SHASTA DAM AND LAKE

Sacramento River, California

REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

APPENDIX I
To
Master Manual of Reservoir Regulation
Sacramento River Basin, California

April 1962
Rev. January 1977

DEPARTMENT OF THE ARMY

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

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REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

JANUARY 1977

Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

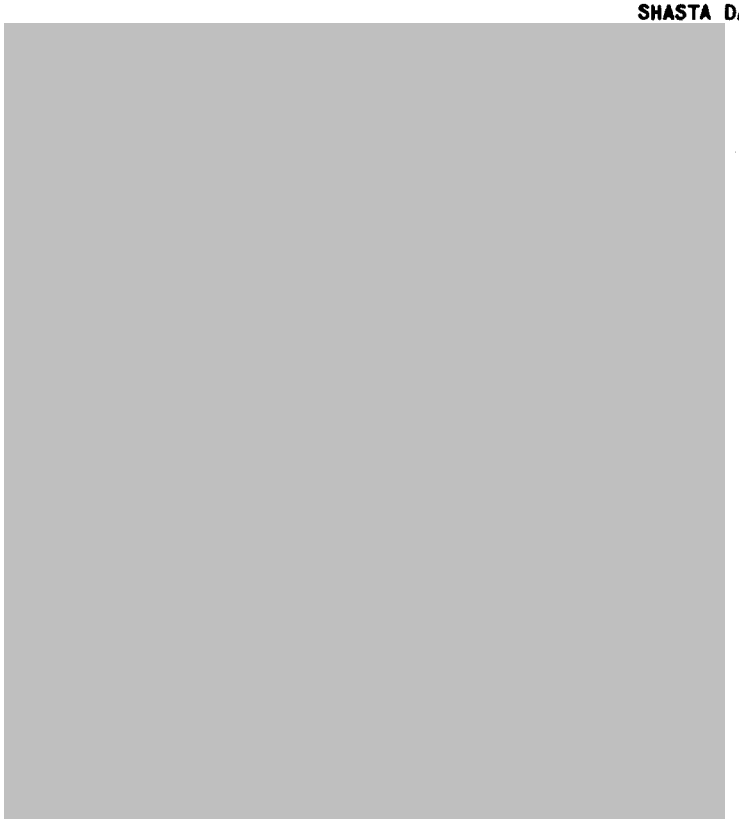
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

PERTINENT DATA

GENERAL

Drainage Areas (excluding Goose Lake Basin)	
Sacramento R. at Shasta Dam	6,421 sq mi
Sacramento R. at Keswick	6,468 sq mi
Sacramento R. above Bend Bridge near Red Bluff	8,900 sq mi
Sacramento R. near Ord Ferry	12,250 sq mi
Pit R. at Big Bend (near head of reservoir)	4,710 sq mi
McCloud R. above Shasta Lake	604 sq mi
Sacramento R. at Delta (near head of reservoir)	425 sq mi
Mean Annual Runoff (1908-1974)	
Sacramento R. at Shasta Dam	5,737,000 ac-ft
Sacramento R. near Red Bluff	8,421,000 ac-ft
Sacramento R. at Ord Ferry	9,812,000 ac-ft
Maximum Flows of Record (1903-1976)	
Sacramento R. at Shasta Lake (16 Jan 1974)	216,000 cfs
Sacramento R. near Red Bluff (28 Feb 1940)	291,000 cfs
Sacramento R. at Ord Ferry (28 Feb 1940)	370,000 cfs

SHASTA DAM AND LAKE



Shasta Lake	
Elevation msl	
Gross pool	1067.0 ft
Minimum operating level	840.0 ft
Taking line	Irregular
Area	
Minimum operating level	6,700 acres
Gross pool	29,500 acres
Taking line	90,000 acres
Storage capacity	
Minimum operating level	587,000 ac-ft
Gross pool	4,552,000 ac-ft

KESWICK DAM AND RESERVOIR

Keswick Reservoir	
Elevation msl	
Maximum operating level	587.0 ft
Minimum operating level	574.0 ft
Area at maximum operating level	643 acres
Storage capacity	
At maximum operating level	23,800 ac ft
At minimum operating level	16,300 ac ft

SHASTA DAM AND LAKE

Mt. Shasta in background

Photo furnished
by U.S.B.R.

REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

SHASTA DAM AND LAKE SACRAMENTO RIVER, CALIFORNIA

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REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

SHASTA DAM AND LAKE SACRAMENTO RIVER, CALIFORNIA

CHAPTER I - GENERAL INFORMATION

1. AUTHORITY AND SCOPE

a. This report on reservoir regulation for flood control, Shasta Dam and Lake, Sacramento River, California, is an appendix to the Master Manual of Reservoir Regulation, Sacramento River Basin, California. It is prepared in accordance with instructions contained in ER 1110-2-240, EM 1110-2-3600, and EC 1110-2-67, all pertaining to requirements for reports on reservoir regulation for projects subject to the provisions of Section 7 of the Flood Control Act of 1944 (58 Stat. 890). The pertinent portion of that act reads as follows:

> "Hereafter it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations . . ."

b. This report contains descriptive information about the project, the methods of operation, and the prescribed regulations for flood control operation. A map of the Shasta Reservoir area is shown on chart 1. Location of the project is shown on chart 2. A portion of the material used in preparation of this report and some of the charts showing features of the project were furnished by the United States Bureau of Reclamation Mid-Pacific Region, Sacramento, California. A description of the overall Sacramento River Basin plan of flood control is given in the Master Manual of Reservoir Regulation, Sacramento River Basin, California.

2. PROJECT AUTHORIZATION

a. Shasta Dam is the key structure and one of the initial features of the Bureau of Reclamation's Central Valley Project, which closely follows original plans of the State of California. The State's Central Valley project took definite form between 1920 and 1930. Specific recommendation for a dam at Kennett (later Shasta Dam) to form one of the storage reservoirs in the Central Valley plan was made in 1927. Hydroelectric generation was to be developed to aid in financing, and the reservoir was to be operated for flood control also. Salt water intrusion at the delta was to be controlled by water released from storage.

b. The State Water Plan, presented as Bulletin 25 in 1931, formed the basis for the State's Central Valley project and was concerned mainly with the initial units to relieve the increasingly serious water supply situation. It provided for constructing Kennett Reservoir, the Delta Cross Channel, Friant Reservoir, the San Joaquin pumping system and conduits for the upper San Joaquin Valley and Contra Costa areas. It also pointed out that the project could not be financed through water and power revenues alone.

c. Conferences of Federal and State officials were held early in 1931 to seek a definite understanding regarding Federal participation in the project. The State's application for Federal financing through Public Works Administration loans and grants was not approved, and proposals for special Congressional legislation to authorize Federal loans and grants did not progress.

d. The project was authorized as a Federal Reclamation project in 1935 in the face of increasingly critical conditions of water shortage and economic distress, by the Finding of Feasibility of the Secretary of the Interior as approved by President Roosevelt. By direct presidential action, Public Works Administration funds were allotted to the Department of the Interior for Construction of certain project features subject to the reclamation laws. Congressional authorization was provided in the River and Harbor Act of 26 August 1937 (50 Stat. 850), and the River and Harbor Act of 17 October 1940 (ch 895, 54 Stat. 1198, 1199) extended the authorization to include irrigation distribution systems. The name of the dam was changed to 'Shasta' in September 1937.

3. CHANGES TO THE AUTHORIZED PLAN

Studies and investigations subsequent to project construction have resulted in the following modifications to the as built project.

a. *Spillway.* - The gross pool elevation was increased from 1065.0 feet to 1067.0 feet in 1965 by installation of flashboard gates which seat on the existing drum gates. Gross pool capacity accordingly was increased from 4,493,000 acre-feet to 4,552,100 acre-feet.

4. CONSTRUCTION HISTORY

Shasta Dam was constructed for interim operation during the period from September 1938 to June 1945. Storage of water in Shasta Lake began in December 1943. Gates, valves, etc., and other items of finish work, deferred during the war, were completed and placed in full operation in April of 1949. Approximately 37 miles of the Southern Pacific Railroad main line to Portland, Oregon, and 21 miles of U.S. Highway 99 (Interstate Route 5) were relocated around the reservoir during this period.

CHAPTER II - BASIN DESCRIPTION

5. DESCRIPTION OF THE PROJECT AREA

The Sacramento River drains about 26,000 square miles; excluding the Goose Lake drainage of the Pit River, which, although topographically within the Pit River Basin, rarely contributes to the flow. The Sacramento River drainage area of principal interest in operation of Shasta Dam includes the area above the dam; the local inflow tributary area to the river between the dam and Bend Bridge control point; and the area between Bend Bridge (Red Bluff) and the head of the Sacramento River Flood Control Project at Ord Ferry. A map of the basin is shown on chart 2 and topographic features, including locations of stream gaging stations are delineated on chart 3. Stream profiles of the main stem Sacramento River and its principal tributaries above Ord Ferry are shown on chart 4. The basin areas are briefly described in the following paragraphs. A general description of the entire Sacramento River Basin and the flood control works along the main stem below Shasta Dam is contained in the Master Manual.

6. AREA ABOVE SHASTA DAM

The drainage area above Shasta Dam consists of about 6,400 square miles of mountain and plateau area at the head of the Sacramento Valley portion of the Central Valley of California. While elevations in the basin vary from about 600 feet at Shasta Dam to 14,000 feet at Mount Shasta, approximately 65 percent of the mountainous area lies below 4,000 feet in elevation, and 97 percent lies below 7,000 feet. The two principal tributaries to Sacramento River above Shasta Dam, McCloud and Pit Rivers, drain a portion of the Trinity and Cascade Mountains to the north and east of Sacramento Valley.

The Pit River portion of the drainage area comprises the plateau area east of the crest of the Cascade Mountains which is drained by the Pit River and its principal tributaries Burney, Hat and Ash Creeks, and Fall River. The total drainage area is about 4,700 square miles; excluding the Goose Lake Basin. Pit River rises on the western slopes of the Warner Mountains, and flows generally southwesterly across an arid plateau underlain by extensive porous lava beds and other volcanic materials to its canyon through the Cascades. Vegetation is very sparse or entirely absent except for a thin cover of conifers immediately east of the Cascade crest. Much of the drainage is underground through the porous lavas and there are numerous small lakes and ponds, many of which have no surface outlets. The remaining portion of the drainage basin consists of the rugged mountainous areas on the western and eastern slopes of the Cascade and Trinity Mountains, respectively, drained by the main stem of the Sacramento River, McCloud River, Squaw Creek, and Pit River below Big Bend gaging station. The total drainage area is about 1,700 square miles. Sacramento River rises in the Trinity Mountains and the McCloud River rises on the slopes of Mount Shasta in the Cascade's. Both flow generally south to unite with the Pit River in Shasta Lake behind Shasta Dam. Elevations range from about 600 feet at Shasta Dam to about 6,000 feet along the crest of the Cascade and Trinity Mountains. Mount Shasta rises above the crest level to an elevation of 14,161 feet. Vegetative cover increases in density with elevation, from brush and scattered deciduous trees to a heavy coniferous forest. Soils are shallow and largely of clay types and are relatively tight. Winter flood flows originate on this mountainous portion while most of the summer flow originates along the Pit River above this area and in the upper McCloud River area. Although a number of small privately owned irrigation dams have been built on the Pit River

and tributaries, there are no large irrigation diversions upstream of Shasta Lake. The extensive system of hydroelectric dams, along Pit River and its tributaries develop very little storage and do not significantly modify flood flows.

7. FOOTHILL AREA (SHASTA DAM TO RED BLUFF)

Below Shasta Dam, Sacramento River flows southward for about 54 miles in a natural channel through rolling hilly country to the head of the Sacramento Valley near Red Bluff. This drainage basin consists of about 2,600 square miles of mountainous and valley floor area between Shasta Dam and the Bend Bridge gaging station near where the Sacramento River cuts through a line of low hills. The stream system is radial; Cottonwood Creek which drains the eastern slope of the Coast Ranges and south slope of the Trinity Mountains coming from the west, Clear Creek which drains the eastern slope of the Trinity Mountains from the northwest, Sacramento River from the north, and Cow, Battle, and Paynes Creeks which drain a segment of the western slope of the Cascade Mountains from the east. The crest elevation of the surrounding mountains is about 6,000 feet, with Mount Lassen rising above this level to about 10,000 feet. The river elevation at Bend Bridge is about 280 feet. About 800 square miles of the area is mountainous and the remaining 1,800 square miles are rolling hills and valley floor. Soil cover is moderately deep and ranges from sandy in the Cottonwood Creek area, clayey in the Cow Creek area, and porous volcanic material in the Battle Creek area. The valley floor area is grass covered with scattered oak trees on the east and a thin cover of scrub pine on the west. On the mountain slopes, vegetation increases with elevation to moderately heavy coniferous forest on the crests. The main stem of Sacramento River has an average slope of only 5 feet per mile while Cottonwood Creek on the west and Battle Creek on the east have average slopes of 110 and 150 feet per mile, respectively. Whiskeytown Dam and Reservoir on Clear Creek, one of the major features of the Trinity River Division of the Bureau of Reclamation's Central Valley Project, has a total capacity of 241,000 acre-feet. The Cottonwood Creek Project authorized for construction by the Corps of Engineers provides for a dam on the main stem of Cottonwood Creek (Dutch Gulch Dam) and one across the South Fork (Tehama Dam). Together both lakes would provide a total storage capacity of 2,000,000 acre-feet for flood control, local irrigation, municipal, and industrial water supply, recreation, and fish and wildlife purposes.

8. VALLEY FLOOR AREA

Below Red Bluff, Sacramento River continues to flow southward for about 65 miles to Ord Ferry. This portion of the basin comprises about 3,600 square miles of mountainous and valley floor area lying between the Coast Ranges on the west and the Cascade-Sierra Nevada Range on the east. Elevations range from less than 100 feet at Ord Ferry to about 7,500 feet on Black Butte on the west and 10,000 feet on the volcanic cone of Mt. Lassen on the east with approximately 50 percent of this area below 1,000 feet. The average slope of the main stem channel is about 1 foot per mile. The western slope of the Cascade-Sierra Nevada Range is drained by the roughly parallel streams of Antelope, Mill, Deer, and Big Chico Creeks which enter the main stem from the east, and the eastern slope of the Coast Ranges is drained by Elder, Thomes, and Stony Creeks which enter the main stem from the west and southwest. Most of the valley floor area is developed farm land but the area above the foothill line is rugged and undeveloped. Vegetative cover varies with elevation from grass and orchards on the valley floor and foothills, chaparral at intermediate elevations to moderately dense coniferous forest above 5,000 feet. Reservoirs of significant size in this area are

East Park and Stony Gorge (total capacity 101,200 acre-feet) of the Orland Irrigation Project (Bureau of Reclamation) on Stony Creek, a Coast Range tributary which enters Sacramento River just above Ord Ferry. These two reservoirs are filled as early in the winter flood season as possible and thereafter pass inflow. Black Butte Reservoir, constructed by the Corps of Engineers on Stony Creek for flood control and other purposes, has a total capacity of 160,000 acre-feet. The flood-control function of this reservoir is primarily protection of the local area, however, in conjunction with control of Stony Creek flows, operation of Black Butte Reservoir provides the maximum practicable assistance in preventing damage from high flows on Sacramento River in downstream reaches.

Below Ord Ferry, Sacramento River continues southward across the alluvial valley for about 184 miles through the improved channels of the Sacramento River Flood Control Project, a complex system of leveed channels and bypasses, to Collinsville at the head of Suisun Bay, a tidal arm of San Francisco Bay (see Master Manual). In the reach from Ord Ferry to the mouth of Feather River, local inflow is comparatively small in amount and is entirely intercepted by bypasses or natural flood basins so that it does not enter the river directly. There are no reservoirs of significant size on the tributaries in this reach. In the reach from the mouth of Feather River to Suisun Bay, large volumes of runoff enter the Sacramento River Flood Control Project channels from the Feather, American, Cache, and Putah sub-basins. The most important reservoirs in the reach are Oroville Reservoir on the Feather River; New Bullards Bar Reservoir on the North Fork Yuba River; Indian Valley Reservoir on the North Fork Cache Creek; Lake Berryessa (Monticello Dam) on Putah Creek, and Folsom Reservoir on the American River. Their flood operations, however, are independent of the flood control operation of Shasta Lake and are not described in this report.

9. CLIMATE

a. The climate in the upper Sacramento River Basin is characterized by wet cool winters and hot dry summers. The major storm period is during the months October through April. The average seasonal precipitation of the principal flood runoff area above Shasta Dam and below the Big Bend gaging station on Pit River, averages about 68 inches, and on the entire drainage area averages about 36 inches. Chart 5 shows normal annual precipitation over the drainage area. Normal annual precipitation for the entire drainage area ranges from about 11 inches in the eastern part of the Pit River Basin to about 85 inches just north of Shasta Dam. Precipitation usually occurs as rain at elevations below 4,000 feet and snow at higher elevations, although snow has occurred in the valley and rain has occurred at the highest elevations in the basin. About 75 percent of the annual precipitation occurs during the months of November through March, and about 15 percent during the months of April through July. The normal monthly distribution of precipitation at representative stations based on records through 1974 is shown in the following tabulation:

Average Monthly Precipitation

Month	Mt. Shasta City Elev. 3544		Vollmers Elev. 1335		Mineral Elev. 4910	
	Inches	% of Annual	Inches	% of Annual	Inches	% of Annual
July	0.32	0.8	0.17	0.2	0.09	0.2
August	0.31	0.8	0.47	0.7	0.47	0.9
September	0.69	1.8	0.91	1.3	0.86	1.6
October	2.54	6.8	4.61	6.7	4.41	8.1
November	5.09	13.6	9.73	14.1	7.16	13.1
December	6.25	16.7	11.70	17.0	9.56	17.5
January	6.65	17.7	13.05	18.9	10.08	18.5
February	5.61	15.0	10.71	15.5	7.32	13.4
March	4.03	10.8	7.59	11.0	6.07	11.1
April	3.05	8.1	5.63	8.2	4.26	7.8
May	1.87	5.0	2.89	4.2	2.61	4.8
June	1.08	2.9	1.53	2.2	1.63	3.0
TOTAL	37.49	100.0	68.99	100.0	54.52	100.0
Period of Record	87 years		37 years		50 years	

A more detailed discussion of the climate of Sacramento Valley is contained in the Master Manual.

b. Winter temperatures in the mountain areas average around 32°F., but occasionally descend below zero, while summers are moderate. Observed temperature extremes are 103 and zero degrees at Mt. Shasta City, 114 and 17 degrees at Redding and 100 and -13 degrees at Mineral. The monthly distribution of mean temperatures at representative stations are given in the following tabulation:

Monthly Normal Temperatures (° F)

Month	Mt. Shasta City Elev. 3544	Redding F.S.#2 Elev. 575	Mineral Elev. 4910
January	33.6	46.1	31.1
February	37.8	50.7	33.4
March	40.4	53.9	35.5
April	46.3	60.3	41.1
May	53.3	67.8	48.1
June	60.0	75.6	55.1
July	67.8	83.1	62.4
August	66.0	80.6	60.9
September	61.2	76.7	57.3
October	51.4	65.7	48.4
November	41.7	54.3	39.1
December	35.5	47.2	33.3
NORMAL	49.6	63.5	45.5
Period of Record	61 years	99 years	48 years

c. Normal annual snow accumulation at selected stations is as follows:

Station	Elev.	Drainage	Normal Water Equivalent Snow in Inches			
			1 Feb	1 Mar	1 Apr	1 May
Adin Mt.	6350	Pit River	9.0	11.7	13.5	5.9
Stouts Meadow	5400	McCloud River	26.2	35.4	43.1	34.4
Mount Shasta	7900	Sacramento River	32.1	42.6	50.0	52.0

10. RUNOFF CHARACTERISTICS

Although some of the streams in the basin have their source in large perennial springs and flow at a fairly constant rate all year, the runoff pattern of the Sacramento River and tributaries above Shasta Dam is generally similar to the precipitation pattern. That is, maximum flows occur between the months of November and April and are the result of direct runoff from intense precipitation; with the largest sustained flows usually in April and May. Flows decrease during the summer, reaching the lowest flows in August, September and October. Runoff in the Sacramento River and tributaries varies both seasonally and from year to year, and long drought periods have been experienced. The average annual runoff of the Sacramento River at Shasta Dam for 67 years of record is 5,737,000 acre-feet, the maximum recorded value being 10,796,000 acre-feet (188 percent) for the 1973-74 water year and the minimum, 2,479,000 acre-feet (43 percent) in 1923-24. Chart 6 gives the historical inflow (1944-1974) on monthly and annual basis for Shasta Lake. High rates of flow may occur concurrently from local tributaries to Sacramento River between Shasta Dam and Ord Ferry, and such local inflow alone may exceed safe channel capacities at Red Bluff and Ord Ferry. Winter rains sometimes extend in the higher elevations and can result in record floods particularly if there is a moderate snowcover in the mountains. Monthly normal flows for Sacramento River Basin are illustrated by the following tabulation:

AVERAGE MONTHLY RUNOFF

(In 1,000 acre feet)

MONTH	SACTO. RIVER AT DELTA DA = 425 sq mi		McCLOUD RIVER AB. SHASTA LAKE DA = 604 sq mi		PIT RIVER AT BIG BEND DA = 4,710 sq mi		SHASTA LAKE NEAR REDDING DA = 6,421 sq mi		SACTO. RIVER ABOVE BEND BR. NEAR RED BLUFF* DA = 8,900 sq mi		SACTO. RIVER AT ORD FERRY DA = 12,480 sq mi	
	Runoff	Percent	Runoff	Percent	Runoff	Percent	Runoff	Percent	Runoff	Percent	Runoff	Percent
Oct	26	2.9	54	5.1	12	2.7	281	4.4	449	4.8	447	4.4
Nov	59	6.5	70	6.6	9	2.0	406	6.3	540	5.8	592	5.8
Dec	97	10.7	110	10.4	34	7.6	673	10.5	937	10.0	1,084	10.5
Jan	127	14.0	134	12.7	83	18.7	928	14.5	1,371	14.7	1,703	16.6
Feb	141	15.5	133	12.6	68	15.3	885	13.9	1,253	13.4	1,680	16.3
Mar	122	13.4	122	11.6	78	17.5	832	13.0	784	8.4	1,043	10.1
Apr	133	14.7	122	11.6	82	18.4	778	12.2	754	8.1	901	8.8
May	109	12.0	96	9.1	40	9.0	561	8.8	707	7.6	692	6.7
Jun	46	5.1	65	6.2	16	3.6	345	5.4	643	6.9	558	5.4
Jul	20	2.2	54	5.1	8	1.8	253	4.0	704	7.5	568	5.5
Aug	14	1.5	49	4.6	8	1.8	226	3.5	682	7.3	553	5.4
Sep	14	1.5	46	4.4	7	1.6	223	3.5	518	5.5	462	4.5
Annual	908	100.0	1,055	100.0	445	100.0	6,391	100.0	9,342	100.0	10,283	100.0

Period of Record Water Year 1950 - 1973

*Prior to 1968, published as "Near Red Bluff".

A list of stream gaging stations, their locations, drainage areas, periods of record, and peak flows is given on Chart 3.

CHAPTER III - FLOOD POTENTIAL

11. FLOOD CHARACTERISTICS

a. Floods on Sacramento River are caused primarily by winter rainstorms augmented by melting of accumulated snow on the drainage area. Sometimes floods are decreased by absorption of rain within the snow pack. Flood flows originating above the dam are generally confined to canyons and stream channels, and travel rapidly to the lake without causing significant damage. Below Shasta Dam local tributary inflow to Sacramento River flows in streams confined to narrow canyons above the foothill line, below which the streambed gradient decreases sharply and flood flows tend to spread over wide areas if not confined by levees. Floods caused by rain are characterized by high peak values and short durations (about three days at the foothill line) while snowmelt floods may produce moderately high flows over a sustained period of several weeks.

b. Among the largest floods at the dam site during the period of record (1895 to date) are those of March 1907, January-February 1909, February 1915, December 1937, February-March 1940, February-April 1941, December 1955, January 1956, February 1958, December 1964, January 1969, January 1970 and January 1974. These floods occurred during the winter season and were caused primarily by rainfall augmented in most cases by melting snow. The storms causing each of these major floods have much in common. All follow the general pattern of flood-producing precipitation in California, which occurs when the deep southwest wind current of a warm moist sector of a Pacific storm is superimposed on the efficient rain-producing mechanism of California topography. The January 1974 flood produced the highest flow of record (215,700 c.f.s., 16 January 1974) above Shasta Dam while the January-February 1909 flood sequence produced the greatest recorded volume of flood runoff. The December 1937 flood produced outstanding flows from the minor eastside tributaries between Shasta Dam and Ord Ferry, while the December 1964 and January 1970 and 1974 floods were very heavy in the Sacramento River basin above Ord Ferry, particularly on the west side tributaries.

12. DOWNSTREAM AREAS SUBJECT TO FLOODING

Areas along the Sacramento River downstream from Shasta Dam that are subject to flooding consist of the towns of Redding, Anderson, Red Bluff, and Tehama. Also subject to flooding are agricultural lands and industrial developments. Large floods, like the January 1974 flood, may inundate over 200,000 acres. About half of the flooding occurs within the confines of dedicated floodways and natural overflow basins. Areas subject to flooding are shown on chart 7.

13. RAIN FLOOD POTENTIAL

High intensity rain floods may occur in the Sacramento River Basin downstream from Shasta Dam any time from November to April. These floods can cause flooding of extensive areas and result in considerable damage to agricultural and urban developments in the Sacramento River flood plain. Rain flood frequency curves for Sacramento River at Shasta Dam and Sacramento River above Bend Bridge near Red Bluff are shown on charts 8 and 9, respectively.

14. SEASONAL VARIATION OF RAIN FLOOD POTENTIAL

Large rainstorms in the Sacramento River Basin occur most frequently in the months of November through March, and are not known to occur in the months of June through August. For a specified ground condition, the seasonal variation of rain flood potential is dependent on the

seasonal variation of storm potential, which is a function of latitude and the amount of storm precipitation that normally occurs at any location. This seasonal variation of storm potential is defined by criteria contained in office report, "Reservoir Operation Criteria for Flood Control," dated October 1959.

15. SNOWMELT FLOOD POTENTIAL

Snowmelt runoff is caused by the gradual melting, in the spring and early summer, of snow and ice which have accumulated during the winter in the high mountains. Snowmelt runoff alone does not cause damage in the Sacramento Valley but prolonged high stages in the lower channels will occasionally inundate bypass lands during part of the growing season and may cause seepage through levees.

16. FLOOD MAGNITUDES

A comparison of the standard project flood with major historical floods and the probable maximum flood, expressed as ratios of standard project flood values to those of the major floods is tabulated below:

Flood	Peak Flows		5-Day volumes	
	Flow (1,000 c.f.s.)	Ratio (Flood/SPF)	Volume (acre feet)	(Flood/SPF)
Std. Proj.	345,000	1.00	1,574,000	1.00
Jan. 1974	215,700	0.63	1,088,500	0.69
Jan. 1970	210,000	0.61	1,101,500	0.70
Dec. 1955	193,000	0.56	1,089,000	0.69
Feb. 1940	182,000	0.53	946,000	0.60
Mar. 1907	160,000	0.46	952,000	0.60
Prob. Max.	450,000	1.30	1,800,000	1.14

Routings of historical floods are shown on chart 10.

17. STANDARD PROJECT FLOOD

The standard project flood at Shasta Dam has a peak flow of 345,000 c.f.s. and a 5-day volume of 1,574,000 acre-feet. This standard project flood is described in office report, 'Standard Project Floods, Sacramento River and Tributaries Above Ord Ferry, Sacramento River, Calif.,' dated 15 March 1963. The flood was determined by use of the 6-hour unit hydrograph shown on Table III in the above mentioned report. A routing of the standard project flood through Shasta Reservoir is shown on chart 11. The maximum outflow is 205,000 c.f.s. with maximum storage 4,580,000 acre-feet.

18. RESERVOIR DESIGN FLOOD

Shasta Reservoir does not have a Reservoir Design flood. The hypothetical flood representing the maximum flood controllable to project objective outflows (corresponding to 79,000 c.f.s. at tailwater of Keswick Dam and 100,000 c.f.s. at Sacramento River at Bend Bridge gaging station) and utilizing 1,300,000 acre-feet of flood control space is the 100 year flood. It has a peak flow rate of about 290,000 c.f.s. and a 5-day volume of 1,338,000 acre-feet. A routing of the 100 year flood through Shasta Reservoir is shown on chart 12. The maximum outflow is 79,000 c.f.s. with a maximum storage of 4,550,000 acre-feet.

19. SPILLWAY DESIGN

The spillway design flood was based on the maximum probable storm which was assumed to occur at a time when antecedent conditions were optimum for high flood runoff. The storm produced an average of 20.4 inches of precipitation in five days over 2,370 square miles. Because of the volcanic soils in the Pit River basin, the effective flood producing area for Shasta Dam was assumed to end near Fall River Mills. A runoff factor of 80 percent was used in computing a design flood peak of 450,000 c.f.s. and a 13-day volume of 2,060,000 acre-feet. This flood was routed through the reservoir under the assumption that antecedent inflow had filled the reservoir to the top of the raised spillway gates (elevation 1,065). The routing was made using minimum release rates indicated on chart A-9, the Emergency Spillway Release Diagram. Maximum outflow would reach 346,000 c.f.s. combined flow through outlets and over the spillway. Maximum pool elevation would reach 1071.2 feet or 6.3 feet surcharge, about half the available freeboard above gross pool. Chart 13 shows the routing of the spillway design flood.

CHAPTER IV - PROJECT FEATURES

20. DESCRIPTION OF THE PROJECT

Shasta Dam and Lake are located on the Sacramento River below its confluence with Pit River, about ten miles north of Redding, California, and function as the key unit of the Central Valley Project, one of the most extensive man-made water transport systems in the world (see chart 2). This project extends 500 miles through the length of the great Central Valley of California from the Cascade Range in the north, to the semiarid plains along the Kern River in the south. Although the primary purpose of the Central Valley Project is irrigation development including the transfer of water from the Sacramento River basin where a surplus exists into the water deficient areas of the San Joaquin Valley hundreds of miles to the south, other purposes of the project include flood control and improvement of Sacramento River navigation, domestic and industrial water supply, generation of electric power, fish and wildlife conservation, recreation, protecting the Sacramento-San Joaquin Delta from intrusion of saline ocean water, and other water uses.

a. Shasta Dam is a curved, gravity-type, concrete structure with a small earthfill section

22. IRRIGATION AND NAVIGATION

The principal irrigation season is April through October and many irrigation diversions are made along Sacramento River below Shasta Dam as discussed in paragraph 35, including diversions to the Delta Cross Channel, which carries a large volume of water into the San Joaquin Basin. The Sacramento River Navigation Project extends up the main channel of Sacramento River to Red Bluff, about 60 miles below Shasta Dam. However, navigation on Sacramento River is and has been very limited above Colusa and is practically nonexistent above Chico Landing.

23. RECREATION FACILITIES

The Whiskeytown-Shasta-Trinity National Recreation Area was established by Act of Congress in November 1965. The area comprises three separate units. One is at Whiskeytown Lake, one at Shasta Lake, and the third includes Clair Engle-Lewiston Lakes. The Shasta Unit and the Clair Engle-Lewiston Unit are within the Shasta-Trinity National Forests, and are administered by the Forest Service. The Whiskeytown Unit is administered by the National Park Service. These three units of the National Recreation area surround major reservoirs of the Central Valley Project of California. The recreation area provides recreation for present and future generations, and in addition, assures the conservation of lands having scenic, scientific, and historic values. Facilities provided at Shasta Lake, by the Forest Service, include twenty-nine campgrounds, four boat-launching ramps and two beach and picnic areas. In addition to the Forest Service facilities, about eighteen resorts and marinas are operating under permit within the Shasta Lake Unit. Facilities provided by these permit-holders include rental housing, stores, snack bars, restaurants, excursion boats, boat-dock service and rental, camping areas, and boat-launching ramps. A map showing locations of the recreation facilities in the Whiskeytown-Shasta-Trinity National Recreation area are shown on chart 17.

CHAPTER V - FLOOD CONTROL DESIGN REQUIREMENTS

24. HYDROLOGIC BASIS FOR DESIGN

As a key structure and one of the initial features of the Central Valley Project, Shasta Dam and Lake were designed as provided for in the Rivers and Harbors Act, "That the dam and reservoir shall be used, first for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and third, for power."

25. FLOOD CONTROL SPACE REQUIREMENTS

The currently required flood control storage reservation is determined from the Flood Control Diagram. The diagram requires:

(1) Minimum 1,300,000 acre-feet of storage space from 1 November to 23 December, and

(2) Conditional flood control space up to a maximum of 1,300,000 acre-feet from 23 December to 20 March, decreasing again to zero on 15 June. The required space is determined by use of a ground wetness index during this period.

26. MULTIPLE USE OF RESERVOIR SPACE

The allocation of a portion of project costs to flood control at Shasta Lake is based on optimum use of reservoir space for all project purposes with space reserved for flood control use on a priority basis when needed, as defined in the approved flood control regulations. Since the rain flood potential varies seasonally, it is possible to obtain optimum usage of that portion of the reservoir space required for flood control during flood seasons by carefully defining seasonal limits and space requirements for flood control, thus allowing the reservoir space to be used for other purposes when it is not required for flood protection.

27. GROUND WETNESS INDEX

The ground wetness index is a parameter value computed on a daily basis to reflect the current ground wetness and adjusted to account for evaporation and ground losses within the Sacramento River Basin above Shasta Dam. Loss rates vary with soil type, from high, in sub-basins with porous volcanic soils, to low, in sub-basins with clay soils. Losses decrease during storms as surface detention fills and the ground becomes saturated. Two-hour loss data were computed for upper Sacramento River above Shasta Dam during the February 1958, Janaury 1956, December 1955, and December 1937 storms. The storm of January 1956 was the second major storm in this wet season on this area. Due to the very wet ground conditions esulting from the December 1955 storm, analysis of the 1956 storm was very important in determining loss values with very wet ground conditions. The storm of 9-12 December 1937, on the other hand, was notable for heavy rainfall on relatively dry ground and large areal extent.

The current ground wetness index adopted for Shasta Lake is the parameter value (see chart A-8) computed in c.f.s. days from the accumulation of seasonal inflow by adding the current day's inflow in c.f.s. to 95 percent of the parameter value computed through the preceding day. The adopted parameter is more responsive to changing conditions than the previous parameter based on the most recent 30-day inflow to Shasta Lake. In addition, studies were conducted utilizing parameters based on precipitation with varying degrees of decay. The precipitation parameter fluctuated more rapidly than the adopted inflow parameter. It was agreed by representatives of the Corps and U.S.B.R. that the resultant rate of change in storage would prove to be excessive.

28. FLOOD CONTROL DIAGRAM

The Flood Control Diagram for Shasta Dam and Lake is shown on chart A-8. This diagram is the result of a joint investigation by Sacramento District and Bureau of Reclamation Mid-Pacific Regional Office personnel utilizing the operating experience gained during the last 22 years. The end of month allowable storages for the period 1921 - 1974, as computed by the Flood Control Diagram are tabulated on chart 18.

CHAPTER VI - GENERAL PROJECT OPERATION

29. OBJECTIVES

Shasta Lake is operated for flood control, power, and conservation on the basis of the following objectives:

a. To restrict flows downstream in the Sacramento River to the controlling flow rate of 79,000 c.f.s. at tailwater of Keswick Dam; and 100,000 c.f.s. at Sacramento River at Bend Bridge gage (near Red Bluff); insofar as possible.

b. To provide the maximum practicable amount of conservation storage for irrigation, domestic, and municipal uses without impairment of the flood control functions of the reservoir.

c. To provide the maximum practicable amount of power without impairment of the flood control functions of the reservoir.

d. To provide sufficient releases to maintain downstream navigation channels of the Sacramento River to authorized depths.

e. To maintain sufficient releases to aid in the control of salt water intrusion in the Sacramento-San Joaquin Delta.

f. To provide fish and wildlife mitigation, and when possible operate to provide enhancement of California's fish and wildlife.

g. To maintain a minimum pool of at least 587,000 acre-feet.

30. RESPONSIBILITY FOR OPERATION

Shasta Reservoir is operated by the Bureau of Reclamation, United States Department of the Interior, and is under the jurisdiction of their Regional Director, Mid Pacific Region, Sacramento, California. Details concerning the responsibility for flood control operation are discussed in Appendix A to this report. Flood control regulations prescribed by the Secretary of the Army under the authority of Section 7 of the Flood Control Act of 1944 and in accordance with rules and regulations contained in the Code of Federal Regulations Title 33 Part 208.11 are reflected in the accompanying Field Working Agreement and Flood Control Diagram, included in Appendix A to this report.

31. PRESENT REGULATION

Present regulation of Shasta Dam for flood control requires that releases from Shasta Lake shall be restricted to quantities which will not cause downstream flows or stages to exceed, insofar as possible, any one of the following criteria:

a. A flow of 79,000 cubic feet per second at the tailwater of Keswick Dam;

b. A stage of 39.2 feet at the Sacramento River at Bend Bridge gaging station near Red Bluff (considered to correspond to a flow of approximately 100,000 cubic feet per second);

c. Storage space in Shasta Lake of 1,300,000 acre-feet below elevation 1,067.0 is kept available for flood control purposes on a seasonal basis in accordance with the Flood Control Diagram in force.

32. MINIMUM RELEASE REQUIREMENTS

The minimum releases as authorized by Congress are for fishery purposes in the Sacramento River. These minimum releases are 2,300 cfs from March 1 - August 31, 2,600 cfs from December 1 - February 28-29, and 3,900 cfs from September 1 - November 30. In critically dry years these minimum releases are reduced to ~~2,800~~ 1,800, 1,500, and 2,300 cfs respectively. Additional releases are

made for irrigation, navigation, and water quality. Generally, the minimum flow requirement for fishery protection and navigation are exceeded by those required for irrigation and water quality.

33. DOWNSTREAM CHANNEL CAPACITIES

Sacramento River between Shasta Dam and Bend Bridge gaging station (the farthest downstream control point used in the flood control operation of Shasta Lake) flows through 54 miles of natural river channel. The carrying capacities at control points of the various reaches are as follows:

Reach	Index Station	Stage	Flow
Shasta Dam to Red Bluff	Keswick	32.3 ft. G.H.	79,000 c.f.s.
Red Bluff to Ord Ferry	Bend Bridge	39.2 ft. G.H.	100,000 c.f.s.

These capacities have been accepted as operating criteria for the flood control operation of Shasta Dam and Lake as outlined in Appendix A to this report. Below Ord Ferry, the improved channels and bypasses of the Sacramento River Flood Control Project have a total capacity which increases progressively from about 150,000 c.f.s. near Ord Ferry to about 500,000 c.f.s. at Suisun Bay. The flow times for the main stem of the Sacramento River are as follows:

Reach	Travel Time
Shasta Dam to Bend Bridge	12 hours
Bend Bridge to Ord Ferry	18 hours

Rating curves for stations on Sacramento River pertinent to flood control operation of Shasta Dam are shown on chart A-6 and A-7. Since the beginning of operation of Shasta Dam there has been some encroachment into the natural channels in spite of the posting of warning signs by the Bureau of Reclamation to indicate areas along the Sacramento River that might be subject to inundation from Shasta Dam releases. Recently, the Sacramento River has been included in the designated floodway program of the State of California. Under this program, the State Reclamation Board has statutory authority to regulate the uses of and construction in designated floodways so as not to impair floodflows.

34. FLOOD DAMAGES

Operation of Shasta Dam and Lake from 1903 to 1974 in accordance with prescribed flood control regulations contained in this report would have resulted in reduction of the number of times seriously damaging flows occurred on Sacramento River below Shasta Dam from about 48 to about 16 during the period. The largest floods would still have exceeded channel capacities but would have been significantly reduced. The average annual reduction in flood damage and seepage through and under levees was estimated for purposes of the report on feasibility and cost allocation of the Central Valley Project (House Document No. 146, 80th Congress, 1st Session) to be $586,000. In addition, the average annual benefit from resultant change in land use was estimated at the same time to be $118,000. At the request of the Bureau of Reclamation on 25 November 1968, flood control benefits were reevaluated. The revised flood control benefits, as

transmitted to the Bureau of Reclamation 1 April 1969 ranged from $704,000 as set forth in H.D. 146 to $6,180,000 per year, the exact amount depending on the various stipulated conditions used in estimating benefits. Even though Shasta provides substantial protection, considerable flood damages will continue to occur along the channels between Shasta Dam and Ord Ferry. As mentioned in paragraph 33, some channel encroachment has occurred and flows of less than the accepted channel capacity will cause minor damage between Redding and Chico Landing. A description of overflow areas and flow-damage information for this reach as well as for major downstream damage reaches are contained in the Master Manual.

35. CONSERVATION AND NAVIGATION OPERATION

The most efficient use of water resources made available by Shasta Dam can be realized by coordinated operation with some other units of the Central Valley Project, locations of which are shown in the Master Manual. In the operation of the Central Valley Project (CVP), each reservoir upstream of the Delta must meet the demands which can be met only from that reservoir. Below the confluence of the Sacramento and American Rivers on the edge of the Delta, there is, however, considerable flexibility in operating to meet the requirements which physically can be served from either the Shasta-Trinity complex or the American River facilities (Folsom and Auburn). Service is likely to be by various combinations of supplies. This coordination also provides a supplemental supply to provide 5,000 cfs for navigation on the Sacramento River. The Bureau of Reclamation share of Delta demands can be commonly met at various times and in varying proportions from the Shasta-Trinity system, and from the American River facilities.

At ultimate level of development it is estimated that an integrated CVP could supply diversion requirements in the Sacramento Valley of about 3.8 million acre-feet; diversion requirements in the American River basin of about 1.7 million acre-feet, and export pumping requirements of about 3.7 million acre-feet. Additionally Delta area consumptive use needs, including an estimated 1.6 million acre-feet for the Delta lowlands and uplands are provided for in a joint CVP - State Water Project operation.

Operational features of the CVP include releases for fishery maintainence from Clair Engle Reservoir to the Trinity River, from Shasta Reservoir to the Sacramento River, and from Folsom Reservoir to the American River. Further benefits are obtained through coordinated operation of Central Valley Project with projects of the State Water Project. The Bureau of Relamation and the State Department of Water Resources work closely on such a coordinated operation, particularly with respect to the joint Federal-State San Luis Project.

37. RELATION TO OTHER PROJECTS

While Shasta Lake is operated for conservation and other purposes as a unit of the Central Valley Project, its operation for flood control is independent of the flood control operation of any other reservoir. Principal existing and proposed reservoirs in the upper Sacramento River Basin are shown on chart 19.

CHAPTER VII - OPERATIONAL CONTROLS

38. HYDROLOGIC FACILITIES

a. Hydrologic stations from which current reports are available for direct operation of Shasta [redacted]

b. Outflow from Shasta Dam is computed by the summation of flows through the powerhouse, through the river outlets, and over the spillway. [redacted]. Flows through the river outlets and spillway gates are calculated from the rating of these structures for various openings and heads. Outflow from Keswick Dam is computed in a manner similar to that for Shasta Dam.

[redacted]

39. FORECASTS OF FLOOD RUNOFF

a. Flood-control operation of Shasta Lake requires forecasting of flood runoff both above and below the dam for from 6 to 24 hours in advance. The most critical forecast is that of the local inflow entering Sacramento River between the dam and the Sacramento River at Bend Bridge gage. Less critical forecasts are required of the local inflow between the Bend Bridge gage, and the Ord Ferry gage, and of the inflow to the reservoir. With rapidly changing inflow, the forecasts of the various inflows can be revised each 6 hours. The time of stream flow travel from Shasta Dam to Bend Bridge is about 12 hours and to Ord Ferry about 30 hours.

b. The Bureau of Reclamation has arranged with the NOAA Office in Sacramento to forecast the local flow from the streams entering Sacramento River between Keswick Dam and the Sacramento River Bend Bridge (Red Bluff) gage for 6 to 24 hours in advance during flood periods. The data available are (1) current runoff at Red Bluff, (2) twice-daily precipitation data from the extensive reporting network of NOAA, (3) data from eight on-call type radio-reporting precipitation stations operated by the Bureau of Reclamation and six precipitation stations reporting every 6 hours operated by NOAA at key points in the local area above Red Bluff, and (4) a quantitative forecast of the average precipitation that can be expected over the Shasta zone for the next 48 hours, made by NOAA on each day during the winter flood season from 1 November to 1 May.

40. COORDINATION WITH OTHER AGENCIES

In order to assure that the flood control operation of Shasta Dam and Lake will be as effective and reasonable as possible, it is essential that the operating agency keep advised at all times of possible flood hazards, weather, inflow to the reservoir, and flow in downstream tributaries. This requires close liason with the NOAA, Soil Conservation Service, Geological Survey, Corps of Engineers, State of California Department of Water Resources and downstream interests.

CHAPTER VIII - PROJECT ACCOMPLISHMENTS

41. EXAMPLES OF OPERATION

Routings of historical floods (1955, 1958, 1964-65, 1970 and 1974) are shown on chart 10. A routing of the standard project flood is shown on chart 11 and a routing of the 100-year flood is shown on chart 12. The spillway design flood routing is shown on chart 13. Rain flood frequency curves (pre-project and project conditions) are shown on charts 8 and 9. Stage duration curves are shown on chart 20 and stage frequency curves are shown on chart 21. The seasonal variation of reservoir storage is shown on chart 22.

42. OPERATION RECORD

a. The official operating record is published in the Water Supply Papers of the U.S. Geological Survey.

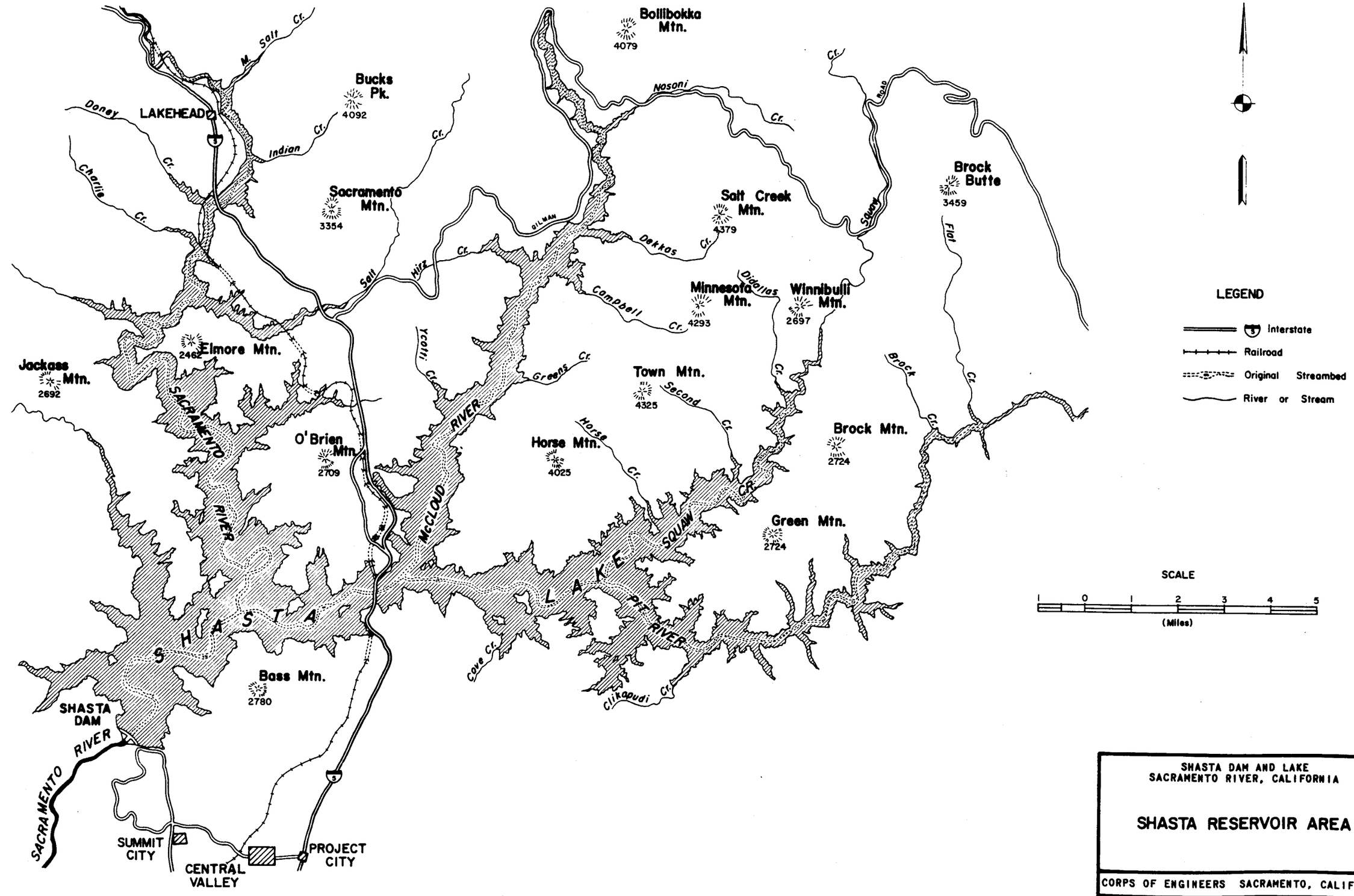
b. The operation of Shasta Lake began in January 1944 and is shown in graphical form on chart 23.

c. A record of flood control requirements, and of storage and flow pertinent to the flood control operation is contained in the monthly reports submitted to the Chief of Engineers by the District Engineer, Corps of Engineers, Sacramento, California.

CHAPTER IX - STUDIES IN PROGRESS OR PLANNED

43. CURRENT STUDIES

No studies are currently in progress for the upper Sacramento River Basin. Future studies will include coordinated system operation studies of the Sacramento River system, including Shasta Lake and related features, and the authorized Dutch Gulch and Tehama Reservoirs (Cottonwood Creek Project) to meet flood control objectives on the Sacramento River.



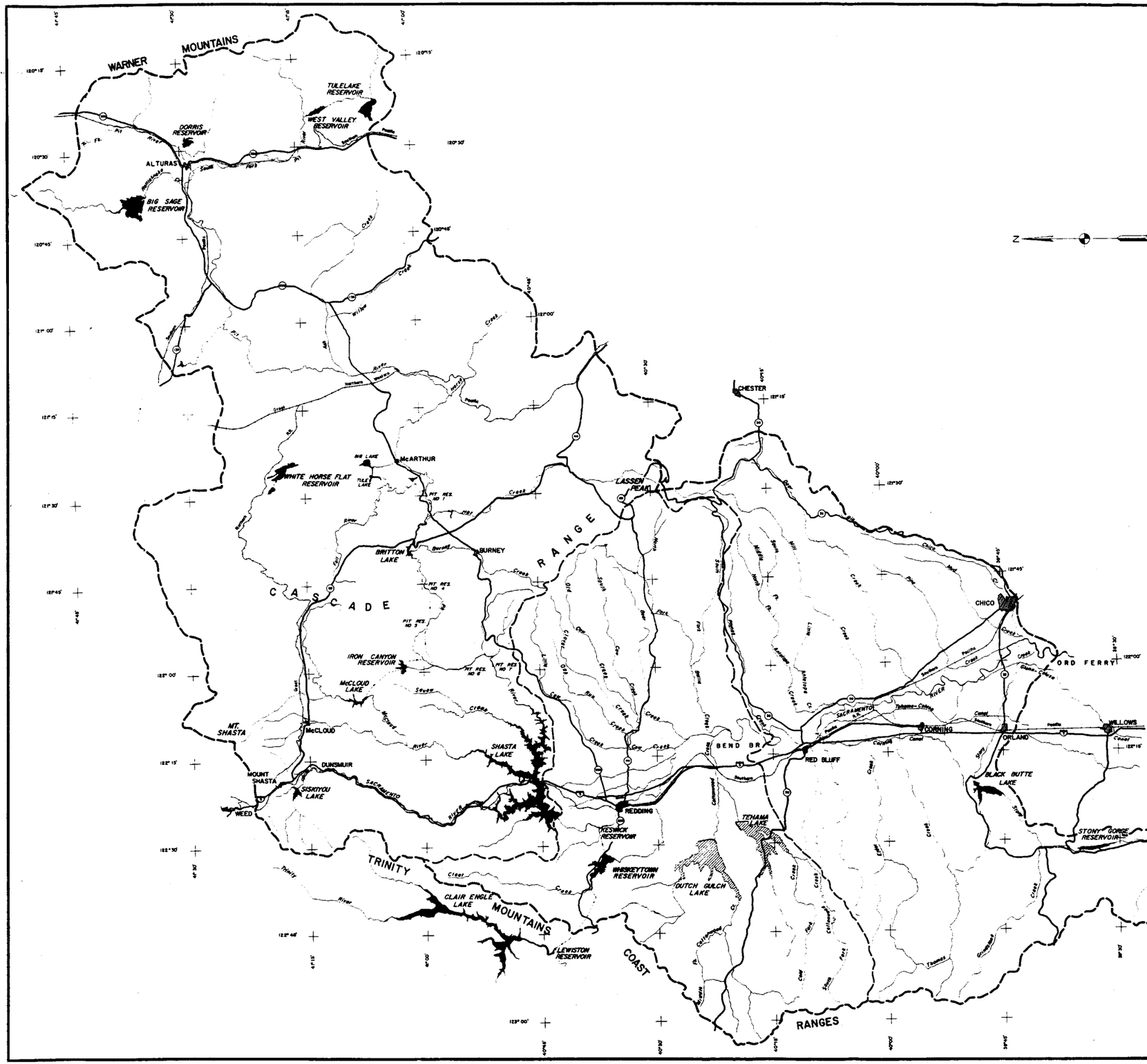
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

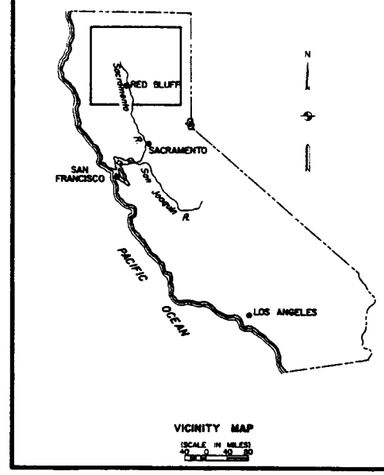
SHASTA RESERVOIR AREA

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.
Drawn: T.K.B.
Date: FEBRUARY 1976

CHART 1





VICINITY MAP

SCALE IN MILES
40 0 40 80

LEGEND

- Drainage boundary
- U.S. Highway / State Highway
- Interstate Highway
- Railroad
- Intermittent Stream
- Perennial Stream
- Canal
- Reservoir or Lake
- Authorized Reservoir

SCALE
5 0 5 10 15 20
(Statute Miles)

SHASTA DAM AND RESERVOIR SACRAMENTO RIVER, CALIFORNIA

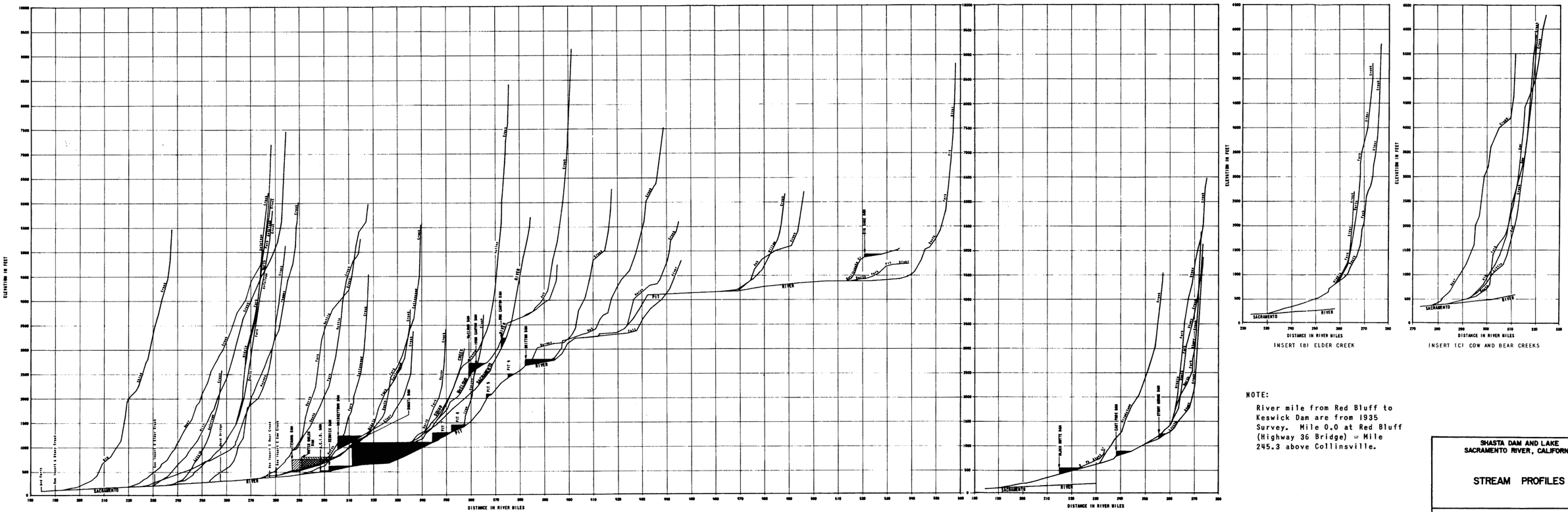
GENERAL MAP

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

PREPARED: R.L.L.
DRAWN: T.K.B.
DATE: SEPTEMBER 1975

CHART 2

CHART 3



NOTE:

River mile from Red Bluff to Keswick Dam are from 1935 Survey. Mile 0.0 at Red Bluff (Highway 36 Bridge) = Mile 245.3 above Collinsville.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

STREAM PROFILES

CORPS OF ENGINEERS	SACRAMENTO, CALIFORNIA
PREPARED : T.G.K.	DATE : FEBRUARY 1976
DRAWN : T.K.B.	

CHART 4

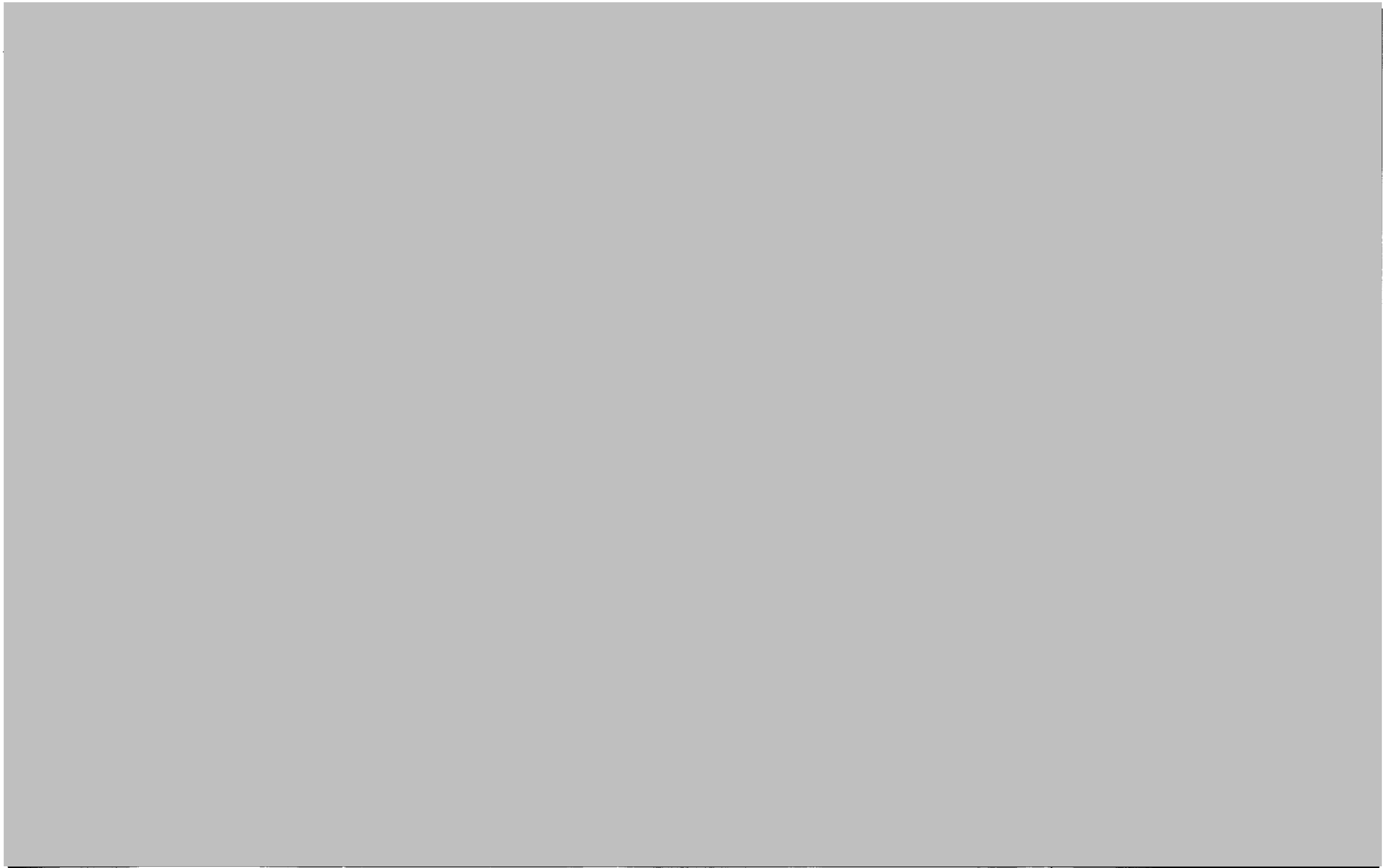


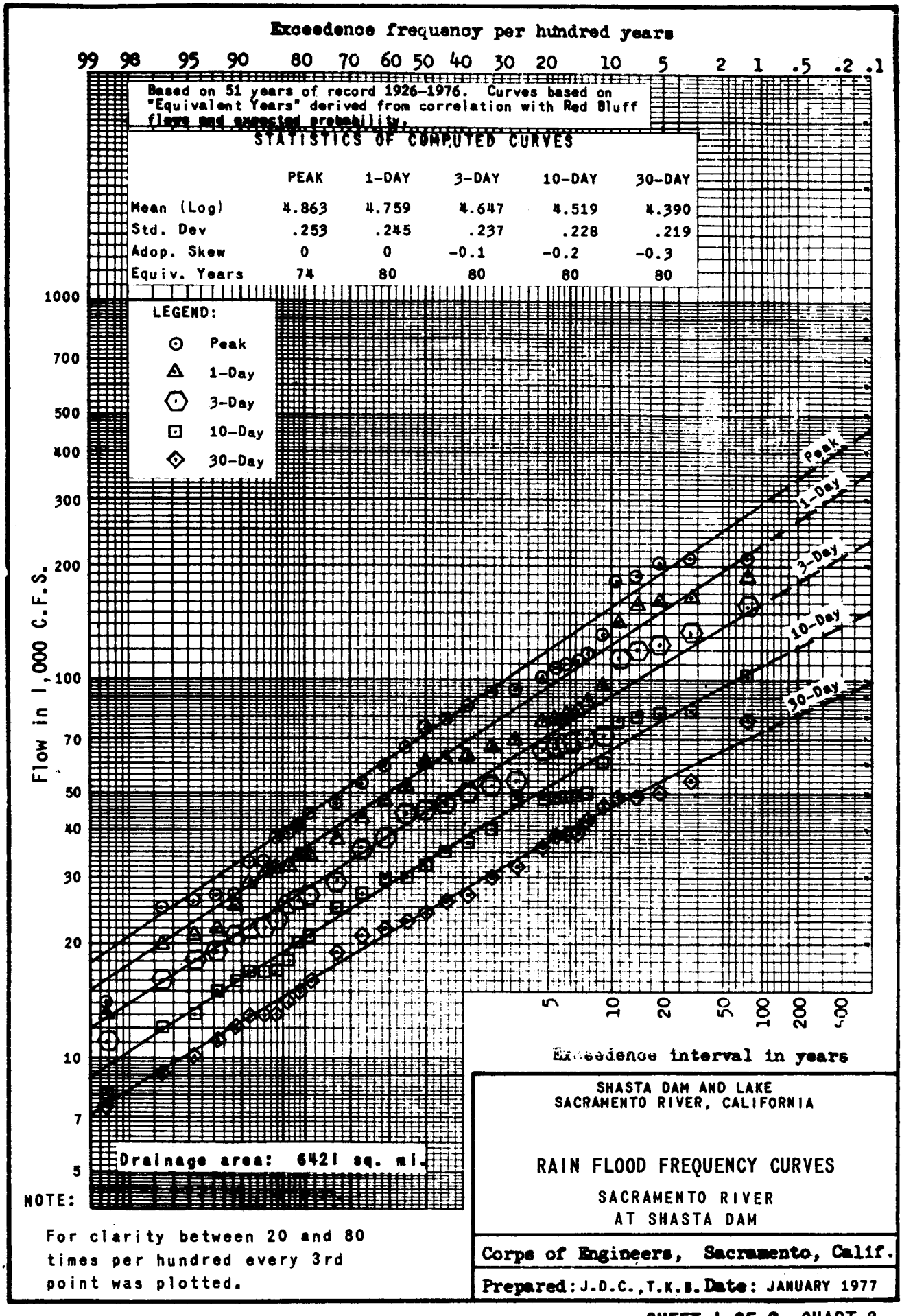
CHART 5

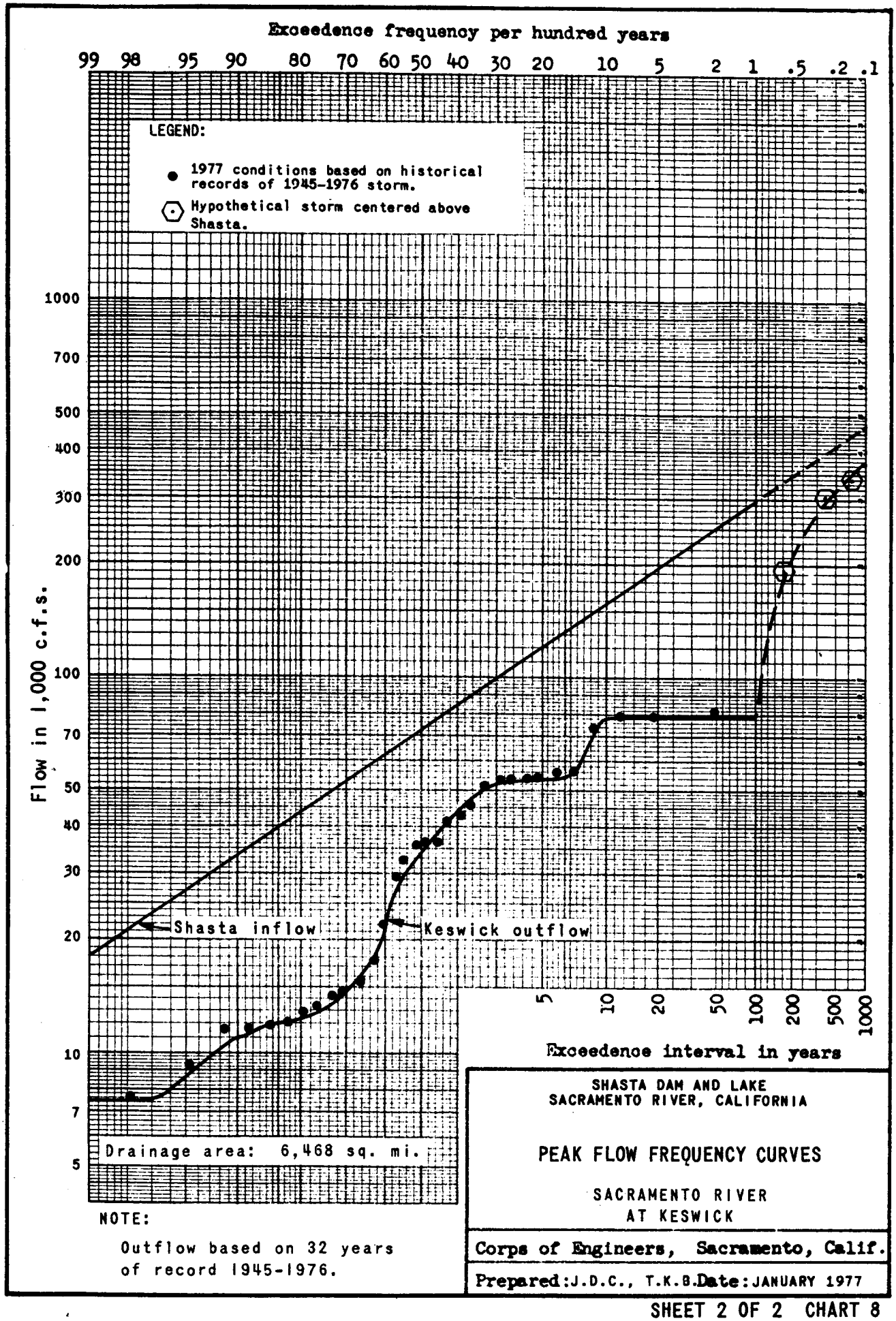
HISTORICAL INFLOWS
TO
SHASTA LAKE

Runoff in 1,000 acre-feet

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1945	223.0	378.2	497.4	389.7	913.9	510.9	471.1	498.7	344.1	228.9	206.1	195.9	4857.9
1946	282.0	474.1	1323.7	776.7	423.2	597.0	593.9	465.3	286.5	250.9	228.6	202.9	5904.8
1947	213.6	294.5	306.4	233.2	436.8	716.3	448.8	271.8	374.9	223.2	199.9	188.0	3907.4
1948	289.7	237.8	237.2	742.4	270.6	530.7	1132.4	799.6	511.4	252.9	205.1	206.3	5416.1
1949	214.8	239.5	267.0	218.0	371.5	1141.3	611.5	499.8	247.9	196.2	186.8	173.2	4367.5
1950	190.7	206.5	206.3	477.3	576.7	651.8	616.3	408.3	239.7	195.2	185.6	179.2	4133.6
1951	529.2	593.7	954.5	731.0	983.0	663.1	503.2	501.9	263.7	206.8	198.7	186.7	6315.5
1952	237.2	387.9	1060.7	748.2	1140.4	923.1	1301.4	826.9	399.2	301.0	231.9	228.1	7786.0
1953	237.7	236.1	639.2	1677.4	496.9	663.3	629.4	664.9	538.3	295.6	232.7	229.2	6540.7
1954	246.7	393.3	349.5	951.5	1055.5	959.5	1035.9	479.7	324.7	256.5	252.4	234.5	6539.7
1955	241.4	349.8	502.1	338.9	328.8	375.8	574.3	507.0	270.2	219.0	198.2	206.9	4112.1
1956	205.7	293.4	1869.7	1758.1	1208.7	888.5	734.9	729.9	383.6	278.6	247.5	232.8	8831.4
1957	288.4	259.7	262.4	312.2	854.6	1001.9	615.4	705.3	333.2	256.0	223.1	256.6	5368.8
1958	394.3	377.1	634.4	888.4	2480.4	1319.2	1394.9	800.9	523.2	344.6	281.2	260.9	9699.5
1959	279.1	259.6	289.4	951.8	839.8	609.5	510.9	369.0	269.2	234.3	211.6	262.0	5086.2
1960	232.6	224.1	246.1	401.9	874.1	873.5	473.9	453.1	319.6	223.5	208.2	202.4	4733.0
1961	227.0	318.6	640.3	404.4	861.9	718.3	501.4	472.2	305.4	220.2	206.5	196.7	5072.9
1962	221.6	332.6	531.9	323.2	1252.6	698.5	594.6	422.0	282.2	207.7	205.3	189.0	5261.2
1963	658.9	312.6	633.8	386.4	908.2	658.9	1631.9	751.7	343.8	267.2	231.1	217.8	7002.3
1964	256.5	487.6	298.1	595.3	354.7	355.9	364.0	300.5	317.5	201.2	187.1	187.0	3905.4
1965	211.7	322.2	1611.6	1339.7	583.3	443.8	1002.1	485.1	284.3	258.5	226.8	214.3	6983.4
1966	229.2	500.3	344.5	718.6	604.5	890.7	712.1	395.3	263.4	227.0	207.8	205.9	5299.3
1967	212.8	540.5	901.8	738.3	749.5	1005.1	998.1	932.5	530.5	299.0	262.5	233.1	7403.7
1968	266.1	252.6	317.9	414.4	1036.8	745.6	444.4	365.1	251.1	216.7	234.4	226.8	4771.9
1969	253.6	279.1	529.7	1426.3	1228.6	870.7	1090.3	813.8	405.2	278.7	235.2	255.8	7667.0
1970	271.5	264.3	938.0	2924.9	863.7	813.2	439.6	375.5	301.9	246.7	239.5	222.5	7901.3
1971	265.5	654.2	987.1	1027.7	558.5	1046.7	833.7	712.2	492.4	293.6	227.8	227.9	7327.3
1972	280.4	285.9	371.5	548.0	559.1	948.4	700.6	397.5	286.9	236.0	234.0	229.3	5077.6
1973	285.8	438.5	509.4	1029.0	1038.5	899.3	552.8	477.9	270.6	236.2	212.8	215.7	6166.5
1974	311.9	1577.3	1183.1	2099.1	695.4	1777.9	1198.4	666.1	413.8	325.6	277.1	270.6	10796.3
MEAN	275.3	392.4	648.2	852.4	818.3	809.9	757.1	551.6	345.9	249.3	222.9	217.9	6141.2

Chart 7


Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
Based on 51 years of record 1926-1976. Curves based on "Equivalent Years" derived from correlation with Red Bluff flows and expected probability.
STATISTICS OF COMPUTED CURVES
PEAK 1-DAY 3-DAY 10-DAY 30-DAY
Mean (Log) 4.863 4.759 4.647 4.519 4.390
Std. Dev .253 .245 .237 .228 .219
Adop. Skew 0 0 -0.1 -0.2 -0.3
Equiv. Years 74 80 80 80 80
LEGEND:
Peak
1-Day
3-Day
10-Day
30-Day
Flow in 1,000 C.F.S.
1000
700
500
400
300
200
100
70
50
40
30
20
10
7
5
Peak
1-Day
3-Day
10-Day
30-Day
5 10 20 50 100 200 500
Exceedence interval in years
Drainage area: 6421 sq. mi.
NOTE:
For clarity between 20 and 80 times per hundred every 3rd point was plotted.
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA
RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER
AT SHASTA DAM
Corps of Engineers, Sacramento, Calif.
Prepared: J.D.C., T.K.B. Date: JANUARY 1977



NOTE:

Outflow based on 32 years of record 1945-1976.

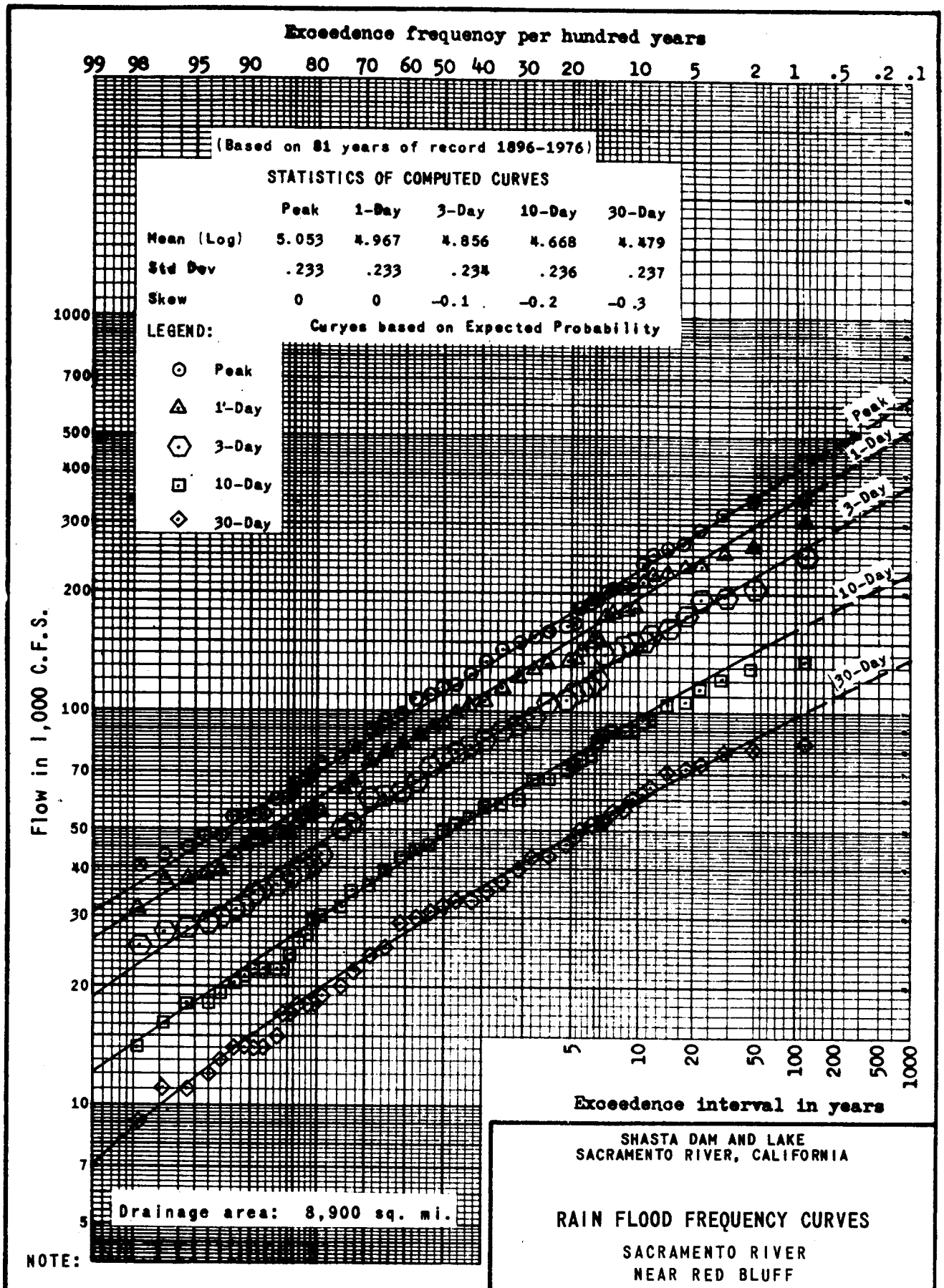
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

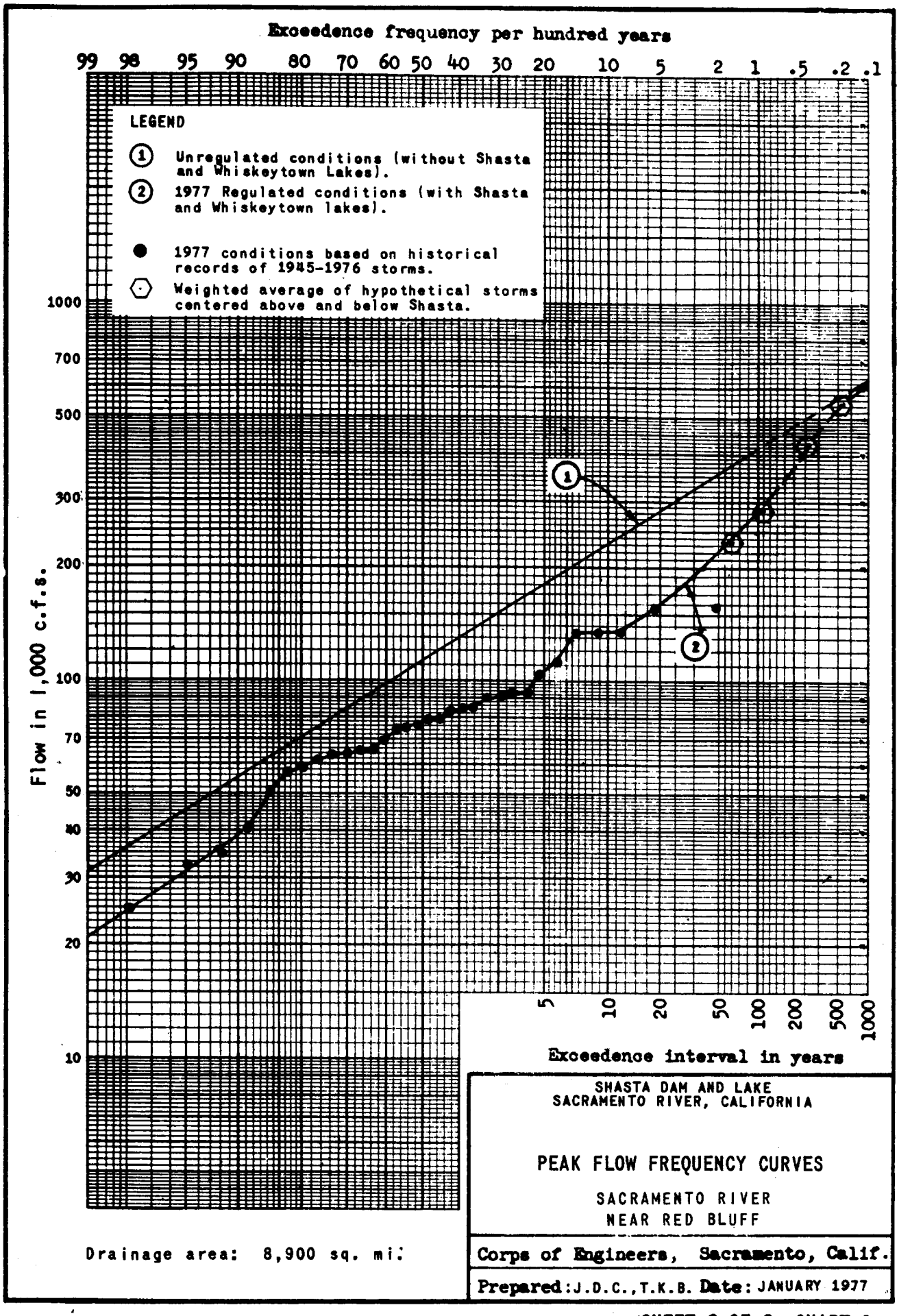
PEAK FLOW FREQUENCY CURVES

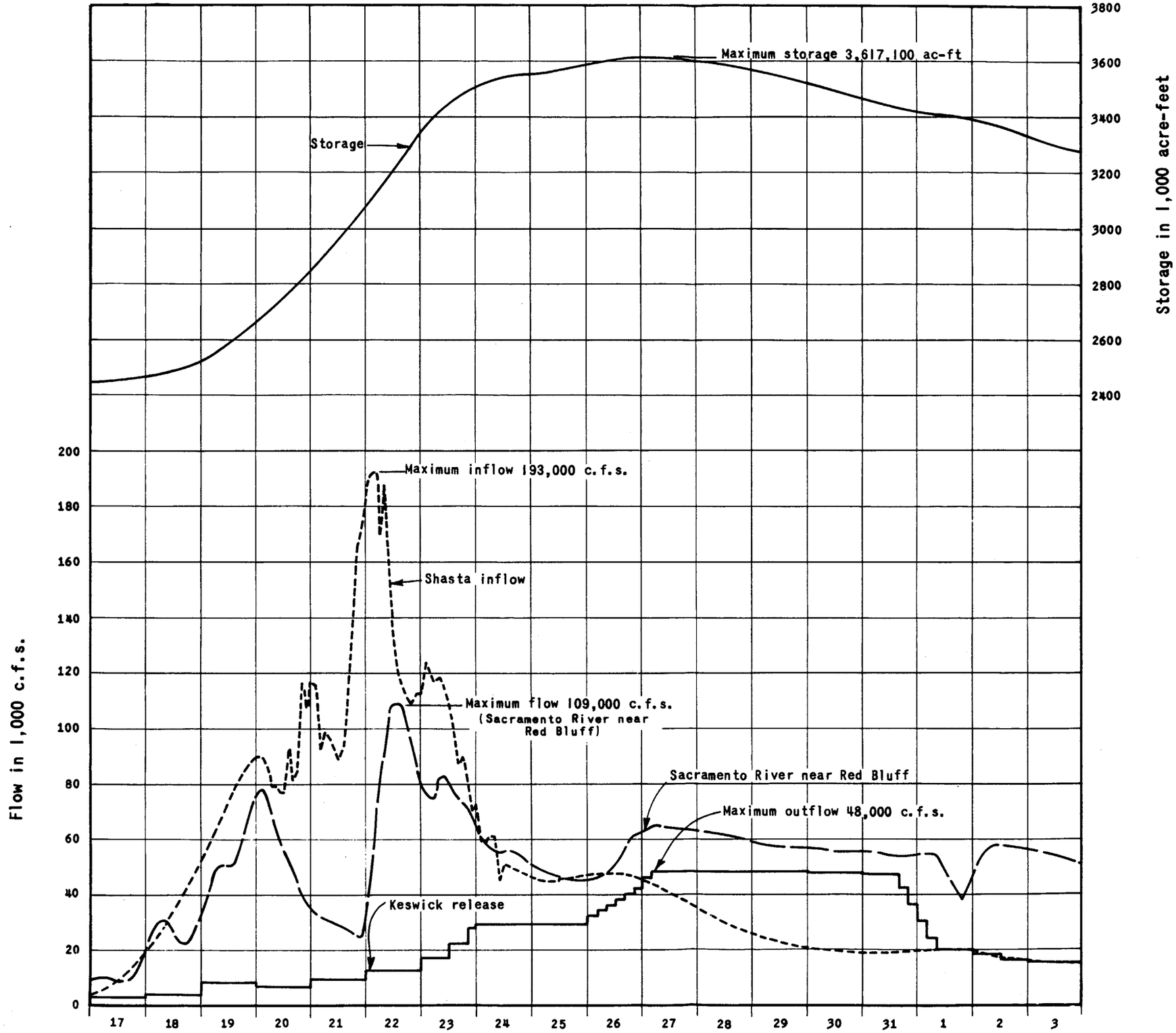
SACRAMENTO RIVER
AT KESWICK

Corps of Engineers, Sacramento, Calif.

Prepared: J.D.C., T.K.B. Date: JANUARY 1977


Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
(Based on 81 years of record 1896-1976)
STATISTICS OF COMPUTED CURVES
Peak 1-Day 3-Day 10-Day 30-Day
Mean (Log) 5.053 4.967 4.856 4.668 4.479
Std Dev .233 .233 .234 .236 .237
Skew 0 0 -0.1 -0.2 -0.3
LEGEND:
Curves based on Expected Probability
Peak
1-Day
3-Day
10-Day
30-Day
Flow in 1,000 C.F.S.
1000
700
500
400
300
200
100
70
50
40
30
20
10
7
5
Peak
1-Day
3-Day
10-Day
30-Day
5 10 20 50 100 200 500 1000
Exceedence interval in years
Drainage area: 8,900 sq. mi.
NOTE:
For clarity between 20 and 80 times per hundred every 3rd point was plotted.
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA
RAIN FLOOD FREQUENCY CURVES
SACRAMENTO RIVER
NEAR RED BLUFF
Corps of Engineers, Sacramento, Calif.
Prepared: J.D.C., T.K.B. Date: JANUARY 1977


Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
LEGEND
1 Unregulated conditions (without Shasta and Whiskeytown Lakes).
2 1977 Regulated conditions (with Shasta and Whiskeytown lakes).
1977 conditions based on historical records of 1945-1976 storms.
Weighted average of hypothetical storms centered above and below Shasta.
Flow in 1,000 c.f.s.
1000
700
500
300
200
100
70
50
40
30
20
10
5 10 20 50 100 200 500 1000
Exceedence interval in years
Drainage area: 8,900 sq. mi.
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA
PEAK FLOW FREQUENCY CURVES
SACRAMENTO RIVER
NEAR RED BLUFF
Corps of Engineers, Sacramento, Calif.
Prepared: J.D.C., T.K.B. Date: JANUARY 1977



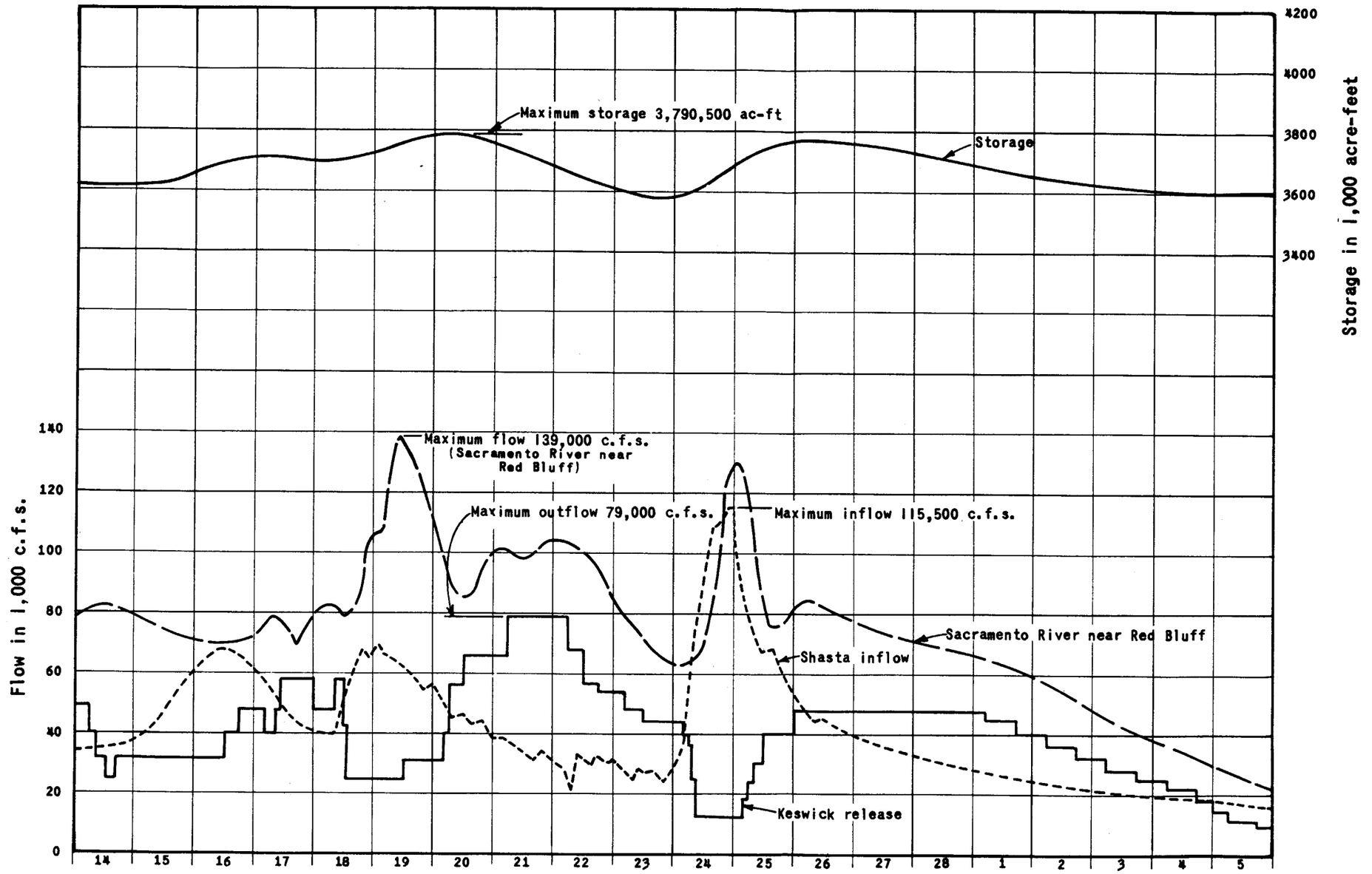
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL FLOOD
ROUTING 1955

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: JANUARY 1976

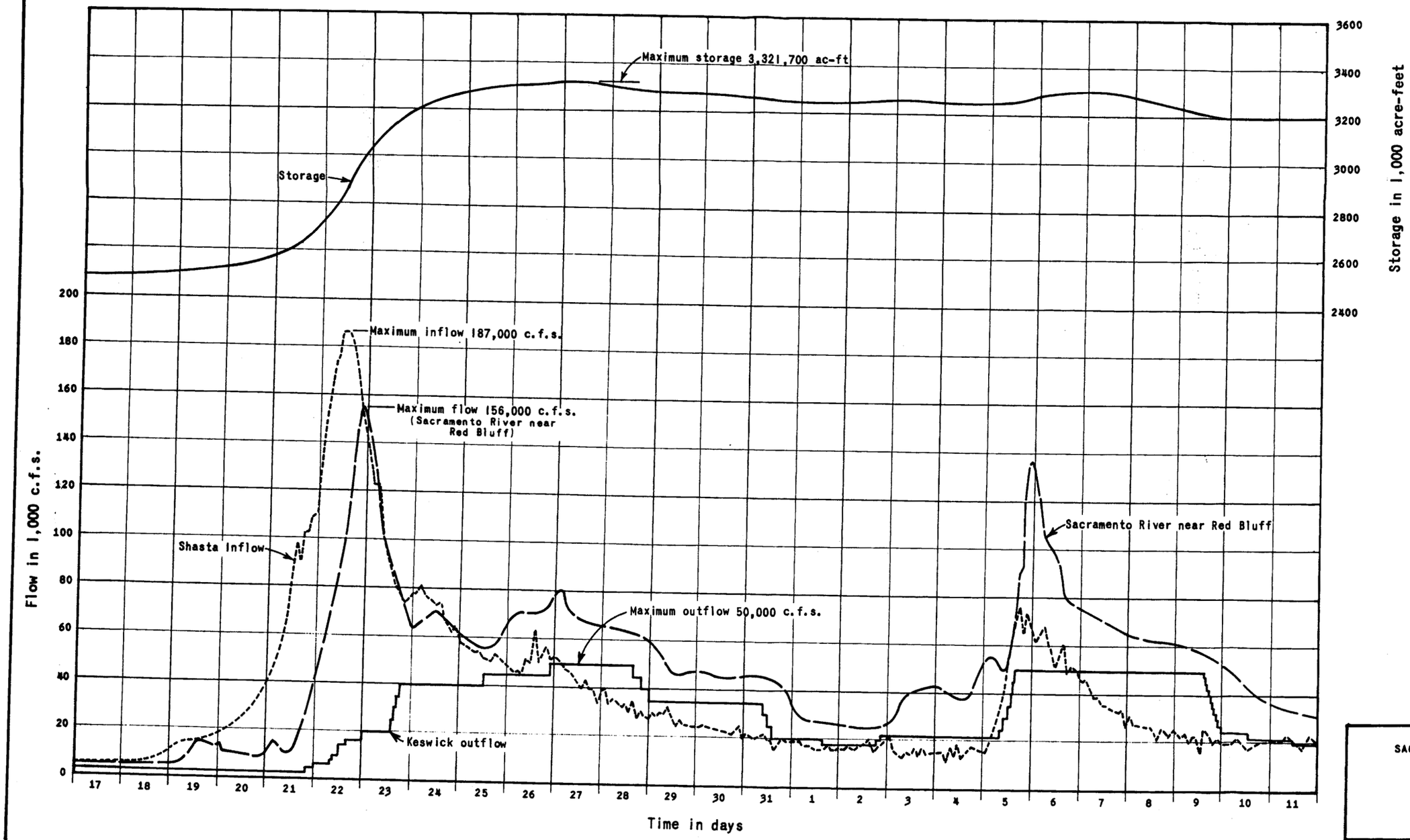


SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL FLOOD
ROUTING 1958

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.
Date: JANUARY 1976



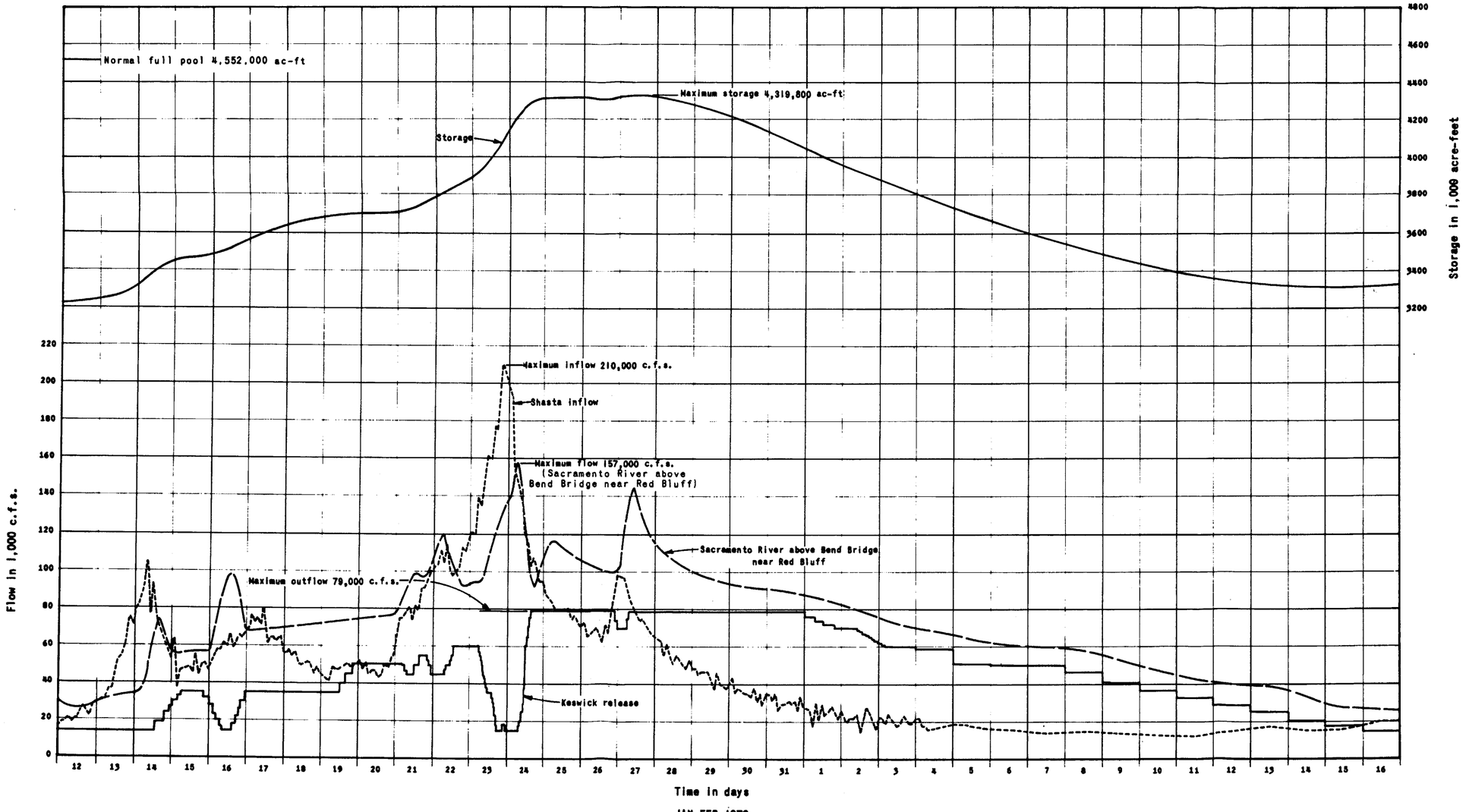
DEC 1964-JAN 1965

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL FLOOD ROUTING 1964-1965

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.
Date: JANUARY 1976



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

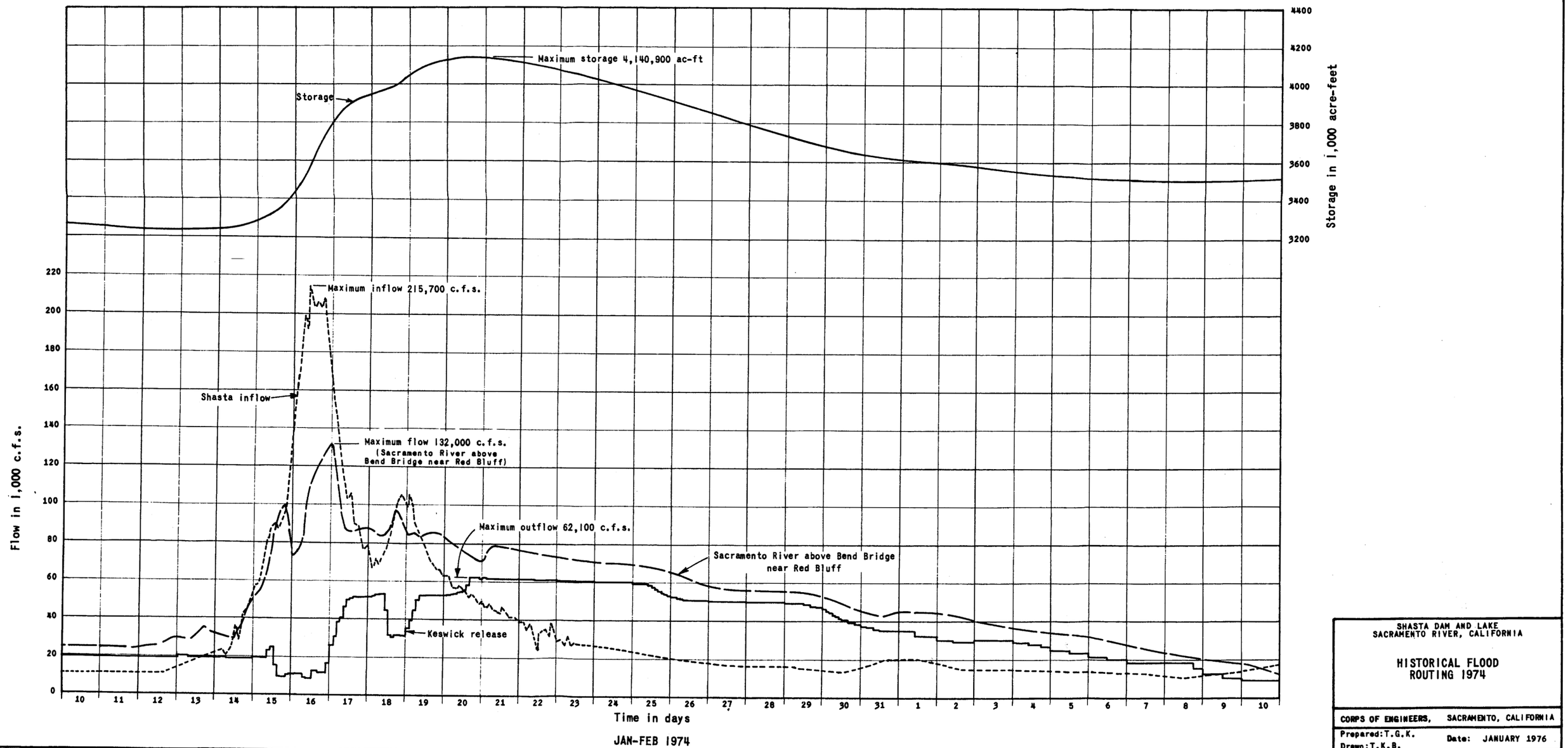
HISTORICAL FLOOD
ROUTING 1970

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: T.G.K. Date: JANUARY 1976

Drawn: T.K.B.

SHEET 4 OF 5 CHART 10



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

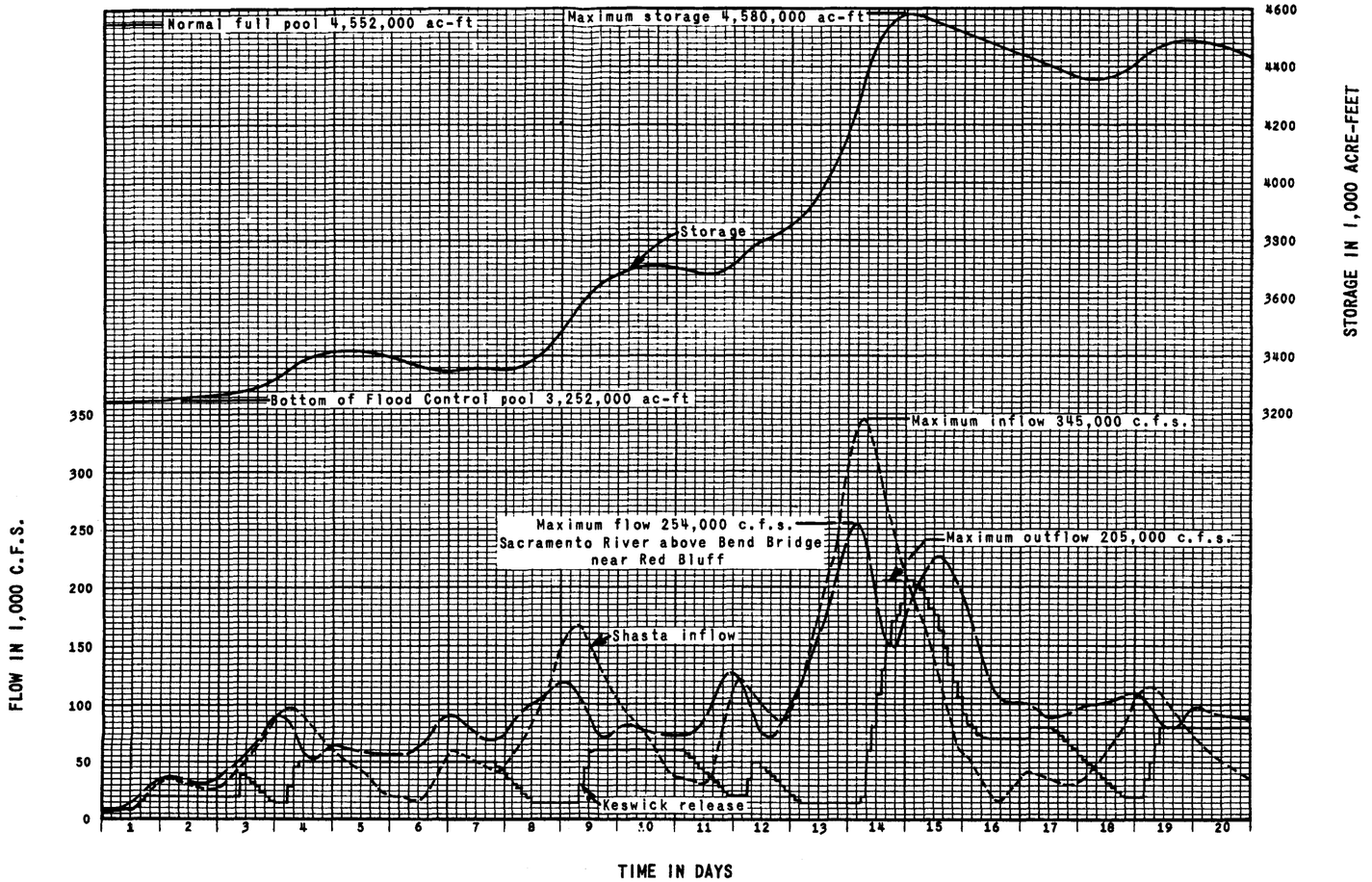
HISTORICAL FLOOD
ROUTING 1974

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: JANUARY 1976

SHEET 5 OF 5 CHART 10



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

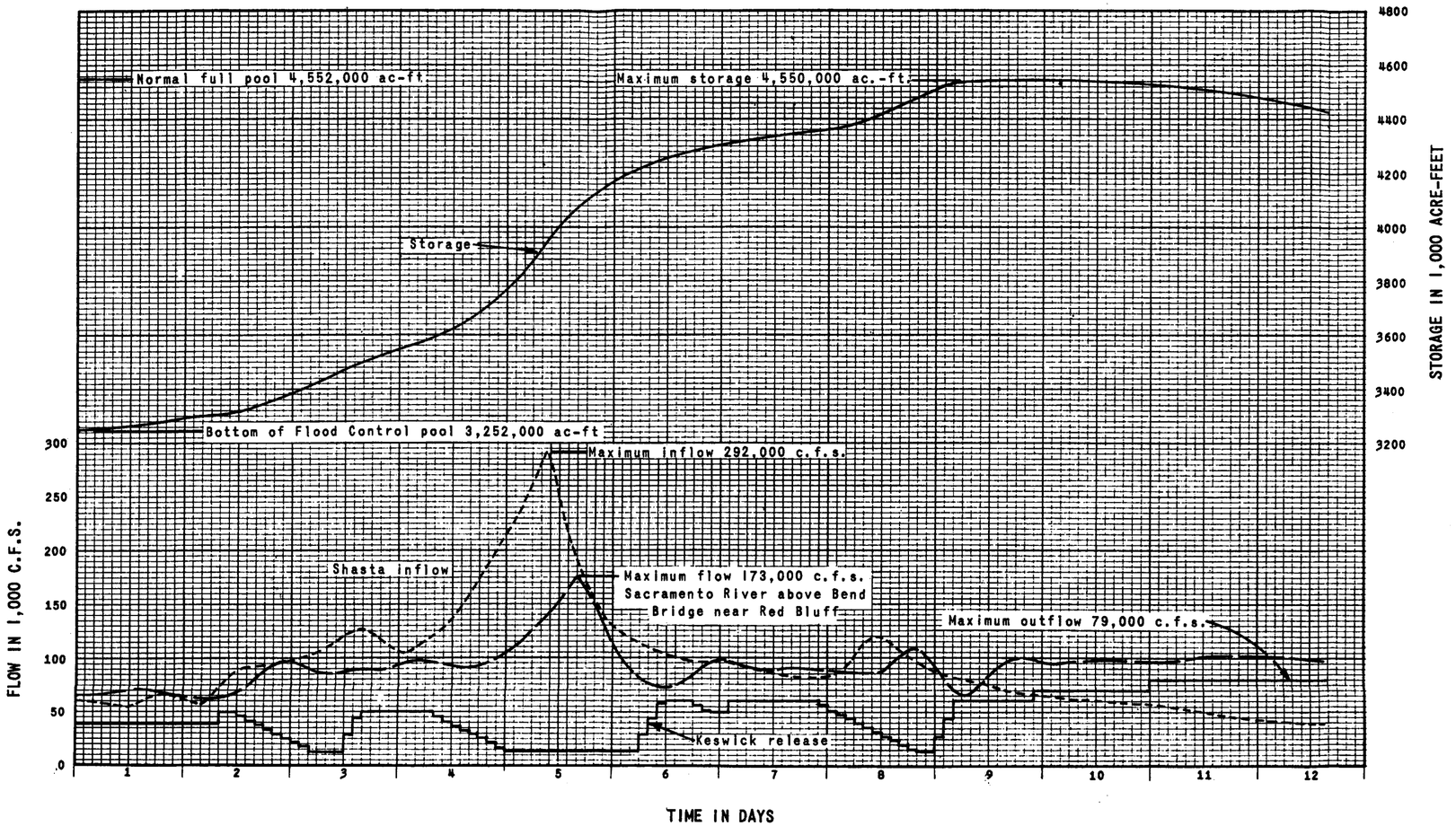
SPF ROUTING

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: MAY 1976

CHART 11



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

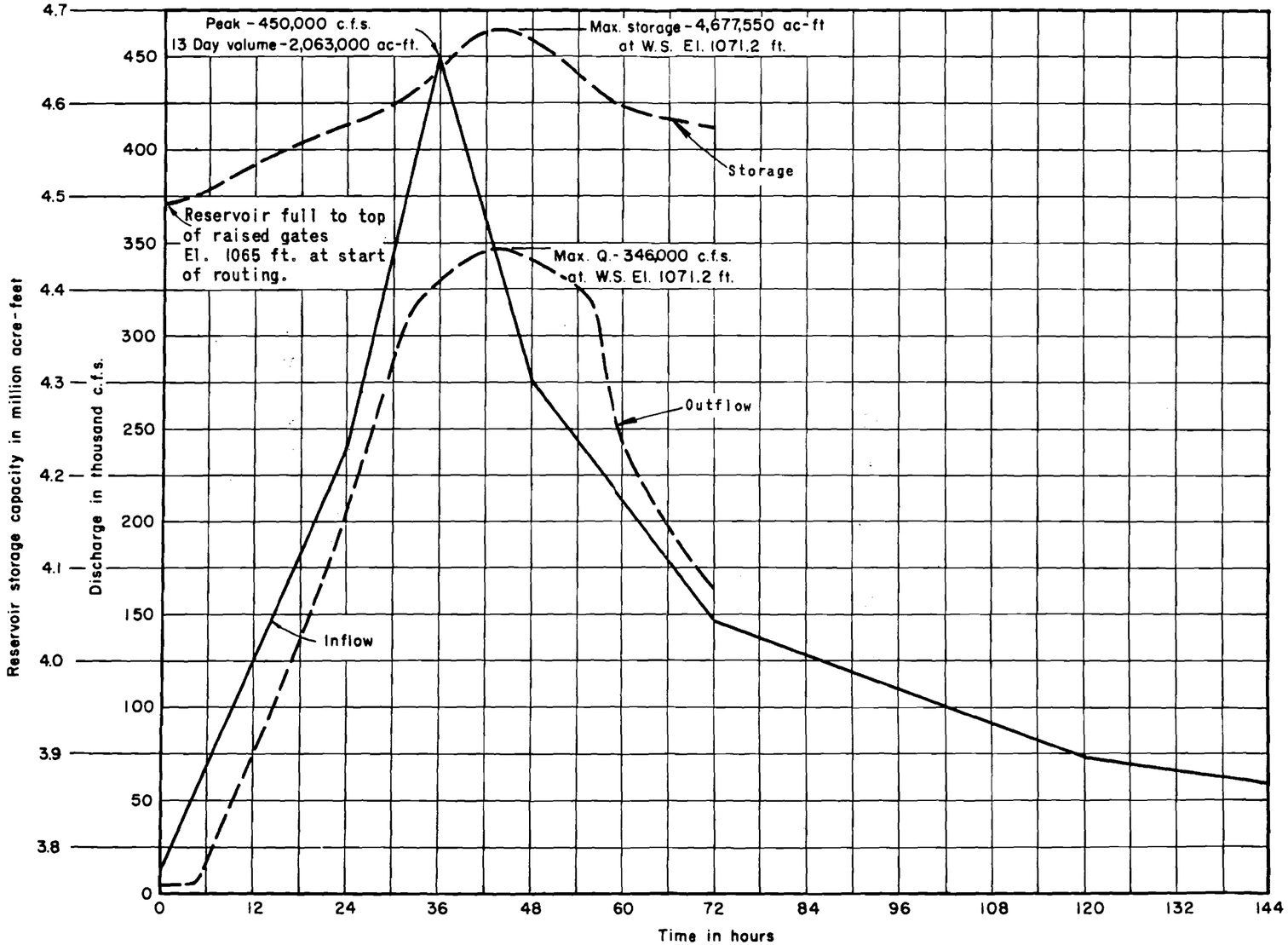
100-YEAR
FLOOD ROUTING

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: JANUARY 1977

CHART 12



NOTES:

The flood was routed in accordance with criteria shown on the Emergency Spillway Release Diagram, Chart A-9.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

SPILLWAY DESIGN FLOOD ROUTING

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.
Drawn: T.K.B.

Date: FEBRUARY 1976

CHART 14

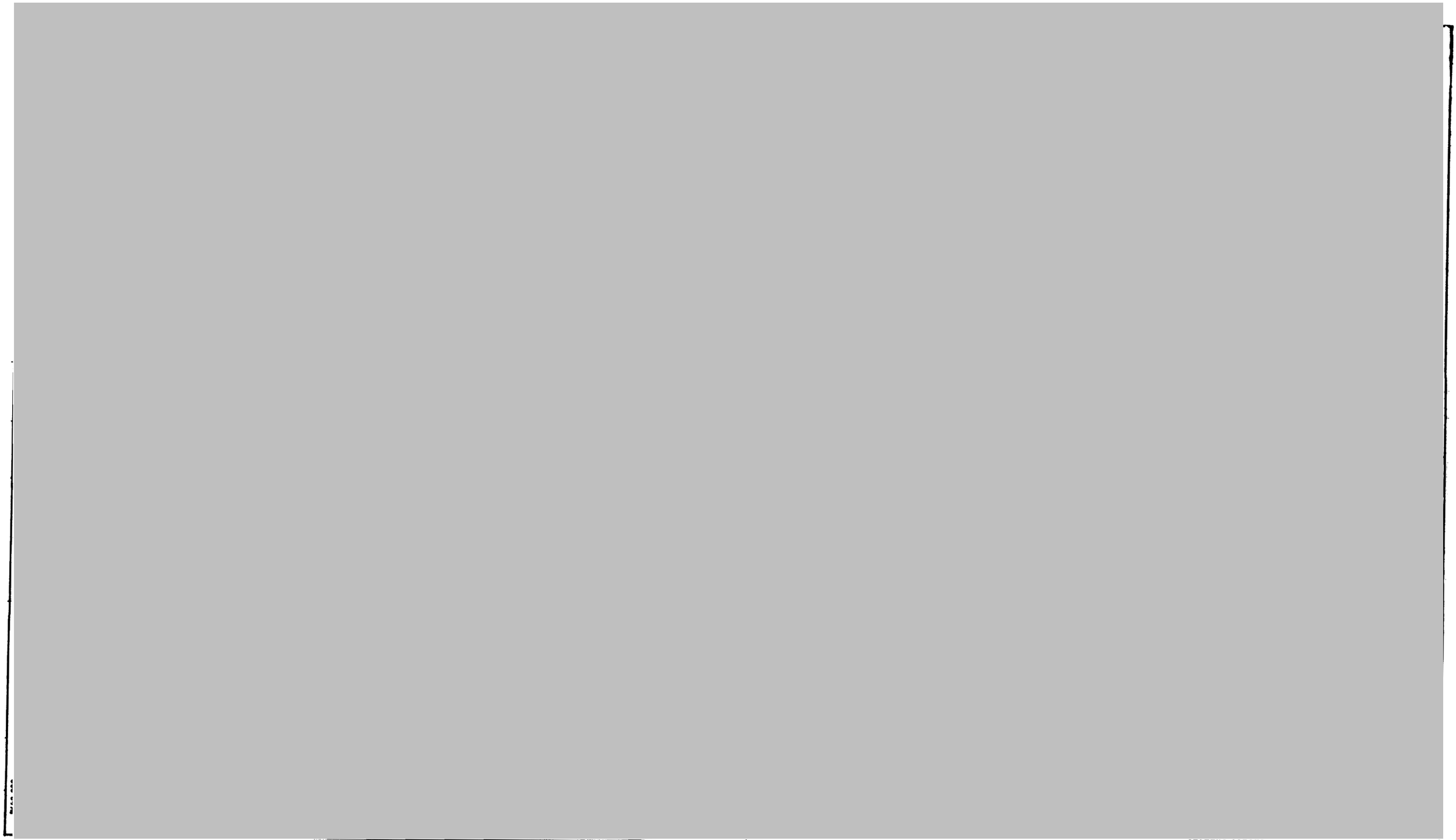
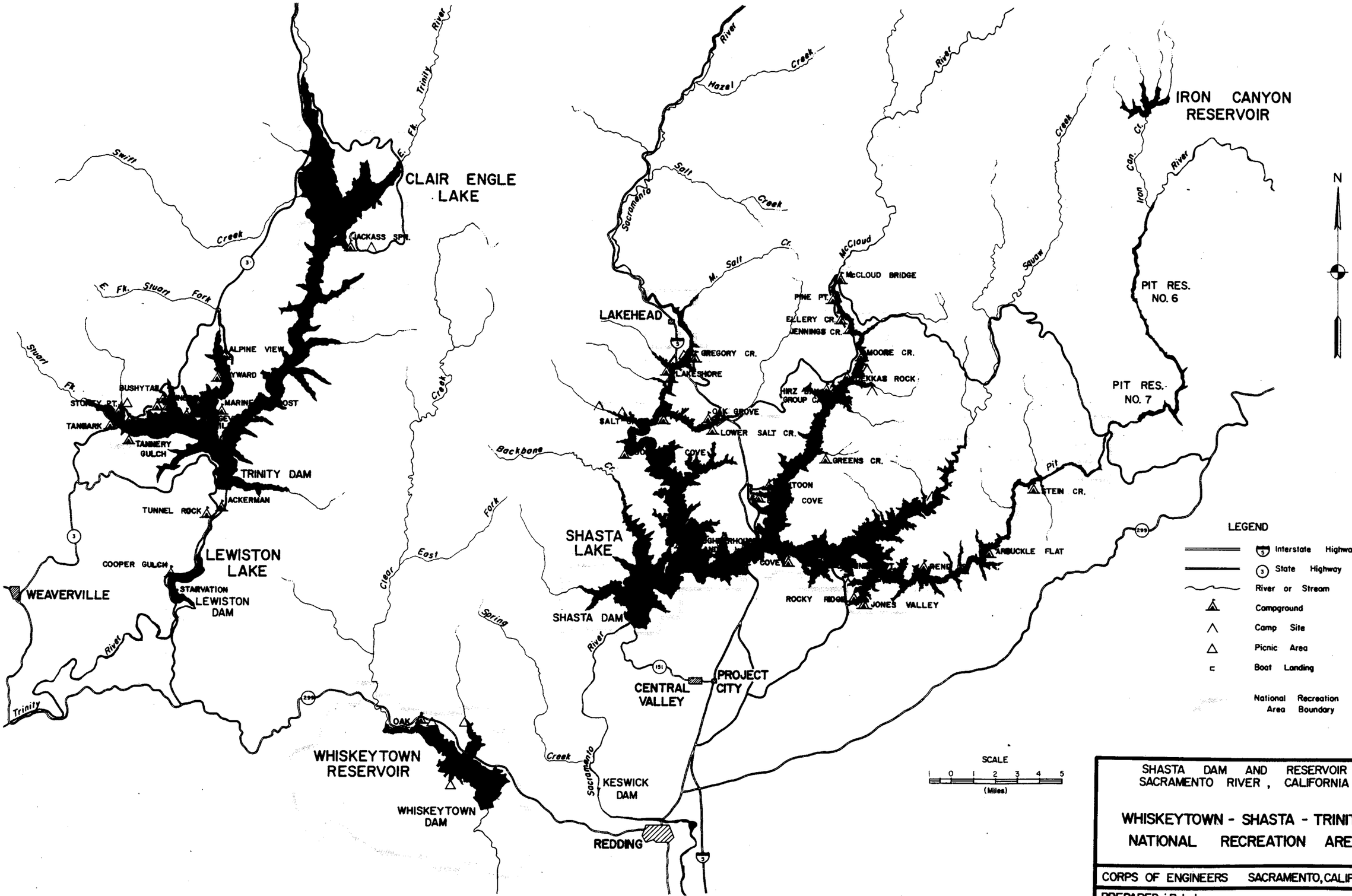


CHART 16



SHASTA DAM AND RESERVOIR
SACRAMENTO RIVER, CALIFORNIA

WHISKEYTOWN - SHASTA - TRINITY NATIONAL RECREATION AREA

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

PREPARED : R. L. L.
DRAWN : T. K. B.

DATE : SEPTEMBER 1975

CHART 17

MONTHLY REQUIRED FLOOD CONTROL SPACE
SHASTA LAKE

JANUARY 1976

Water Year	Flood Control Space in thousand acre-feet at end of month											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	660.7	1300.0	1184.5	723.9	509.8	221.7	0.0	0.0	0.0	0.0	0.0	0.0
1923			1183.1	737.9	309.5	0.0	0.0					
1924			1181.8	723.9	295.5	0.0	0.0					
1925			1181.8	732.8	847.2	119.3	0.0					
1926			1181.8	723.9	569.5	0.0	0.0					
1927			1204.9	883.9	1089.8	410.5	0.0					
1928			1189.0	790.6	452.8	587.1	0.0					
1929			1181.8	723.9	295.5	0.0	0.0					
1930			1203.8	770.2	497.9	102.3	0.0					
1931			1181.8	723.9	295.5	0.0	0.0					
1932			1192.6	734.4	300.9	113.2	0.0					
1933			1181.8	723.9	295.5	242.4	0.0					
1934			1184.1	737.7	460.7	0.0	0.0					
1935			1181.8	763.5	429.0	70.1	61.4					
1936			1181.8	854.4	964.3	142.1	0.0					
1937			1181.8	723.9	295.5	273.1	0.0					
1938			1241.6	883.8	992.1	1135.6	494.3					
1939			1181.8	723.9	295.5	57.4	0.0					
1940			1181.8	922.7	1300.0	1117.3	18.1					
1941			1259.1	1235.4	1129.2	612.4	95.5					
1942			1235.5	1162.6	1036.0	192.4	0.0					
1943			1195.6	1010.7	703.8	434.0	0.0					
1944			1181.8	723.9	354.8	0.0	0.0					
1945			1199.6	760.7	603.5	97.5	0.0					
1946			1286.7	930.0	479.4	99.1	0.0					
1947			1181.8	723.9	363.5	114.4	0.0					
1948			1181.8	799.6	298.5	73.4	129.9					
1949			1181.8	723.9	358.2	481.4	0.0					
1950			1181.8	789.0	498.5	186.0	0.0					
1951			1229.6	928.3	757.6	200.5	0.0					
1952			1246.2	948.5	812.7	530.4	261.6					
1953			1206.8	1186.2	591.6	228.3	0.0					
1954			1187.8	999.8	890.8	446.2	5.7					
1955			1192.4	738.6	317.5	0.0	0.0					
1956			1300.0	1300.0	1263.6	537.6	0.0					
1957			1181.8	723.9	876.7	422.8	0.0					
1958			1214.2	1021.4	1300.0	1135.6	379.4					
1959			1181.8	903.9	775.3	174.1	0.0					
1960			1181.8	769.0	557.6	279.2	0.0					
1961			1201.7	801.3	637.6	272.2	0.0					
1962			1195.6	733.3	877.1	260.1	0.0					
1963			1202.8	788.0	608.4	325.8	415.0					
1964			1186.4	847.4	358.0	0.0	0.0					
1965			1300.0	1183.5	639.1	5.2	51.8					
1966			1193.4	826.9	514.8	322.9	0.0					
1967			1217.4	1001.2	632.3	519.4	73.2					
1968			1181.8	759.9	898.4	303.6	0.0					
1969			1198.1	1193.6	1072.2	521.9	117.8					
1970			1235.3	1300.0	1120.7	380.0	0.0					
1971			1233.1	1036.9	585.5	678.8	0.0					
1972			1186.7	838.0	572.8	302.6	0.0					
1973			1206.1	999.6	916.4	390.0	0.0					
1974	660.7	1300.0	1285.1	1300.0	858.1	1135.6	262.9	0.0	0.0	0.0	0.0	0.0

CHART 18

PRINCIPAL EXISTING AND PROPOSED RESERVOIRS
SACRAMENTO RIVER BASIN, CALIFORNIA

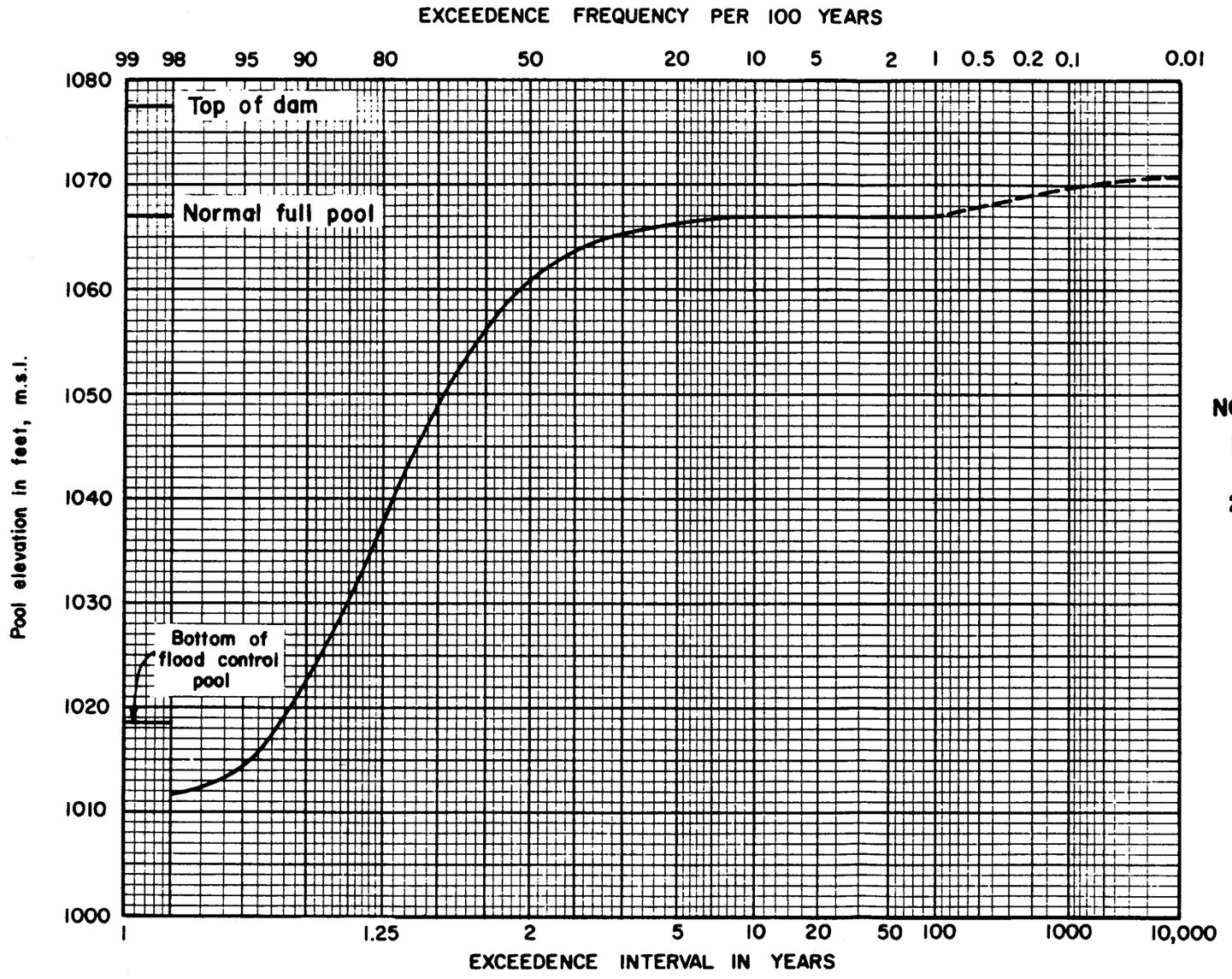
NO.	GENERAL FEATURES								
	COUNTY	NAME OF DAM OR RESERVOIR	STREAM	TRIB AREA (sq mi)	PURPOSE*	OPERATING AGENCY	COMPL DATE (year)	STORAGE CAPACITY (ac-ft)	FC STOR ALLOC (ac-ft)
1	MODOC	McBRIEN	PIT RIVER	1,087	I,D	AMANDA HAGGE	1880	1,000	-
2	MODOC	DANHAUSER	TRIB SFK PIT RIVER	2	I	JOHN AND WARREN WEBER	1890	1,258	-
3	MODOC	TORESON	TOMS CREEK	18	I	ROBERT C. MONROE ET AL	1898	1,140	-
4	LASSEN	TULE LAKE	CEDAR CREEK	82	I,R	OCCIDENTAL PETROL LAND AND DEV CORP	1904	39,500	-
5	MODOC	ROBERTS	TRIB PIT RIVER	23	I	BIG VALLEY MUTUAL W. CO	1905	5,500	-
6	LASSEN	SPOONER	TRIB ASH CREEK	7	I,D	OCCIDENTAL PETROL LAND AND DEV CORP	1906	3,123	-
7	MODOC	C	TRIB CLOVER SWALE	10	I	NATL DRILLING CO. INC.	1911	2,082	-
8	MODOC	BIG DOBE NORTH	TRIB RATTLESNAKE CR	17	I	ROBERT L SCHLUTER	1912	6,530	-
9	MODOC	BIG DOBE SOUTH	TRIB RATTLESNAKE CR	28	I	ROBERT L SCHLUTER	1912	3,860	-
10	MODOC	GRAVEN	TRIB CANYON CREEK	1	I	HERBERT E BELL JR	1917	1,100	-
11	MODOC	SX	TRIB PIT RIVER	12	I	PELISSA AND HALE	1917	4,225	-
12	MODOC	DUNCAN	TRIB PIT RIVER	11	I,D	F R BACON JR	1919	2,575	-
13	MODOC	BIG SAGE	RATTLESNAKE CREEK	107	I	HOT SPRINGS VALLEY ID	1921	77,000	-
14	MODOC	HUFFMAN ANTELOPE	CLOVER SWALE	36	I	PELISSA AND HALE	1922	1,550	-
15	SHASTA	PIT NO. 3	PIT RIVER	4,747	P	PG&E CO.	1925	40,600	-
16	MODOC	LITTLE JUNIPER	LITTLE JUNIPER CREEK	9	I	HERBERT E BELL JR	1926	1,370	-
17	LASSEN	SILVA FLAT	JUNIPER CREEK	16	I	H W KILLERBREW	1926	3,900	-
18	LASSEN	PIT NO. 4	PIT RIVER	4,747	P	PG&E CO.	1927	2,000	-
19	MODOC	PAYNE	TRIB S FK PIT RIVER	5	I	CHARLES E MASSAE	1928	2,850	-
20	LASSEN	COYOTE FLAT	COYOTE CREEK	30	I	T E CONNOLLY	1928	5,250	-
21	MODOC	WEST VALLEY	WEST VALLEY CREEK	142	I	SOUTH FORK IRRIG DIST	1936	21,700	-
22	SHASTA	PIT NO. 5 COND EMBANK	SUGAR PINE CREEK	1	P	PG&E CO.	1943	1,147	-
23	SHASTA	PIT NO. 1 FOREBAY	FALL RIVER		P	PG&E CO.	1947	2,800	-
24	MODOC	TAYOR CREEK NO. 1	TAYOR CREEK	42	I,D	EAGLE BANNER RANCHES	1952	1,500	-
25	MODOC	DONOVAN	RYE GRASS SWALE	35	I	CALIFORNIA PINES RECREATIONAL EST INC.	1953	1,234	-
26	MODOC	BAYLES RESERVOIR	CROOKS CANYON	34	I,D	OCCIDENTAL PETROL LAND AND DEV CORP ET AL	1954	2,390	-
27	TRINITY	TRINITY	TRINITY RIVER **	688	I	BUREAU OF RECLAMATION	1960	2,448,000	-
28	SHASTA	WHISKEYTOWN	CLEAR CREEK	201	I,P,R	BUREAU OF RECLAMATION	1963	241,000	-
29	SHASTA	SPRING CREEK DEBRIS	SPRING CREEK	16	P,DEBRIS	BUREAU OF RECLAMATION	1963	5,874	-
30	TRINITY	LEWISTON	TRINITY RIVER **	713	I,P,R	BUREAU OF RECLAMATION	1963	14,600	-
31	SHASTA	HAYNES RESERVOIR	GOOSE CREEK	5	I,D	GOOSE VALLEY RANCH INC.	1965	5,870	-
32	SHASTA	IRON CANYON	CEDAR SALT LOG CR	11	P	PG&E CO.	1965	24,300	-
33	SHASTA	McCLOUD	McCLOUD RIVER	420	I	PG&E CO.	1965	35,300	-
34	SHASTA	PIT NO. 6	PIT RIVER	5,020	I,P	PG&E CO.	1965	15,700	-
35	SHASTA	PIT NO. 7	PIT RIVER	5,170	I,P	PG&E CO.	1965	34,000	-
36	LASSEN	IVERSON	TRIB JUNIPER CREEK	2	I	J R McARTHUR ET AL	1968	2,000	-
37	SISKIYOU	BOX CANYON	SACRAMENTO RIVER	126	I,R,F	SISKIYOU COUNTY FCWCD	1969	26,000	-
38	MODOC	CLOVERSWALE	TRIB WITCHER CREEK	5	I	ANDREW L AND VEOLA A PELISSA	UC	4,620	-

CHART 19

NOTES:

*SYMBOLS USED IN PURPOSE COLUMN ARE AS FOLLOWS:
I - IRRIGATION P - POWER F - FISH FLOW
R - RECREATION D - DOMESTIC USE DEBRIS - DEBRIS CONTROL

**ADJACENT BASIN TO WEST; SURPLUS WATER IMPORTED INTO SACRAMENTO RIVER BASIN FOR USE IN CENTRAL VALLEY BASIN.



NOTES:

1. Curve based on historical reservoir operation 1945 - 1975
2. Extension of curve above elevation 1067 feet estimated on basis of routings of hypothetical floods.

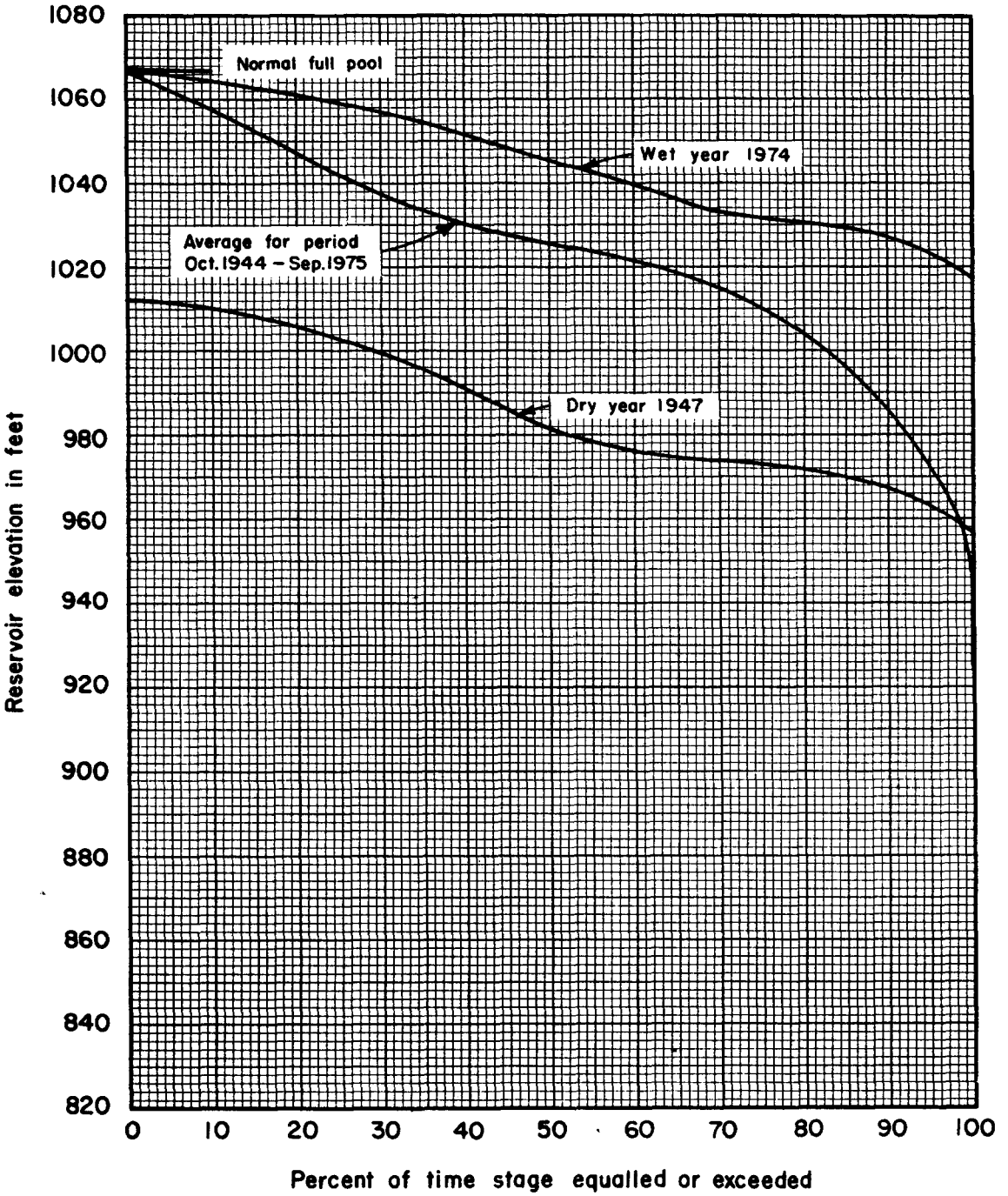
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

STAGE FREQUENCY CURVE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: J.J.S. Date: JANUARY 1976
Drawn: T.K.B.

CHART 20



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

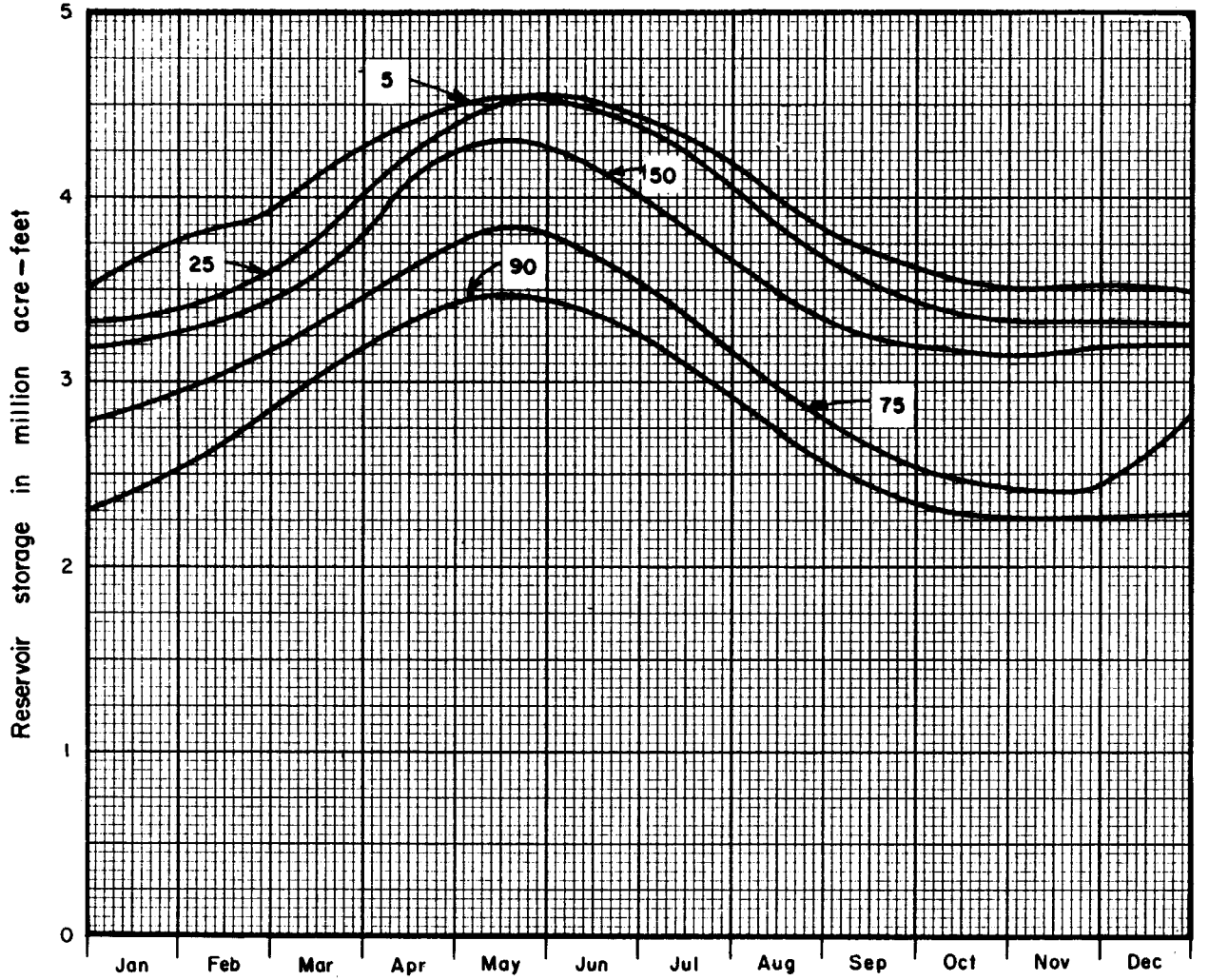
STAGE-DURATION CURVE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: J.J.S.
Drawn: T.K.B.

Date: JANUARY 1976

CHART 21



NOTE:

Indicated value is percentage of years that storage is exceeded on a given date based on total end of month storage for the years 1945-1974. Data abstracted from U.S.G.S. water supply papers.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

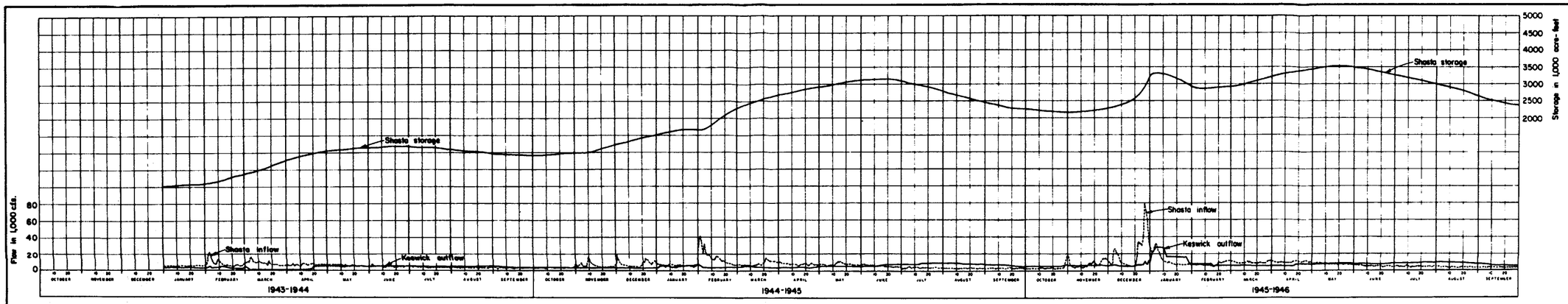
SEASONAL VARIATION OF RESERVOIR STORAGE FREQUENCY

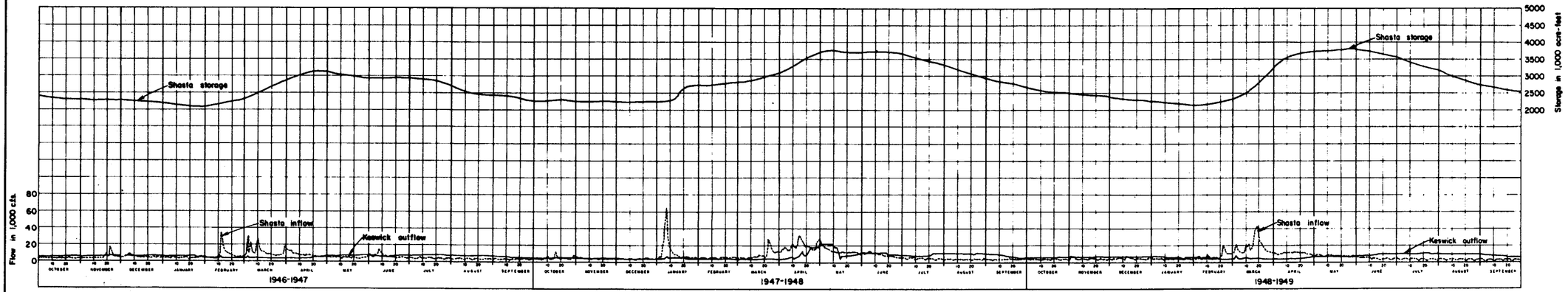
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

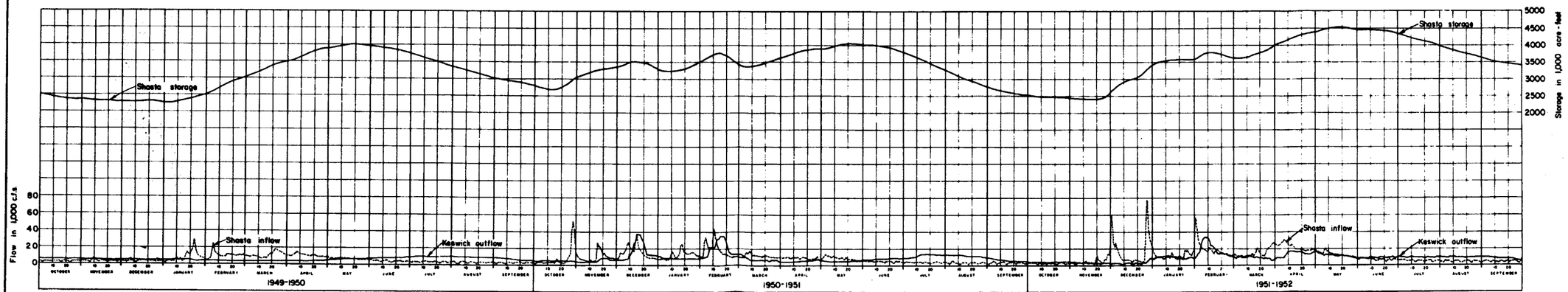
Prepared: R.L.L.
Drawn: T.K.B.

Date: JANUARY 1976

CHART 22





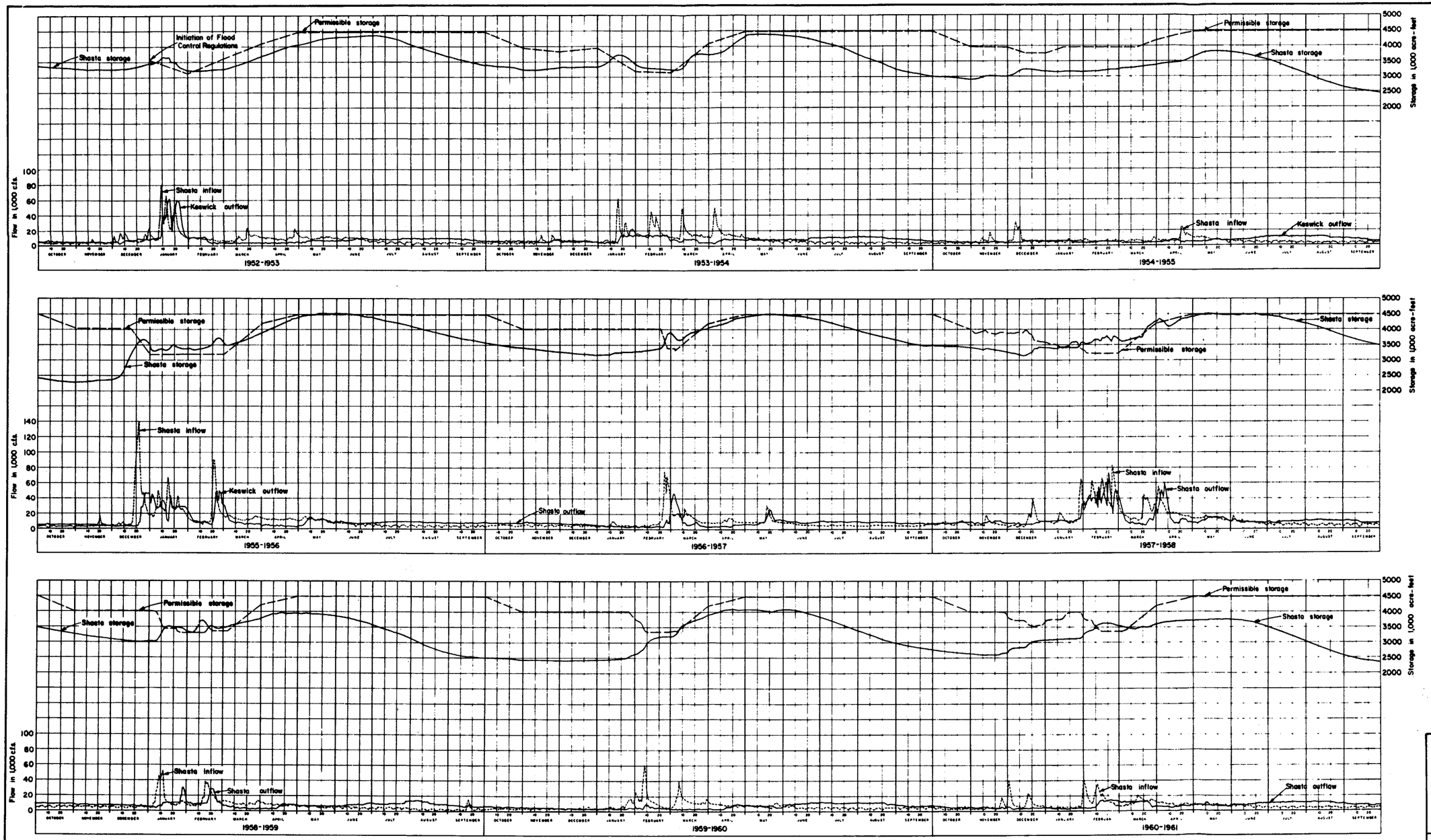


SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL OPERATIONS
SHASTA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared T.K.B.
Drawn T.K.B.
Date MARCH 1976

SHEET 1 OF 4 CHART 23

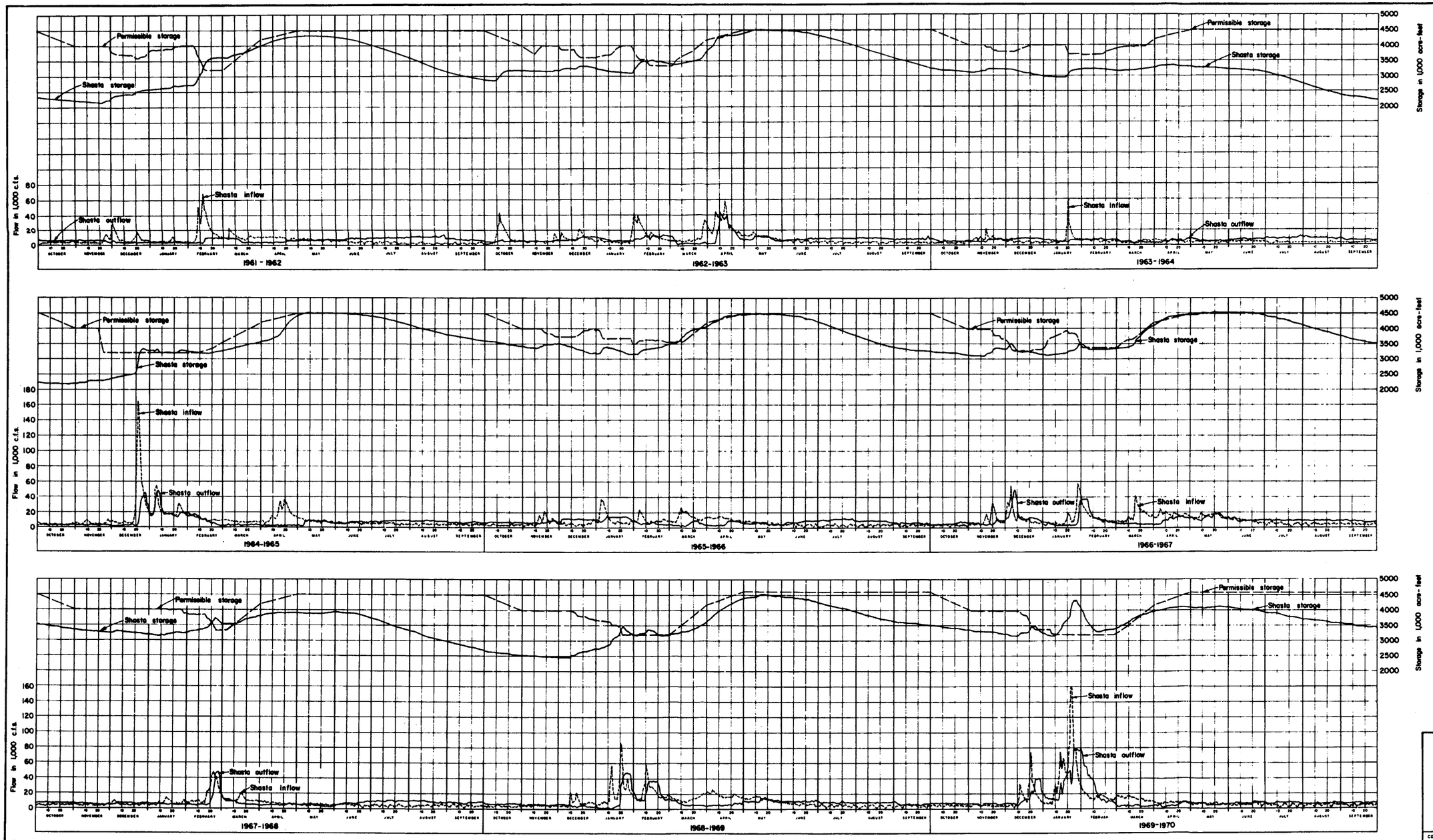


SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL OPERATIONS
SHASTA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared T.K.B. Date MARCH 1976
Drawn T.K.B.



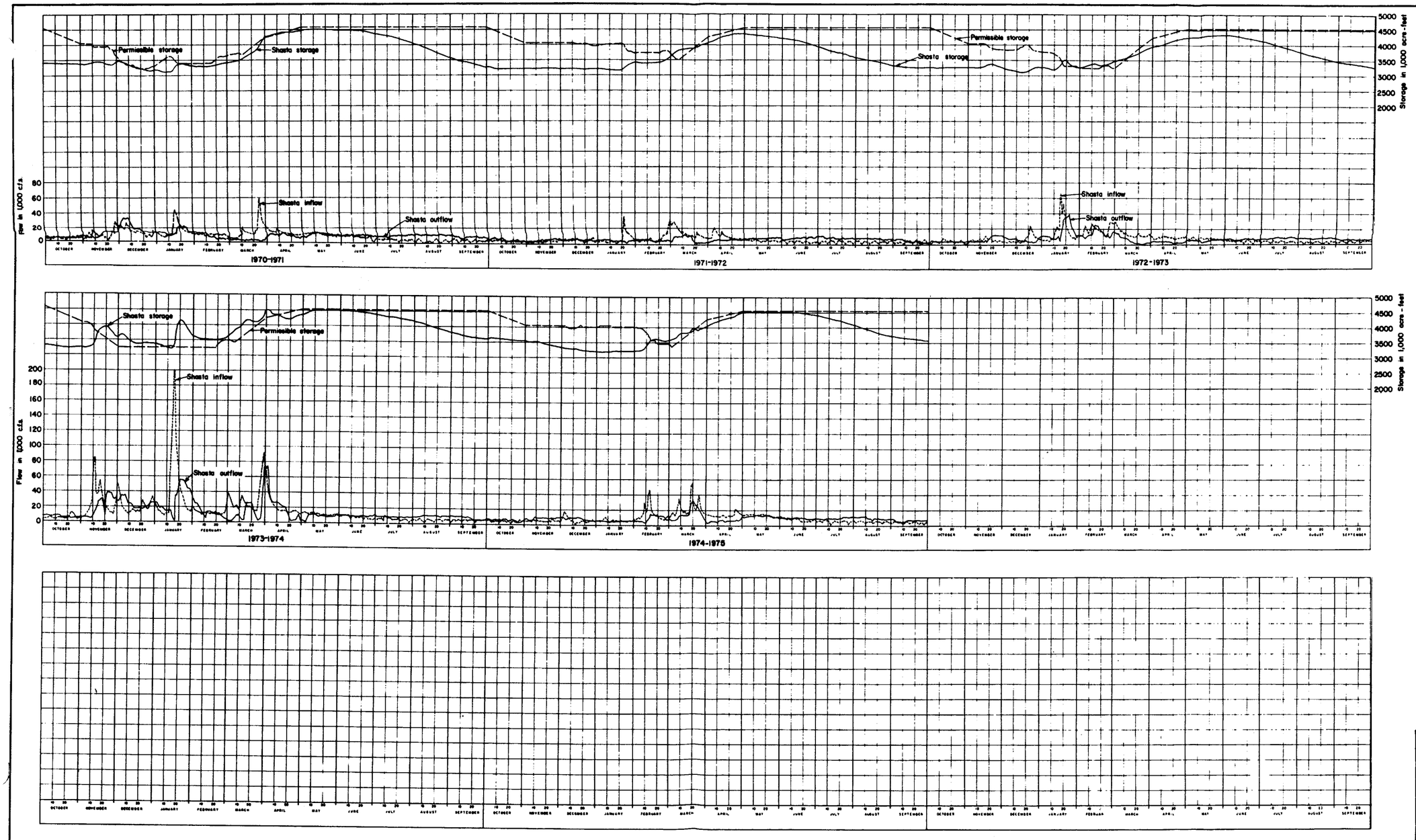
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL OPERATIONS
SHASTA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared T.K.B.
Drawn T.K.B.
Date MARCH 1976

SHEET 3 OF 4 CHART 23



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

HISTORICAL OPERATIONS
SHASTA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared R.L.L.
Drawn T.K.B.

Date MARCH 1976

SHEET 4 OF 4 CHART 23

APPENDIX A

STANDING OPERATING INSTRUCTIONS AND FLOOD CONTROL REGULATIONS FOR SHASTA DAM AND LAKE SACRAMENTO RIVER, CALIFORNIA

PART I - STANDING INSTRUCTIONS TO DAM TENDERS

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Code of Federal Regulations Title 33 Part 208.11
Field Working Agreement Central Valley Project Dams and Reservoirs

REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL SHASTA DAM AND LAKE SACRAMENTO RIVER, CALIFORNIA

APPENDIX A

STANDING INSTRUCTIONS TO DAMTENDERS AND FLOOD CONTROL REGULATIONS

1. GENERAL

a. This appendix to the "Report on Reservoir Regulation for Flood Control, Shasta Dam and Lake, Sacramento River, California," is prepared in accordance with instructions contained in EM 1110-2-3600, paragraph 4-07, (Standing Instructions to Damtenders) and pertains to duties and responsibilities of the damtender in connection with the functional operation of Shasta Dam and Lake, and the reporting of required hydrologic data.

b. Operational instructions to the damtender are briefly outlined with specific emphasis on the damtender's duties and responsibilities during extreme flood emergencies when communication facilities between him and his operating office may have been disrupted. It is designed to be used independently as an emergency flood control guide, or as published, in conjunction with the "Report on Reservoir Regulation for Flood Control." To facilitate independent use of this appendix, charts required for the emergency flood control operation of Shasta Lake are included herein. Charts A-1 through A-9 are included for use in accomplishing the various operational requirements specified herein.

2. FLOOD CONTROL OPERATION REQUIREMENTS

a. Shasta Dam and Lake will be operated for flood control in accordance with rules and regulations prescribed by the Code of Federal Regulations Title 33 Part 208.11, and the Field Working Agreement for Central Valley Project Dams and Reservoirs, copies of which are contained in this Appendix. Accompanying these regulations are the Flood Control Diagram and the Emergency Spillway Release Diagram, which together define the requirements for flood control operation of Shasta Dam and Lake. The flood control objectives for Shasta Dam and Lake are:

(1) To control flows in the Sacramento River, insofar as possible, to not more than 79,000 c.f.s. at the tailwater of Keswick Dam; and to not more than about 100,00 c.f.s. at the Sacramento River at Bend Bridge gage.

(2) To permit use of the maximum practical amount of storage space for conservation, power, and other purposes without impairment of the flood control functions.

b. Storage space in Shasta Lake shall be reserved on the basis of the Flood Control Diagram, Chart A-8, which indicates variable storage space requirements according to the current flood hazard as measured by the accumulation of seasonal inflow to the reservoir. Whenever encroachment into the currently required flood control storage reservation occurs this water should be released in accordance with the schedule contained on the Flood Control Diagram, Chart A-8.

c. The currently required flood control storage reservation is determined from Chart A-8, which indicates the required flood control storage reservation at any time in the flood season from 1 October to 15 June. The diagram requires:

(1) Flood control space increases from zero on 1 October to a maximum of 1,300,000 acre-feet on 1 November and is required until 23 December.

(2) A variable flood control space reservation up to a maximum of 1,300,000 acre-feet from 23 December to 15 June, is required. This space varies according to parameters based on the accumulation of seasonal inflow. This variable space provides the required flood space while allowing the space not required to be filled for conservation purposes. Provision of this space, therefore, allows a more efficient operation of the project.

d. The flood control operation each day consists of determining the required storage space reservation and scheduling releases as to provide the required space reservation by the end of the day, whenever possible. This procedure requires a forecast of reservoir inflow for the next 24 hours.

3. LIMITATIONS ON STORAGE

Operational limitations on storage in Shasta Lake are specified in paragraph 2 of this Appendix. There are no legal limitations on storage as the taking line is above the maximum operating level.

4. LIMITATIONS ON RELEASES

Flood control releases from Shasta reservoir will meet the flow criteria below Keswick and at Bend bridge specified in this section. Releases at Keswick dam will be limited to 79,000 c.f.s. which will allow 1,000 c.f.s. local inflow and not exceed 80,000 c.f.s. at Redding. The nondamage Sacramento river flow at Bend Bridge is 100,000 c.f.s. Releases must account for inflow between Redding and Bend Bridge. Travel time to Bend Bridge is approximately 12 hours. Releases from Shasta Dam should be limited to as little as minimum power releases as necessary whenever either of the above criteria is in danger of being exceeded. The rate of change of release will be restricted to values that will not endanger life and property in the flood plain area along Sacramento River below Keswick Dam. As an operating guide, the rate of change of release from Keswick Dam should be limited insofar as practicable to:

a. Increasing release up to 15,000 c.f.s. each 2 hours.

b. Decreasing releases not to exceed 4,000 c.f.s. each 2 hours.

5. EMERGENCY OPERATION OF GATED SPILLWAY

a. Whenever the reservoir level approaches gross pool level and the reservoir is rising rapidly because of flood inflow, the necessity for emergency releases should be determined. The Emergency Spillway Release Diagram, Chart A-9, indicates the minimum permissible releases that can be made without endangering the structure and without releasing quantities in excess of natural runoff. In order to assure the safety of the structure, minimize surcharge, or prevent, insofar as practicable, releases greater than 250,000 c.f.s., the operating agency may, on the basis of forecasts, make releases somewhat greater than those required by the diagram. Releases larger than 250,000 c.f.s. may cause damage to the spillway apron, powerhouse and to the Keswick Power Plant.

b. The diagram is derived in accordance with procedures outlined in EM 1110-2-3600 and is based on minimum remaining volume of inflow when only reservoir elevations and inflow are known. This minimum volume of remaining inflow was estimated on the basis that inflow peak was past and that recession of flow would be somewhat steeper than in most observed floods. The diagram is thus designed to defer emergency releases until it is virtually certain that those or larger

releases will be necessary. Accordingly, when such releases are indicated by the diagram, it is essential that they be made immediately in order that it will not subsequently be necessary to make still larger releases. For this reason, the reservoir operators at the dam should be thoroughly familiar with the Emergency Spillway Release Diagram and should be empowered by standing instructions to initiate use of the diagram if required when communication with Central Valley Project operations in Sacramento is disrupted.

6. STANDING INSTRUCTIONS DURING FLOOD EMERGENCY

a. The functional operation of Shasta Dam and Lake is under the direction of the Regional Director, Mid-Pacific Region, U.S. Bureau of Reclamation. Instructions to U.S. Bureau of Reclamation personnel are the responsibility of the Regional Director. The following are suggested instructions for emergency operation of Shasta Dam and Lake. During flood periods close contact will be maintained between the damtender (or operating personnel) and the Regional Office.

b. If communication is broken between the operating personnel and the Regional Office during a flood emergency, the following procedure is recommended:

(1) Continue releases in accordance with the last instructions received from the Regional Office and make every attempt to re-establish communication.

(2) If communications cannot be re-established and larger releases are required by the Flood Control Diagram (Chart A-8), release should be increased in accordance with the diagram.

(3) Whenever the reservoir level of Shasta Lake approaches gross pool elevation (1067.0 feet) and the reservoir level is rising because of flood inflow, the necessity for emergency spillway release from Shasta Lake should be determined. Chart A-9, Emergency Spillway Release Diagram, indicates the minimum release considered permissible to avoid endangering the structure.

7. OPERATIONAL RESPONSIBILITIES

Responsibilities for flood control operation of Shasta Lake are summarized in the following paragraphs. A list of personnel involved in operation of the reservoir for flood control are contained at the front of the Appendix.

a. The District Engineer, Sacramento District Corps of Engineers, is responsible for:

(1) Approving and disapproving deviations from the prescribed flood control criteria on Charts A-8 and A-9.

(2) Advising the operating agencies and the Chief of Engineers of any departure from the flood control regulations.

(3) Preparing monthly operation and other special reports relative to operation of the reservoir required by the Office, Chief of Engineers.

(4) Preparing revisions to the flood control criteria found herein.

b. The Regional Director Mid-Pacific Region, Bureau of Reclamation is responsible for:

(1) Accomplishing the physical operation of the reservoir and associated facilities in accordance with the official regulations.

(2) Advising the District Engineer, Sacramento District, Corps of Engineers, of any deviation from prescribed requirements.

(3) Reporting to the District Engineer, Sacramento District, Corps of Engineers, any unusual condition in the reservoir or along downstream channels that might interfere with the planned flood control operation of the reservoir.

(4) Keeping downstream interests advised of all changes of flood control releases which might affect them.

(5) Reporting to the Reservoir Control Section, Sacramento District, Corps of Engineers, and to the Department of Water Resources of the State of California, data as outlined in paragraph 8a below and other data that may be required from time to time.

(6) Keeping informed of the rules and regulations contained in the reservoir regulation manual and bringing to the attention of the District Engineer, Sacramento District, Corps of Engineers any feature of the manual that may require clarification or revision.

(7) Keeping the District Engineer, Sacramento District, Corps of Engineers advised of any inaccuracies contained in the manual or that may develop as a consequence of changing conditions.

(8) Immediately after the end of each month, transmitting to the Reservoir Control Section, Sacramento District, Corps of Engineers data specified in paragraph 8b below.

8. OPERATION REPORTS

a. The reservoir operator or operating agency shall report to the Reservoir Control Section, Sacramento District, of the Corps of Engineers and to the Department of Water Resources, State of California, each workday between 8:00 and 9:00 a.m. and at other times upon request, data as follows:

(1) The amount of flood control space required in Shasta Lake.

(2) Storage, inflow, outflow, at Shasta Lake.

(3) Forecasted inflow and anticipated outflow changes at Shasta Lake.

(4) Precipitation at the dam and at reporting stations in or adjacent to the drainage basin.

Data obtained on non-work days shall be furnished on the first work day following.

b. Immediately after the end of each month, the operating agency shall dispatch to the Reservoir Control Section, Sacramento District, Corps of Engineers a summary of the following operation data:

(1) Daily inflow, outflow, and storage at Shasta Lake.

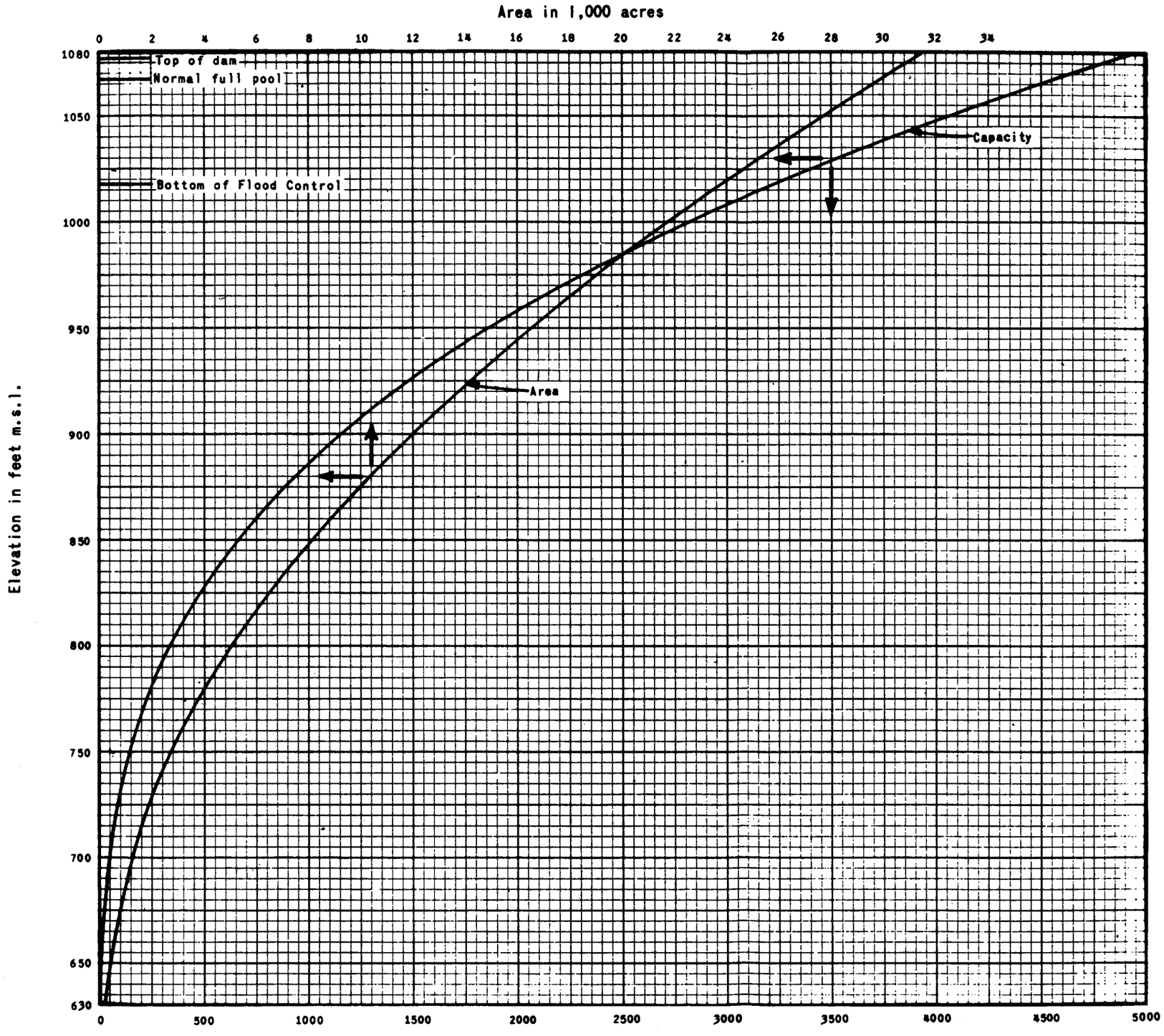
(2) Daily release at Keswick Dam.

(3) Daily requirement of flood control space at Shasta Lake.

(4) Precipitation at Shasta Dam.

9. MODIFICATION OF REGULATIONS

The official regulations are subject to temporary modification during flood emergencies by the District Engineer, Sacramento District, Corps of Engineers. The flood control criteria will be revised by the Corps of Engineers, as necessary, to reflect changed conditions that come to bear upon flood control operation of the reservoir. Permanent revisions of the flood control criteria are subject to prior approval of the Chief of Engineers or his duly authorized representative.



NOTE:

Curves based on data furnished by Bureau of Reclamation.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

AREA-CAPACITY CURVES

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: JANUARY 1976

CHART A-1

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION II
BRANCH OF OPERATION AND MAINTENANCE
DIVISION OF IRRIGATION OPERATIONS

CAPACITIES OF SHASTA RESERVOIR NEAR REDDING, CALIFORNIA

Calculations based on topographic maps of reservoir (scale 1 inch = 1000 feet, with contour interval of 20 feet) prepared by U. S. Geological Survey.

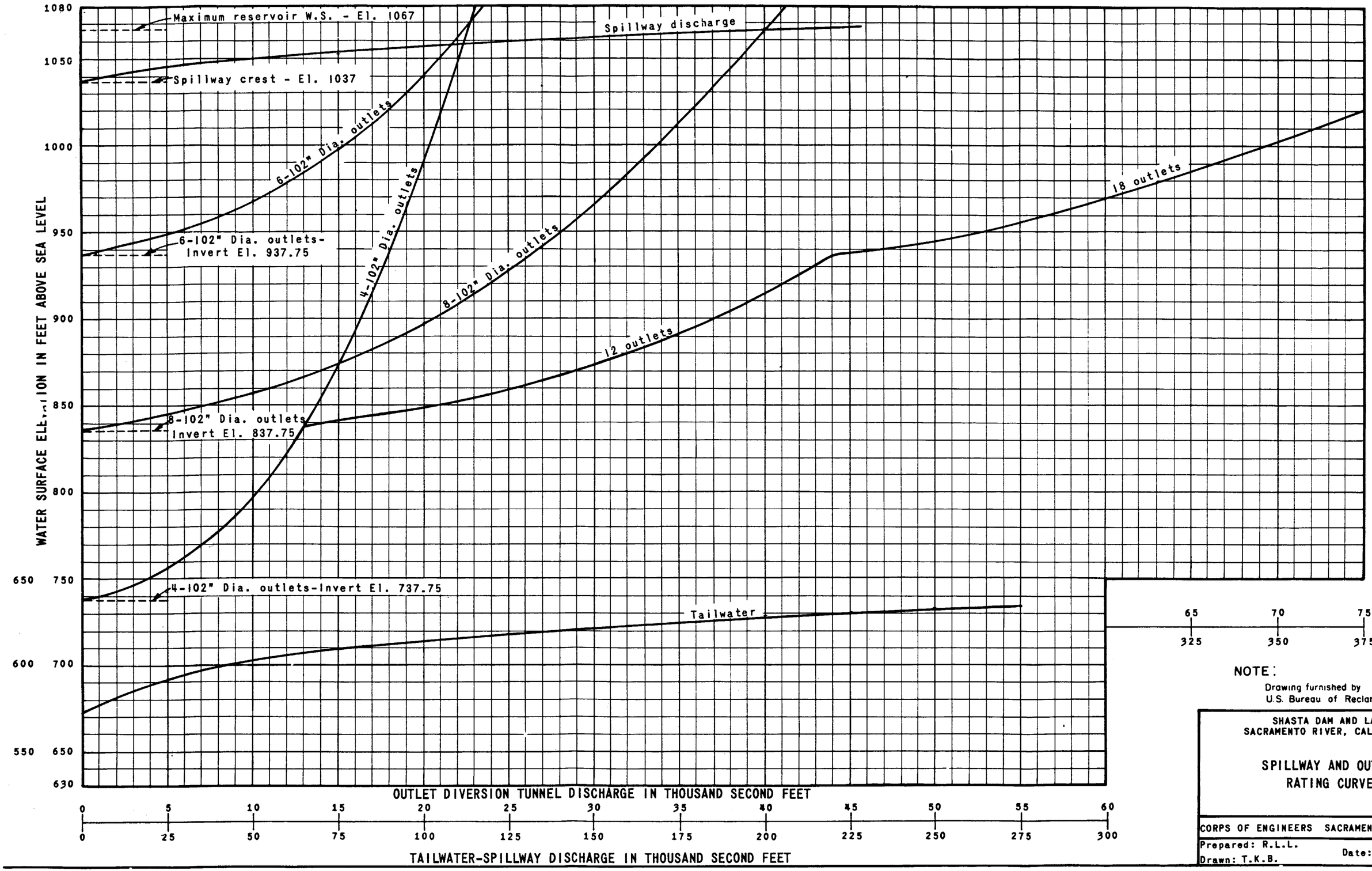
Elev. Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Difference
					ACRE-FEET						
821	456,605	457,235	457,865	458,495	459,125	459,756	460,386	461,016	461,646	462,276	6,301
822	462,906	463,542	464,178	464,814	465,450	466,087	466,723	467,359	467,995	468,631	6,101
823	469,267	469,909	470,552	471,194	471,836	472,479	473,121	473,763	474,405	475,048	6,423
824	475,690	476,339	476,987	477,636	478,284	478,933	479,582	480,230	480,879	481,527	6,486
825	482,176	482,831	483,485	484,140	484,795	485,450	486,104	486,759	487,414	488,068	6,547
826	488,723	489,384	490,045	490,706	491,367	492,028	492,689	493,350	494,011	494,672	6,610
827	495,333	496,000	496,668	497,335	498,003	498,670	499,337	500,005	500,672	501,340	6,674
828	502,007	502,681	503,354	504,028	504,701	505,375	506,049	506,722	507,396	508,069	6,736
829	508,743	509,423	510,103	510,783	511,463	512,143	512,823	513,503	514,183	514,863	6,800
830	515,543	516,229	516,916	517,602	518,289	518,975	519,661	520,348	521,034	521,721	6,864
831	522,407	523,100	523,793	524,486	525,179	525,872	526,564	527,257	527,950	528,643	6,929
832	529,336	530,035	530,735	531,434	532,134	532,833	533,532	534,232	534,931	535,631	6,994
833	536,330	537,036	537,742	538,447	539,153	539,859	540,565	541,271	541,976	542,682	7,058
834	543,388	544,100	544,813	545,525	546,238	546,950	547,662	548,375	549,087	549,800	7,124
835	550,512	551,231	551,950	552,669	553,388	554,107	554,826	555,545	556,264	556,983	7,190
836	557,702	558,428	559,153	559,879	560,604	561,330	562,056	562,781	563,507	564,232	7,256
837	564,958	565,690	566,422	567,155	567,887	568,619	569,351	570,083	570,816	571,548	7,322
838	572,280	573,019	573,758	574,497	575,236	575,975	576,714	577,453	578,192	578,931	7,390
839	579,670	580,416	581,161	581,907	582,653	583,399	584,144	584,890	585,636	586,381	7,457
840	587,127	587,880	588,633	589,385	590,138	590,891	591,644	592,397	593,149	593,902	7,528
841	594,655	595,415	596,174	596,934	597,693	598,453	599,213	599,972	600,732	601,491	7,596
842	602,251	603,017	603,784	604,550	605,317	606,083	606,849	607,616	608,382	609,149	7,664
843	609,915	610,688	611,462	612,235	613,008	613,782	614,555	615,328	616,101	616,875	7,733
844	617,648	618,428	619,208	619,989	620,769	621,549	622,329	623,109	623,890	624,670	7,802
845	625,450	626,237	627,025	627,812	628,599	629,387	630,174	630,961	631,748	632,536	7,873
846	633,323	634,117	634,911	635,705	636,499	637,294	638,088	638,882	639,676	640,470	7,941
847	641,264	642,065	642,866	643,668	644,469	645,270	646,071	646,872	647,674	648,475	8,012
848	649,276	650,084	650,892	651,701	652,509	653,317	654,125	654,933	655,742	656,550	8,082
849	657,358	658,173	658,989	659,804	660,619	661,435	662,250	663,065	663,880	664,696	8,153
850	665,511	666,334	667,156	667,979	668,801	669,624	670,446	671,269	672,091	672,914	8,225
851	673,736	674,566	675,395	676,225	677,054	677,884	678,714	679,543	680,373	681,202	8,296
852	682,032	682,869	683,706	684,543	685,380	686,217	687,053	687,890	688,727	689,564	8,369
853	690,401	691,245	692,089	692,933	693,777	694,621	695,465	696,309	697,153	697,997	8,440
854	698,841	699,692	700,544	701,395	702,247	703,098	703,949	704,801	705,652	706,504	8,514
855	707,355	708,214	709,072	709,931	710,789	711,648	712,507	713,365	714,224	715,082	8,586
856	715,941	716,807	717,673	718,539	719,405	720,272	721,138	722,004	722,870	723,736	8,661
857	724,602	725,475	726,349	727,222	728,096	728,969	729,842	730,716	731,589	732,463	8,734
858	733,336	734,217	735,098	735,978	736,859	737,740	738,621	739,502	740,382	741,263	8,808
859	742,144	743,032	743,921	744,809	745,697	746,586	747,474	748,362	749,250	750,139	8,883
860	751,027	751,919	752,810	753,702	754,593	755,485	756,377	757,268	758,160	759,051	8,916
861	759,943	760,842	761,741	762,641	763,540	764,439	765,338	766,237	767,137	768,036	8,992
862	768,935	769,842	770,748	771,655	772,561	773,468	774,374	775,281	776,187	777,094	9,065
863	778,000	778,914	779,828	780,743	781,657	782,571	783,485	784,399	785,314	786,228	9,142
864	787,142	788,064	788,985	789,907	790,828	791,750	792,672	793,593	794,515	795,436	9,216
865	796,358	797,287	798,217	799,146	800,075	801,005	801,934	802,863	803,792	804,722	9,293
866	805,651	806,586	807,525	808,462	809,399	810,336	811,272	812,209	813,146	814,083	9,369
867	815,020	815,965	816,909	817,854	818,798	819,743	820,687	821,632	822,576	823,521	9,445
868	824,465	825,417	826,370	827,322	828,274	829,227	830,179	831,131	832,083	833,036	9,523
869	833,988	834,948	835,908	836,868	837,828	838,789	839,749	840,709	841,669	842,629	9,601
870	843,589	844,557	845,524	846,492	847,460	848,428	849,395	850,363	851,331	852,298	9,677
871	853,266	854,242	855,217	856,193	857,169	858,145	859,120	860,096	861,072	862,047	9,757
872	863,023	864,006	864,990	865,973	866,957	867,940	868,923	869,907	870,890	871,874	9,834
873	872,857	873,848	874,840	875,831	876,822	877,814	878,805	879,796	880,787	881,779	9,913
874	882,770	883,769	884,769	885,768	886,767	887,767	888,766	889,765	890,764	891,764	9,993
875	892,763	893,770	894,778	895,785	896,792	897,800	898,807	899,814	900,821	901,829	10,073
876	902,836	903,851	904,866	905,882	906,897	907,912	908,927	909,942	910,958	911,973	10,152
877	912,988	914,011	915,035	916,058	917,081	918,105	919,128	920,151	921,174	922,198	10,233
878	923,221	924,252	925,284	926,315	927,347	928,378	929,409	930,441	931,472	932,504	10,314
879	933,535	934,574	935,614	936,653	937,693	938,732	939,771	940,811	941,850	942,890	10,394
880	943,929	944,970	946,011	947,053	948,094	949,135	950,176	951,217	952,259	953,300	10,412

CHART A-2

Elev. Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Difference
					ACRE-FEET						
881	954,341	955,390	956,439	957,488	958,537	959,598	960,636	961,685	962,734	963,783	10,491
882	964,832	965,889	966,947	968,004	969,061	970,119	971,176	972,233	973,290	974,348	10,573
883	975,405	976,471	977,536	978,602	979,667	980,733	981,798	982,864	983,929	984,994	10,655
884	986,060	987,134	988,207	989,281	990,354	991,428	992,501	993,575	994,648	995,722	10,735
885	996,795	997,877	998,959	1,000,040	1,001,122	1,002,204	1,003,286	1,004,368	1,005,449	1,006,531	10,818
886	1,007,613	1,008,703	1,009,793	1,010,883	1,011,973	1,013,063	1,014,154	1,015,244	1,016,334	1,017,424	10,901
887	1,018,514	1,019,612	1,020,711	1,021,809	1,022,907	1,024,006	1,025,104	1,026,202	1,027,300	1,028,399	10,983
888	1,029,497	1,030,604	1,031,710	1,032,817	1,033,924	1,035,031	1,036,137	1,037,244	1,038,351	1,039,457	11,067
889	1,040,564	1,041,679	1,042,794	1,043,909	1,045,024	1,046,139	1,047,253	1,048,368	1,049,483	1,050,598	11,149
890	1,051,713	1,052,836	1,053,960	1,055,083	1,056,207	1,057,330	1,058,453	1,059,577	1,060,700	1,061,824	11,234
891	1,062,947	1,064,079	1,065,211	1,066,343	1,067,475	1,068,607	1,069,738	1,070,870	1,072,002	1,073,134	11,319
892	1,074,266	1,075,406	1,076,546	1,077,687	1,078,827	1,079,967	1,081,107	1,082,247	1,083,388	1,084,528	11,402
893	1,085,668	1,086,817	1,087,966	1,089,114	1,090,263	1,091,412	1,092,561	1,093,710	1,094,858	1,096,007	11,488
894	1,097,156	1,098,313	1,099,471	1,100,628	1,101,785	1,102,942	1,104,100	1,105,257	1,106,414	1,107,572	11,573
895	1,108,729	1,109,895	1,111,061	1,112,227	1,113,393	1,114,558	1,115,724	1,116,890	1,118,056	1,119,222	11,659
896	1,120,388	1,121,563	1,122,737	1,123,912	1,125,086	1,126,261	1,127,436	1,128,610	1,129,785	1,130,959	11,746
897	1,132,134	1,133,317	1,134,500	1,135,683	1,136,866	1,138,049	1,139,233	1,140,416	1,141,599	1,142,782	11,831
898	1,143,965	1,145,157	1,146,349	1,147,540	1,148,732	1,149,924	1,151,116	1,152,308	1,153,499	1,154,691	11,918
899	1,155,883	1,157,083	1,158,284	1,159,484	1,160,685	1, 161,885	1,163,086	1,164,286	1,165,487	1,166,687	12,005
900	1,167,888	1,169,088	1,170,289	1,171,489	1,172,690	1,173,890	1,175,090	1,176,291	1,177,491	1,178,692	12,004
901	1,179,892	1,181,101	1,182,310	1,183,519	1,184,728	1,185,936	1,187,145	1,188,354	1,189,563	1,190,772	12,089
902	1,191,981	1,193,199	1,194,416	1,195,634	1,196,852	1,198,069	1,199,287	1,200,505	1,201,723	1,202,940	12,177
903	1,204,158	1,205,384	1,206,611	1,207,837	1,209,064	1,210,290	1,211,516	1,212,743	1,213,969	1,215,196	12,264
904	1,216,422	1,217,657	1,218,892	1,220,127	1,221,362	1,222,597	1,223,833	1,225,068	1,226,303	1,227,538	12,351
905	1,228,773	1,230,017	1,231,261	1,232,505	1,233,749	1,234,993	1,236,237	1,237,481	1,238,725	1,239,969	12,440
906	1,241,213	1,242,466	1,243,718	1,244,971	1,246,223	1,247,476	1,248,729	1,249,981	1,251,234	1,252,486	12,526
907	1,253,739	1,255,001	1,256,262	1,257,524	1,258,786	1,260,047	1,261,309	1,262,571	1,263,833	1,265,094	12,617
908	1,266,356	1,267,626	1,268,897	1,270,167	1,271,438	1,272,708	1,273,978	1,275,249	1,276,519	1,277,790	12,704
909	1,279,060	1,280,339	1,281,619	1,282,898	1,284,178	1,285,457	1,286,736	1,288,016	1,289,295	1,290,575	12,794
910	1,291,854	1,293,142	1,294,431	1,295,719	1,297,007	1,298,295	1,299,584	1,300,872	1,302,160	1,303,449	12,883
911	1,304,737	1,306,034	1,307,332	1,308,629	1,309,927	1,311,224	1,312,521	1,313,819	1,315,116	1,316,414	12,974
912	1,317,711	1,319,017	1,320,324	1,321,630	1,322,936	1,324,242	1,325,549	1,326,855	1,328,161	1,329,468	13,065
913	1,330,774	1,332,089	1,333,405	1,334,720	1,336,036	1,337,351	1,338,667	1,339,982	1,341,298	1,342,613	13,155
914	1,343,929	1,345,253	1,346,578	1,347,902	1,349,227	1,350,551	1,351,876	1,353,201	1,354,525	1,355,849	13,245
915	1,357,174	1,358,508	1,359,841	1,361,175	1,362,509	1,363,842	1,365,176	1,366,510	1,367,844	1,369,177	13,337
916	1,370,511	1,371,854	1,373,197	1,374,540	1,375,883	1,377,225	1,378,568	1,379,911	1,381,254	1,382,597	13,429
917	1,383,940	1,385,292	1,386,644	1,387,996	1,389,348	1,390,700	1,392,053	1,393,405	1,394,757	1,396,109	13,521
918	1,397,461	1,398,822	1,400,184	1,401,545	1,402,906	1,404,267	1,405,629	1,406,990	1,408,351	1,409,713	13,613
919	1,411,074	1,412,445	1,413,815	1,415,186	1,416,556	1,417,929	1,419,298	1,420,668	1,422,039	1,423,409	13,706
920	1,424,780	1,426,153	1,427,525	1,428,898	1,430,270	1,431,643	1,433,016	1,434,388	1,435,761	1,437,133	13,726
921	1,438,506	1,439,888	1,441,270	1,442,651	1,444,033	1,445,415	1,446,797	1,448,179	1,449,560	1,450,942	13,818
922	1,452,324	1,453,715	1,455,106	1,456,497	1,457,888	1,459,279	1,460,671	1,462,062	1,463,453	1,464,844	13,911
923	1,466,235	1,467,635	1,469,036	1,470,436	1,471,837	1,473,237	1,474,638	1,476,038	1,477,439	1,478,839	14,005
924	1,480,240	1,481,650	1,483,059	1,484,469	1,485,878	1,487,288	1,488,698	1,490,107	1,491,517	1,492,926	14,096
925	1,494,336	1,495,755	1,497,174	1,498,594	1,500,013	1,501,432	1,502,851	1,504,270	1,505,690	1,507,109	14,192
926	1,508,528	1,509,956	1,511,385	1,512,813	1,514,242	1,515,670	1,517,099	1,518,527	1,519,956	1,521,384	14,285
927	1,522,813	1,524,251	1,525,689	1,527,127	1,528,565	1,530,003	1,531,441	1,532,879	1,534,317	1,535,755	14,380
928	1,537,193	1,538,640	1,540,088	1,541,535	1,542,983	1,544,430	1,545,877	1,547,325	1,548,772	1,550,220	14,474
929	1,551,667	1,553,124	1,554,581	1,556,038	1,557,495	1,558,952	1,560,410	1,561,867	1,563,324	1,564,781	14,571
930	1,566,238	1,567,704	1,569,171	1,570,637	1,572,104	1,573,570	1,575,037	1,576,503	1,577,970	1,579,436	14,665
931	1,580,903	1,582,379	1,583,855	1,585,332	1,586,808	1,588,284	1,589,760	1,591,236	1,592,713	1,594,189	14,762
932	1,595,665	1,597,151	1,598,637	1,600,122	1,601,608	1,603,094	1,604,580	1,606,066	1,607,551	1,609,037	14,858
933	1,610,523	1,612,018	1,613,514	1,615,010	1,616,505	1,618,001	1,619,496	1,620,991	1,622,487	1,623,983	14,955
934	1,625,478	1,626,983	1,628,488	1,629,993	1,631,498	1,633,003	1,634,509	1,636,014	1,637,519	1,639,024	15,051
935	1,640,529	1,642,044	1,643,559	1,645,074	1,646,589	1,648,104	1,649,618	1,651,133	1,652,648	1,654,163	15,149
936	1,655,678	1,657,203	1,658,727	1,660,252	1,661,777	1,663,302	1,664,826	1,666,351	1,667,876	1,669,400	15,247
937	1,670,925	1,672,460	1,673,994	1,675,528	1,677,063	1,678,597	1,680,132	1,681,667	1,683,201	1,684,736	15,345
938	1,686,270	1,687,814	1,689,359	1,690,903	1,692,447	1,693,991	1,695,536	1,697,080	1,698,624	1,700,169	15,443
939	1,701,713	1,703,267	1,704,821	1,706,376	1,707,930	1,709,484	1,711,038	1,712,592	1,714,147	1,715,701	15,542
940	1,717,255	1,718,808	1,720,361	1,721,914	1,723,467	1,725,020	1,726,573	1,728,126	1,729,679	1,731,232	15,530
941	1,732,785	1,734,348	1,735,910	1,737,473	1,739,035	1,740,598	1,742,161	1,743,723	1,745,286	1,746,848	15,626
942	1,748,411	1,749,984	1,751,556	1,753,129	1,754,701	1,756,274	1,757,847	1,759,419	1,760,992	1,762,564	15,726
943	1,764,137	1,765,719	1,767,302	1,768,884	1,770,466	1,772,049	1,773,631	1,775,213	1,776,795	1,778,378	15,823
944	1,779,960	1,781,552	1,783,145	1,784,737	1,786,329	1,787,921	1,789,514	1,791,106	1,792,698	1,794,291	15,923
945	1,795,883	1,797,485	1,799,087	1,800,690	1,802,292	1,803,894	1,805,496	1,807,098	1,808,701	1,810,303	16,022
946	1,811,905	1,813,517	1,815,129	1,816,742	1,818,354	1,819,966	1,821,578	1,823,190	1,824,803	1,826,415	16,122
947	1,828,027	1,829,649	1,831,271	1,832,893	1,834,515	1,836,137	1,837,758	1,839,380	1,841,002	1,842,624	16,219
948	1,844,246	1,845,878	1,847,511	1,849,143	1,850,776	1,852,409	1,854,041	1,855,673	1,857,306	1,858,939	16,325
949	1,860,571	1,862,214	1,863,856	1,865,498	1,867,141	1,868,784	1,870,426	1,872,068	1,873,711	1,875,354	16,425
950	1,876,996	1,878,648	1,880,300	1,881,952	1,883,604	1,885,256	1,886,908	1,888,560	1,890,212	1,891,864	16,520

Elev. Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Difference
					ACRE-FEET						
951	1,893,516	1,895,179	1,896,841	1,898,503	1,900,166	1,901,828	1,903,491	1,905,153	1,906,816	1,908,479	16,625
952	1,910,141	1,911,814	1,913,486	1,915,159	1,916,831	1,918,504	1,920,177	1,921,849	1,923,522	1,925,194	16,726
953	1,926,867	1,928,550	1,930,233	1,931,916	1,933,599	1,935,282	1,936,964	1,938,647	1,940,330	1,942,013	16,829
954	1,943,696	1,945,389	1,947,082	1,948,775	1,950,468	1,952,161	1,953,855	1,955,548	1,957,241	1,958,934	16,931
955	1,960,627	1,962,330	1,964,033	1,965,737	1,967,440	1,969,143	1,970,846	1,972,549	1,974,253	1,975,956	17,032
956	1,977,659	1,979,373	1,981,086	1,982,800	1,984,514	1,986,228	1,987,941	1,989,655	1,991,369	1,993,082	17,137
957	1,994,796	1,996,520	1,998,244	1,999,968	2,001,692	2,003,417	2,005,141	2,006,865	2,008,589	2,010,313	17,241
958	2,012,037	2,013,771	2,015,506	2,017,240	2,018,975	2,020,709	2,022,443	2,024,178	2,025,912	2,027,647	17,344
959	2,029,381	2,031,126	2,032,871	2,034,615	2,036,360	2,038,105	2,039,850	2,041,595	2,043,339	2,045,084	17,448
960	2,046,829	2,048,575	2,050,320	2,052,066	2,053,811	2,055,557	2,057,303	2,059,048	2,060,794	2,062,539	17,456
961	2,064,285	2,066,041	2,067,797	2,069,553	2,071,309	2,073,065	2,074,821	2,076,577	2,078,333	2,080,089	17,560
962	2,081,845	2,083,611	2,085,378	2,087,145	2,088,911	2,090,677	2,092,444	2,094,211	2,095,977	2,097,743	17,665
963	2,099,510	2,101,287	2,103,064	2,104,840	2,106,617	2,108,394	2,110,171	2,111,948	2,113,724	2,115,501	17,768
964	2,117,278	2,119,065	2,120,852	2,122,640	2,124,427	2,126,214	2,128,001	2,129,788	2,131,576	2,133,363	17,872
965	2,135,150	2,136,948	2,138,745	2,140,543	2,142,341	2,144,139	2,145,936	2,147,734	2,149,532	2,151,329	17,977
966	2,153,127	2,154,935	2,156,744	2,158,552	2,160,360	2,162,169	2,163,977	2,165,785	2,167,593	2,169,402	18,083
967	2,171,210	2,173,029	2,174,848	2,176,667	2,178,486	2,180,304	2,182,123	2,183,942	2,185,761	2,187,580	18,189
968	2,189,399	2,191,228	2,193,058	2,194,887	2,196,716	2,198,545	2,200,375	2,202,204	2,204,033	2,205,863	18,293
969	2,207,692	2,209,532	2,211,372	2,213,212	2,215,052	2,216,892	2,218,733	2,220,573	2,222,413	2,224,253	18,401
970	2,226,093	2,227,944	2,229,794	2,231,645	2,233,496	2,235,346	2,237,197	2,239,048	2,240,899	2,242,749	18,507
971	2,244,600	2,246,461	2,248,323	2,250,184	2,252,046	2,253,907	2,255,768	2,257,630	2,259,491	2,261,353	18,614
972	2,263,214	2,265,086	2,266,958	2,268,831	2,270,703	2,272,575	2,274,447	2,276,319	2,278,192	2,280,064	18,722
973	2,281,936	2,283,819	2,285,702	2,287,585	2,289,468	2,291,350	2,293,233	2,295,116	2,296,999	2,298,882	18,829
974	2,300,765	2,302,659	2,304,552	2,306,445	2,308,339	2,310,232	2,312,126	2,314,020	2,315,913	2,317,806	18,935
975	2,319,700	2,321,605	2,323,509	2,325,414	2,327,319	2,329,224	2,331,128	2,333,033	2,334,938	2,336,842	19,047
976	2,338,747	2,340,652	2,342,578	2,344,493	2,346,408	2,348,324	2,350,239	2,352,154	2,354,069	2,355,985	19,153
977	2,357,900	2,359,826	2,361,753	2,363,679	2,365,605	2,367,531	2,369,458	2,371,384	2,373,310	2,375,237	19,263
978	2,377,163	2,379,100	2,381,038	2,382,975	2,384,912	2,386,849	2,388,787	2,390,724	2,392,661	2,394,599	19,373
979	2,396,536	2,398,484	2,400,431	2,402,381	2,404,329	2,406,277	2,408,226	2,410,174	2,412,122	2,414,071	19,483
980	2,416,019	2,417,975	2,419,931	2,421,887	2,423,843	2,425,799	2,427,755	2,429,711	2,431,667	2,433,623	19,560
981	2,435,579	2,437,546	2,439,513	2,441,481	2,443,448	2,445,415	2,447,382	2,449,349	2,451,317	2,453,284	19,672
982	2,455,251	2,457,229	2,459,207	2,461,185	2,463,163	2,465,141	2,467,119	2,469,097	2,471,075	2,473,053	19,780
983	2,475,031	2,477,020	2,479,010	2,480,999	2,482,988	2,484,978	2,486,967	2,488,956	2,490,945	2,492,935	19,893
984	2,494,924	2,496,924	2,498,925	2,500,925	2,502,926	2,504,926	2,506,926	2,508,927	2,510,927	2,512,928	20,004
985	2,514,928	2,516,939	2,518,951	2,520,962	2,522,973	2,524,984	2,526,996	2,529,007	2,531,018	2,533,030	20,113
986	2,535,041	2,537,064	2,539,086	2,541,109	2,543,132	2,545,154	2,547,177	2,549,200	2,551,223	2,553,245	20,227
987	2,555,268	2,557,302	2,559,336	2,561,370	2,563,404	2,565,438	2,567,471	2,569,505	2,571,539	2,573,573	20,339
988	2,575,607	2,577,652	2,579,697	2,581,743	2,583,788	2,585,833	2,587,878	2,589,923	2,591,969	2,594,014	20,452
989	2,596,059	2,598,115	2,600,172	2,602,228	2,604,284	2,606,341	2,608,397	2,610,453	2,612,509	2,614,566	20,563
990	2,616,622	2,618,690	2,620,757	2,622,825	2,624,893	2,626,960	2,629,028	2,631,096	2,633,164	2,635,231	20,677
991	2,637,299	2,639,378	2,641,457	2,643,536	2,645,615	2,647,694	2,649,773	2,651,852	2,653,931	2,656,010	20,790
992	2,658,089	2,660,179	2,662,270	2,664,360	2,666,451	2,668,541	2,670,632	2,672,722	2,674,813	2,676,903	20,905
993	2,678,994	2,681,096	2,683,198	2,685,300	2,687,402	2,689,503	2,691,605	2,693,707	2,695,809	2,697,911	21,019
994	2,700,013	2,702,126	2,704,240	2,706,353	2,708,466	2,710,580	2,712,693	2,714,806	2,716,919	2,719,033	21,133
995	2,721,146	2,723,271	2,725,396	2,727,521	2,729,646	2,731,770	2,733,895	2,736,020	2,738,145	2,740,270	21,249
996	2,742,395	2,744,531	2,746,667	2,748,804	2,750,940	2,753,076	2,755,212	2,757,348	2,759,485	2,761,621	21,362
997	2,763,757	2,765,905	2,768,053	2,770,201	2,772,349	2,774,497	2,776,645	2,778,793	2,780,941	2,783,089	21,480
998	2,785,237	2,787,396	2,789,556	2,791,716	2,793,875	2,796,034	2,798,194	2,800,354	2,802,513	2,804,672	21,595
999	2,806,832	2,809,003	2,811,175	2,813,346	2,815,517	2,817,688	2,819,860	2,822,031	2,824,202	2,826,374	21,712
1,000	2,828,544	2,830,723	2,832,902	2,835,081	2,837,260	2,839,440	2,841,619	2,843,798	2,845,977	2,848,156	21,791
1,001	2,850,335	2,852,526	2,854,717	2,856,908	2,859,099	2,861,290	2,863,480	2,865,671	2,867,862	2,870,053	21,909
1,002	2,872,244	2,874,447	2,876,649	2,878,852	2,881,054	2,883,257	2,885,460	2,887,662	2,889,865	2,892,067	22,026
1,003	2,894,270	2,896,484	2,898,698	2,900,912	2,903,126	2,905,340	2,907,554	2,909,768	2,911,982	2,914,196	22,140
1,004	2,916,410	2,918,636	2,920,862	2,923,089	2,925,315	2,927,541	2,929,767	2,931,993	2,934,220	2,936,446	22,262
1,005	2,938,672	2,940,910	2,943,147	2,945,385	2,947,623	2,949,860	2,952,098	2,954,336	2,956,574	2,958,811	22,377
1,006	2,961,049	2,963,299	2,965,549	2,967,799	2,970,049	2,972,298	2,974,548	2,976,798	2,979,048	2,981,298	22,499
1,007	2,983,548	2,985,809	2,988,071	2,990,332	2,992,594	2,994,855	2,997,116	2,999,378	3,001,639	3,003,901	22,614
1,008	3,006,162	3,008,435	3,010,709	3,012,982	3,015,255	3,017,528	3,019,802	3,022,075	3,024,348	3,026,622	22,733
1,009	3,028,895	3,031,180	3,033,466	3,035,752	3,038,037	3,040,322	3,042,608	3,044,894	3,047,179	3,049,464	22,855
1,010	3,051,750	3,054,047	3,056,345	3,058,642	3,060,939	3,063,236	3,065,534	3,067,831	3,070,128	3,072,426	22,973
1,011	3,074,723	3,077,032	3,079,342	3,081,651	3,083,961	3,086,270	3,088,579	3,090,889	3,093,198	3,095,508	23,094
1,012	3,097,817	3,100,138	3,102,460	3,104,781	3,107,102	3,109,424	3,111,745	3,114,066	3,116,387	3,118,709	23,213
1,013	3,121,030	3,123,364	3,125,697	3,128,030	3,130,364	3,132,698	3,135,031	3,137,364	3,139,698	3,142,032	23,335
1,014	3,144,365	3,146,710	3,149,056	3,151,402	3,153,747	3,156,092	3,158,438	3,160,784	3,163,129	3,165,474	23,455
1,015	3,167,820	3,170,178	3,172,536	3,174,894	3,177,252	3,179,610	3,181,969	3,184,327	3,186,685	3,189,043	23,581
1,016	3,191,401	3,193,771	3,196,140	3,198,510	3,200,879	3,203,249	3,205,619	3,207,988	3,210,358	3,212,727	23,696
1,017	3,215,097	3,217,479	3,219,862	3,222,244	3,224,626	3,227,008	3,229,391	3,231,773	3,234,155	3,236,538	23,823
1,018	3,238,920	3,241,314	3,243,708	3,246,103	3,248,497	3,250,891	3,253,285	3,255,679	3,258,074	3,260,468	23,942
1,019	3,262,862	3,265,269	3,267,675	3,270,082	3,272,489	3,274,896	3,277,302	3,279,709	3,282,116	3,284,522	24,067
1,020	3,286,929	3,289,339	3,291,749	3,294,158	3,296,568	3,298,978	3,301,388	3,303,798	3,306,207	3,308,617	24,098

Elev. Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Difference
					ACRE-FEET						
1,021	3,311,027	3,313,449	3,315,872	3,318,294	3,320,717	3,323,139	3,325,561	3,327,984	3,330,406	3,332,829	24,224
1,022	3,335,251	3,337,685	3,340,120	3,342,554	3,344,989	3,347,423	3,349,857	3,352,292	3,354,726	3,357,161	24,344
1,023	3,359,595	3,362,042	3,364,488	3,366,935	3,369,382	3,371,828	3,374,275	3,376,722	3,379,169	3,381,615	24,467
1,024	3,384,062	3,386,521	3,388,981	3,391,440	3,393,899	3,396,358	3,398,818	3,401,277	3,403,736	3,406,196	24,593
1,025	3,408,655	3,411,127	3,413,598	3,416,070	3,418,541	3,421,013	3,423,485	3,425,956	3,428,428	3,430,899	24,716
1,026	3,433,371	3,435,855	3,438,339	3,440,823	3,443,307	3,445,791	3,448,274	3,450,758	3,453,242	3,455,726	24,839
1,027	3,458,210	3,460,706	3,463,203	3,465,699	3,468,195	3,470,692	3,473,188	3,475,684	3,478,180	3,480,677	24,963
1,028	3,483,173	3,485,682	3,488,191	3,490,700	3,493,209	3,495,718	3,498,228	3,500,737	3,503,246	3,505,755	25,091
1,029	3,508,264	3,510,785	3,513,307	3,515,828	3,518,350	3,520,871	3,523,392	3,525,914	3,528,435	3,530,957	25,214
1,030	3,533,478	3,536,012	3,538,546	3,541,080	3,543,614	3,546,148	3,548,682	3,551,216	3,553,750	3,556,284	25,340
1,031	3,558,818	3,561,365	3,563,911	3,566,457	3,569,004	3,571,551	3,574,097	3,576,643	3,579,190	3,581,737	25,465
1,032	3,584,283	3,586,842	3,589,401	3,591,961	3,594,520	3,597,079	3,599,638	3,602,197	3,604,757	3,607,316	25,592
1,033	3,609,875	3,612,447	3,615,019	3,617,591	3,620,163	3,622,735	3,625,308	3,627,880	3,630,452	3,633,024	25,721
1,034	3,635,596	3,638,181	3,640,766	3,643,350	3,645,934	3,648,519	3,651,104	3,653,688	3,656,273	3,658,857	25,846
1,035	3,661,442	3,664,039	3,666,637	3,669,234	3,671,831	3,674,429	3,677,026	3,679,623	3,682,220	3,684,818	25,973
1,036	3,687,415	3,690,025	3,692,635	3,695,246	3,697,856	3,700,466	3,703,076	3,705,686	3,708,297	3,710,907	26,102
1,037	3,713,517	3,716,140	3,718,762	3,721,385	3,724,008	3,726,631	3,729,253	3,731,876	3,734,499	3,737,121	26,227
1,038	3,739,744	3,742,380	3,745,015	3,747,651	3,750,286	3,752,922	3,755,558	3,758,193	3,760,829	3,763,464	26,356
1,039	3,766,100	3,768,749	3,771,398	3,774,047	3,776,696	3,779,345	3,781,994	3,784,643	3,787,292	3,789,941	26,490
1,040	3,792,590	3,795,237	3,797,884	3,800,531	3,803,178	3,805,825	3,808,472	3,811,119	3,813,766	3,816,413	26,470
1,041	3,819,060	3,821,720	3,824,381	3,827,041	3,829,701	3,832,362	3,835,022	3,837,682	3,840,342	3,843,003	26,603
1,042	3,845,663	3,848,336	3,851,008	3,853,681	3,856,354	3,859,026	3,861,699	3,864,372	3,867,045	3,869,717	26,727
1,043	3,872,390	3,875,076	3,877,762	3,880,447	3,883,133	3,885,819	3,888,505	3,891,191	3,893,866	3,896,562	26,858
1,044	3,899,248	3,901,946	3,904,645	3,907,343	3,910,042	3,912,740	3,915,438	3,918,137	3,920,835	3,923,534	26,984
1,045	3,926,232	3,928,944	3,931,655	3,934,366	3,937,078	3,939,790	3,942,501	3,945,212	3,947,924	3,950,636	27,115
1,046	3,953,347	3,956,072	3,958,796	3,961,521	3,964,246	3,966,971	3,969,695	3,972,420	3,975,145	3,977,869	27,247
1,047	3,980,594	3,983,331	3,986,069	3,988,807	3,991,544	3,994,281	3,997,019	3,999,756	4,002,494	4,005,232	27,375
1,048	4,007,969	4,010,719	4,013,470	4,016,220	4,018,971	4,021,721	4,024,471	4,027,222	4,029,972	4,032,723	27,504
1,049	4,035,473	4,038,236	4,041,000	4,043,764	4,046,527	4,049,291	4,052,054	4,054,818	4,057,581	4,060,344	27,635
1,050	4,063,108	4,065,885	4,068,661	4,071,438	4,074,214	4,076,991	4,079,766	4,082,544	4,085,321	4,088,097	27,766
1,051	4,090,874	4,093,664	4,096,454	4,099,244	4,102,034	4,104,823	4,107,613	4,110,403	4,113,192	4,115,983	27,899
1,052	4,118,773	4,121,576	4,124,379	4,127,182	4,129,985	4,132,787	4,135,590	4,138,393	4,141,196	4,143,999	28,029
1,053	4,146,802	4,149,618	4,152,434	4,155,250	4,158,066	4,160,882	4,163,697	4,166,513	4,169,329	4,172,145	28,159
1,054	4,174,961	4,177,790	4,180,620	4,183,449	4,186,278	4,189,108	4,191,937	4,194,766	4,197,595	4,200,425	28,293
1,055	4,203,254	4,206,097	4,208,940	4,211,783	4,214,626	4,217,468	4,220,311	4,223,154	4,225,997	4,228,840	28,429
1,056	4,231,683	4,234,538	4,237,394	4,240,250	4,243,105	4,245,960	4,248,816	4,251,671	4,254,527	4,257,382	28,555
1,057	4,260,238	4,263,108	4,265,977	4,268,847	4,271,716	4,274,586	4,277,456	4,280,325	4,283,195	4,286,064	28,696
1,058	4,288,934	4,291,817	4,294,699	4,297,582	4,300,464	4,303,346	4,306,229	4,309,112	4,311,994	4,314,876	28,825
1,059	4,317,759	4,320,655	4,323,551	4,326,446	4,329,342	4,332,238	4,335,134	4,338,030	4,340,925	4,343,821	28,958
1,060	4,346,717	4,349,611	4,352,505	4,355,399	4,358,293	4,361,188	4,364,082	4,366,976	4,369,870	4,372,764	28,941
1,061	4,375,658	4,378,565	4,381,472	4,384,379	4,387,286	4,390,193	4,393,100	4,396,007	4,398,914	4,401,821	29,070
1,062	4,404,728	4,407,649	4,410,569	4,413,490	4,416,410	4,419,330	4,422,251	4,425,171	4,428,092	4,431,013	29,205
1,063	4,433,933	4,436,867	4,439,800	4,442,734	4,445,668	4,448,602	4,451,535	4,454,469	4,457,403	4,460,336	29,337
1,064	4,463,270	4,466,217	4,469,164	4,472,112	4,475,059	4,478,006	4,480,953	4,483,900	4,486,848	4,489,795	29,472
1,065	4,492,742	4,495,703	4,498,663	4,501,623	4,504,584	4,507,544	4,510,505	4,513,466	4,516,426	4,519,386	29,605
1,066	4,522,347	4,525,321	4,528,296	4,531,270	4,534,244	4,537,218	4,540,193	4,543,167	4,546,141	4,549,116	29,743
1,067	4,552,090										



NOTE:

Drawing furnished by
U.S. Bureau of Reclamation

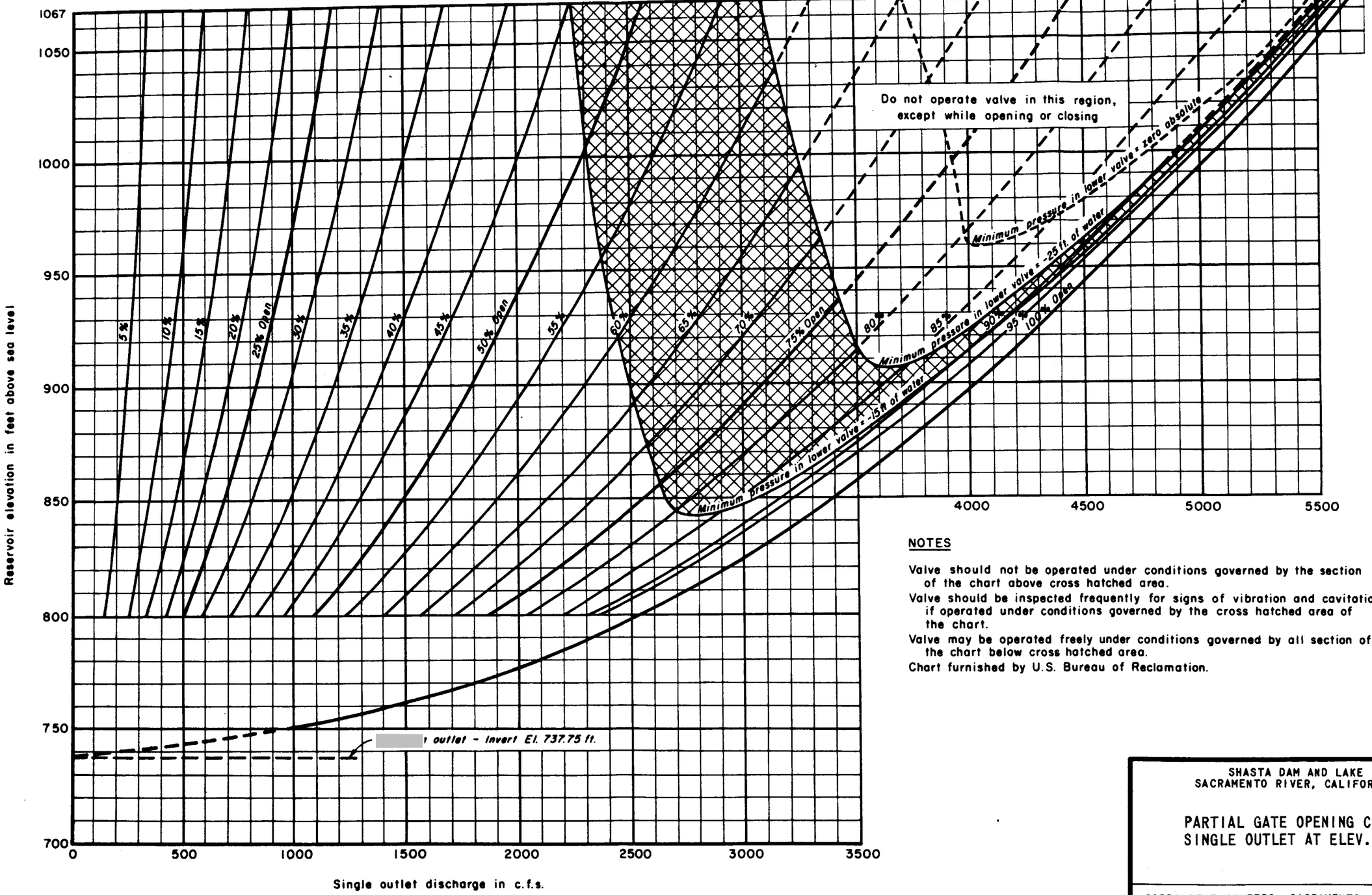
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

SPILLWAY AND OUTLET
RATING CURVES

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.
Drawn: T.K.B.
Date: FEBRUARY 1976

CHART A-3



NOTES

Valve should not be operated under conditions governed by the section of the chart above cross hatched area.

Valve should be inspected frequently for signs of vibration and cavitation if operated under conditions governed by the cross hatched area of the chart.

Valve may be operated freely under conditions governed by all section of the chart below cross hatched area.

Chart furnished by U.S. Bureau of Reclamation.

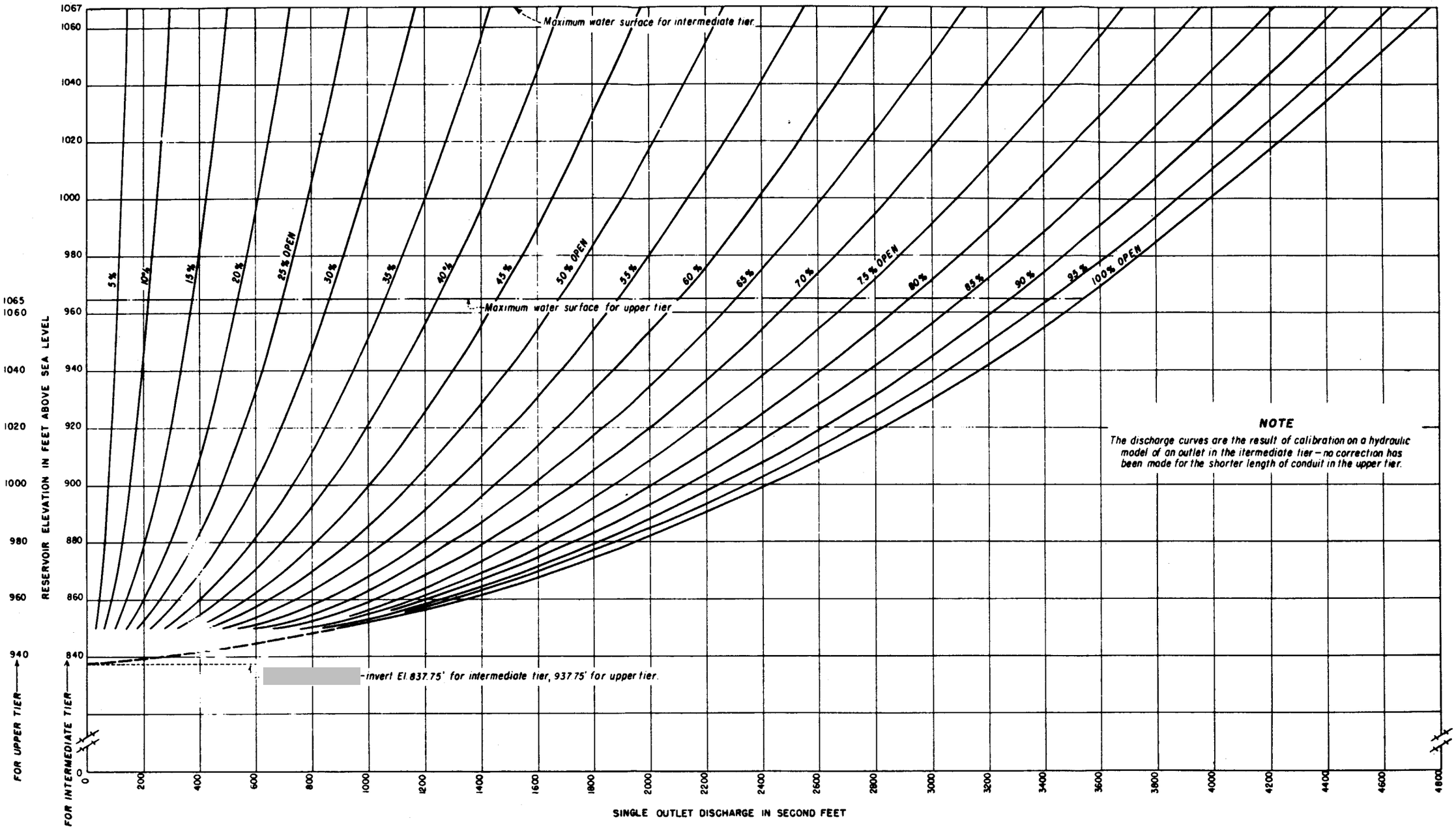
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

PARTIAL GATE OPENING CURVE
SINGLE OUTLET AT ELEV. 742

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.
Drawn: T.K.B.

Date: FEBRUARY 1976



NOTE

The discharge curves are the result of calibration on a hydraulic model of an outlet in the itermediate tier – no correction has been made for the shorter length of conduit in the upper tier.

NOTE :

Drawing furnished by
U.S. Bureau of Reclamation

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

SHASTA DAM
DISCHARGE CURVES

SINGLE OUTLET AT ELEV. 842
AND ELEV. 942

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.
Drawn: T.K.B.
Date: FEBRUARY 1976

DISCHARGE IN CUBIC FEET PER SECOND FOR ONE GATE

RESERVOIR ELEVATION (in feet)	ELEVATION OF HIGH POINT OF DRUM GATE FEET																											
	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065
1071	83,960	76,950	71,290	66,830	63,350	60,300	57,690	54,940	52,210	49,350	46,650	44,040	41,430	38,850	36,210	33,620	31,170	28,760	26,440	24,090	21,810	19,580	17,440	15,370	13,390	11,490	9,680	7,980	6,360
1070.5	82,210	75,100	69,430	65,040	61,690	58,660	56,080	53,350	50,570	47,760	45,110	42,500	39,920	37,420	34,810	32,250	29,840	27,500	25,210	22,900	20,660	18,470	16,370	14,350	12,430	10,580	8,810	7,150	5,600
1070	79,870	73,280	67,690	63,260	60,040	57,040	54,480	51,770	48,950	46,250	43,560	40,980	38,430	36,010	33,450	30,960	28,570	26,260	23,960	21,740	19,520	17,380	15,320	13,360	11,500	9,680	7,970	6,350	4,860
1069.5	77,960	71,370	65,960	61,600	58,410	55,540	52,820	50,140	47,440	44,710	42,060	39,530	37,060	34,620	32,120	29,630	27,280	25,040	22,760	20,570	18,400	16,300	14,300	12,390	10,560	8,810	7,150	5,590	4,150
1069	76,060	69,490	64,170	59,950	56,720	53,860	51,260	48,540	45,850	43,150	40,600	38,110	35,670	33,250	30,750	28,370	26,050	23,820	21,620	19,490	17,310	15,270	13,310	11,450	9,660	7,960	6,350	4,850	3,480
1068.5	74,190	67,720	62,390	58,240	55,120	52,300	49,680	46,960	44,320	41,680	39,150	36,700	34,290	31,940	29,430	27,090	24,840	22,620	20,460	18,330	16,240	14,260	12,340	10,530	8,800	7,140	5,580	4,150	2,860
1068	72,340	65,970	60,730	56,630	53,560	50,750	48,130	45,450	42,780	40,240	37,740	35,320	32,930	30,580	28,180	25,840	23,640	21,460	19,330	17,220	15,210	13,250	11,380	9,630	7,940	6,340	4,850	3,480	2,270
1067.5	70,410	64,240	59,080	55,050	52,000	49,250	46,560	43,900	41,300	38,820	36,350	33,960	31,600	29,230	26,910	24,640	22,440	20,300	18,230	16,180	14,180	12,280	10,500	8,750	7,120	5,570	4,140	2,850	1,730
1067	68,500	62,440	57,370	53,470	50,460	47,710	45,010	42,400	39,880	37,370	34,980	32,600	30,280	27,960	25,650	23,470	21,280	19,210	17,120	15,130	13,190	11,350	9,580	7,900	6,310	4,830	3,480	2,270	1,240
1066.5	66,620	60,750	55,760	51,920	48,900	46,220	43,520	40,940	38,450	35,990	33,630	31,290	29,000	26,710	24,460	22,260	20,130	18,080	16,090	14,110	12,230	10,460	8,700	7,080	5,550	4,130	2,850	1,730	800
1066	64,760	59,000	54,090	50,310	47,370	44,680	42,040	39,510	37,100	34,630	32,270	29,990	27,710	25,440	23,290	21,120	19,070	17,010	15,040	13,110	11,280	9,540	7,860	6,280	4,820	3,470	2,260	1,240	440
1065.5	63,010	57,350	52,520	48,800	45,890	43,200	40,610	38,100	35,680	33,290	30,980	28,760	26,470	24,240	22,110	19,970	17,910	15,960	14,020	12,150	10,390	8,660	7,040	5,520	4,120	2,840	1,720	800	150
1065	61,280	55,630	50,900	47,230	44,360	41,740	39,170	36,630	34,290	31,930	29,700	27,450	25,240	23,080	20,950	18,840	16,850	14,930	13,030	11,200	9,500	7,820	6,250	4,800	3,460	2,260	1,240	440	0
1064.5	59,490	54,020	49,360	45,750	42,920	40,330	37,780	35,320	32,960	30,670	28,480	26,210	24,030	21,900	19,810	17,740	15,810	13,920	12,060	10,300	8,610	7,010	5,490	4,100	2,830	1,720	800	150	
1064	57,720	52,430	47,780	44,300	41,500	38,880	36,410	33,940	31,600	29,360	27,180	25,090	22,850	20,770	18,690	16,690	14,790	12,940	11,120	9,420	7,780	6,220	4,770	3,440	2,250	1,230	440	0	
1063.5	56,050	50,850	46,290	42,860	40,090	37,500	35,020	32,630	30,320	28,180	25,930	23,800	21,680	19,640	17,600	15,660	13,790	11,980	10,220	8,540	6,970	5,460	4,080	2,820	1,720	800	150		
1063	54,320	49,230	44,750	41,440	38,650	36,150	33,650	31,280	29,020	26,850	24,850	22,620	20,540	18,530	16,550	14,640	12,820	11,050	9,340	7,710	6,180	4,750	3,430	2,240	1,230	440	0		
1062.5	52,690	47,620	43,300	39,970	37,280	34,760	32,300	29,980	27,850	25,660	23,560	21,470	19,430	17,450	15,510	13,640	11,870	10,140	8,470	6,910	5,430	4,060	2,810	1,710	800	150			
1062	51,010	46,040	41,860	38,590	35,890	33,440	30,970	28,710	26,530	24,400	22,370	20,340	18,330	16,390	14,490	12,680	10,930	9,260	7,650	6,130	4,710	3,410	2,230	1,230	440	0			
1061.5	49,360	44,360	40,390	37,230	34,560	32,100	29,670	27,490	25,410	23,260	21,220	19,230	17,260	15,360	13,490	11,740	10,040	8,400	6,840	5,380	4,030	2,790	1,700	800	150				
1061	47,720	42,830	38,930	35,890	33,250	30,790	28,390	26,240	24,120	22,120	20,080	18,130	16,210	14,330	12,540	10,820	9,160	7,580	6,070	4,670	3,380	2,220	1,220	430	0				
1060.5	46,180	41,270	37,560	34,560	31,920	29,500	27,180	25,000	23,000	20,950	18,980	17,060	15,190	13,340	11,600	9,940	8,310	6,780	5,330	3,990	2,770	1,680	790	150					
1060	44,590	39,730	36,150	33,250	30,660	28,260	25,980	23,840	21,820	19,820	17,920	16,000	14,170	12,380	10,680	9,080	7,490	6,010	4,620	3,350	2,200	1,210	430	0					
1059.5	43,030	38,220	34,620	31,920	29,410	27,000	24,800	22,660	20,680	18,740	16,840	14,990	13,190	11,450	9,790	8,210	6,700	5,280	3,950	2,740	1,680	790	150						
1059	41,490	36,730	33,450	30,660	28,160	25,800	23,600	21,520	19,550	17,680	15,800	13,990	12,230	10,540	8,920	7,400	5,940	4,570	3,310	2,180	1,200	430	0						
1058.5	39,970	35,330	32,160	29,410	26,940	24,650	22,460	20,410	18,500	16,630	14,800	13,020	11,310	9,660	8,090	6,620	5,210	3,910	2,710	1,660	780	150							
1058	38,480	33,940	30,840	28,140	25,710	23,510	21,330	19,300	17,430	15,590	13,800	12,070	10,410	8,810	9,290	5,860	4,520	3,270	2,150	1,190	420	0							
1057.5	37,010	32,630	29,580	26,940	24,550	22,330	20,240	18,250	16,410	14,600	12,840	11,160	9,540	7,990	6,510	5,140	3,860	2,680	1,640	770	150								
1057	35,570	31,290	28,310	25,710	23,410	21,210	19,130	17,210	15,390	13,600	11,900	10,270	8,700	7,180	5,770	4,450	3,230	2,120	1,170	420	0								
1056.5	34,150	30,020	27,100	24,550	22,250	20,110	18,100	16,190	14,410	12,670	11,010	9,400	7,890	6,420	5,060	3,800	2,640	1,620	760	150									
1056	32,750	28,730	25,870	23,410	21,150	19,070	17,070	15,200	13,450	11,740	10,130	8,570	7,080	5,680	4,380	3,180	2,090	1,160	410	0									
1055.5	31,380	27,460	24,660	22,250	20,040	17,980	16,050	14,220	12,500	10,840	9,270	7,750	6,330	4,970	3,730	2,600	1,590	750	150										
1055	30,030	26,250	23,510	21,150	18,960	16,960	15,050	13,300	11,580	9,980	8,440	6,970	5,600	4,300	3,120	2,060	1,140	410	0										
1054.5	28,710	25,030	22,350	20,040	17,900	15,950	14,090	12,350	10,690	9,140	7,640	6,220	4,890	3,680	2,550	1,560	740	140											
1054	27,410	23,830	21,220	18,960	16,890	14,970	13,160	11,460	9,830	8,310	6,870	5,510	4,230	3,060	2,020	1,120	400	0											
1053.5	26,100	22,690	20,130	17,900	15,870	14,010	12,240	10,560	9,040	9,520	6,120	4,810	3,610	2,500	1,530	720	140												
1053	24,850	21,540	19,040	16,860	14,910	13,080	11,360	9,710	8,190	6,760	5,420	4,160	3,010	1,980	1,100	390	0												
1052.5	23,630	20,410	17,980	15,850	13,940	12,160	10,470	8,890	7,410	6,030	4,740	3,550	2,460	1,500	710	140													
1052	22,430	19,300	16,940	14,860	13,000	11,270	9,620	8,090	6,660	5,330	4,090	2,960	1,950	1,070	390	0													
1051.5	21,260	18,220	15,950	13,900	12,090	10,400	8,800	7,310	5,930	4,660	3,490	2,420	1,480	690	140														
1051	20,110	17,170	14,950	12,960	11,220	9,550	8,000	6,570	5,290	4,030	2,910	1,910	1,050	380	0														
1050.5	18,960	16,140	13,980	12,070	10,360	8,740	7,240	5,860	4,580	3,430	2,380	1,450	680	130															
1050	17,870	15,140	13,040	11,180	9,520	7,950	6,510	5,170	3,960	2,860	1,880	1,030	370	0															
1049.5	16,770	14,160	12,130	10,340	8,710	7,180	5,810	4,530	3,370	2,330	1,420	670	130																
1049	15,730	13,200	11,240	9,520	7,930	6,460	5,130	3,910	2,810	1,840	1,010	360	0																
1048.5	14,690	12,280	10,370	8,710	7,170	5,760	4,480	3,330	2,290	1,390	650	130																	
1048	13,700	11,370	9,550	7,930	6,450	5,090	3,870	2,780	1,810	990	350	0																	
1047.5	12,720	10,500	8,740	7,170	5,740	4,460	3,290	2,260	1,370	680	120																		
1047	11,790	9,650	7,950	6,450	5,080	3,850	2,750	1,790	970	350	0																		
1046.5	10,870	8,830	7,200	5,740	4,460	3,270	2,240	1,350	630	120																			
1046	9,980	8,040	6,470	5,080	3,840	2,730	1,770	960	360	0																			
1045.5	9,120	7,280	5,760	4,460	3,260	2,230	1,340	620	120																				
1045	8,300	6,540	5,090	3,840	2,720	1,750	950	340	0																				
1044.5	7,490	5,830	4,460	3,270	2,230	1,330	610	120																					
1044	6,720	5,150	3,850	2,730	1,750	940	330	0																					
1043.5	5,980	4,500	3,270	2,220	1,320	610	120																						
1043	5,270	3,870	2,730	1,750	940	330	0																						
1042.5	4,600	3,290	2,220	1,320	600	110																							
1042	3,960	2,740	1,750	940	330	0																							
1041.5	3,360	2,230	1,320	600	110																								
1041	2,790	1,750	940	320	0																								
1040.5	2,260	1,330	600	110																									
1040	1,780	940	320	0																									
1039.5	1,340	600	110																										
1039	950	320	0																										
1038.5	610	110																											
1038	320	0																											
1037.5	110																												
1037	0																												

NOTES:

Drum gates should be operated symmetrically to insure proper action in stilling basin.

Data furnished by U.S.B.R.

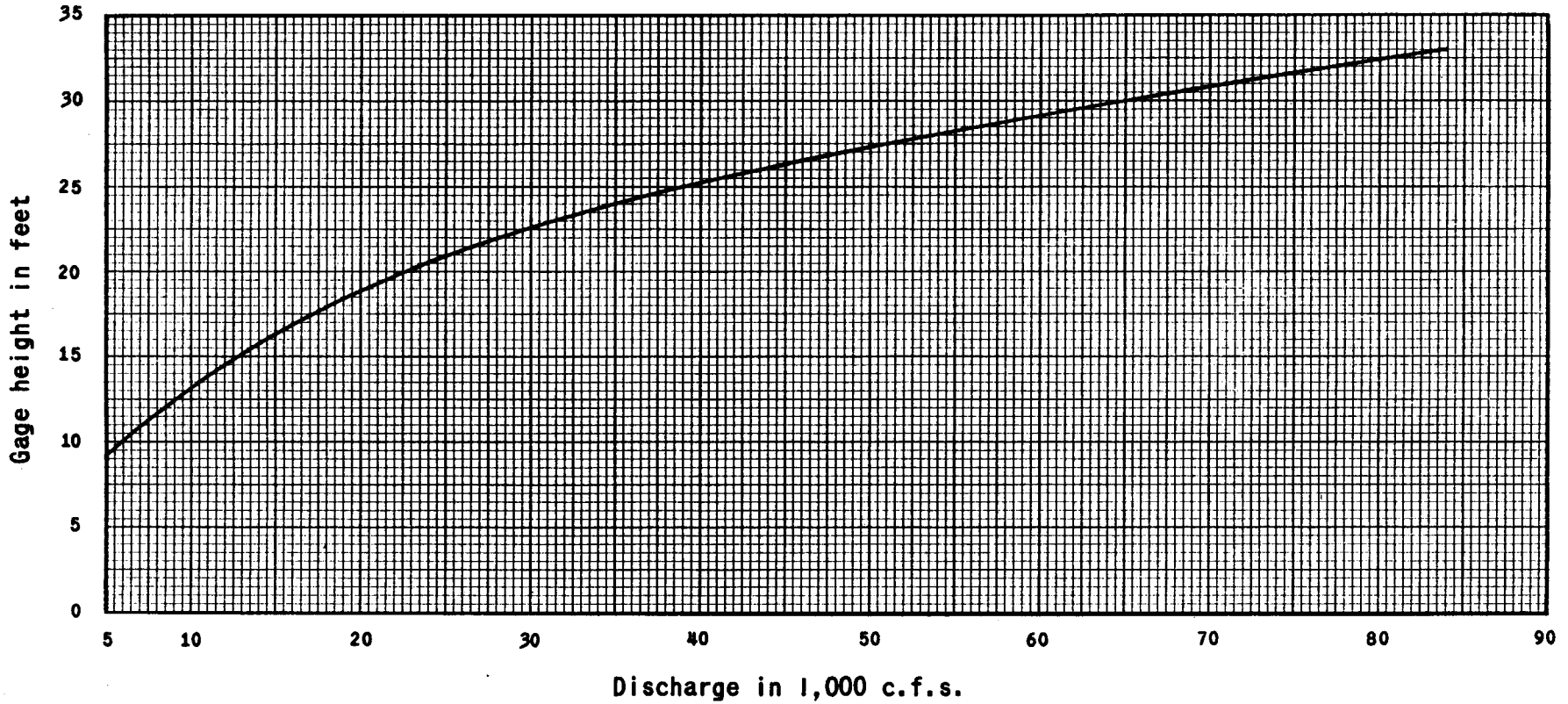
SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

SHASTA DAM
RATING TABLE FOR
DRUM GATE SPILLWAY

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.
Date: JANUARY 1977

CHART A-5



NOTE:

Zero on gage = 479.81 feet M.S.L.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

DISCHARGE RATING CURVE
SACRAMENTO RIVER AT
KESWICK

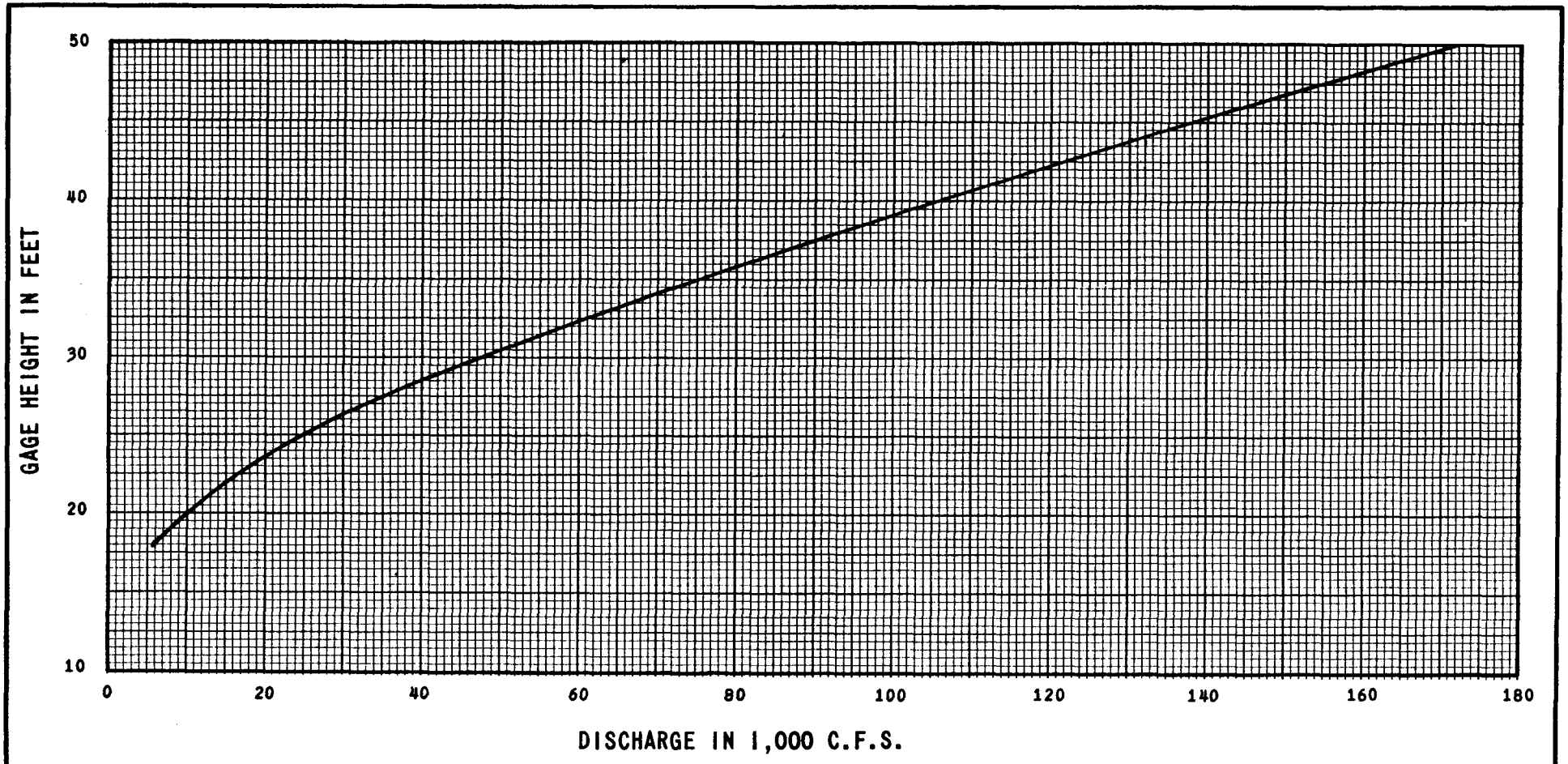
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T.G.K.
Drawn: T.K.B.

Date: JANUARY 1976

CHART A-6

☆GPO 691-283-1976



NOTE:

Zero on gage = 263 feet m.s.l.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

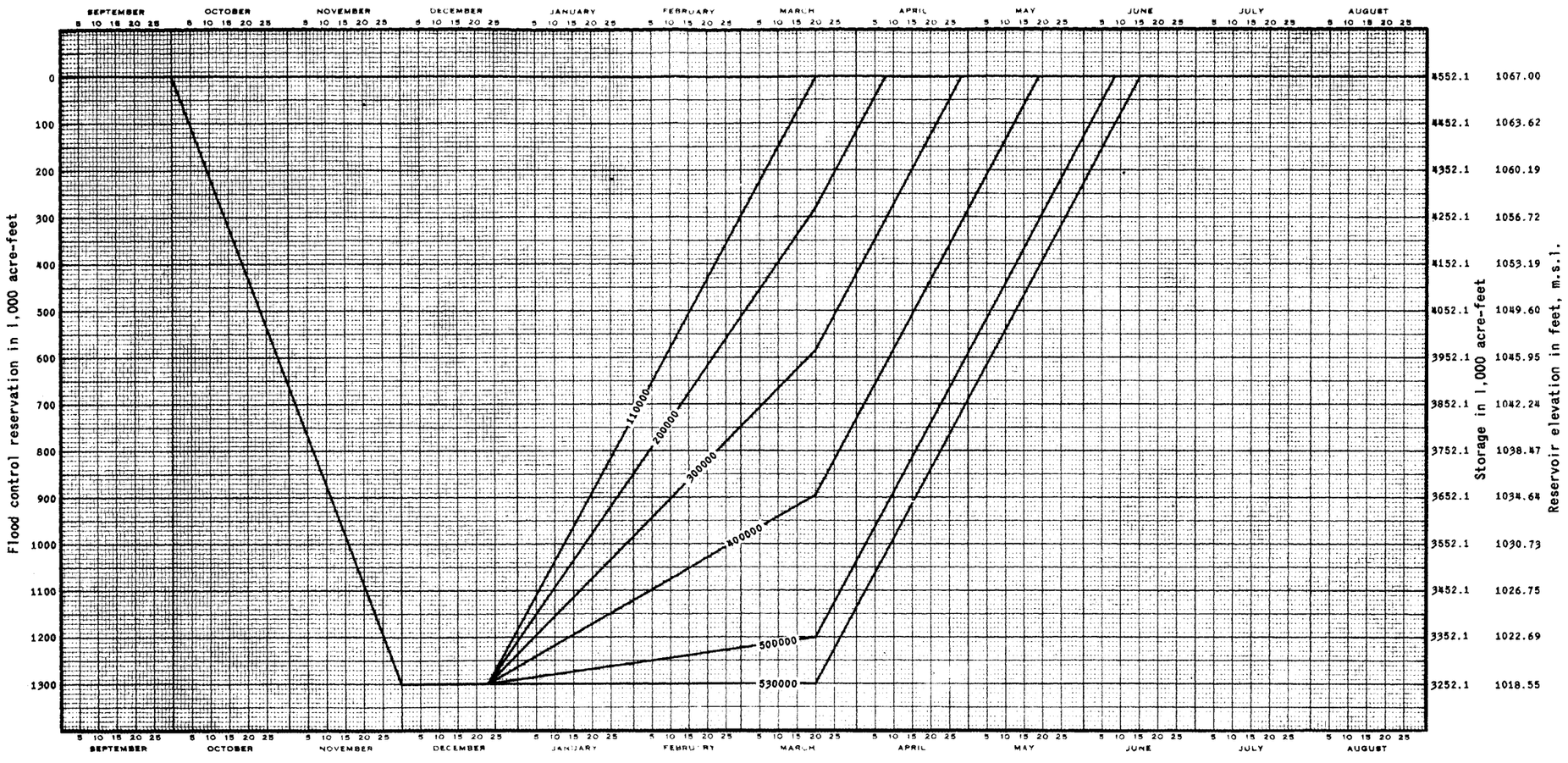
DISCHARGE RATING CURVE
SACRAMENTO RIVER AT BEND BRIDGE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: T. G. K.
Drawn: T. K. B.

Date: FEBRUARY 1976

CHART A-7

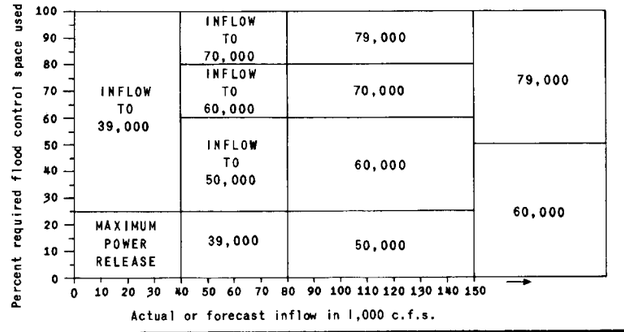


USE OF DIAGRAM

1. Rainflood parameters relate the accumulation of seasonal inflow to the required flood control space reservation on any given day. Parameter values are computed daily, from the accumulation of seasonal inflow by adding the current day's inflow in cubic feet per second (cfs) to 95% of the parameter value computed through the preceding day.*
2. Except when releases are governed by the emergency spillway release diagram currently in force (File No. SA-26-92), water stored in the flood control reservation, defined hereon, shall be released as rapidly as possible, subject to the following conditions:
   a. That releases are made according to the Release Schedule hereon.
   b. That flows in Sacramento River below Keswick Dam do not exceed 79,000 cfs.
   c. That flows in Sacramento River at Bend Bridge gage do not exceed 100,000 cfs.
   d. That releases are not increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period.

*Flood Control Diagram is initialized each flood season by assuming a parameter value of 100,000 c.f.s. day on 1 October.

RELEASE SCHEDULE



SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

FLOOD CONTROL DIAGRAM

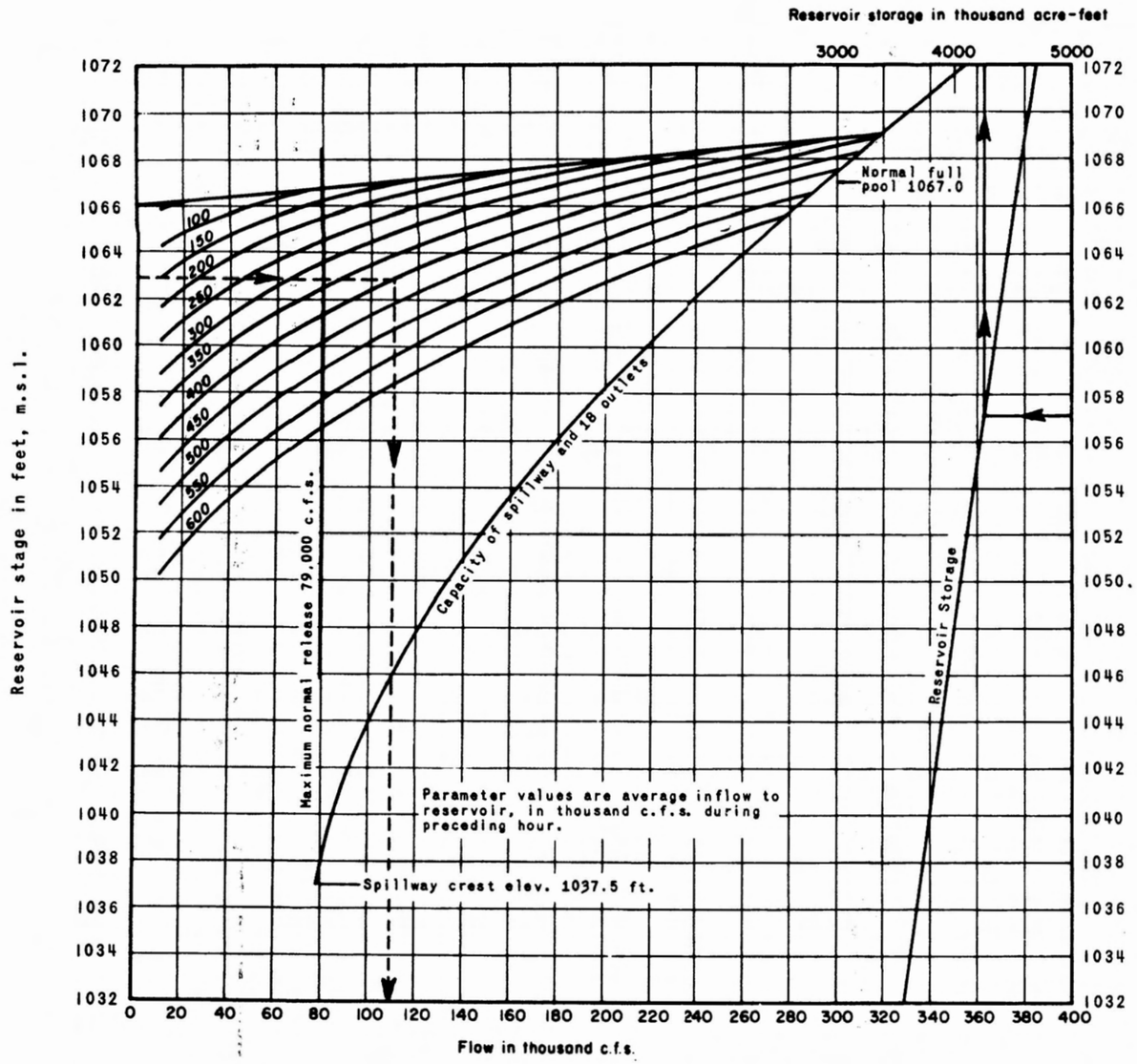
Prepared Pursuant to Flood Control Regulations for Shasta Dam and Lake

APPROVED: Richard M. Connell
Brigadier General, USA, Division Engineer
South Pacific Division

APPROVED: B. E. Martin
Regional Director Mid Pacific Region
U.S.B.R.

Effective Date: 8 JUL 1977 File No. SA-17-26-13

CHART A-8



USE OF DIAGRAM

1. When reservoir stage is rising, determine the average inflow to the reservoir during the preceding hour.
2. From the parameter line corresponding to this inflow, read the flow corresponding to the current reservoir stage.
3. When this value of flow exceeds the current release, increase the release to this value.
4. Repeat steps 1 through 3 each hour until maximum gate opening has been reached.
5. Maintain this maximum gate opening until reservoir stage begins to fall and is below elevation 1069 feet.
6. When the reservoir stage is falling and is below elevation 1069 feet determine the average inflow to the reservoir during the preceding hour.
7. Decrease the release by .3 of the value obtained in step 6.
8. Repeat steps 6 through 7 each hour, as long as the reservoir level is receding, until the release have been reduced to the value required by the Flood Control Diagram.
9. Once operation in accordance with the Emergency Spillway Release Diagram is initiated, gate changes shall be made only at such times as criteria under steps 1 through 4 require increased gate openings or criteria under steps 6 through 8 require decreased gate openings, until the release has been reduced to the value required by the Flood Control Diagram.

NOTES:

Top of spillway gates in raised position is at elevation 1065.0 feet.

Spillway discharge is controlled by three 110 feet by 28 feet drum gates.

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

EMERGENCY SPILLWAY RELEASE DIAGRAM

Prepared Pursuant to Flood Control Regulations for Shasta Dam and Lake

APPROVED: Richard M. Connell
Brigadier General, USA, Division Engineer
South Pacific Division

APPROVED: B. E. Martin
Regional Director Mid Pacific Region
U.S.B.R.

Effective Date: 8 JUL 19[illegible] File No. SA-26-92

CHART A-9

SHASTA DAM AND LAKE
SACRAMENTO RIVER, CALIFORNIA

REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

JANUARY 1977

APPENDIX A
PART II
FLOOD CONTROL REGULATIONS

Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

absence of any indication that further public comment would shed any new light on the matter, OSHA concludes that no change in the standard is warranted. Accordingly, the ground-fault protection standard at 29 CFR 1910.309(c) and 29 CFR 1926.400(h), as promulgated on December 21, 1976, is hereby reaffirmed.

(Secs. 6(b) and 8(c), Pub. L. 91-596, 84 Stat. 1593, 1599 (29 U.S.C. 655, 657); sec. 107, Pub. L. 91-54, 83 Stat. 96 (40 U.S.C. 333); Secretary of Labor's Order No. 8-76 (41 FR 25059); 29 CFR Part 1911.)

Signed at Washington, D.C., this 3d day of October 1978.

EULA BINGHAM,
Assistant Secretary of Labor.

[FR Doc. 78-28687 Filed 10-12-78; 8:45 am]

[3710-92-M]

Title 33—Navigation and Navigable Waters

CHAPTER II—CORPS OF ENGINEERS, DEPARTMENT OF THE ARMY

[ER 1110-2-241]

PART 208—FLOOD CONTROL REGULATIONS

Use of Storage Allocated for Flood Control and Navigation Purposes

AGENCY: U.S. Army Corps of Engineers, DOD.

ACTION: Final rule.

SUMMARY: This revision of 33 CFR 208.11 regulations prescribes the policy and procedure for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation. The revised regulations are applicable to dam and reservoir projects licensed, maintained, and operated under provisions of the Federal Power Act (41 Stat. 1063 (16 U.S.C. 791(A))), Pub. L. 83-436, and other similar authorizing legislation; as well as to reservoir projects constructed wholly or in part with Federal funds as directed by section 7 of the Flood Control Act of 1944. These regulations are intended to establish an understanding between project owners, operating agencies and the Corps of Engineers with regard to certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. Interested persons were given until November 2, 1977 (42 FR 57141) to submit comments. No written comments were received.

DATES: This regulation is effective on October 15, 1978.

ADDRESSES: HQDA (DAEN-CWE-HY) Washington, D.C. 20314.

FOR FURTHER INFORMATION CONTACT:

Mr. Edgar P. Story, Engineering Division, Civil Works Directorate, Office of the Chief of Engineers, Washington, D.C. 20314 202-693-7330.

SUPPLEMENTARY INFORMATION: This final regulation is essentially the same as the proposed rule (42 FR 53637), however, certain reordering has been done of the reference material presented in § 208.11(b). Specifically, excerpts from sections 4(e), 10(a), and 10(c) of the Federal Power Act have been added for improved clarity. Also Federal Power Commission order No. 540 issued October 31, 1975, and published November 7, 1975 (40 FR 51998), amending § 2.9 of the Commission's general policy and interpretations which prescribed standardized conditions (Forms) for inclusion in preliminary permits and licenses issued under part I of the Federal Power Act has been cited and appropriately excerpted. Reference to and citation from article 33 of Federal Power Commission license No. 2009 have been deleted in lieu thereof.

In addition to the proposed action, certain project names and pertinent data are added to and deleted from the list of projects shown in § 208.11(e), list of projects (42 FR 53637). The following projects are added to the list of projects:

(a) U.S. Army Corps of Engineers, Missouri River Division area: Webster Dam and Lake.

(b) U.S. Army Corps of Engineers, New England Division area:

(i) Bear Swamp Pumped Storage Project.

(ii) Turners Falls Reservoir.

(c) U.S. Army Corps of Engineers, North Pacific Division area:

(i) American Falls Dam and Reservoir.

(ii) Anderson Ranch Dam and Reservoir.

(iii) Arrowrock Dam and Reservoir.

(iv) Brownlee Dam and Reservoir.

(v) Grand Coulee Dam and Franklin D. Roosevelt Lake.

(vi) Hells Canyon Dam and Reservoir.

(vii) Kerr Dam and Flathead Lake.

(viii) Mayfield Dam and Reservoir.

(ix) Mossyrock Dam and Davisson Lake.

(x) Oxbow Dam and Reservoir.

(xi) Priest Rapids Dam and Reservoir.

(xii) Ririe Dam and Reservoir.

(xiii) Rocky Reach Dam and Lake Entiat.

(xiv) Ross Dam and Reservoir.

(xv) Upper Baker Dam and Baker Lake.

(xvi) Wanapum Dam and Reservoir.

(xvii) Wells Dam and Lake Pateros.

(d) U.S. Army Corps of Engineers, South Atlantic Division area: Lewis M. Smith Dam and Reservoir.

(e) U.S. Army Corps of Engineers, South Pacific Division area:

(i) Indian Valley Dam and Reservoir.

(ii) Lemon Dam and Reservoir.

(iii) Navajo Dam and Reservoir.

(iv) Paoina Dam and Reservoir.

(v) Vallecito Dam and Reservoir.

The following projects are deleted from the list of projects:

(a) U.S. Army Corps of Engineers, South Altantic Division area: H. Neely Henry Dam and Reservoir.

(b) U.S. Army Corps of Engineers, South Pacific Division area:

(i) Causey Dam and Reservoir.

(ii) Devil Creek Dam and Reservoir.

NOTE.—The Chief of Engineers has determined that this rule does not contain a major proposal requiring preparation of an inflation impact statement under Executive Order 11821 and OMB Circular A-107 (Statutory Authority Pub. L. 90-483).

Dated: October 10, 1978.

CHARLES I. MCGINNIS,
Major General, USA,
Director of Civil Works.

Section 208.11 is revised to read as follows:

§ 208.11 Regulations for use of storage allocated for flood control or navigation and/or project operation at reservoirs subject to prescription of rules and regulations by the Secretary of the Army in the interest of flood control and navigation.

(a) *Purpose.* This regulation prescribes the responsibilities and general procedures for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation, except projects owned and operated by the Corps of Engineers; the International Boundary and Water Commission, United States and Mexico; and those under the jurisdiction of the International Joint Commission, United States, and Canada, and the Columbia River Treaty. The intent of this regulation is to establish an understanding between project owners, operating agencies, and the Corps of Engineers.

(b) *Responsibilities.* The basic responsibilities of the Corps of Engineers regarding project operation are set out in the cited authority and described in the following paragraphs:

(1) Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) directs the Secretary of the Army to prescribe regulations for flood control and navigation in the following manner:

Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: *Provided*, That this section shall not apply to the Tennessee Valley Authority, except that in case of danger from floods on the lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of water from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department.

(2) Federal Energy Regulatory Commission (formerly Federal Power Commission (FPC)) licenses.

(i) Responsibilities of the Secretary of the Army and/or the Chief of Engineers in Federal Energy Regulatory Commission (FERC) licensing actions are set out in the Federal Power Act. Pertinent sections of that Act are cited herein. The Commission may also stipulate, as part of license conditions, that the licensee enter into an agreement with the Department of the Army providing for operation of the project during flood times, in accordance with rules and regulations prescribed by the Secretary of the Army.

(A) Section 4(e) of the Federal Power Act requires approval by the Chief of Engineers and the Secretary of the Army of plans of dams or other structures affecting the navigable capacity of any navigable waters of the United States, prior to issuance of a license by the Commission as follows:

The Commission is hereby authorized and empowered to issue licenses to citizens * * * for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation and for the development, transmission, and utilization of power across, along, from or in any of the streams or other bodies of water over which Congress has jurisdiction * * * *Provided further*, That no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of the Army.

(B) Sections 10(a) and 10(c) of the Federal Power Act specify conditions of project licenses including the following:

(1) Section 10(a). That the project adopted * * * shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use of benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, and for other beneficial public use * * *.

(2) Section 10(c). That the licensee shall * * * so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property.* * *

(C) Section 18 of the Federal Power Act directs the operation of any navigation facilities built under the provision of that act, be controlled by rules and regulations prescribed by the Secretary of the Army as follows:

The operation of any navigation facilities which may be constructed as part of or in connection with any dam or diversion structure built under the provisions of this Act, whether at the expense of a licensee hereunder or of the United States, shall at all times be controlled by such reasonable rules and regulations in the interest of navigation; including the control of the pool caused by such dam or diversion structure as may be made from time to time by the Secretary of the Army, * * *

(ii) Federal Power Commission order No. 540 issued October 31, 1975, and published November 7,1975 (40 FR 51998), amending section 2.9 of the Commission's general policy and interpretations prescribed standardized conditions (forms) for inclusion in preliminary permits and licenses issued under part I of the Federal Power Act. As an example, article 12 of standard form L-3, titled: "Terms and Conditions of License for Constructed Major Projects Affecting Navigable Waters of the United States," sets out the Commission's interpretation of appropriate sections of the Act, which deal with navigation aspects, and attendant responsibilities of the Secretary of the Army in licensing actions as follows:

The United States specifically retains and safeguards the right to use water in such amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected; and the operation of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, * * *, and the Licensee shall release water from the project reservoir at such rate * * *, as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.

(3) Section 9 of Public Law 436, 83d Congress (68 Stat. 303) provides for the development of the Coosa River, Ala. and Ga., and directs the Secretary of the Army to prescribe rules and regulations for project operation in the interest of flood control and navigation as follows:

The operation and maintenance of the dams shall be subject to reasonable rules and regulations of the Secretary of the Army in the interest of flood control and navigation.

NOTE.—This Regulation will also be applicable to dam and reservoir projects operated under provisions of future legislative acts wherein the Secretary of the Army is directed to prescribe rules and regulations in the interest of flood control and navigation. The Chief of Engineers, U.S. Army Corps of Engineers, is designated the duly authorized representative of the Secretary of the Army to exercise the authority set out in the congressional acts. This regulation will normally be implemented by letters of understanding between the Corps of Engineers and project owner and will incorporate the provisions of such letters of understanding prior to the time construction renders the project capable of significant impoundment of water. A water control agreement signed by both parties will follow when deliberate impoundment first begins or at such time as the responsibilities of any corps-owned projects may be transferred to another entity. Promulgation of this regulation for a given project will occur at such time as the name of the project appears in the FEDERAL REGISTER in accordance with the requirements of § 208.11(d)(11). When agreement on a water control plan cannot be reached between the corps and the project owner after coordination with all interested parties, the project name will be entered in the FEDERAL REGISTER and the Corps of Engineers plan will be the officials water control plan until such time as differences can be resolved.

(c) *Scope and terminology.* This regulation applies to Federal authorized flood control and/or navigation storage projects, and to non-Federal projects which require the Secretary of the Army to prescribe regulations as a condition of the license, permit or legislation, during the planning, design and construction phases, and throughout the life of the project. In compliance with the authority cited above, this regulation defines certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. In carrying out the conditions of this regulation, the owner and/or operating agency will comply with applicable provisions of Pub. L. 85-624, the Fish and Wildlife Coordination Act of 1958, and Pub. L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. This regulation does not apply to local flood protection works governed by § 208.10, or to navigation facilities and associated structures which are otherwise covered by part 207 (Navigation Regulations) of title 33 of the code. Small reservoirs, containing less than 12,500 acre-feet of flood control or navigation storage, may be excluded from this regulation and covered under § 208.10, unless specifically required by law or conditions of the license or permit.

(1) The terms "reservoir" and "project" as used herein include all water resource impoundment projects constructed or modified, including natural lakes, that are subject to this regulation.

(2) The term "project owner" refers to the entity responsible for maintenance, physical operation, and safety of the project, and for carrying out the water control plan in the interest of flood control and/or navigation as prescribed by the Corps of Engineers. Special arrangements may be made by the project owner for "operating agencies" to perform these tasks.

(3) The term "letter of understanding" as used herein includes statements which consummate this regulation for any given project and define the general provisions or conditions of the local sponsor, or owner, cooperation agreed to in the authorizing legislative document, and the requirements for compliance with section 7 of the 1944 Flood Control Act, the Federal Power Act or other special congressional act. This information will be specified in the water control plan and manual. The letter of understanding will be signed by a duly authorized representative of the Chief of Engineers and the project owner. A "field working agreement" may be substituted for a letter of understanding, provided that the specified minimum requirements of the latter, as stated above, are met.

(4) The term "water control agreement" refers to a compliation of water control criteria, guidelines, diagrams, release schedules, rule curves and specifications that basically govern the use of reservoir storage space allocated for flood control or navigation and/or release functions of a water control project for these purposes. In general, they indicate controlling or limiting rates of discharge and storage space required for flood control and/or navigation, based on the runoff potential during various seasons of the year.

(5) For the purpose of this regulation, the term "water control plan" is limited to the plan of regulation for a water resources project in the interest of flood control and/or navigation. The water control plan must conform with proposed allocations of storage capacity and downstream conditions or other requirements to meet all functional objectives of the particular project, acting separately or in combination with other projects in a system.

(6) The term "real-time" denotes the processing of current information or data in a sufficiently timely manner to influence a physicial response in the system being monitored and controlled. As used herein the term connotes * * * the analyses for and execution of water control decisions for both minor and major flood events and for navigation, based on prevailing hydrometeorological and other conditions and constraints, to achieve efficient management of water resource systems.

(d) *Procedures.* (1) *Conditions during project formulation.* During the planning and design phases, the project owner should consult with the Corps of Engineers regarding the quantity and value of space to reserve in the reservoir for flood control and/or navigation purposes, and for utilization of the space, and other requirements of the license, permit or conditions of the law. Relevant matters that bear upon flood control and navigation accomplishment include: runoff potential, reservoir discharge capability, downstream channel characteristics, hydrometeorological data collection, flood hazard, flood damage charateristics, real estate acquisition for flowage requirements (fee and easement), and resources required to carry out the water control plan. Advice may also be sought on determination of and regulation for the probable maximum or other design flood under consideration by the project owner to establish the quantity of surcharge storage space, and freeboard elevation of top of dam or embankment for safety of the project.

(2) *Corps of Engineers involvement.* If the project owner is responsible for real-time implemenetation of the water control plan, consultation and assistance will be provided by the Corps of Engineers when appropriate and to the extent possible. During any emergency that affects flood control and/or navigation, the Corps of Engineers may temporarily prescribe regulation of flood control or navigation storage space on a day-to-day (real-time) basis without request of the project owner. Appropriate consideration will be given for other authorized project functions. Upon refusal of the project owner to comply with regulations prescribed by the Corps of Engineers, a letter will be sent to the project owner by the Chief of Engineers or his duly authorized representative describing the reason for the regulations prescribed, events that have transpired, and notification that the project owner is in violation of the Code of Federal Regulations. Should an impasse arise, in that the project owner or the designated operating entity persists in noncompliance with regulations prescribed by the Corps of Engineers, measures may be taken to assure compliance.

(3) *Corps of Engineers implementation of real-time water control decisions.* The Corps of Engineers may prescribe the continuing regulation of flood control storage space for any project subject to this regulation on a day-to-day (real-time) basis. When this is the case, consultation and assistance from the project owner to the extent possible will be expected. Special requests by the project owner, or appropriate operating entity, are preferred before the Corps of Engineers offers advice on real-time regulation during surcharge storage utilization.

(4) *Water control plan and manual.* Prior to project completion, water control managers from the Corps of Engineers will visit the project and the area served by the project to become familiar with the water control facilities, and to insure sound formulation of the water control plan. The formal plan of regulation for flood control and/or navigation, referred to herein as the water control plan, will be developed and documented in a water control manual prepared by the Corps of Engineers. Development of the manual will be coordinated with the project owner to obtain the necessary pertinent information, and to insure compatibility with other project purposes and with surcharge regulation. Major topics in the manual will include: Authorization and description of the project, hydrometeorology, data collection and communication networks, hydrologic forecasting, the water control plan, and water resource management functions, including responsibilities and coordination for water control decisionmaking. Special instructions to the dam tender or reservoir manager on data collection, reporting to higher Federal authority, and on procedures to be followed in the event of a communication outage under emergency conditions, will be prepared as an exhibit in the manual. Other exhibits will include copies of this regulation, letters of understanding consummating this regulation, and the water control agreements. After approval by the Chief of Engineers or his duly authorized representative, the manual will be furnished the project owner.

(5) *Water control agreement.* (i) A water control diagram (graphical) will be prepared by the Corps of Engineers for each project having variable space reservation for flood control and/or navigation during the year; e.g., variable seasonal storage, joint-use space, or other rule curve designation. Reservoir inflow parameters will be included on the diagrams when appropriate. Concise notes will be included on the diagrams prescribing the use of storage space in terms of release schedules, runoff, nondamaging or other controlling flow rates downstream of the damsite, and other major factors as appropriate. A water control release schedule will be prepared in tabular form for projects that do not have variable space reservation for flood control and/or navigation. The water control diagram or release schedule will be signed by a duly authorized representative of the Chief of Engineers, the project owner, and the designated operating agency, and will be used as the basis for carrying out this

regulation. Each diagram or schedule will contain a reference to this regulation.

(ii) When deemed necessary by the Corps of Engineers, information given on the water control diagram or release schedule will be supplemented by appropriate text to assure mutual understanding on certain details or other important aspects of the water control plan not covered in this regulation, on the water control diagram or in the release schedule. This material will include clarification of any aspects that might otherwise result in unsatisfactory project performance in the interest of flood contol and/or navigation. Supplementation of the agreement will be necessary for each project where the Corps of Engineers exercises the discretionary authority to prescribe the flood control regulation on a day-to-day (real-time) basis. The agreement will include delegation of the responsibility. The document should also cite, as appropriate, section 7 of the 1944 Flood Control Act, the Federal Power Act and/or other congressional legislation authorizing construction an/or directing operation of the project.

(iii) All flood control regulations published in the FEDERAL REGISTER under this section (part 208) of the code prior to the date of this publication which are listed in paragraph 208.11(e) are hereby superseded.

(iv) Nothing in this regulation prohibits the promulgation of specific regulations for a project in compliance with the authorizing acts, when agreement on acceptable regulations cannot be reached between the Corps of Engineers and the owner.

(6) *Hydrometeorological instrumentation.* The project owner will provide instrumentation in the vicinity of the damsite and will provide communication equipment necessary to record and transmit hydrometeorological and reservoir data to all appropriate Federal authorities on a real-time basis unless there are extenuating circumstances or are otherwise provided for as a condition of the license or permit. For those projects where the owner retains responsibility for real-time implementation of the water control plan, the owner will also provide or arrange for the measurement and reporting of hydrometeorological parameters required within and adjacent to the watershed and downstream of the damsite, sufficient to regulate the project for flood control and/or navigation in an efficient manner. When data collection stations outside the immediate vicinity of the damsite are required, and funds for installation, observation, and maintenance are not available from other sources, the Corps of Engineers may agree to share the costs for such stations with the project owner. Availability of funds and urgency of data needs are factors which will be considered in reaching decisions on cost sharing.

(7) *Project safety.* The project owner is responsible for the safety of the dam and appurtenant facilities and for regulation of the project during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the project owner, and does not relieve the owner of the responsibility for safety of the project.

(8) *Notification of the general public.* The Corps of Engineers and other interested Federal and State agencies, and the project owner will jointly sponsor public involvement activities, as appropriate, to fully apprise the general public of the water control plan. Public meetings or other effective means of notification and involvement will be held, with the initial meeting being conducted as early as practicable but not later than the time the project first becomes operational. Notice of the initial public meeting shall be published once a week for 3 consecutive weeks in one or more newspapers of general circulation published in each county covered by the water control plan. Such notice shall also be used when appropriate to inform the public of modifications in the water control plan. If no newspaper is published in a county, the notice shall be published in one or more newspapers of general circulation within that county. For the purposes of this section a newspaper is one qualified to publish public notices under applicable State law. Notice shall be given in the event significant problems are anticipated or experienced that will prevent carrying out the approved water control plan or in the event that an extreme water condition is expected that could produce severe damage to property or loss of life. The means for conveying this information shall be commensurate with the urgency of the situation. The water control manual will be made available for examination by the general public upon request at the appropriate office of the Corps of Engineers, project owner or designated operating agency.

(9) *Other generalized requirements for flood control and navigation.* (i) Storage space in the reservoirs allocated for flood control and navigation purposes shall be kept available for those purposes in accordance with the water control agreement, and the plan of regulation in the water control manual.

(ii) Any water impounded in the flood control space defined by the water control agreement shall be evacuated as rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from reservoirs shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan or regulation may require releases to be completely curtailed in the interest of flood control or safety of the project.

(iii) Nothing in the plan of regulation for flood control shall be construed to require or allow dangerously rapid changes in magnitudes of releases. Releases will be made in a manner consistent with requirements for protecting the dam and reservoir from major damage during passage of the maximum design flood for the project.

(iv) The project owner shall monitor current reservoir and hydro- meteorological conditions in and adjacent to the watershed and downstream of the damsite, as necessary. This and any other pertinent information shall be reported to the Corps of Engineers on a timely basis, in accordance with standing instructions to the damtender or other means requested by the Corps of Engineers.

(v) In all cases where the project owner retains responsibility for real-time implementation of the water control plan, he shall make current determinations of: Reservoir inflow, flood control storage utilized, and scheduled releases. He shall also determine storage space and releases required to comply with the water control plan prescribed by the Corps of Engineers. The owner shall report this information on a timely basis as requested by the Corps of Engineers.

(vi) The water control plan is subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the project owner and shall include justification for the action.

(vii) The project owner may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest

means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Chief of Engineers, or his duly authorized representative.

(viii) Advance approval of the Chief of Engineers, or his duly authorized representative, is required prior to any deviation from the plan of regulation prescribed or approved by the Corps of Engineers in the interest of flood control and/or navigation, except in emergency situations provided for in paragraph (d)(9)(vii) of this section. When conditions appear to warrant a prolonged deviation from the approved plan, the project owner and the Corps of Engineers will jointly investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigations and evaluations have been conducted to the extent deemed necessary by the Chief of Engineers, or his designated representatives, to fully substantiate the deviation.

(10) *Revisions.* The water control plan and all associated documents will be revised by the Corps of Engineers, as necessary, to reflect changed conditions that come to bear upon flood control and navigation, e.g., reallocation of reservoir storage space due to sedimentation or transfer of storage space to a neighboring project. Revision of the water control plan, water control agreement, water control diagram, or release schedule requires approval of the Chief of Engineers or his duly authorized representative. Each such revision shall be effective upon the date specified in the approval. The original (signed document) water control agreement shall be kept on file in the Office, Chief of Engineers, Department of the Army, Washington, D.C. Copies of the agreement shall be kept on file and may be obtained from the office of the project owner, or from the office of the appropriate Division Engineer, Corps of Engineers.

(11) *Federal Register.* The following information for each project subject to section 7 of the 1944 Flood Control Act and other applicable congressional acts shall be published in the FEDERAL REGISTER prior to the time the projects becomes operational and prior to any significant impoundment before project completion or * * * at such time as the responsibility for physical operation and maintenance of the Corps of Engineers owned projects is transferred to another entity: (i) Reservoir, dam, and lake names, (ii) stream, county, and State corresponding to the damsite location, (iii) the maximum current storage space in acre-feet to be reserved exclusively for flood control and/or navigation purposes, or any multiple-use space (intermingled) when flood control or navigation is one of the purposes, with corresponding elevations in feet above mean sea level, and area in acres at the upper and lower limits of said space, (iv) the name of the project owner, and (v) congressional legislation authorizing the project for Federal participation.

(e) *List of projects.* The following tables, "Pertinent Project Data—Section 208.11 Regulation," show the pertinent data for projects which are subject to this regulation.

(Sec. 7, Pub. L. 78-534, 58 Stat. 890 (33 U.S.C. 709); the Federal Power Act, 41 Stat. 1063 (16 U.S.C. 791(A)); and Sec. 9, Pub. L. 83-436, 68 Stat. 303.)

[FR Doc. 78-29100 Filed 10-12-78; 8:45 am]

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Alpine Dam	Keith Creek	Winnebago, IL	0.585	796.0	764.0	51.88	0	-	-	-	-	-	City of Rockford, IL	PWA Proj.
Agency Valley Dam & Res	N. Fork Malheur Riv.	Malheur, OR	-	-	-	-	-	60.0	3340.0	3263.21	1,900	0	Bureau of Reclamation	PL 68-292
American Falls Dam & Reservoir	Snake River	Power, ID	-	-	-	-	-	1,700	4343.2	4295.6	56,100	0	Bureau of Reclamation	FPC NO. 2259
Anderson Ranch Dam & Reservoir	S.Fk. Boise River	Elmore, ID	-	-	-	-	-	423.2	4196.0	4043.0	4,740	1,150	Bureau of Reclamation	Rec. Proj. Act of 1939 (53 Stat. 1187)
Arrowrock Dam & Reservoir	Boise River	Elmore, ID	-	-	-	-	-	286.6	3216.0	2967.0	3,100	200	Bureau of Reclamation	Rec.Act of 17 Jun 1902 (32 Stat. 388)
Bear Creek Dam	Bear Creek	Marion & Ralls, MO	8.7	546.5	520.0	540	0	-	-	-	-	-	City of Hannibal, MO	PL 83-780
Bear Swamp Pumped Storage Proj.	Trib. of Deerfield River	Franklin, MA	-	-	-	-	-	(No specific FC/Nav. Storage Allocation)					New Eng Power CO.	Fed. Power Act.
Big Dry Creek and Diversion	Big Dry Creek and Dog Creek	Fresno, CA	16.25	425.0	393.0	1,530	0	-	-	-	-	-	Reclamation Board CA	PL 77-228
Bonny Dam & Reservoir	S. Fork Republican River	Yuma, CO	128.8	3710.0	3672.0	5,036	2,042	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Boysen Dam & Reservoir	Wind River	Fremont, WY	146.0	4732.0	4725.0	22,100	19,560	146.1	4725.0	4717.0	19,560	16,955	Bureau of Reclamation	PL 78-534
Brownlee Dam & Reservoir	Snake River	Baker, OR; Washington, ID	-	-	-	-	-	980.3	2077.0	1976.0	13,840	6,650	Idaho Power Company	FPC No. 1971-C
Bully Creek Dam & Reservoir	Bully Creek	Malheur, OR	-	-	-	-	-	31.65	2523.0	2456.8	1,082	140	Bureau of Reclamation	PL 86-248
Comanche Dam & Reservoir	Mokelumne River	San Joaquin, CA	-	-	-	-	-	200.0	235.5	205.1	7,600	5,507	East Bay Mun Util Dist. Oakland, CA	PL 86-645
Canyon Ferry Dam & Lake	Missouri Riv.	Lewis & Clark, MT	104.3	3800.0	3797.0	35,181	34,435	799.1	3797.0	3770.0	34,435	24,126	Bureau of Reclamation	PL 78-534

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Cedar Bluff Dam & Reservoir	Smoky Hill River	Trego, KS	191.9	2166.0	2144.0	10,790	6,869	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Clark Canyon Dam & Reservoir	Beaverhead River	Beaverhead, MT	79.1	5560.4	5546.1	5,903	5,160	50.4	5546.1	5535.7	5,160	4,496	Bureau of Reclamation	PL 78-534
Del Valle Dam & Reservoir	Alameda Creek	Alameda,CA	37.0	745.0	703.1	1,060	710	1.0	703.1	702.2	710	700	CA Dept of Water Resources	PL 87-874
East Canyon Dam & Reservoir	East Canyon Creek	Morgan, UT	-	-	-	-	-	48.0	5705.5	5577.0	684	127	Bureau of Reclamation	PL 81-273
Echo Dam and Reservoir	Weber River	Summit, UT	-	-	-	-	-	74.0	5560.0	5450.0	1,455	0	Bureau of Reclamation	PL 81-273
Emigrant Dam & Reservoir	Emigrant Creek	Jackson, OR	39.0	2241.0	2131.5	801	80	-	-	-	-	-	Bureau of Reclamation	PL 83-606
Enders Dam & Reservoir	Frenchman Creek	Chase, NB	30.0	3127.0	3112.3	2,405	1,707	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Folsom Dam & Lake	American River	Sacramento,CA	-	-	-	-	-	400.0	466.0	427.0	11,450	9,040	Bureau of Reclamation	PL 81-356
Friant Dam & Reservoir (Millerton Lake)	San Joaquin River	Fresno, CA	-	-	-	-	-	390.0	578.0	466.3	4,850	2,101	Bureau of Reclamation	PL 75-39[illegible] PL 76-868
Gaston-Roanoke Rapids Dam & Reservoir	Roanoke River	Northampton & Halifax,NC	63.0	203.0	200.0	22,500	20,300	-	-	-	-	-	VA Electric & Power Co.	Fed Power Act
Glen Elder Dam & Waconda Lake	Solomon River	Mitchell, KS	722.3	1488.3	1455.6	3[illegible],682	12,602	-	-	-	-	-	Bureau of Reclamation	PL 78-534 PL 79-526
Glendo Dam & Reservoir	N. Platte River	Platte,WY	271.9	4653.0	4635.0	17,986	12,365	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Grand Coulee Dam, Franklin D. Roosevelt Lake	Columbia River	Grant & Okanogan,WA	-	-	-	-	-	5185.45	1290.0	1208.0	82,280	45,592	Bureau of Reclamation	PL 89-561 3rd Power-house
Heart Butte Dam & Lake Tschida	Heart River	Grant,ND	150.0	2094.5	2064.5	6,625	3,400	-	-	-	-	-	Bureau of Reclamation	PL 78-534

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Hells Canyon Dam & Reservoir	Snake River	Wallowa, OR; Adams, ID	-	-	-	-	-	11.7	1688.0	1683.0	2,380	2,280	Idaho Power Company	FPC No. 1971-A
Hoover Dam & Lake Mead	Colorado River	Clark NV & Mohave, AZ	1500.0	1229.0	1219.6	162,700	156,500	15.853	1219.6	1083.0	156,500	83,500	Bureau of Reclamation	PL 70-642
Hungry Horse Dam & Reservoir	S. Fork Flathead Riv.	Flathead, MT	2982.0	3560.0	3336.0	23,800	5,400	-	-	-	-	-	Bureau of Reclamation	PL 78-329
Indian Valley Dam&Reservoir	N.Fork Cache Creek	Lake, CA	-	-	-	-	-	40.0	1485.0	1474.7	3,975	3,749	Yolo Cty Fl. Cont&WtrCons Dist.	PL 84-984
Jamestown Dam & Reservoir	James River	Stutsman,ND	185.4	1454.0	1432.67	13,206	2,555	6.6	1432.67	1429.8	2,555	2,085	Bureau of Reclamation	PL 78-534
Kerr Dam Flathead Lake	Flathead River	Lake, MT	-	-	-	-	-	1219.0	2893.0	2883.0	125,560	120,000	Montana Power Co.	FPC No. 5
Keyhole Dam & Reservoir	Belle Fourche	Crook, WY	140.2	4111.5	4099.3	13,686	9,394	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Kirwin Dam & Reservoir	N. Fork Solomon River	Phillips,KS	215.1	1757.3	1729.25	10,640	5,073	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Lemon Dam & Reservoir	Florida River	La Plata, Colorado	-	-	-	-	-	39.0	8148	8023	622	62	Bureau of Reclamation	PL 84-485
Lewis M. Smith Dam & Reservoir	Sipsey Fork Black Warrior Riv.	Cullman & Walker,AL	280.6	522.0	510.0	25,700	21,200	-	-	-	-	-	Alabama Power Co.	Fed.Power Act
Little Wood River Dam & Reservoir	Little Wood River	Blain,ID	30.0	5237.3	5127.8	574	0	-	-	-	-	-	Bureau of Reclamation	PL 84-993
Logan Martin Dam & Reservoir	Coosa River	Talladega, AL	245.3	477.0	465.0	26,310	15,260	-	-	-	-	-	Alabama Power Co.	PL 83-436
Los Banos Dam & Detention Res.	Los Banos Creek	Merced,CA	-	-	-	-	-	14.0	353.5	327.8	619	467	Bureau of Reclamation	PL 86-488
Lost Creek Dam & Res.	Lost Creek	Morgan,UT	-	-	-	-	-	20.0	6005.0	5912.0	365	93	Bureau of Reclamation	PL 81-273
Lovewell Dam & Reservoir	White Rock Creek	Jewell,KS	50.5	1595.3	1582.6	5,025	2,986	-	-	-	-	-	Bureau of Reclamation	PL 78-534

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

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Markham Ferry Dam & Lake Wash E. Hudson	Grand (Neosho) River	Mayes, OK	244.2	636.0	619.0	18,000	10,900	-	-	-	-	-	Grand River Dam Authority	PL 76-476
Mayfield Dam & Reservoir	Cowlitz River	Lewis, WA	-	-	-	-	-	21.4	425.0	415.0	2,070	1,825	City of Tacoma	FPC No. 2016-A
Medicine Creek Dam & Harry Strunk Lake	Medicine Creek	Frontier, NB	52.2	2386.2	2366.1	3,465	1,850	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Mossyrock Dam Davisson Lake	Cowlitz River	Lewis, WA	-	-	-	-	-	1397.0	778.5	621.5	11,800	5,000	City of Tacoma	FPC No. 2016-B
Navajo Dam Reservoir	San Juan River	Rio Arriba & San Juan, NM	-	-	-	-	-	1036.1	6085	5990	15,610	7,400	Bureau of Reclamation	PL 84-485
New Exchequer Dam & Lake McClure	Merced River	Tuolomne, CA	-	-	-	-	-	400.0	867.0	799.7	7,110	4,849	Merced Irrig. District	PL 86-645
Norton Dam & Reservoir	Prairie Dog Creek	Norton, KS	98.8	2331.4	2304.3	5,316	2,181	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Ochoco Dam & Reservoir	Ochoco Creek	Crook, OR	51.4	3136.2	3048.1	1,150	120	-	-	-	-	-	Bureau of Reclamation	PL 84-992
Oroville Dam & Lake	Feather River	Butte, CA	-	-	-	-	-	750.0	900.0	848.5	15,800	13,346	CA Dept of Wtr Resources	PL 85-500
Oxbow Dam & Reservoir	Snake River	Baker, OR; Adams, ID	-	-	-	-	-	5.0	1805.0	1800.0	1,165	1,115	Idaho Power Company	FPC No. 1971-B
Pactola Dam & Reservoir	Rapid Creek	Pennington, SD	43.0	4621.5	4580.2	1,232	860	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Palisades Dam & Reservoir	Snake River	Bonneville, ID	1202.0	5620.0	5452.43	16,100	2,170	-	-	-	-	-	Bureau of Reclamation	PL 81-864
Paonia Dam & Reservoir	Muddy Creek	Gunnison, Colorado	-	-	-	-	-	17.0	6447.5	6373.0	334	120	Bureau of Reclamation	PL 80-117 PL 84-485
Pineview Dam & Reservoir	Odgen River	Weber, UT	-	-	-	-	-	110.0	4900.0	4818.0	2,874	0	Bureau of Reclamation	PL 81-273
Platora Dam & Reservoir	Conejos River	Conejos, CO	6.0	10034.0	10027.5	947	920	540.0	10027.5	994.5	920	0	Bureau of Reclamation	PL 76-640
Priest Rapids Dam & Reservoir	Columbia River	Grant, WA	-	-	-	-	-	44.0	488.0	481.5	7,100	6,500	Grant County PUD No. 2	FPC No. 2114-A
Prineville Dam & Reservoir	Crooked Creek	Crook, OR	153.0	3234.8	3112.0	2,990	120	-	-	-	-	-	Bureau of Reclamation	PL 84-992

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Prosser Creek & Reservoir	Prosser Creek	Nevada, CA	-	-	-	-	-	20.0	5741.2	5703.7	745	334	Bureau of Reclamation	PL 84-858
Red Willow Dam & Hugh Butler Lake	Red Willow Creek	Frontier, NB	48.9	2604.9	2581.8	2,682	1,629	-	-	-	-	-	Bureau of Reclamation	PL 78-534 &PL 85-783
Ririe Dam & Reservoir	Willow Creek Snake River	Bonneville,ID	-	-	-	-	-	90.0	5119.0	5023.0	1,560	360	Bureau of Reclamation	PL 87-874
Rocky Reach Dam Lake Entiat	Columbia River	Chelan, WA	-	-	-	-	-	37.0	707.0	703.0	9,600	0	Chelan Cnty PUD No. 1	FPC No. 2145
Ross Dam & Reservoir	Skagit River	Whatcom, WA	-	-	-	-	-	530.5	1602.5	1475.0	6,000	2,168	City of Seattle	FPC No. 553-C
Savage River Dam & Res.	Savage River	Garrett, MD	-	-	-	-	-	16.028	1468.5	1400.0	366	127	Upper Potomac Riv Commission	PL 79-526
Shadehill Dam & Reservoir	Grand River	Perkins, SD	217.7	2302.0	2272.0	9,900	4,800	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Shasta Dam & Lake	Sacramento River	Shasta, CA	-	-	-	-	-	1300.0	1067.0	1018.6	29,570	23,894	Bureau of Reclamation	PL 75-392 &PL 76-868
Smith Mtn & Leesville Dam & Res.	Roanoke River	Bedford, Campbell & Pittsylvania,VA	-	-	-	-	-	(No Specific FC/Nav. Storage Allocation)					Appalacian Power Co.	Fed.Power Act
Trenton Dam & Reservoir	Republican River	Hitchcock,NB	133.8	2773.0	2752.0	7,975	4,974	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Turner Falls Res (Includes Northfield Mtn Pumped Storage Project)	Connecticut River (Briggs Brook)	Franklin, MA	-	-	-	-	-	(No Specific FC/Nav. Storage Allocation)					Northeast Utilities Service Co. Hartford, CT	Fed. Power Act
Twitchell Dam & Reservoir	Cuyama River	Santa Barbara, CA	89.0	651.5	623.0	3,690	2,650	-	-	-	-	-	Bureau of Reclamation	PL 83-774
Upper Baker Dam Baker Lake	Baker River	Whatcom, WA	-	-	-	-	-	220.63	724.0	655.0	4,890	0	Puget Sound Power & Light Co.	Sec. 201 PL 89-298 FPC No. - 2150-B

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION					MULTIPLE-USE FLOOD CONTROL/NAVIGATION					PROJECT OWNER	AUTH. LEGIS.
			STORAGE	ELEV. LIMITS		AREA		STORAGE	ELEV. LIMITS		AREA			
			1000 ac-ft	feet m.s.l. UPPER	LOWER	acres UPPER	LOWER	1000 ac-ft	feet m.s.l. UPPER	LOWER	acres UPPER	LOWER		
Vallecito Dam Reservoir	Los Pinos River	La Plata, Colorado	-	-	-	-	-	115.4	7665	7600	2,723	693	Bureau of Reclamation	PL 61-288 PL 68-292
Wanapum Dam & Reservoir	Columbia River	Grant, WA	-	-	-	-	-	151.6	571.5	560.0	14,400	9,600	Grant County PUD No. 2	FPC No. 2114-B
Wanship Dam & Rockport	Weber River	Summit, UT	-	-	-	-	-	61.0	6037.0	5930.0	1,077	121	Bureau of Reclamation	PL 81-273
Warm Springs Dam & Res.	Middle Fork Malheur Riv.	Malheur, OR	-	-	-	-	-	191.0	3406.0	3327.0	4,600	90	50%Vale Irr. Dist & 50% Bu. of Rec.	-
Waterbury Dam & Reservoir	Little River	Washington, VT	27.7	617.5	592.0	1,330	890	-	-	-	-	-	State of Vermont	PL 78-534
Weiss Dam & Reservoir	Coosa River	Cherokee, AL	397.0	574.0	564.0	50,000	30,200	-	-	-	-	-	Alabama Power Co.	PL 83-436
Wells Dam & Lake Pateros	Columbia River	Douglas, WA	-	-	-	-	-	74.0	779.0	771.0	10,700	7,700	Douglas Cnty PUD No. 1	FPC No. 2149
Webster Dam & Reservoir	S. Fork Solomon Riv.	Rooks, KS	183.4	1923.7	1892.45	8,480	3,766	-	-	-	-	-	Bureau of Reclamation	PL 534-78-2
Yellowtail Dam & Bighorn Lake	Bighorn River	Big Horn, MT	259.0	3657.0	3640.0	17,298	12,685	250.0	3640.0	3614.0	12,685	7,410	Bureau of Reclamation	PL 78-534

FIELD WORKING AGREEMENT
BETWEEN
DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION
AND
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS
FOR
FLOOD CONTROL OPERATION
OF
CENTRAL VALLEY PROJECT DAMS AND RESERVOIRS
IN
CALIFORNIA

THIS agreement, made and entered into this 14th day of August, 1978, between the Bureau of Reclamation and the Corps of Engineers,

WITNESSETH THAT:

WHEREAS, the Department of the Interior, acting through the Bureau of Reclamation, represented by its appropriate Regional Director, has constructed or assumed operation of Federally constructed dams and reservoirs on the Sacramento and San Joaquin Rivers and their tributaries, and is responsible for normal operation and structural safety of the projects, and

WHEREAS, the Department of the Army, acting through the Corps of Engineers, represented by its appropriate District and Division Engineers, is responsible for the flood control operation plans of said dams and reservoirs in accordance with Section 7 of the 1944 Flood Control Act (33 U.S.C. 709) and as promulgated in Code of Federal Regulations, Title 33, Part 208.11, and

WHEREAS, there is a need for a working agreement to insure a clear understanding of the flood control regulations and information exchange required for the projects operation.

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto that the Central Valley Project will be operated in accordance with the following criteria:

(a) Conservation operations shall be in accordance with Bureau of Reclamation criteria as determined by the Regional Director or his designated representative.

(b) Storage space in the Central Valley Project shall be made available on a seasonal basis and operated for flood control in accordance with the Flood Control Diagrams currently in force.

(c) Emergency operation shall be in accordance with the procedure set forth on the Emergency Spillway Release Diagrams or procedures currently in force.

(d) The Regional Director is responsible for the safety of the dam and appurtenant facilities and for regulation of reservoirs in the Central Valley Project during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the Regional Director, and does not relieve the Regional Director of the responsibility for safety of the dams in the Central Valley Project.

(e) Revisions of the Flood Control or Emergency Spillway Release Diagrams and procedures may be developed as necessary by parties of this agreement. Each such revision shall be effective on the date specified.

(f) Except as necessary in order to comply with Emergency Operation procedures, the flood control regulations shall not be construed to require dangerously rapid changes in magnitude of releases. Releases will be made in a manner consistent with requirements for protecting the dam, reservoir and appurtenances from major damages.

(g) Any water impounded in the flood control space defined by the Flood Control Diagrams shall be evacuated as rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from the reservoir shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dams, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan of regulation may require releases to be completely curtailed in the interest of flood control or safety of the projects.

(h) The Regional Director shall procure such current basic hydrologic data and make such current determinations of required flood control space and releases at the reservoir as are required to accomplish the flood control objectives.

(i) The Regional Director shall keep the District Engineer advised of such reservoir operating data as the District Engineer may request. The minimum data required is reservoir storage, inflow, releases and streamflow at control points designated by the Flood Control Diagrams on a daily basis.

(j) The flood control regulations are subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the office of the Regional Director and shall include justification for the action.

(k) The Regional Director may temporarily deviate from the flood control regulations in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Division Engineer.

IN WITNESS WHEREOF, the parties hereto have caused this memorandum of agreement to be executed as the day and date first above written.

CORPS OF ENGINEERS

By: William E. Vandenberg
Division Engineer
South Pacific Division

BUREAU OF RECLAMATION

By: M. A. Catino
Acting Regional Director
Mid Pacific Region

PRESENT IMPAIRED FLOWS
SACRAMENTO RIVER AT SHASTA DAM

Runoff in 1,000 acre-feet

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1945	223.0	378.2	497.4	389.7	913.9	510.9	471.1	498.7	344.1	228.9	206.1	195.9	4857.9
1946	282.0	474.1	1323.7	776.7	423.2	597.0	593.9	465.3	286.5	250.9	228.6	202.9	5904.8
1947	213.6	294.5	306.4	233.2	436.8	716.3	448.8	271.8	374.9	223.2	199.9	188.0	3907.4
1948	289.7	237.8	237.2	742.4	270.6	530.7	1132.4	799.6	511.4	252.9	205.1	206.3	5416.1
1949	214.8	239.5	267.0	218.0	371.5	1141.3	611.5	499.8	247.9	196.2	186.8	173.2	4367.5
1950	190.7	206.5	206.3	477.3	576.7	651.8	616.3	408.3	239.7	195.2	185.6	179.2	4133.6
1951	529.2	593.7	954.5	731.0	983.0	663.1	503.2	501.9	263.7	206.8	198.7	186.7	6315.5
1952	237.2	387.9	1060.7	748.2	1140.4	923.1	1301.4	826.9	399.2	301.0	231.9	228.1	7786.0
1953	237.7	236.1	639.2	1677.4	496.9	663.3	629.4	664.9	538.3	295.6	232.7	229.2	6540.7
1954	246.7	393.3	349.5	951.5	1055.5	959.5	1035.9	479.7	324.7	256.5	252.4	234.5	6539.7
1955	241.4	349.8	502.1	338.9	328.8	375.8	574.3	507.0	270.2	219.0	198.2	206.9	4112.1
1956	205.7	293.4	1869.7	1758.1	1208.7	888.5	734.9	729.9	383.6	278.6	247.5	232.8	8831.4
1957	288.4	259.7	262.4	312.2	854.6	1001.9	615.4	705.3	333.2	256.0	223.1	256.6	5368.8
1958	394.3	377.1	634.4	888.4	2480.4	1319.2	1394.9	800.9	523.2	344.6	281.2	260.9	9699.5
1959	279.1	259.6	289.4	951.8	839.8	609.5	510.9	369.0	269.2	234.3	211.6	262.0	5086.2
1960	232.6	224.1	246.1	401.9	874.1	873.5	473.9	453.1	319.6	223.5	208.2	202.4	4733.0
1961	227.0	318.6	640.3	404.4	861.9	718.3	501.4	472.2	305.4	220.2	206.5	196.7	5072.9
1962	221.6	332.6	531.9	323.2	1252.6	698.5	594.6	422.0	282.2	207.7	205.3	189.0	5261.2
1963	658.9	312.6	633.8	386.4	908.2	658.9	1631.9	751.7	343.8	267.2	231.1	217.8	7002.3
1964	256.5	487.6	298.1	595.3	354.7	355.9	364.0	300.5	317.5	201.2	187.1	187.0	3905.4
1965	211.7	322.2	1611.6	1339.7	583.3	443.8	1002.1	485.1	284.3	258.5	226.8	214.3	6983.4
1966	229.2	500.3	344.5	718.6	604.5	890.7	712.1	395.3	263.4	227.0	207.8	205.9	5299.3
1967	212.8	540.5	901.8	738.3	749.5	1005.1	998.1	932.5	530.5	299.0	262.5	233.1	7403.7
1968	266.1	252.6	317.9	414.4	1036.8	745.6	444.4	365.1	251.1	216.7	234.4	226.8	4771.9
1969	253.6	279.1	529.7	1426.3	1228.6	870.7	1090.3	813.8	405.2	278.7	235.2	255.8	7667.0
1970	271.5	264.3	938.0	2924.9	863.7	813.2	439.6	375.5	301.9	246.7	239.5	222.5	7901.3
1971	265.5	654.2	987.1	1027.7	558.5	1046.7	833.7	712.2	492.4	293.6	227.8	227.9	7327.3
1972	280.4	285.9	371.5	548.0	559.1	948.4	700.6	397.5	286.9	236.0	234.0	229.3	5077.6
1973	285.8	438.5	509.4	1029.0	1038.5	899.3	552.8	477.9	270.6	236.2	212.8	215.7	6166.5
1974	311.9	1577.3	1183.1	2099.1	695.4	1777.9	1198.4	666.1	413.8	325.6	277.1	270.6	10796.3
MEAN	275.3	392.4	648.2	852.4	818.3	809.9	757.1	551.6	345.9	249.3	222.9	217.9	6141.2

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