



ISABELLA LAKE

Kern River, California

RESERVOIR REGULATION MANUAL

May 1953

Rev. January 1978

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

USACE Sacramento District Datum Documentation Report

Project: Isabella Lake and Dam

Isabella project datum to NGS published NGVD 29 conversion Factor: add 1.15ft

NGVD 29To NAVD 88 Datum Conversion Factor: add 2.61ft.

Isabella Project Datum to NAVD 88 Conversion Factor: add 3.76ft.

Note: If unsure what conversions is needed, contact the USACE Sacramento District Datum Coordinator for help.

Datum Conversion Procedure: Isabella Dam was built with a local project datum it is referred to as Isabella project Datum. The Isabella project datum to NGVD 29 conversion factor was done using historical elevations to published NGVD 29. The USACE Mapping Unit and A-E Contractor performed field measurements with known historical elevations. All documentation and raw data is filed with the USACE Sacramento District Mapping Unit. All survey and gage control is in US feet and is tied to NGS monument FU3315. For questions or comments contact the Sacramento District Datum Coordinator. The results of this survey produced an averaged difference between NGVD 29 and NAVD 88 of 2.61 feet for the USACE Isabella Lake and Dam civil works project.

Station ID	COE-NGVD29 record	NAVD 88	Difference
FU3315 (Round)	2774.70	2777.31	2.61
KE1-161	2636.99	2634.39	2.60
KE1-180	2634.30	2636.91	2.61
			Average = 2.607
Averaged Delta = 2.61ft conversion factor			

Accuracy Statement: The NAVD88 datum conversion accuracy is: +/- 0.25 feet to real work NAVD 88 elevations per EC- 1110-2-6065 Comprehensive Evaluation of Project Datums. The stated conversion factor is for planning, operations, water management and legacy conversion only. All future design work and survey work shall adhere to the NAVD 88 datum and follow EM 1110-1-1005 Control and Topographic Surveying. Contact the USACE Sacramento District’s survey unit or the district’s datum coordinator for current survey control.

**ISABELLA LAKE
KERN RIVER, CALIFORNIA**

PERTINENT DATA

GENERAL

Drainage Area	
Kern River at Kernville	1,009 sq mi
South Fork Kern River at Onyx	530 sq mi
Kern River at Isabella Dam	2,074 sq mi
Kern River near Bakersfield	2,407 sq mi
Flows at Isabella Dam	
Mean Annual Runoff (1946-1977)	613,700 ac-ft
Average Flow	847 cfs
Minimum, Mean Daily (7 Aug 77)	72 cfs
Maximum, Mean Daily (6 Dec 66)	72,782 cfs
Maximum, Instantaneous (6 Dec 66)	120,000 cfs
Standard Project Flood Peak Inflow	173,000 cfs
Standard Project Flood Peak Outflow	13,100 cfs
Spillway Design Flood Peak Inflow	204,000 cfs
Spillway Design Flood Peak Outflow	53,000 cfs

ISABELLA LAKE

Elevation	
Inactive Pool	2470.0 ft
Flood Control Pool (bottom)	2470.0 ft
Gross Pool	2605.5 ft
Spillway Design Flood Pool	2627.0 ft
Area	
Inactive Pool	60 acres
Flood Control Pool (bottom)	60 acres
Gross Pool	11,400 acres
Spillway Design Flood Pool	13,900 acres
Storage Capacity	
Inactive Pool	496 ac-ft
Flood Control Pool (bottom)	496 ac-ft
Gross Pool	570,000 ac-ft
Spillway Design Flood Pool	842,000 ac-ft
Spillway (uncontrolled ogee)	
Location	Left Abutment of Main Dam
Crest Length	140 ft
Crest Elevation	2605.5 ft
Head at Gross Pool	0 ft
Head at Spillway Design Flood Pool	21.5 ft
Discharge Capacity (H = 21.5 ft)	52,700 cfs

ISABELLA MAIN DAM (Earthfill)



ISABELLA AUXILIARY DAM (Earthfill)



MAIN OUTLET



Capacity	
For Pool Elevation 2533.0	8,000 cfs
For Pool Elevation 2605.5	11,400 cfs

**AUXILIARY DAM OUTLET
(Borel Canal)**



RESERVOIR REGULATION MANUAL

FOR

ISABELLA LAKE

KERN RIVER, CALIFORNIA

APPENDIX II

TO

MASTER MANUAL OF RESERVOIR REGULATION

TULARE LAKE BASIN, CALIFORNIA

Date May 1953

Revised January 1978

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

REGULATION MANUAL
ISABELLA LAKE
BAKERSFIELD, CALIFORNIA

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RESERVOIR REGULATION MANUAL

ISABELLA DAM AND LAKE KERN RIVER, CALIFORNIA

CHAPTER I - GENERAL INFORMATION

1. AUTHORITY AND SCOPE

a. This reservoir regulation manual is an appendix to the "Master Manual of Reservoir Regulation, Tulare Lake Basin, California," and is prepared in accordance with instructions in ER 1110-2-240 and EM 1110-2-3600.

b. This manual contains descriptive information about the project, operating rules for Isabella Lake, Kern River, California, and assigns responsibilities for the operation of the project. A description of the general plan of reservoir regulation for the Tulare Lake Basin, of which Kern River is a unit, is given in the Master Manual.

2. PROJECT AUTHORIZATION

The Isabella Project, Kern River, California was authorized by the Flood Control Act of 1944, approved 22 December 1944, the pertinent portion of which follows:

"The project for the Isabella Reservoir on the Kern River for flood control and other purposes in the San Joaquin Valley, California, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in his report dated 26 January 1944, contained in House Document Numbered 513, Seventy-eighth Congress, Second Session, . . ."

3. CHANGES TO AUTHORIZED PLAN

Major changes to the plan of improvement proposed in the project document are as follows:

Item	Project Document	Constructed
Reservoir Inactive Storage	50,000 ac-ft	496 <u>1/</u>
Main Dam		
[REDACTED]	[REDACTED]	[REDACTED]
Auxiliary Dam		
Top elevation	[REDACTED]	[REDACTED]
Spillway		
Type	[REDACTED]	[REDACTED]
Crest elevation	[REDACTED]	[REDACTED]
Capacity	64,000 c.f.s.	52,700 c.f.s.
Main Outlet Conduits		
Number	[REDACTED]	[REDACTED]
Size	[REDACTED]	[REDACTED] "
Main Outlet Valves		
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED] "
Borel Canal Outlet Conduits		
Number	[REDACTED]	[REDACTED]
Size	[REDACTED]	[REDACTED]
Borel Canal Outlet Gates		
Type	[REDACTED]	[REDACTED]
Number	[REDACTED]	[REDACTED]
Size	[REDACTED]	[REDACTED]
Power Generating and Pumping Plants		
Number	[REDACTED]	[REDACTED]

1/ See paras. 8a and 25d.

CHAPTER II - BASIN DESCRIPTION

4. DESCRIPTION OF PROJECT AREA

a. The project area, shown on chart 1, is located in Tulare Lake Basin in the southern portion of the San Joaquin Valley. It is comprised of the Kern River watershed above the valley floor, the alluvial fan area, the Buena Vista Lakebed, and the Tulare Lakebed. The Tulare Lakebed is the common terminus of the Kings, Kaweah, Tule, and Kern Rivers, plus other smaller streams. Tulare Lake Basin is a closed drainage area of about 12,500 square miles with no outlet to the ocean. However, the Kings River has a distributary channel that can carry some Kings River flow to the north into the San Joaquin River Basin.

b. The Kern River is the southern-most river in the Tulare Lake Basin. The majority of its watershed lies behind a barrier ridge, the seaward face of which drains the Kaweah and Tule Rivers and other smaller streams. The basin rises in the Sierra Nevada mountains to an elevation of about 14,000 feet near Mt. Whitney, and drains a rugged mountainous area through a well developed drainage system composed of two principal streams: the main stem of Kern River (also called North Fork) and the South Fork. Both streams flow generally southward and converge in Isabella Lake. A high north-south mountain ridge (near 10,000 feet) separates the North Fork from the South Fork. The North Fork contributes about 85 percent of the total flow into the reservoir. About eighty percent of the Kern River watershed is above the 5,000-foot level. Topography of the area is shown on chart 2.

c. There is considerable variation in soil and vegetative cover in the Kern River watershed. The density of vegetative cover varies from sparse to light at the low elevations, increases to heavy in a few intermediate areas, and becomes practically non-existent at high elevations. Maps prepared by the U.S. Forest Service indicate the following extent and type of vegetative cover for the total watershed above Isabella Lake.

General Type of Vegetative Cover	Range of Elevation (feet)	Percent of Basin Area
Grass land (with scattered timber)	(2,500-3,000) (8,000-9,000)	5
Brush land (chapparal, etc.)	(2,500-6,000)	28
Deciduous forest	(4,000-6,000)	7
Light coniferous forest (20-50% cover)	(6,000-9,000)	22
Heavy coniferous forest (over 50% cover)	(7,000-7,500)	Negligible
Sub-alpine timber (juniper, lodge pole, pine, etc.)	(9,000-12,000)	9
Open ground (barren, and lakes)	(2,500-5,000) (11,000-14,000)	12
Foothill conifers	(4,000-7,000)	17

d. Downstream from Isabella Lake, the Kern River flows southwesterly through a deep canyon for about thirty-three miles. Three of the four power plants on the Kern River are located in this reach. At the Canyon mouth (elevation 500 feet) the streambed reaches an alluvial fan about twelve miles northeast of Bakersfield. From there it flows through the Bakersfield-Oildale area past Buena Vista Lake and finally to its termination point at Tulare Lakebed (elevation 200 feet) eighty-five miles downstream from the canyon mouth. Between the canyon mouth and Tulare Lakebed there are numerous diversions for irrigation. Generally, except for years of exceptionally large runoff, all of the Kern River water is either stored in Isabella Lake, used for irrigation, or used to recharge the groundwater basin. In years when flood water potentially damaging to Tulare Lake Basin is available, all or a portion of it can be diverted to the California Aqueduct via the Kern River - California Aqueduct Intertie (completed in 1977).

e. Both Buena Vista and Tulare Lakebeds are broad, flat, closed depressions occupying lower portions of Tulare Lake Basin. These lakebeds are normally dry and are intensively farmed. Kern River water can be diverted into Buena Vista Lake through existing facilities, and up to 30,000 acre-feet of floodwater can be stored in cells 1 and 2 per agreements between the landowners and Buena Vista Water Storage District. The inlet channel to the lakebed has a capacity of 1,000 cubic feet per second, and the outlet channel has a capacity of 750 cubic feet per second. The lowest elevation in Tulare Lakebed is approximately 175 feet

and the only outlet is across the ridge to the north (at elevation 207 feet) into San Joaquin River. Farming of the lakebed has been facilitated by a network of levees designed to confine floodwaters to the smallest practicable area.

f. During "Operation Foresight", in anticipation of the 1969 snow-melt runoff, two spreading basins were built by the Corps of Engineers in cooperation with local interests to prevent excess water from reaching Tulare Lakebed. One was the Sand Ridge Detention Basin on the Kern River Flood Channel, just south of Tulare Lake. The project stored some 63,000 acre-feet of Kern River floodwaters with a flooded area of 15,000 acres. The other Operation Foresight project was along Jerry Slough (about six miles downstream from Bakersfield) where about 800 acres of percolation ponds were constructed. The Jerry Slough project and numerous ancillary features prevented about 37,000 acre-feet of floodwater from reaching Tulare Lakebed during the 1969 snowmelt flood. The storage and percolation capabilities of both these projects remain in place. However, new flowage easements would have to be obtained in order to use these projects again, because the original easements were purchased by local interests for one season only. In addition, the Cross Valley Canal presently blocks the inlet to the Jerry Slough project.

g. Present population of Tulare Basin is about 600,000, with the largest center of population (approximately 200,000) in Metropolitan Bakersfield. The economy of the region is orientated around the agriculture and petroleum industries. A large part of California's field crops, fruits, nuts, livestock, and dairy products are produced here and more than one-fourth of the state's total oil production occurs in this region. The main line of the Atchison, Topeka and Santa Fe Railroad and the valley route of the Southern Pacific Railroad between San Francisco and Los Angeles pass through the basin. Branch lines serve important agricultural and petroleum centers within the area. Shops and yards of both lines are located in Bakersfield. Interstate 5 crosses Kern River about fifteen miles southwest of Bakersfield and U.S. Highway 99 crosses the Kern River at Bakersfield. Numerous state highways and an extensive system of county roads also serve the area.

5. CLIMATE

a. Normal seasonal precipitation varies from about 6 inches at the edge of the valley floor to a maximum of 45 inches in the main Kern River area. About 90 percent of the runoff-producing precipitation occurs during the winter months of November through April, as demonstrated in the monthly precipitation averages at key stations as follow:

Normal Precipitation

Month	: Bakersfield : (elev 495)		: Isabella Dam <u>1/</u> : (elev 2660)		: Kern PH #3 <u>2/</u> : (elev 2703)		: Grant Grove (elev 6600)	
	: Amount :	% :	: Amount :	% :	: Amount :	% :	: Amount :	% :
July	0.02	0.3	0.09	0.9	0.10	0.9	0.06	0.1
Aug	0.01	0.2	0.22	2.1	0.19	1.6	0.08	0.2
Sept	0.08	1.4	0.44	4.2	0.27	2.3	0.52	1.2
Oct	0.26	4.6	0.30	2.9	0.28	2.4	1.46	3.4
Nov	0.69	12.1	1.15	11.0	1.33	11.4	5.14	11.9
Dec	0.74	12.9	1.89	18.1	1.78	15.2	7.56	17.4
Jan	0.96	16.8	2.07	19.8	2.74	23.5	7.83	18.1
Feb	1.03	18.0	1.73	16.6	1.88	16.1	7.16	16.5
Mar	0.83	14.5	1.23	11.8	1.66	14.2	6.78	15.6
Apr	0.85	14.9	0.93	8.9	1.15	9.9	4.81	11.1
May	0.19	3.3	0.28	2.7	0.22	1.9	1.55	3.6
June	0.06	1.0	0.10	1.0	0.07	0.6	0.39	0.9
Total	5.72	100.0	10.43	100.0	11.67	100.0	43.34	100.0

1/ Average for 1954-1976

2/ Average for 1947-1976

Normal annual precipitation for the Kern River Basin is shown on chart 3. The following tabulation gives the normal annual precipitation for different segments of the Kern River Basin.

Segment of Basin Area	: : :	Normal Annual Precipitation (inches)
Buena Vista Lakebed		5.0
Tulare Lakebed		6.5
Alluvial Fan		6.5
Foothill below Isabella Dam		14.7
Main Kern above Isabella Lake		28.4
South Fork Kern above Isabella Lake		16.7

b. Normally, precipitation falls as rain at elevations below 5,000 feet and as snow at higher elevations, but snow has occurred on the valley floor and rain has occurred above 10,000 feet. The snow pack accumulates during the winter months until about 1 April when increased temperatures cause the snow pack to begin melting. Snow pack data typical of wet snow years is illustrated by that for 1969, and snow pack data typical of below-normal years is illustrated by that for 1977 in the following tabulation: (1965 nearest to average snow year)

1 April Snow Survey Data
Kern River Basin

Index:	Snow	Elev	in	Depth			Water Content					
				in	in	inches	Inches			Average 1/:		
No.	Course	Feet	1969	1965	1977	1969	1965	1977	1931-75	1969	1965	1977
250	Bighorn Plateau	11,350	123.7	65.6	17.4	55.3	25.8	5.0	23.0	240	112	22
257	Big Whitney Meadow	9,750	102.4	44.0	18.6	45.0	13.7	4.9	17.0	265	81	29
254	Guyot Flat	10,650	117.5	50.9	18.8	50.6	18.0	4.8	21.0	241	86	23
261	Bonita Meadows	8,300	115.5	23.0	6.9	50.2	10.3	3.6	14.0	359	74	26

1/ Average values of 1 April Water Content in inches are averages for 45-year period (1931-1975) from Snow Survey Data, California Cooperative Snow Surveys, 1977.

c. The valley area is characterized by hot, dry summers and moderate winters. Temperatures in the mountains decrease generally with increasing elevation, and the summers are cool at higher elevations while the winters are severe. Observed temperature extremes are 120° and 15° F on the valley floor, 118° and 13° F at Bakersfield, 112° and 11° F at Isabella Dam, 109° and 11° F at Kern River P.H. #3 above Kernville, and 90° and -6° F at Grant Grove. The monthly distribution of mean temperatures in the Kern River Basin and adjacent areas is illustrated at key stations below:

Monthly Normal Temperature (°F)

Month	: Bakersfield : (Elev. 495)	Kern P.H. #3 1/ (Elev. 2703)	Isabella Dam 2/ (Elev. 2660)	Grant Grove (Elev. 6600)
Jan	47.5	44.8	43.8	33.2
Feb	52.4	48.4	47.1	33.6
Mar	56.6	51.6	50.0	34.5
Apr	62.7	57.8	54.4	39.5
May	69.8	65.6	63.3	46.4
June	76.9	73.8	72.5	54.1
July	83.9	81.2	79.6	62.6
Aug	81.6	79.4	78.0	61.3
Sept	76.6	74.5	72.0	57.0
Oct	66.9	63.5	61.8	49.1
Nov	56.0	52.6	51.2	40.5
Dec	47.9	45.9	44.6	35.3
Mean	64.9	61.6	59.9	45.6

1/ Average for 1947-1976

2/ Average for 1955-1976

6. RUNOFF

a. About two-thirds of the annual runoff usually occurs from snowmelt during the April through July period. The average annual runoff of Kern River at Isabella Dam is about 613,700 acre-feet (1946-1977). The average annual runoff from the foothill area between the dam and the valley floor is about 50,000 acre-feet. Streamflow records for Kern River near Bakersfield date back to 1893. Drainage areas and record periods for other key streamflow gaging stations are tabulated below. Locations of these gages and other stream gages are shown on chart 2.

Stream	:	Station Name	:	Drainage Area	:	Record Period (Calendar Years)
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*Crest stage gage 1970 and 1973-1976

b. Recorded runoff data for Kern River at Kernville and South Fork Kern River near Onyx are given in the following tabulation:

Recorded Runoff Data

	: Kern River near : Kernville	: South Fork Kern : River near Onyx
Period of Record Included	1912-1975	1911-13, 1919-25 1926-27, 1929-42 1946-75
Drainage Area, sq. mi.	846	530
Instantaneous Flows, cfs		
Maximum	60,000 (6 Dec 66)	28,700 (6 Dec 66)
Minimum	78 (30,31, Aug 24 17,19 Sept 24)	Ø (Sept 34)
Mean Daily	722	114
Instantaneous Flow, cfs/sq. mi.		
Maximum	71	54
Minimum	0.09	0.00
Mean Daily	0.85	0.21
Annual Flow, ac-ft		
Maximum	1,577,000 (1969)	438,300 (1969)
Minimum	162,600 (1924)	8,400 (1961)
Mean	523,100	82,590
Annual Flow, inches		
Maximum	34.95	15.48
Minimum	3.6	0.30
Mean	11.59	2.92
Apr-July Flow, ac-ft		
Maximum	1,203,200 (1969)	360,190 (1969)
Minimum	92,600 (1924)	2,100 (1961)
Mean	353,600	57,600
Apr-July Flow, inches		
Maximum	26.67	12.72
Minimum	2.05	0.07
Mean	7.83	2.06

c. The seasonal variation of runoff at Isabella Lake is illustrated in the following table:

Average Monthly Runoff Data

Month	Kern River near Kernville		South Fork Kern River near Onyx	
	Acre-ft.	%	Acre-ft.	%
Oct	14,100	2.7	1,300	1.6
Nov	15,700	3.0	1,900	2.3
Dec	20,400	3.9	3,700	4.5
Jan	19,400	3.7	3,600	4.4
Feb	25,600	4.9	4,800	5.8
Mar	35,600	6.8	8,300	10.0
Apr	64,900	12.4	19,600	23.7
May	114,500	21.9	25,200	30.5
June	117,200	22.4	9,200	11.2
July	57,000	10.9	2,700	3.2
Aug	24,100	4.6	1,300	1.6
Sept	14,600	2.8	1,000	1.2
Totals	523,100	100.0	82,600	100.0

d. Historic inflow to Isabella Lake is shown on chart 4.



CHAPTER III - PROJECT FEATURES

7. DESCRIPTION OF THE PROJECT



5 A reservoir of a branching shape extends up the main Kern River about eight miles and up the South Fork of Kern River about nine miles. The total area is about 11,000 acres, half of which was formerly irrigated ranch land and half was river bottom, and desert sidehill. Two small communities, Isabella and Kernville, were located within the reservoir area. The former was abandoned, and the latter has been moved outside the reservoir area. The more important state and county highways through the reservoir area have also been relocated. A reach of Borel Canal extending 3,240 feet upstream of the auxiliary dam has been realigned and modified, with a wasteway and auxiliary inlet constructed.

The reservoir has a capacity of 570,000 acre-feet at gross pool elevation 2,605.5 feet.

b. Pertinent data for Isabella Dam and Lake are shown on the inside cover of this manual. A map of the reservoir area is shown on chart 6.

8. RECREATION FACILITIES

a. The expanding population of California is creating a heavy demand on all existing recreation facilities. The problem is particularly acute in Southern California due to the large population and the lack of freshwater resources suitable for recreation. Isabella is the largest fresh-water fishery in Southern California. Recreation is not an authorized purpose of Isabella Lake. However, in 1963 an agreement was made between Kern County and the water users to maintain a minimum recreation pool of 30,000 acre-feet.

b. Twenty-six areas at Isabella Lake are identified for recreation development. Existing and proposed facilities in these areas include picnicking, camping, boat-launching, swimming, marina concessions, visitor center, public access, parking and hiking, cycling, equestrian and nature trails. Recreation facilities are available in seventeen of the twenty-six areas. Facilities at these areas have been provided by the Corps of Engineers, Kern County, the California Department of Navigation and Oceanic Development, the California Wildlife Conservation Board, and private concessionaires.

c. Isabella Lake became fully operational in 1954 and records of recreation use began in 1955. The annual visitation for the period of record at 5-year intervals and for the last six years is shown in the following tabulation.

<u>Year</u>	<u>Attendance</u>
1955	200,000
1960	782,000
1965	1,312,500
1970	1,558,300
1971	1,455,500
1972	1,147,000
1973	869,750
1974	1,008,100
1975	858,900
1976	849,400

d. Recreation developments in the Isabella Lake area are shown on chart 7 and are described in the [REDACTED]. It is planned to routinely update the Master Plan in the future when necessary.

9. CONSTRUCTION HISTORY

a. Construction of the Isabella Project was initiated and completed on various schedules as follows:

Schedule	: Beginning Date	: Completion Date
Auxiliary Dam (1st Contract)	26 Mar 1948	28 Nov 1951
(2nd Contract)	18 Jan 1949	30 Jan 1953
Outlet Works	8 Jul 1949	12 Jan 1952
Spillway	5 Nov 1951	30 Jan 1953
Borel Canal	23 Nov 1951	30 Jan 1953
Main Dam	1 May 1952	18 Mar 1953

b. The town of Kernville was moved to its new location by 1952. Relocation of roads and utilities and acquisition of land was completed in 1953. Clearing on area "A", which comprised 375 acres of medium and heavy growth located in the immediate vicinity of the main dam, was started in November 1951 and completed by June 1952. Clearing on area "B", which comprised about 275 acres of heavy growth located on each side of the main river channel upstream from the Borel Canal Diversion, was completed in September 1953. Removal of buildings and other floatable material from the reservoir was completed by September 1953. The Borel Canal outflow gaging station, pool-level recording installation, main outflow gaging station, and the inflow gaging station on Kern River at Kernville were completed in 1953. Sedimentation ranges and field survey work were completed by September 1953. Operators' quarters were completed in August 1953. Telemark facilities for the stream gaging station on Kern River at the mouth of the canyon were installed in the summer of 1954.

c. Water was stored in the project for the first time in April 1953 and the project was operated for conservation for the first time in April 1954.

CHAPTER IV - FLOOD POTENTIAL

10. FLOOD CHARACTERISTICS

a. Precipitation in the area is largely orographic in nature and usually results from air masses traveling inland from a westerly direction. Flood flows on Kern River are of two types, winter rain floods and spring snowmelt floods. Winter rain floods, which generally occur during the period of November through March, are caused by heavy rains and sometimes augmented by the melting of snow at intermediate elevations. These winter floods have sharp, high peaks and are usually of short duration and comparatively small volume. Generally a major portion of winter precipitation occurs as snow and remains in the mountains above the 5,000 feet m.s.l. elevation until the spring. Snowmelt floods have comparatively moderate peak flows, but very large volumes extending over a two to four month period. Generally, approximately sixty-five percent of the annual runoff occurs between the first of April and the end of July.

b. The largest rainflood of record on Kern River occurred on 6 December 1966 had an estimated peak inflow to Isabella Lake of 120,000 c.f.s. and a peak local flow at Bakersfield of about 9,000 c.f.s. Maximum release from Isabella during the peak of the December 1966 rainflood was 430 c.f.s. A large flood also occurred in December 1867, but detailed information about this flood is not documented. A comparison of maximum experienced flows at Kern River at Kernville and South Fork Kern River near Onyx is as follows:

Date	Kern River at Kernville		South Fork Kern River near Onyx	
	Peak discharge: (cfs)	4-day volume: (acre-feet)	Peak discharge: (cfs)	4-day volume: (acre-feet)
6 Dec 1966	74,000	152,500	28,700	41,800
1 Feb 1963	32,800	67,300	3,400	11,100
23 Dec 1955	29,400	58,500	-	-
24 Dec 1955	-	-	2,050	6,000
25 Jan 1969	26,900	65,000	9,200	16,500

c. During the 1955 and 1963 floods local flow below the dam was nominal. During the January 1969 flood, the peak local flow at Bakersfield was about 3,000 cubic feet per second. No significant runoff occurs from general rain storms over the alluvial fan portion of the basin.

d. During large snowmelt floods the North Fork Kern River produces about 80 percent of the total Kern River snowmelt runoff. The largest

1

snowmelt flood of record occurred in 1969 when inflow to Isabella Lake was 1,657,000 acre-feet for the April through July period. This compares with 1,390,000 acre-feet during the 1906 flood.

11. RAINFLOOD POTENTIAL

The major rainflood threat to areas protected by Isabella Lake comes from the local area between the project and the canyon mouth. Under normal conditions, a rainflood of the magnitude necessary to cause the project to spill would be accompanied by an extremely large local flow below the reservoir, the peak of which would probably exceed the peak outflow from the project. Rainflood frequency curves at Isabella Dam and at Bakersfield are shown on charts 8 and 9, respectively.

12. SEASONAL VARIATION OF RAINFLOOD POTENTIAL

Large rainfloods in the Tulare 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 rainflood potential is dependent on the seasonal variation of storm precipitation.

13. SNOWMELT FLOOD POTENTIAL

In spite of extensive spreading activities in 1969, it is estimated that 227,000 acre-feet of Kern River snowmelt reached Tulare Lake. The Kern River Intertie should divert all or a part of future Kern River snowmelt flood water that would otherwise flow into Tulare Lake. Snowmelt flow frequency curves at Isabella Dam and at Bakersfield are shown on charts 10 and 11.

14. STANDARD PROJECT FLOOD

The standard project flood presented in this manual was developed in 1977 and is presently being reviewed. Precipitation for computing the main wave flood hydrograph averaged 17.88 inches over the main Kern River drainage and 8.66 inches concurrently over the South Fork drainage. Corresponding snowmelt during the standard project storm was 2.83 inches for main Kern River and 2.67 inches for the South Fork. The standard project flood routing through Isabella Lake is shown on chart 12. The peak inflow is 173,000 cubic feet per second and the flood volume is approximately 470,000 acre-feet.

15. RESERVOIR DESIGN FLOOD

a. Prior to project authorization in 1944, the April-July 1906 flood was the largest snowmelt flood of record on all of the major streams in the San Joaquin and Tulare Lake Basins. It was adopted as the

reservoir design flood for Isabella Reservoir. A standard project rainflood was developed to determine the rainflood reservation using 60 percent of the spillway design storm values discussed in paragraph 16.

b. During the 1969 snowmelt season the volume of the 1906 flood was exceeded. Routings of both floods are shown on chart 13. The frequencies of the 1906 and 1969 flood are estimated to be 40 and 90 years, respectively.

c. Recent hydrologic studies have indicated the original standard project flood is inadequate; therefore, the rainflood reservation has been modified to control the revised standard project flood discussed in paragraph 14 to an acceptable downstream flow.

16. SPILLWAY DESIGN FLOOD

The spillway design flood for Isabella Dam was based on estimates of probable maximum precipitation computed from Hydrometeorological Report Number 24, "Maximum Possible Precipitation - San Joaquin Basin, California," dated July 1947. Precipitation for computing the flood hydrograph averaged 21.0 inches over the North Fork and 10.5 inches over the South Fork area. Total surface runoff was 10.15 inches from the North Fork and 1.22 inches from the South Fork. The total reservoir inflow was about 660,000 acre-feet in five days with a peak of about 200,000 c.f.s. The inflow hydrograph and routing is shown on chart 14. Recent estimates of probable maximum precipitation for Kern River Basin, as indicated by the Weather Bureau's Hydrometeorological Report No. 36, "Interim Report, Probable Maximum Precipitation in California," revised October 1969, show higher values.



CHAPTER V - GENERAL PROJECT OPERATION

17. OBJECTIVES

a. Isabella Reservoir will be operated for flood control and conservation in accordance with the regulations contained herein to achieve the following objectives:

(1) To restrict flows in downstream channels of Kern River and its distributaries to non-damaging rates.

(2) To eliminate or minimize flood flows from Kern River into Tulare lakebed.

(3) To provide the maximum practicable amount of storage space for conservation of irrigation and power water without impairment of the flood-control functions.

b. In achieving the above objectives, forecasting of snowmelt runoff is important. When it is anticipated that flood water might be discharged into Tulare Lake, the Watermaster will be alerted and requested to provide updated irrigation and spreading capabilities so that all possible use of the water can be made for irrigation and spreading. Since the rate at which water can be used for irrigation and spreading is relatively small, releases for such purposes should be initiated as soon as possible in order to obtain the maximum empty space for the storage of subsequent floodwaters. However, releases to Tulare Lake should be delayed as long as is practicable in order to allow harvesting of crops and to guard against making unnecessary releases because of errors in forecast.

18. RESONSIBILITY FOR OPERATION


Isabella Lake is operated by the U.S. Army Corps of Engineers and is under the jurisdiction of the District Engineer, Sacramento, California.


19. UPSTREAM REGULATION

There is no significant regulation of flows in the Kern River Basin above Isabella Lake.

20. DOWNSTREAM REGULATION

The Kern River Intertie (completed in 1977) will be operated to provide flood protection to Tulare Lake. It will divert Kern River snowmelt flood flows to the State Aqueduct.





21. RELEASE REQUIREMENTS

a. It has been a practice to maintain a minimum release of approximately 5 c.f.s. for fish enhancement. No official requirement has been established for the action.

b. Releases for purposes other than flood control are initiated on the Watermaster's request. Such requests should be coordinated with downstream interests by the Watermaster.

22. DOWNSTREAM CHANNEL CAPACITIES AND FLOW CHARACTERISTICS

a. The maximum non-damaging capacities of downstream channels of Kern River and its distributaries are estimated as shown on chart A-6. The controlling capacity for reservoir operation purposes is the combined capacity of the river channel and bypass system below Pioneer Turnout, which is 4,600 cubic feet per second. The travel time from Isabella Lake to Pioneer Turnout is a minimum of 18 hours.

b. In the Bakersfield area flows of about 8,000 c.f.s. will cause some damage to industrial areas, however, levees protect the urban areas from flows to approximately 20,000 c.f.s.

23. FLOOD DAMAGES UNDER PROJECT CONDITIONS

a. Since completion of Isabella Lake, the largest rainflood of record (1893-1977) occurred in December 1966 and the largest snowmelt flood of record occurred in 1969. Releases from Isabella Lake during the 1966 flood were nominal and caused no damage downstream. In 1969, measures were taken by both the Federal government and local interests to spread the excess snowmelt flow, but in spite of these measures, it is estimated that 227,000 acre-feet of water from Kern River reached Tulare Lake. However, flows in the Kern River below Isabella Lake were kept at or below channel capacity during the 1969 flood, and the Kern River Intertie is expected to divert all or a portion of future snowmelt flood releases to Tulare Lake.

b. The December 1966 flood was followed by a snowmelt flood in the spring, and throughout the entire flood season it is estimated that Isabella Lake prevented about \$50,000,000 in flood damage to the Bakersfield-Oildale area and about \$1,300,000 in flood damage to Tulare Lake. Similarly, the 1969 snowmelt flood was preceded by a rainflood. During the entire 1969 flood season Isabella Lake prevented approximately \$6,000,000 in flood damage to the Bakersfield-Oildale area and \$2,100,000 flood damage in Tulare Lake.

24. FLOOD CONTROL OPERATION

a. The schedule of flood control releases at Isabella Reservoir under the multiple-purpose operation is given on chart A-7. Specified releases include flows released through the Borel Canal outlet at all times.

25. CONSERVATION OPERATION

Operation for conservation in accordance with the contract with local interests is as follows:

a. All inflow in excess of the release requested by the Kern River Watermaster will be stored to the extent that conservation space in the reservoir is available. Releases adequate to satisfy power entitlements will be made when necessary.

b. Water stored for irrigation will be released in accordance with the requests of the Kern River Watermaster.

c. When Borel Canal is not operating under reservoir head, water is diverted to Borel Power House directly from the Kern River. When the canal is operating under reservoir head, releases to Borel Canal will be as requested by the Southern California Edison Company up to the total power entitlements or up to canal capacity during the irrigation season when releases exceed power entitlements.

d. Water stored for recreation purposes (30,000 A.F.) will not be released for other than flood control purposes except by mutual agreement between the parties involved. This requirement is established by the "Agreement for Establishment and Maintenance of Minimum Recreation Pool of 30,000 Acre-Feet in Isabella Reservoir", dated 8 November 1963.

e. Requests by the Kern River Watermaster for irrigation releases will normally be made directly to the reservoir operator and will be coordinated with downstream interests by the Watermaster.

26. SEDIMENTATION AND WATER QUALITY MEASUREMENT

a. A system of 24 sedimentation ranges was established by ground survey methods in or adjacent to the reservoir area in 1952 before any significant water had been stored in the reservoir. Each range is straight and is marked by a permanent monument above gross pool level at each end. The original level profile along each range, measured ground surface elevations at intervals of about 50 feet and at all principal breaks in profile and is to an accuracy of 0.2 ft. in elevation and 5 ft. in distance. Each profile is recorded on a permanent drawing to a horizontal scale of 1 inch to 400 feet and a vertical scale of 1 inch to 20 feet with an attached table showing the

coordinates of all survey points. It was intended to resurvey the ranges at 5-year intervals, or more often when the Hydrology Section determines sediment inflow has been exceptionally large. After the detailed range-line-survey of March 1969, the Hydrology Section prepared a report titled "Sedimentation Survey of Isabella Lake, 24 February 1971" which recommended frequency of further surveys be dictated by the occurrence of floods having the capabilities of carrying large bedloads, rather than once every 5 years as previously proposed. The sedimentation ranges are shown on chart 16.

b. Estimates of sediment deposits in Isabella Lake are made based on sedimentation data collected by the Corps. Data collected through 1969 shows that the annual sediment transport above Isabella Lake is 0.12 acre-feet per square mile or approximately 250 acre-foot annually. The resultant sediment deposit would be 25,000 acre-feet in 100 years: less than five percent of the current gross pool capacity of 570,000 acre-feet.

c. Samples from the inflow, outflow and reservoir are analyzed periodically for water quality. In addition, the temperature of the inflow and the outflow is monitored continuously. The quality of releases from Isabella Lake is generally good to excellent.

27. RELATION TO OTHER PROJECTS

a. Isabella Lake operates in connection with three other federal storage projects (Lake Kaweah, Pine Flat Lake and Success Lake) to minimize floodflows into Tulare Lake. The operation of these projects will be coordinated for the maximum realization of their common goal.

b. The Kern River Intertie also operates to minimize floodflows into Tulare Lake and will require coordination with the operation of Isabella Lake. The State has requested seven days advance notice prior to any diversions through the intertie.

c. Of the four power projects on the Kern River, only the three downstream from the Isabella Lake are factors in its operation. They have water rights (discussed in paragraph 40) which must be considered in determining releases.

d. Before Isabella Lake was constructed, the Borel Powerhouse received flows from North Fork Kern River via Borel Canal. The auxiliary dam for the Isabella Lake project was constructed across the canal and consequently an outlet was provided to pass flows through the auxiliary dam to the canal and powerhouse. Two modes of release are feasible: when the reservoir pool is at or above approximately 2,548 feet (approximately 110,000 acre-feet), water is released directly from the reservoir to the canal through the auxiliary dam outlet. However, when the pool is below this elevation there is insufficient head to make such releases and the diversion and canal

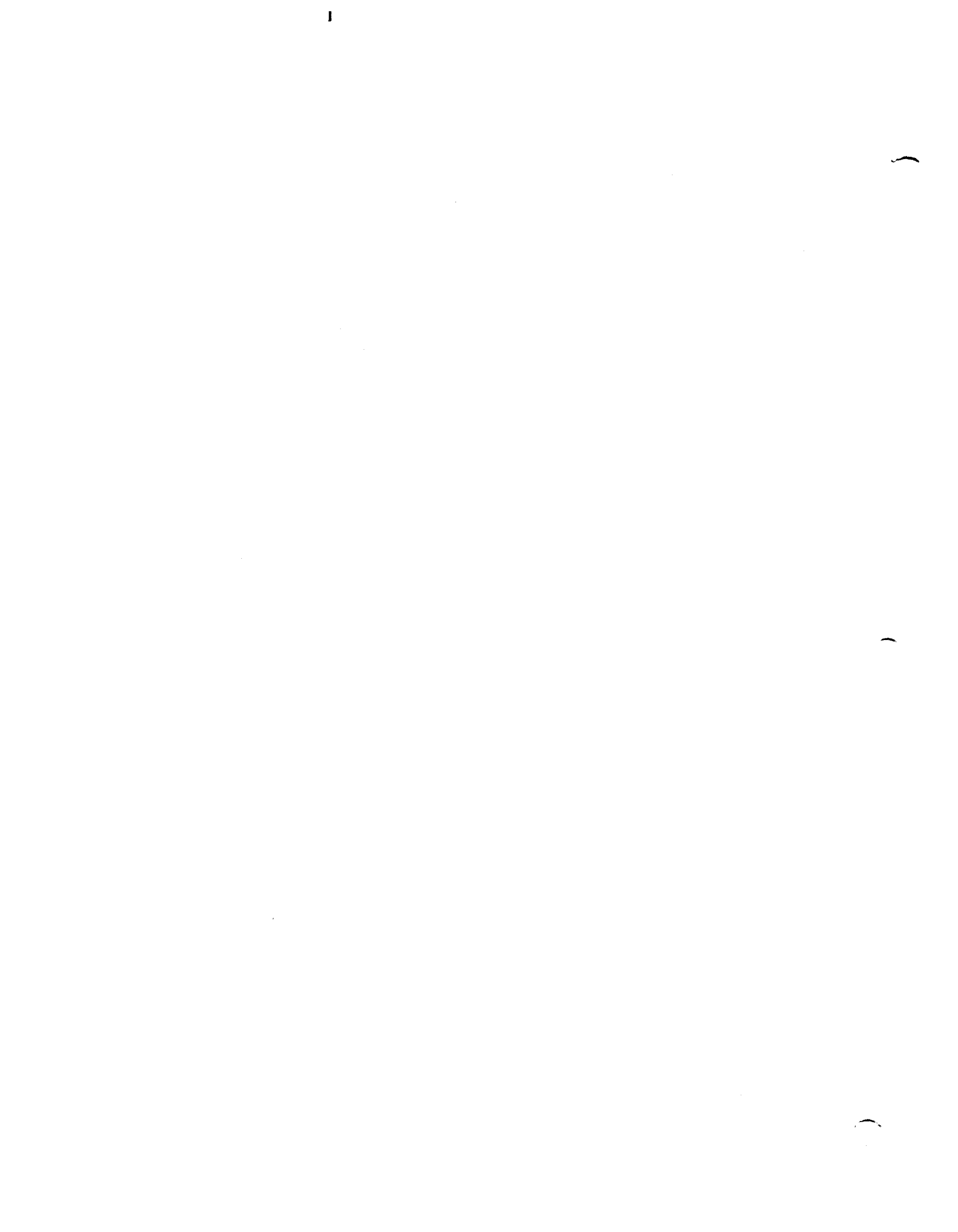
from North Fork Kern River must be reactivated to divert flow to the Borel Canal and Powerhouse through the auxiliary dam. The operation technique during the transition period is discussed in Appendix A. Since construction of the project, the diversion and canal have been reactivated four times.

28. SPREADING

When water is temporarily stored in the flood control reservation as determined from the flood control diagram, it will be released as rapidly as possible in accordance with instructions on the diagram. These flood releases will be disposed of to the extent possible by spreading in agricultural fields and by diversion into the spreading basins for percolation to the groundwater table, thus preventing floodflows into Tulare Lake.

29. GATE OPERATION

Outflow from Isabella Reservoir is divided between Borel Canal and the main river until it reaches the tailrace of the Southern California Edison Company's Borel Power Plant. Normally releases for purposes other than power will be made to Borel Powerhouse up to its capacity before using the main gates except for minor voluntary releases for fish and wildlife preservation. A detailed description of gate operation is contained in Appendix A.



CHAPTER VI - FLOOD CONTROL DESIGN REQUIREMENTS

30. HYDROLOGIC BASIS FOR DESIGN

a. The selection of the reservoir capacity of Isabella Reservoir was based primarily on flood control requirements with the following objectives:

(1) Protection of the city of Bakersfield against all reasonably probable rain floods.

(2) Prevention of damaging flows into Tulare Lake in all except the extreme flood years, and minimizing and delaying damaging flows in those extreme years.

(3) Control of flows in Kern River insofar as practicable to capacities of channels between Bakersfield and Tulare Lake during both rain and snowmelt floods.

b. The total reservoir capacity (570,000 acre-feet) may be devoted to controlling snowmelt floods depending on the forecasted runoff. The reservation required to control rainfloods (325,000 acre-feet) is based on passing the standard project 30-day flood series without exceeding a flow of 15,000 cfs through Bakersfield. A standard project flood routing is shown on Chart 12.

31. FLOOD CONTROL SPACE REQUIREMENTS

Prior to authorization it was determined that 550,000 acre-feet of flood control reservation would be required to control the 1906 flood to objective flows with only minor damaging flows to Tulare Lake. It was also found that in evacuating the reservoir by the start of the snowmelt season, sufficient space (400,000 acre-feet) would normally be available to control all but extremely rare rainfloods. For operational purposes, a rainflood reservation of 150,000 acre-feet was adopted based on the standard project flood developed at that time. However, routings of the standard project flood discussed in paragraph 14 indicate a rainflood reservation of 325,000 acre-feet from 1 November to 1 March is required to protect the urban development in the Bakersfield area. The flood control space requirements are shown on chart A-7.

32. MULTIPLE USE OF RESERVOIR SPACE

Prior to 1 February when snowmelt forecasts become available, the Flood Control Space will normally be kept empty in preparation for the snowmelt season. However, requests for encroachments in the Flood Control Space for the purpose of carrying over conservation water will be considered on an individual basis based on prevailing conditions.

Under no condition will the storage of conservation water be permitted in the 325,000 acre-feet reservation required to control rainfloods between 1 November and 1 March. The space made available for conservation water in the Conditional Space will be based on forecast snowmelt runoff.

33. FLOOD CONTROL DIAGRAM

The flood control diagram for Isabella Lake is shown on chart A-7. It is based on 85 years of hydrologic data for the basin, 25 years of operational experience with the project, and current irrigation demands. The diagram gives the required flood control release for a given storage at any particular time of year.

CHAPTER VII - OPERATIONAL CONTROLS

34. DIVISION OF RESPONSIBILITY FOR OPERATION

a. The primary responsibilities of operating Isabella Reservoir are delegated to units of the Engineering Division and Construction-Operations Division as outlined herein. Names, addresses, and telephone numbers for those individuals whose responsibilities are outlined in the following paragraphs are given on the personnel chart at the front of this report.

b. The Reservoir Control Section (Engineering Division), will be responsible for:

(1) Analyzing current reservoir and hydrologic data, determining the condition under which the reservoir shall be operated, and issuing appropriate operation instructions to the reservoir operator.

(2) Preparing monthly operation and other special reports relative to operation of the reservoir as required by the Office, Chief of Engineers, and as needed for operational purposes.

(3) Advising the District Engineer whenever there has been an unavoidable departure from these regulations, or when there is a need for making a temporary modification of these regulations.

(4) Keeping advised at all times of downstream channel conditions by making periodic field inspections.

(5) Arranging with local interests for collection of current flow and diversion data.

(6) Obtaining from local interests each month a summary of recorded Kern River flows and diversions; maintaining a record of instructions issued, data transmitted to other agencies, and requests received from other agencies.

c. The responsibilities of the Reservoir Operator (Construction-Operations Division) are outlined in Appendix A.

d. The Hydrology Section (Engineering Division) will be responsible for:

(1) Obtaining current hydrometeorological data and weather forecast for the region as required for use by the chief, Reservoir Control Section.

(2) Maintaining hydrologic equipment and supervising its operation.

(3) Supervising a program of water quality and sediment measurement.

35. HYDROLOGIC FACILITIES

Hydrologic facilities for operation of the project consist of:



■ Other recording stream gaging stations on downstream channels as shown on chart 2.

e. ■ [REDACTED]

f. ■ [REDACTED].

g. Snow courses shown on chart 3.

h. Snow pillows shown on chart 3.

i. Precipitation stations shown on chart 3.

j. Sedimentation ranges shown on chart 16.

36. FORECASTS OF FLOOD RUNOFF

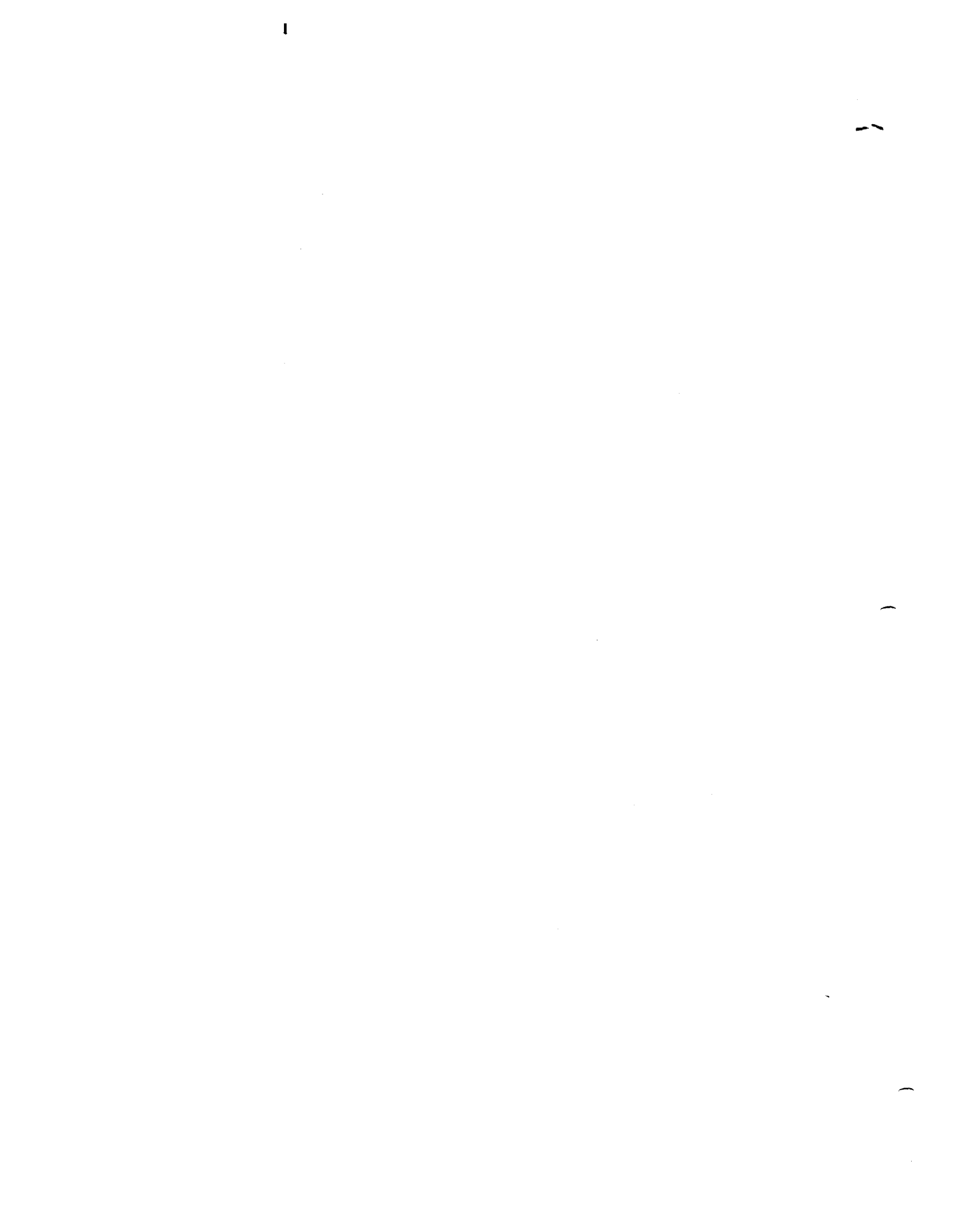
a. Because of the large reservation maintained in anticipation of snowmelt floods, the probability of spills from Isabella Lake due to a rainflood is very small. Rainflood forecasts are not critical to the operation of Isabella Lake. However, local flows downstream may

be substantial and releases should be curtailed at the onset of an impending flood. Rainflood forecast criteria for flows into Isabella Lake is shown on chart 17.

b. During the snowmelt season the release schedule for Isabella Lake is based on runoff forecasts and therefore these forecasts are very important. Forecasts of snowmelt made by the Department of Water Resources of the State of California will be used in the operation of Isabella Lake. The department publishes forecasts of runoff through July into Isabella Lake as of 1 February, 1 March, 1 April, and 1 May of each year. Preliminary forecast values are furnished the District Office by the 10th of each of these months. The forecasts are published in "Water Conditions in California". A forecast summary is shown on chart 18.

37. COORDINATION WITH OTHER AGENCIES

In order to assure that the flood control operation of Isabella Lake will be as effective and reasonable as possible, it is essential the Corps of Engineers (the operating agency) keep advised at all times of possible flood hazards, weather conditions, inflow to the lake and the flows in Kern River below Isabella Dam. This requires close liaison with other agencies including the National Weather Service, the State of California Department of Water Resources, the Kern River Watermaster, the Kern County Water Agency and other downstream interests.



CHAPTER VIII - WATER RIGHTS

38. WATER RIGHTS FOR IRRIGATION WITHIN RESERVOIR AREA

The lands within Isabella Reservoir up to elevation 2,617 together with their water rights have been acquired in fee by the United States Government. The State of California made an investigation to estimate the amount of water available under the existing appropriative water rights within the Isabella Reservoir area. Using the period 1930-42 and 1948-49 inclusive, the State estimated that the average amount available from these combined appropriative water rights is on the order of 6,500 acre-feet per season (April, May and June). This is based on the assumption that the average seasonal consumptive use within the reservoir area from gravity diversion is the measure of the combined appropriative water rights of the land owners within that area. This includes 6,000 acre-feet from South Fork rights and 500 acre-feet from North Fork rights. During a dry year like 1931, the water available from the North Fork would remain at about 500 acre-feet while that available in the South Fork would be reduced to about 2,000 acre-feet. Some of these lands suitable for farming or grazing are available for leasing. The leasees may use the water in the same manner as it was used in the past. The remainder of the water is stored in Isabella Lake for public recreational purposes.

39. WATER RIGHTS FOR DOWNSTREAM IRRIGATION

The use of Kern River water for irrigation has been governed by the Miller-Haggin agreement, dated 28 July 1888 and as amended most recently on 1 January 1964. The 1964 Amendment details the present allocation of water between the upstream parties on Kern River. However, on 31 December 1962 all the parties to the Conservation Interest in the Isabella Project entered into the Kern River Water Rights and Storage Agreement which distributes the Kern River flow between the "Upstream Group" and the Downstream Group". This latter agreement consists of many pages of details. Herewith are the essential elements of the agreement:

The Districts agreed with each other (in part) as follows:

(1) Upstream-Downstream Division.

All parties agree from and after the date hereof (31 Dec 62) all waters of Kern River shall be divided and apportioned between North Kern and Buena Vista and the parties they represent (hereinafter called "Upstream Group"), on the one hand, and Tulare Lake, Hacienda and all other parties establishing rights to such waters north of the Wasco-Paso Robles Highway (hereinafter called "Downstream Group"), on the other hand, as follows:

(a) The following percentages of the calculated natural flow of Kern River at First Point of Measurement will be allocated and belong to the Downstream Group (with the remainder going to the Upstream Group) during the indicated periods of each calendar year:

<u>Aggregate Kern River Flow in Thousands of Acre-Feet</u>	<u>Downstream Group Percentage</u>
<u>January - March</u>	
First 250	None
All over 250	33%
<u>April - July</u>	
First 550	None
Next 50 (from 550 to 600)	33%*
Next 50 (from 600 to 650)	33%
Next 400 (from 650 to 1050)	44%
All over 1050	60.5%
<u>August - December</u>	
	None

* Only in certain years, namely, each year immediately following a year in which the April - July flow equals or exceeds 600,000 acre-feet.

40. WATER RIGHTS FOR POWER

a. The flow of Kern River above the South Fork up to 605 cubic feet per second must be made available to the Southern California Edison Company for diversion through their Borel Power Plant. In addition, water released from reservoir storage (or from current South Fork flows) for purposes other than power will be made available for diversion through Borel Power Plant up to the capacity flow whenever physical facilities permit, with the possible exception of minor flows voluntarily released for the preservation of fish and wildlife. The supply of water from the reservoir for Borel Power Plant use over and above the North Fork flow will require payment to the United States under the Federal Power Act. The amount and method of payment is determined by the Federal Power Commission.

b. The Southern California Edison Company claims the following water rights in connection with the operation of their Kern River Power Plant No. 1: during October through May, the preproject flow of Kern River (including South Fork) up to 412 cubic feet per second (the capacity of the plant); during June through September, the first 74 cubic feet per second of flow of the river, the next 50 cubic feet per second to bypass the plant for recreational purposes, and the next 338 cubic

feet per second to be diverted for power. The supply of water from the reservoir for power use over and above the Kern River preproject flow requires payment to the United States under the Federal Power Act.

c. The Pacific Gas and Electric Company's Kern Canyon Power Plant has preproject diversion rights of 550 cubic feet per second, under state license, and claims an additional 250 cubic feet per second under other rights. Actual maximum diversion in recent years has been about 720 cubic feet per second. The 550-cubic-feet-per-second right, however, is subject to upstream storage by irrigation interests provided that an equivalent amount of water in excess of natural flow is made available for power use by release from storage at a later time. The supply of water from the reservoir for power use over and above that available for preproject use requires payment to the United States under the Federal Power Act.



CHAPTER IX - PROJECT ACCOMPLISHMENTS

41. EXAMPLES OF OPERATION

Hypothetical operation during the standard project and the December 1966 rainflood is illustrated on chart 12. A hypothetical operation of Isabella Dam and Lake during the spillway design flood is shown on chart 14. Hypothetical routings of historic snowmelt floods are shown on chart 13. Stage duration curves are presented on chart 19, a stage frequency curve on chart 20, and a seasonal variation of reservoir storage on chart 21.

42. OPERATION RECORD

The official operation record of Isabella Lake is included in a monthly report submitted to the Chief of Engineers. Daily storage and daily flows at the inflow and outflow stations are published annually in the U.S. Geological Survey Water Supply Papers. Historical operation of Isabella Lake is shown graphically on chart 22.

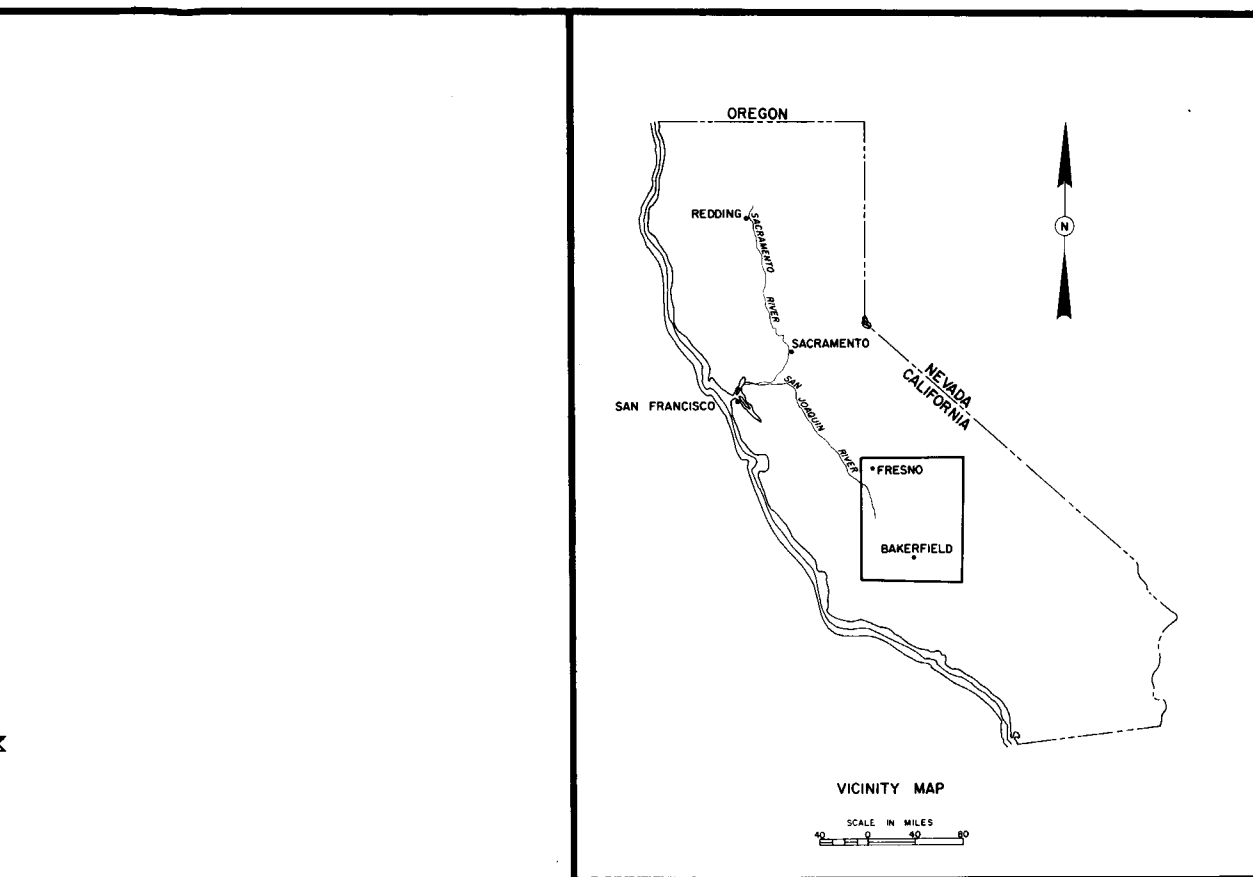
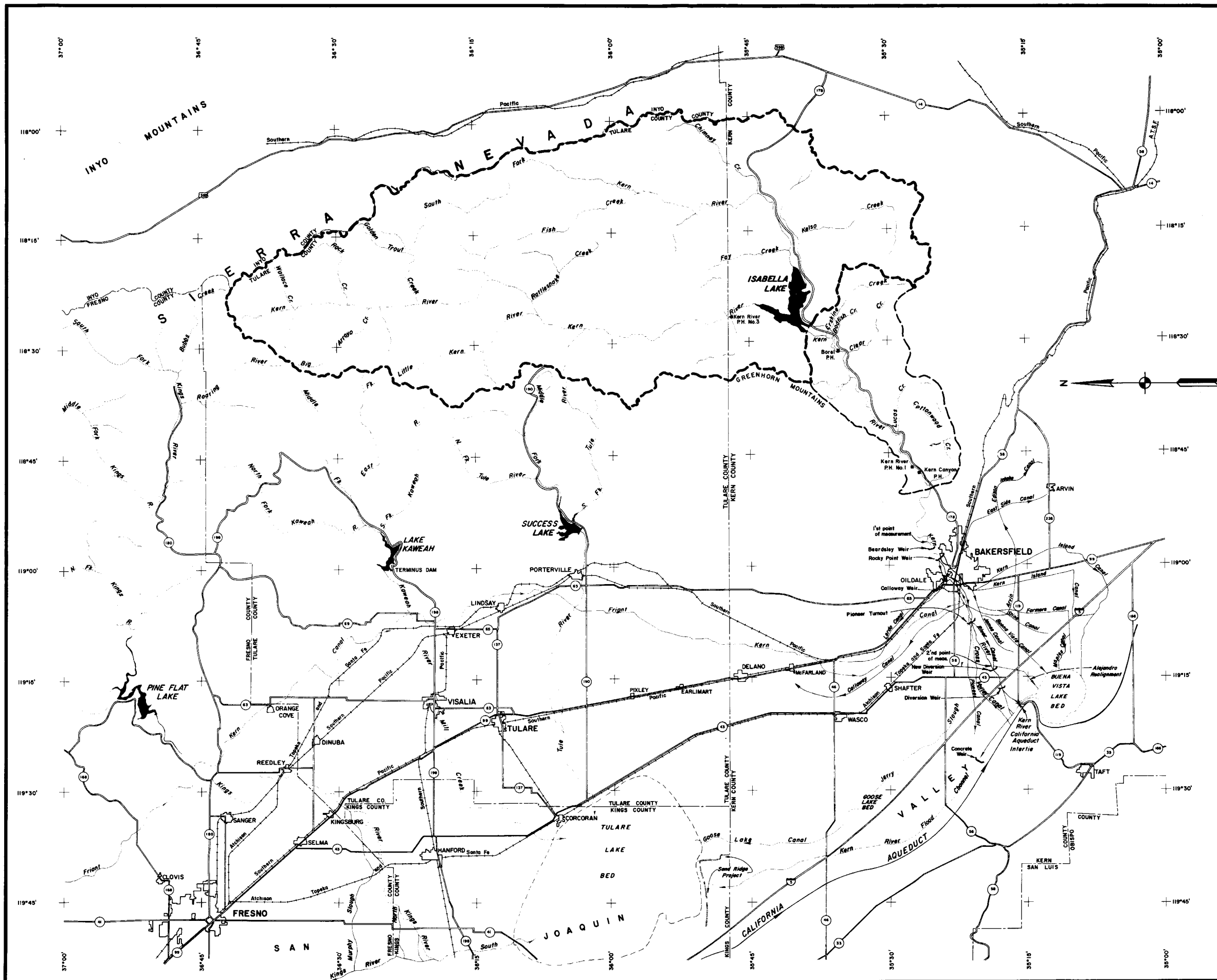


CHAPTER X - STUDIES IN PROGRESS OR PLANNED

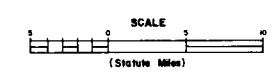
43. CURRENT STUDIES

At the request of local interests, studies are presently underway to determine if it would be desirable and economically feasible to increase the minimum recreation pool in Isabella Lake. The Corps of Engineers is currently conducting an earthquake analysis of the dam as prescribed by ER 1110-2-1806, dated 30 April 1977. In addition, the Corps is reviewing the adequacy of the spillway as directed by the Office of the Chief of Engineers.





- LEGEND**
- Drainage Boundary
 - U.S. Highway
 - State Highway
 - Interstate Highway
 - Railroad
 - Levee
 - Intermittent Stream
 - Perennial Stream
 - Canal
 - Reservoir or Lake
 - Authorized Reservoir



ISABELLA LAKE
KERN RIVER, CALIFORNIA

GENERAL MAP

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: C.D.M. Date: NOVEMBER 1977

Drawn: T.K.B.





**HISTORICAL INFLOWS
TO
LAKE ISABELLA**

Runoff in 1,000 acre-feet

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL TOTAL
1955	11.8	14.4	16.0	18.1	22.7	28.1	35.1	67.9	83.4	29.1	18.9	10.3	355.8
1956	9.5	11.5	90.4	77.1	48.2	59.9	94.5	156.3	167.4	97.2	38.1	20.3	870.4
1957	17.6	15.7	15.1	16.4	25.3	30.3	38.5	78.1	131.8	41.0	16.4	12.5	438.7
1958	13.6	13.3	17.6	20.6	36.5	61.5	153.6	312.3	231.7	120.1	51.1	25.8	1057.7
1959	20.6	18.7	17.8	19.3	21.2	31.7	39.5	39.4	33.0	15.8	9.9	9.6	276.5
1960	9.6	9.7	10.3	12.2	27.9	30.2	44.5	58.0	45.5	15.1	7.9	8.4	279.3
1961	9.5	13.0	11.7	10.6	10.0	13.1	23.0	29.1	23.8	8.5	15.1	7.6	175.0
1962	7.1	8.8	11.0	12.4	47.1	32.4	140.5	130.8	154.7	72.1	23.7	13.1	653.7
1963	12.9	11.6	11.1	26.5	99.6	41.0	67.6	134.0	162.3	102.6	42.2	26.5	737.9
1964	24.5	23.8	21.5	18.2	16.6	22.7	39.6	60.0	52.3	22.0	13.3	8.6	323.1
1965	8.7	13.9	44.2	43.5	30.2	33.2	74.5	131.0	149.9	94.9	50.7	22.0	696.7
1966	15.6	28.4	28.3	27.0	21.4	37.8	66.7	81.5	45.4	21.9	16.1	9.6	399.7
1967	9.5	13.7	299.0	59.6	62.5	83.2	95.5	268.1	302.9	238.1	90.5	53.5	1576.1
1968	34.9	31.9	33.0	32.2	38.9	47.1	64.4	86.7	62.1	28.4	18.4	11.3	489.3
1969	12.6	15.3	17.1	159.4	93.4	133.9	337.4	597.5	485.6	236.0	93.8	44.3	2226.3
1970	33.3	32.4	30.9	61.8	39.0	56.9	62.1	109.8	92.7	49.2	22.7	13.4	604.2
1971	12.7	18.8	26.8	31.5	29.4	40.6	51.1	64.4	81.1	41.6	18.9	11.1	428.0
1972	11.4	13.4	17.2	18.2	17.6	32.3	27.3	45.4	37.7	14.6	10.7	11.2	256.8
1973	10.6	14.5	19.3	30.5	32.2	45.0	103.9	282.5	226.5	91.8	36.9	18.8	912.0
1974	16.8	20.4	25.1	45.6	28.1	68.8	108.1	182.2	166.7	68.6	37.6	20.4	788.3
1975	19.1	17.6	20.6	21.1	25.3	39.9	43.9	142.8	138.8	50.3	22.4	16.2	558.0
1976	15.1	14.7	15.6	14.6	15.3	21.8	24.2	47.0	18.9	13.9	13.7	23.1	237.8
1977	18.7	11.7	10.0	12.2	12.0	12.6	22.4	24.3	34.5	10.3	9.8	7.0	185.5
MEAN	15.5	16.8	35.2	34.3	34.8	43.7	76.4	136.0	127.3	64.4	29.5	17.6	631.6

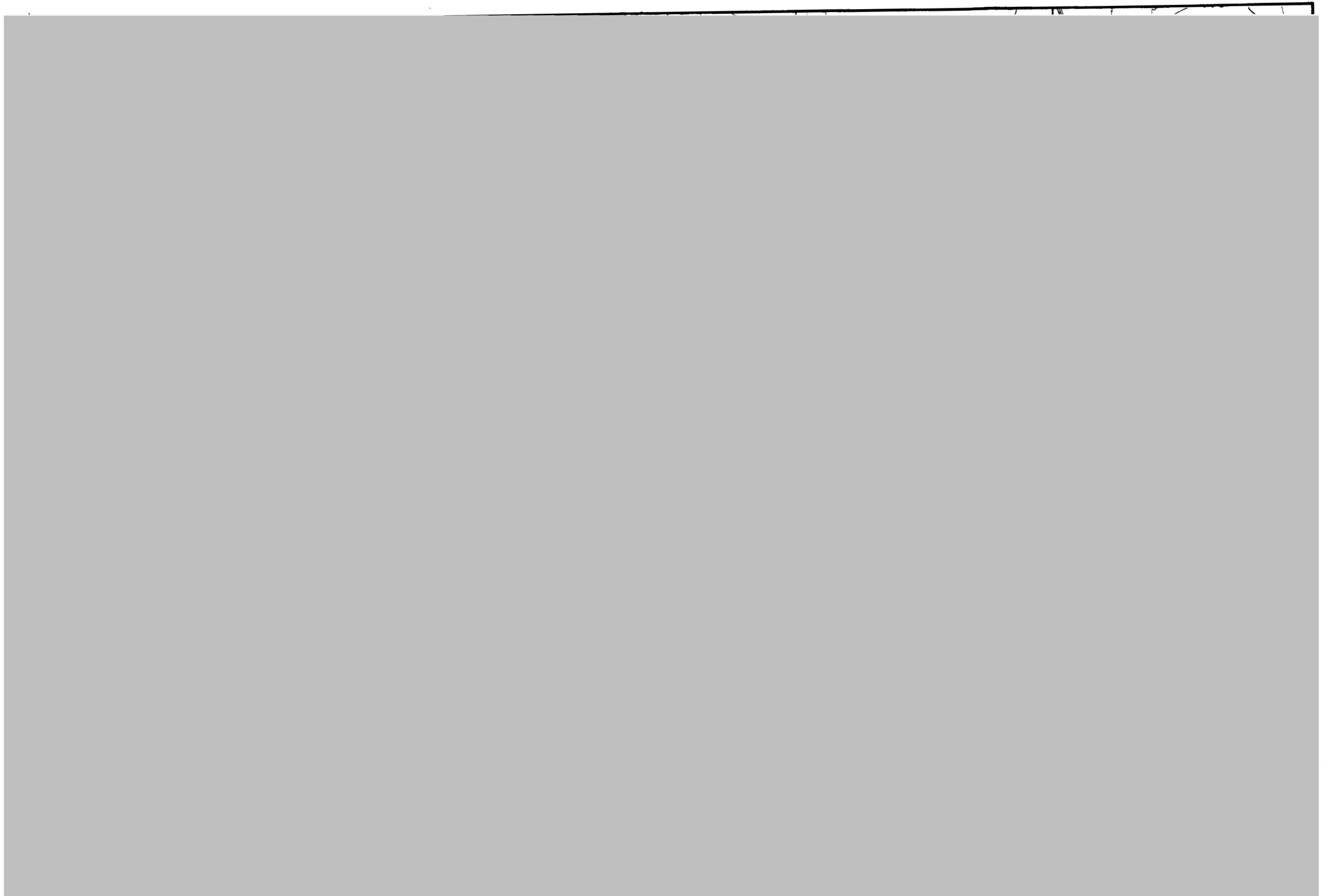
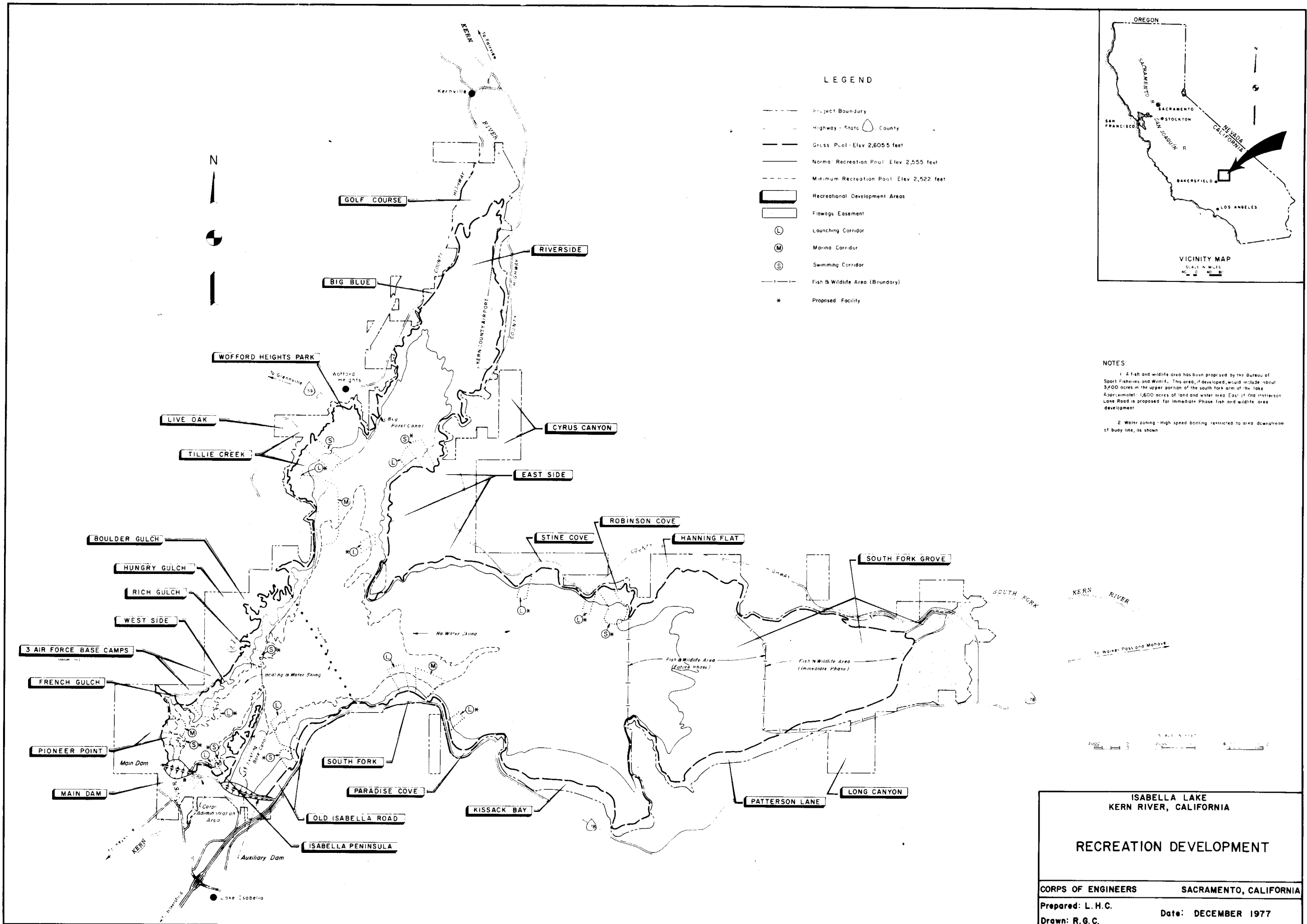


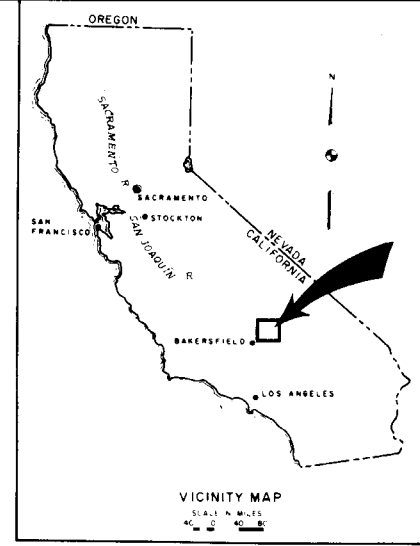


Chart 6



LEGEND

- Project Boundary
- Highway - State County
- Gross Pool - Elev 2,605.5 feet
- Normal Recreation Pool - Elev 2,555 feet
- Minimum Recreation Pool - Elev 2,522 feet
- ▭ Recreational Development Areas
- ▭ Flowage Easement
- Launching Corridor
- Marina Corridor
- Swimming Corridor
- Fish & Wildlife Area (Boundary)
- * Proposed Facility



NOTES:

1. A fish and wildlife area has been proposed by the Bureau of Sport Fisheries and Wildlife. This area, if developed, would include about 3,000 acres in the upper portion of the south fork arm of the lake. Approximately 1,600 acres of land and water area East of Old Patterson Lane Road is proposed for immediate phase fish and wildlife area development.
2. Water zoning - High speed boating restricted to area downstream of buoy line, as shown.

**ISABELLA LAKE
KERN RIVER, CALIFORNIA**

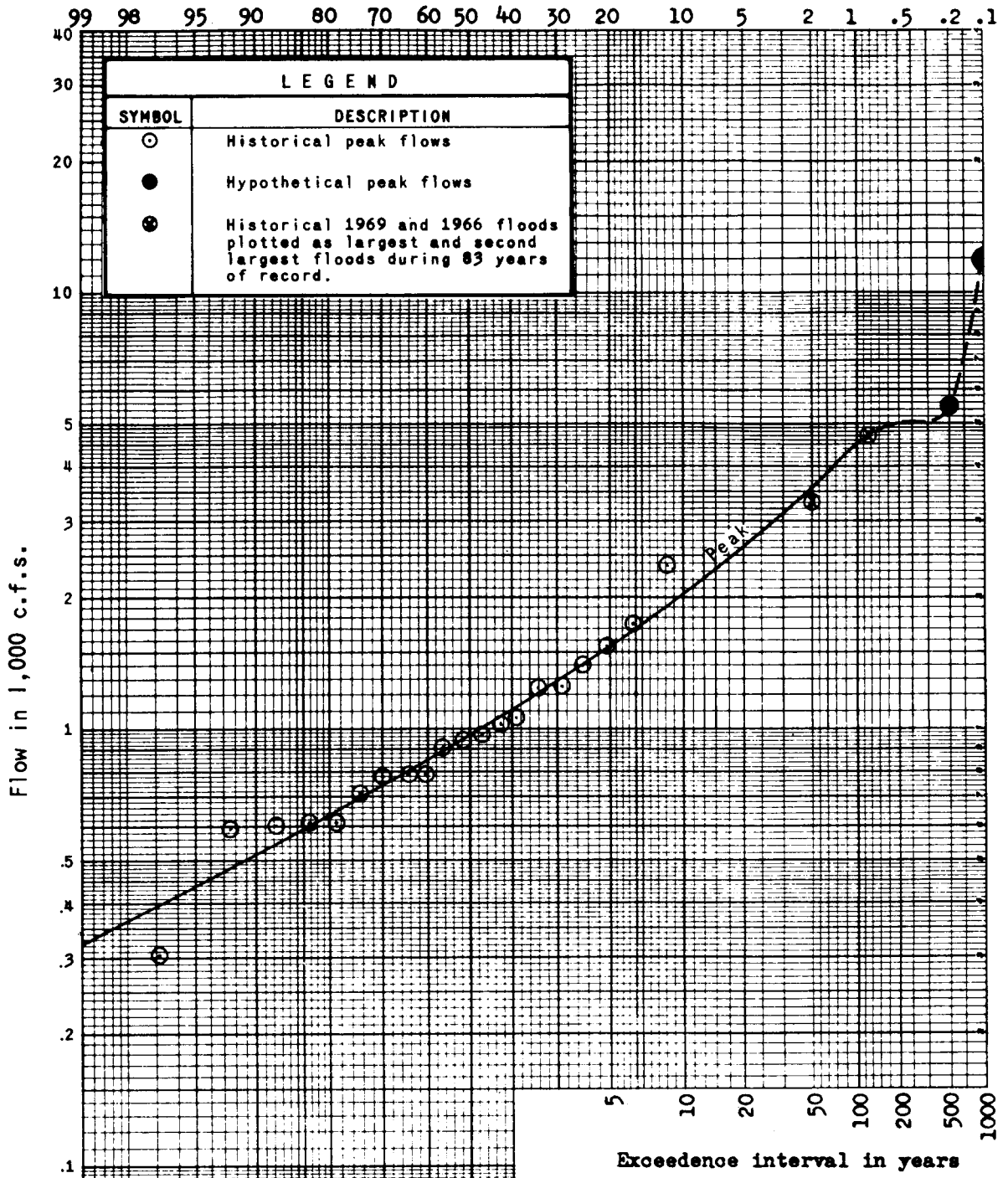
RECREATION DEVELOPMENT

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: L. H. C. Date: DECEMBER 1977

Drawn: R. G. C.

Exceedence frequency per hundred years



ISABELLA LAKE
 KERN RIVER, CALIFORNIA

RAIN FLOW FREQUENCY
 REGULATED CONDITIONS

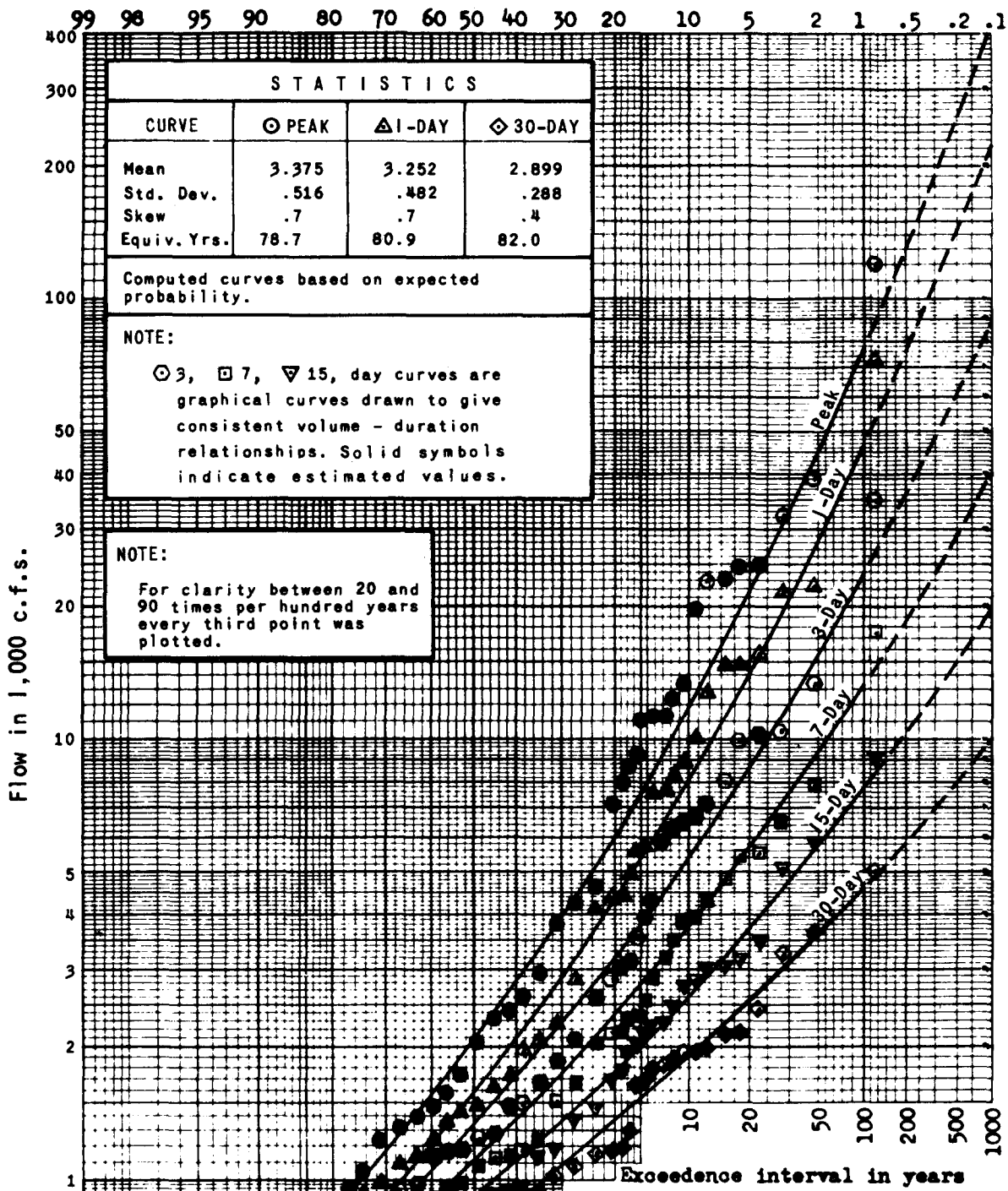
KERN RIVER BELOW ISABELLA DAM

Corps of Engineers, Sacramento, Calif.

Prepared: M.A.S. Date: NOVEMBER 1977

Period of record: 1955-1976
 Drainage area: 2074 sq. mi.

Exceedence frequency per hundred years



ISABELLA LAKE
 KERN RIVER, CALIFORNIA

RAIN FLOW FREQUENCY
 UNREGULATED CONDITIONS

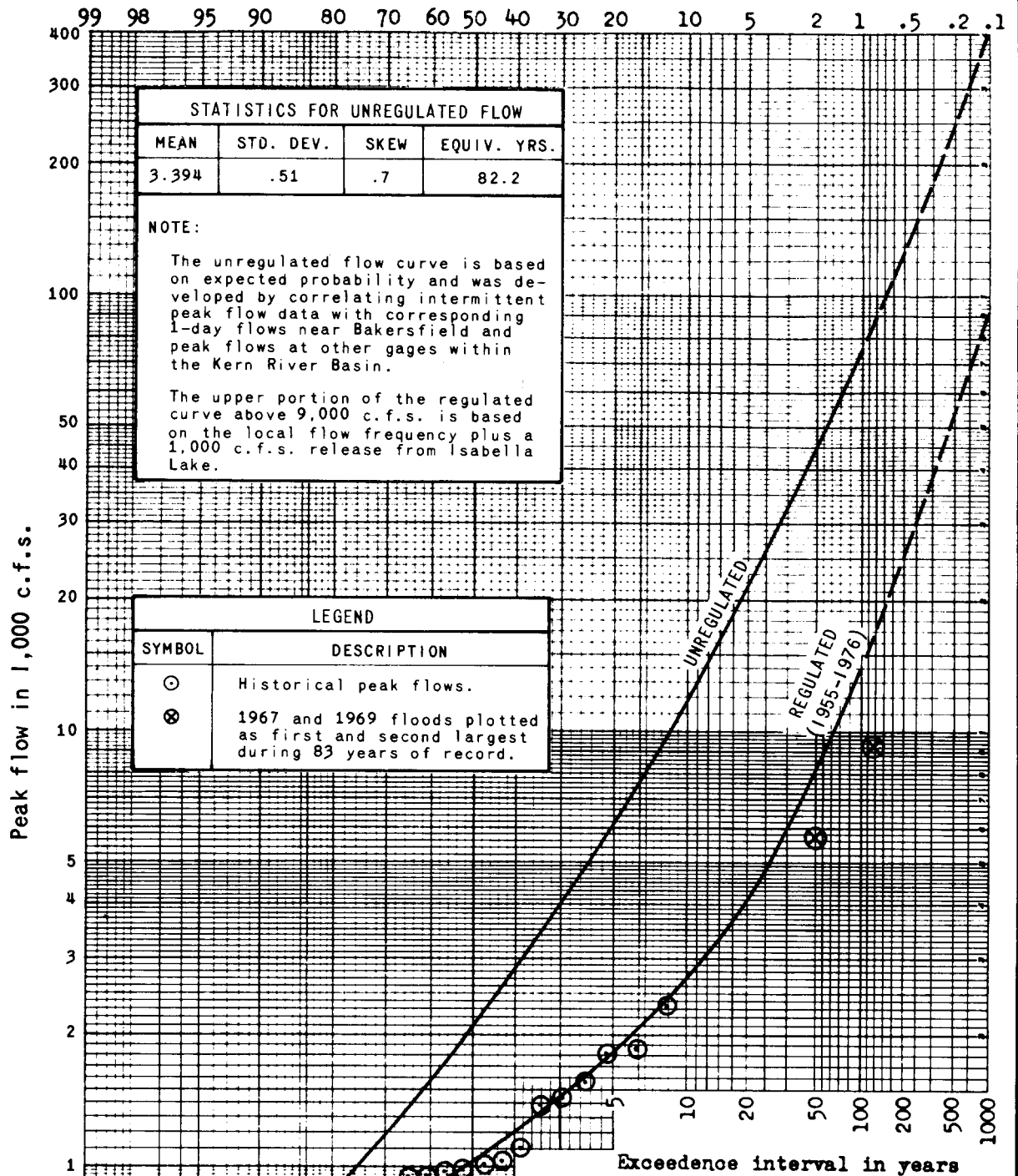
KERN RIVER BELOW ISABELLA DAM

Extended period of record: 1894-1976
 Drainage area: 2074 sq. mi.

Corps of Engineers, Sacramento, Calif.

Prepared: R.C.K. Date: NOVEMBER 1977

Exceedence frequency per hundred years



STATISTICS FOR UNREGULATED FLOW			
MEAN	STD. DEV.	SKEW	EQUIV. YRS.
3.394	.51	.7	82.2

NOTE:

The unregulated flow curve is based on expected probability and was developed by correlating intermittent peak flow data with corresponding 1-day flows near Bakersfield and peak flows at other gages within the Kern River Basin.

The upper portion of the regulated curve above 9,000 c.f.s. is based on the local flow frequency plus a 1,000 c.f.s. release from Isabella Lake.

LEGEND	
SYMBOL	DESCRIPTION
○	Historical peak flows.
⊗	1967 and 1969 floods plotted as first and second largest during 83 years of record.

Drainage area: 2407 sq. mi.

ISABELLA LAKE
KERN RIVER, CALIFORNIA

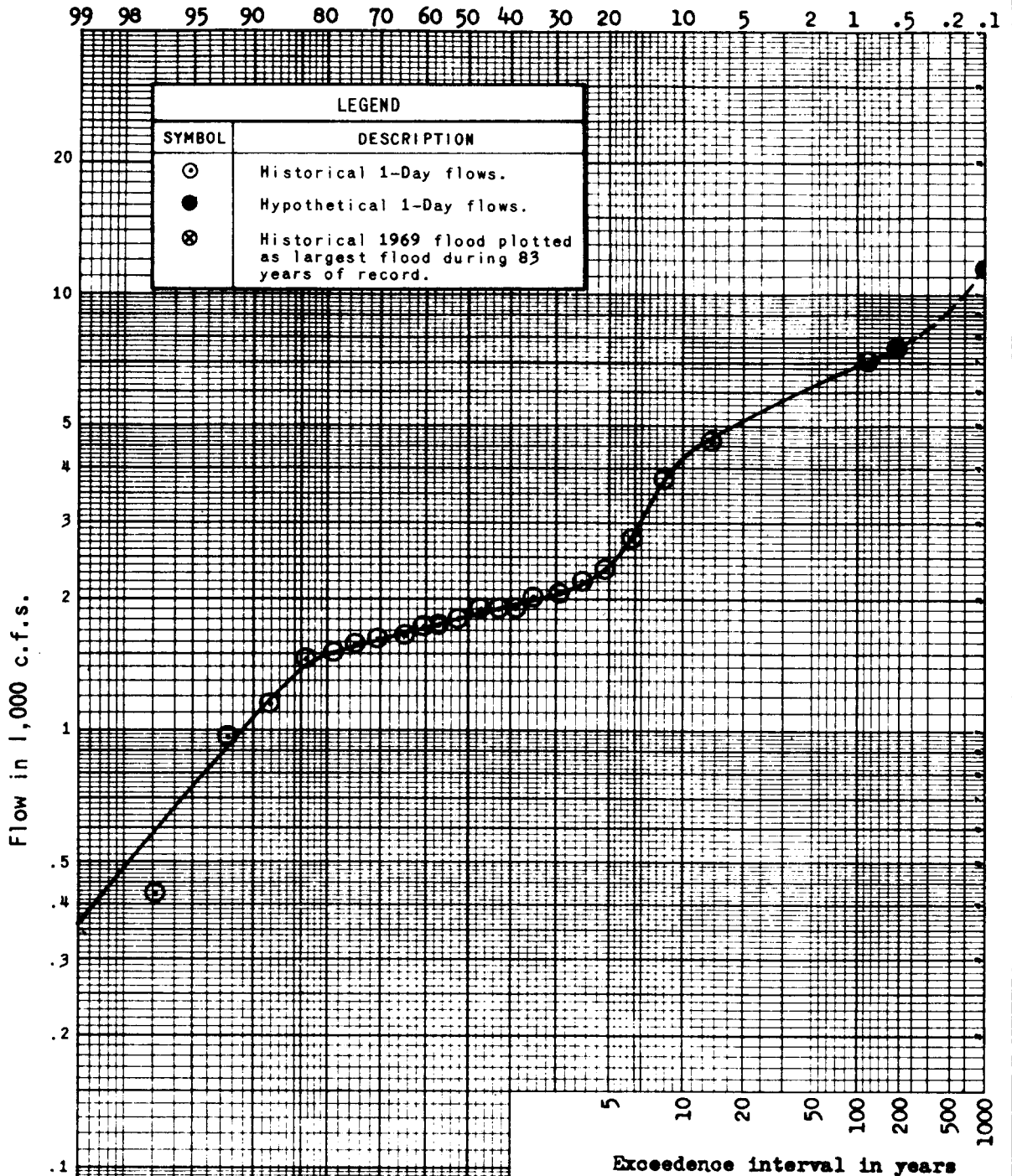
**PEAK RAIN FLOW FREQUENCY
REGULATED CONDITIONS**

KERN RIVER NEAR BAKERSFIELD

Corps of Engineers, Sacramento, Calif.

Prepared: H.T.M. Date: NOVEMBER 1977

Exceedence frequency per hundred years



LEGEND	
SYMBOL	DESCRIPTION
○	Historical 1-Day flows.
●	Hypothetical 1-Day flows.
⊗	Historical 1969 flood plotted as largest flood during 83 years of record.

ISABELLA LAKE
 KERN RIVER, CALIFORNIA
 SNOWMELT FLOW FREQUENCY
 REGULATED CONDITIONS
 KERN RIVER BELOW ISABELLA DAM
 Corps of Engineers, Sacramento, Calif.
 Prepared: M.A.S. Date: NOVEMBER 1977

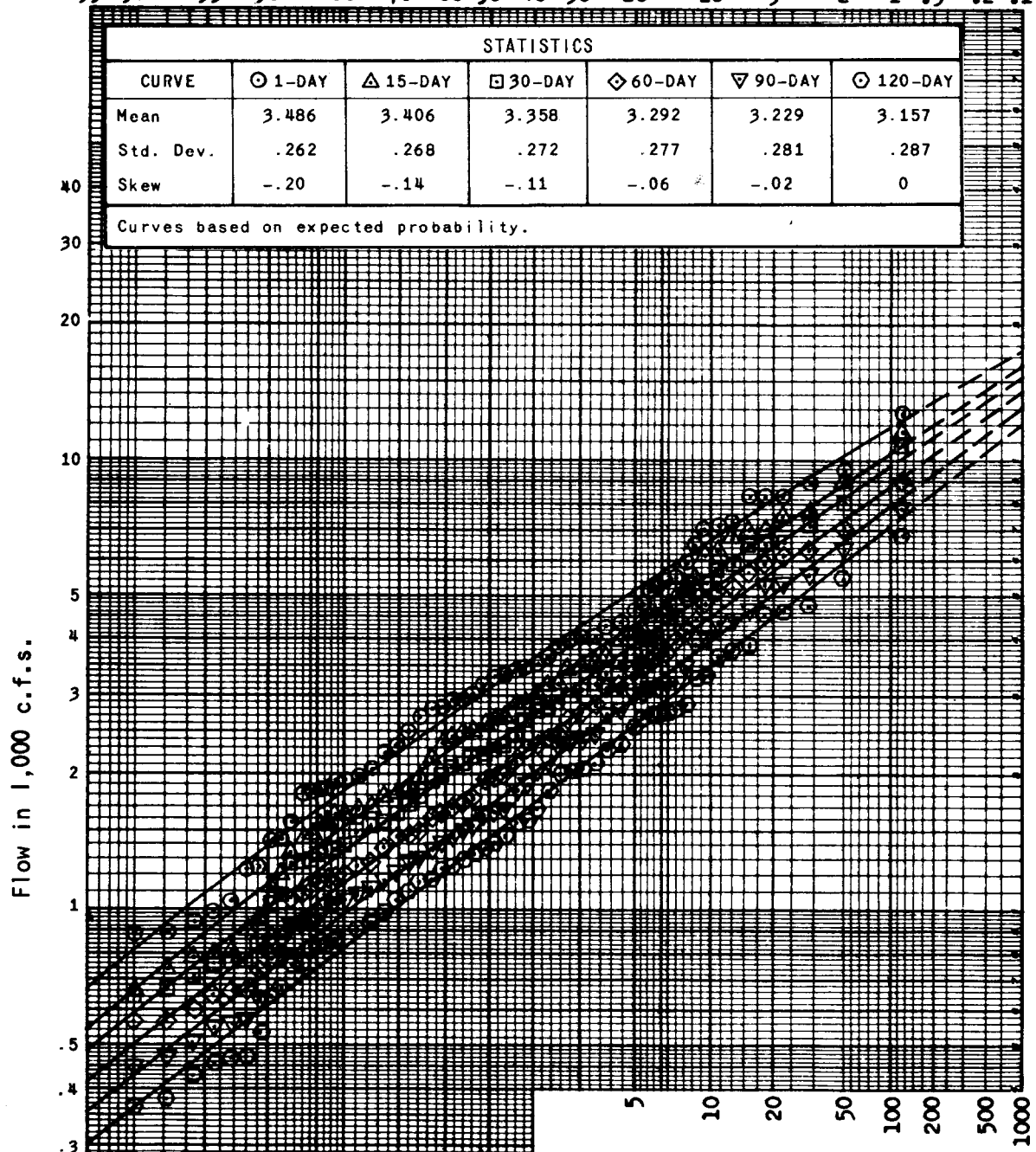
Period of record: 1955-1976
 Drainage area: 2074 sq. mi.

Exceedence frequency per hundred years

99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1

STATISTICS						
CURVE	⊙ 1-DAY	△ 15-DAY	□ 30-DAY	◇ 60-DAY	▽ 90-DAY	⊙ 120-DAY
Mean	3.486	3.406	3.358	3.292	3.229	3.157
Std. Dev.	.262	.268	.272	.277	.281	.287
Skew	-.20	-.14	-.11	-.06	-.02	0

Curves based on expected probability.



NOTE:
For clarity between 20 and 80 times per hundred years every second point was plotted.

**ISABELLA LAKE
KERN RIVER, CALIFORNIA**

**SNOWMELT FLOW FREQUENCY
UNREGULATED CONDITIONS**

KERN RIVER BELOW ISABELLA DAM

Corps of Engineers, Sacramento, Calif.

Prepared: L.H.C. Date: NOVEMBER 1977

Period of record: 1894-1976
Drainage area: 2074 sq. mi.

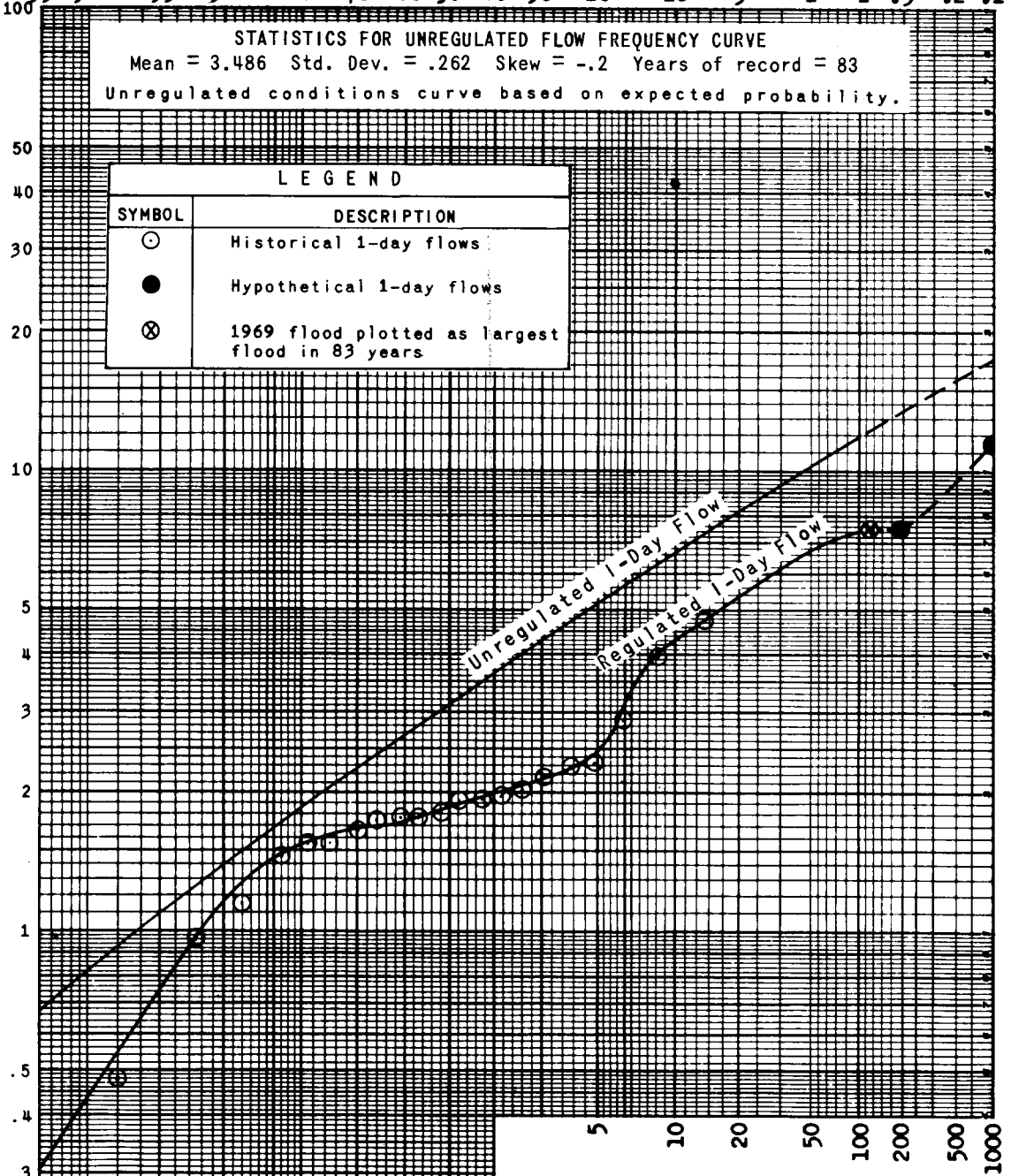
Exceedence frequency per hundred years

99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1

STATISTICS FOR UNREGULATED FLOW FREQUENCY CURVE
 Mean = 3.486 Std. Dev. = .262 Skew = -.2 Years of record = 83
 Unregulated conditions curve based on expected probability.

LEGEND	
SYMBOL	DESCRIPTION
○	Historical 1-day flows
●	Hypothetical 1-day flows
⊗	1969 flood plotted as largest flood in 83 years

Flow in 1,000 c.f.s.



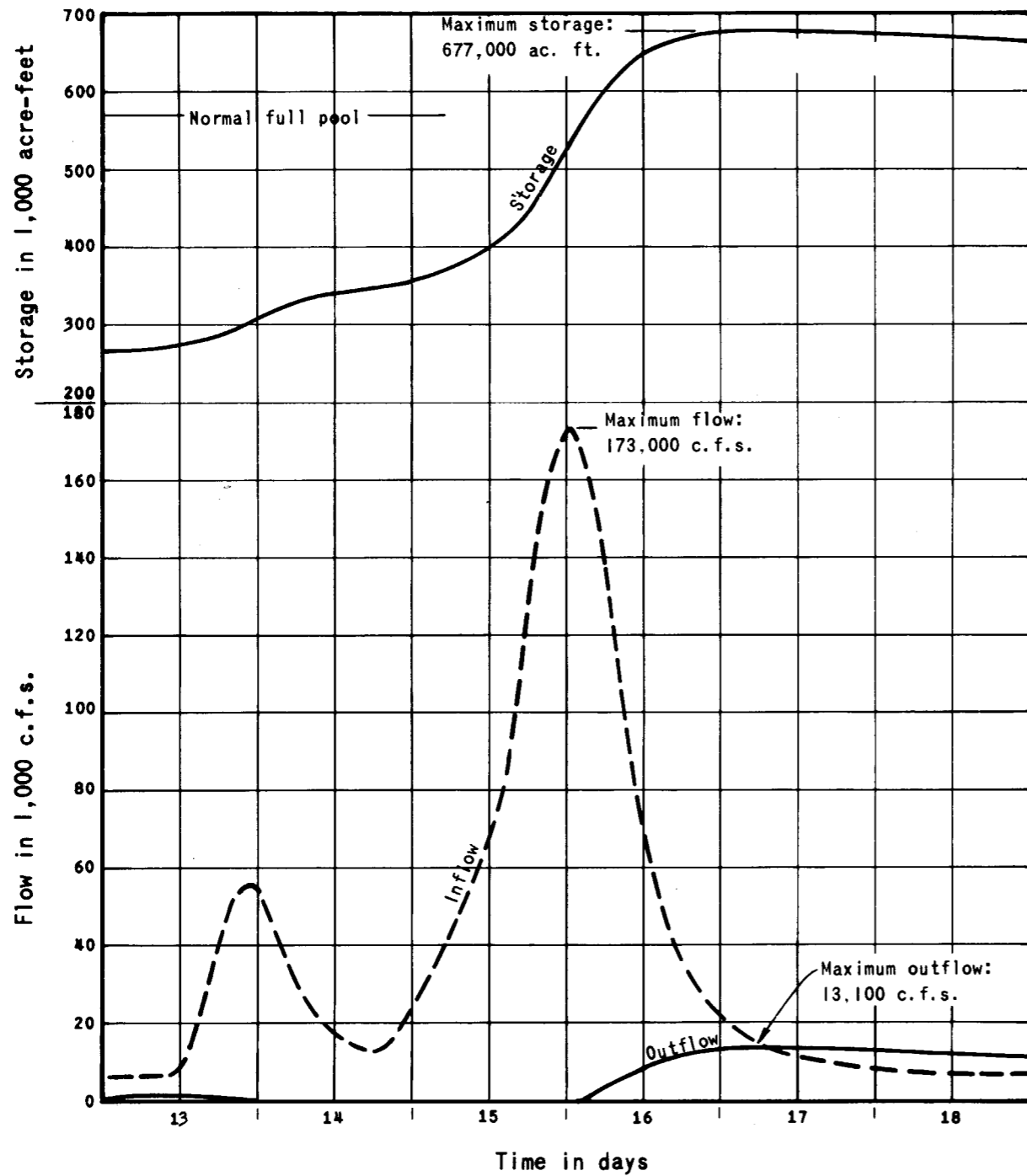
Exceedence interval in years

ISABELLA LAKE
 KERN RIVER, CALIFORNIA
 SNOWMELT FLOW FREQUENCY
 REGULATED CONDITIONS
 KERN RIVER NEAR BAKERSFIELD

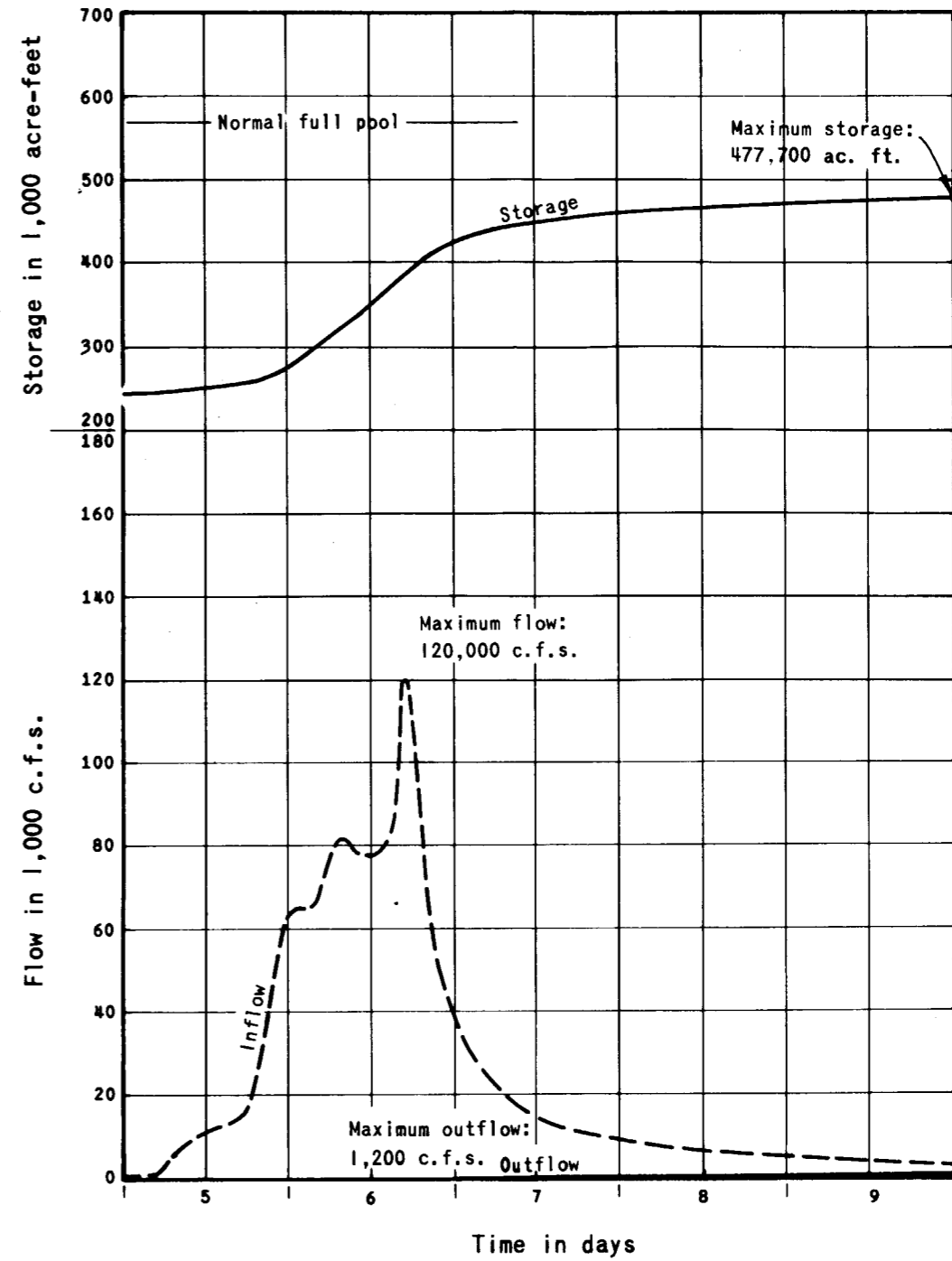
Drainage area: 2,407 sq. mi.

Corps of Engineers, Sacramento, Calif.

Prepared: H.T.M., L.H.C. Date: DECEMBER 1977



MAIN WAVE OF STANDARD PROJECT 30-DAY FLOOD SERIES



DECEMBER 1966 FLOOD

NOTE:

245,000 acre-feet (the bottom of the rainflood reservation) was the starting storage for both routings. January irrigation, overirrigation and spreading demands were used for the SPF routing.

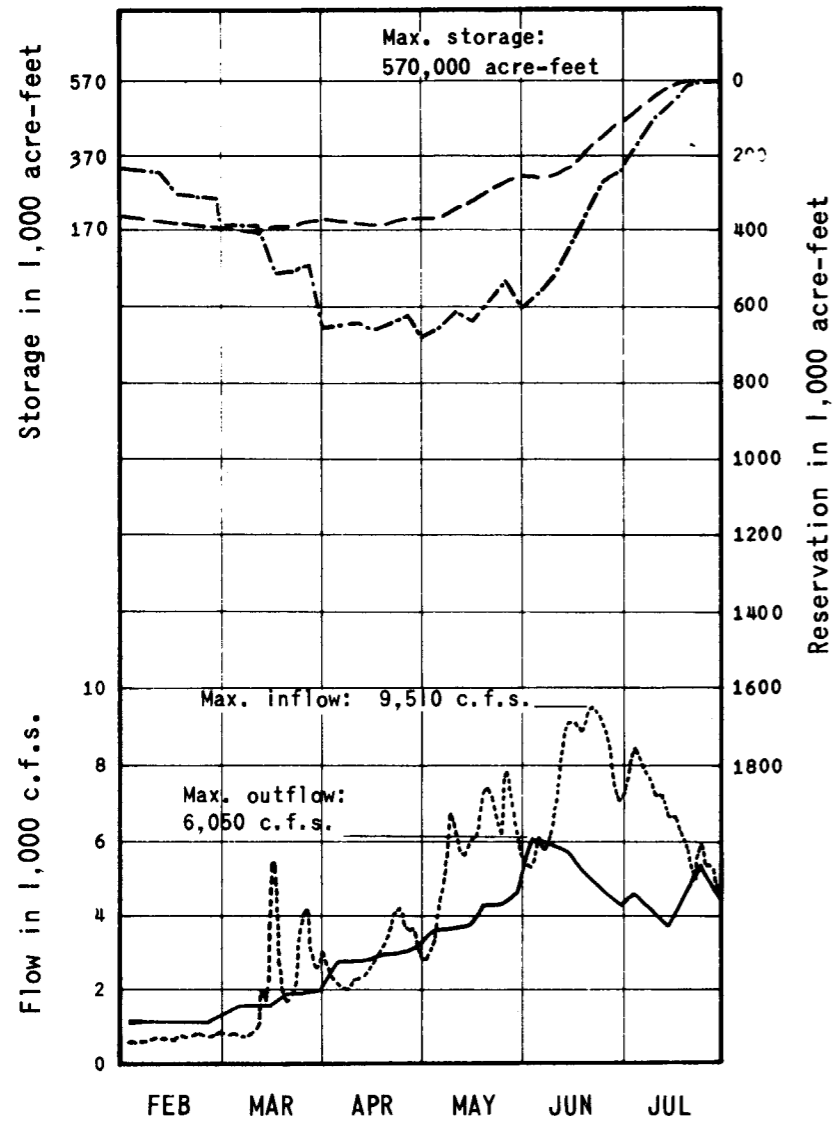
ISABELLA LAKE
KERN RIVER, CALIFORNIA

HYPOTHETICAL ROUTINGS
OF RAIN FLOODS

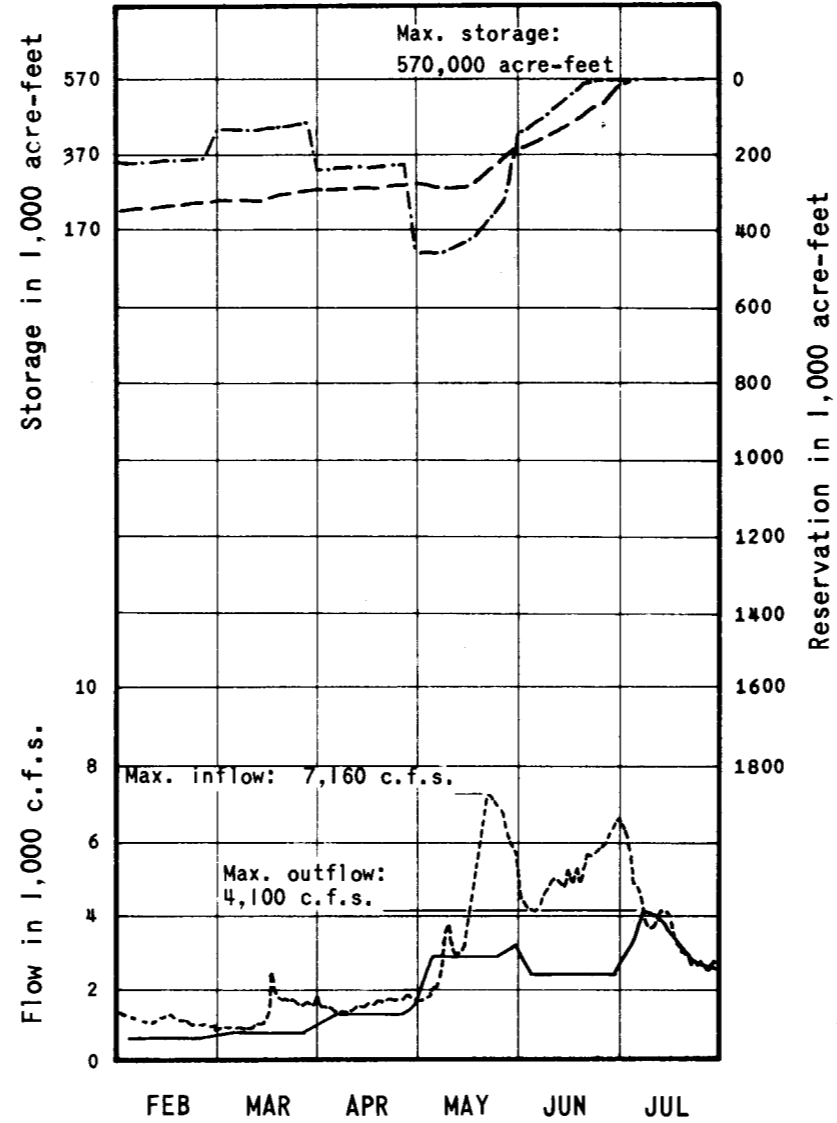
ISABELLA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

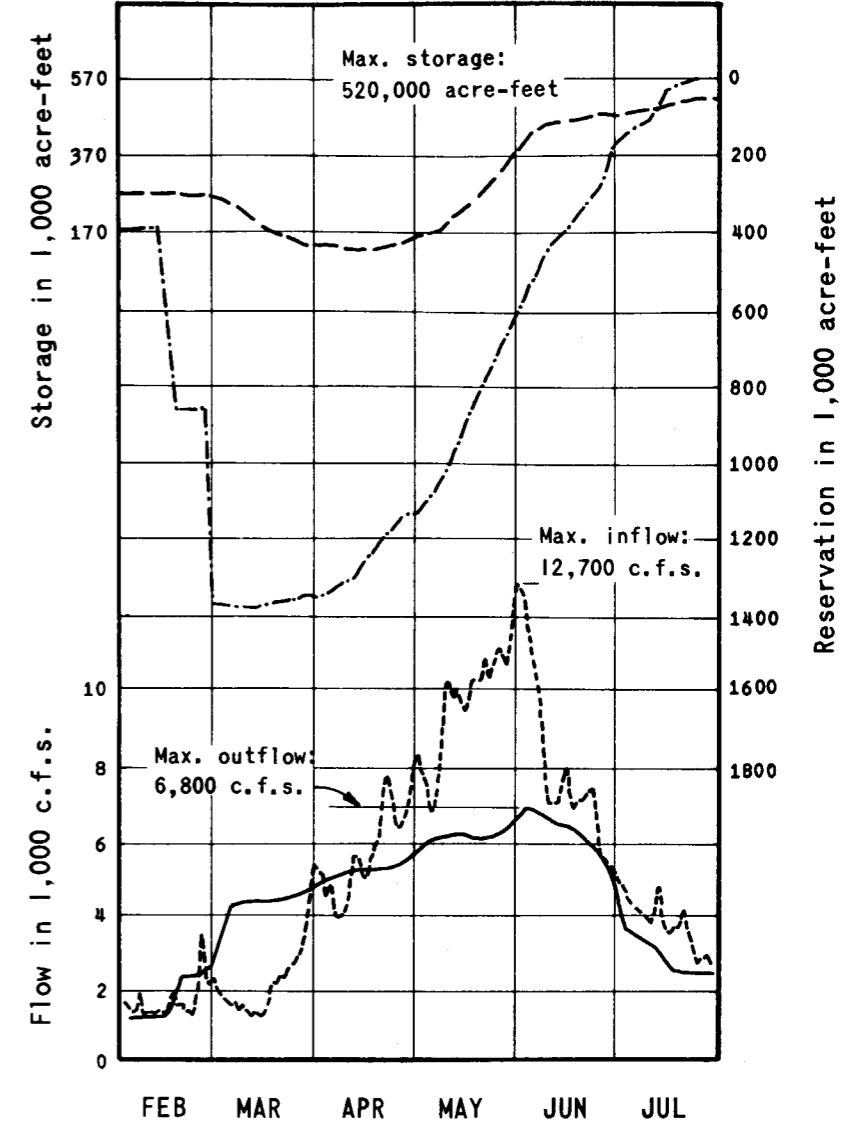
Prepared: H.T.M. Date: NOVEMBER 1977
Drawn: M.A.S.



1906



1967



1969

LEGEND	
SYMBOL	DESCRIPTION
-----	Inflow
————	Release
-----	Storage
-----	Required Reservation

NOTE:

The 1967 and 1969 flood routings were based on forecasts published by the State of California. The forecasts for the 1906 flood routings were estimated from historic precipitation using current techniques.

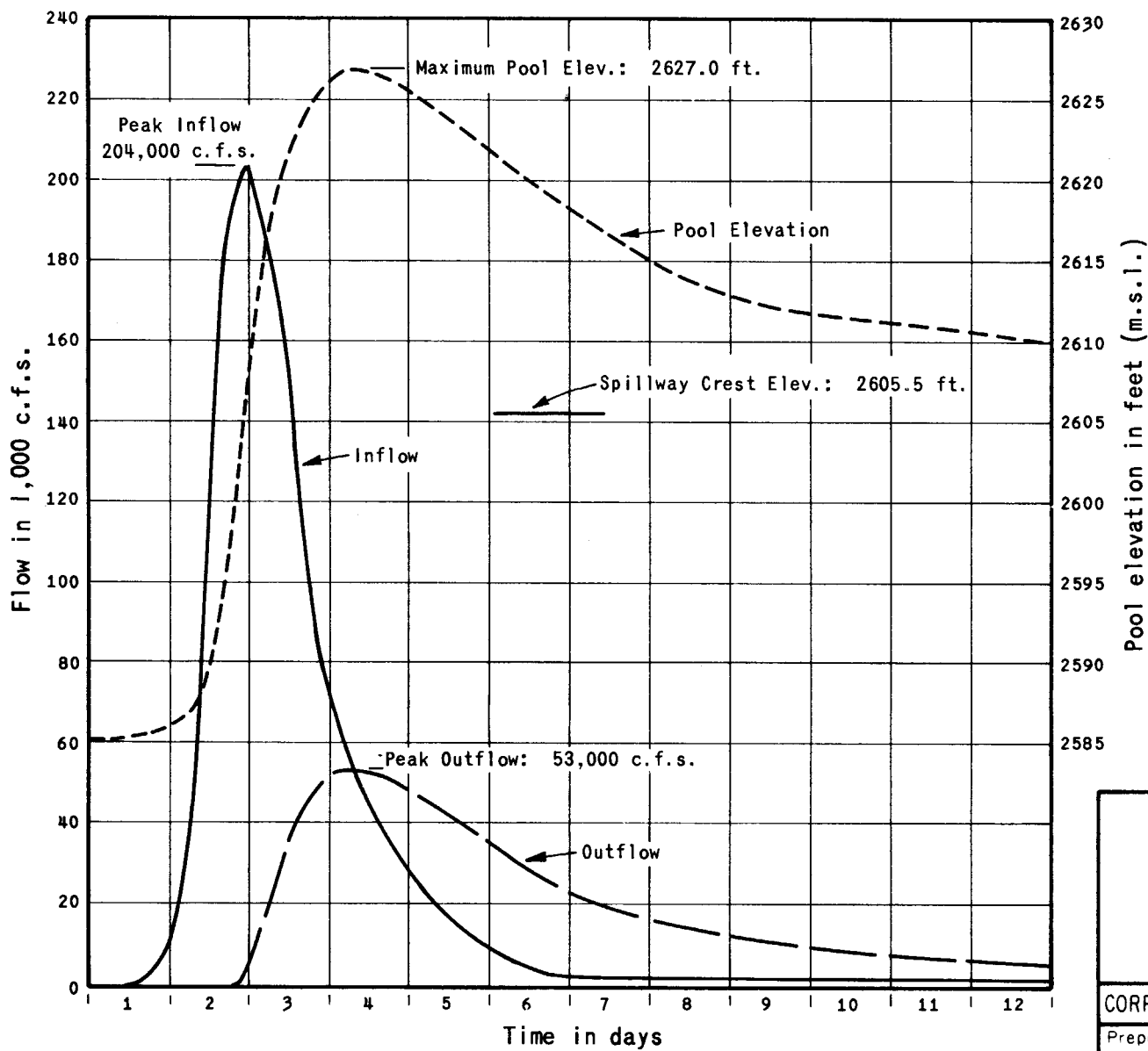
ISABELLA LAKE
KERN RIVER, CALIFORNIA

**HYPOTHETICAL ROUTINGS
OF HISTORICAL
SNOWMELT FLOODS**

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: H.T.M.
Drawn: L.H.C.

Date: NOVEMBER 1977



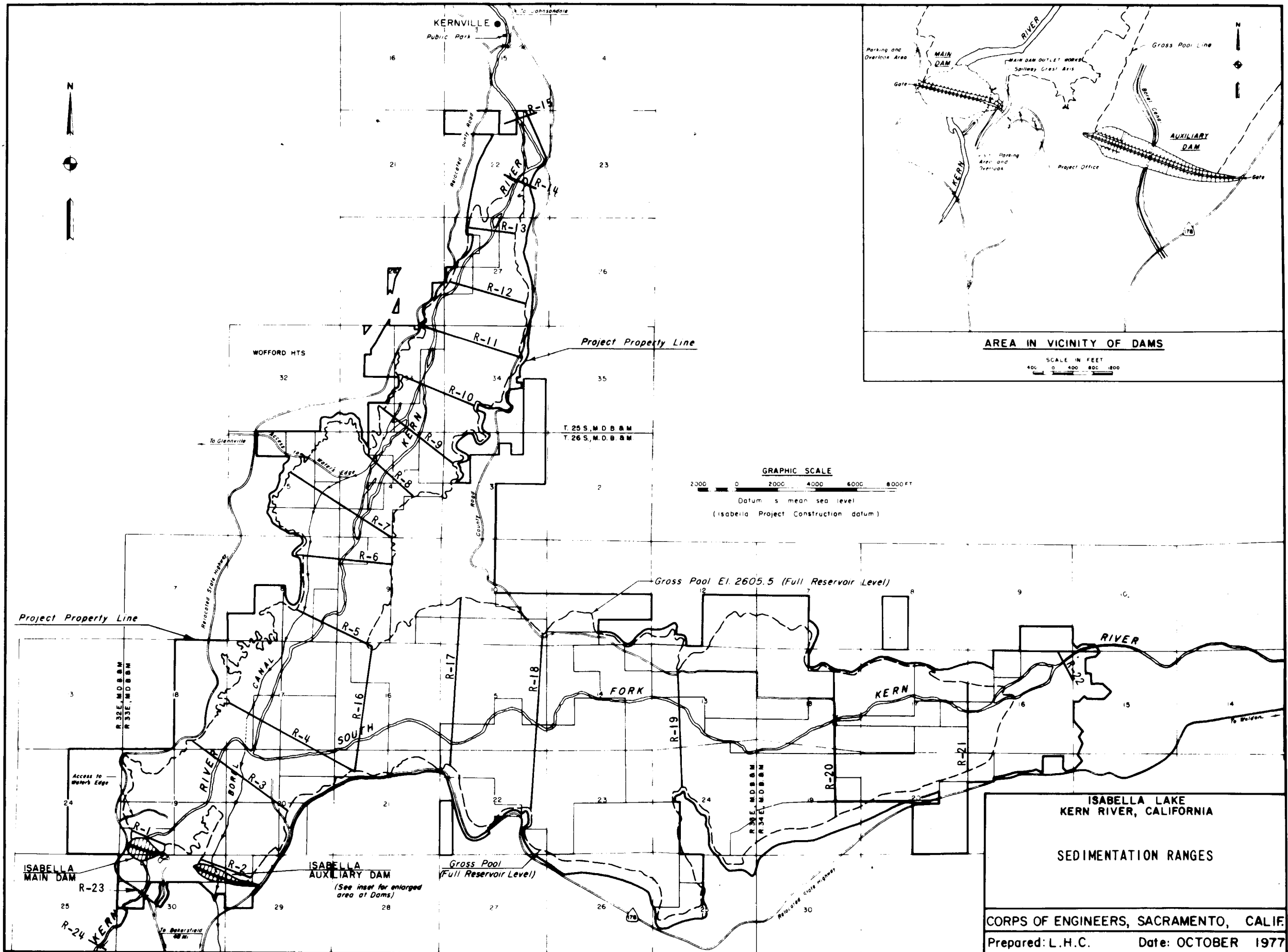
ISABELLA LAKE
KERN RIVER, CALIFORNIA

SPILLWAY DESIGN FLOOD ROUTING

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: H. T. M. Date: NOVEMBER 1977
 Drawn: M. A. S.

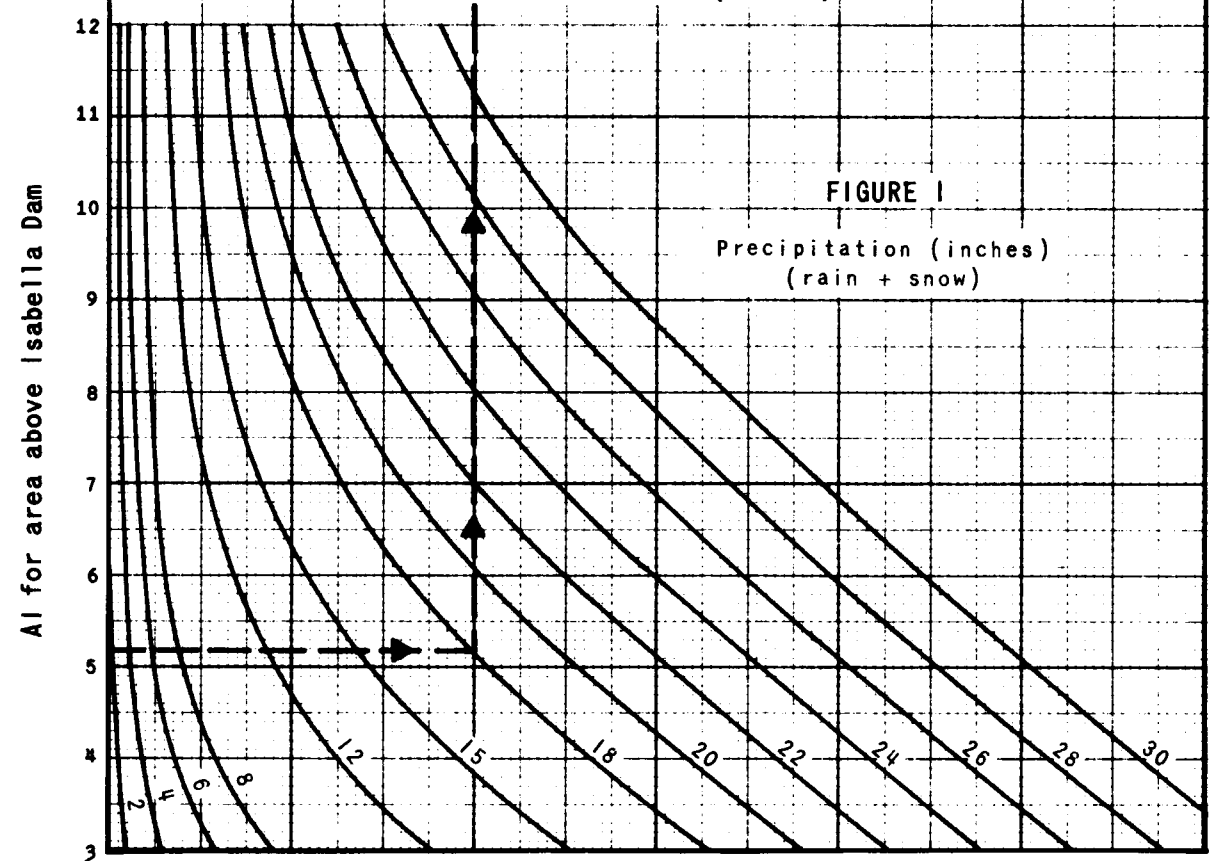
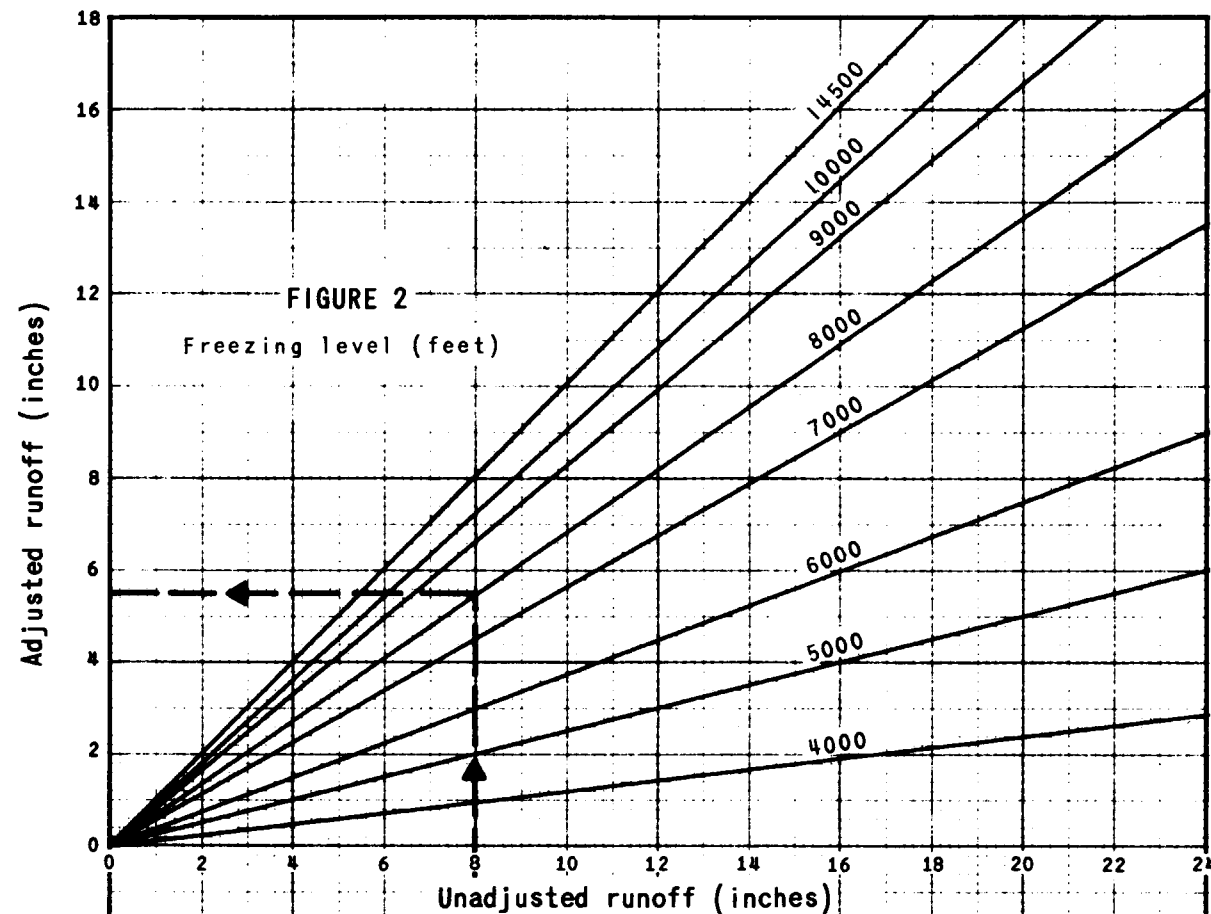




ISABELLA LAKE
KERN RIVER, CALIFORNIA

SEDIMENTATION RANGES

CORPS OF ENGINEERS, SACRAMENTO, CALIF.
Prepared: L.H.C. Date: OCTOBER 1977



NOTES:

1. The Antecedent Moisture Index (AI) is an index of the loss potential of the basin, or an index of the relationship between rainfall and surface runoff for a storm period. The value of this AI indicates the approximate number of inches of rain that would be required to produce one inch of surface runoff. The AI values and freezing levels will be supplied by the State-Federal River Forecast Center.
2. The basin-mean precipitation may be based on forecasts or on data available during a given storm.
3. Data shown in Figure 1 have been supplied by the State-Federal River Forecast Center.

EXAMPLE OF CRITERIA APPLICATION

1. For an assumed AI of 5.20 inches for the storm period and an assumed basin-mean-precipitation of 18.00 inches recorded to date, read the total potential runoff (unadjusted) of 8.00 inches.
2. With 8.00 inches of unadjusted runoff and an assumed average freezing level of 8,000 feet (averaged for the desired period), read the adjusted runoff of 5.50 inches.
3. Basin area = 2074 sq. mi. Conversion from inches per sq. mi. to acre feet = 53.333. $2074 \times 53.333 \times 5.50 = 608,400$ acre-feet runoff.

**6-HOUR UNIT HYDROGRAPH
AT ISABELLA DAM SITE**

TIME IN HOURS	FLOW IN C.F.S.
0	0
6	81,500
12	68,400
18	39,000
24	21,000
30	10,000
36	4,000
42	1,200
48	0

ISABELLA LAKE
KERN RIVER, CALIFORNIA

**RAIN FLOOD
FORECAST CRITERIA**

INFLOW TO ISABELLA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: H. T. M. Date: SEPTEMBER 1977
Drawn: M. A. S.

SUMMARY OF FORECASTED AND ACTUAL SNOWMELT RUNOFF INTO ISABELLA LAKE

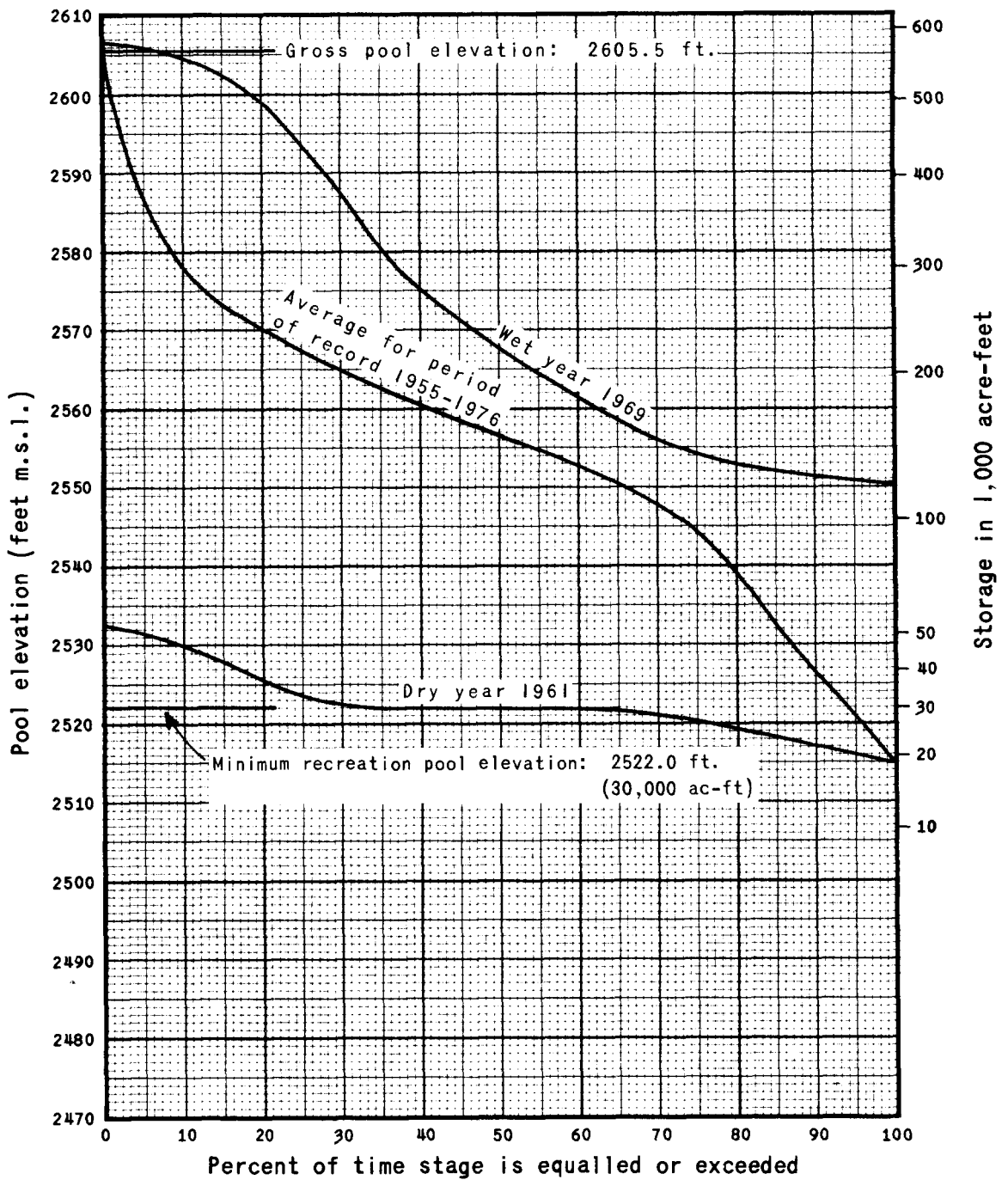
(Flow in 1,000 acre-feet)

WATER YEAR	ACTUAL	I APRIL-31 JULY RUNOFF								
		I FEBRUARY			I MARCH			I APRIL		
		FORECAST	ERROR	% ERROR	FORECAST	ERROR	% ERROR	FORECAST	ERROR	% ERROR
1953	303	550	+ 247	+ 45	400	+ 97	+ 24	250	- 53	- 21
1954	355	275	- 80	- 29	300	- 55	- 18	390	+ 35	+ 9
1955	225	450	+ 225	+ 50	400	+ 175	+ 44	235	+ 10	+ 4
1956	526	800	+ 274	+ 34	525	- 1	0	400	- 126	- 32
1957	292	280	- 12	- 4	260	- 32	- 12	210	- 82	- 39
1958	832	420	- 412	- 98	470	- 362	- 77	850	+ 18	+ 2
1959	131	200	+ 69	+ 35	240	+ 109	+ 45	120	- 11	- 9
1960	169	130	- 38	- 29	280	+ 112	+ 40	171	+ 2	+ 1
1961	87	200	+ 113	+ 57	100	+ 13	+ 13	70	- 17	- 24
1962	516	250	- 266	- 106	500	- 16	- 3	539	+ 23	+ 4
1963	477	250	- 227	- 91	280	- 197	- 70	381	- 96	- 25
1964	183	240	+ 57	+ 24	170	- 13	- 8	195	+ 12	+ 6
1965	450	515	+ 65	+ 13	390	- 60	- 15	360	- 90	- 25
1966	220	410	+ 190	+ 46	310	+ 90	+ 29	235	+ 15	+ 6
1967	845	700	- 145	- 21	580	- 265	- 46	700	- 145	- 21
1968	242	310	+ 68	+ 22	280	+ 38	+ 14	210	- 38	- 18
1969	1,657	880	- 777	- 88	1,850	+ 193	+ 10	1,800	+ 143	+ 8
1970	314	410	+ 96	+ 23	390	+ 76	+ 19	380	+ 66	+ 17
1971	238	365	+ 127	+ 35	260	+ 22	+ 8	220	- 18	- 8
1972	125	250	+ 125	+ 50	185	+ 60	+ 32	95	- 30	- 32
1973	704	500	- 204	- 41	650	- 54	- 8	735	+ 31	+ 4
1974	526	400	- 126	- 32	330	- 196	- 59	440	- 86	- 20
1975	376	190	- 186	- 98	250	- 126	- 50	360	- 16	- 4
1976	104	115	+ 11	+ 10	120	+ 16	+ 13	110	+ 6	+ 6
1977	92	125	+ 33	+ 26	95	+ 3	+ 13	80	- 12	- 15
Mean(+)	399	369	+ 130	+ 42	374	+ 77	+ 23	381	+ 33	+ 6
Mean(-)	-	-	- 225	- 58	-	- 115	- 31	-	- 59	- 21
Extreme(+)	1,657	880	+ 274	+ 57	1,850	+ 193	+ 45	1,800	+ 143	+ 17
Extreme(-)	92	115	- 777	- 106	95	- 362	- 77	70	- 145	- 39

GIVEN DATE THROUGH 31 JULY RUNOFF											
I MAY				I JUNE				I JULY			
ACTUAL	FORECAST	ERROR	% ERROR	ACTUAL	FORECAST	ERROR	% ERROR	ACTUAL	FORECAST	ERROR	% ERROR
235	259	+ 24	+ 9	158	NA	NA	NA	66	NA	NA	NA
237	290	+ 53	+ 18	107	NA	NA	NA	36	NA	NA	NA
187	197	+ 10	+ 5	113	NA	NA	NA	29	NA	NA	NA
428	342	- 86	- 25	268	NA	NA	NA	100	NA	NA	NA
253	171	- 82	- 48	173	NA	NA	NA	41	NA	NA	NA
664	912	+ 248	+ 27	352	355	+ 3	+ 1	120	NA	NA	NA
90	79	- 11	- 14	49	NA	NA	NA	16	NA	NA	NA
122	125	+ 3	+ 2	64	75	+ 9	+ 12	17	20	+ 3	+ 15
63	46	- 17	- 37	33	21	- 8	- 38	9	6	- 3	- 50
369	391	+ 23	+ 6	232	206	- 26	- 13	75	66	- 9	- 14
401	311	- 96	- 31	269	171	- 98	- 57	105	54	- 51	- 94
140	145	+ 5	+ 3	74	80	+ 6	+ 8	22	25	+ 3	+ 12
376	331	- 45	- 14	245	181	- 64	- 35	95	56	- 39	- 70
151	131	- 20	- 15	67	71	+ 4	+ 6	22	21	- 1	- 5
746	810	+ 64	+ 8	555	430	- 125	- 29	244	150	- 94	- 63
177	135	- 42	- 31	91	60	- 31	- 52	28	25	- 3	- 12
1,320	1,465	+ 145	+ 10	721	870	+ 148	+ 17	236	340	+ 104	+ 31
252	290	+ 38	+ 13	142	160	+ 18	+ 11	49	50	+ 1	+ 2
187	155	- 32	- 21	123	85	- 38	- 45	42	25	- 17	- 68
93	60	- 33	- 55	57	35	- 17	- 33	15	10	- 5	- 50
601	630	+ 29	+ 5	318	330	+ 12	+ 4	92	110	+ 18	+ 16
418	365	- 53	- 15	235	195	- 40	- 21	69	60	- 9	- 15
332	340	+ 8	+ 2	189	185	- 4	- 2	50	60	+ 10	+ 17
80	86	+ 6	+ 7	33	46	+ 13	+ 28	14	13	- 1	- 8
69	53	- 16	- 30	45	24	- 21	- 88	10	8	- 2	- 25
320	325	+ 50	+ 9	189	188	+ 27	+ 11	64	61	+ 23	+ 16
-	-	- 44	- 28	-	-	- 43	- 38	-	-	- 20	- 40
1,320	1,465	+ 248	+ 27	712	870	+ 158	+ 28	244	340	+ 104	+ 31
59	46	- 96	- 55	33	21	- 125	- 88	9	6	- 94	- 94

NOTES:

1. NA = Not Available.
2. Forecasts not made prior to 1953.
3. Forecasts prepared and published by State of California.
4. Over the years, the amount of snowpack data available has increased, experience has been gained and the methods of processing the data have improved. Therefore, a computed error based on past performance is not necessarily indicative of the accuracy that may be achieved in the future.
5. Prior to 1968, flows are based on the computed natural flow at the Kern River near Bakersfield gage.



ISABELLA LAKE
KERN RIVER, CALIFORNIA

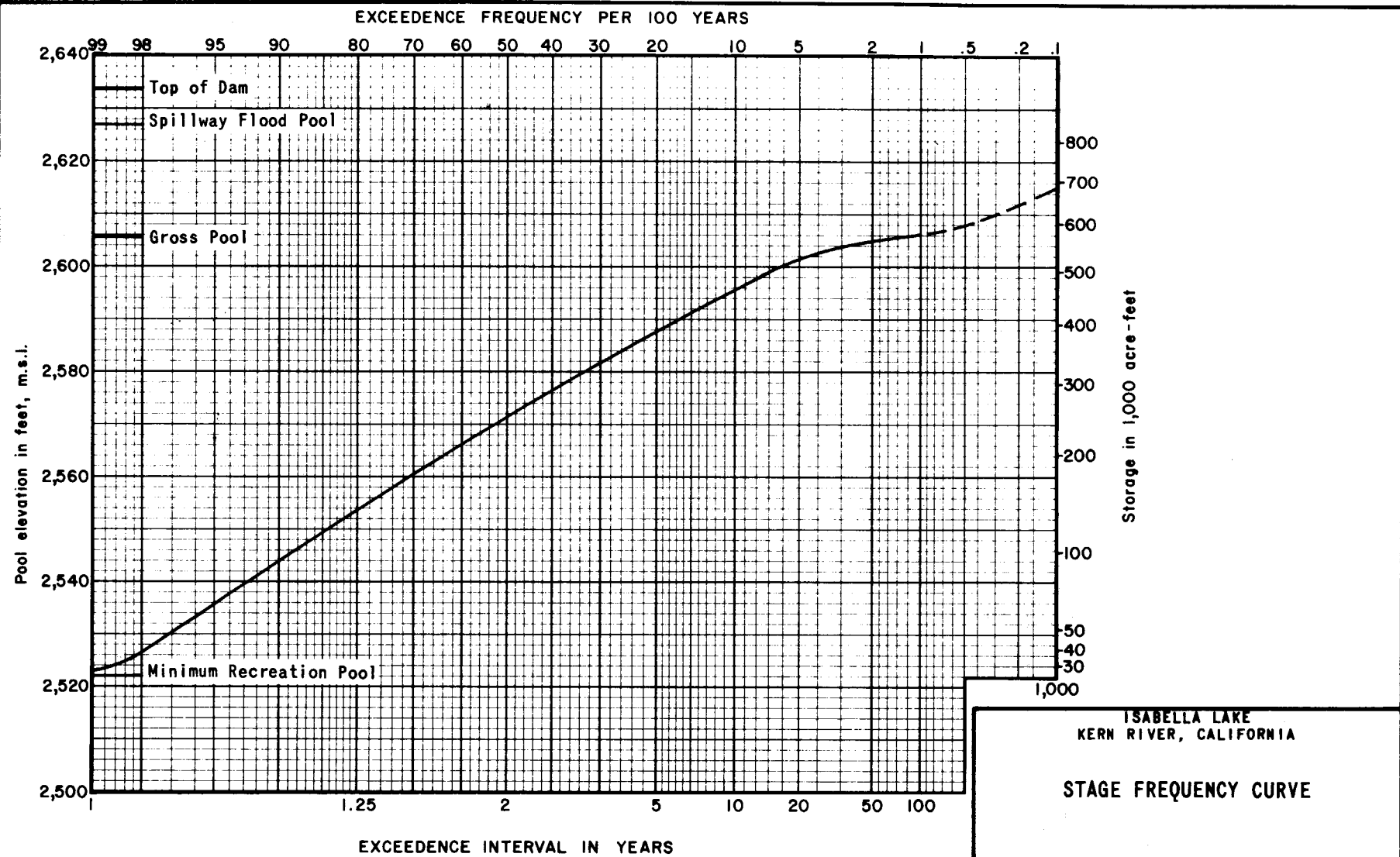
STAGE - DURATION CURVES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L. H. C.

Date: SEPTEMBER 1977

Drawn: M. A. S.



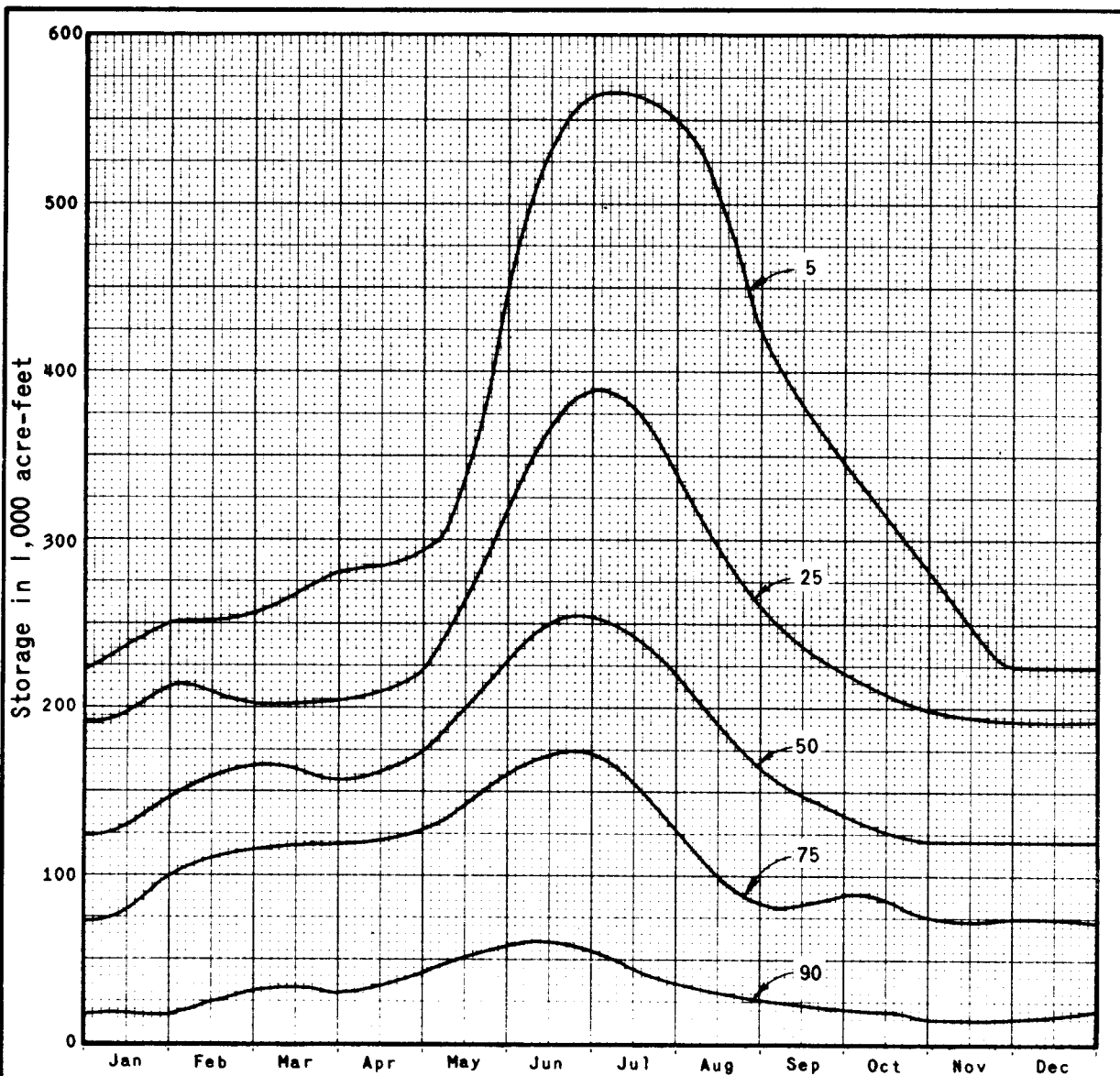
NOTE: Curve based on historical reservoir operation 1955-1976

ISABELLA LAKE
KERN RIVER, CALIFORNIA

STAGE FREQUENCY CURVE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C. Date: DECEMBER 1977
Drawn: L.H.C.



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 1955-1975. Data abstracted from U.S.G.S. water supply papers.

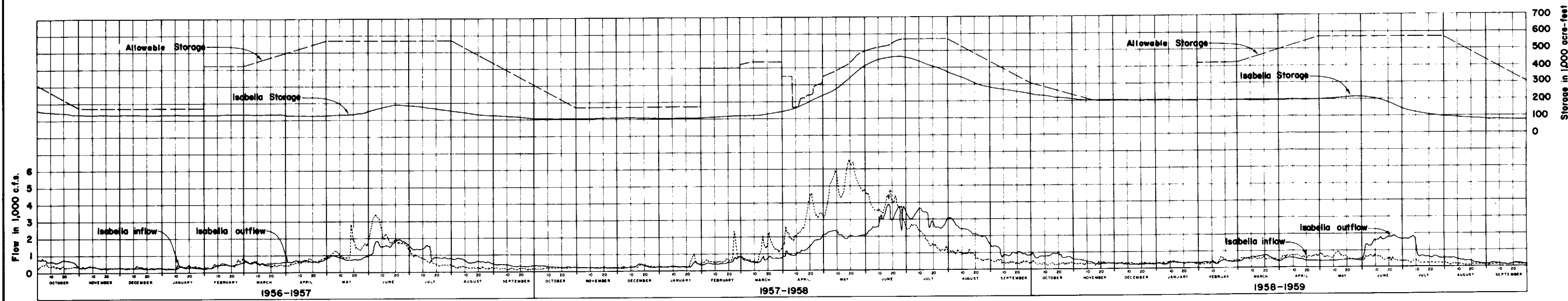
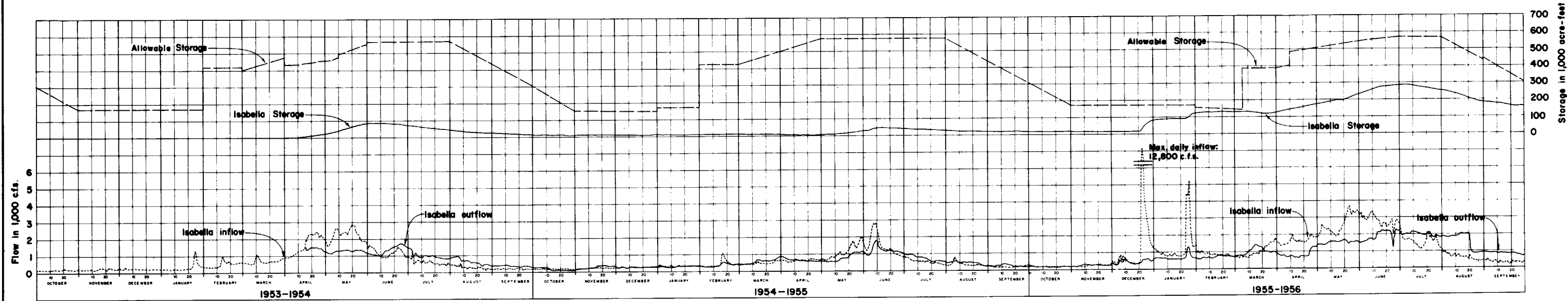
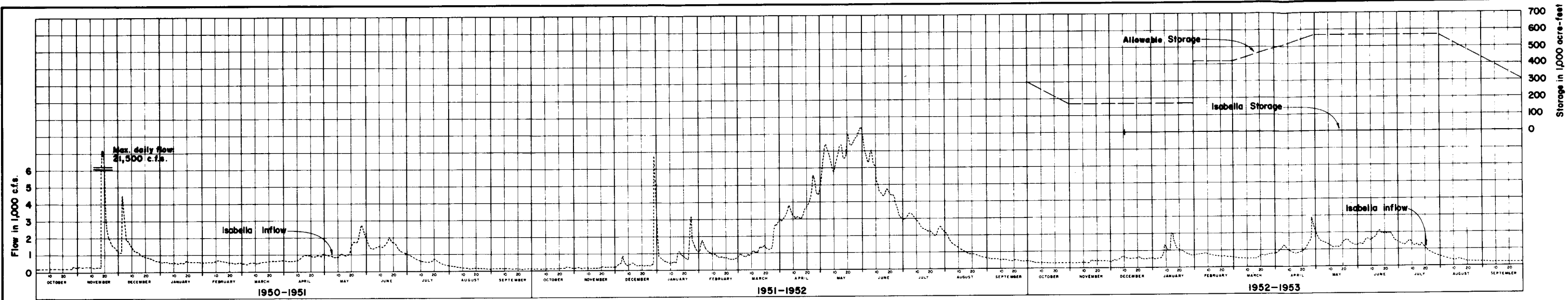
ISABELLA LAKE
KERN RIVER, CALIFORNIA

**SEASONAL VARIATION
OF RESERVOIR STORAGE**

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: J.J.S.
Drawn: L.H.C.

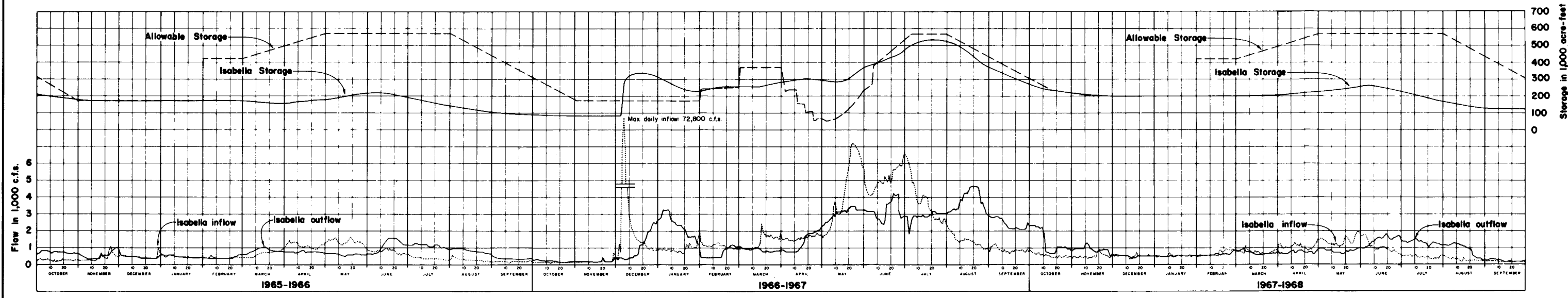
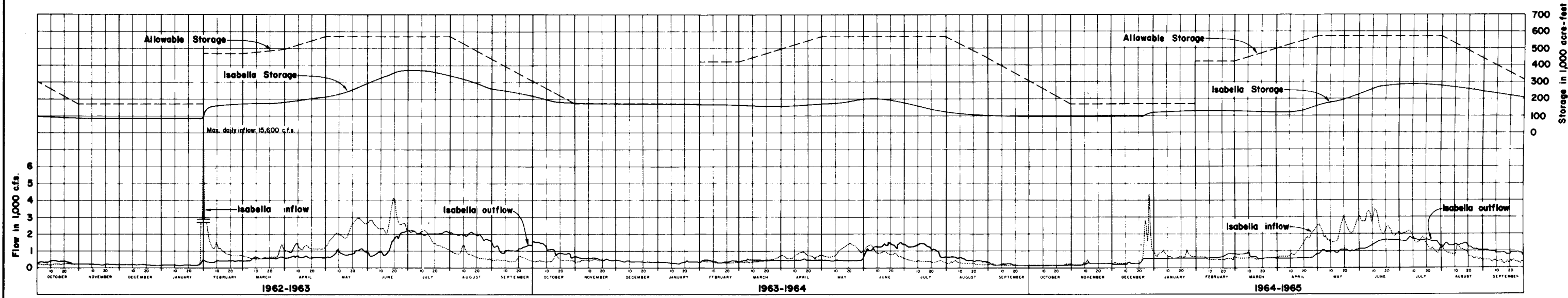
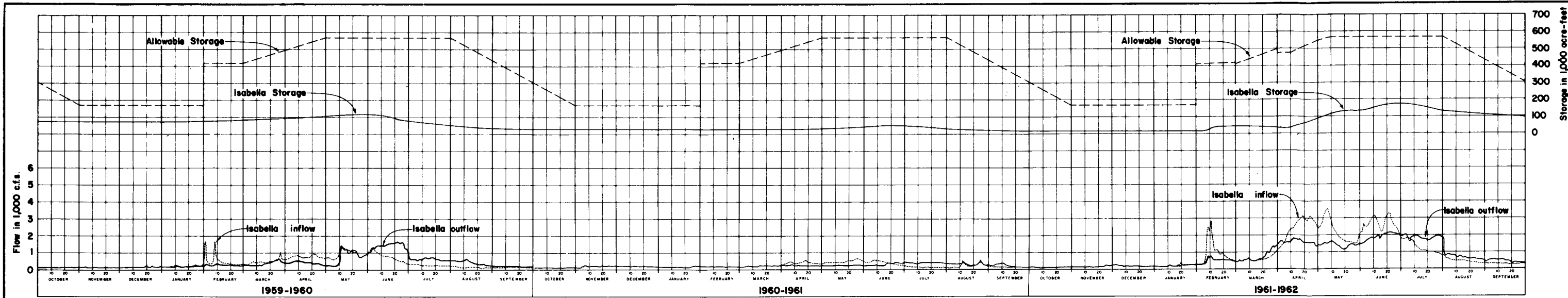
Date: DECEMBER 1977



ISABELLA LAKE
KERN RIVER, CALIFORNIA

HISTORICAL OPERATION
ISABELLA LAKE

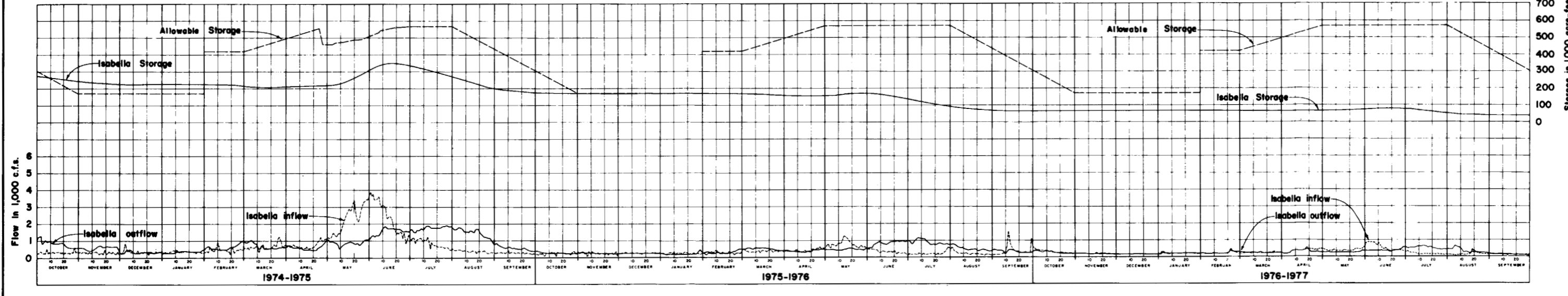
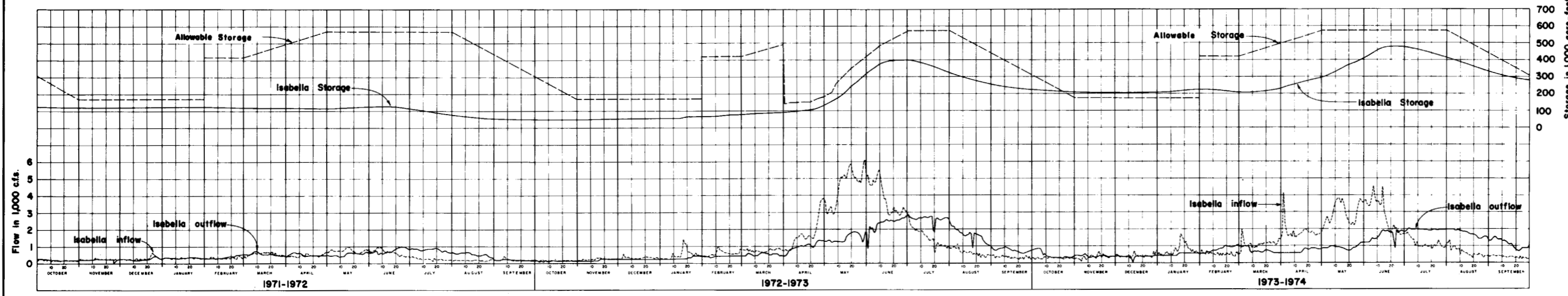
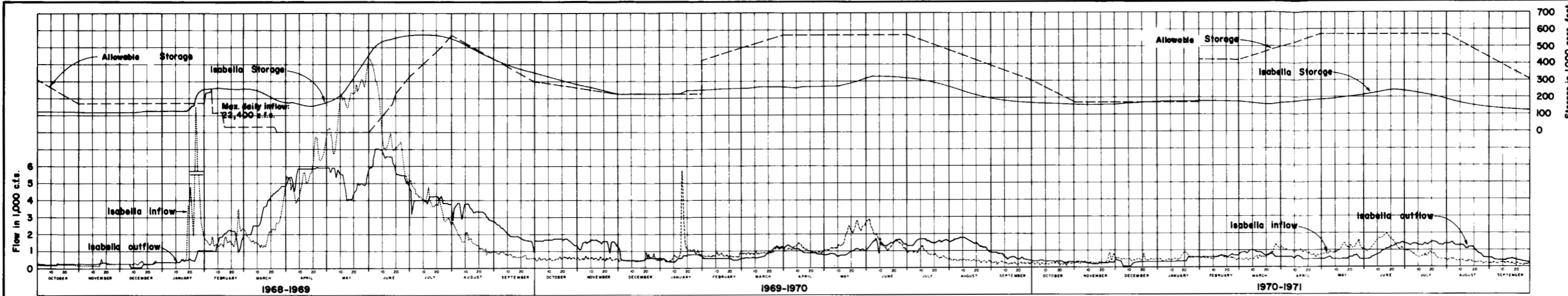
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared LNC Date APRIL 1977
Drawn T&B



ISABELLA LAKE
KERN RIVER, CALIFORNIA

**HISTORICAL OPERATION
ISABELLA LAKE**

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared LJC Date APRIL 1977
Drawn T.R.B.



Storage in 1,000 acre-feet

Storage in 1,000 acre-feet

Storage in 1,000 acre-feet

ISABELLA LAKE
KERN RIVER, CALIFORNIA

HISTORICAL OPERATION
ISABELLA LAKE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared LMC
Drawn T&B
Date NOVEMBER 1977

RESERVOIR REGULATION MANUAL

FOR

ISABELLA LAKE

KERN RIVER, CALIFORNIA

APPENDIX A

STANDING OPERATING INSTRUCTIONS

Date May 1953

Revised January 1978

**DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA**



RESERVOIR REGULATION MANUAL
FOR
ISABELLA LAKE
KERN RIVER, CALIFORNIA

APPENDIX A
STANDING OPERATING INSTRUCTIONS

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RESERVOIR REGULATION MANUAL

ISABELLA LAKE KERN RIVER, CALIFORNIA

APPENDIX A STANDING OPERATING INSTRUCTIONS

1. GENERAL

a. This appendix to the "Reservoir Regulation Manual, Isabella Lake, Kern River, California" is prepared in accordance with instructions contained in EM 1110-2-3600, paragraph 4-07 (Standing Instructions to Dam Operators) and pertains to duties and responsibilities of the Dam Operator in connection with the functional operation of Isabella Lake for flood control, and the reporting of required hydrologic data.

b. Operational instructions to the Dam Operator are briefly outlined with specific emphasis on the Dam Operator's duties and responsibilities during extreme flood emergencies when communication facilities between him and the Sacramento District Office are disrupted. It is designed for optional separation from the manual, and use as an emergency flood control regulation guide, or as published in conjunction with the "Reservoir Regulation Manual for Isabella Lake." To facilitate independent use of this appendix, charts required for emergency flood control operation of Isabella Lake are included herein.

2. OPERATION REQUIREMENTS

Operation of Isabella Lake is accomplished by Corps of Engineers personnel under supervision of the Construction-Operations Division of the Sacramento District Office, with instructions on all matters covering flood control operation received directly from the Reservoir Control Section of the Engineering Division. The reservoir operator is responsible for:

a. Accomplishing the physical operation of the reservoir in accordance with instructions contained in this manual or issued by the Reservoir Control Section. During storms, this will often require 24-hour attendance at the dam.

b. Calculating and maintaining a continuous provisional record of inflows, outflows, storage, weather data, and other data specified by the Reservoir Control Section. This information should be recorded on forms designed for that purpose.

c. Reporting by radio (or telephone) to the Reservoir Control Section data as outlined in paragraphs 6 and 7, and other data that may be requested from time to time.

d. Keeping local interests continuously advised of the operation of the reservoir.

e. Reporting to the Reservoir Control Section any unusual condition in the reservoir or along the downstream channels which might interfere with the planned operation of the reservoir.

f. Maintaining all trash racks clear of trash in order that the outlet gates can be operated systematically and effectively.

g. Maintaining a log of gate operation on the appropriate form furnished, containing (1) change in position of gates, (2) date and time, (3) reservoir water level, and (4) the initials of the individual accomplishing the change.

h. Immediately after the end of each month, dispatching the Reservoir Control Section data specified in paragraph b.

i. Making emergency operation changes when contact with the District Office is broken and a clearly defined change occurs that warrants immediate action. Charts A-1 through A-7 are included for use in accomplishing the various operational requirements specified above, and in preparing the required operation reports listed in paragraph 6.

3. LIMITATION ON STORAGE

Operational limitations on storage in Isabella Reservoir are specified on the Flood Control Diagram. Physical limitations on storage are as follow:

Storage (ac-ft)	Water Surface Elev (feet)	Flow Over Spillway (cfs)	Remarks
30,000	2,522.0	0	Minimum recreation pool
110,000	2,548.0	0	Water level required to supply Borel Canal from reservoir pool
570,000	2,605.5	0	Gross pool
709,000	2,617.0	19,300	Water level at taking line

4. LIMITATIONS ON RELEASES

Releases must be restricted as long as possible to maintain flows within downstream channel capacities as listed on chart A-6 or as otherwise determined by Corps of Engineers field inspections. The timing of releases in excess of irrigation, and spreading use should be coordinated with appropriate downstream interests to permit maximum harvesting of crops before flood water enters Buena Vista and Tulare lakebeds.

5. GATE OPERATION

Outflow from Isabella Reservoir is divided between Borel Canal and the main river until it reaches the tailrace of the Southern California Edison Company's Borel Power Plant. The water in Borel Canal is supplied by a diversion on the North Fork Kern River or directly from the reservoir when its level is high enough. When releases are made directly from the reservoir to the Borel Canal, the gates will be operated automatically as described below. Normally, releases for purposes other than power will be made to the Borel Powerhouse up to its capacity before making releases from the main gates except for minor voluntary fish and wildlife releases. Releases through the main outlet will be made entirely through the center gate (gate 2) as long as the capacity of that gate is adequate. Required flows in excess of that capacity will be released equally through gates 1 and 3. Rating curves for the main outlet gates are given on Chart A-4. These curves are used primarily for estimating gate changes. The actual outflow is estimated from the river stage at the outflow station. The frequency and rate of change in release from the reservoir will be kept to a practical minimum. Release changes should be timed, whenever possible, to allow for a 12-hour time interval for travel to First Point and for daylight operation of diversion weirs from that point downstream.

a. If the reservoir level rises above spillway-crest elevation, the river outlets will be closed progressively so as to maintain the total outflow, including water passing over the spillway, equal to the desired outflow as long as possible. When the water level recedes after such operation, the river outlets will be progressively opened so as to maintain the desired outflow.

b. When it first becomes necessary to release impounded water through the Borel Canal outlet, care must be exercised so that excessive releases will not result, even for short periods, inasmuch as there are no facilities for spilling excess water from the canal immediately below the dam. The changeover from canal flow regulated at the headworks to flow from the reservoir regulated at the canal outlet can best be accomplished in the following manner:

(1) When the reservoir rises to the level of the water in the canal at the intake, the control gates in the tower are to be alternately lowered manually in 0.5 foot increments at 10-minute intervals until the upstream canal rises to a gage reading of 7.50 feet. Gates should be operated less frequently or in smaller increments if the water level in the canal downstream experiences a total drop of more than about 0.1 foot.

(4) In the event that the reservoir water level rises above the water level in the canal before the tainter gate is opened, the water levels should be equalized by reducing releases temporarily as outlined in subparagraph (1) above.

c. The changeover from pressure operation to freeflow operation after the reservoir level has receded to the canal level will be accomplished upon the request of the Edison Co. by closing the tainter gate and leaving the automatic gate mechanism operative until the outlet gates are fully open.

d. Automatic operation of Borel Canal outflows is accomplished by operating one slide gate (with fixed opening of the other slide gate) when the water surface is below elevation 2,560 feet, and operating the two bypass valves simultaneously (with fixed openings of the slide gates) when the water surface is above elevation 2,560 feet. Some variation of this criterion may be dictated by experience. If at any time the automatic gate mechanism does not accomplish the desired result, the gates should be operated manually. It is anticipated that the effect of a gate change will register at the outflow station in the canal within a few minutes of the time of the gate change. Rating curves for the Borel Canal outlet are shown on chart A-4. These curves are used primarily for estimating gate changes. The actual outflow is estimated from the stage at the outflow station in the canal.

6. OPERATION REPORTS

a. The reservoir operator shall report by radio or telephone to the Reservoir Control Section each work day [REDACTED] . [REDACTED] , data as follow:

- (1) Reservoir stage and storage as of midnight.
- (2) Reservoir storage increment (ending at midnight).
- (3) Pan evaporation.
- (4) Lake evaporation.
- (5) Mean daily flows (ending at midnight) of:
 - (a) Kern River below Isabella Dam.
 - (b) Borel Canal below Isabella Dam.
 - (c) Total inflow.

- (6) Preproject flow.
- (7) Flow at Kern River at Kernville (at 7:00 a.m.).
- (8) Precipitation at the dam as measured and seasonal total to date.
- (9) Inches (total and change) of precipitation, snow and temperature [REDACTED], reported by radio reporting hydrologic gages.

When conditions do not warrant weekend or holiday reports, complete reports for each day shall be made on the first day following the non-reporting period. More frequent reports of the above information and reports of other Kern River data will be made in the same manner when requested by the Reservoir Control Section. Forms furnished to the operators are to be used in computing the above information.

b. Immediately after the end of each month, the reservoir operator will dispatch to the Reservoir Control Section all original forms used for observations and computations as specified in paragraphs 2b, 2g and 6a above. The charts and punch tapes for that month from the following instruments will be included.



7. SPECIAL WEATHER AND FLOOD REPORTS

During the rainflood season 1 October to 1 May the reservoir operator shall call the Reservoir Control Section immediately whenever one of the following occurs:

- a. One inch or more of rainfall occurs at the project during any 6-hour period or 1.5 inches of rainfall during any 24-hour period.
- b. An increase in flow of 2,000 c.f.s. or more at the Kern River at Kernville station during any 8-hour period.

Any special report based on one of the foregoing criteria should include the latest available data concerning the other. On non-working days or at night, these special reports should be telephoned directly to the Chief of the Reservoir Control Section or his designated alternate.

8. COMPUTATION OF HYDROLOGIC DATA

a. The required hydrologic data to be reported, as specified in paragraph 6 above, for the use in operation of Isabella Lake and for official record purposes may be obtained or computed as follows:

(1) Reservoir stage is obtained from the recording pool gage at the dam and storage is obtained from the Isabella Lake area-capacity table.

(2) Reservoir storage increment is the algebraic difference between the previous day's recorded midnight storage and the most recent midnight storage.

(3) Pan evaporation is obtained from the class A evaporation land pan located at Isabella Dam.

(4) Lake evaporation in inches is equal to the pan evaporation in inches multiplied by the evaporation coefficient shown on chart A-3. For this computation, pan evaporation as measured at 7:00 a.m. is used to compute lake evaporation for the previous day.

$$\begin{aligned} & \text{(a) Pan evaporation (inches) } \times \frac{\text{Gross Evaporation Coefficient}}{12} \\ & \quad \times \text{Average Lake Area (acres)} = \text{Acre-Feet} \\ & \quad \text{(Round to nearest acre-foot for next computation)} \\ & \quad \text{Acre-Feet } \times 0.50417^* = \text{s.f.d.} = \text{mean c.f.s. for 24-hours} \end{aligned}$$

* Coefficient shown is for 24-hour day. When changing to daylight saving time or from daylight saving time the coefficients are as follows: for 23-hour day (change to D.S.T.) use 0.52609; for 25-hour day (change from D.S.T.) use 0.48400.

(b) Lake area used when computing evaporation will be the average area for the day; obtained by averaging the midnight areas at the beginning and ending of the period being computed.

(5) Procedures used to compute mean daily flows are detailed in subparagraph 8b below. The gage heights to compute flows required in subparagraph 6a (5) should be obtained as follows:

(a) Kern River below Isabella Dam from gage reading.

(b) Borel Canal below Isabella Dam from gage reading.

(c) Computed mean inflow to the lake will be taken as the algebraic sum of the mean total outflow, change in lake storage, and evaporation for the lake water surface and will represent mean inflow to the lake from all sources including rainfall on the lake surface.

$$\begin{aligned} & \text{Total Mean Daily Outflow (c.f.s.) } + \\ & \text{Change in Lake Storage (s.f.d.) } + \\ & \text{Evaporation (s.f.d.) } = \\ & \text{Mean Inflow (c.f.s.)} \end{aligned}$$

(6) Computed preproject flow at the lake will be the mean daily inflow.

(7) Obtain Kern River at Kernville from telemark streamgage.

(8) Precipitation at the dam is measured at the weather station.

b. Mean Daily Flow Computations

(1) Check punch tape for errors in gage height and for time. Time is corrected to the current 15 minutes; gage height to the nearest .01 foot.

(2) Tabulate correct gage height readings at odd hours, starting with 0100 hours. Punch tape correction, if any, should be noted.

(3) Enter current rating table, using shifts as applicable, determine and list flow at each odd hour, using the procedure as indicated for mean daily flow in paragraph 8b (5) below.

(4) Total the 12 flow readings so obtained and divide by 12. This is the mean daily flow.

(5) Mean daily flow will be listed to nearest 0.1 c.f.s. for flows up to 10 c.f.s., and to the nearest c.f.s. for flows above 10 c.f.s. Such values will later be rounded to 3 significant figures by the USGS prior to publication.

(6) When calculating discharge for minus shift correction, enter rating table at shift amount less than corrected height, i.e., corrected gage height - 4.86 and shift is -.02 enter rating table at 4.84 to obtain discharge. For (+) shift, enter rating table at shift amount above correct gage height.

(7) In order to obtain a desired flow under shift conditions use the following procedures for (-) shifts.

(a) Add amount of (-) shift to gage height obtained from table. This is the required gage height for desired discharge.

Example: Shift (-.03) desired discharge = 5,000 c.f.s.

Rating table shows gage height of 10.20 = 5,000 c.f.s. Required gage height for 5,000 c.f.s. is $10.20 - (-.03) = 10.23$.

(b) For (+) shift use same procedure except subtract amount of shift for required gage height.

Example: Shift = (+.06) desired discharge = 5,000 c.f.s.

Rating table shows gage height of 10.20 = 5,000 c.f.s. Required gage height = $10.20 - (.06) = 10.14$.

9. STANDING INSTRUCTIONS DURING FLOOD EMERGENCY

a. Flood control operation shall be in accordance with instructions from the Reservoir Control Section. During flood periods, close contact will be maintained between project and District personnel on a 24-hour per day basis or as otherwise required.

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

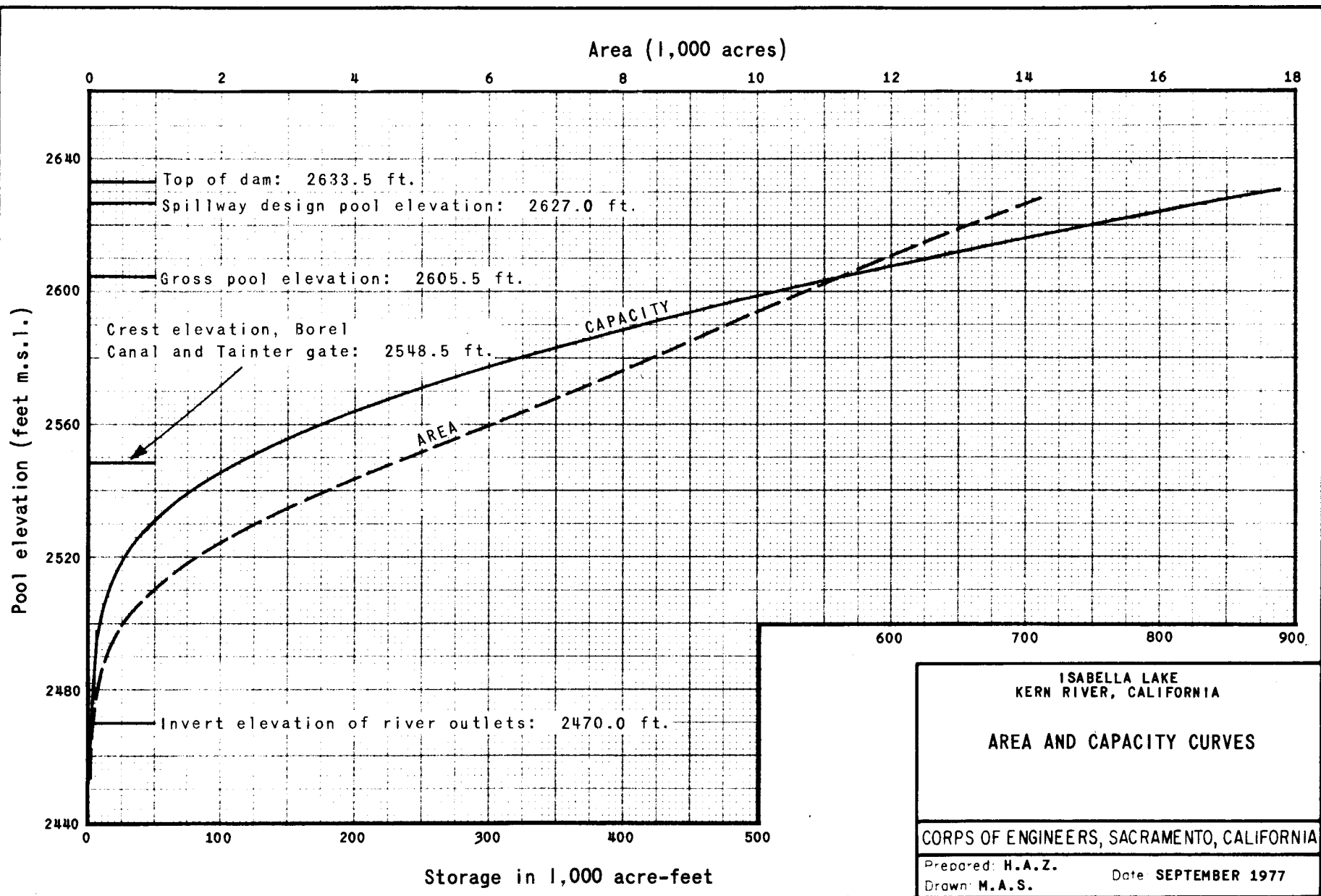
(1) Continue releases in accordance with the last instructions received from the Sacramento District Office and make every attempt to re-establish communication.

(2) If communications cannot be re-established and larger releases are required by the Flood Control Diagram (chart A-7), release should be increased in accordance with the diagram.

10. MODIFICATION OF INSTRUCTIONS

The operating rules contained herein are subject to temporary modification by the District Engineer during flood or other emergencies. Major changes in the operating rules are subject to prior approval by the Chief of Engineers.

Chart A-1



ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2450.0	0	0	0	0	0	0	0	0	0	0
2451.0	0	0	0	0	0	0	0	0	0	0
2452.0	0	1	1	1	1	1	1	1	2	2
2453.0	1	1	2	2	2	3	3	3	3	4
2454.0	4	4	5	5	6	6	7	7	8	8
2455.0	9	10	10	11	12	13	13	14	15	16
2456.0	17	18	19	20	21	22	23	24	26	27
2457.0	28	29	31	32	33	35	36	38	39	41
2458.0	42	44	46	47	49	51	53	54	56	58
2459.0	60	62	64	66	68	70	73	75	77	79
2460.0	82	84	86	89	91	94	96	99	101	104
2461.0	107	109	112	115	118	121	123	126	129	132
2462.0	135	138	142	145	148	151	154	158	161	164
2463.0	168	171	175	178	182	185	189	193	196	200
2464.0	204	208	212	215	219	223	227	231	235	239
2465.0	244	248	252	256	260	265	269	274	278	282
2466.0	287	291	296	301	305	310	315	319	324	329
2467.0	334	339	344	349	354	359	364	369	374	379
2468.0	384	390	395	400	406	411	416	422	427	433
2469.0	438	444	450	455	461	467	473	478	484	490

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA • AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2470.0	496 60	502 60	508 60	514 61	520 61	527 62	533 62	539 62	545 63	551 63
2471.0	558 64	564 64	571 64	577 65	584 65	590 65	597 66	603 66	610 67	617 67
2472.0	623 68	630 68	637 68	644 69	651 69	658 70	665 70	672 70	679 71	686 71
2473.0	693 72	700 72	707 73	715 73	722 73	729 74	737 74	744 75	752 75	759 76
2474.0	767 76	774 77	782 77	790 78	798 78	806 79	813 79	821 80	829 80	837 81
2475.0	845 81	854 82	862 82	870 83	878 83	887 84	895 84	903 85	912 85	920 86
2476.0	929 86	938 87	946 87	955 88	964 88	973 89	982 90	991 90	1000 91	1009 91
2477.0	1018 92	1027 92	1036 93	1046 94	1055 94	1065 95	1074 95	1084 96	1093 97	1103 97
2478.0	1113 98	1123 99	1133 99	1143 100	1153 101	1163 101	1173 102	1183 103	1193 103	1204 104
2479.0	1214 105	1225 105	1235 106	1246 107	1257 108	1267 108	1278 109	1289 110	1300 111	1311 111
2480.0	1323 112	1334 113	1345 114	1356 114	1368 115	1380 116	1391 117	1403 118	1415 119	1427 119
2481.0	1439 120	1451 121	1463 122	1475 123	1487 124	1500 125	1512 125	1525 126	1538 127	1550 128
2482.0	1563 129	1576 130	1589 131	1602 132	1616 133	1629 134	1642 135	1656 136	1670 137	1683 138
2483.0	1697 139	1711 140	1725 141	1739 142	1754 143	1768 144	1782 145	1797 146	1812 147	1826 148
2484.0	1841 150	1856 151	1871 152	1887 153	1902 154	1917 155	1933 156	1949 158	1965 159	1981 160
2485.0	1997 161	2013 163	2029 164	2046 165	2062 166	2079 168	2096 169	2113 170	2130 171	2147 173
2486.0	2164 174	2182 175	2199 177	2217 178	2235 180	2253 181	2271 182	2289 184	2308 185	2326 187
2487.0	2345 188	2364 190	2383 191	2402 192	2422 194	2441 195	2461 197	2480 199	2500 200	2520 202
2488.0	2541 203	2561 205	2582 206	2602 208	2623 210	2644 211	2666 213	2687 215	2708 216	2730 218
2489.0	2752 220	2774 221	2796 223	2819 225	2841 227	2864 228	2887 230	2910 232	2933 234	2957 236

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2490.0	2981 238	3004 239	3028 241	3053 243	3077 245	3102 247	3126 249	3151 251	3177 253	3202 255
2491.0	3228 257	3253 259	3279 261	3305 263	3332 265	3358 267	3385 269	3412 271	3439 273	3467 275
2492.0	3495 278	3522 280	3550 282	3579 284	3607 286	3636 288	3665 291	3694 293	3724 295	3753 298
2493.0	3783 300	3813 302	3844 304	3874 307	3905 309	3936 312	3967 314	3999 316	4030 319	4062 321
2494.0	4095 324	4127 326	4160 329	4193 331	4226 334	4260 336	4293 339	4328 341	4362 344	4396 347
2495.0	4431 349	4466 352	4502 355	4537 357	4573 360	4609 363	4646 366	4682 368	4719 371	4756 374
2496.0	4794 377	4832 379	4870 382	4908 385	4947 388	4986 391	5025 394	5065 397	5104 400	5145 403
2497.0	5185 406	5226 409	5267 412	5308 415	5350 418	5392 421	5434 424	5476 427	5519 430	5563 434
2498.0	5606 437	5650 440	5694 443	5739 446	5783 450	5828 453	5874 456	5920 459	5966 463	6012 466
2499.0	6059 470	6106 473	6154 476	6201 480	6250 483	6298 487	6347 490	6396 494	6446 497	6496 501
2500.0	6546 504	6596 508	6647 511	6699 515	6750 519	6802 522	6855 526	6908 530	6961 533	7014 537
2501.0	7068 541	7122 545	7177 549	7232 552	7288 556	7343 560	7400 564	7456 568	7513 572	7571 576
2502.0	7628 580	7687 584	7745 588	7804 592	7863 596	7923 600	7983 604	8044 608	8105 612	8166 616
2503.0	8228 620	8291 625	8353 629	8416 633	8480 637	8544 642	8608 646	8673 650	8738 655	8804 659
2504.0	8870 663	8937 668	9004 672	9071 677	9139 681	9207 685	9276 690	9345 695	9415 699	9485 704
2505.0	9556 708	9627 713	9698 717	9770 722	9843 727	9915 731	9989 736	10063 741	10137 746	10212 750
2506.0	10267 755	10363 760	10439 765	10516 770	10593 775	10671 780	10749 785	10828 790	10907 794	10987 799
2507.0	11067 805	11148 810	11229 815	11311 820	11393 825	11475 830	11559 835	11642 840	11727 845	11812 851
2508.0	11897 856	11983 861	12069 866	12156 872	12243 877	12331 882	12420 888	12509 893	12599 899	12689 904
2509.0	12779 909	12871 915	12962 920	13055 926	13148 932	13241 937	13335 943	13430 948	13525 954	13620 960

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2510.0	13717 965	13813 971	13911 977	14009 982	14107 988	14206 994	14306 1000	14406 1006	14507 1011	14609 1017
2511.0	14711 1023	14813 1029	14916 1035	15020 1041	15125 1047	15230 1053	15335 1059	15441 1065	15548 1071	15656 1077
2512.0	15764 1083	15872 1090	15982 1096	16091 1102	16202 1108	16313 1114	16425 1121	16537 1127	16650 1133	16764 1139
2513.0	16878 1146	16993 1152	17108 1159	17225 1165	17341 1171	17459 1178	17577 1184	17696 1191	17815 1197	17935 1204
2514.0	18056 1210	18177 1217	18299 1224	18422 1230	18545 1237	18669 1243	18794 1250	18919 1257	19045 1264	19172 1270
2515.0	19300 1277	19428 1284	19556 1291	19686 1298	19816 1305	19947 1311	20078 1318	20210 1325	20343 1332	20477 1339
2516.0	20611 1346	20746 1353	20882 1360	21018 1367	21155 1374	21293 1381	21431 1389	21571 1396	21711 1403	21851 1410
2517.0	21993 1417	22135 1425	22278 1432	22421 1439	22565 1446	22710 1454	22856 1461	23003 1468	23150 1476	23298 1483
2518.0	23446 1491	23596 1498	23746 1506	23897 1513	24049 1521	24201 1528	24354 1536	24508 1543	24663 1551	24819 1559
2519.0	24975 1566	25132 1574	25290 1582	25448 1589	25607 1597	25768 1605	25928 1613	26090 1620	26252 1628	26416 1636
2520.0	26580 1644	26744 1652	26910 1660	27076 1668	27244 1676	27411 1683	27580 1691	27750 1699	27920 1708	28091 1716
2521.0	28263 1724	28436 1732	28610 1740	28784 1748	28959 1756	29135 1764	29312 1772	29490 1781	29668 1789	29847 1797
2522.0	30028 1805	30209 1814	30390 1822	30573 1830	30756 1839	30941 1847	31126 1856	31312 1864	31499 1872	31686 1881
2523.0	31875 1889	32064 1898	32254 1906	32445 1915	32637 1923	32830 1932	33024 1941	33218 1949	33414 1958	33610 1967
2524.0	33807 1975	34005 1984	34204 1993	34403 2001	34604 2010	34805 2019	35008 2028	35211 2037	35415 2045	35620 2054
2525.0	35826 2063	36033 2072	36240 2081	36449 2090	36658 2099	36869 2108	37080 2117	37292 2126	37505 2135	37719 2144
2526.0	37934 2153	38150 2162	38366 2171	38584 2180	38802 2189	39022 2199	39242 2208	39463 2217	39685 2226	39909 2235
2527.0	40133 2245	40357 2254	40583 2263	40810 2273	41038 2282	41267 2291	41496 2301	41727 2310	41958 2319	42191 2329
2528.0	42424 2338	42658 2348	42893 2357	43130 2367	43367 2376	43605 2386	43844 2395	44084 2405	44325 2415	44567 2424
2529.0	44810 2434	45054 2443	45298 2453	45544 2463	45791 2472	46039 2482	46287 2492	46537 2502	46788 2511	47039 2521

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2530.0	47292 2531	47546 2541	47800 2551	48056 2560	48312 2570	48570 2580	48828 2590	49088 2600	49348 2610	49610 2620
2531.0	49872 2630	50136 2640	50400 2650	50666 2660	50932 2670	51200 2680	51468 2690	51738 2700	52008 2710	52280 2720
2532.0	52552 2731	52826 2741	53100 2751	53376 2761	53653 2771	53930 2781	54209 2792	54489 2802	54769 2812	55051 2822
2533.0	55334 2833	55618 2843	55902 2853	56188 2864	56475 2874	56763 2884	57052 2895	57342 2905	57633 2916	57925 2926
2534.0	58218 2937	58513 2947	58808 2958	59104 2968	59401 2979	59700 2989	59999 3000	60300 3010	60601 3021	60904 3031
2535.0	61208 3042	61512 3053	61818 3063	62125 3074	62433 3084	62742 3095	63052 3106	63363 3116	63675 3127	63988 3138
2536.0	64303 3149	64618 3159	64934 3170	65252 3181	65571 3192	65890 3203	66211 3213	66533 3224	66856 3235	67180 3246
2537.0	67505 3257	67831 3268	68159 3279	68487 3290	68817 3301	69147 3311	69479 3322	69812 3333	70146 3344	70481 3355
2538.0	70817 3366	71154 3377	71492 3388	71832 3400	72172 3411	72514 3422	72857 3433	73200 3444	73545 3455	73891 3466
2539.0	74239 3477	74587 3488	74936 3500	75287 3511	75638 3522	75991 3533	76345 3544	76700 3556	77056 3567	77413 3578
2540.0	77772 3589	78131 3601	78492 3612	78854 3623	79216 3634	79580 3646	79946 3657	80312 3668	80679 3680	81048 3691
2541.0	81418 3702	81788 3714	82160 3725	82533 3737	82908 3748	83283 3760	83659 3771	84037 3782	84416 3794	84796 3805
2542.0	85177 3817	85559 3828	85943 3840	86327 3851	86713 3863	87100 3874	87488 3886	87877 3897	88267 3909	88659 3921
2543.0	89052 3932	89445 3944	89840 3955	90236 3967	90634 3979	91032 3990	91432 4002	91832 4014	92234 4025	92638 4037
2544.0	93042 4049	93447 4060	93854 4072	94262 4084	94671 4095	95081 4107	95492 4119	95904 4131	96318 4142	96733 4154
2545.0	97149 4166	97566 4178	97984 4189	98404 4201	98825 4213	99246 4225	99669 4237	100094 4248	100519 4260	100946 4272
2546.0	101374 4284	101803 4296	102233 4308	102664 4319	103097 4331	103530 4343	103965 4355	104401 4367	104839 4379	105277 4391
2547.0	105717 4403	106158 4415	106600 4427	107043 4439	107488 4451	107933 4463	108380 4474	108828 4486	109277 4498	109728 4510
2548.0	110179 4522	110632 4534	111086 4546	111542 4558	111998 4570	112456 4583	112914 4595	113375 4607	113836 4619	114298 4631
2549.0	114762 4643	115227 4655	115693 4667	116160 4679	116629 4691	117098 4703	117569 4715	118041 4727	118515 4739	118989 4752

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2550.0	119465 4764	119942 4776	120420 4788	120900 4800	121380 4812	121862 4824	122345 4836	122829 4849	123315 4861	123802 4873
2551.0	124290 4885	124779 4897	125269 4910	125760 4922	126253 4934	126747 4946	127242 4958	127739 4970	128237 4983	128736 4995
2552.0	129236 5007	129737 5019	130239 5032	130743 5044	131248 5056	131754 5068	132262 5081	132771 5093	133280 5105	133792 5117
2553.0	134304 5130	134817 5142	135332 5154	135848 5166	136366 5179	136884 5191	137404 5203	137925 5215	138447 5228	138970 5240
2554.0	139495 5252	140021 5265	140548 5277	141076 5289	141606 5302	142136 5314	142668 5326	143202 5338	143736 5351	144272 5363
2555.0	144809 5375	145347 5388	145886 5400	146427 5412	146969 5425	147512 5437	148056 5449	148602 5462	149148 5474	149697 5486
2556.0	150246 5499	150796 5511	151348 5524	151901 5536	152455 5548	153011 5561	153567 5573	154125 5585	154684 5598	155245 5610
2557.0	155806 5622	156369 5635	156933 5647	157499 5660	158065 5672	158633 5684	159202 5697	159772 5709	160344 5721	160917 5734
2558.0	161491 5746	162066 5759	162642 5771	163220 5783	163799 5796	164379 5808	164961 5820	165543 5833	166127 5845	166712 5858
2559.0	167299 5870	167886 5882	168475 5895	169065 5907	169657 5920	170249 5932	170843 5944	171438 5957	172034 5969	172632 5982
2560.0	173231 5994	173831 6006	174432 6019	175035 6031	175638 6044	176243 6056	176849 6068	177457 6081	178066 6093	178676 6106
2561.0	179287 6118	179899 6130	180513 6143	181128 6155	181744 6168	182361 6180	182980 6192	183600 6205	184221 6217	184843 6230
2562.0	185467 6242	186091 6254	186718 6267	187345 6279	187973 6291	188603 6304	189234 6316	189866 6329	190500 6341	191135 6353
2563.0	191771 6366	192408 6378	193046 6391	193686 6403	194327 6415	194969 6428	195612 6440	196257 6452	196903 6465	197550 6477
2564.0	198198 6490	198848 6502	199499 6514	200151 6527	200804 6539	201459 6551	202114 6564	202771 6576	203430 6589	204089 6601
2565.0	204750 6613	205412 6626	206075 6638	206739 6650	207405 6663	208072 6675	208740 6687	209409 6700	210080 6712	210752 6724
2566.0	211425 6737	212099 6749	212774 6761	213451 6774	214129 6786	214809 6798	215489 6811	216171 6823	216853 6835	217538 6848
2567.0	218223 6860	218910 6872	219598 6885	220287 6897	220977 6909	221669 6922	222361 6934	223055 6946	223751 6958	224447 6971
2568.0	225145 6983	225843 6995	226544 7008	227245 7020	227948 7032	228652 7044	229356 7057	230063 7069	230770 7081	231479 7094
2569.0	232189 7106	232900 7118	233613 7130	234326 7143	235041 7155	235757 7167	236475 7179	237193 7192	237913 7204	238634 7216

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

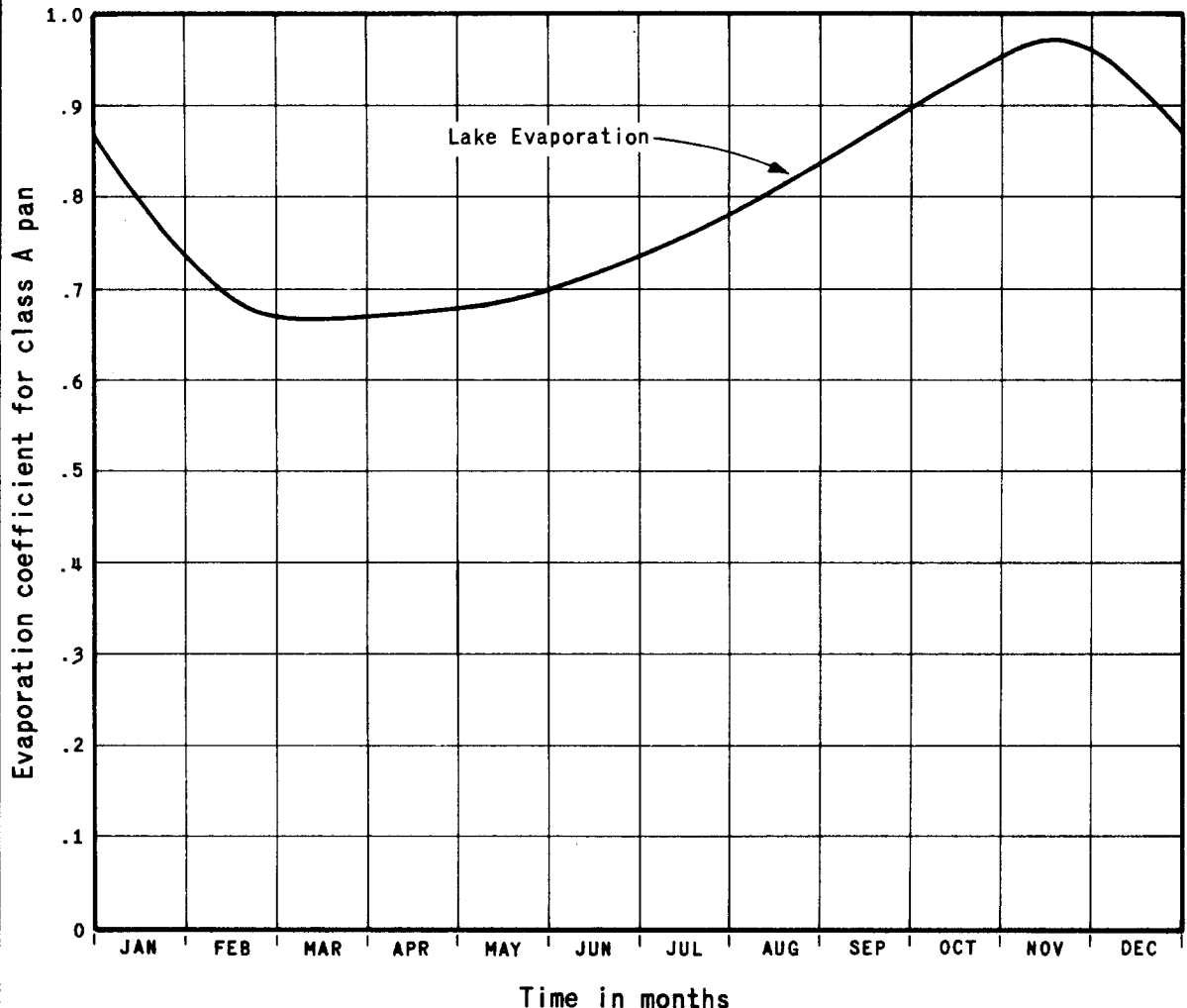
ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2570.0	239356 7228	240079 7241	240804 7253	241530 7265	242257 7277	242986 7289	243715 7302	244446 7314	245178 7326	245911 7338
2571.0	246646 7350	247381 7363	248118 7375	248856 7387	249596 7399	250336 7411	251078 7424	251821 7436	252565 7448	253310 7460
2572.0	254057 7472	254805 7484	255554 7497	256304 7509	257056 7521	257808 7533	258562 7545	259317 7557	260074 7570	260831 7582
2573.0	261590 7594	262350 7606	263111 7618	263874 7630	264637 7642	265402 7654	266168 7667	266935 7679	267704 7691	268474 7703
2574.0	269245 7715	270016 7727	270790 7739	271564 7751	272340 7763	273117 7775	273895 7787	274674 7799	275455 7812	276237 7824
2575.0	277020 7836	277804 7848	278589 7860	279376 7872	280164 7884	280953 7896	281743 7908	282534 7920	283327 7932	284121 7944
2576.0	284916 7956	285712 7968	286509 7980	287308 7992	288108 8004	288909 8016	289711 8028	290514 8040	291319 8052	292125 8064
2577.0	292932 8076	293740 8088	294549 8100	295360 8112	296172 8124	296985 8136	297799 8148	298614 8160	299431 8172	300249 8184
2578.0	301068 8196	301888 8208	302709 8219	303531 8231	304355 8243	305180 8255	306006 8267	306834 8279	307662 8291	308492 8303
2579.0	309323 8315	310155 8327	310988 8339	311823 8350	312658 8362	313495 8374	314333 8386	315172 8398	316013 8410	316854 8422
2580.0	317697 8434	318541 8445	319386 8457	320232 8469	321080 8481	321929 8493	322778 8505	323630 8517	324482 8528	325335 8540
2581.0	326190 8552	327045 8564	327903 8576	328761 8587	329620 8599	330481 8611	331342 8623	332205 8635	333069 8646	333935 8658
2582.0	334801 8670	335669 8682	336537 8694	337407 8705	338278 8717	339151 8729	340024 8741	340899 8752	341775 8764	342652 8776
2583.0	343530 8788	344409 8799	345290 8811	346171 8823	347054 8835	347938 8846	348823 8858	349710 8870	350598 8882	351486 8893
2584.0	352376 8905	353267 8917	354159 8928	355053 8940	355948 8952	356843 8964	357740 8975	358638 8987	359538 8999	360438 9010
2585.0	361340 9022	362242 9034	363146 9045	364052 9057	364958 9069	365865 9080	366774 9092	367684 9104	368595 9115	369507 9127
2586.0	370420 9139	371334 9150	372250 9162	373167 9173	374085 9185	375004 9197	375924 9208	376845 9220	377768 9232	378692 9243
2587.0	379617 9255	380543 9266	381470 9278	382398 9290	383328 9301	384259 9313	385190 9324	386123 9336	387058 9348	387993 9359
2588.0	388930 9371	389867 9382	390806 9394	391746 9406	392687 9417	393630 9429	394573 9440	395517 9452	396463 9463	397410 9475
2589.0	398358 9487	399307 9498	400258 9510	401209 9521	402162 9533	403116 9544	404071 9556	405027 9567	405984 9579	406943 9590

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2590.0	407903 9602	408863 9614	409825 9625	410788 9637	411753 9648	412718 9660	413684 9671	414652 9683	415621 9694	416591 9706
2591.0	417562 9717	418534 9729	419508 9740	420483 9752	421458 9763	422435 9775	423413 9786	424392 9798	425373 9809	426355 9821
2592.0	427337 9832	428321 9844	429306 9855	430292 9867	431279 9878	432268 9890	433257 9901	434248 9913	435240 9924	436233 9936
2593.0	437227 9947	438222 9959	439219 9970	440216 9982	441215 9993	442215 10005	443216 10016	444218 10028	445221 10039	446226 10050
2594.0	447232 10062	448238 10073	449246 10085	450255 10096	451265 10108	452277 10119	453289 10131	454303 10142	455318 10154	456334 10165
2595.0	457351 10177	458369 10188	459388 10199	460409 10211	461431 10222	462453 10234	463477 10245	464502 10257	465529 10268	466556 10280
2596.0	467585 10291	468614 10303	469645 10314	470677 10325	471710 10337	472745 10348	473780 10360	474816 10371	475854 10383	476893 10394
2597.0	477933 10406	478974 10417	480016 10429	481060 10440	482104 10451	483150 10463	484197 10474	485245 10486	486294 10497	487344 10509
2598.0	488396 10520	489448 10532	490502 10543	491557 10554	492613 10566	493670 10577	494728 10589	495788 10600	496849 10612	497910 10623
2599.0	498973 10635	500037 10646	501102 10657	502169 10669	503236 10680	504305 10692	505374 10703	506445 10715	507518 10726	508591 10738
2600.0	509665 10749	510740 10761	511817 10772	512895 10783	513974 10795	515054 10806	516135 10818	517218 10829	518301 10841	519386 10852
2601.0	520472 10864	521558 10875	522646 10887	523736 10898	524826 10910	525918 10921	527010 10933	528104 10944	529199 10955	530295 10967
2602.0	531392 10978	532491 10990	533590 11001	534691 11013	535793 11024	536896 11036	538000 11047	539105 11059	540212 11070	541320 11082
2603.0	542428 11093	543538 11105	544649 11116	545761 11128	546875 11139	547989 11151	549104 11162	550222 11174	551340 11185	552459 11197
2604.0	553579 11208	554700 11220	555823 11231	556946 11243	558072 11254	559197 11266	560324 11277	561452 11289	562582 11300	563713 11312
2605.0	564845 11323	565977 11335	567111 11346	568247 11358	569383 11369	570520 11381	571659 11393	572799 11404	573940 11416	575083 11427
2606.0	576226 11439	577370 11450	578516 11462	579662 11473	580810 11485	581960 11496	583109 11508	584261 11520	585413 11531	586567 11543
2607.0	587722 11554	588878 11566	590035 11577	591194 11589	592353 11601	593513 11612	594675 11624	595838 11635	597003 11647	598168 11658
2608.0	599334 11670	600501 11682	601670 11693	602840 11705	604011 11716	605184 11728	606357 11740	607532 11751	608707 11763	609884 11774
2609.0	611062 11786	612241 11798	613422 11809	614603 11821	615786 11833	616970 11844	618155 11856	619341 11867	620528 11879	621717 11891

ISABELLA RESERVOIR, KERN RIVER, CALIFORNIA - AREA AND CAPACITY TABLE SEPTEMBER 1975

ELEV FEET	CAP AREA .0	CAP AREA .1	CAP AREA .2	CAP AREA .3	CAP AREA .4	CAP AREA .5	CAP AREA .6	CAP AREA .7	CAP AREA .8	CAP AREA .9
2610.0	622907 11902	624097 11914	625289 11926	626483 11937	627677 11949	628872 11961	630068 11972	631266 11984	632466 11996	633666 12007
2611.0	634867 12019	636069 12031	637273 12042	638478 12054	639684 12066	640891 12077	642100 12089	643309 12101	644520 12112	645731 12124
2612.0	646945 12136	648159 12147	649374 12159	650591 12171	651808 12182	653027 12194	654247 12206	655468 12218	656691 12229	657914 12241
2613.0	659139 12253	660365 12264	661592 12276	662820 12288	664049 12300	665280 12311	666511 12323	667744 12335	668979 12347	670214 12358
2614.0	671450 12370	672687 12382	673927 12394	675166 12405	676407 12417	677650 12429	678893 12441	680138 12452	681383 12464	682631 12476
2615.0	683879 12488	685128 12499	686379 12511	687630 12523	688883 12535	690137 12546	691393 12558	692649 12570	693906 12582	695166 12593
2616.0	696425 12605	697686 12617	698949 12629	700212 12641	701477 12652	702743 12664	704010 12676	705278 12688	706547 12699	707818 12711
2617.0	709089 12723	710362 12735	711637 12747	712912 12758	714188 12770	715466 12782	716744 12794	718024 12806	719306 12817	720588 12829
2618.0	721871 12841	723156 12853	724442 12865	725729 12876	727017 12888	728307 12900	729597 12912	730889 12924	732182 12935	733476 12947
2619.0	734771 12959	736068 12971	737365 12983	738664 12994	739964 13006	741265 13018	742568 13030	743871 13042	745176 13053	746482 13065
2620.0	747789 13077	749097 13089	750407 13101	751718 13112	753030 13124	754343 13136	755657 13148	756972 13160	758289 13171	759607 13183
2621.0	760926 13195	762246 13207	763567 13219	764889 13230	766213 13242	767538 13254	768863 13266	770191 13278	771519 13289	772849 13301
2622.0	774179 13313	775511 13325	776844 13336	778178 13348	779515 13360	780850 13372	782188 13383	783527 13395	784867 13407	786209 13419
2623.0	787551 13430	788894 13442	790239 13454	791585 13466	792932 13477	794280 13489	795630 13501	796981 13513	798333 13524	799686 13536
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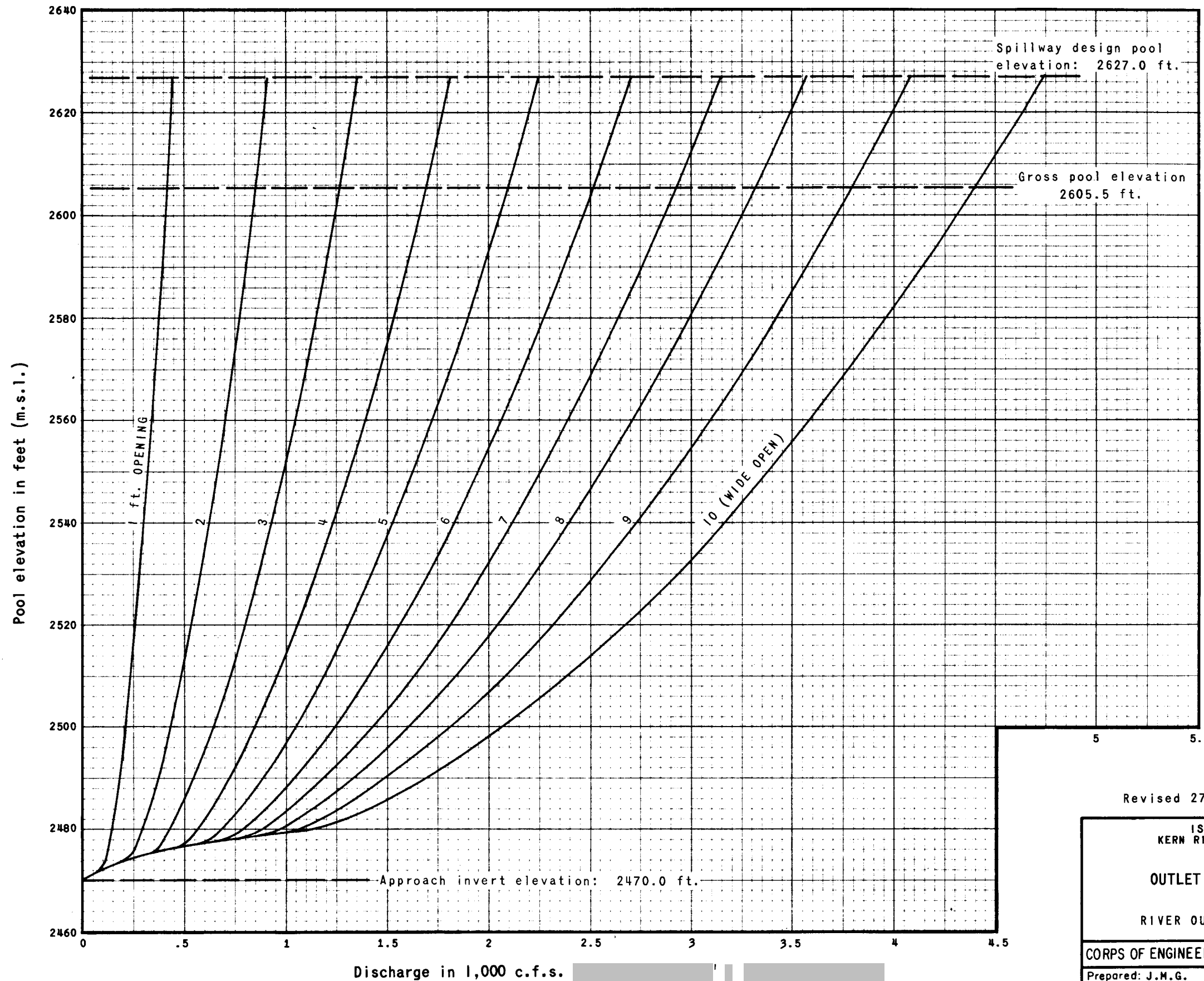
NOTE:

To convert inches per day to s.f.d., multiply by area of lake (in acres) and by the constant 0.042.

AVERAGE MONTHLY EVAPORATION COEFFICIENTS

Jan	0.804	Jul	0.768
Feb	0.696	Aug	0.816
Mar	0.672	Sep	0.876
Apr	0.672	Oct	0.936
May	0.684	Nov	0.960
Jun	0.720	Dec	0.924

ISABELLA LAKE KERN RIVER, CALIFORNIA	
EVAPORATION COEFFICIENTS	
ISABELLA LAKE	
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA	
Prepared: H. T. M.	Date: NOVEMBER 1977
Drawn: M. A. S.	



Revised 27 September 1954

ISABELLA LAKE
KERN RIVER, CALIFORNIA

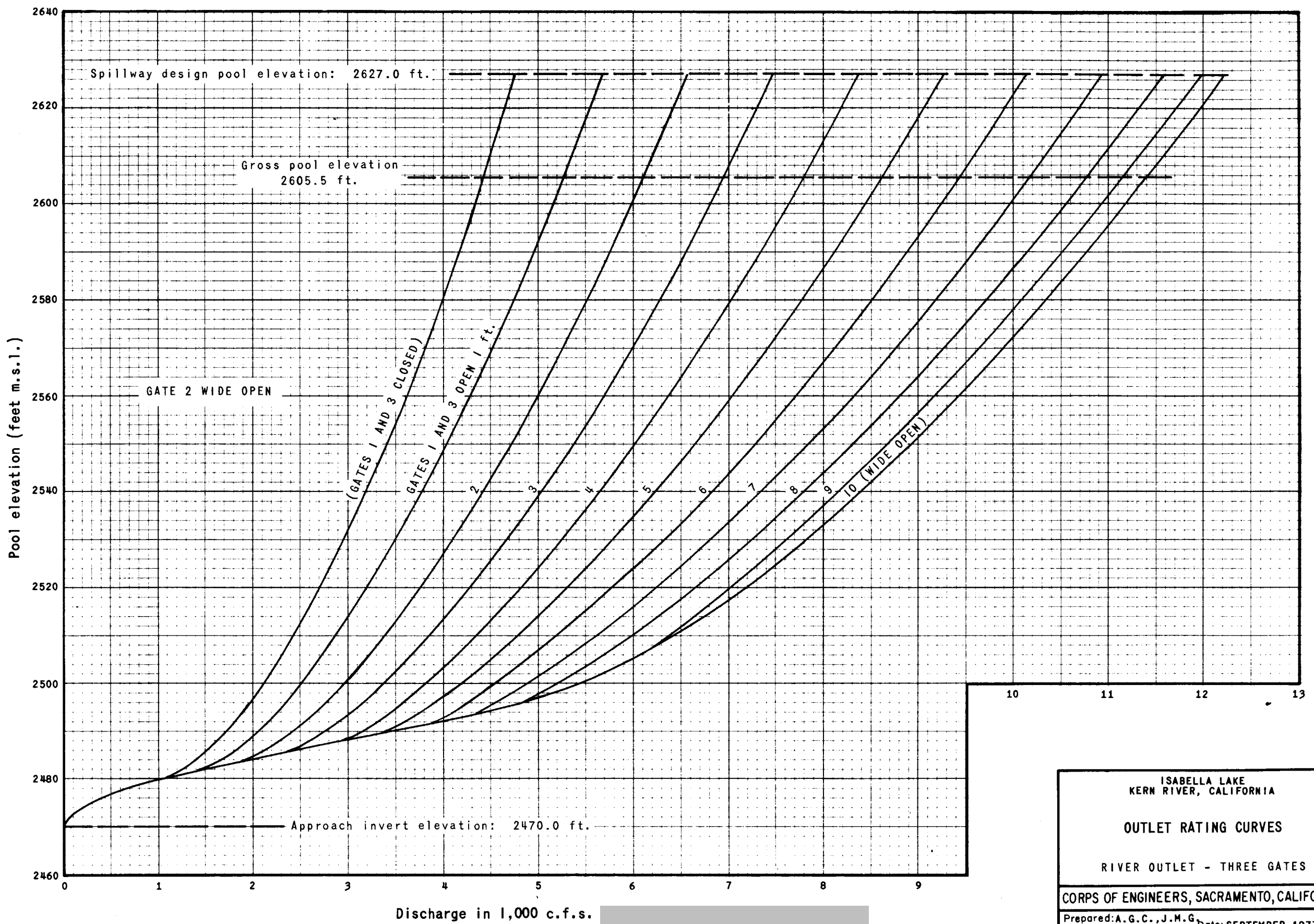
OUTLET RATING CURVES

RIVER OUTLET - ONE GATE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: J.M.G.
Drawn: M.A.S.

Date: SEPTEMBER 1977



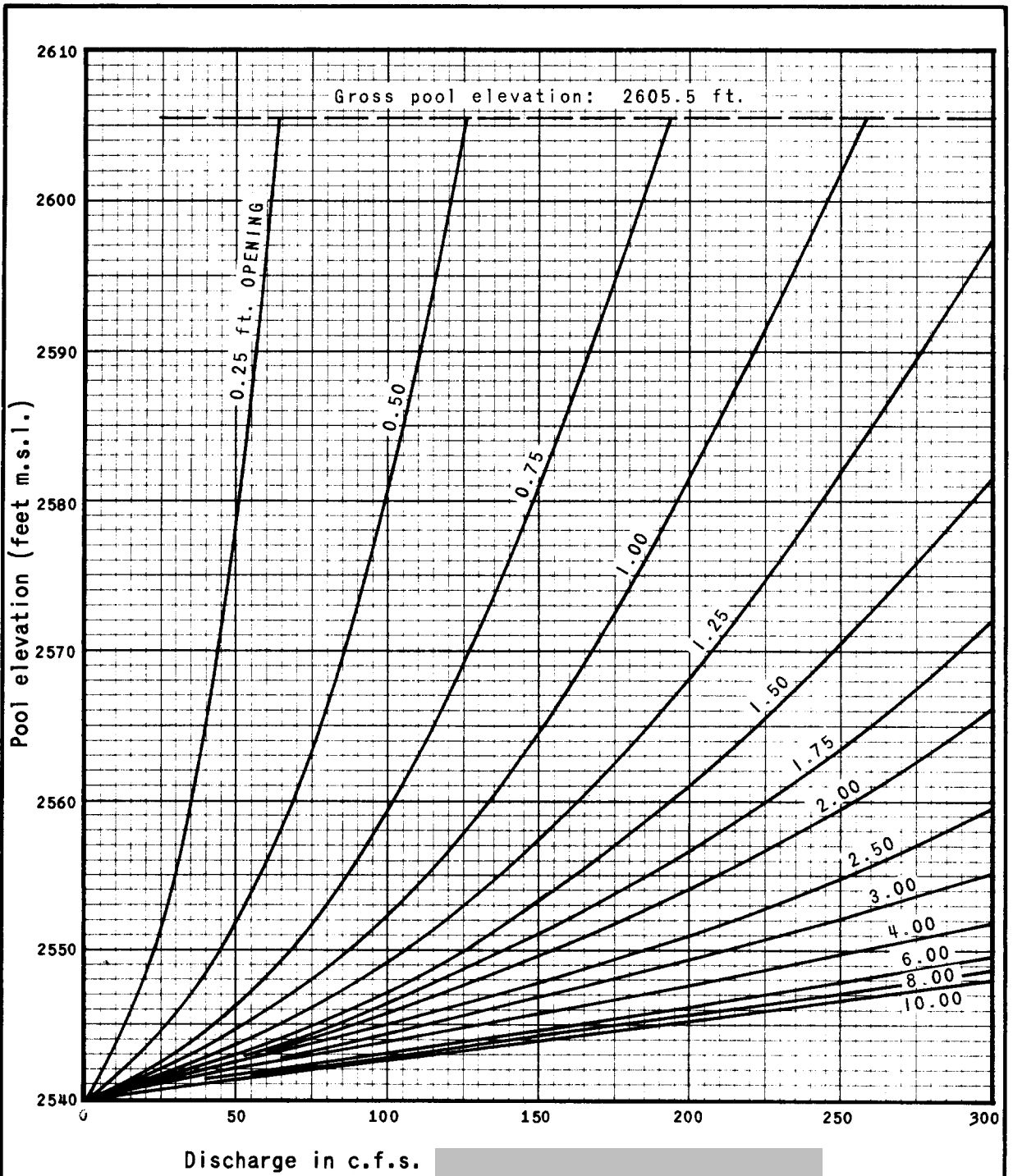
ISABELLA LAKE
 KERN RIVER, CALIFORNIA

OUTLET RATING CURVES

RIVER OUTLET - THREE GATES

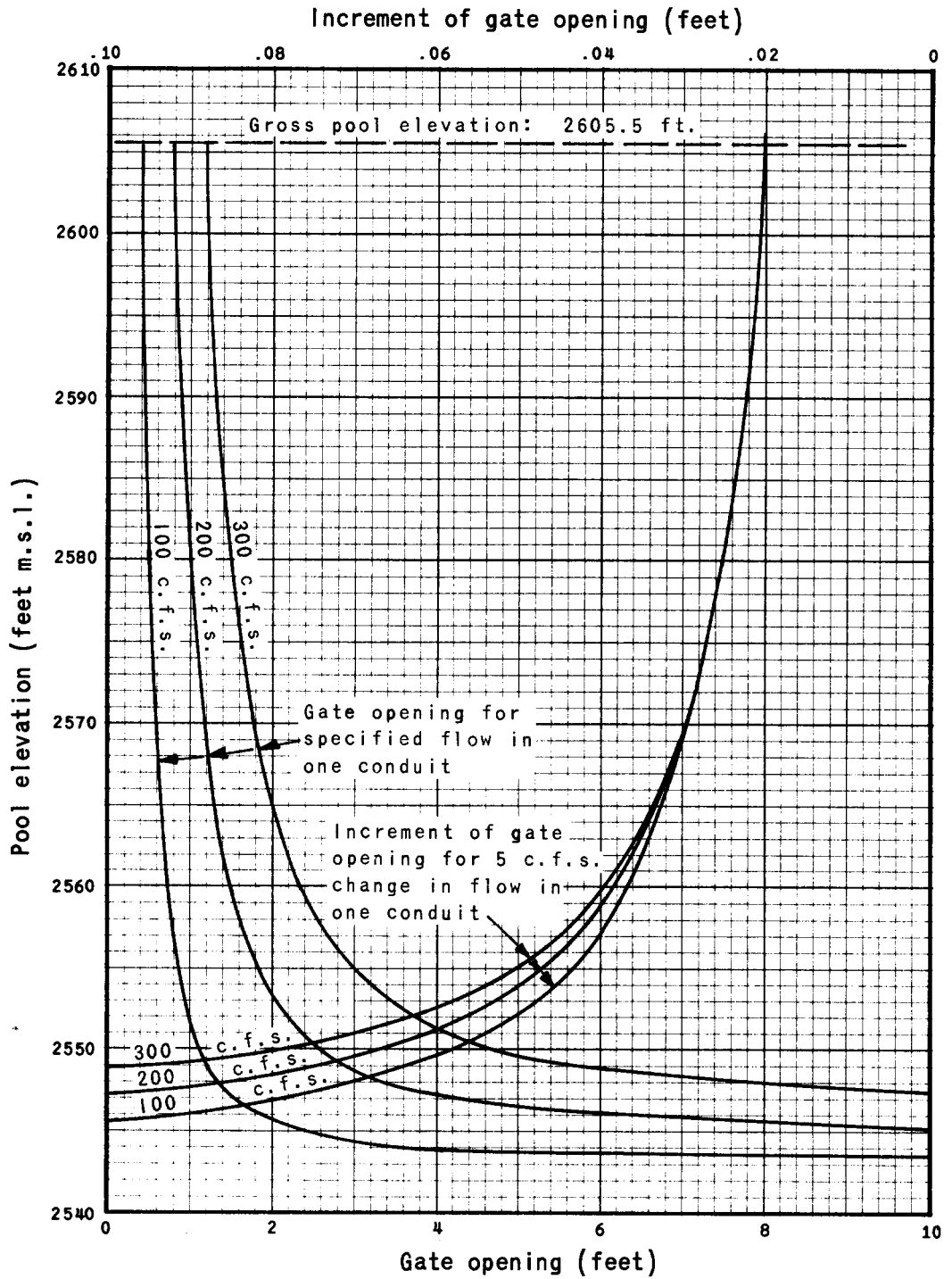
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: A.G.C., J.M.G. Date: SEPTEMBER 1977
 Drawn: M.A.S.



Revised 27 September 1954

ISABELLA LAKE KERN RIVER, CALIFORNIA	
OUTLET RATING CURVES	
BOREL CANAL OUTLET	
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA	
Prepared: A.W.H.	Date: SEPTEMBER 1977
Drawn: M.A.S.	



ISABELLA LAKE
KERN RIVER, CALIFORNIA

OUTLET RATING CURVES

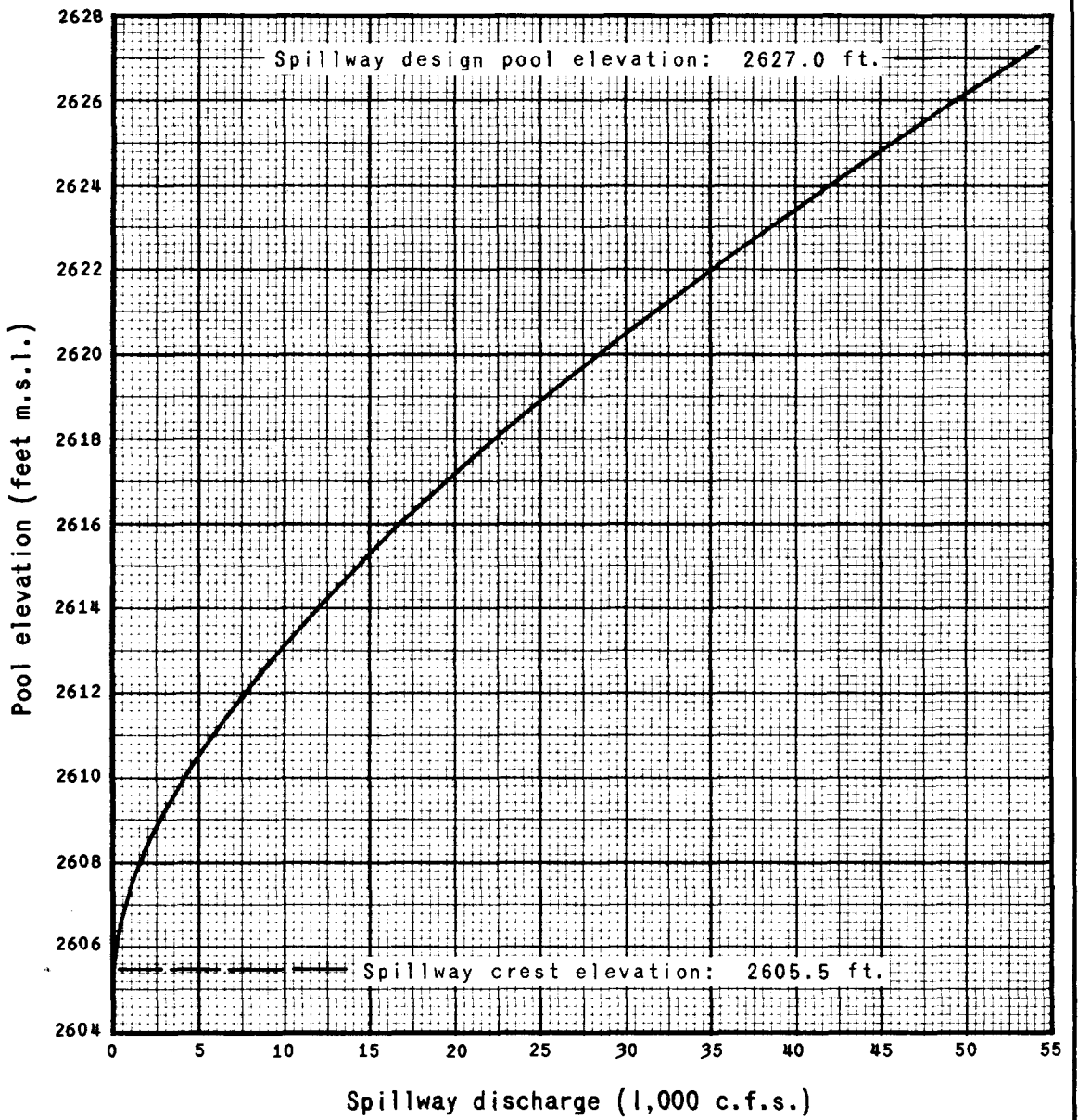
BOREL CANAL OUTLET

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Revised September 1954

Prepared: A.W.H.
Drawn: M.A.S.

Date: SEPTEMBER 1977



ISABELLA LAKE
KERN RIVER, CALIFORNIA

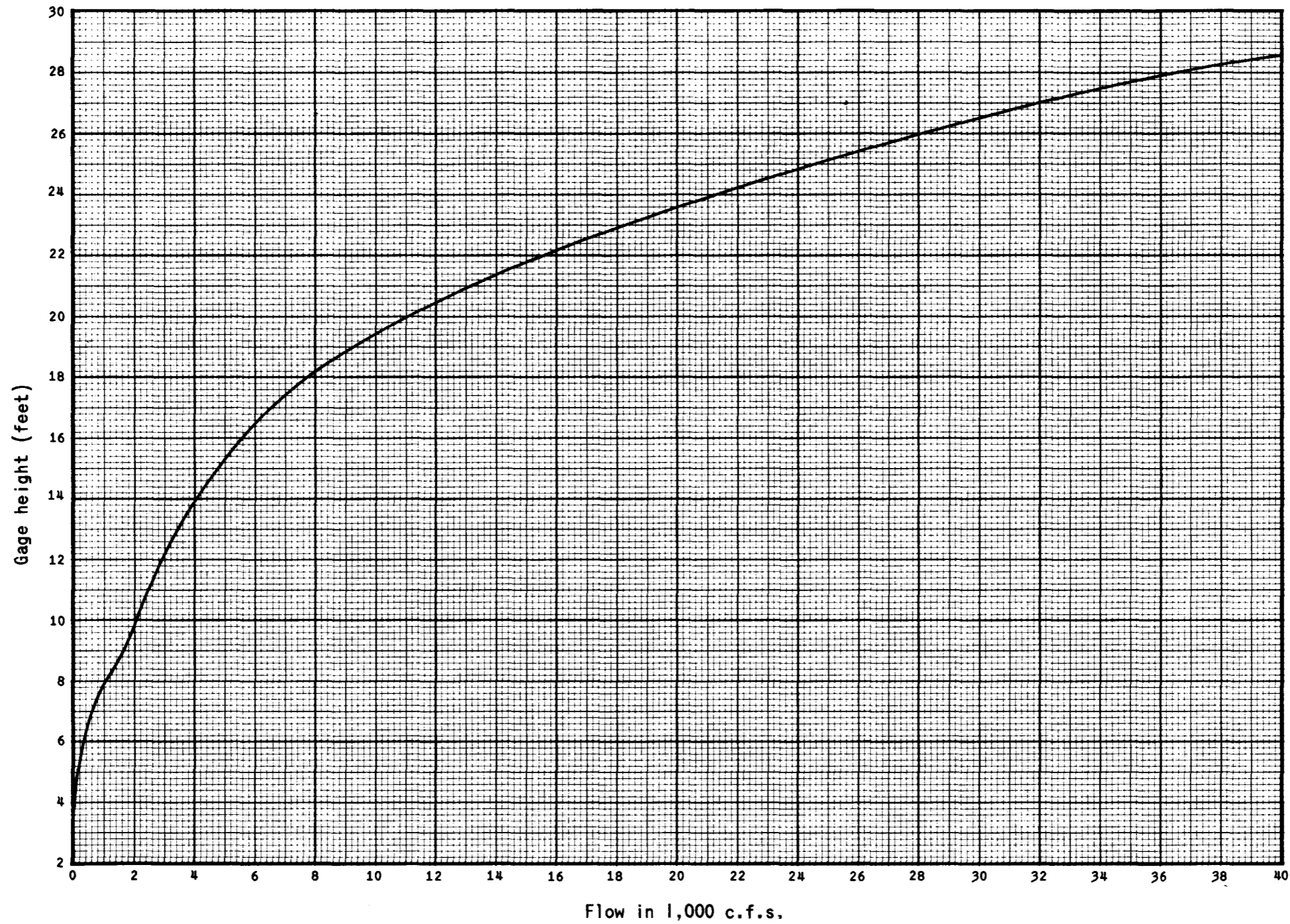
SPILLWAY RATING CURVE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Revised September 1954, October 1965

Prepared: C. E. F.
Drawn: M. A. S.

Date: SEPTEMBER 1977



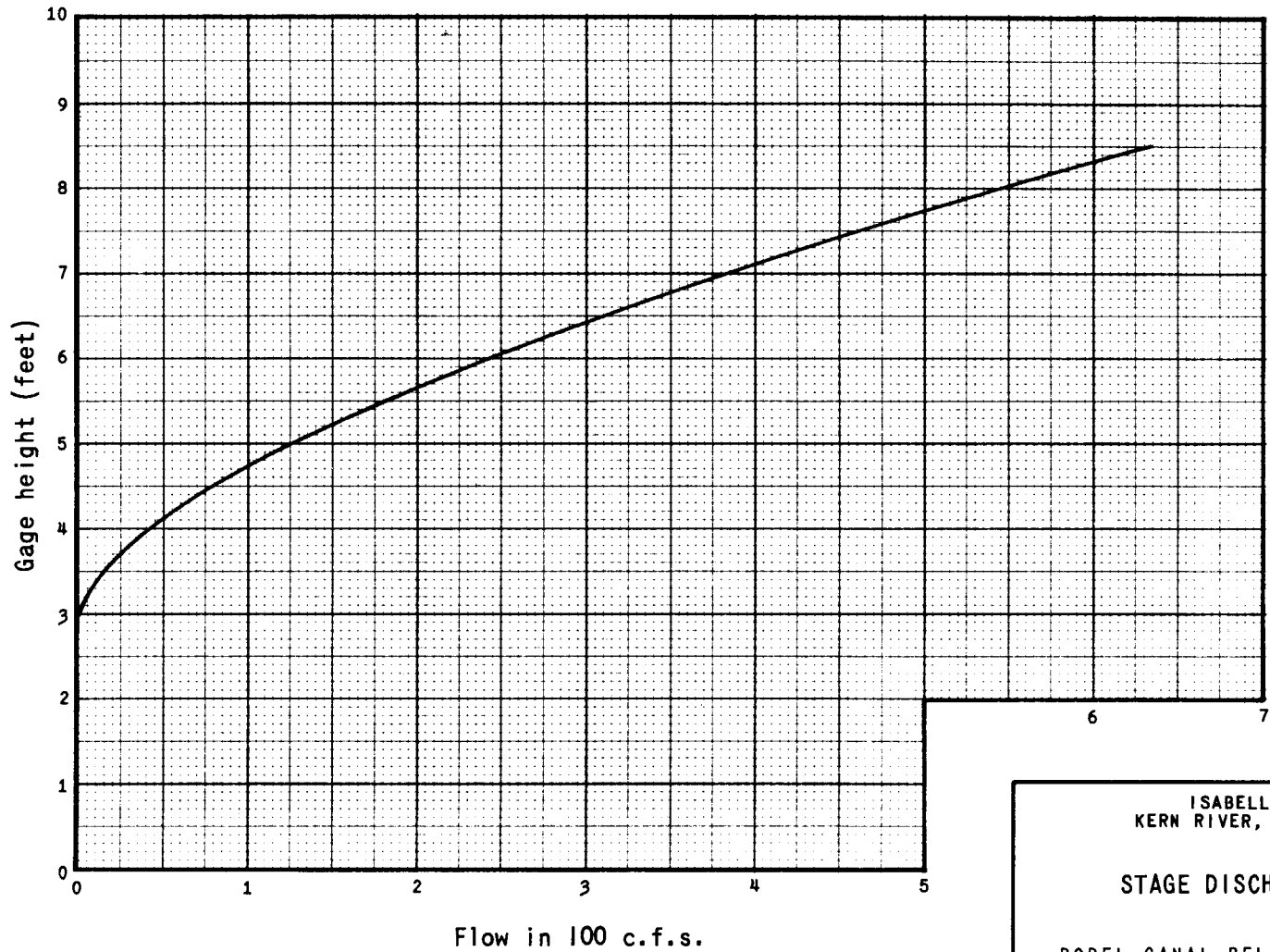
ISABELLA LAKE
 KERN RIVER, CALIFORNIA

STAGE DISCHARGE CURVE

KERN RIVER BELOW ISABELLA DAM

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C. Date: SEPTEMBER 1977
 Drawn: M.A.S.



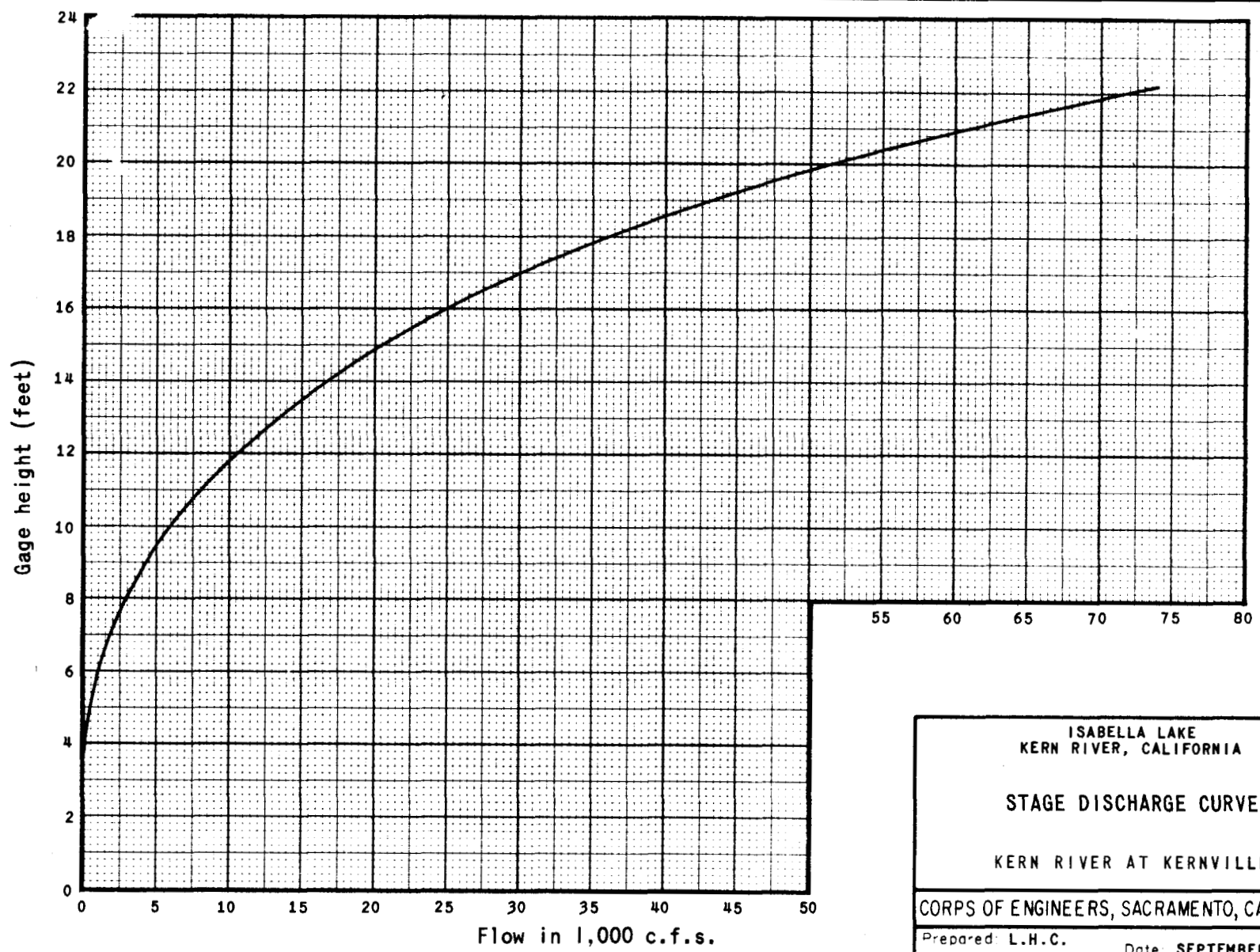
ISABELLA LAKE
KERN RIVER, CALIFORNIA

STAGE DISCHARGE CURVE

BOREL CANAL BELOW ISABELLA DAM

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C. Date: SEPTEMBER 1977
Drawn: M.A.S.



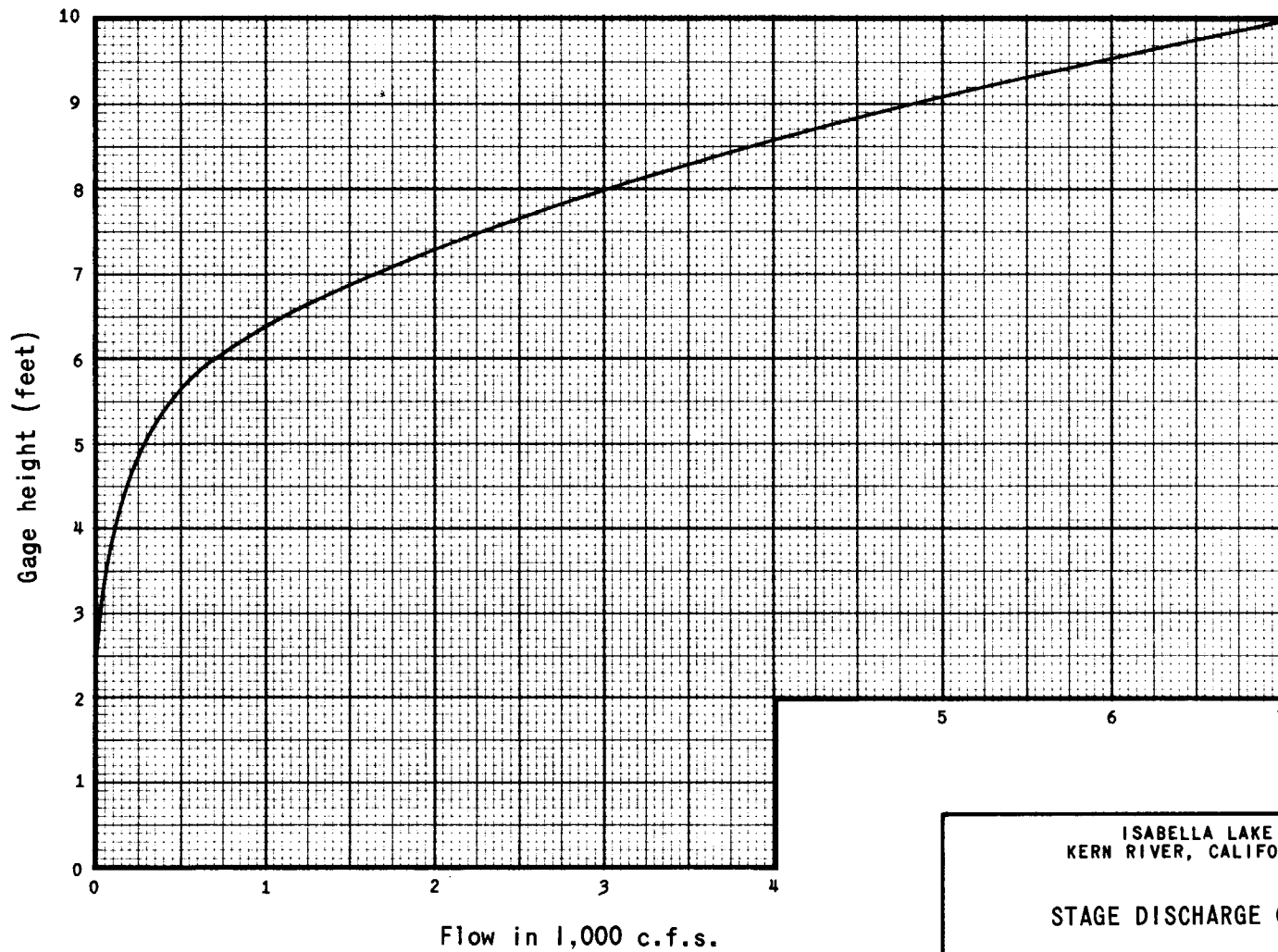
ISABELLA LAKE
KERN RIVER, CALIFORNIA

STAGE DISCHARGE CURVE

KERN RIVER AT KERNVILLE

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C. Date: SEPTEMBER 1977
Drawn: M.A.S.



ISABELLA LAKE
KERN RIVER, CALIFORNIA

STAGE DISCHARGE CURVE

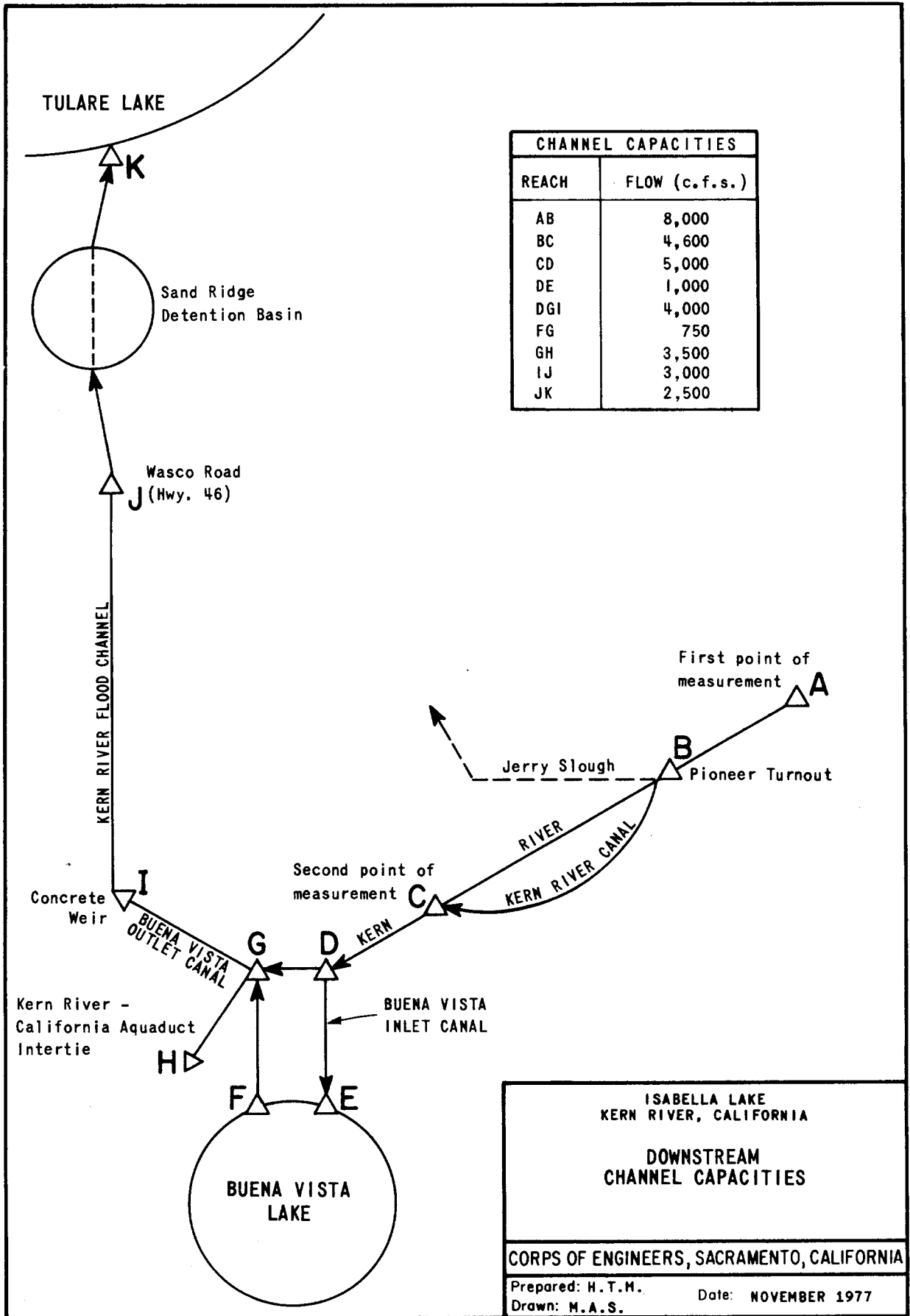
SOUTH FORK KERN RIVER NEAR ONYX

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C.

Date: SEPTEMBER 1977

Drawn: M.A.S.



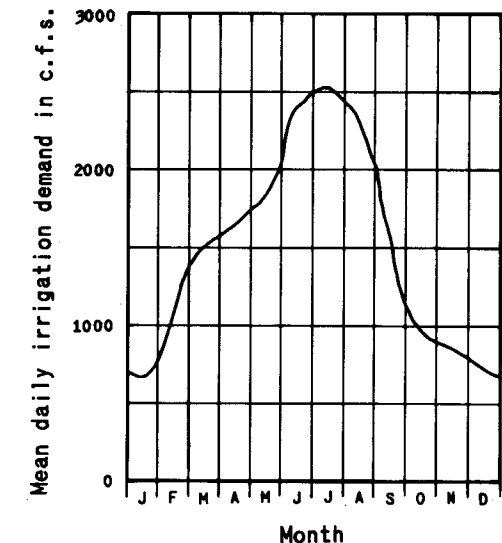
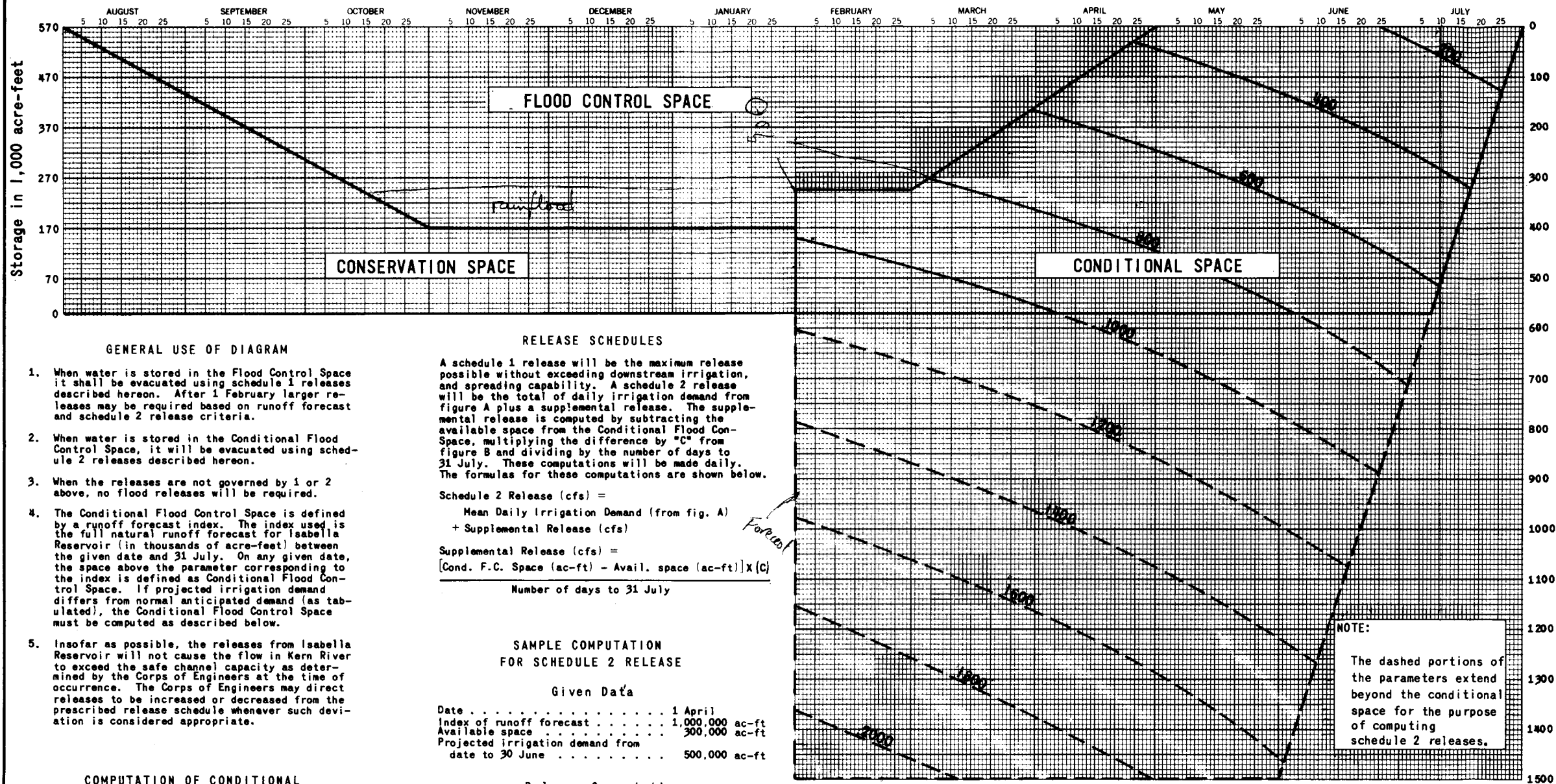


Figure A

NORMAL ANTICIPATED IRRIGATION AND SPREADING DEMANDS

Month	IRRIGATION		SPREADING	
	(1,000 A.F./Month)	(Mean Monthly C.F.S.)	(1,000 A.F./Month)	(Mean Monthly C.F.S.)
JAN	41	670	33	550
FEB	59	1,060	33	550
MAR	92	1,510	33	550
APR	99	1,660	33	550
MAY	112	1,830	34	550
JUN	143	2,410	36	610
JUL	153	2,500	36	590
AUG	142	2,320	36	590
SEP	91	1,530	34	570
OCT	58	950	33	550
NOV	51	870	33	550
DEC	44	710	33	550
TOTAL	1,095		407	

GENERAL USE OF DIAGRAM

- When water is stored in the Flood Control Space it shall be evacuated using schedule 1 releases described hereon. After 1 February larger releases may be required based on runoff forecast and schedule 2 release criteria.
- When water is stored in the Conditional Flood Control Space, it will be evacuated using schedule 2 releases described hereon.
- When the releases are not governed by 1 or 2 above, no flood releases will be required.
- The Conditional Flood Control Space is defined by a runoff forecast index. The index used is the full natural runoff forecast for Isabella Reservoir (in thousands of acre-feet) between the given date and 31 July. On any given date, the space above the parameter corresponding to the index is defined as Conditional Flood Control Space. If projected irrigation demand differs from normal anticipated demand (as tabulated), the Conditional Flood Control Space must be computed as described below.
- Insofar as possible, the releases from Isabella Reservoir will not cause the flow in Kern River to exceed the safe channel capacity as determined by the Corps of Engineers at the time of occurrence. The Corps of Engineers may direct releases to be increased or decreased from the prescribed release schedule whenever such deviation is considered appropriate.

RELEASE SCHEDULES

A schedule 1 release will be the maximum release possible without exceeding downstream irrigation, and spreading capability. A schedule 2 release will be the total of daily irrigation demand from figure A plus a supplemental release. The supplemental release is computed by subtracting the available space from the Conditional Flood Control Space, multiplying the difference by "C" from figure B and dividing by the number of days to 31 July. These computations will be made daily. The formulas for these computations are shown below.

Schedule 2 Release (cfs) =
 Mean Daily Irrigation Demand (from fig. A)
 + Supplemental Release (cfs)
 Supplemental Release (cfs) =

$$\frac{[\text{Cond. F.C. Space (ac-ft)} - \text{Avail. space (ac-ft)}] \times C}{\text{Number of days to 31 July}}$$

SAMPLE COMPUTATION FOR SCHEDULE 2 RELEASE

Given Data
 Date 1 April
 Index of runoff forecast 1,000,000 ac-ft
 Available space 300,000 ac-ft
 Projected irrigation demand from date to 30 June 500,000 ac-ft

Release Computation
 Normal Anticipated Irrigation Demand from date to 31 July (from tabulation) 354,000 ac-ft
 Irrigation demand adjustment 354,000 - 500,000 = -146,000 ac-ft
 Unadjusted Conditional Flood Control Space (from diagram) 555,000 ac-ft
 Conditional Flood Control Space 555,000 - 146,000 = 409,000 ac-ft
 C (from figure B) 0.453
 Number of days to 31 July 122
 Irrigation demand (from figure A) 1,600 cfs
 Supplemental release =

$$\frac{(409,000 - 300,000) \times 0.453}{122} = 405 \text{ cfs}$$

 Schedule 2 release = 405 + 1,600 = 2,005 cfs

COMPUTATION OF CONDITIONAL FLOOD CONTROL SPACE

Determine unadjusted Conditional Flood Control Space, based on a runoff forecast index _____

Determine the difference between the normal anticipated irrigation demand (as tabulated) and the projected irrigation demand for the period between the given date and 30 June. If the projected demand is larger, reduce the unadjusted Conditional Flood Control Space by the difference; if the projected demand is smaller, increase the unadjusted Conditional Flood Control Space by the difference ± _____

Conditional Flood Control Space Total _____

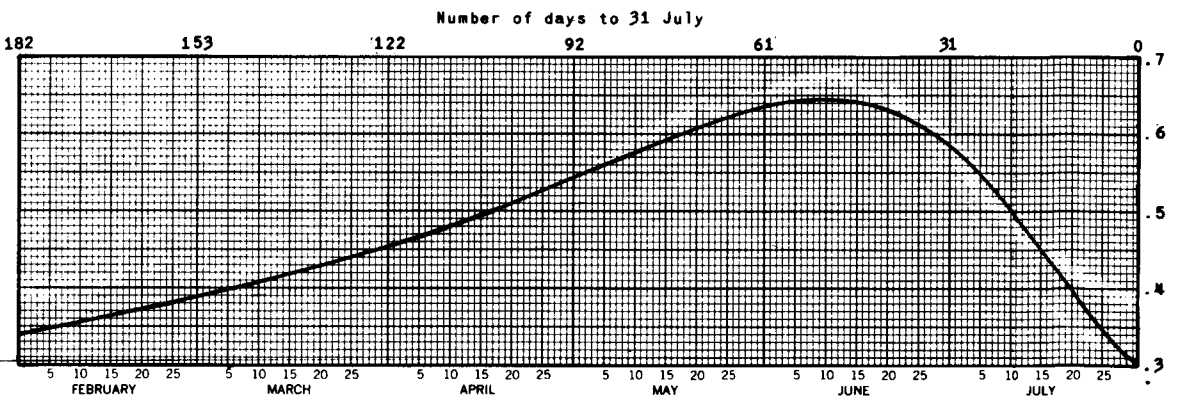


Figure B

**ISABELLA LAKE
KERN RIVER, CALIFORNIA**

FLOOD CONTROL DIAGRAM

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
 Prepared: H.T.M. Date: OCTOBER 1977
 Drawn: L.H.C.