.44

EXHIBITS

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

HULAH LAKE

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

HULAH LAKE

TABLE OF CONTENTS

1. GENERAL INFORMATION

Other names for Projects	None
Location	Caney River Basin, Caney River, river mile 96.2, 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 three contracts totaling 19,800 acre-feet. All available water supply storage is currently under contract.
Water rights	The Oklahoma Water Resource Board (OWRB) has issued water rights on the Caney River basin below Hulah Lake. Releases may be required from Hulah Lake to meet some of these water rights.
Project cost	$11,200,000
Closure date	The project was placed in operation on September 1951.

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	779.5	---	---	---	---	---
Maximum Pool	775.87	17,916	472,563	156,665	4.01	337,500
Top of Surcharge Pool	767.0	13,780	315,898	26,810	0.69	219,100
Top of Flood Control Pool	765.0	13,000	289,088	227,680	5.83	196,500
Spillway Crest	740.0	5,160	61,408	30,252	0.77	9,500
Top of Conservation Pool	733.0	3,568	31,156	31,156	0.80	8,350
Top of Inactive Pool	710.0	0	0	0	0	0
Flood Control Storage	733.0-765.0	---	257,932	---	6.61	---
Conservation Storage	710.0-733.0	---	31,156[3]	---	0.80	---
Streambed at Dam	685.5	---	---	---	---	---

(1) Based on 1973 sedimentation survey.
(2) One inch of runoff equals 39,040 acre-feet.
(3) Includes 19,800 acre-feet for water supply (12.4 mgd yield), 7,100 acre-feet for water quality (4.5 mgd yield), and 4,200 acre-feet for sediment reserve.

MAXIMUM FLOODS PAST THE DAM SITE

Date	Peak Flow (cfs)	Volume (Acre-feet)	Runoff (inches)(1)
Sep 29 - Oct 1, 1986	133,000	366,500	9.40
Mar 9 – 11, 1974	70,100	125,600	3.22
Nov 20 – 21, 1979	68,740	87,100	2.23

(1) One inch of runoff equals 39,040 acre-feet, based upon 732 square miles of drainage area.

Real estate taking line	The fee taking line is a blocked perimeter to elevation 769.0. In the upper reaches of the lake, the blocked perimeter encompasses the backwater profile up to elevation 775.0. The fee taking line contains 20,676 acres.
Real estate taking line for easement	Roadway easements were obtained totaling 25.5 acres.
Range of clearing	Main body of lake, up to elevation 733.0 feet, NGVD.
Pool elevation corresponding to discharge capability of maximum nondamaging flow rate downstream	The nondamaging channel capacity immediately below Hulah Dam is estimated to be 6,500 cfs. This flow rate can be discharged when the lake level is at elevation 72 2.5 and above.
Reservoir length at top of conservation pool	3.5 miles
Reservoir length at top of flood pool	11.6 miles
Shoreline length at top of conservation pool	62 miles
Safety aspects, possibly requiring warning	All access roads are constructed above elevation 733.0. Some access roads are affected by flood waters at elevation 736.0 (about 1-year pool elevation frequency). All access roads to recreation areas are impassable when the pool reaches elevation 753.0 (3-year pool elevation frequency). The Project Manager will make every effort to inform campsite users when roads and campsites are closed. One private access road is impassable at elevation 734.0 and another at 747.5. When water is released for flood control purposes, a horn will sound.

Emergency drawdown	The minimum time required to empty the lake when the water level is at the top of the conservation pool (elevation 733.0), to the top of the inactive pool (elevation 710,0) is 3 days. The entrance invert elevation for the sluice gates is 702.0 feet, NGVD.

3. HYDROLOGY

Drainage area	The total drainage area above Hulah Lake is 732 square miles.

Probable Maximum flood

Max. water surface elevation	775.87 feet, NGVD
Peak inflow (into full pool)	430,000 cfs
Total storm runoff	23.4 inches
Volume (into full pool)	915,000 acre-feet
Maximum outflow (into full pool)	337,500 cfs
Flood duration	3 days

Standard Project Flood

Maximum water surface elevation	766.96 feet, NGVD
Peak inflow (into full pool)	215,000 cfs
Total storm runoff	11.7 inches
Volume (into full pool)	457,500 acre-feet
Maximum outflow (into full pool)	215,600 cfs
Flood duration	3 days

Climate	Moderate
One inch runoff	39,040 acre-feet.
Storm types	Primarily thunderstorms
Flood season	Primary flood period March through June with a secondary period September through November; however, floods are possible in any month of the year.
Low flow season	Primarily August, December through February; however, low flow can occur at any time of the year.
Minimum daily flow	0 cfs (numerous occurrences) Period of record is 1918 to 1997
Minimum monthly flow	0 acre-feet (numerous occurrences)
Minimum annual flow	9,650 acre-feet (1956)
Average annual flow	322,204 acre-feet (1918 to 1997)
Maximum daily flow	69,600 cfs (October 3, 1986)
Maximum instantaneous flow	133,000 cfs (October 3, 1986)
Maximum monthly flow	332,900 acre-feet (October 1986)
Maximum annual flow	912,400 acre-feet (1986)
Maximum flood volume	366,500 acre-feet (29 September-4 October 1986)
Name and location of key streamflow stations	Elgin, Ok, Caney River (river mile 117.8) Bartlesville OK, Caney River (river mile 69.2) Ramona, OK, Caney River (river mile 32.0) Claremore, OK, Verdigris River (river mile 76.0)
Type of hydrometeorologic data recorded at damsite	Recording rainfall gage, pool elevation (recording and staff) and tailwater elevation (staff gage).

Number of precipitation stations used in hydrologic forecasting of Hulah Lake	28 recording
Number of sediment ranges	31
Number of degradation ranges	6

4. EMBANKMENTS

Location	Caney River at river mile 96.2
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	94 feet above streambed
Length	5,200 feet
Top elevation	779.5 feet
Design flood	Probable Maximum Flood
Freeboard	3.6 feet above maximum pool elevation
Used for roadway	Yes, Oklahoma Highway 10 crosses the embankment and spillway with a 24-foot wide bituminous surfaced roadway.
Elevation of streambed	685.5 feet

5. SPILLWAY

Location	Near right abutment.
Type	Gated controlled spillway, gravity ogee weir
Crest elevation	740.0 feet
Net overflow length	400 feet
Number, type, and size gates	10 - 40' x 25' tainter gates operated by individual electric powered hoists.
Top of gate elevation	765.0 feet, in closed position.
Induced surcharge	2 feet above top of flood pool, elevation 767.0.
Design head	34 feet
Maximum discharge capacity	328,000 cfs at elevation 775.87
Type energy dissipator	Stilling Basin with two rows of baffles and a 7 foot high end sill.
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 gates, except for periodic maintenance, are activated only during flood conditions.

6. OUTLET FACILITIES

a. Sluices

Location	Through intermediate piers in spillway
Purpose	Flood control releases
Type of outlet	Rectangular sluices
Number and size of gates	9 - 5' x 6.5' gates
Type of service gates	Hydraulically operated lift gates
Entrance invert elevation	702.0 feet
Discharge at pertinent elevations	Bottom of conservation pool (710.0) - 0 cfs
	Top of conservation pool (733.0) - 8,350 cfs
	Spillway crest (740.0) – 9,500 cfs
	Top of flood control pool (765.0) - 13,000 cfs (tainter gates closed)
	Top of maximum pool (775.87) - 11,500 cfs (tainter gates open)
Minimum pool elevation when inoperative	702.0 feet
Minimum time required to open or close service gates	Average time is 13 minutes from completely closed to completely opened positions for each gate.
Type of emergency closure	Auxiliary gates similar to service gates.
Type of energy dissipator	Tetrahedral deflector

b. Low flow

Location	One through each of the second monoliths from each abutment.
Type and size of outlet	Two, circular 24-inch diameter
Type of gate	24" butterfly valve
Entrance invert elevation	706.0 feet
Capacity at top of conservation pool	170 cfs

c. Water supply

Location	Through right abutment
Number, type and size outlet	One 10" diameter circular pipe
Type service gate	Deferred (pipe blind flanged)
Entrance invert elevation	712.0 feet

7. CONTROL POINTS

a. Hulah Gage

Location	On left bank, 1200 feet downstream from Hulah Dam at river mile 95.9.
Purpose	Used by Corps of Engineers to determine benefits,
Channel and floodplain description	The channel is well defined, crooked, laden with drift along the sideslopes, and with sloughing and caving sides. The floodplain is broad, with trees, cultivated crops, oil wells, and some rural development.

Uncontrolled drainage area	1 square mile
Target flow rate	Bankfull stage is 13.5 feet, 6500 cfs
Time of crest travel	Approximately 1 hour from Hulah Dam to Hulah gage.
Description of equipment	Staff gage
Zero of gage	Elevation 694.0 feet

b. Bartlesville Gage

Location	At right bank in the City of Bartlesville water intake tower at river mile 68.7.
Purpose	Provide river stage data for flood control and to determine benefits.
Channel and floodplain description	The channel is well defined, crooked, laden with drift along the sideslopes, and with sloughing and caving sides. The floodplain is broad, with trees, cultivated crops, oil wells, and some rural development.
Uncontrolled drainage area	155 square miles
Treatment of uncontrolled Runoff.	Contributes to flood control target flows.
Target flow rate	Bankfull stage is 13.0 feet, 10,500 cfs (current rating)
Time of water travel	26 hours (approximate) from Hulah dam to gage
Description of equipment	Water-stage recorder with a Sutron DCP
Zero of gage	Elevation 653.33 feet

c. Ramona Gage

Location	On left bank on Washington County road bridge, 4.5 miles southeast of Ramona, Oklahoma at river mile 32.0.
Purpose	Provide river stage data for flood control and to determine benefits. Also used by the NWS and the USGS.
Channel and floodplain description	The channel is relatively narrow and deep, with heavily wooded banks. The floodplain is in excess of 1 mile wide, with trees, cultivated crops, oil wells, and some rural development.
Uncontrolled drainage area	718 square miles
Treatment of uncontrolled runoff.	Contributes to flood control target flows.
Target flow rate	Bankfull stage is 26.0 feet, 10,400 cfs (current rating)
Time of water travel	50 hours (approximate) from Hulah dam to gage
Description of equipment	Water-stage recorder with a Sutron DCP
Zero of gage	Elevation 653.33 feet

EXHIBIT B

WATER SUPPLY CONTRACTS

HULAH LAKE

Contract No. DA-34-066-CIVENG-57-717

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
THE CITY OF BARTLESVILLE, OKLAHOMA
FOR
WATER STORAGE SPACE IN HULAH RESERVOIR

THIS CONTRACT, entered into this 9th day of May 1957, by THE UNITED STATES OF AMERICA (hereinafter called the Government), represented by the Contracting Officer executing this contract, and the CITY OF BARTLESVILLE, OKLAHOMA, a municipal corporation existing under the laws of the State of Oklahoma with its principal office in the City of Bartlesville, Washington County, State of Oklahoma (hereinafter called the City), WITNESSETH, That:

WHEREAS, The Government in pursuance of the Flood Control Act approved June 22, 1936 (Public Law 738, 74th Congress), has constructed and is now operating and maintaining the Hulah Dam and Reservoir, Caney River, Kansas and Oklahoma; and

WHEREAS, The Act of Congress approved July 30, 1956 (Public Law 843, 84th Congress, Chapter 787, 2d Session), provides as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That

"(a) The Secretary of the Army is hereby authorized to contract with the City of Bartlesville, Oklahoma, upon such terms and for such period, not to exceed fifty years, as he may deem reasonable, for the use of not to exceed fifteen thousand four hundred acre-feet of storage space in the Hulah Reservoir, for the purpose of providing such city a regulated water supply.

"(b) The project for the Hulah Reservoir on the Caney River authorized by the Act entitled 'An Act authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes', approved June 22, 1936, is hereby modified in accordance with the provisions of this Act.

"(c) All moneys received by the Chief of Engineers pursuant to this Act shall be deposited in the Treasury of the United States as miscellaneous receipts.

"(d) Nothing in this Act shall affect water rights under State law."; and

WHEREAS, The City of Bartlesville, Oklahoma started taking water from the Caney River at Bartlesville, Oklahoma, and has taken all of its municipal water supply from the Caney River and its tributaries since 1897, and, on October 15, 1953, applied to the Oklahoma Planning and Resources Board to take twelve thousand acre-feet per year from the Caney River at Bartlesville, Oklahoma; said application being No. 53-752, which application was filed by the Oklahoma Planning and Resources Board, prior to December 2, 1953, and whereas, on February 22, 1957, the City of Bartlesville, Oklahoma, made an amended application with the Oklahoma Planning and Resources Board to take fifteen thousand four hundred acre-feet of water per year from the Caney River, at Hulah Reservoir, which application was filed on February 25, 1957, under Application No. 57-187; and

WHEREAS, The City of Bartlesville, Oklahoma, recognizes that these applications are subject to such agreements as may result from future interstate compact or compacts relating to the allocation of waters of the Arkansas River and tributaries.

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

ARTICLE 1. WATER STORAGE SPACE. - The City shall have the right to utilize an undivided 57.249 per cent of the storage space in the reservoir between elevations 733.0 feet above mean sea level and 710.0 feet above mean sea level, exclusive of sediment reserve, as deemed necessary by the City to impound water in the project and make such diversions as have been or are granted to the City by the State of Oklahoma, to the extent such storage space will provide, and subject to the retention by the Government and others of the remaining undivided 42.751 per cent of the storage space for such purposes as the Government may deem desirable. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies between users of the aforesaid storage space, except as such controversies may affect storage space retained by the Government.

The City shall have the right to withdraw water from the aforesaid 57.249 per cent of the storage space, or to order releases therefrom to be made by the Government, at any time so long as the elevation of the water within the project is above 710.0 feet above mean sea level, provided, that such release when combined with local runoff below the dam will not cause flooding.

The design and location of any future City installations or facilities that the City may construct at the project for the purpose of diversions or withdrawals shall be subject to the approval of the Contracting Officer, and the cost of such installations shall be borne by the City.

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

The City recognizes that the storage space being made available to the City under the terms of this agreement will provide raw water. The Government makes no representation with respect to the condition of potability or availability of water and assumes no responsibility therefor, or for treatment of the water.

ARTICLE 2. METERING. - For the purpose of determining that the City does not exceed their proportionate share of the water yield from the conservation storage, the City shall install suitable meters or metering devices satisfactory to the Contracting Officer to measure the quantity of water drawn from such conservation storage. The City shall furnish the Government monthly statements of the quantity so drawn.

ARTICLE 3. FEDERAL AND STATE LAWS. - The City shall utilize such storage space in a manner consistent with Federal and State laws.

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

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

(1) In annual installments, 5.508 per cent of the total cost of the project, including interest at the rate of two and one-half per cent ($2\frac{1}{2}\%$) per annum during the construction period of the project, which is the City's share of the total cost of the project as determined in the manner set out in Exhibit A. Based on the total cost of the completed project, payment at the rate of $21,800 annually will be made commencing the date this contract is approved by the Secretary of the Army. The first payment will be due and payable as of the date this contract is approved by the Secretary of the Army; will be for the period ending the 30th of June following the approval; and will be prorated for that period on the basis of the estimated annual charge. Annual payments thereafter will be due and payable on 1 September of each year for the period of this contract. Payment for any fractional part of a year which may result from termination of this contract shall be prorated on the basis of the annual charge.

(2) 5.508 per cent of the annual experienced cost of operation and maintenance of the project exclusive of the operation and maintenance cost for land management and public utilization. The first payment

will be due and payable on the date this contract is approved by the Secretary of the Army; will be for the period ending the 30th of June following the approval; and will be prorated on the basis of the estimated annual charge. Items of operation and maintenance which form the basis of computation and which will be used in future computation of maintenance and operation charges are included as Exhibit A. As set out in Exhibit A the present estimate of the City's annual payment of ordinary operation and maintenance costs is $4,200. Subsequent to the first payment, annual payments will be due and payable in advance on 1 September of each year thereafter and will be equal to 5.508 per cent of the actual experienced cost of operation and maintenance for the preceding Government fiscal year. The second payment shall be increased or decreased in an amount to reflect the difference between the first payment and 5.508 per cent of the annual experienced cost of operation and maintenance for the first year or portion thereof as set forth above. Payment for any fractional part of a year which may result from termination of this contract shall be prorated on the basis of the annual charges.

Records of cost of operation and maintenance of the project shall be available for inspection and examination by the City.

The extent of operation and maintenance of the project shall be determined by the Contracting Officer and all records and accounting shall be maintained by the Contracting Officer. In the event that the City should require additional operation and maintenance for the conservation storage over and above that determined by the Contracting Officer and over and above that which formed the basis for determination as set out in Exhibit A, the City shall bear the entire cost of such additional expense.

(3) 100 per cent of the total annual costs for specific operation for water supply presently estimated as $700 annually.

(4) The total cost, in the amount of $5,280, for the 10-inch water supply pipe through the dam, which shall be reserved for the exclusive use of the City for water supply purposes.

(5) In the event of default in the payment of the costs contained in Article 5 (1), (2), (3) and (4), the City shall pay interest on such overdue payments at the rate of two and one-half per cent (2½%) per annum thereon, compounded annually; and such interest shall be charged from the date such payments are due until paid.

ARTICLE 6. PERIOD OF CONTRACT. - This contract shall become effective as of the date it is approved by the Secretary of the Army, as set forth in Articles 5(1) and 16, and shall continue in full force and effect thereafter until the 30th of June following, and shall be automatically extended thereafter each fiscal year for a period of fifty (50) years.

ARTICLE 7. NEW CONTRACT. - It is the understanding and expectation of the parties hereto that upon expiration of this contract the City shall have the right, subject to any required approval of appropriate State authorities, to negotiate for use of storage space then available for water supply purposes. The terms of the new contract shall be subject to mutual agreement at the time, it being the further expectation of the parties that in determining the changes to be specified in such new contract full consideration will be given to the amount of reimbursement which has been made to the Government for the investment allocable to water supply at that time. Consideration will also be given to any extraordinary expenditures made or expected to be made by the Government and which are not recovered during the original contract period.

ARTICLE 8. DEFAULT. - In the event that the City refuses or fails to comply with any of the terms of this contract, including the foregoing provisions with respect to payments, the Government reserves the right to terminate this contract.

ARTICLE 9. OPERATION AND MAINTENANCE. - The Government shall operate and maintain the project owned by the Government. The City shall have the right to make withdrawals of water for its purpose as needed in accordance with Article 1. The City shall be responsible for operation and maintenance of all features and appurtenances which may be provided and owned by the City.

ARTICLE 10. RIGHTS-OF-WAY. - The grant of an easement for right-of-way over, across, in and upon Government-owned lands, under the control of the Secretary of the Army, required for transmission of the water from the point of withdrawal, shall be by separate instrument without additional cost to the City, under the authority, and in accordance with the provisions of the Act of Congress, approved May 17, 1926, Ch. 313, Sec. 142, 44 Stat. 562 (10 U.S.C. 1351 and 1352) and Sec. 7 of the Flood Control Act of 1946 (60 Stat. 643; 43 U.S.C. 931b).

ARTICLE 11. RELEASE OF CLAIMS. - The City shall hold and save the Government including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for

damages which may be filed or asserted as a result of withdrawal or release of water from the project made or ordered by the City, or as a result of the construction, operation, or maintenance of the features or appurtenances owned and operated by the City.

ARTICLE 12. TRANSFER OR ASSIGNMENT. - The City shall not transfer or assign this agreement nor suballot said conservation storage or any part thereof, nor grant any interest, privilege, or license whatsoever in connection with this contract, without permission in writing from the Secretary of the Army, provided that this restriction shall not be construed to apply to any water which may be obtained from the conservation storage by the City and furnished to any third party or parties nor any method of allocation thereof.

ARTICLE 13. OFFICIALS NOT TO BENEFIT. - No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 14. COVENANT AGAINST CONTINGENT FEES. - The City warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the City for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 15. DISPUTES. - Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce his decision to writing and mail or otherwise furnish a copy thereof to the City. Within 30 days from the receipt of such copy, the City may appeal by mailing or otherwise furnishing to the Contracting Officer a written appeal addressed to the Secretary, and the decision of the Secretary or his duly authorized representative for the hearing of such appeals shall, unless determined by a court of competent jurisdiction to have been fraudulent or capricious or arbitrary or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence, be final and conclusive; provided that, if no such appeal is taken, the decision of the Contracting Officer shall be final and conclusive. In connection with any appeal proceeding

under this clause, the City shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the City shall proceed diligently with the performance of the contract and in accordance with the Contracting Officer's decision.

ARTICLE 16. APPROVAL OF CONTRACT. - This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

ARTICLE 17. DEFINITIONS. - (a) The term "Secretary" means the Secretary of the Army; the terms "Secretary of the Army" or "Head of the Department" as used herein shall have one and the same meaning; and the term "his duly authorized representative" means the Chief of Engineers, Department of the Army, or an individual or board designated by him.

(b) Except for the original signing of this contract and except as otherwise stated herein, the term "Contracting Officer" as used herein shall include his duly appointed successor or his authorized representative.

ARTICLE 18. ALTERATIONS. - The following alterations have been made in the provisions of this contract: None.

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

APPROVED, JUN 12 1957
Date

THE UNITED STATES OF AMERICA

By _____
JOHN D. BRISTOR
Colonel, CE
District Engineer
Contracting Officer

(SEAL)

ATTEST:

_____
City Clerk
(Address)

CITY OF BARTLESVILLE, OKLAHOMA

By _____
Mayor

Contract No. DA-34-066-CIVENG-57-717

I, Oleta Martin, certify that I am the City Secretary of the City of Bartlesville, Oklahoma, named as City herein, that W. A. Hensley, who signed this contract on behalf of the City was then Mayor of said City of Bartlesville, Oklahoma; that said contract was duly signed for and on behalf of said City of Bartlesville, Oklahoma, by authority of its governing body and is within the scope of its legal powers.

IN WITNESS WHEREOF, I have hereunto affixed my hand and the seal of said City of Bartlesville, Oklahoma, this 13th day of May 1957.

Oleta Martin
City Secretary
Clerk

CORPORATE SEAL

Contract No. DA-34-066-CIVENG-57-717
Modification No. 1

SUPPLEMENTAL AGREEMENT

This supplemental agreement, entered into this 8th day of June 1970 by and between the UNITED STATES OF AMERICA (hereinafter referred to as the Government), represented by the Contracting Officer executing this supplemental agreement, and the CITY OF BARTLESVILLE, OKLAHOMA (hereinafter referred to as the City), WITNESSETH, THAT:

WHEREAS, there is now in full force and effect between the parties hereto a certain contract bearing date of the 9th day of May 1957 (being Contract No. DA-34-066-CIVENG-57-717), which authorizes the City to utilize 57.249 percent (15,400 acre-feet) of the conservation storage space in the Hulah Reservoir, Caney River, Oklahoma, between elevation 733.0 and 710.0 feet above mean sea level; and,

WHEREAS, by letter, dated 12 April 1966, the City requested permission to purchase the remaining unassigned 2,200 acre-feet of conservation storage space in the Project to supplement the storage provided under Contract No. 57-717.

WHEREAS, under provisions of Section 6 of the Act of December 22, 1944 (58 Stat. 890; 33 U.S.C. 708), as revived and reenacted by the Act approved 23 May 1952 (Public Law 82-360, 66 Stat. 93), the Government is authorized to make contracts with States and local interests for water supply storage for municipal and industrial purposes, under conditions provided therein; and,

WHEREAS, subject to the limitations prescribed thereby, Public Law 88-140 (43 U.S.C. 390c-e) makes permanent the rights of States and local interests to utilize municipal and industrial storage in Corps of Engineers reservoirs for which they have contributed or will hereafter contribute, or have contracted or will hereafter contract to pay to the Government over a specified period of years money, exclusive of interest, equivalent to the cost of providing space for such storage.

NOW, THEREFORE, the parties do mutually agree that Contract No. DA-34-066-CIVENG-57-717 shall be and the same is hereby modified in the following particulars:

Item 1: The first two paragraphs of ARTICLE 1, WATER STORAGE SPACE, are hereby deleted and the following substituted therefor:

"Article 1, Water Storage Space. The City shall have the right to utilize a total of 65.427 percent of the conservation storage space in the reservoir between elevations 733.0 feet above mean sea level and 710.0 feet above mean sea level as follows:

a. An undivided 57.249 percent of the storage space in the reservoir between said elevations as provided under the original contract No. DA-34-066-CIVENG-57-717, and hereinafter referred to as Storage Space No. 1.

b. An undivided 8.178 percent of additional storage space in the reservoir between said elevations, hereinafter referred to as Storage Space No. 2.

The City shall have the right to impound water in the Project for its municipal and industrial use and to make such withdrawals as have been granted to the City by the State of Oklahoma, to the extent such storage space will provide, subject to the retention by the Government and others of the remaining undivided 34.573 percent of the storage space between elevations 733.0 and 710.0 feet above mean sea level for such purposes as the Government may deem desirable. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies between users of the aforesaid storage space, except as such controversies may affect storage space retained by the Government.

The City shall have the right to withdraw water from the aforesaid storage space, or to order releases therefrom to be made by the Government, at any time so long as the elevation of the water within the Project is above 710.0 feet above mean sea level, provided that such release when combined with local runoff below the dam will not cause flooding."

Item 2: Paragraphs (1), (2), and (3) of Article 5, Consideration and Payment, sets out the payments to be made for the storage designated as Storage Space No. 1 in Item 1 of this supplemental agreement. The following paragraphs are hereby added to Article 5:

"(6) A schedule of annual payments for Storage Space No. 1 is shown on Exhibit B attached hereto and made a part hereof.

(7) In consideration of the Government providing Storage Space No. 2, the City shall pay the Government the following amounts:

(a) Annual payments of $3,036, based on the yearly amount required to amortize the cost, including interest during construction, of said storage over a 50-year period as determined in the manner set out in Exhibit C attached hereto and made a part hereof. Except for the first payment, which shall be applied solely to the retirement of principal, all payments shall include accrued interest at the rate of 2.5 percent per annum on the unpaid balance. A schedule of annual payments is shown on Exhibit D attached hereto and made a part hereof. The first payment will be due and payable within 30 days of the date the City is notified that this modification is approved by the Secretary of the Army; will be for the period ending the 30th of June following the approval; and will be prorated for that period on the basis of the estimated annual charge. Annual payments thereafter will be due and payable on 1 July of each year for the period of this contract.

(b) 0.767 percent of the annual experienced cost of ordinary operation and maintenance of the Project, exclusive of the operation and maintenance costs for land management and public utilization. Items of operation and maintenance which form the basis of computation and which will be used in future computation of operation and maintenance charges are shown in Exhibit C. Each payment shall be equal to 0.767 percent of the actual experienced cost of operation and maintenance for the preceding Government fiscal year. The annual payment will be due and payable under terms set forth in paragraph (7)(a) above.

(c) 0.787 percent of the cost of major capital replacement items and sedimentation resurveys, when incurred. Payment shall be made with the first annual payment becoming due after the date said cost is incurred.

(8) The extent of operation and maintenance of the Project shall be determined by the Contracting Officer, and all records and accounting shall be maintained by the Contracting Officer. Records of cost of operation and maintenance of the Project shall be available for inspection and examination by the City.

(9) In the event that the City requests additional operation and maintenance for the water supply storage over and above that determined by the Contracting Officer and over and above that which formed the basis for determination as set out in Exhibit A and C, the City shall bear the entire cost of such additional expense.

(10) In the event of default in the payment of the costs contained in paragraph (7) above, the City shall pay interest on such overdue payments at the rate of 2.5 per annum. Such amount of interests shall be compounded annually and charged from the date such payments are due until paid. The amount of interest payable for any fractional part of a year will be figured on a monthly basis. For example, if the payment is made within the first month after being overdue,30 to 60 days after anniversary date, one month's interest will be charged."

Item 3: Article 6, Period of Contract is hereby modified by adding the following:

"The City's rights to Storage Space No. 2 shall continue in full force and effect for the period of the initial payment therefor. The City shall have the right to renew this contract as to Storage Space No. 2 each year thereafter for a total period of 50 years after initial payment therefor or the life of the Project, whichever is lesser. Receipt of each annual payment shall constitute renewal for the ensuing year."

Item 4: Article 7, New Contract is deleted in its entirety, and the following substituted therefor:

"Article 7, Permanent Rights to Storage. The City shall have a permanent right, under the provisions of Public Law 88-140, to the use of Storage Space No. 1 and Storage Space No. 2 as set forth in amended Article 1 hereof, subject to the following conditions:

a. The City must have discharged its responsibilities for payment of the costs allocated to Storage Space No. 1 and Storage Space No. 2. However, failure to meet the obligations of one storage space shall not impair the rights to the other storage space since the rights and obligations attached to Storage Space No. 1 and Storage Space No. 2 shall be independent of each other.

b. That the City shall pay its proportionate share of any further costs allocated to water supply which may, subsequent to 50 years from the effective date of the original contract with regard to Storage Space No. 1, and subsequent to 50 years from the date of this modification with regard to Storage Space No. 2, be required for such reconstruction, rehabilitation, or replacement of Project facilities and for such annual

operation and maintenance as determined necessary to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer. Repayment arrangements will be made by further modification to this contract.

c. Upon expiration of 50 years from the date of the first payment for Storage Space No. 1, the Contracting Officer shall redetermine the storage space for municipal and industrial water supply taking into account such equitable reallocation of reservoir capacities among the purposes served by the Project as may be necessary due to sedimentation. Such findings, and the storage space allocated to municipal and industrial water supply, shall be defined and described in an exhibit which will be made a part of a supplemental agreement to this agreement. Following the same principle, such reallocations of reservoir storage capacity may be further adjusted from time to time as a result of sedimentation resurveys to reflect actual rates of sedimentation and the contract further modified on the basis of revisions in storage space allocated to municipal and industrial water supply.

d. The permanent rights of the City under this contract shall continue so long as the Government continues to operate the Project. In the event the Government ceases to operate the Project, such rights may be continued subject to the execution of a separate contract, or additional supplemental agreement to this contract providing for:

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

(2) Terms which will protect the public interest; and,

(3) Effective absolvement of the Government by the City from all liability in connection with such continued operation."

Item 5: Article 15, Disputes, is deleted in its entirety.

EXCEPT as herein modified, all the terms and conditions of said contract shall remain unchanged and in full force and effect.

THIS supplemental agreement shall be subject to the written approval of the Secretary of the Army and shall not be binding until so approved.

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

APPROVED:

Secretary of the Army

NOV 1970

Date:

THE UNITED STATES OF AMERICA

By
VERNON W. PINKEY
Colonel, CE, District Engineer
Contracting Officer

CITY OF BARTLESVILLE, OKLAHOMA

Attest:
City Clerk

By
Mayor

I, , certify that I am the City Clerk of the City of Bartlesville, Oklahoma, named as City herein; that , who signed this supplemental agreement on behalf of the City was then Mayor of the City of Bartlesville, Oklahoma, that said supplemental agreement was duly signed for and is within the scope of its legal powers.

In Witness Whereof, I have hereunto affixed my hand and the seal of said City of Bartlesville, Oklahoma, this 8 day of June, 1970.

(Seal)

City Clerk

REVIEWED FOR LEGAL SUFFICIENCY

By

Date

Audit Branch Review

By

Date 4 Aug 70

TECHNICAL REVIEW

BY

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

City of Bartlesville, Oklahoma
(hereinafter called "Applicant-Recipient")

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

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

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Applicant-Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

Dated June 9, 1970

City of Bartlesville, Oklahoma
(Applicant-Recipient)

By W. A. Hensley, Mayor

ATTEST: Oleta Martin
City Clerk

SWT Form 553-C
22 Mar 67

L. HARTUNG cy.

Contract No. DACW56-71-C-0021

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
HULAH WATER DISTRICT INCORPORATED
FOR
WATER SUPPLY STORAGE SPACE IN HULAH RESERVOIR

THIS CONTRACT is made this 21 day of August 1970, by and between the United States of America (hereinafter called the "United States"), represented by the Contracting Officer executing this contract, and the Hulah Water District, Inc. (hereinafter called the "User").

WITNESSETH:

WHEREAS, the Flood Control Act approved 22 June 1936, (Public Law 738, 74th Congress) (60 Stat. 635), authorized the construction, operation, and maintenance of the Hulah Dam and Reservoir, on Caney River, in the State of Oklahoma (hereinafter called the "Project"); and

WHEREAS, the User desires to contract with the United States for inclusion in the Project of storage 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 so to contract and is vested with all necessary powers for accomplishment of the purposes of this contract.

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

ARTICLE 1. WATER SUPPLY STORAGE

a. Rights of User. The User shall have the right to utilize an undivided 0.370 percent of the storage space in the Project between elevations 733.0 feet above mean sea level and 710.0 feet above mean sea level, estimated to be 100 acre-feet, to impound water for present demand or need for municipal and industrial water supply. The

User shall have the right to withdraw water from the reservoir, or to order releases to be made by the United States, 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 diversions or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way over, across, in and upon land of the United States 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 and in accordance with the provisions of 10 U.S.C. 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.

b. Rights Reserved. The United States reserves the right to maintain downstream releases to meet the established requirements of riparian owners through the gates or spillway of the dam. The United States further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life or property.

c. Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The United States 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 the water supply from the aforesaid storage space shall be the responsibility of the User. The User has the full responsibility to acquire in accordance with State laws and regulations, and if necessary to establish and defend, and all water rights needed for utilization of the storage space provided under this contract. The United States shall not be responsible for diversion 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 United States. The User shall utilize the aforesaid storage space in a manner consistent with Federal and State laws.

ARTICLE 3. OPERATION AND MAINTENANCE. The United States shall operate and maintain the dam and reservoir and the User shall pay to the United States a share of the costs of such operation and maintenance as provided herein. The User shall have the right to direct releases of water to be made for its purposes as provided in Article 1. 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 United States 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 United States 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. 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. CONSIDERATION AND PAYMENT. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User agrees to pay to the United States the following sums:

a. The User shall repay to the United States, in a lump-sum payment the amount stated below which, on the basis of costs shown in Exhibit A attached hereto and made a part of this contract, constitute the amount of the construction costs, including interest during construction, plus the present worth of the estimated annual costs of major capital replacement items and operation and maintenance of the Project over a 50-year period, for providing the aforesaid storage space. The interest rate to be used for purposes of computing interest during construction and the present worth of costs of major replacement and operation and maintenance shall be at the rate of 2.5 percent per annum. The lump-sum payment shall be due and payable within thirty (30) days after the date the User is notified that this contract is approved by the Secretary of the Army. The User shall repay:

0.036 percent of the project cost (0.036% x $11,215,980)	$4,000
Present worth of 0.036 percent of the estimated annual operation, maintenance and major replacements costs and sedimentation resurveys for a 50-year period	814
Total lump-sum payment	$4,814

b. If the User shall fail to make the aforesaid lump-sum when due, then the overdue payment shall bear interest at the rate of 2.5 percent per annum until paid.

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

ARTICLE 7. PERMANENT RIGHTS TO STORAGE. Upon completion of payments by the User, as provided in Article 5 herein, the User shall have a permanent right, under the provisions of Public Law 88-140, to the use of the water supply storage space in the Project as provided in Article 1, subject to the following:

a. The User shall, after expiration of 50 years from effective date of this contract, resume and continue payment of annual operation and maintenance costs allocated to water supply.

b. The User shall, after expiration of 50 years from effective date of this contract, bear the costs allocated to water supply of any necessary reconstruction, rehabilitation or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer. Repayment arrangements including schedules will be in writing and will be made a part of this contract.

c. The Contracting Officer shall, after 50 years, redetermine the storage space for municipal and industrial water supply, taking into account such equitable reallocation of reservoir storage capacities among the purposes served by the Project as may be necessary due to sedimentation. Such findings, and the storage space allocated to municipal and industrial water supply shall be defined and described in an exhibit which will be made a part of this contract. Following the same principle, such reallocation of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation

resurveys to reflect actual rates of sedimentation and Exhibit A revised to show the revised storage space allocated to municipal and industrial water supply.

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

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

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

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

ARTICLE 8. RELEASE OF CLAIMS. The User shall hold and save the United States, including its officers, agents, and employees, harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the storage and withdrawal or release of water from the Project made or ordered by the User, or as a result of the construction, operation, or maintenance of the features or appurtenances owned and operated by the User.

ARTICLE 9. TRANSFER OR ASSIGNMENT. The User shall not transfer or assign this contract nor any rights acquired thereunder, nor suballot said water or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army; provided that this restriction shall not be construed to apply to any water which may be obtained from the water supply storage space by the User and furnished to any third party or parties or the rates charged therefor.

ARTICLE 10. OFFICIALS NOT TO BENEFIT. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 11. COVENANT AGAINST CONTINGENT FEES. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty, the United States shall have the right to annul this contract without liability, or, in its discretion, to add to the contract price or consideration the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 12. APPROVAL OF CONTRACT. This contract shall be subject to the written approval of the Secretary of the Army, and shall not be binding until so approved.

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

APPROVED:

Secretary of the Army

Date: NOV 1970

THE UNITED STATES OF AMERICA

By _____
VERNON W. PERKEY
Colonel, CE
District Engineer
Contracting Officer

KULAH WATER DISTRICT INCORPORATED

Attest:

By _____

By _____

(Seal)

REVIEWED FOR LEGAL SUFFICIE

By _____

Audit Branch Review

By _____

TECHNICAL REVIE

BY _____

DACW56-71-C-0021

CERTIFICATE

I, Patricia A. Barnett, hereby certify that I am the Secretary-Treasurer of Hulah Water District, Inc., Oklahoma, named as User herein; that Bill Barnett, who signed this contract on behalf of the User was then President of said Hulah Water District, Inc., Oklahoma; that said contract was duly signed for and on behalf of said User by authority of its governing body, and is within the scope of its legal powers.

IN WITNESS WHEREOF, I have hereunto affixed my hand and the seal of Hulah Water District, Inc., Oklahoma, this 21 day of August 1970.

Patricia A. Barnett

(Seal)

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

Hulah Water District, Inc.

(hereinafter called "Applicant-Recipient")

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

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

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Applicant-Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

Dated August 21, 1970

Hulah Water District, Inc.
(Applicant-Recipient)

By Bill Barnett
President, Board of Directors

Patricia A. Barnett
Secretary-Treasurer, Board of Directors

SWT Form 553-C
22 Mar 67

Contract No. DACW56 -82-C-0101

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

ASA/(I) 12 NOV 82

THIS CONTRACT, entered into this ____ day of 82 MAY 27 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 BARTLESVILLE, OKLAHOMA, (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the Flood Control Act, approved 22 June 1936 (Public Law 738, 74th Congress), authorized the construction, operation, and maintenance of the Hulah Lake on the Caney River, Kansas and 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 therof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 USC 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 7.807 percent (estimated to contain 2,100 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 733.0 feet above mean sea level and 710.0 feet above mean sea level, which usable conservation storage space is estimated to contain 26,900 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 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 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, constitute the entire actual amount of the construction costs of the Project, including interest during construction, allocated to the water supply 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, construction of which was initiated in FY 1948, this interest rate is 2.5 percent. The User shall repay 0.751 percent of the total project joint-use cost amounting to $84,224.

(2) The Project investment costs allocated to the storage space indicated in Article 1(b)(1) as being provided for present demand is $84,224, on the basis of the cost presented in Exhibit "A". Interest at the rate provided above will be compounded annually on the amount of the Project investment costs allocated to this storage space from 30 September 1961, the end of the 10-year interest free period, until the date of approval of this contract. The principal plus accrued interest shall be paid within the life of the Project but in no event to exceed 50 consecutive annual installments, the first of which shall be due and payable within 30 days after the User is notified of approval of the contract by the Assistant Secretary of the Army (Civil Works). Annual installments thereafter will be due and payable on the anniversary date of the date of notification. Except for the first payment which will be applied solely to the retirement of principal, all installments shall include accrued interest on the unpaid balance at the rate provided above. The last annual installment shall be adjusted upward or downward when due to assure repayment of all of the investment costs allocated to storage for present demand within 50 years.

(3) An estimated schedule of annual payments for the water supply storage provided for present demand is attached as Exhibit "B" of this contract. The annual payments as provided therein shall be made subject to Article 6.

(4) Subsequent to approval of the Secretary of the Army, Exhibits A and B will be adjusted to reflect the actual accrued interest from the end of the 10-year interest free period to the date of approval of this contract.

(b) Major Replacement Cost. The User will be required to pay 0.751 percent of the cost of joint-use major replacement items. Payment of costs, including interest during construction, shall be made either incrementally during construction, in lump sum upon completion of construction, or annually with interest on the unpaid balance. If paid annually, the User's share shall be paid within the life of the Project in not to exceed 25 consecutive annual installments with the first payment to be made with the first annual payment as set forth in Article 5(a)(2) on the Project investment costs becoming due after the date said major replacement costs are incurred. The first annual payment shall include interest on the investment cost accruing until the payment date. Annual payments thereafter will be due and payable on the anniversary of this repayment date. All annual payments shall include accrued interest on the unpaid balance at the interest rate as determined by the Secretary of the Treasury on the basis as set forth in the Water Supply Act of 1958, as amended, for use in the Government fiscal year in which the major capital replacement is initiated. The last annual payment shall be adjusted upward or downward when due to assure repayment of all the incurred costs within the repayment period.

(c) Annual Operation and Maintenance (O&M) Expense. The User will be required to pay 0.751 percent of the annual experienced joint-use O&M expense of the Project. Payments for O&M expense for present use storage are due and payable in advance on the date for payment of Project investment costs as set forth in Article 5(a)(2) and shall be based on O&M expense for the Project in the Government fiscal year most recently ended. The amount of each annual payment will be the actual experienced O&M expense (allocated

joint-use) for the preceding fiscal year or an estimate thereof when actual expense information is not available.

(d) Major Rehabilitation and Dam Safety Assurance Programs Costs. For costs associated with major rehabilitation programs, the percentages of joint-use costs which the User will be required to pay will be in accordance with Article 5(c). For costs associated with dam safety assurance programs, the percentages of joint-use costs which the User will be required to pay will be in accordance with Article 5(a). Payment for the costs associated with both programs shall be in accordance with Article 5(b).

(e) The User shall have the right at any time it so elects to prepay the indebtedness under this Article, subject to redetermination of costs as provided for in Article 6, in whole or in part, with accrued interest thereon to the date of such prepayment.

(f) Delinquent Payments. If the User shall fail to make any of the aforesaid payments when due, then the overdue payments shall bear interest compounded annually until paid. The interest rate to be used for overdue payments due under the provisions of Articles 5(a), 5(b), 5(c), and 5(d) above, shall be that determined by the Department of the Treasury's Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management"). The amount charged on payments overdue for a period of less than one year shall be figured on a monthly basis. For example, if the payment is made within the first month after being overdue after a 15-day grace period from the anniversary date of the date of notification, one month's interest shall be charged. Thereafter a month's interest will be charged for any portion of each succeeding month that the payment is delinquent. This provision shall not be construed as giving the User a choice of either making payments when due or paying interest, nor shall it be construed as waiving any other rights of the Government, at law or in equity, which might result from any default by the User.

ARTICLE 6 - Adjustment to Project Investment Cost. The investment cost shown in this contract and the exhibits is based on actual final construction cost of the Project. Any further investment cost accruing to the User's water storage right shall be repaid under major replacement costs if capitalized or under operation and maintenance expense if not capitalized.

ARTICLE 7 - Duration of Contract. This contract shall become effective when approved by the Assistant Secretary of the Army (Civil Works) and shall continue in full force and effect for the life of the Project.

ARTICLE 8 - Permanent Rights to Storage. Upon completion of payments by the User, as provided in Article 5(a) herein, the User shall have a permanent right, under the provisions of the Act of 16 October 1963 (Public Law 88-140, 43 USC 390e), to the use of the water supply storage space in the Project as provided in Article 1, subject to the following:

(a) The User shall continue payment of annual operation and maintenance costs allocated to water supply.

(b) The User shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation, or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer and repayment arrangements shall be in writing in accordance with the terms and conditions set forth in Article 5(b) for Major Replacement Costs, and be made a part of this contract.

(c) Upon completion of payments by the User as provided in Article 5(a), the Contracting Officer shall redetermine the storage space for municipal and industrial water supply in accordance with the provisions of Article 1(e). Such redetermination of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the revised storage space allocated to municipal and industrial water supply.

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

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

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

(3) Effective absolvement of the Government by the User from all liability in connection with such continued operation.

ARTICLE 9 - Release of Claims. The User shall hold and save the Government, including its officers, agents, and employees harmless from liability of any nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the storage in the Project, or withdrawal or release of water from the Project, made or ordered by the User or as a result of the construction, operation, or maintenance of the water supply facilities and appurtenances thereto owned and operated by the User, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 10 - Assignment. The User shall not transfer or assign this contract or any rights acquired thereunder, nor sublilot said water supply storage space or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army, provided that, unless contrary to the public interest, this restriction shall not be construed to apply to any water that may be obtained from the water supply storage space by the User and furnished to any third party or parties, nor any method of allocation thereof.

ARTICLE 11 - Officials Not to Benefit. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this

provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12 - Convenant Against Contingent Fees. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration, or otherwise recover the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE 13 - Environmental Quality. During any construction, operation, and maintenance by User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control of burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contaminants, and control of turbidity and siltation from erosion; (3) minimization of noise levels; (4) onsite and offsite disposal of waste and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 14 - Federal and State Laws.

(a) In acting under its rights and obligations hereunder, the User agrees to comply with all applicable Federal and State laws and regulations, including but not limited to the provisions of the Davis-Bacon Act (40 USC 276a et seq); the Contract Work Hours and Safety Standards Act (40 USC 327-333); Title 29, Code of Federal Regulations, Part 3; and Sections 210 and 305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646).

(b) The User furnishes, as part of this contract, an assurance (Exhibit C) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat 241, 42 USC 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

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

ARTICLE 15 - Definitions.

(a) Initial Project investments costs - The initial cost of the Project, including: land acquisition; construction; interest during construction on the value of land, labor, and materials used for planning and construction of the Project.

(b) Interest during construction - An amount of interest which accrues on expenditures for the establishment of Project services during the period between the actual outlay and the time the Project is first made available to User for water storage.

(c) Specific costs - The costs of Project features normally serving only one particular project purpose.

(d) Joint-use costs - The costs of features used for any two or more Project purposes.

(e) Plant-in-service date - This date is the date that the Project is physically available to initiate deliberate impoundment for water supply purposes.

(f) Annual operation and maintenance (O&M) expense - Annual expenses funded under the O&M, General account. These expenses include the daily project O&M costs as well as those O&M costs which are capitalized.

(g) Major replacement cost - Costs funded under the Construction, General account but not associated with initial Project investment costs.

(h) Fiscal Year - Refers to the Government's fiscal year. This year begins on 1 October and ends on 30 September. The September calendar year corresponds to the fiscal year.

(i) Life of the Project - This is the physical life of the Project.

(j) Major Rehabilitation - This program is to facilitate accomplishment of significant, costly infrequent rehabilitation work at the Project without unduly distorting the Operation and Maintenance, General budget.

(k) Dam Safety Assurance Program - This program is to provide for modification of the completed Project to rectify potential safety hazards in light of present day standards, technology, and circumstances.

ARTICLE 16 - Approval of Contract. This contract is subject to the written approval of the Assistant Secretary of the Army (Civil Works) or his duly authorized representative, and shall not be binding until so approved.

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

APPROVED:

William R. Gianelli
Assistant Secretary of the Army
(Civil Works)
DATE: 12 NOV 1982

THE UNITED STATES OF AMERICA

JAMES J. HARMON
Colonel, Corps of Engineers
District Engineer
Contracting Officer

DATE: 27 May 1982

CITY OF BARTLESVILLE, OKLAHOMA

BY
Mayor

DATE: April 19, 1982

ATTEST: George K. Jones City Clerk
SEAL

Reviewed for Legal Sufficiency
By 5/25/82

TECHNICAL REVIEW
By
5/21/82

DACW56 -82-C-0101

CERTIFICATION

"I, Jerry M. Maddux, Attorney for the City of Bartlesville, Oklahoma, named as User herein, hereby certify that the foregoing agreement executed by Arch Robbins, Mayor of the User is within the scope of his authority to act upon behalf of the User, and that in my capacity as Attorney for the User, I have considered the legal effect of Section 221 of the 1970 Flood Control Act (Public Law 91-611) and find that the User is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance, it will be legally enforceable.

Given under my hand, this 19th day of April 1982.

Jerry M. Maddux
Attorney for the
City of Bartlesville, Oklahoma

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

The City of Bartlesville, Oklahoma
(hereinafter called "Applicant-Recipient")

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

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

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date. The Applicant- Recipient recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

Sections IV and VII of Department of Defense Directive 5500.11 setting forth prohibited discriminatory actions and compliance information is on the reverse hereof.

Dated April 19, 1982

THE CITY OF BARTLESVILLE, OKLAHOMA
(Applicant-Recipient)

By _____
Mayor

ATTEST:

_____
City Clerk

SWT Form 553
Rev 23 Jun 72

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

EXHIBIT "C"

EXHIBIT C

STANDING INSTRUCTIONS TO PROJECT MANAGER

HULAH LAKE

EXHIBIT C

STANDING INSTRUCTIONS TO PROJECT MANAGER

HULAH LAKE

TABLE INDEX

EXHIBIT C

STANDING INSTRUCTIONS TO PROJECT MANAGER

HULAH LAKE

I. GENERAL

1. Instructions. Detailed instructions to the project personnel at Hulah 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 observations of rainfall 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 Hulah Lake (see plate 5-3) will be obtained from the WCDS database. Weather data and other data collected by the Copan/Hulah Lakes Project Office will be submitted to the Water Control Section, Hydrology-Hydraulics Branch, Tulsa District Office (telephone 918-669-7102 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 on an as needed basis. 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 total precipitation amounts for the previous 24-hour periods (7:00 a.m. to 7:00 a.m.).

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

c. Number of water supply pumps in operation.

d. The current gate setting and any gate changes made during the past 24-hour period including the time and pool elevation when the change was made.

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

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

b. The current pool elevation readings from the pool gage, 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) 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. 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 on 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 Hulah Dam, Operation and Maintenance Manual, Volume II, dated August 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. 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 6,500 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. Hulah Lake will be regulated for optimum flood reductions, in conjunction with Copan Lake, on the Caney River from the dam to the confluence with the Verdigris River and with the existing system of lakes on the Arkansas River and tributaries to Van Buren, Arkansas. The following regulations, as shown in Table 7-1, will govern releases from Hulah Lake. During flood control regulation, the tainter gates and sluice 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 7-2 or Table C-1 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 2-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-1

EMERGENCY FLOOD CONTROL REGULATION SCHEDULE

HULAH LAKE

LAKE STAGE	POOL CONDITIONS	REGULATION
Below 733.0	Rising	Continue the releases being made at the time of communication failure.
733.0 to 767.0	Rising	If the lake level is below elevation 760.0, 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 760.0 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 2 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 sluice gates will be raised at uniform openings until the lake stops rising or the sluice 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 767.0	Rising	The spillway gates and sluice gates will be maintained fully opened and held in such position.

TABLE C-1 (CONT'D)

LAKE STAGE	POOL CONDITIONS	REGULATION
Above 767.0	Falling	The spillway gates and sluice gates will be maintained fully opened and held in such position until the pool elevation recedes to elevation 767.0.
767.0 - 765.0	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 765.0 or the release is 6,500 cfs.
765.0 – 736.0	Falling	If the maximum release rate exceeded 6,500 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 6,500 cfs. If the maximum release was much lower than 6,500 cfs, this release will be maintained until the lake level reaches 736.0.
736.0 - 733.0	Falling	Begin a gradual reduction of the release rate (not to exceed 1,100 cfs per 3-hr period) so that releases are equal to inflow (the pool is steady) at elevation 733.0.

PLATES

CIVIL WORKS LEGEND

- CIVIL WORKS BOUNDARY
- COMPLETED PROJECTS
- PROJECTS UNDER CONSTRUCTION
- PROJECTS AUTHORIZED
- LOCK AND DAM
- LOCAL PROTECTION PROJECTS & OTHERS
- SALT AREAS
- NAVIGATION SYSTEMS

MILITARY LEGEND

- MILITARY BOUNDARY
- USAF INSTALLATION
- USA INSTALLATION
- DOE INSTALLATION

SCALE OF MILES
25 0 25 50 75

LITTLE ROCK DISTRICT

US Army Corps of Engineers
Southwestern Division
Tulsa District

OKLAHOMA, TEXAS, & KANSAS

PROJECTS

SEPTEMBER 1992

1-1

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

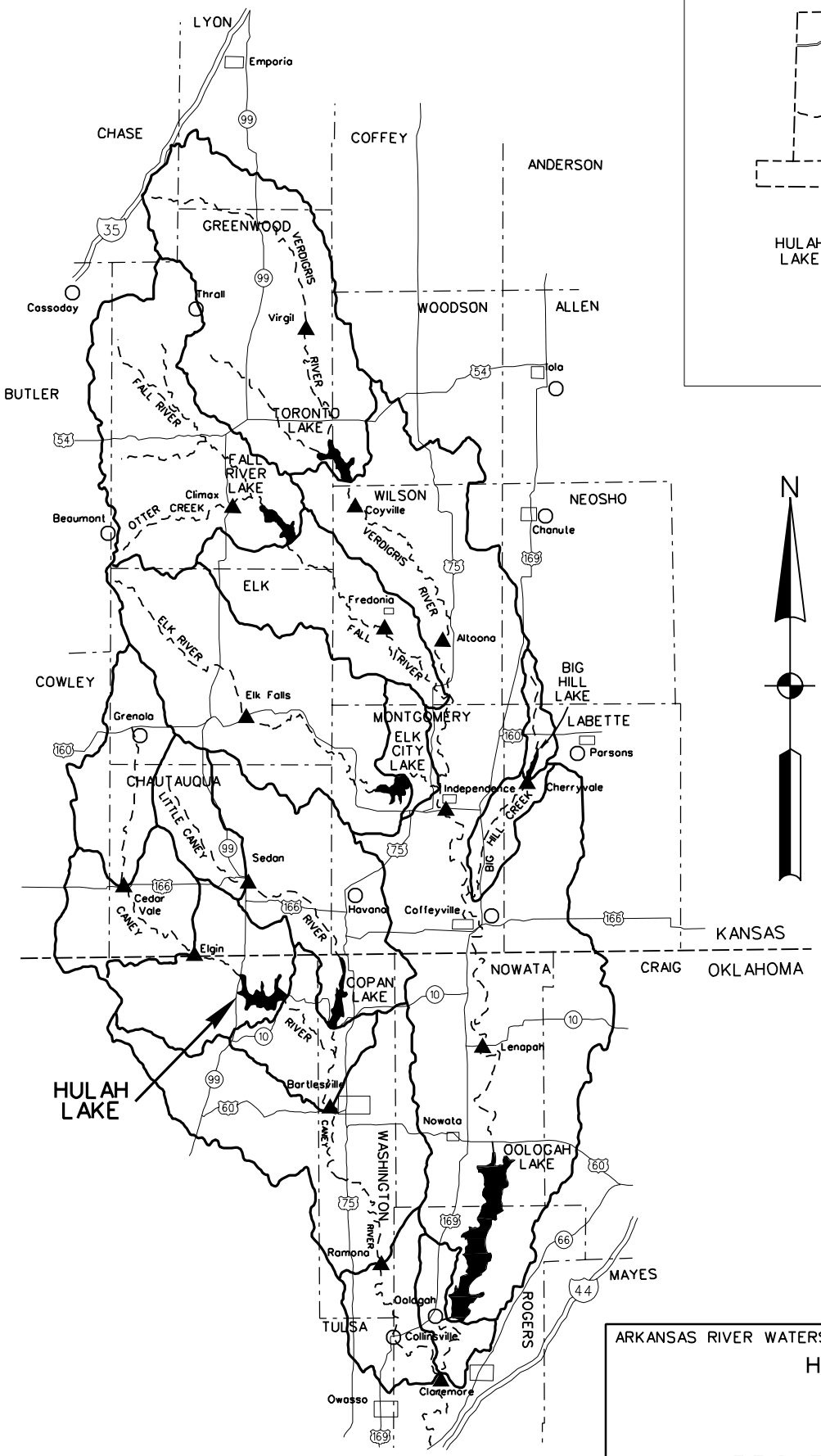
Department of Energy Installation

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 — CANEY RIVER, OKLAHOMA

HULAH LAKE

PROJECT LOCATION AND VICINITY MAP

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.

2-1

(b) (7)(F)

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

GENERAL PLAN & SECTIONS

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

2-2

(b) (7)(F)

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

SPILLWAY PLAN AND SECTIONS

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

2-3

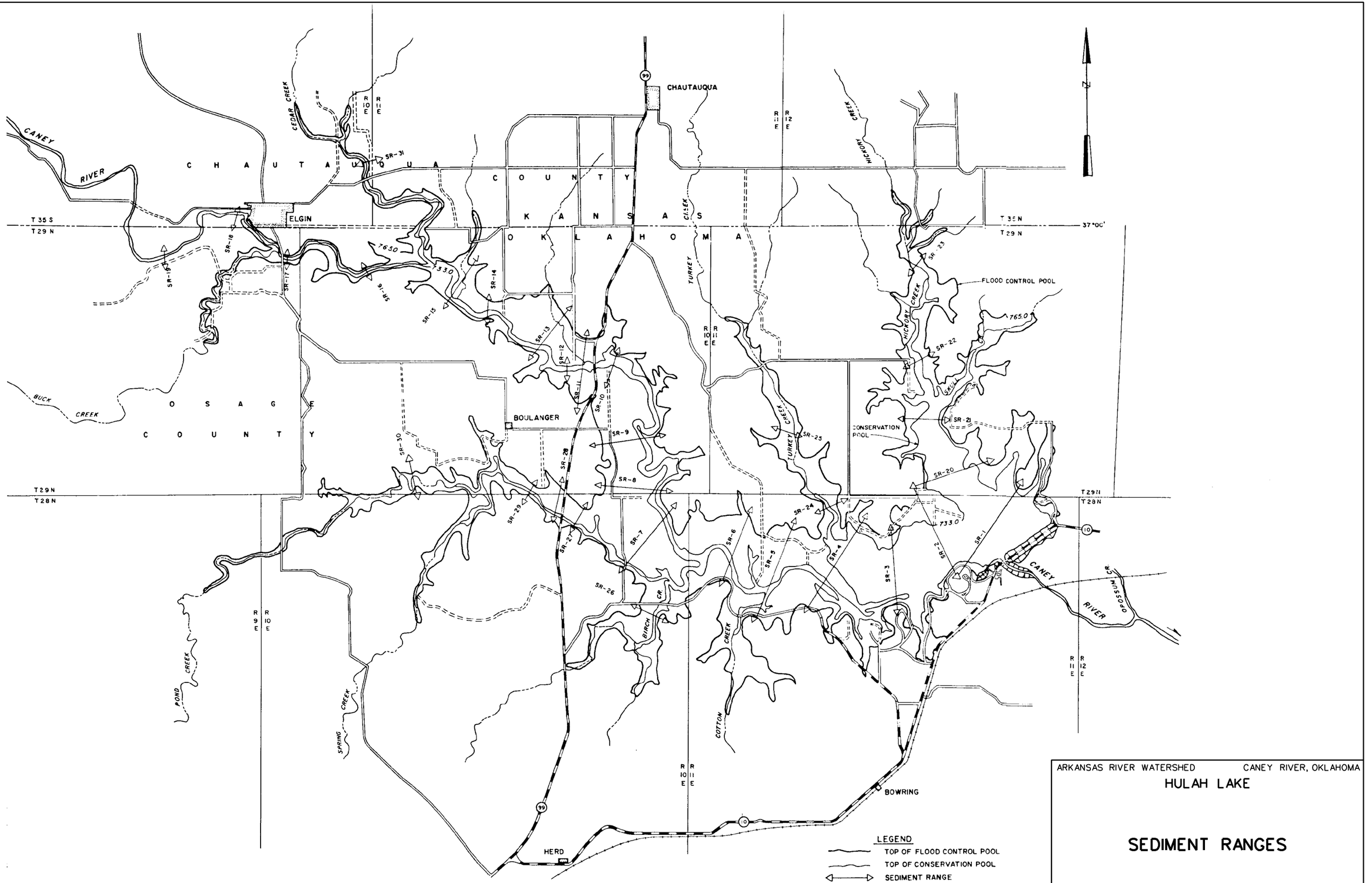
(b) (7)(F)

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

SPILLWAY ELEVATIONS

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

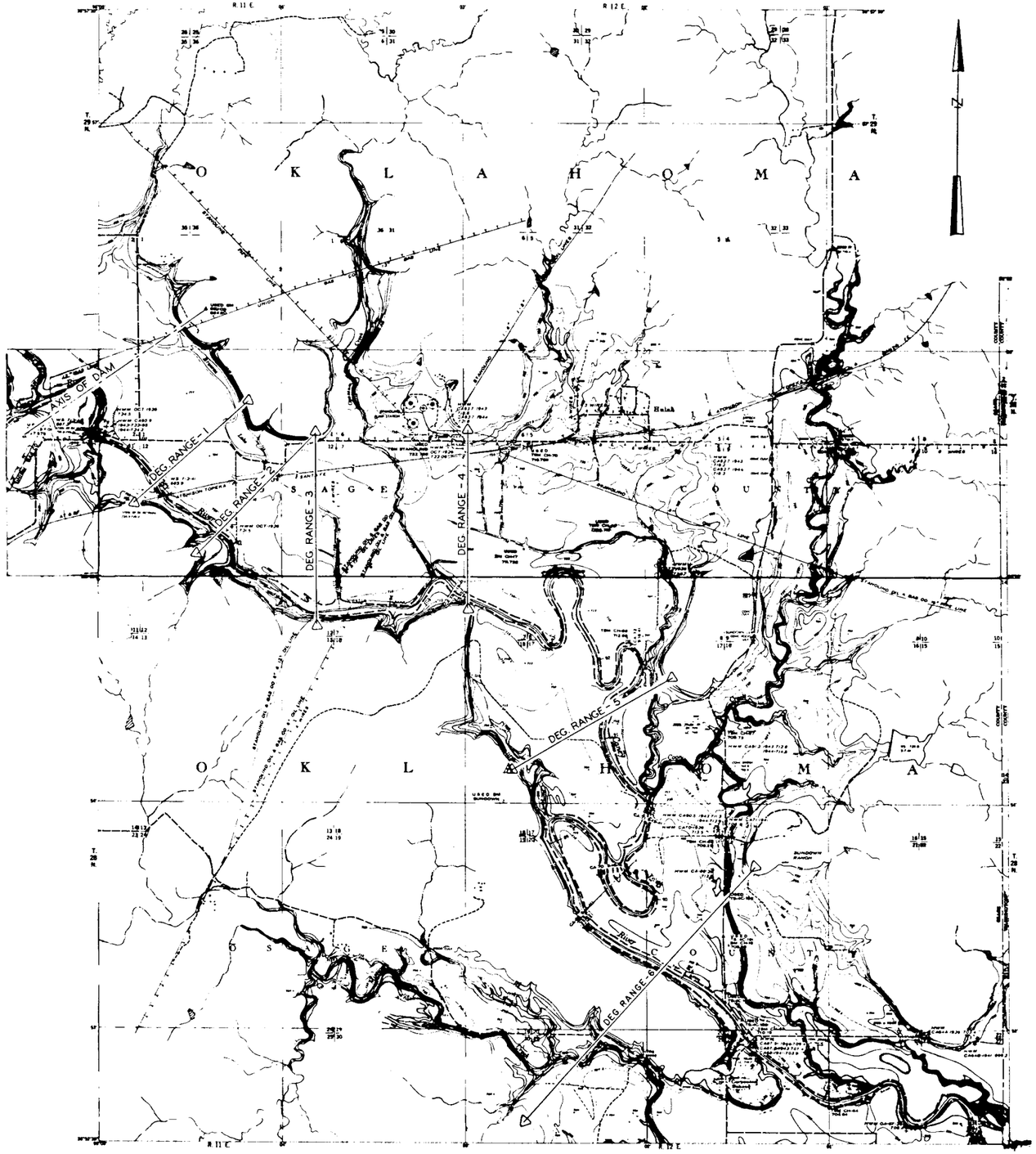


ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

SEDIMENT RANGES

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

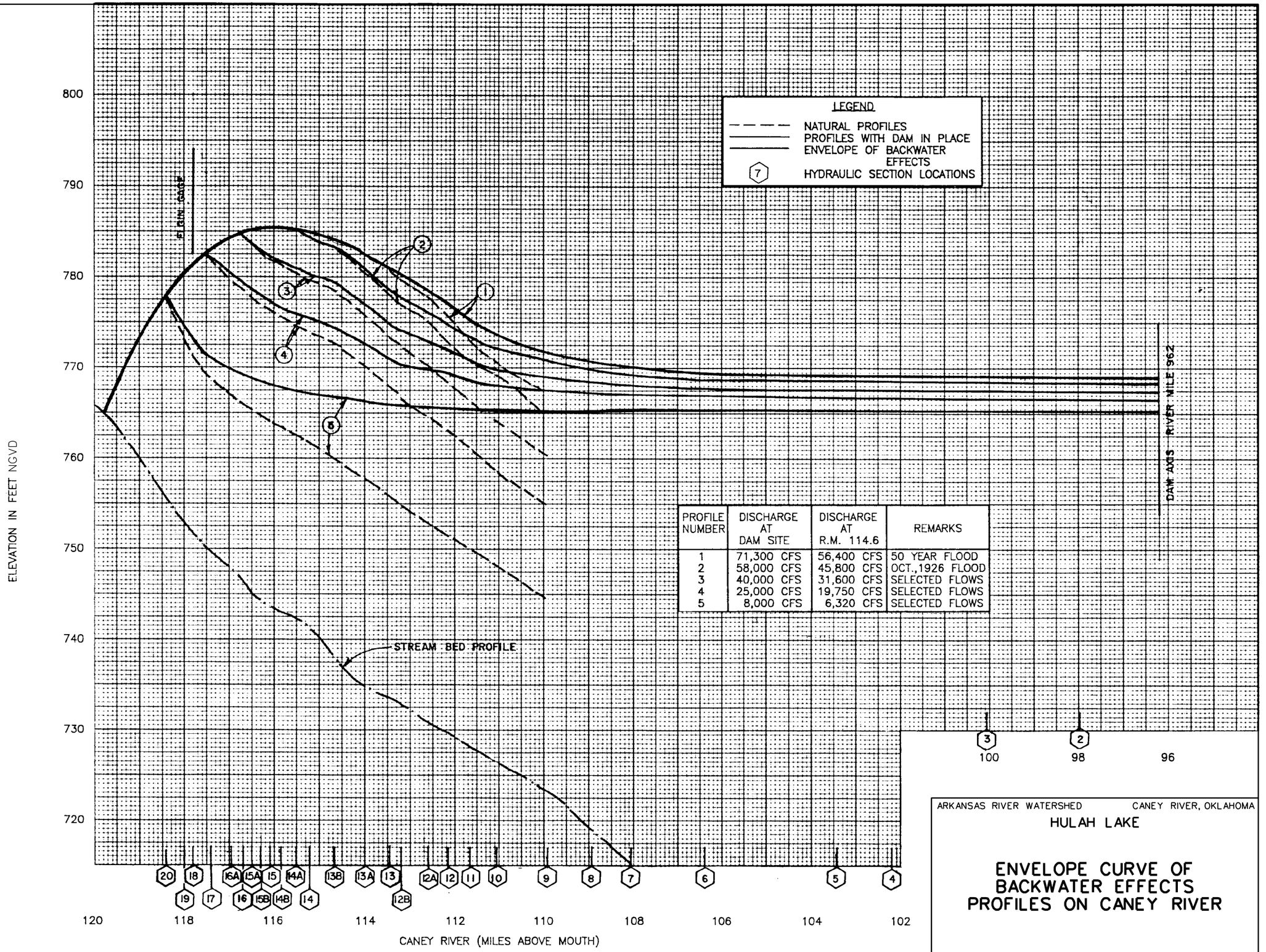


ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

DEGRADATION RANGES

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



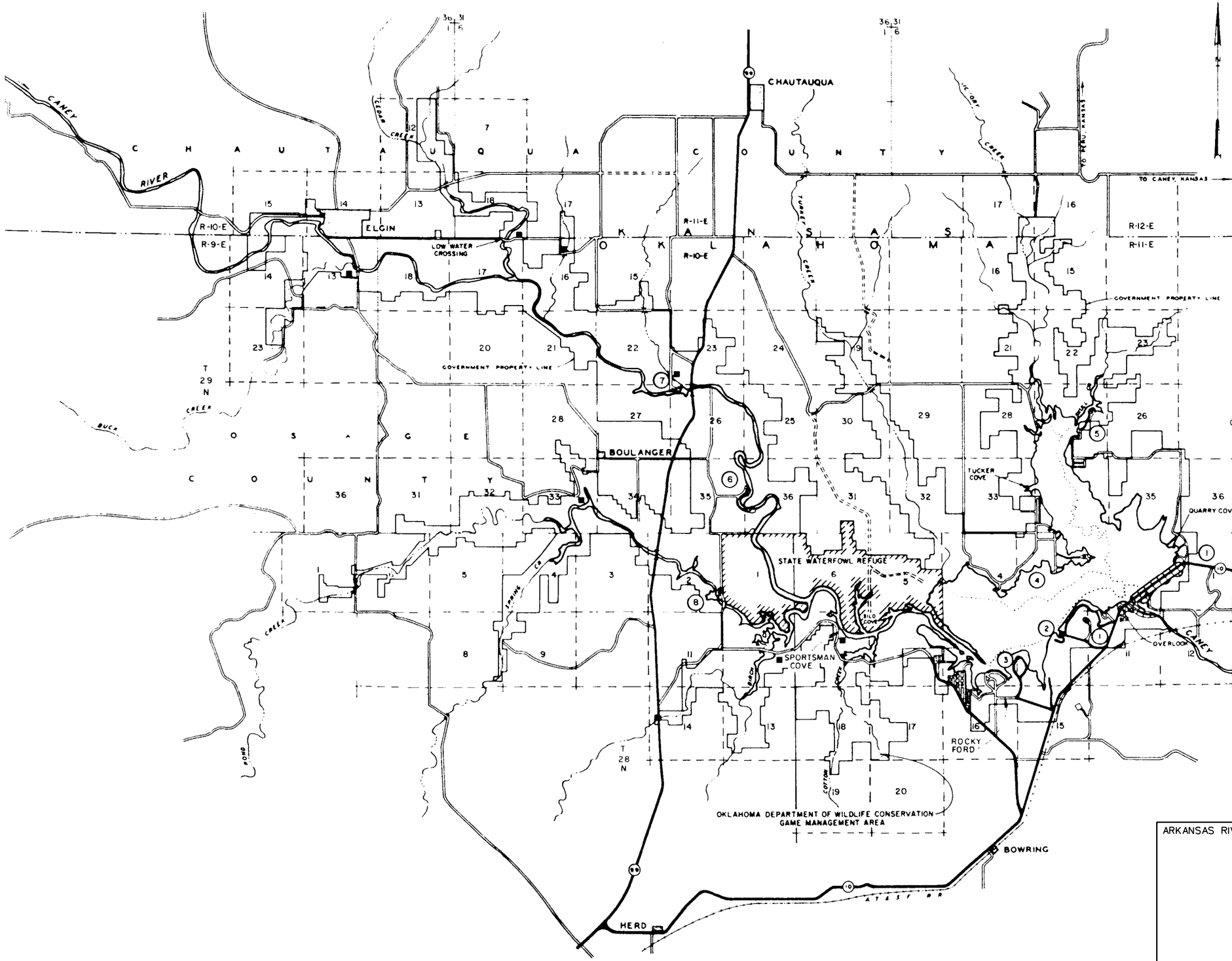
PROFILE NUMBER	DISCHARGE AT DAM SITE	DISCHARGE AT R.M. 114.6	REMARKS
1	71,300 CFS	56,400 CFS	50 YEAR FLOOD
2	58,000 CFS	45,800 CFS	OCT.,1926 FLOOD
3	40,000 CFS	31,600 CFS	SELECTED FLOWS
4	25,000 CFS	19,750 CFS	SELECTED FLOWS
5	8,000 CFS	6,320 CFS	SELECTED FLOWS

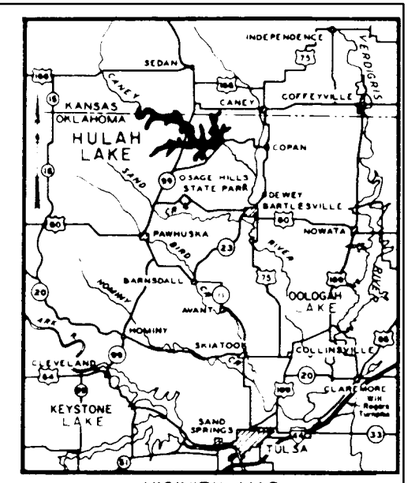
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

ENVELOPE CURVE OF BACKWATER EFFECTS PROFILES ON CANEY RIVER

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





PUBLIC USE AREAS

NO.	NAME
1	DAM SITE AREA
2.	HULAH COVE
3.	CANEY BEND
4	TURKEY CREEK POINT
5	SKULL CREEK
6.	CANEY RIVER
7	BOULANGER LANDING
8.	POND CREEK

SYMBOLS

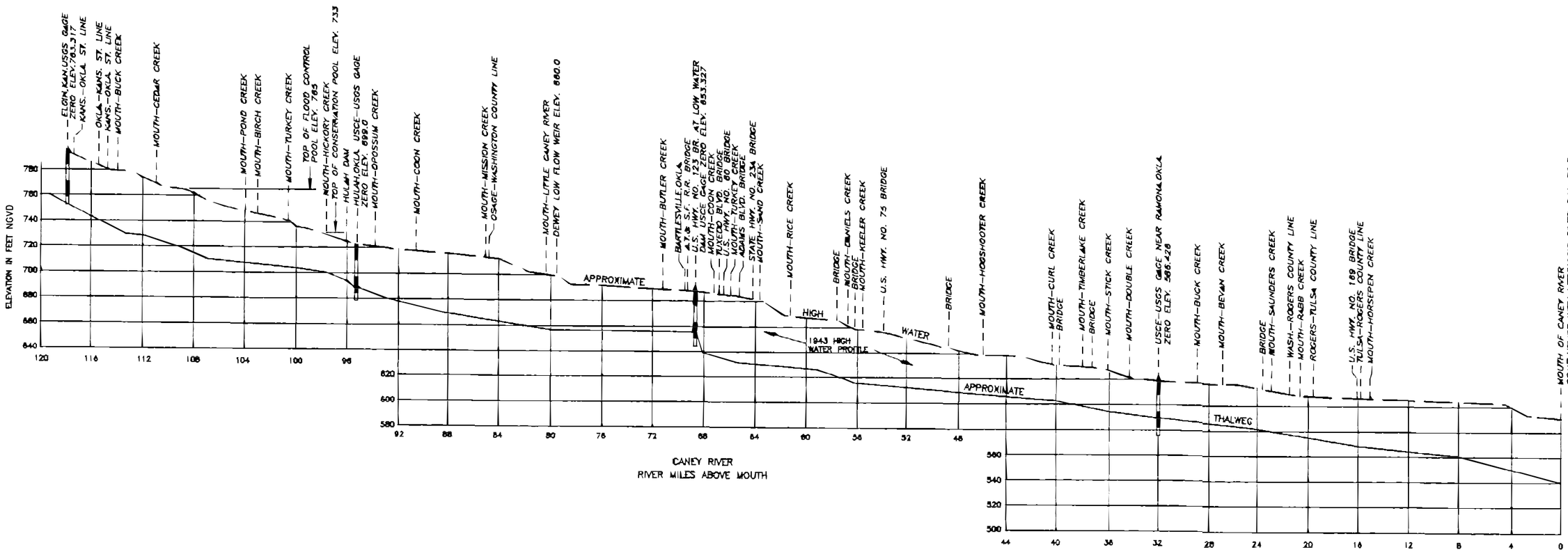
ROADS, PAVED
ROADS, IMPROVED
ROADS, DIRT

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

PUBLIC USE SITES

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

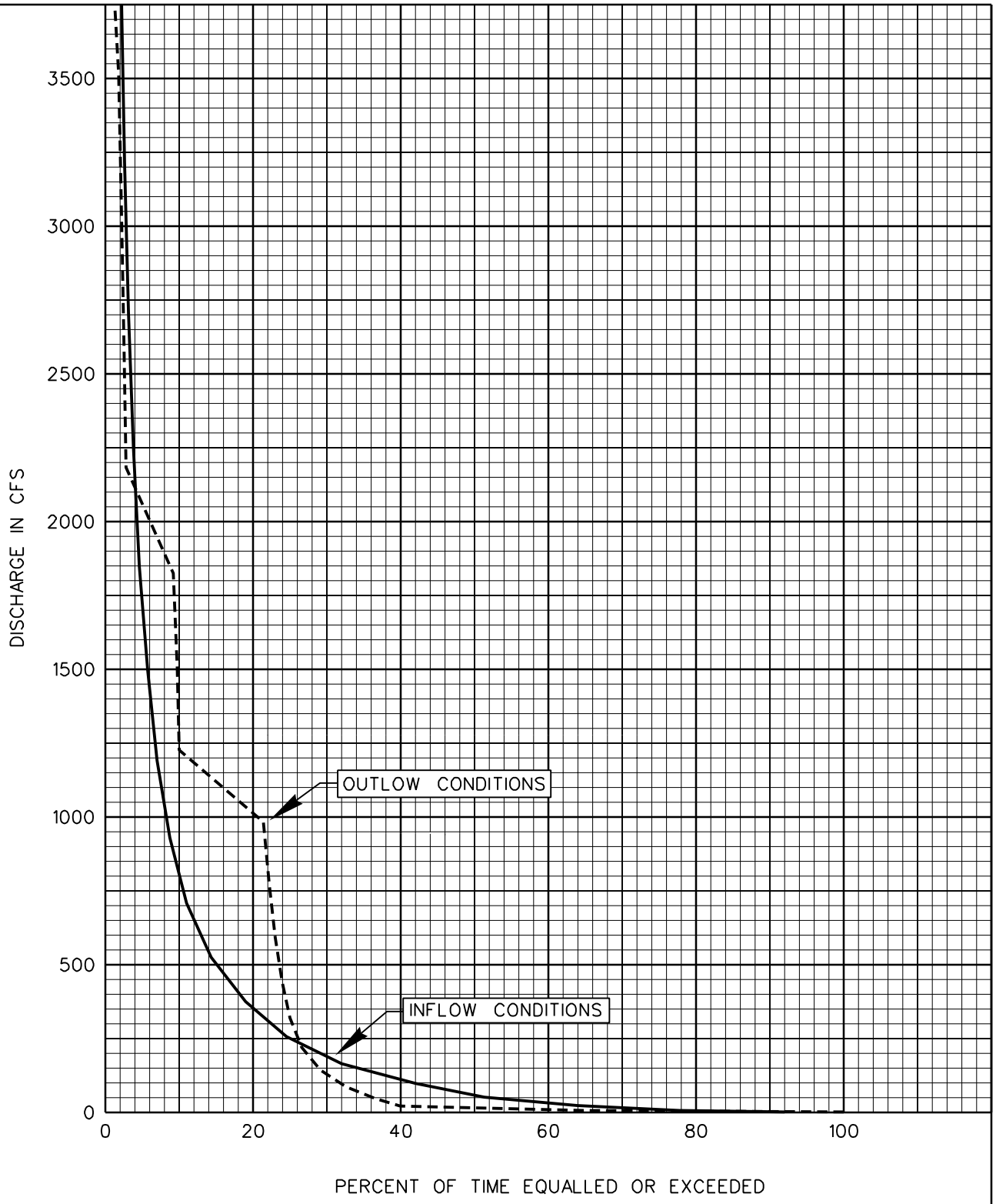


ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

STREAM PROFILE
CANEY RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:

CURVE IS BASED UPON PERIOD OF RECORD JANUARY 1940 THRU DECEMBER 1995 FROM SUPER RUN A98X01.

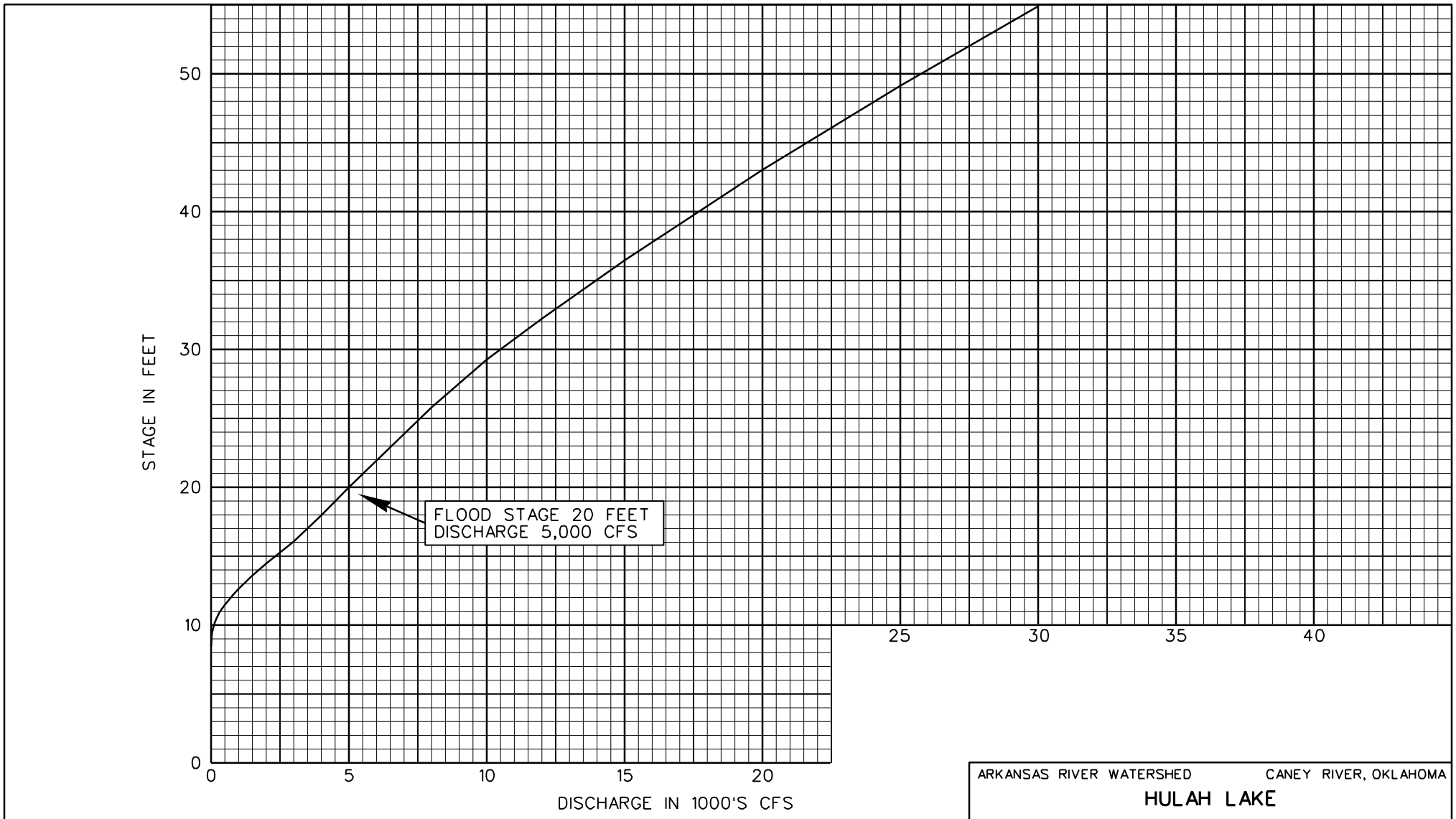
OUTFLOW CONDITIONS CURVE APPROACHES ZERO AT 6700 CFS. INFLOW CONDITIONS CURVE APPROACHES ZERO AT 34,000 CFS.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

FLOW DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:
CURVE IS BASED UPON RATING CURVE
NUMBER 3, DATED SEPTEMBER 30, 1994
AND SHIFT CURVE DATED APRIL 19, 1996.

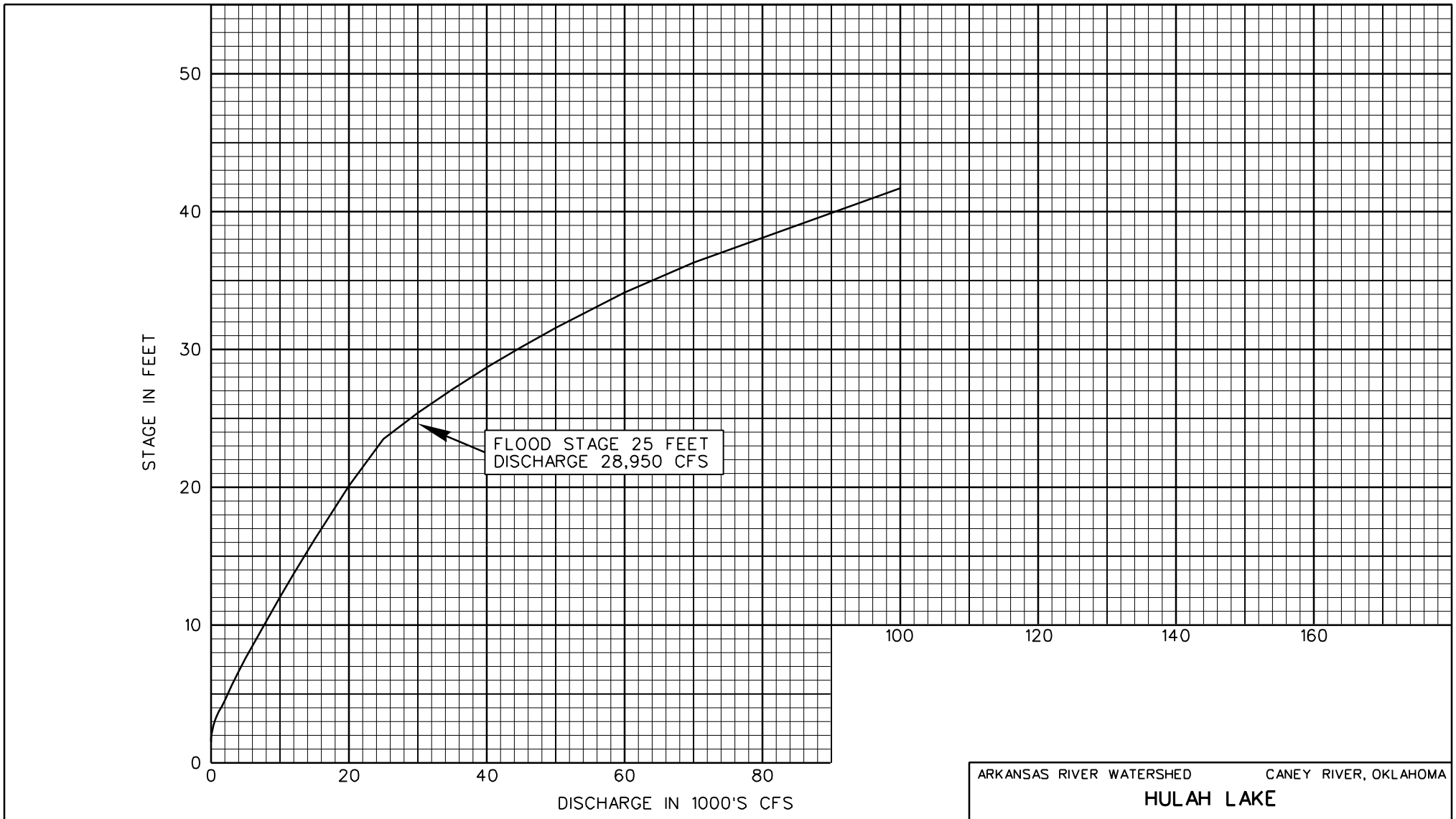
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

DISCHARGE RATING CURVE

CANEY RIVER NEAR
CEDAR VALE, KANSAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:
CURVE IS BASED UPON RATING CURVE
NUMBER 3, DATED SEPTEMBER 30, 1994
AND SHIFT CURVE DATED APRIL 19, 1996.

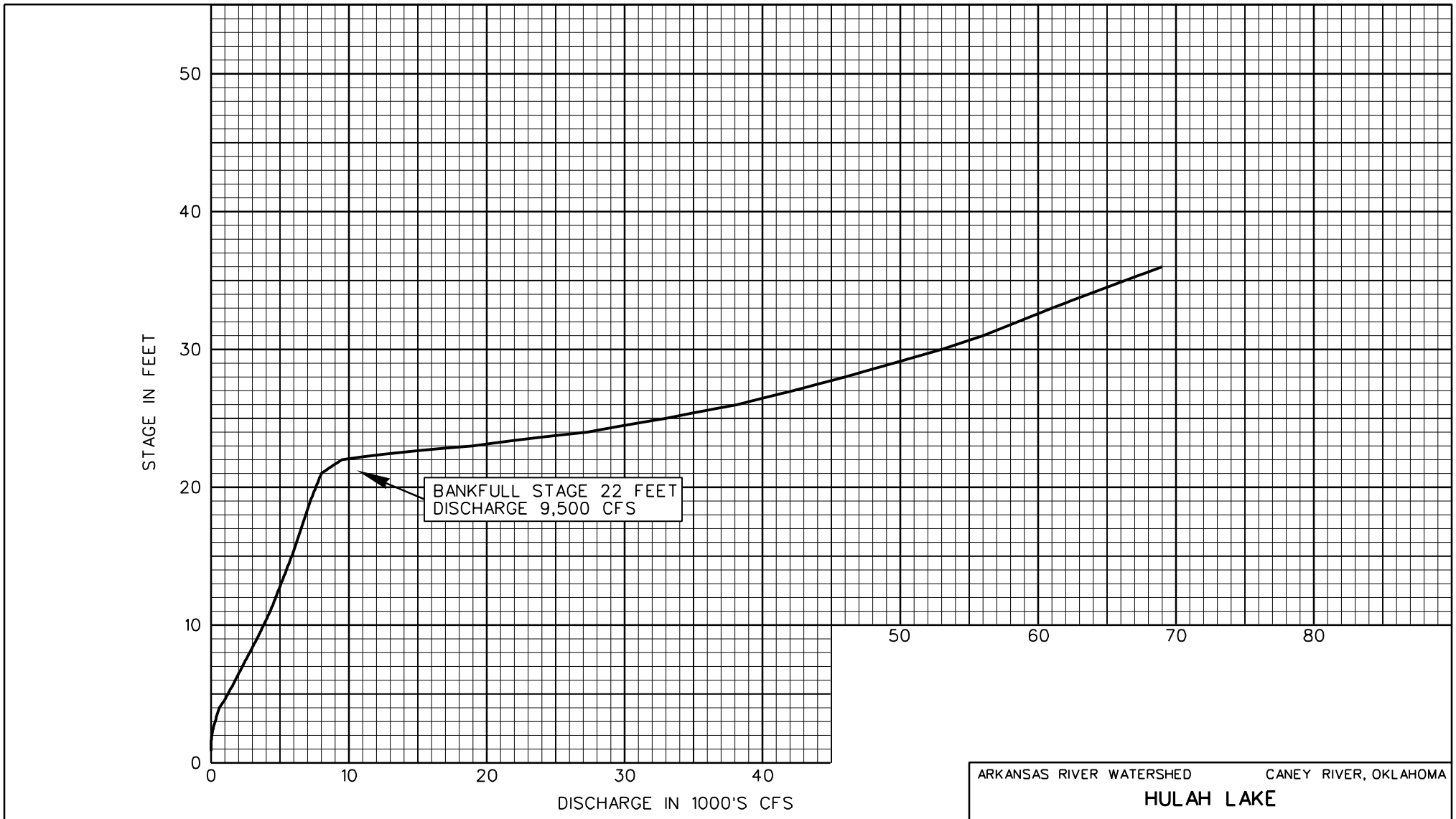
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

DISCHARGE RATING CURVE

CANEY RIVER NEAR
ELGIN, KANSAS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:
CURVE IS BASED UPON RATING CURVE
NUMBER 31, DATED OCTOBER 1, 1991

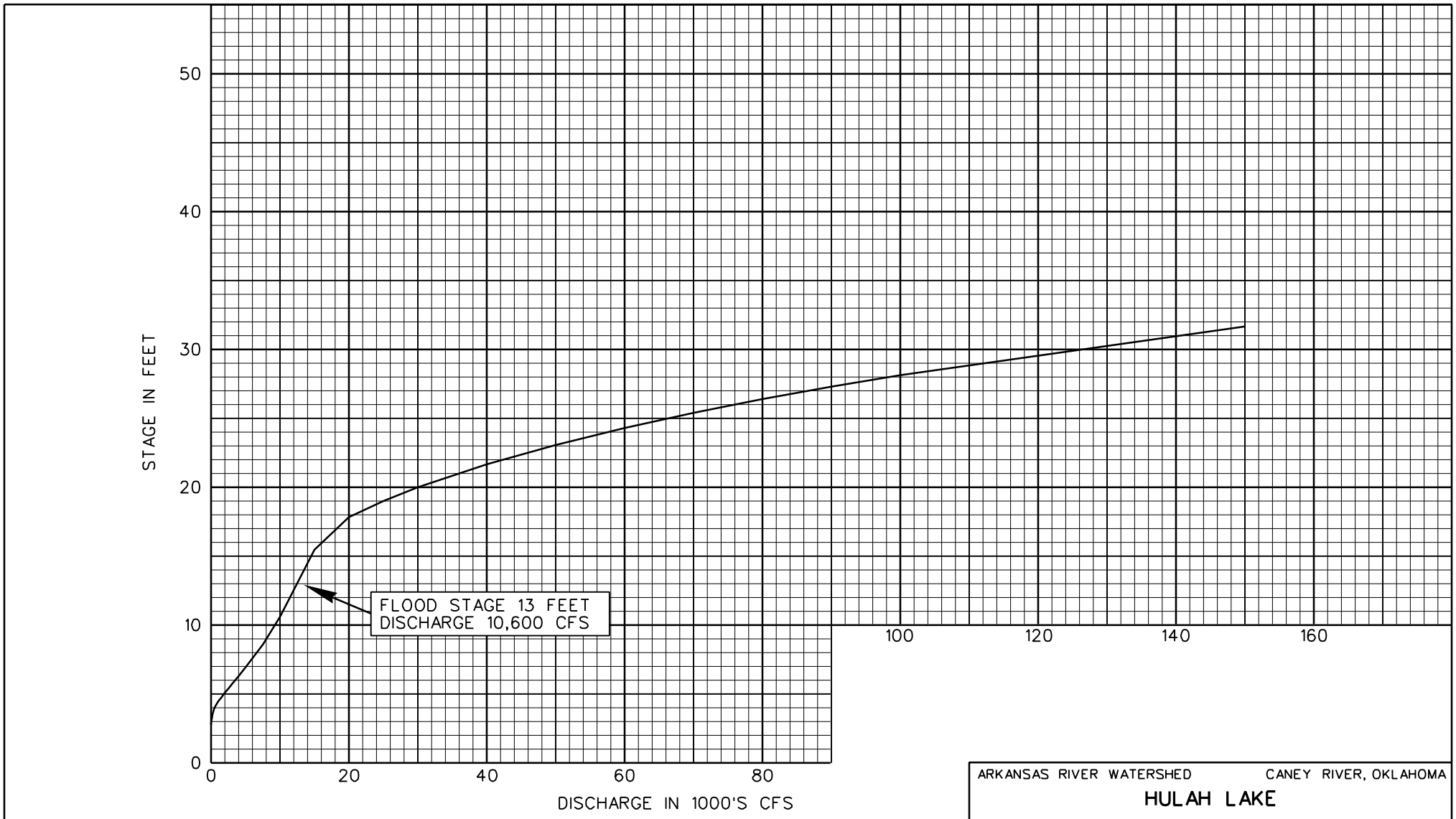
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

DISCHARGE RATING CURVE

CANEY RIVER NEAR
HULAH, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:
CURVE IS BASED UPON RATING CURVE
NUMBER 3, DATED SEPTEMBER 30, 1994
AND SHIFT CURVE DATED APRIL 19, 1996.

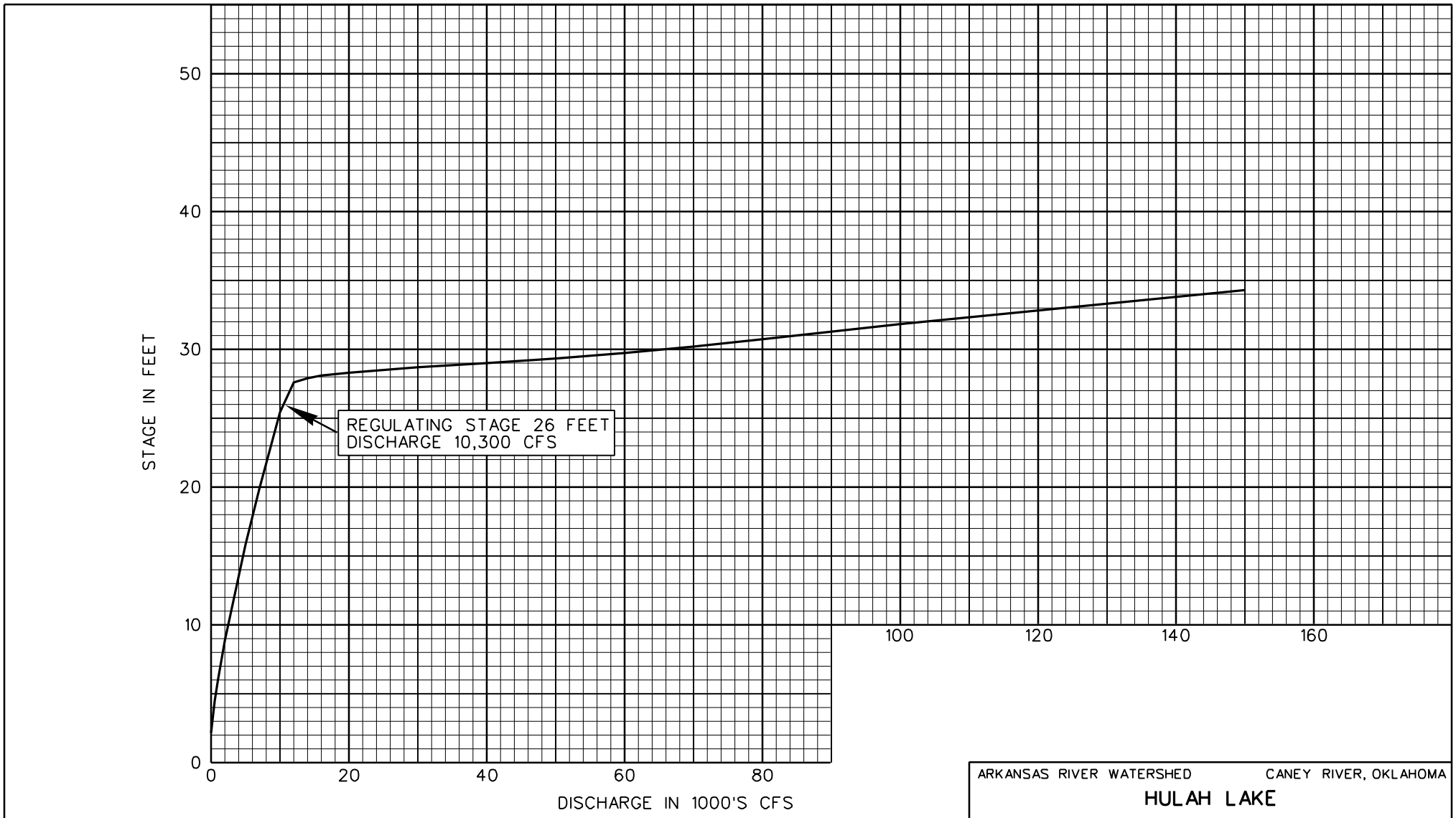
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

DISCHARGE RATING CURVE

CANEY RIVER NEAR
BARTLESVILLE, OKLAHOMA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
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.

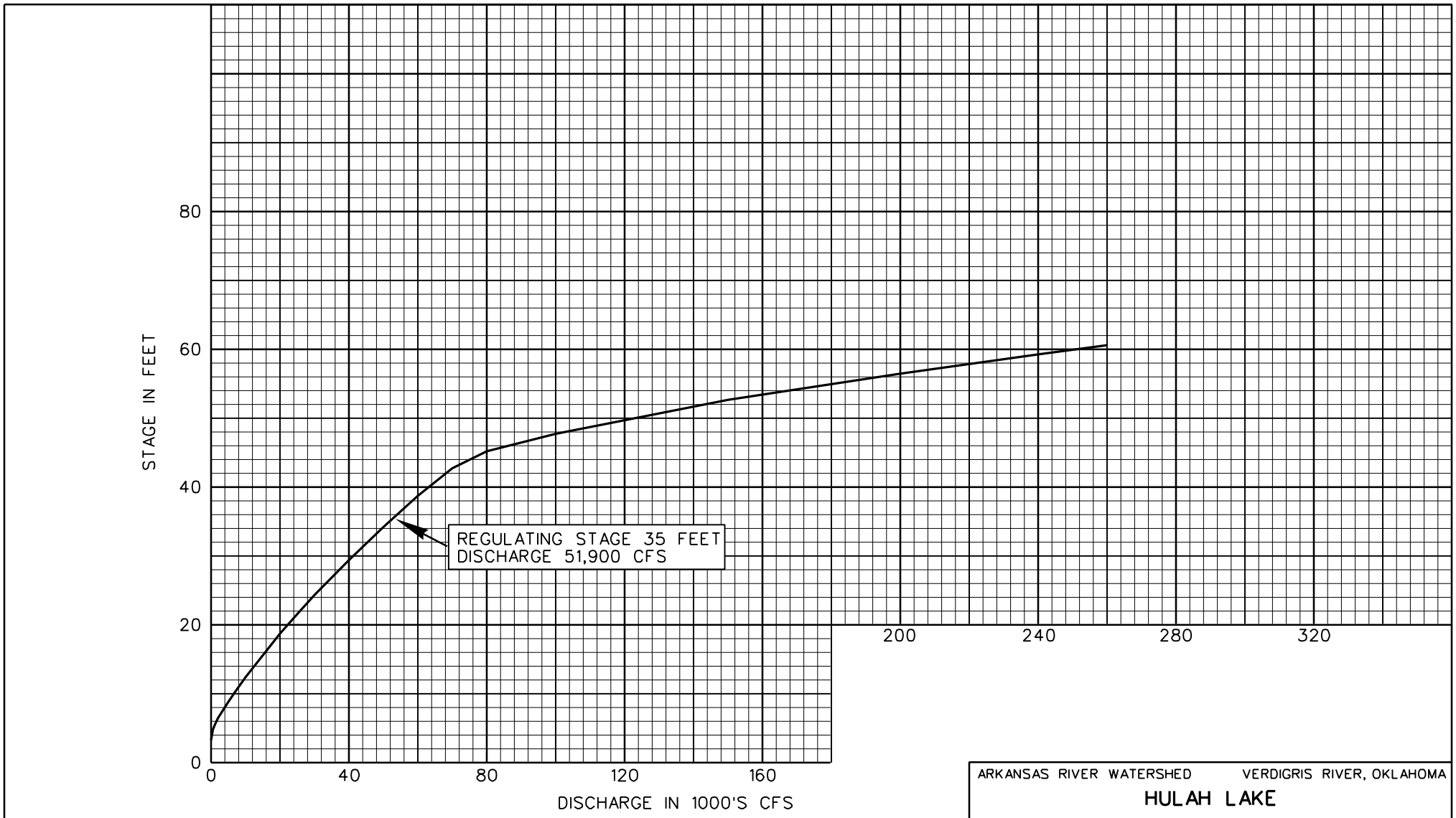
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH 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.

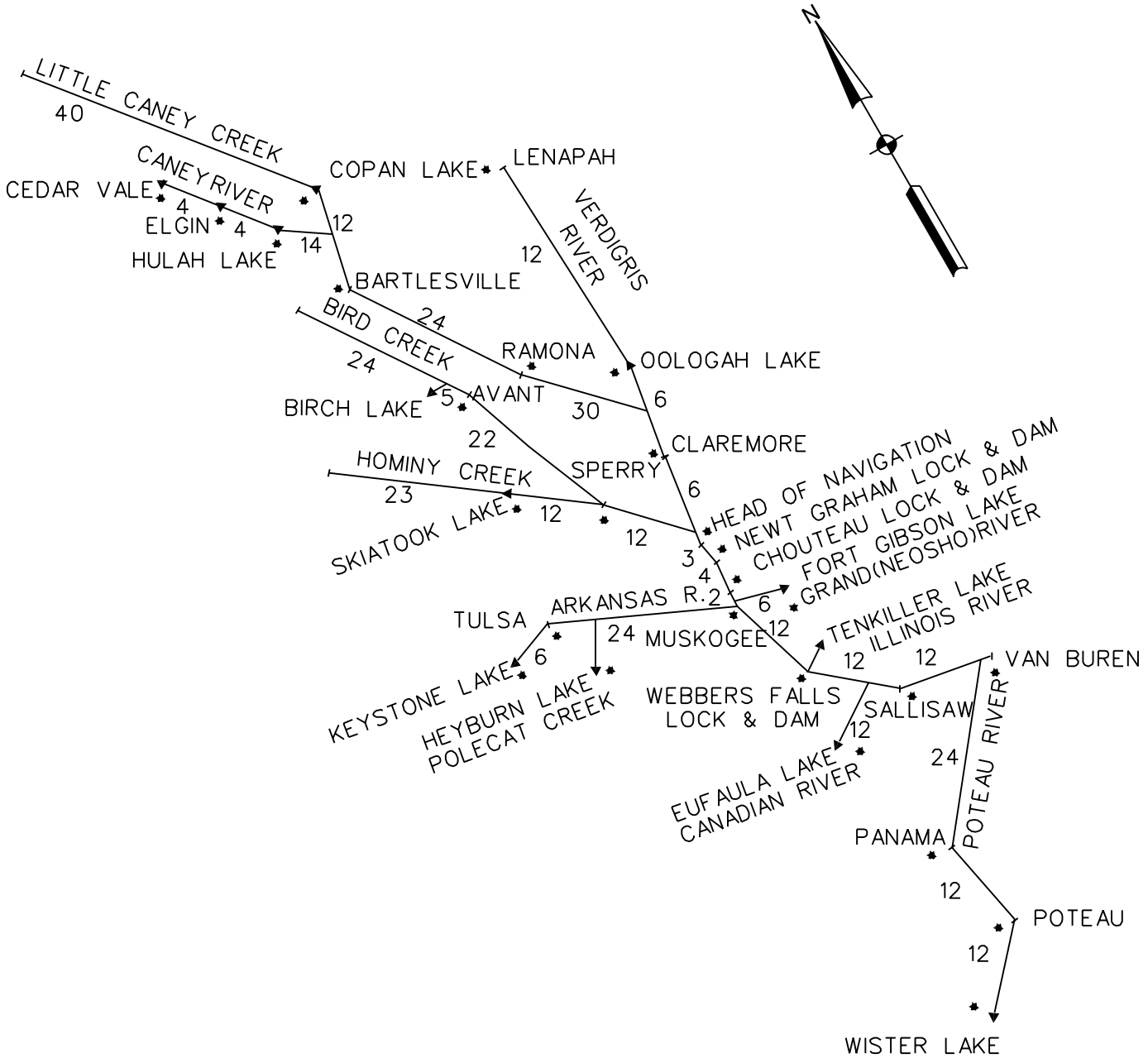
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, OKLAHOMA

HULAH 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.



NOTES:

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

   * 24 *

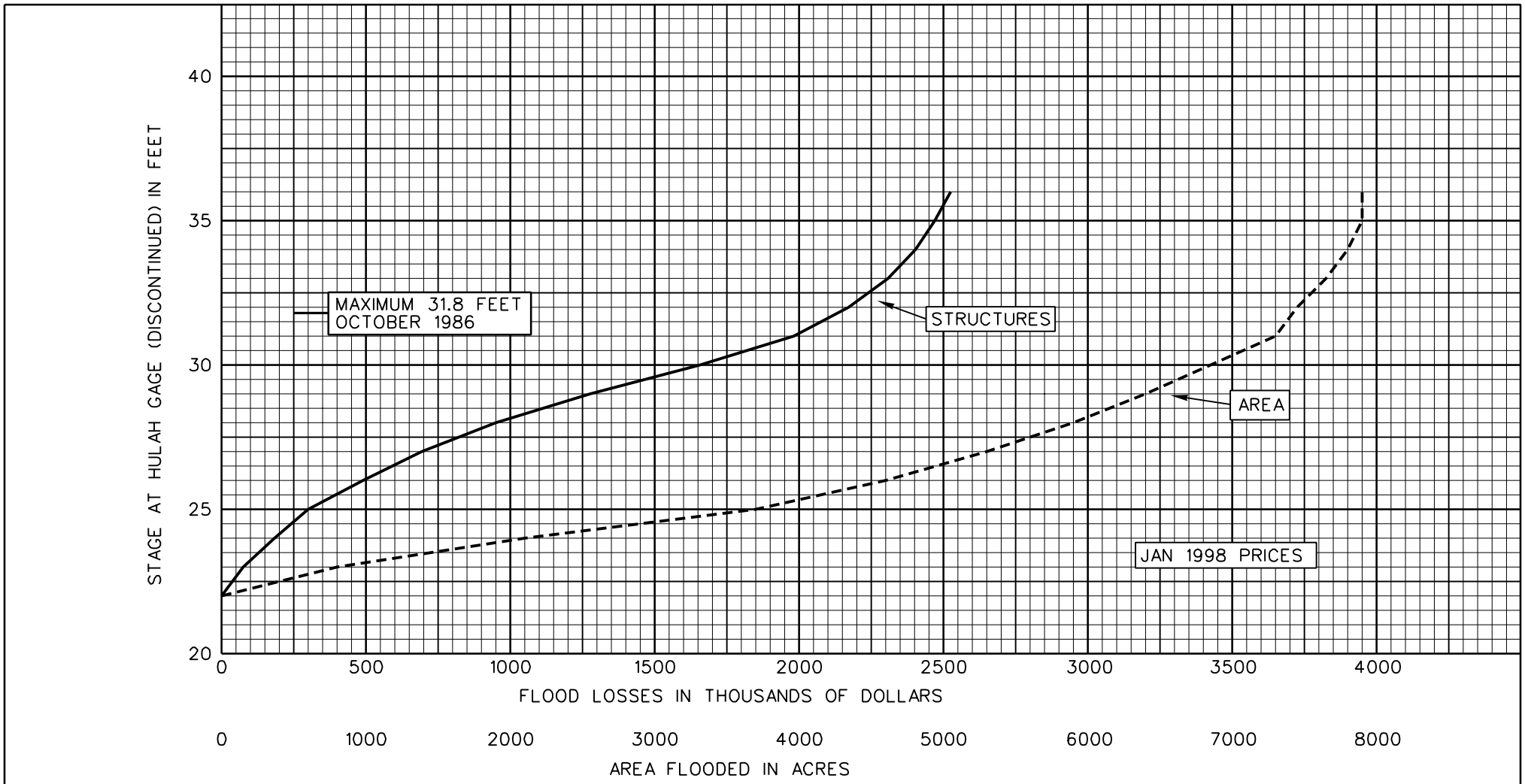
2. TIME SHOWN ABOVE UPSTREAM STATION IS AVERAGE TIME TO CREST AFTER BEGINNING OF RUNOFF.

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

TIME OF CREST TRAVEL

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



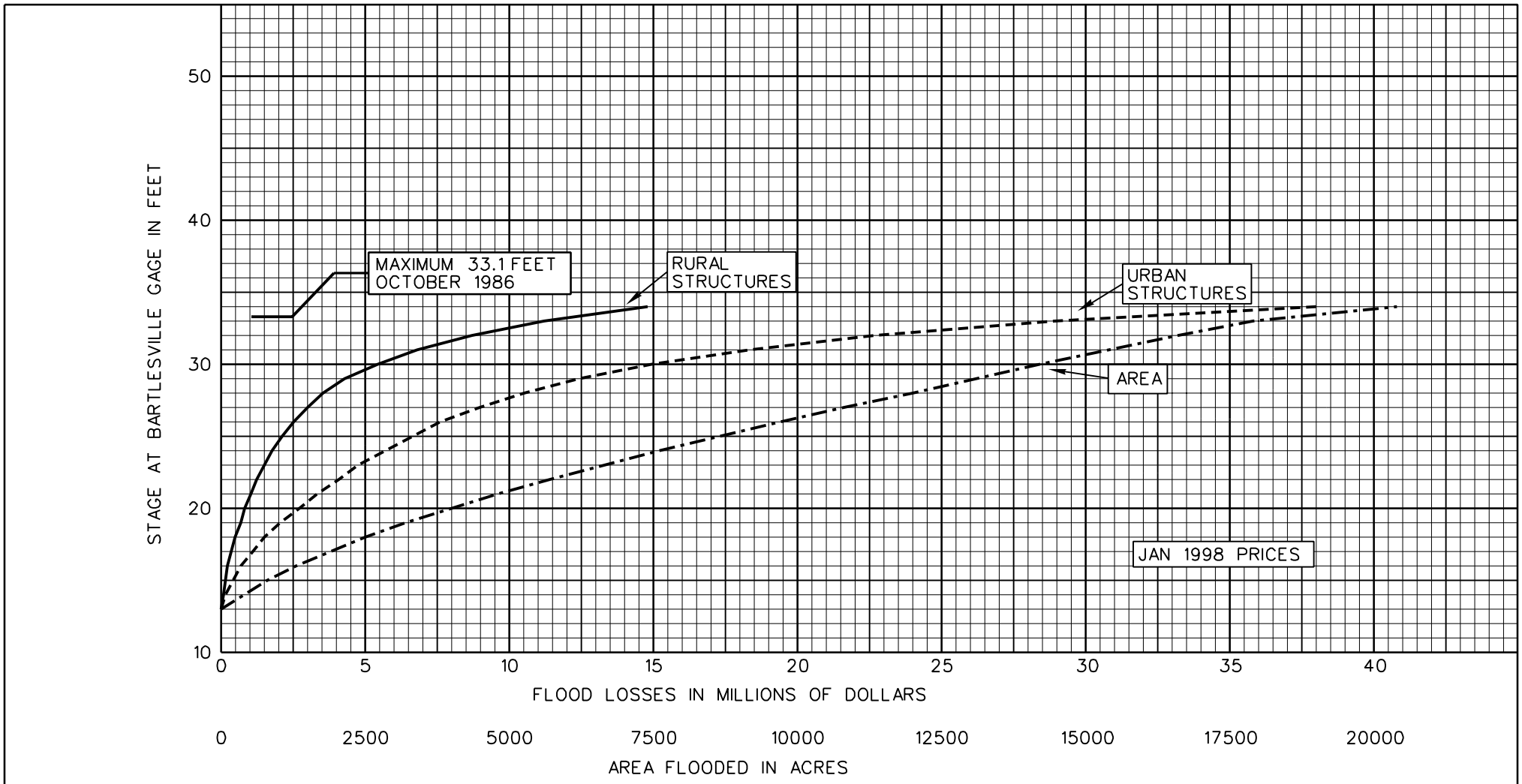
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

STRUCTURAL LOSS AND AREA CURVES

HULAH DAM TO THE CONFLUENCE OF THE LITTLE CANEY RIVER WITH THE CANEY RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



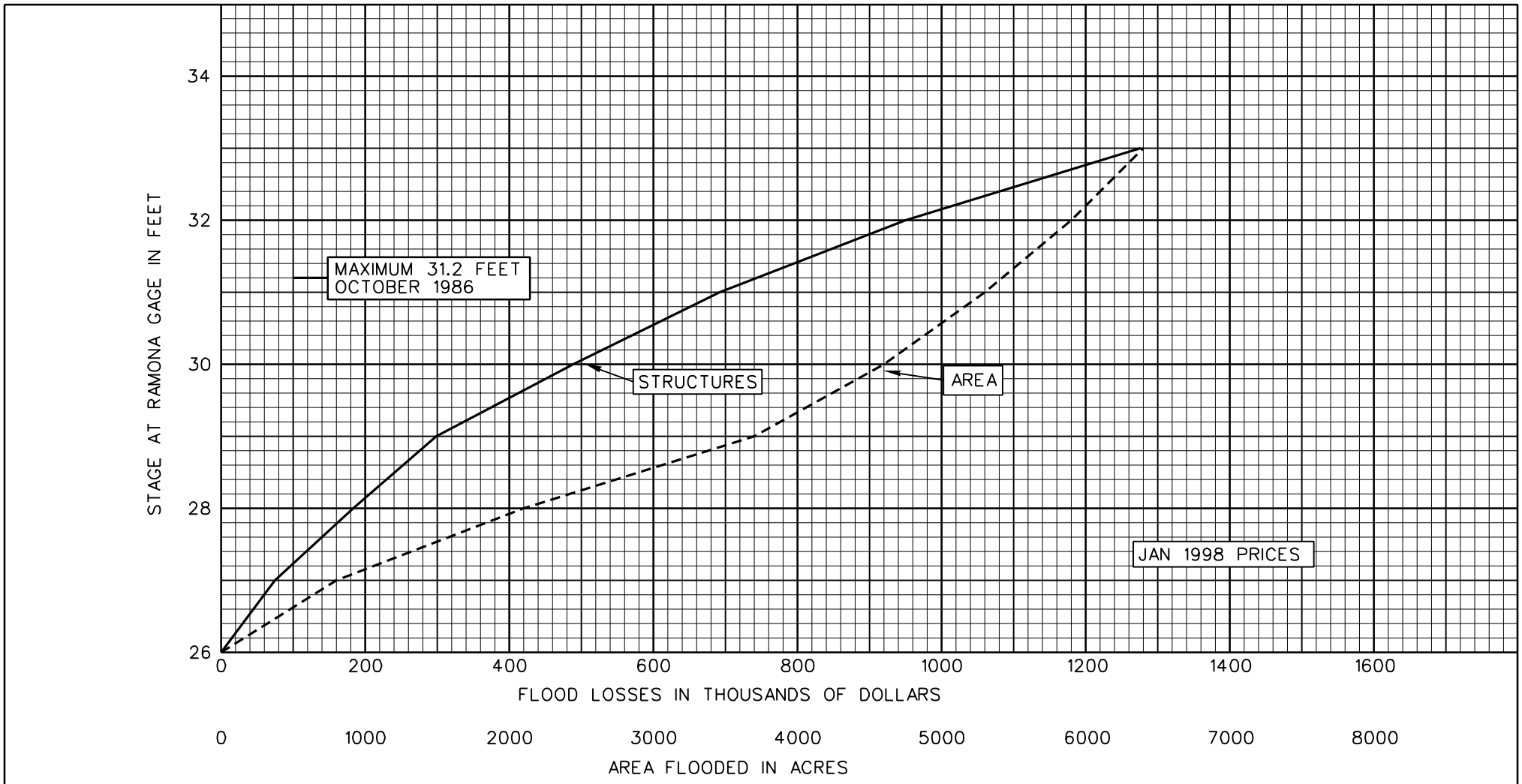
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

STRUCTURAL LOSS AND AREA CURVES

LITTLE CANEY RIVER CONFLUENCE
TO SAND CREEK CONFLUENCE
ON THE CANEY RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



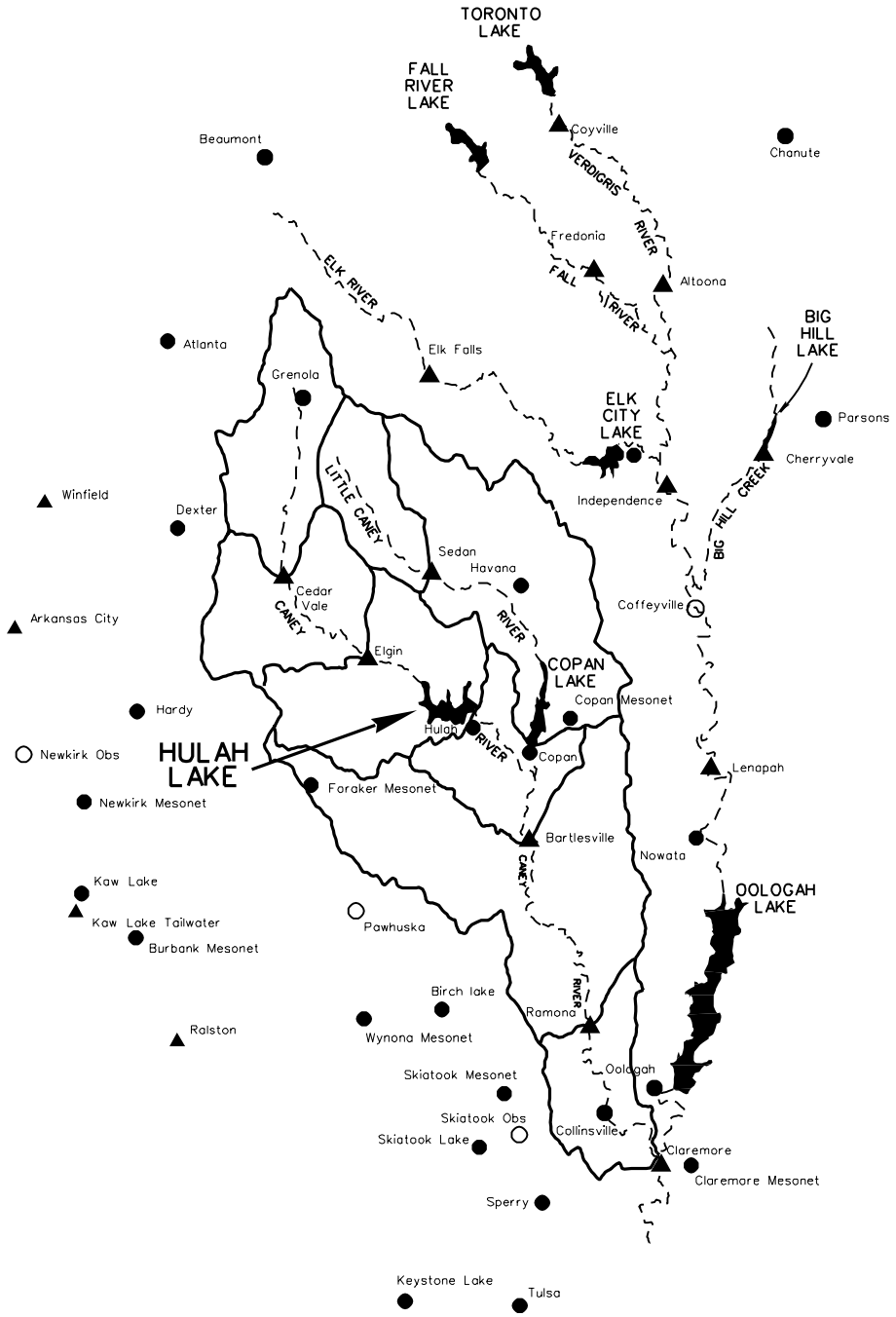
ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

STRUCTURAL LOSS AND AREA CURVES

SAND CREEK CONFLUENCE OF THE CANEY RIVER TO THE CANEY RIVER CONFLUENCE WITH THE VERDIGRIS RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



LEGEND

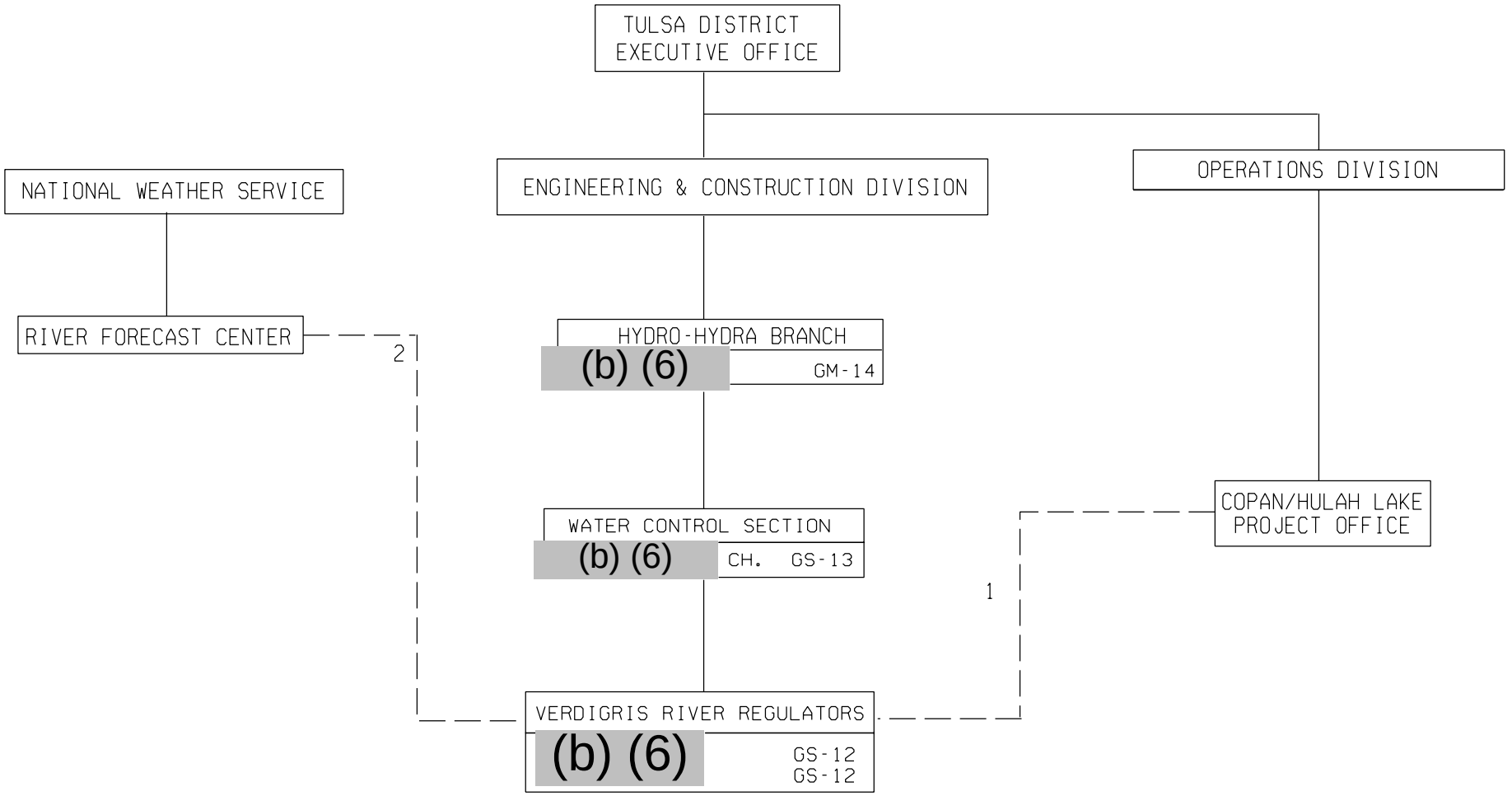
- ● RECORDING PRECIPITATION STATIONS
- ○ OBSERVER PRECIPITATION STATIONS
- ▲ RECORDING STREAM GAGING AND PRECIPITATION STATIONS

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

STREAM GAGING AND RAINFALL STATIONS

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
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 SHARED WITH THE NATIONAL WEATHER SERVICE, RIVER FORECAST CENTER.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

ORGANIZATIONAL CHART

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.

LAKE DATA

HULA

26 JUNE 1991

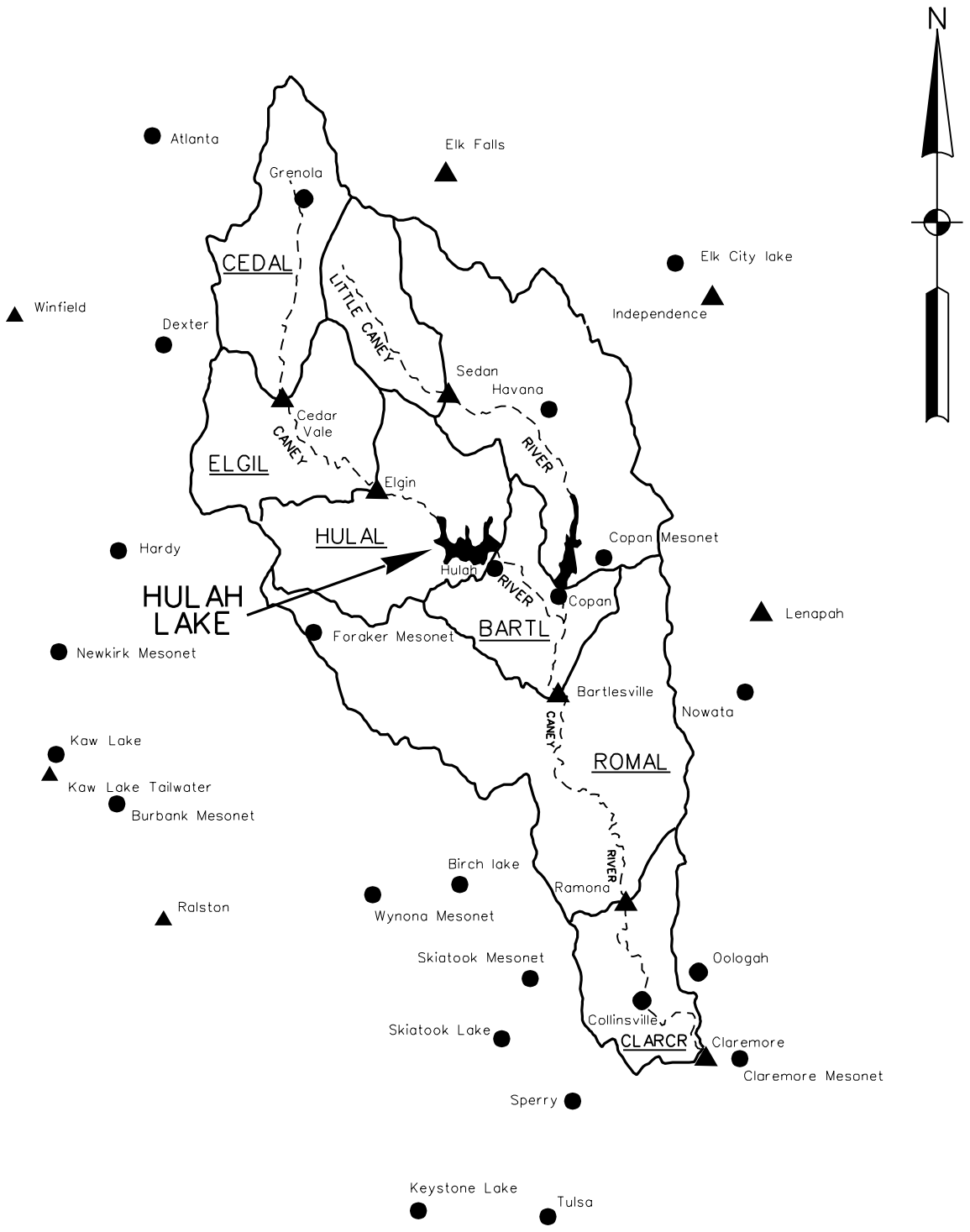
LINE NUMBER	ITEM	TIME								
1	POOL ELEVATION	12N	734.00							
2	POOL ELEVATION	4PM	733.99							
3	POOL ELEVATION	12M	733.95							
4	POOL ELEVATION	8AM	733.90							
5	TAILWATER ELEVATION	8AM								
6	24 HR AVE. POWER DISCHARGE	12M								
7	24 HR AVE. TOTAL DISCHARGE	12M								
8	NET POWER GENERATION	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	400							
12	LAKE CONDITIONS	8AM	⊗							
13	WEATHER COND.	8AM	∅							
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		1-PUMP							
21	GATE SETTINGS NO. TYPE, OPENING	8AM	5SG0.5'							
22	GATE CHANGES DATE TIME		4APR98 1400							
23	POOL ELEVATION		733.98							
24	FROM: GATE SETTING		LF 30%							
25	TO: GATE SETTING		5SG0.5'							
26	GATE CHANGES DATE TIME									
27	POOL ELEVATION									
28	FROM: GATE SETTING									
29	TO: GATE SETTING									
30	RIVER STAGE LOW FLOW WEIR									

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

LAKE DATA

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



LEGEND

● RECORDING PRECIPITATION STATIONS

▲ RECORDING STREAM GAGING AND PRECIPITATION STATIONS

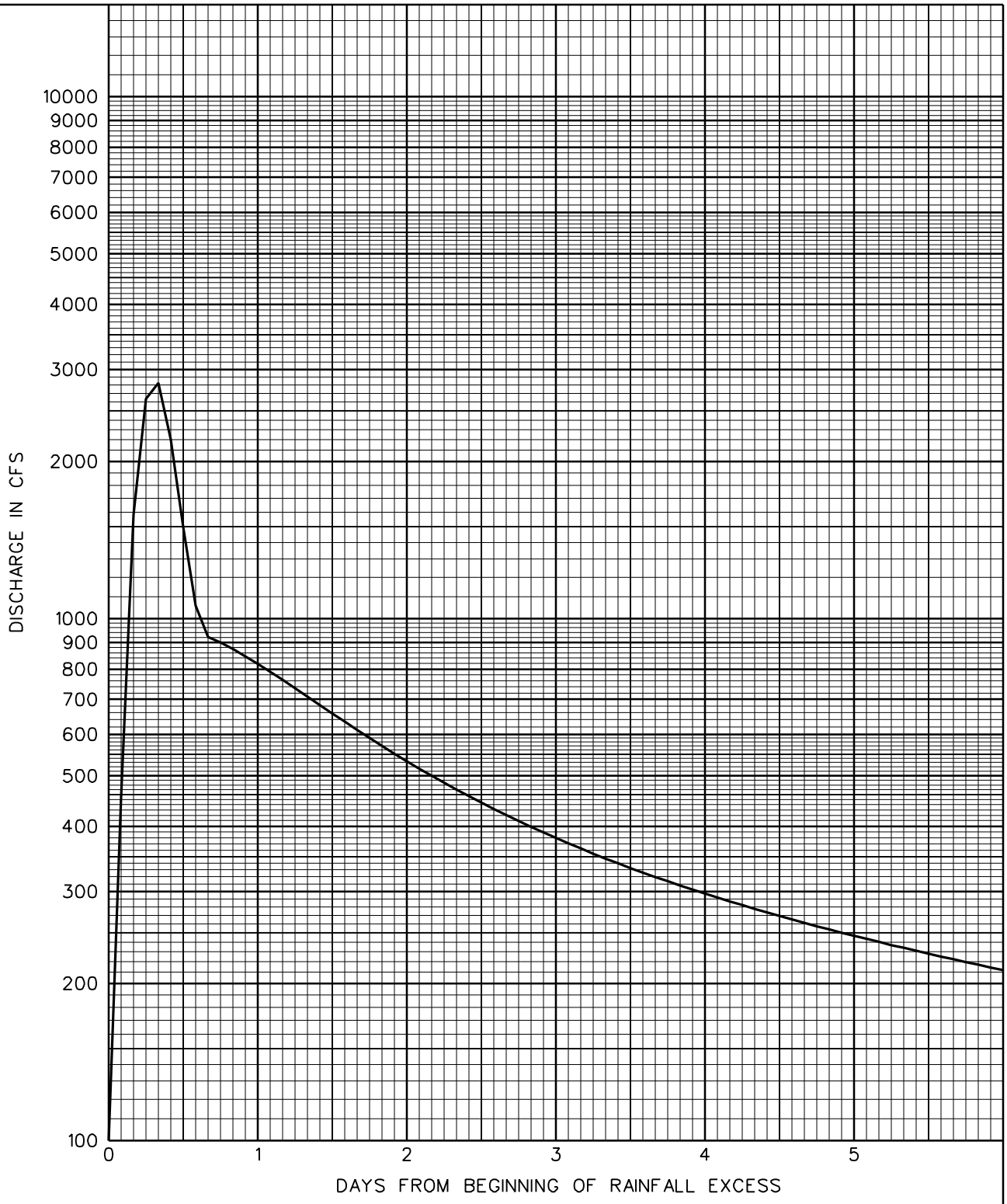
CEDAL - SUBAREA NAME

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

FORECAST REACHES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



DATA BASED ON:

DRAINAGE AREA = 208 SQ. MI.
1" RUNOFF = 11,093 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 — CANEY RIVER, OKLAHOMA

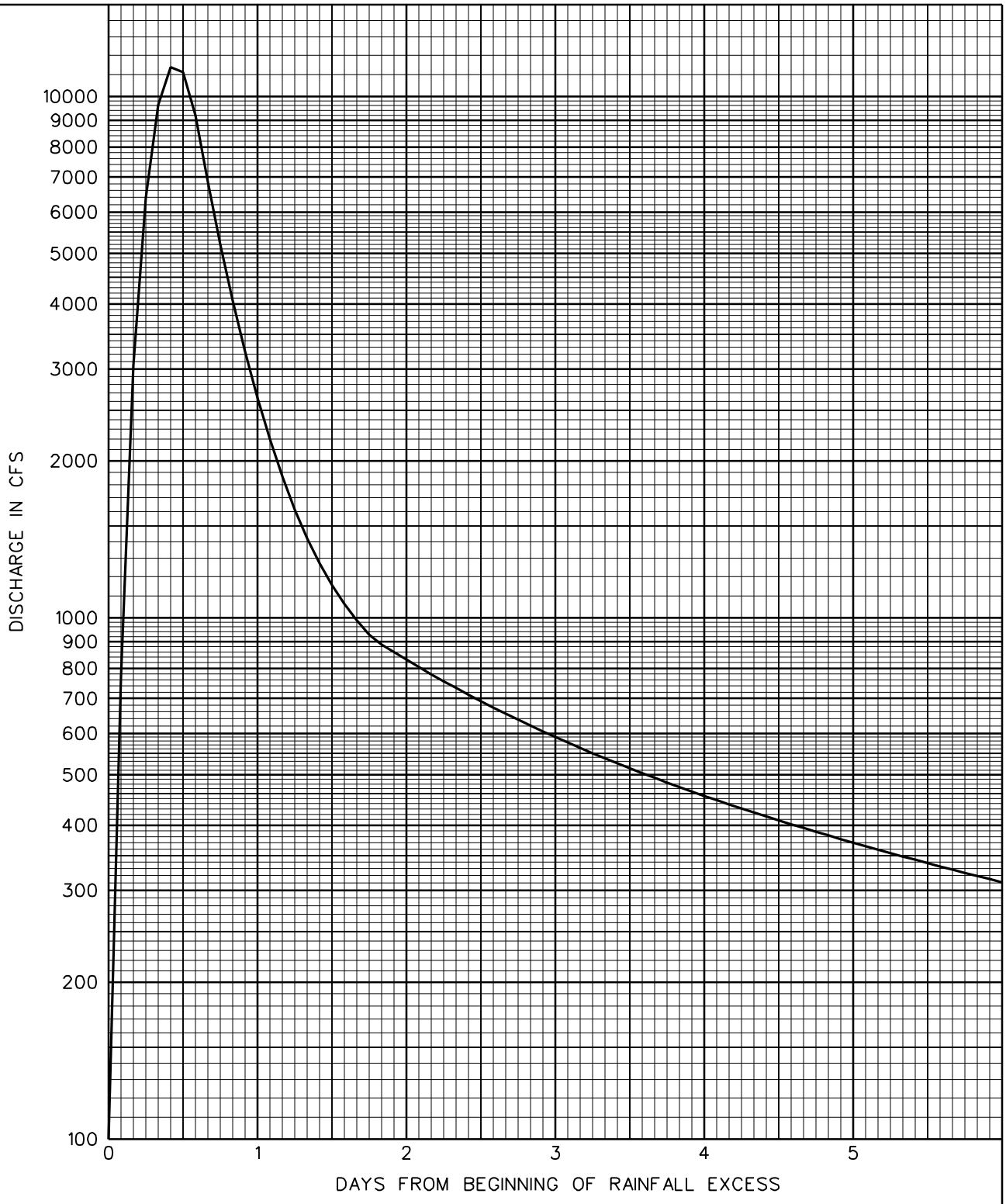
HULAH LAKE

UNIT HYDROGRAPH

AREA ABOVE THE CEDAR VALE GAGE
ON THE CANEY RIVER
ABOVE HULAH LAKE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.

6-2



DATA BASED ON:

DRAINAGE AREA = 445 SQ. MI.
1" RUNOFF = 23,733 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.

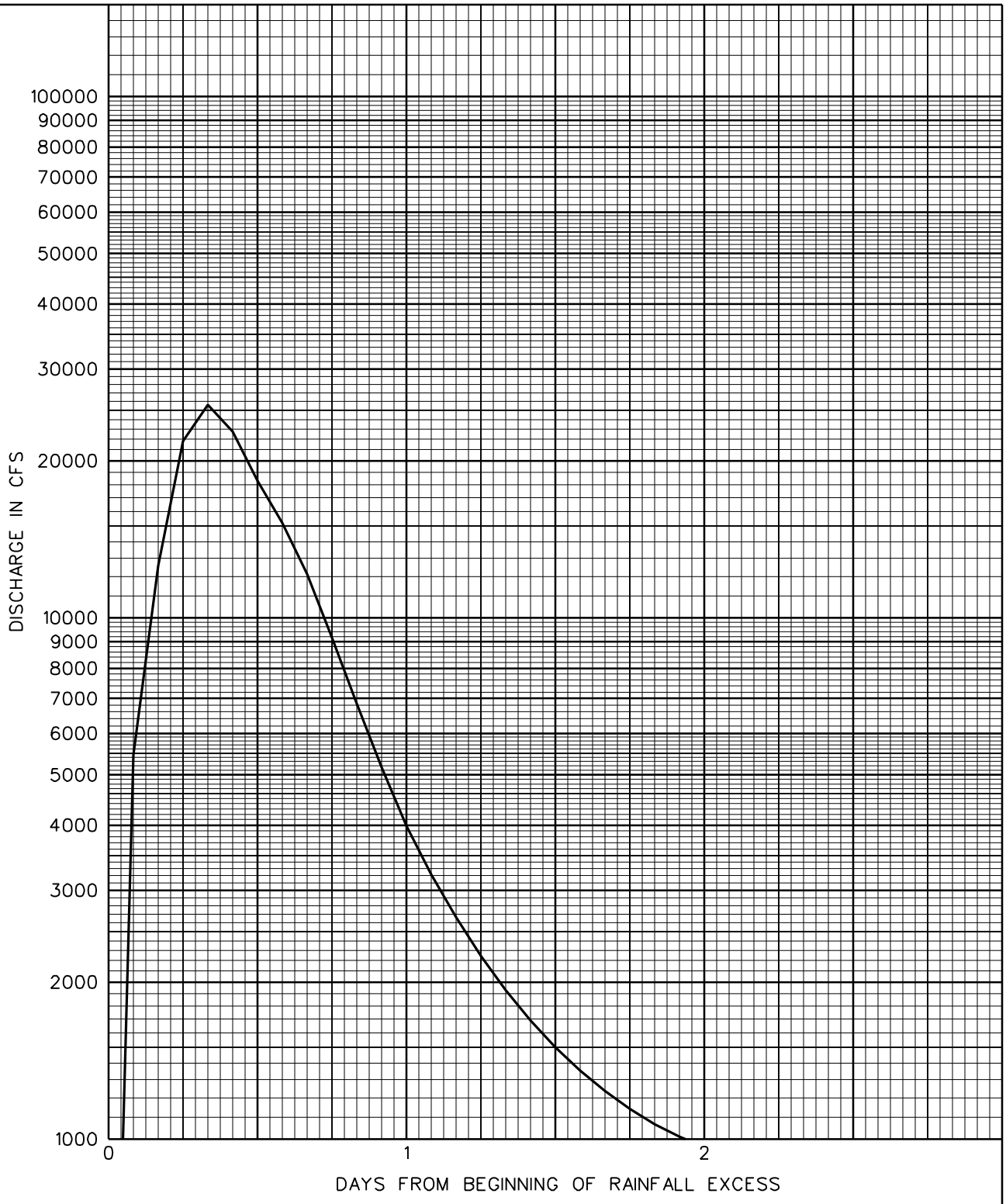
ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

UNIT HYDROGRAPH

AREA ABOVE THE ELGIN GAGE
ON THE CANEY RIVER
ABOVE HULAH LAKE

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



DATA BASED ON:

DRAINAGE AREA = 732 SQ. MI.
1" RUNOFF = 39,040 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.

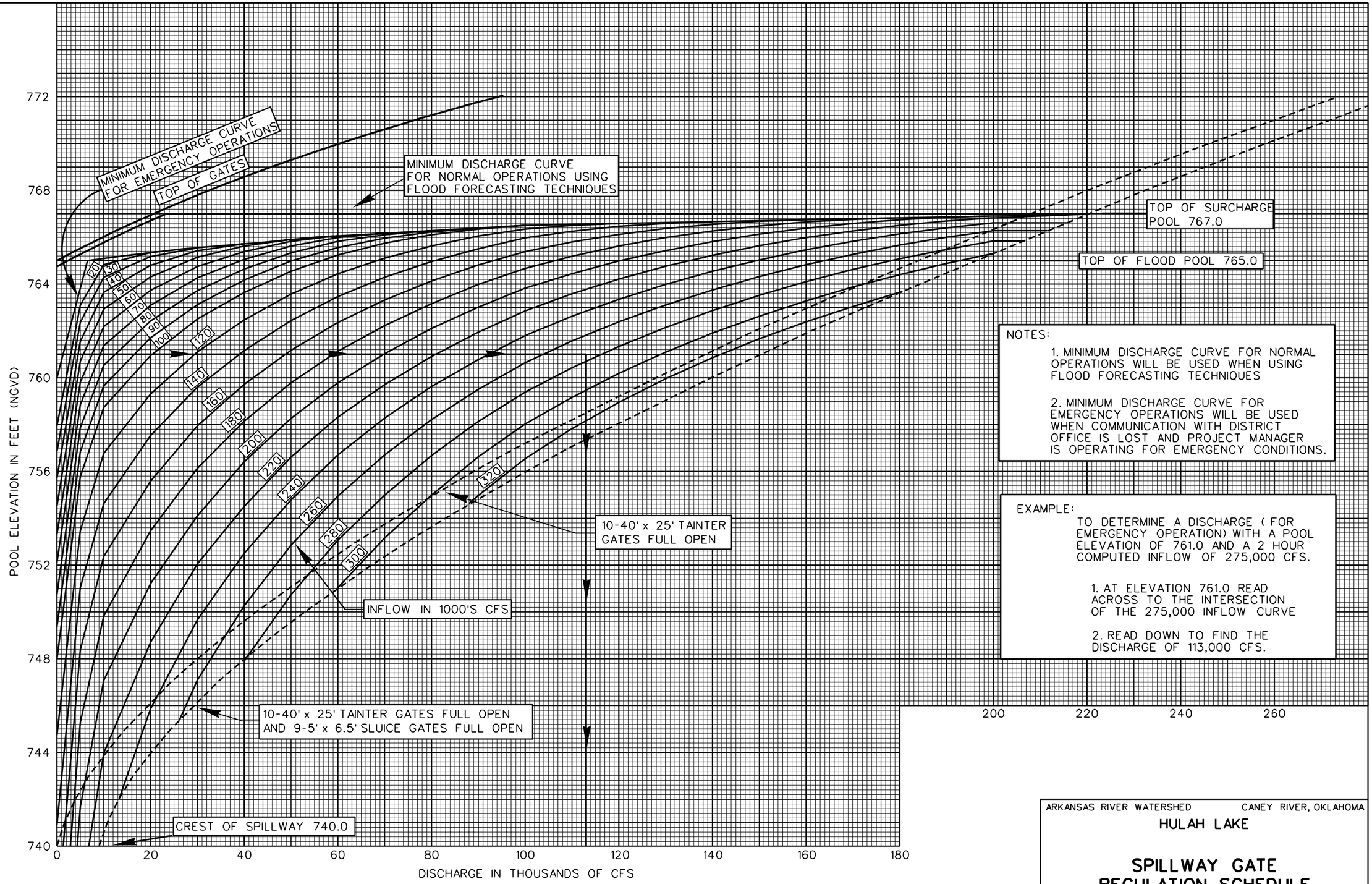
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

UNIT HYDROGRAPH

AREA ABOVE HULAH LAKE
ON THE CANEY RIVER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



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 761.0 AND A 2 HOUR COMPUTED INFLOW OF 275,000 CFS.

1. AT ELEVATION 761.0 READ ACROSS TO THE INTERSECTION OF THE 275,000 INFLOW CURVE

2. READ DOWN TO FIND THE DISCHARGE OF 113,000 CFS.

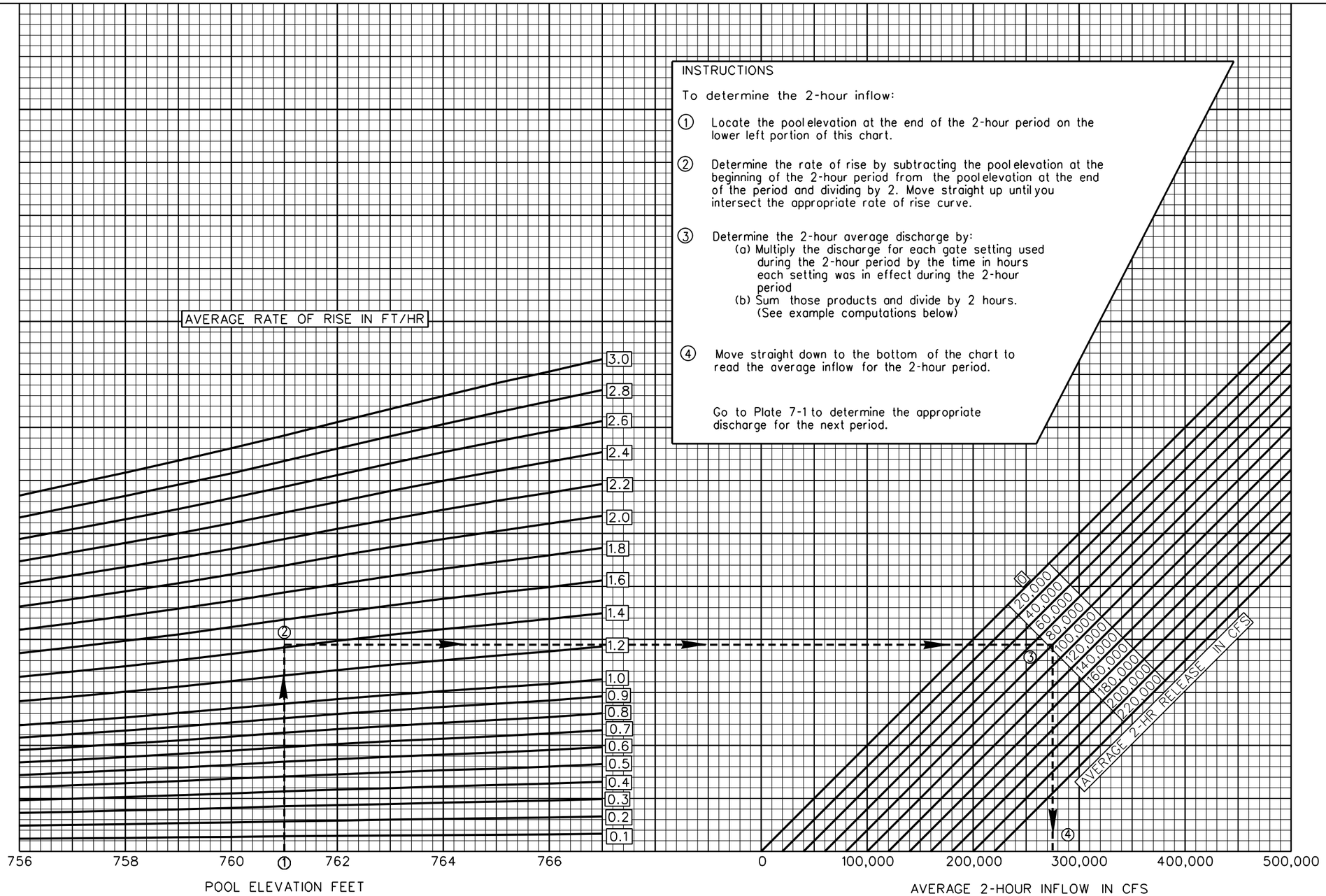
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

SPILLWAY GATE REGULATION SCHEDULE INFLOW PARAMETER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1997
DRAWN: G.D.E.
CHECKED: R.W.B.

7-1



INSTRUCTIONS

To determine the 2-hour inflow:

① Locate the pool elevation at the end of the 2-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 2-hour period from the pool elevation at the end of the period and dividing by 2. Move straight up until you intersect the appropriate rate of rise curve.

③ Determine the 2-hour average discharge by:
   (a) Multiply the discharge for each gate setting used during the 2-hour period by the time in hours each setting was in effect during the 2-hour period
   (b) Sum those products and divide by 2 hours. (See example computations below)

④ Move straight down to the bottom of the chart to read the average inflow for the 2-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 761.00 feet. Two hours ago the elevation was 758.15 feet.

② Rate of rise = (761.00 - 758.15) / 2 hrs = 2.85 feet / 2 hrs = 1.43 ft/hr

③ Releases for last two hours were:

1.0 hrs at 60,000 cfs = 1.0 x 60,000 = 60,000 cfs
1.0 hrs at 100,000 cfs = 1.0 x 100,000 = 100,000 cfs
Total 2 hrs 160,000 cfs

Average release = 160,000 cfs / 2 hrs = 80,000 cfs

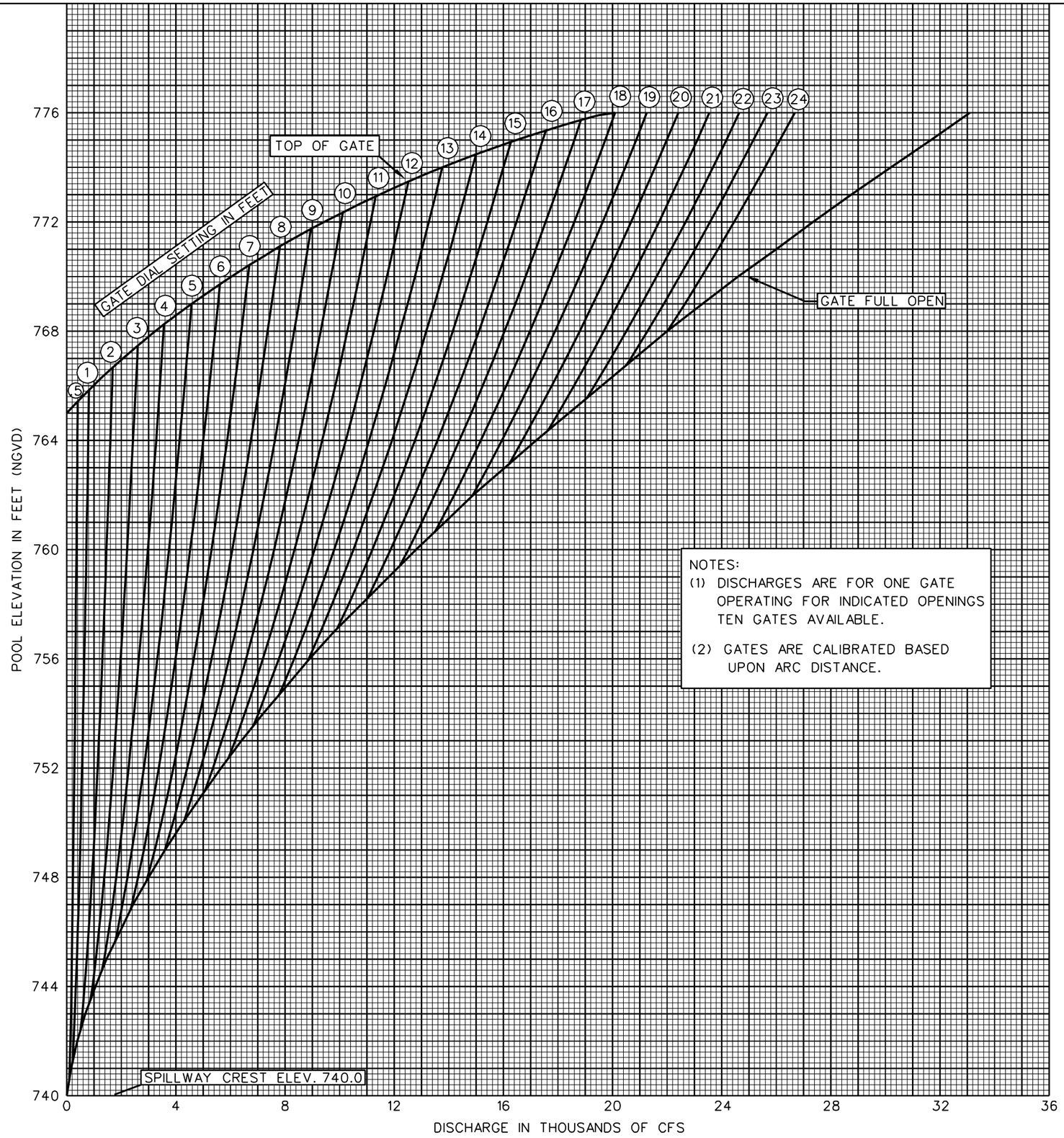
④ The resulting 2-hour inflow is 275,000 cfs.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

INFLOW VS. RATE OF RISE NOMOGRAPH

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTES:

(1) DISCHARGES ARE FOR ONE GATE OPERATING FOR INDICATED OPENINGS TEN GATES AVAILABLE.

(2) GATES ARE CALIBRATED BASED UPON ARC DISTANCE.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

SPILLWAY RATING CURVES

PARTIAL AND FULL GATE OPENINGS

1 - 40' x 25' TAINTER GATE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998.
DRAWN: SKG
CHECKED: GDE

WATER SUPPLY STORAGE ACCOUNTING
HULAH LAKE

(ALL VALUES ARE IN ACRE-FEET)
TOTAL CONSERVATION STORAGE 31100
UN-CONTRACTED STORAGE 0
CONTRACT STORAGE USER # 1 22775. CITY OF BARTLESVILLE
CONTRACT STORAGE USER # 2 116. HULAH WATER DISTRICT
CONTRACT STORAGE USER # 3 8209. WATER QUALITY

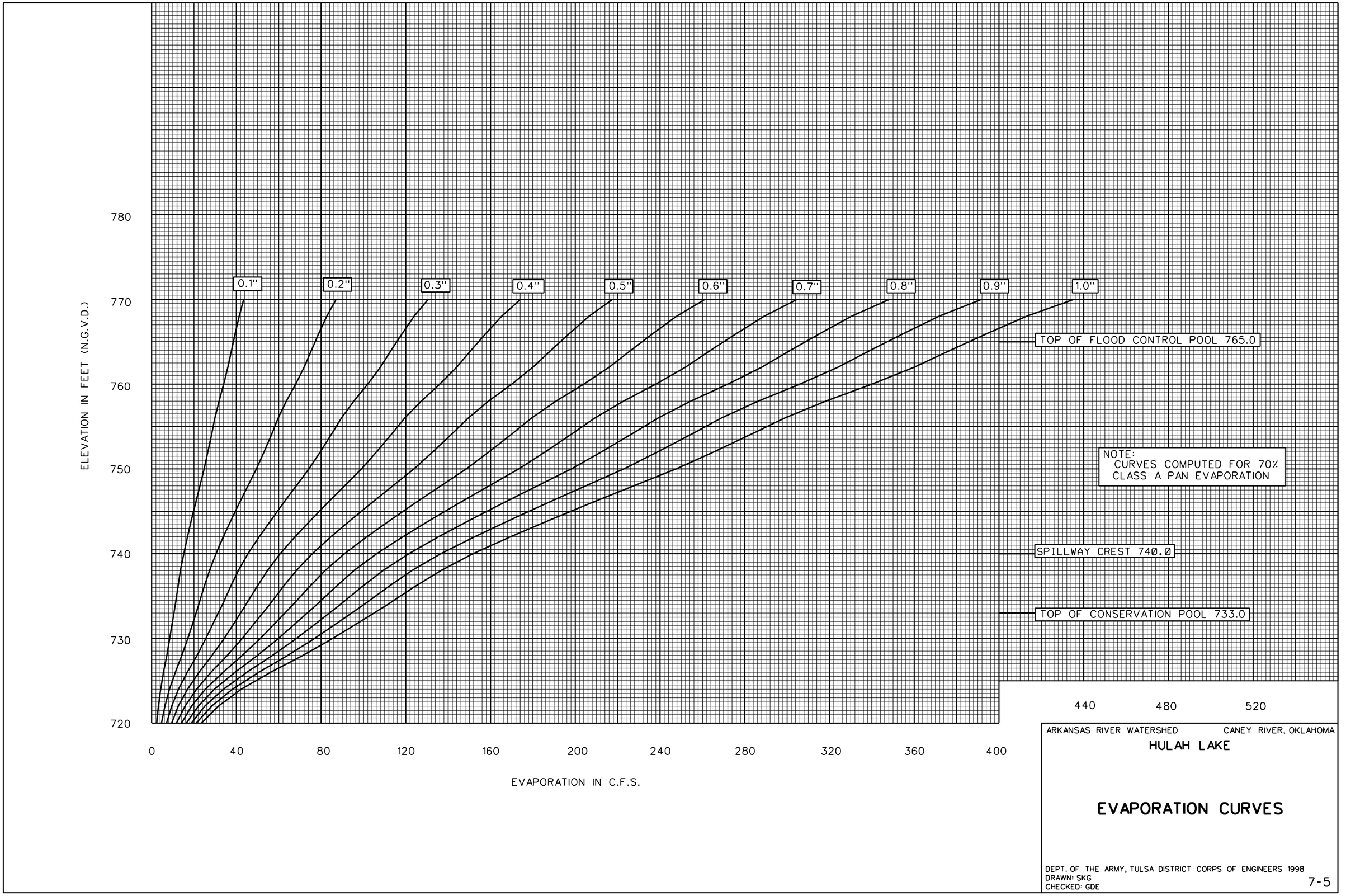
PERIOD MO/YR	USER	BEGINNING STORAGE	INFLOW SHARE	TOTAL LOSSES	WITH-DRAWN	ENDING STORAGE
5/88	LAKE	31100	1457	399	1178	30980
	1	22775	298	298	0	22775
	2	116	4	2	2	116
	3	8209	1156	100	1176	8089
6/88	LAKE	30980	2013	2055	1618	29320
	1	22775	1474	1541	275	22433
	2	116	8	8	2	114
	3	8089	531	506	1341	6773
7/88	LAKE	29320	109	2969	1541	24919
	1	22433	80	2307	501	19706
	2	114	0	12	1	101
	3	6773	29	651	1039	5112
8/88	LAKE	24919	470	2261	1628	21500
	1	19706	344	1823	499	17728
	2	101	2	9	2	92
	3	5112	124	428	1127	3681
9/88	LAKE	21500	438	1359	1129	19450
	1	17728	321	1134	473	16441
	2	92	2	6	2	85
	3	3681	116	219	654	2923
10/88	LAKE	19450	157	1077	840	17690
	1	16441	115	923	259	15375
	2	85	1	5	0	81
	3	2923	41	150	581	2234

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

WATER SUPPLY STORAGE ACCOUNTING

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: SKG
CHECKED: GDE

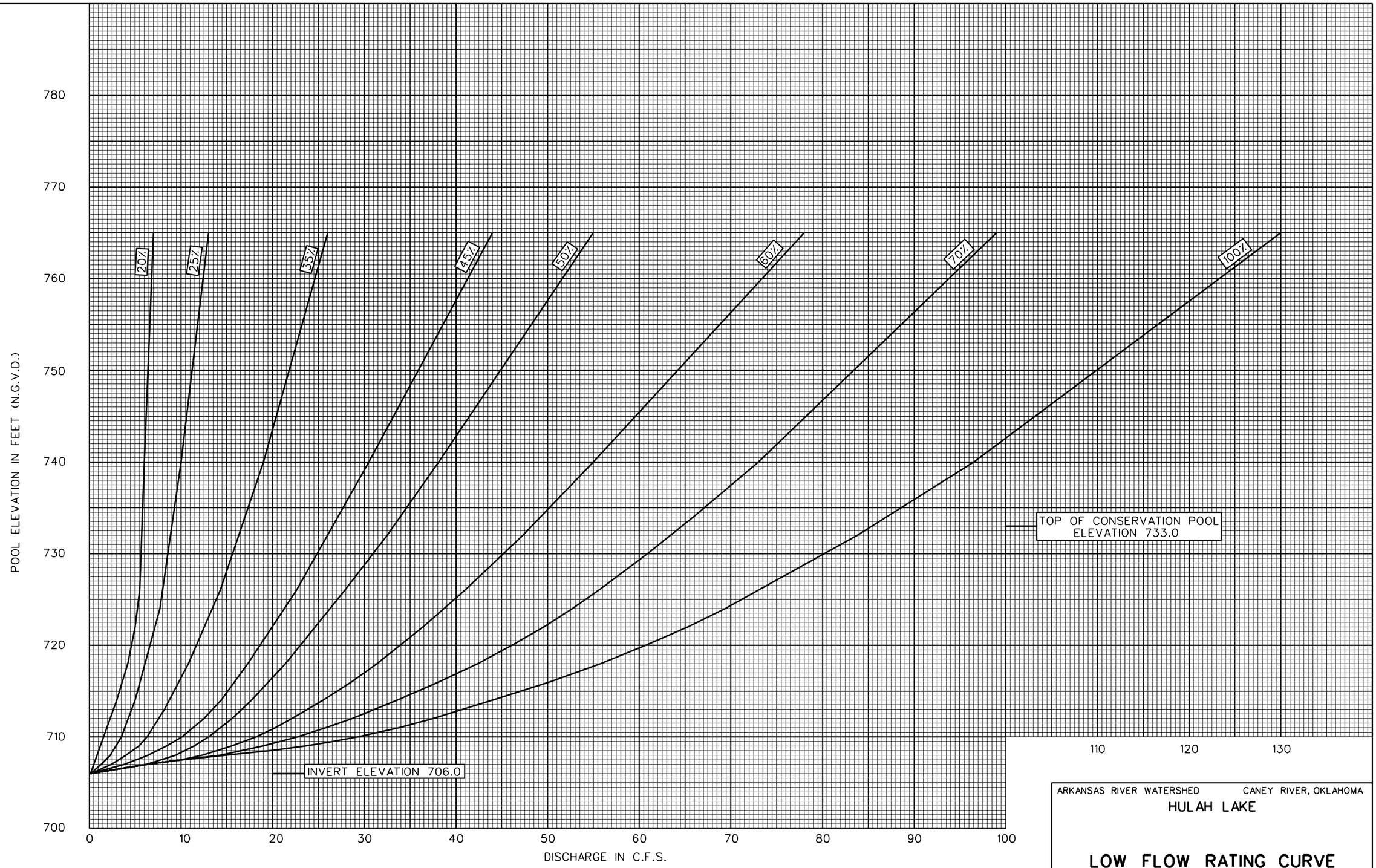


ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

EVAPORATION CURVES

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: SKG
CHECKED: GDE



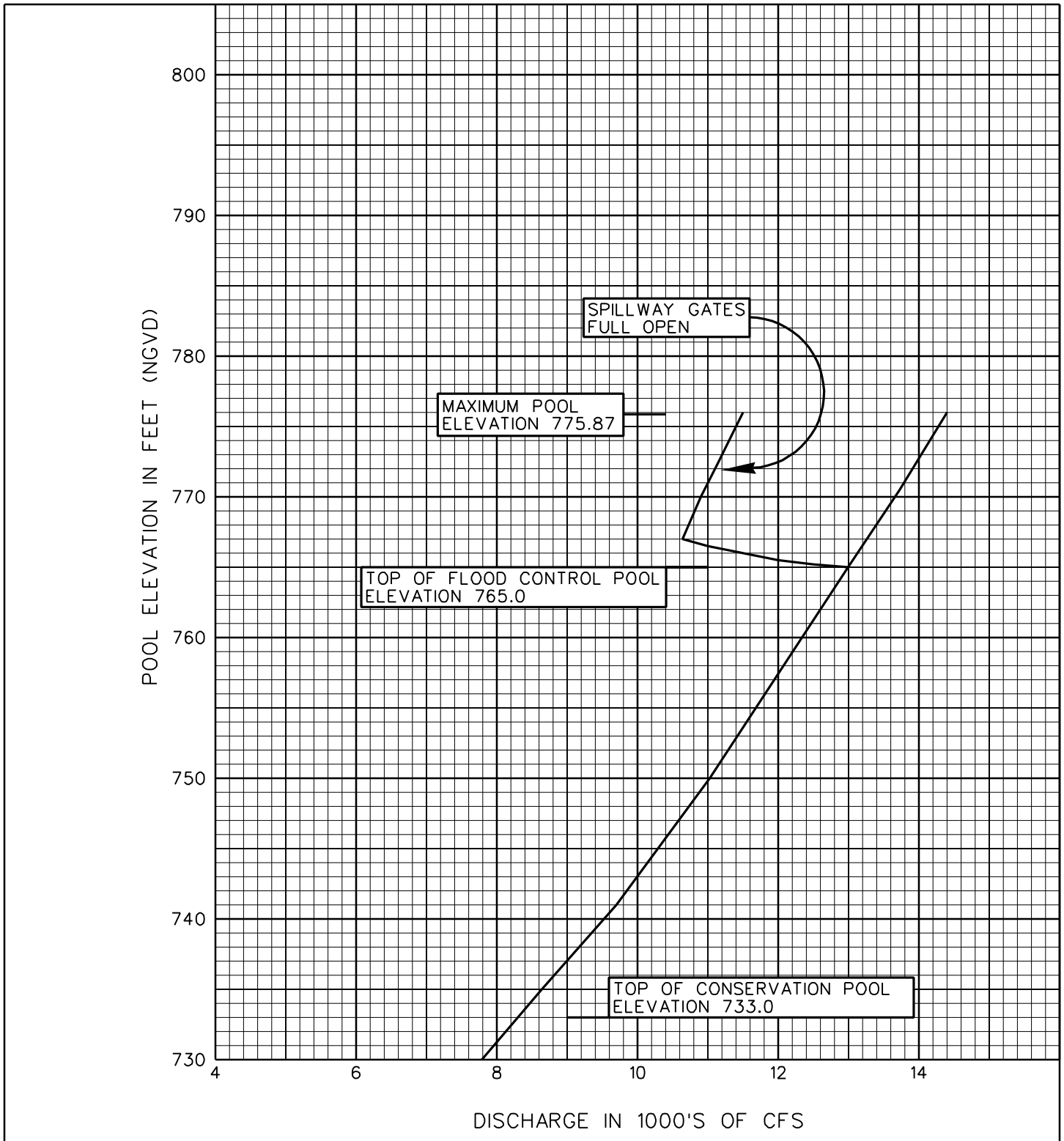
ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

LOW FLOW RATING CURVE

ONE 24" LOW FLOW PIPE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: SKG
CHECKED: GDE



NOTE:

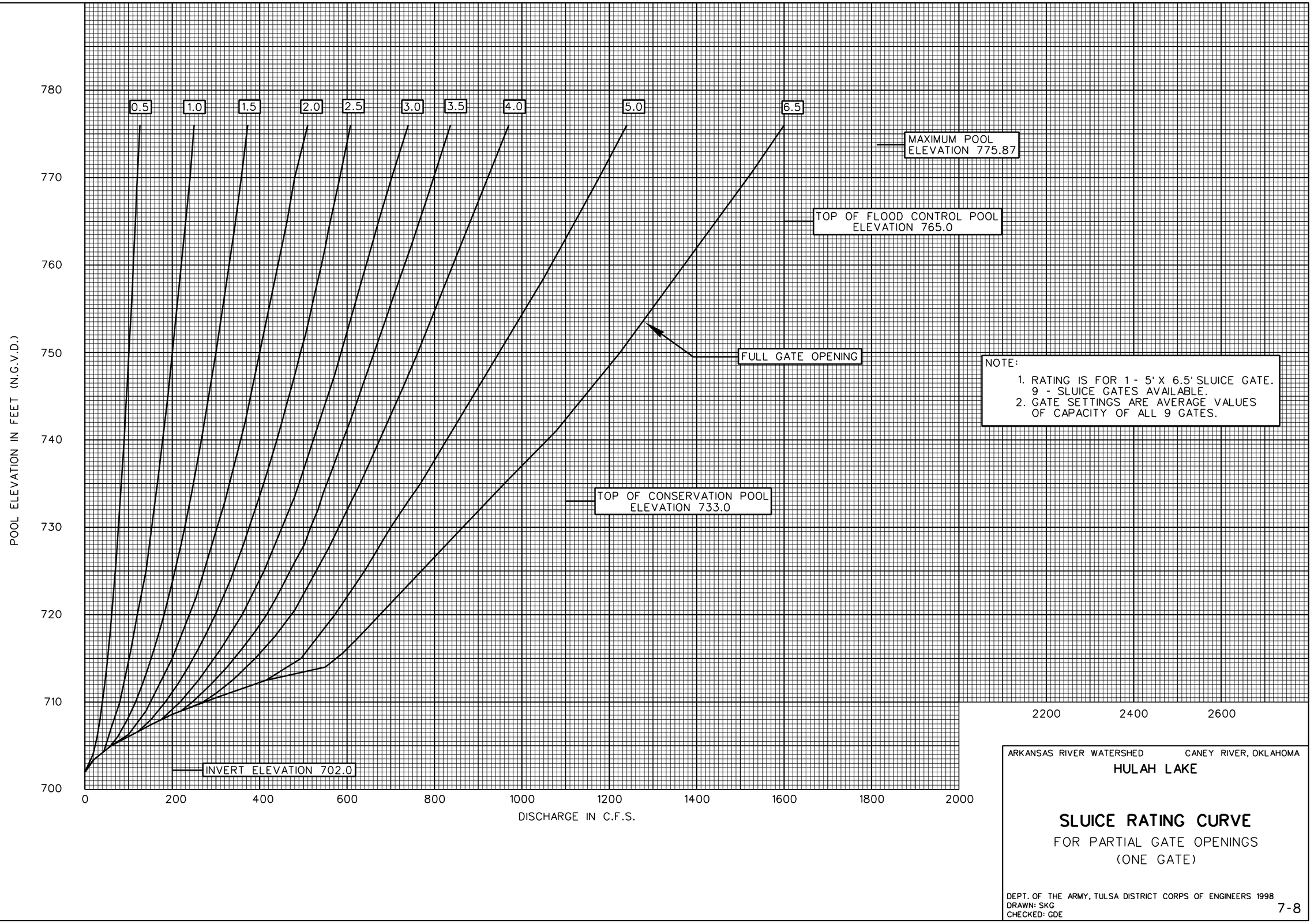
RATING IS FOR 9 - 5' X 6.5' SLUICES.
SLUICE INVERT IS AT ELEVATION 702.00

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

SLUICE RATING CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:

1. RATING IS FOR 1 - 5' X 6.5' SLUICE GATE. 9 - SLUICE GATES AVAILABLE.
2. GATE SETTINGS ARE AVERAGE VALUES OF CAPACITY OF ALL 9 GATES.

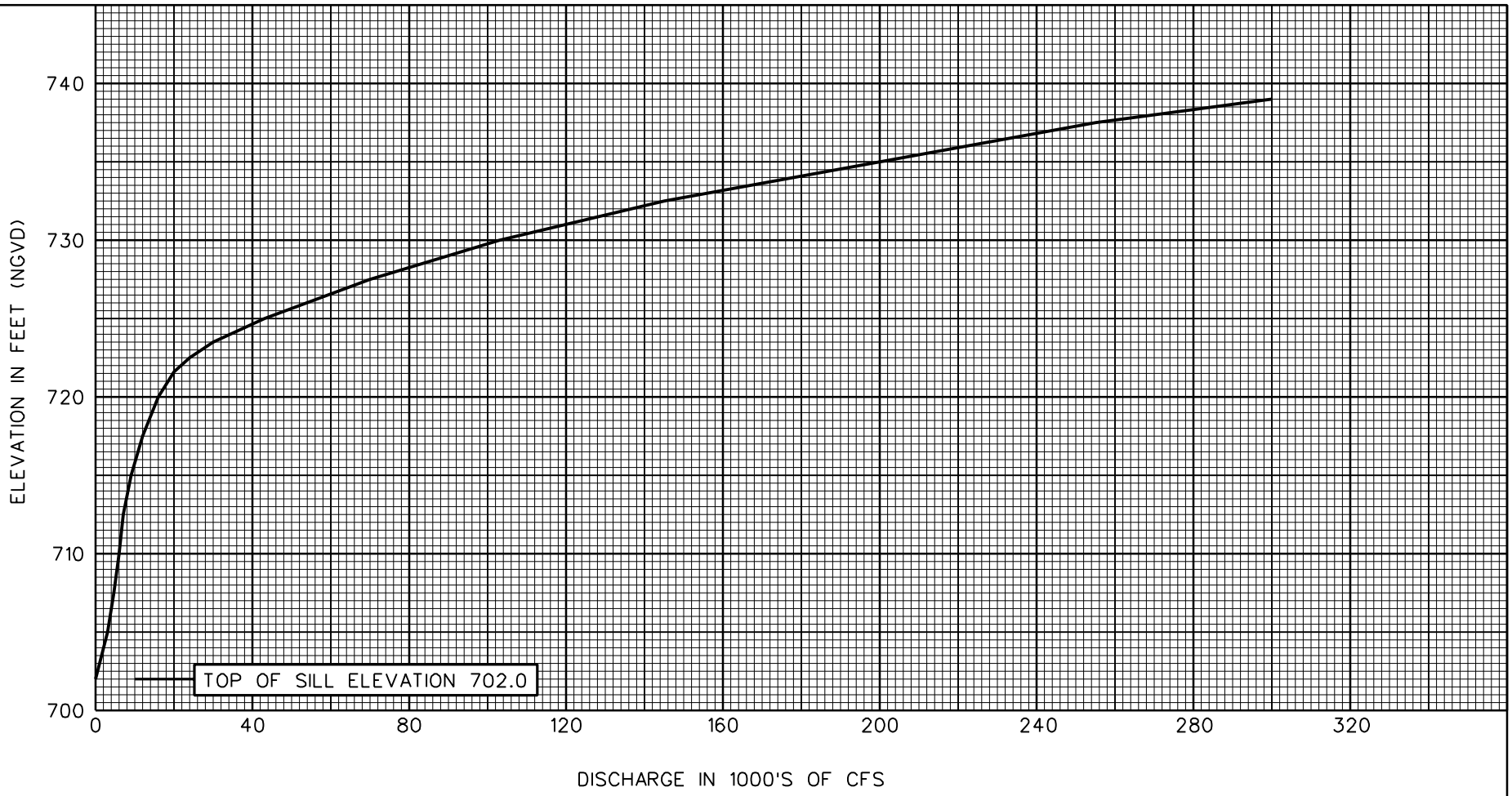
ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

SLUICE RATING CURVE

FOR PARTIAL GATE OPENINGS
(ONE GATE)

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: SKG
CHECKED: GDE



NOTE:

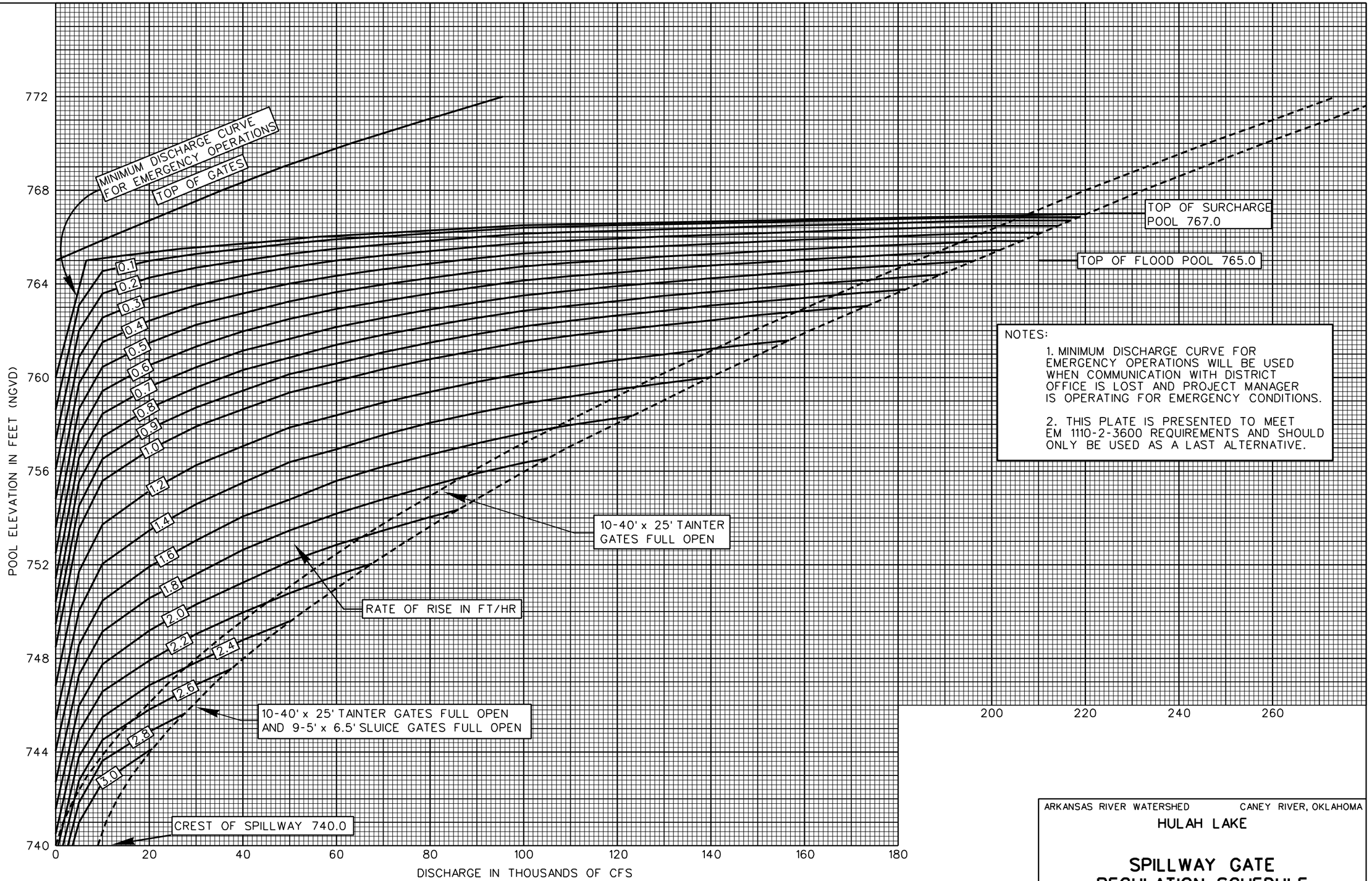
CURVE APPLIES AT R.M. 96.2

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH 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.

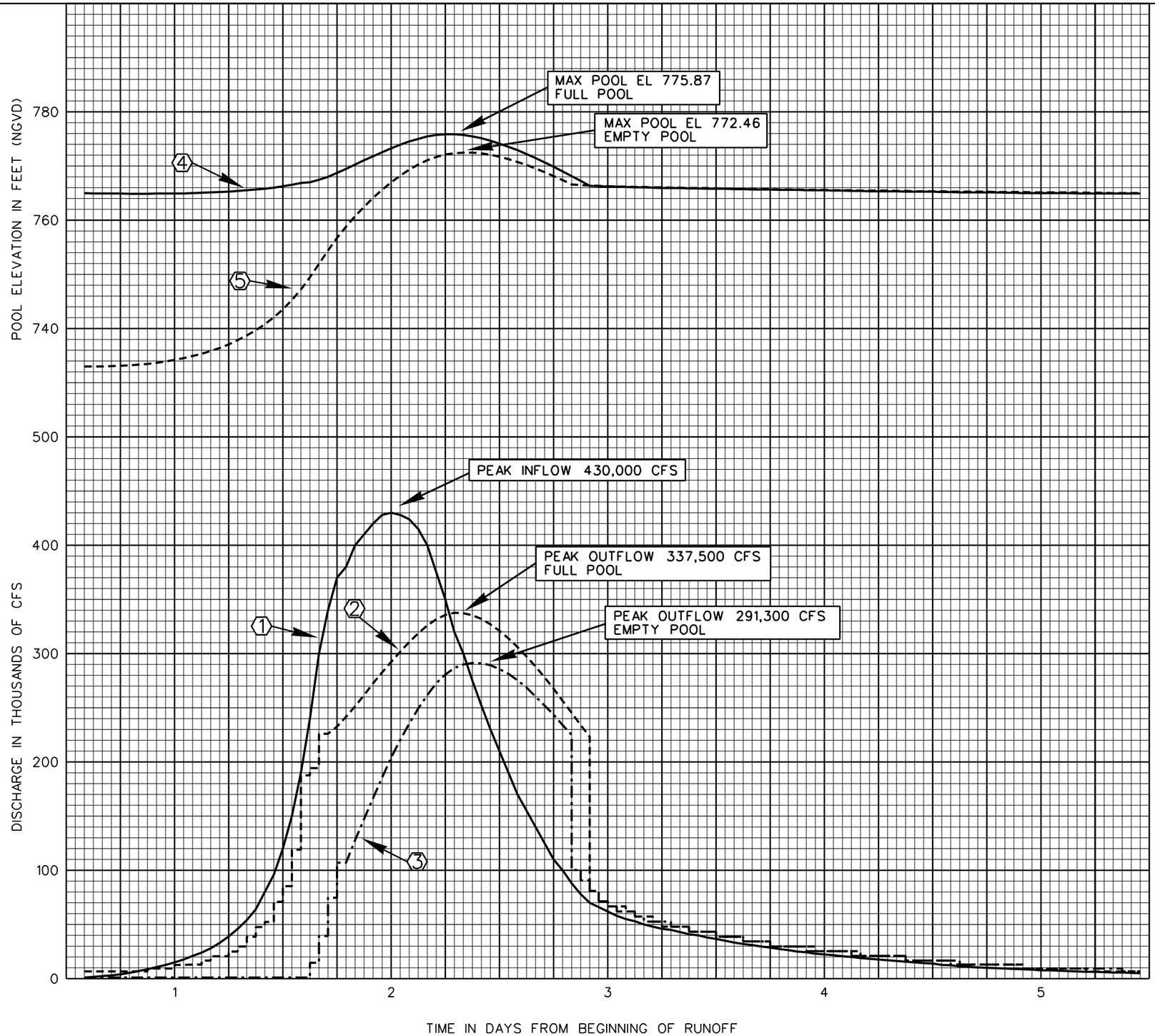
2. THIS PLATE IS PRESENTED TO MEET EM 1110-2-3600 REQUIREMENTS AND SHOULD ONLY BE USED AS A LAST ALTERNATIVE.

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

SPILLWAY GATE REGULATION SCHEDULE RATE OF RISE PARAMETER

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
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 CANEY RIVER, OKLAHOMA

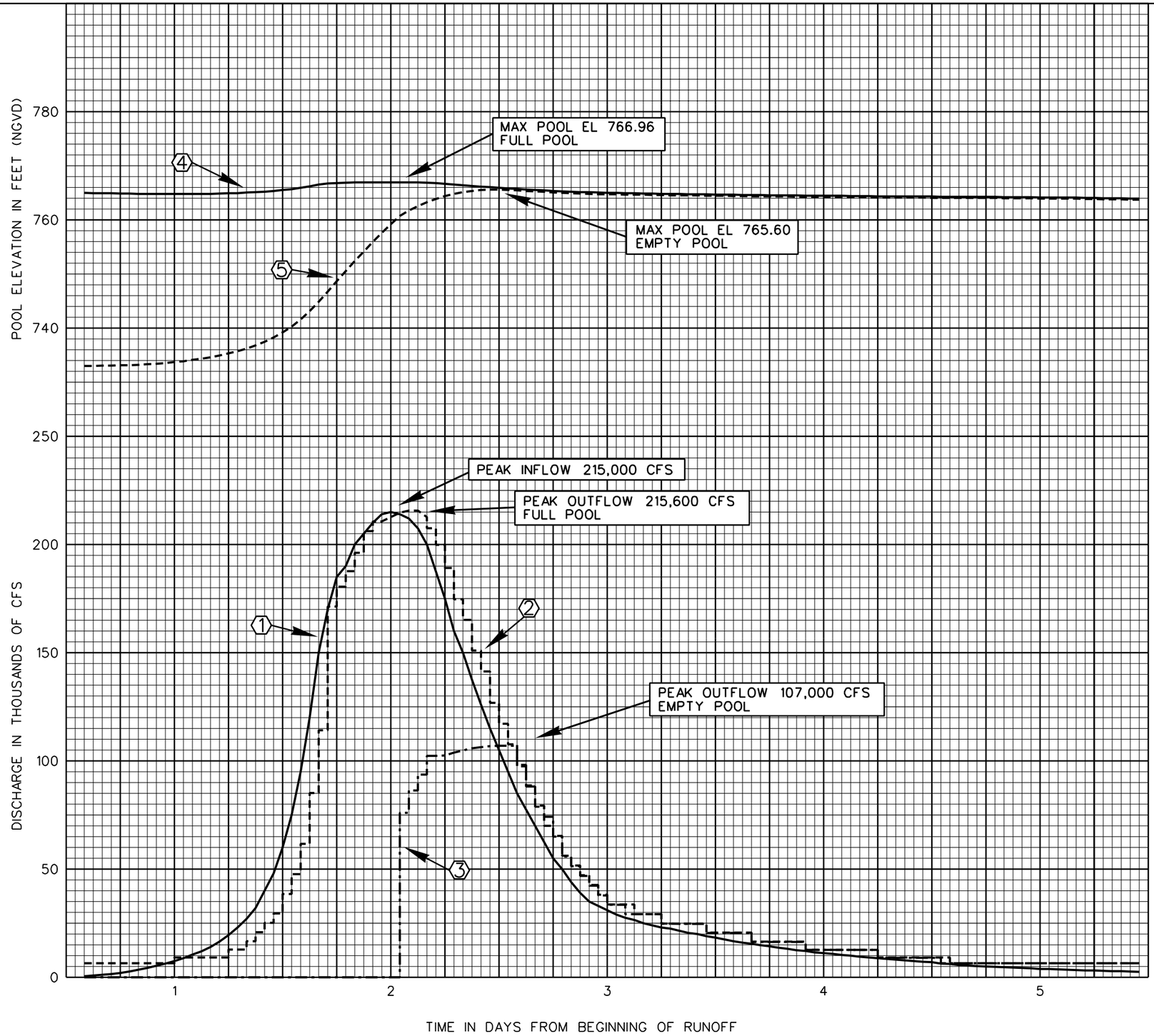
HULAH LAKE

OPERATIONAL HYDROGRAPHS

PROBABLE MAXIMUM FLOOD

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.

8-1



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 — CANEY RIVER, OKLAHOMA

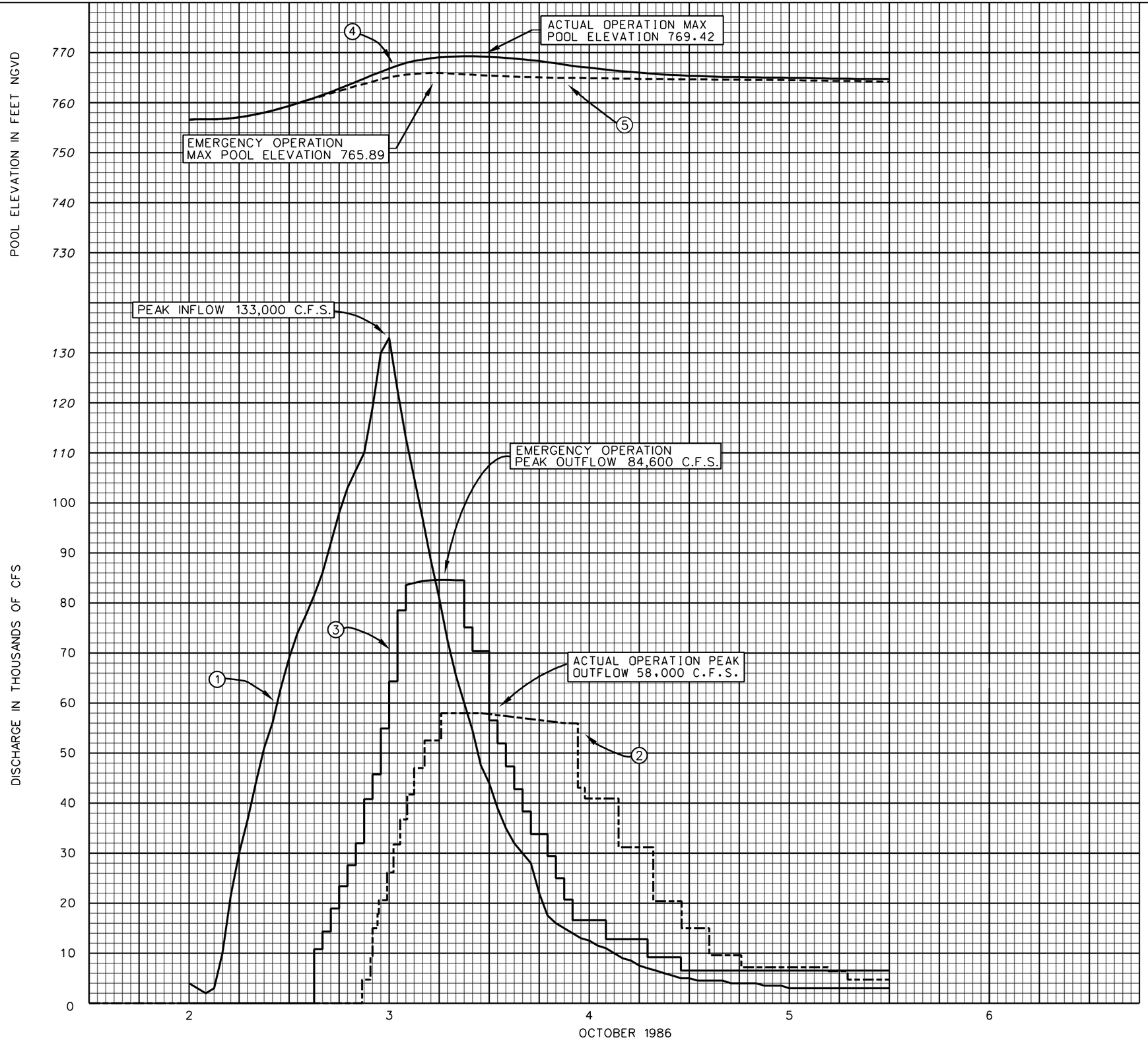
HULAH LAKE

OPERATIONAL HYDROGRAPHS

½ PROBABLE MAXIMUM FLOOD

DEPT. OF THE army, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.

8-2



NOTES: EMERGENCY OPERATIONS

1. INFLOW HYDROGRAPH
2. OUTFLOW-ACTUAL
3. OUTFLOW-EMERGENCY
4. ELEVATION-ACTUAL
5. ELEVATION-EMERGENCY

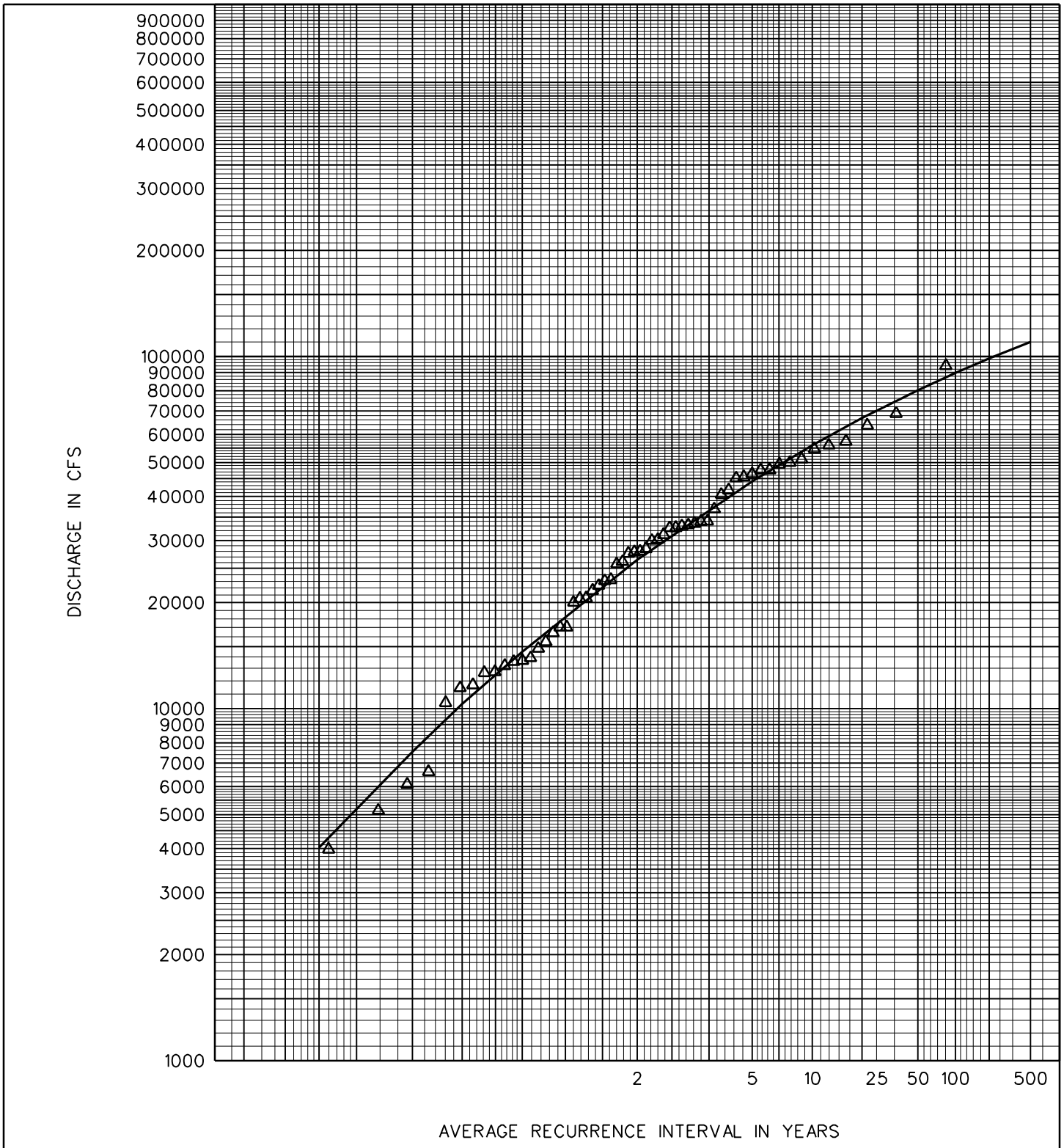
ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

OPERATIONAL HYDROGRAPHS

FLOOD OF OCTOBER 1986

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



——— COMPUTED PEAK INFLOW PROBABILITY
△ HISTORICAL EVENTS

NOTE:

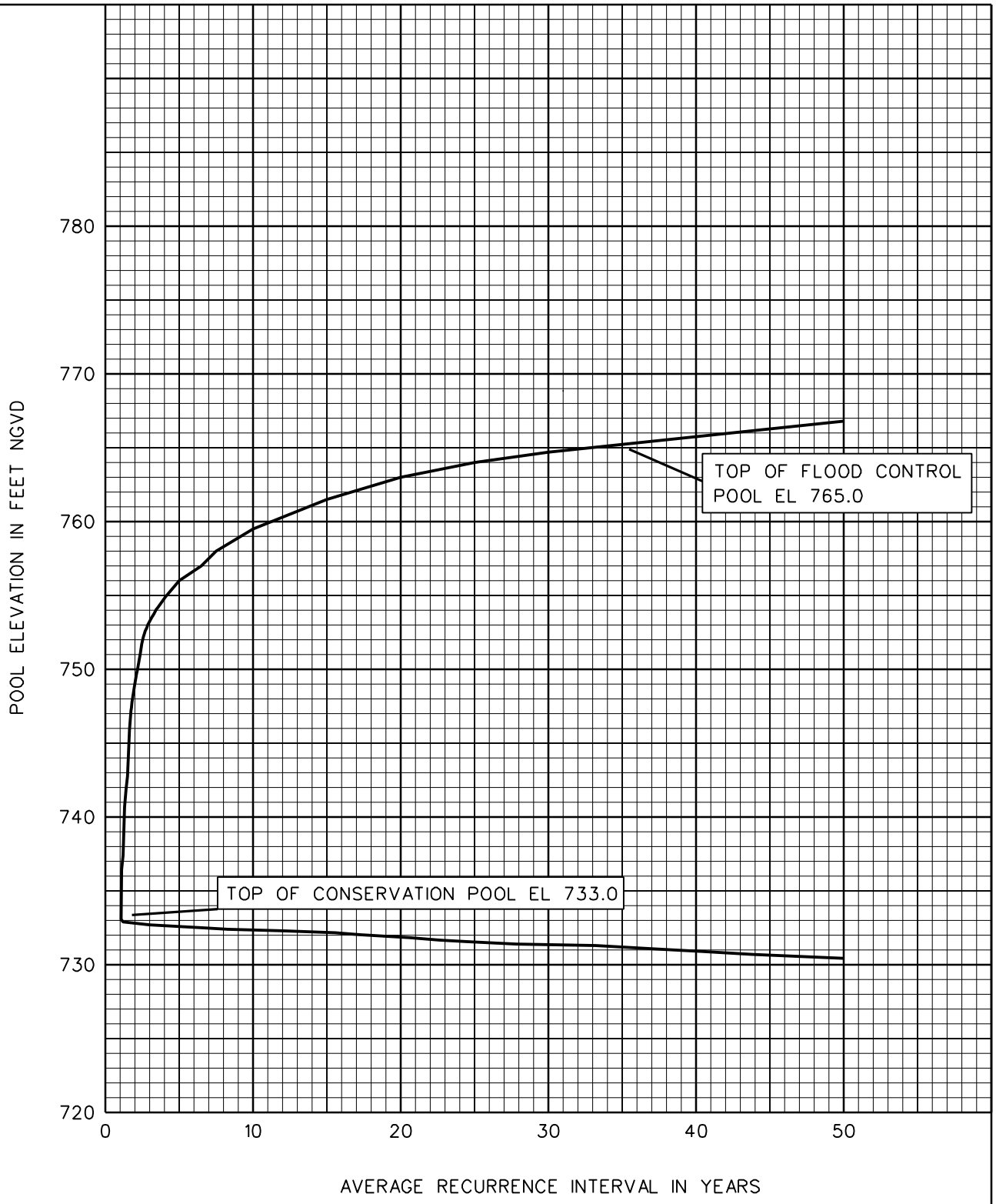
1. BASED ON PERIOD OF RECORD 1940 TO 1997.
2. ADOPTED SKEW COEFFICIENT OF -.554 WAS USED.

ARKANSAS RIVER WATERSHED — CANEY RIVER, OKLAHOMA

HULAH LAKE

PEAK INFLOW PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:

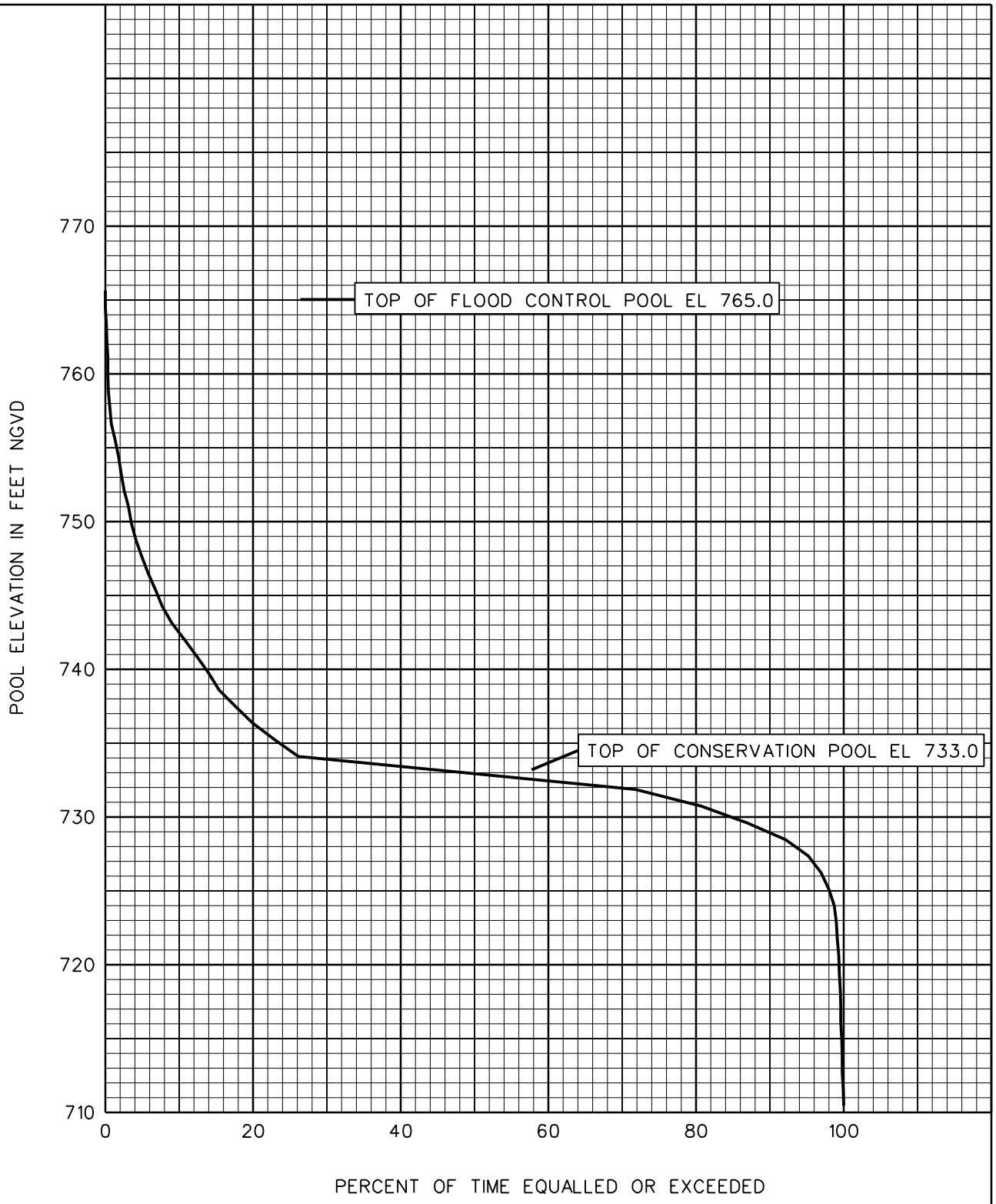
CURVE IS BASED UPON PERIOD OF RECORD JANUARY 1940 THRU DECEMBER 1997 FROM SUPER RUN A95X09.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

POOL ELEVATION PROBABILITY CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.



NOTE:

CURVE IS BASED UPON PERIOD OF RECORD JANUARY 1940 THRU DECEMBER 1995 FROM SUPER RUN A98X01.

ARKANSAS RIVER WATERSHED CANEY RIVER, OKLAHOMA

HULAH LAKE

POOL ELEVATION DURATION CURVE

DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 1998
DRAWN: G.D.E.
CHECKED: R.W.B.