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SANTA MARIA RIVER AND TRIBUTARIES, CALIFORNIA

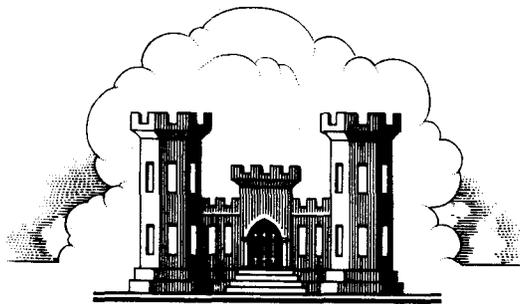
RESERVOIR REGULATION MANUAL

FOR

FLOOD - CONTROL STORAGE

AT

TWITCHELL DAM AND RESERVOIR



U. S. ARMY ENGINEER DISTRICT, LOS ANGELES

CORPS OF ENGINEERS

AUGUST 1960

RESERVOIR REGULATION MANUAL
 FOR
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 SANTA MARIA RIVER AND TRIBUTARIES, CALIF.

CONTENTS

	<u>Page</u>
General	1
Introduction	1
General description	1
Hydrometeorological characteristics	2
Runoff and floods	3
Flood damages	3
Authorization	4
Overall project	5
Changes to House Document plan	6
Hydrologic basis of design	6
Sedimentation	8
Operation	8
Project-document operation plan	8
Flood-operation plan	8
Routing the reservoir design	9
Routing the spillway design flood	9
Channel design flood at Fugler Point	9
Conservation operation	9
Organization for flood-control operation	10
Modification of flood-control regulations	10

TABLES

No.	Title	Page
1.	Summary of climatological data at Santa Maria (public airport), Santa Maria River and tributaries, Calif.	11
2.	Summary of climatological data at Cuyama, Santa Maria River and tributaries, Calif.	13
3.	Existing stream-gaging stations and pertinent data, Santa Maria River and tributaries, Calif.	15
4.	Runoff data, Santa Maria River at Guadalupe, Santa Maria River and tributaries, Calif.	17

CONTENTS--Continued

TABLES--Continued

<u>No.</u>	<u>Title</u>	<u>Page</u>
5.	Runoff data, Huasna River near Santa Maria Santa Maria River and tributaries, Calif	19
6.	Runoff data, Alamos (Alamo) Creek near Santa Maria Santa Maria River and tributaries, Calif	21
7.	Runoff data, Cuyama River near Santa Maria Santa Maria River and tributaries, Calif	23
8.	Runoff data) Sisquoc River near Garey (Gary), Santa Maria River and tributaries, Calif	25
9.	Pertinent data, Twitchell Dam and Reservoir) Santa Maria River and tributaries Calif	27
10.	Area and gross capacity data - Twitchell Dam and Reservoir, Santa Maria River and tributaries, Calif	31
11.	Pertinent data, Santa Maria Valley levees and channel improvements, Santa Maria River and tributaries, Calif	35
12.	Outlet gates operation schedule for flood-control storage - Twitchell-Dam and Reservoir, Santa Maria River and tributaries, Calif	37

PLATES

<u>No.</u>	<u>Title</u>
1.	Topography and drainage areas.
2.	Reservoir area.
3.	Isohyets of mean seasonal-precipitation (1867 to 1947).
4.	Hydrologic map.
5.	Overflow areas prior to improvements.
6.	General plan and sections.
7.	Spillway, general plan, and sections.
8.	Outlet works, plan, profile, and sections.
9.	Area and capacity curves.
10.	Outlet discharge curves, two tandem pairs, 7'-0"x12'-0" gates, low port blocked.
11.	Outlet discharge curves, two tandem pairs, 7'-0"x12'-0" gates, low port open.
12.	Spillway discharge curve.
13.	Design discharges for levee and channel improvements.
14.	Reservoir design flood routing.
15.	Spillway design flood routing.
16.	Channel design flood at Fugler Point.
17.	Organizational chart.
18.	Key personnel.

CONTENTS--Continued

APPENDIX A

Flood control regulations, Twitchell Dam and Reservoir, Santa Maria
River basin, California

RESERVOIR REGULATION
MANUAL

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GENERAL

1. Introduction.--This reservoir regulation manual, which prescribes the use of storage allocated for flood control at Twitchell Dam and Reservoir was prepared in accordance with instructions contained in Engineering Regulation 1110-2-240, dated 8 December 1958, and Civil Works Engineering Manual 1110-2-3600, dated 25 May 1959, issued by the Office, Chief of Engineers. These publications prescribe in part that a reservoir regulation manual will be prepared for each reservoir subject to the provisions of Section 7 of the Flood Control Act of 1944. That Act states that "***Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for use of storage allocated for flood control or navigation at all reservoirs, constructed wholly or in part with Federal funds .***" A copy of the official flood-control regulations for Twitchell Dam and Reservoir is contained in appendix A of this manual.

2. The manual has been divided into a general section containing, descriptive information pertaining to the overall project and an operation section in which details concerning the actual plan of operation are presented. A considerable portion of the material used in the preparation of this manual was supplied by the U. S. Bureau of Reclamation offices in Denver, Colo., and Sacramento, Calif.

3. General description.--Twitchell Dam, and Reservoir (formerly Vaquero Dam and Reservoir) is a multiple-purpose structure for water conservation and flood control, which is located on the Cuyama River, 7 airline miles northeast of Santa Maria, Calif., in the Santa Maria River basin.(see pls. 1 and 2). The dam was completed in December 1958. The drainage area above Twitchell Dam comprises 1,125 square miles of the 1,845 square miles in the Santa Maria River basin. The Santa Maria River is formed by the confluence of the Cuyama and Sisquoc Rivers. All of these rivers flow generally westward. Downstream from the confluence, the basin includes the plain along the Santa Maria River, the Nipomo Upland to the north, and the Orcutt Upland to the south. The Solomon and Casmalia Hills,

ranging in elevation from 500 to 1,600 feet, are along the southern boundary; and a low divide is along the northern boundary. The soil in the valley is composed of alluvium and terrace deposits. The riverwash area, which includes deposits of sand and gravel is very pervious. This area contains irrigated farmland, raising both field and garden crops. The principal cities located below the confluence are Santa Maria, Betteravia, and Guadalupe. The largest of these, Santa Maria, had a population of about 15,000 in 1958. Residential and commercial development is expanding rapidly in the Santa Maria River Valley.

4. The drainage area of the Cuyama River, 1,147 square miles, the larger of the two rivers that combine to form the Santa Maria River, is bounded on the northeast, by the barren Caliente Mountains, whose average crest elevation is about 4,000 feet. The Sierra Madre Mountains on the south and southwest have an average crest elevation of about 5,500 feet, and separate the drainage areas of the Cuyama and Sisquoc Rivers. Scattered conifers are found in the higher elevations, and brush and grass are common on the lower slopes. Parts of the area are frequently denuded by fire. Between these two ranges of mountains is the broad Cuyama Valley. The upper Cuyama area consists of sedimentary and alluvial deposits of gravels, clays, shales, and sandstones. The riverwash area includes deposits of sand and gravel. The valley and riverwash areas are very pervious. About 27 miles downstream of the lower end of the Cuyama Valley proper, the river enters a narrow steep-sided canyon, through which it flows for about 36 miles to its confluence with the Sisquoc River. Alamos Creek and Huasna River, the two largest tributaries of Cuyama River, drain this lower mountainous area.

5. The Sisquoc River (drainage area 483 sq. miles), drains the rugged mountainous area of the Sierra Madre range, which is adjacent to and south of the Cuyama River drainage area. The San Rafael Mountains, forming the southern boundary of the Sisquoc River basin, have an average crest elevation of about 5,000 feet. These mountains, which are mostly sedimentary in origin, consist of shales, gravels, and alluvium. A dense cover of conifers is in the higher elevations; live oak, brush, and grass are common on the lower slopes; and deciduous trees, are along the streams. Parts of the area are frequently denuded by fire.

6. Hydrometeorological characteristics.--The climate of the Santa Maria River basin is generally mild. Extremes of temperature are rare in the valley parts of the basin, but the temperature variation increases with elevation. Prevailing winds, from the Pacific, are generally light to moderate; the highest velocities occur during the spring. Mean seasonal precipitation (July-June), ranges from about 11 inches on the coast to more than 35 inches in the higher mountains (see pl. 3). About 90 percent of the precipitation occurs during the months of November to April, inclusive. Precipitation occurs in the form of rain, except for occasional

light snowfall in mountain areas. Summaries of climatological data for Santa Maria, Calif., And for Cuyama, Calif., are given in tables 1 and 2. The locations of these stations are shown on plate 4.

7. Most storm precipitation in the drainage area results from general winter storms that are associated with extratropical cyclones of North Pacific origin. During the winter season (November-April), such storms move south over the ocean and then inland to southern California, and result in precipitation over large areas. Major storms, which consist of one or more cyclonic disturbances, occasionally last 4 days or more. During major storms, rainfall rates of flood-producing magnitude have extended over periods ranging from a few hours to about 2 days. The greatest floods of record in the drainage area have resulted from this type of storm. Occasionally in the winter season, meteorologic conditions result in random occurrences of unusually heavy but brief rainfall of the thunderstorm type. The duration of heavy intensities during these occurrences is seldom more than 2 hours and rarely more than 3 hours. In summer, rainfall associated with tropical cyclones has occurred in this region, but such occurrences are infrequent and relatively unimportant in the flood history of the drainage area. Summer thunderstorms are not uncommon, but the amount of rainfall in such storms in the area is relatively minor.

8. Runoff and floods.--Floods resulting from rainfall constitute nearly all of the annual runoff in the Santa Maria River basin. Inasmuch as only occasional snowfall occurs, runoff due to snowmelt is of minor consequence. Records of streamflow in the Santa Maria River basin are incomplete and no records exist for Twitchell dam site. At the present time, seven stream-gaging stations are in operation in the Santa Maria River basin. Table 3 summarizes the extent of available records at these stations, and their locations are shown on plate 4. Runoff data for five of these stations pertinent to the operation of Twitchell Reservoir, are given in tables 4 through 8. The station on the Santa Maria River at Guadalupe, Calif., measures runoff from practically the entire Santa Maria River basin. Peak discharges at this station for the flood years 1941, 1943, 1952, and 1958 were 14,700, 13,800, 23,800, and 21,500 cubic feet per second, respectively. Zero flow has occurred numerous times at this station

9. Historical accounts and records of floods that have occurred in the Santa Maria River basin are lacking. However, a study of historical accounts and records of floods that have occurred in adjacent basins indicate that severe floods occurred in the years 1862, 1868, 1884, 1886, 1909, and 1914. The peak discharge for the 1909 flood was estimated at 100,000 cubic feet per second on the Santa Maria River at Guadalupe.

10. Flood damages.--Few monetary estimates of damages from past floods in the Santa Maria River basin are available. Records,

however, indicate that floods have caused extensive damage to agricultural land and to residential, highway, and railroad property. A map of the area subject to overflow for an occurrence of the standard project flood prior to improvements is shown on plate 5. Along the Santa Maria River, floods have caused damage of major proportions by cutting streambanks and changing the shape and location of the channels, damaging, or destroying communication and transportation facilities and inundating rural and urban property. During large floods, the channel has become badly silted, thereby decreasing its carrying capacity. The most recent floods that have occurred in the Santa Maria River basin, those of January 1952 and April 1958, have caused estimated damages of \$250,000 and \$110,000, respectively.

11. Completion of the plan of flood-control improvements, which comprise flood regulation at Twitchell Dam and Reservoir and the Santa Maria River and Bradley Canyon levees, as subsequently described, provides for nearly complete protection to about 26,000 acres of the 32,400-acre overflow area from floods up to the magnitude of the standard project flood. This area of 26,000 acres, includes about 18,700 acres of cultivated land, most of the city of Santa Maria and part of the city of Guadalupe. An unprotected area of 6,400 acres, including about 1,000 acres of farmland west of Guadalupe, Calif., and downstream from the levees, together with streambed and wasteland along the 22-mile reach of the Santa Maria River from Fugler Point to the Pacific Ocean will exist with the completion of the project. Levee protection was not economically justified for this area.

12. Authorization.--The plan for flood-control improvements in the Santa Maria River was set forth in House Document 400, 83d Congress, 2d session, dated 24 May 1954. This plan provided for a multiple-purpose reservoir for water conservation and flood control at the Vaquero (Twitchell) site, on the Cuyama River, and levee and channel improvements along the Santa Maria River and Bradley Canyon. The construction of Twitchell Dam was authorized by Public Law 774, 83d Congress, 2d session, which was passed by Congress 3 September 1954, and authorized the Secretary of the Interior to construct the project for irrigation and the conservation of water, flood control, and for other purposes, on the Santa Maria River, Calif. The Bureau of Reclamation began construction of Twitchell Dam in July 1956 and completed construction in December 1958. The Board of Geographic Names, Department of the Interior, approved the changing of the name of Vaquero Dam to Twitchell Dam and Vaquero Reservoir to Twitchell Reservoir effective 6 September 1957.

13. The plan for flood-control improvements to protect the overflow areas downstream from Twitchell Dam along the Santa Maria River was approved 3 September 1954 by Act of Congress, Public Law 780, 83d Congress, 2d session. The principal features of this plan are the construction of revetted levees and channel clearing under the supervision of the Chief of Engineers. Construction of this project began in April 1959 and is scheduled to be completed in December 1961.

14. Overall project.--The overall project consists of Twitchell Dam, a multiple-purpose structure for water conservation and flood control, located at river mile 8.0 on the Cuyama River, and levee and channel improvements along the Santa Maria River and Bradley Canyon. Twitchell Dam was designed and constructed by the U. S. Bureau of Reclamation. The flood-control storage allocation and flood-control operation, were prescribed by the Corps of Engineers. Agreement was reached between the Bureau of Reclamation and the Corps of Engineers on the allocation for sediment deposition. The levee and channel improvements along the Santa Maria River were designed by the Corps of Engineers and that organization is the construction agency for these improvements.

15. Twitchell Dam is a zoned-earth dam with a maximum height of 216 feet above the Cuyama River. The crest of the dam at elevation 692 is 1,800 feet long. The embankment is constructed of three zones; an impervious central zone flanked by a pervious zone both upstream and downstream, and a miscellaneous zone in the downstream toe. A 25-foot deep cutoff trench is provided under the impervious zone. The general plan and sections of Twitchell Dam are shown on plate 6. The spillway (see pl. 7), located in the right abutment, is an ungated conduit type and consists of a rounded entrance with a level 50-foot uncontrolled crest at elevation 651.5, connecting with a 23-foot diameter discharge tunnel. The tunnel will flow full when reservoir water surface elevation reaches 618.5. The outlet works (see pl. 8) are located in the right abutment of the dam and discharge directly into the Cuyama River. They consist of (a) an intake structure with invert elevation at 504; (b) a 15.0 foot diameter upstream pressure conduit with a 5.0 by 11.0-foot intake port having an invert at elevation 474; (c) a 15.0-foot diameter upstream pressure tunnel; (d) a gate chamber with access shaft and control house; (e) a 19.0- by 17.0-foot downstream free flow tunnel; and (f) an open chute and stilling basin. Two tandem pairs of 7.0- by 12.0-foot outlet gates are located in the outlet works gate chamber. The upstream gates are normally wide open and function as guard gates. The downstream gates are operated for regulation of flow.

16. The reservoir at spillway crest elevation 651.5 has an area of 3,690 acres and a gross capacity of 240,120 acre-feet. The outlet discharges 12,700 cubic feet per second at spillway crest (low port assumed blocked). At top of dam, elevation 692.0, the reservoir has an area of 5,700 acres and a gross capacity of 426,000 acre-feet. At that elevation, the spillway capacity is 28,000 cubic feet per second and the outlet capacity is 14,000 cubic feet per second. Table 9 lists pertinent data for Twitchell Dam and Reservoir. Curves giving area and capacity, outlet discharge (low-port blocked), outlet discharge (low port open), and spillway discharge are shown on plates 9 through 12, respectively. A tabulation of areas and gross capacities are given in table 10.

17. The Santa Maria Valley improvements provide for about 17 miles of levee along the left bank of the Santa Maria River from Fugler Point to State Highway No. 1 bridge at Guadalupe; about 5 miles of levee along the right bank of the Santa Maria River from a point about 1-1/4 miles downstream from U.S. Highway No. 101 to a point about 1-1/2 miles upstream from the Southern Pacific Railroad bridge at Guadalupe; and channel clearing from Fugler Point to the Pacific Ocean. The Bradley Canyon improvements will consist of about 1.8 miles of channel and revetted levees from the mouth of Bradley Canyon to the Santa Maria River. The left side of the channel would be a revetted levee and the right side would be formed by excavating the natural ground to a slope of 1 on 4. Table 11 lists pertinent data for the Santa Maria Valley levees and channel improvements. The locations of the levees are shown on plate 5 and design discharges are shown on plate 13.

18. Changes to House Document plan.--The current plan for flood-control improvements in the Santa Maria River basin described under "Overall project" differs from the project-document plan given in House Document 400. The principal differences are as follows:

(a) The top of the dam was raised from elevation 660.0 to elevation 692.0 increasing the total storage from 153,250 acre-feet, to 426,000 acre-feet. A 150-foot gated spillway with crest at elevation 609.5 having three 50- by 34-foot radial gates was changed to an ungated tunnel spillway with rounded entrance incorporating a level 50-foot, ogee-type crest at elevation 651.5. In lieu of the gated spillway for control of flood flows, as described in the project-document plan, the outlet works with slide gates are used.

(b) Although the allocation of flood-control storage space in Twitchell Reservoir remains the same at 89,000 acre-feet, the 80,000 acre-feet of capacity for water conservation was increased to 110,000 acre-feet and the sediment storage was reduced from 45,000 acre-feet to 40,000 acre-feet.

(c) The capacity of the downstream levees at Fugler Point was increased from 150,000 cubic feet per second to 160,000 cubic feet per second.

19. Hydrologic basis of design.--The reservoir design flood for Twitchell Dam has an inflow Peak of 95,000 cubic feet per second and a maximum 1-day volume of 107,500 acre-feet. Estimates of the magnitude of the flood were based on the unit-hydrograph method using (a) the runoff that would have resulted from the storm of January 1943 if the center of the storm had occurred over the basin above the dam and if the ground conditions had been conducive to fairly high rates of runoff; (b) an average infiltration rate of 0.30 inch per hour for the upper-Cuyama River basin and 0.20 inch per hour for the remainder of the drainage area; (c) variable base flow for mountain and foothill

areas; (d) channel percolation rate of 1-1/2 cubic feet per second per wetted acre for upper Cuyama River area; and (e) negligible effect from snowmelt.

20. The spillway crest elevation for Twitchell Dam was established at elevation 651.5 by the U. S. Bureau of Reclamation, based on a gross storage requirement of 239,000 acre-feet consisting of 40,000 acre-feet for sedimentation, 110,000 acre-feet for conservation, and 89,000 acre-feet for flood control.

21. The spillway design flood developed by the U. S. Bureau of Reclamation has a peak inflow of 120,000 cubic feet per second and a total runoff volume (72 hours) of 368,000 acre-feet. Estimates of the magnitude of the flood were based on the unit-hydrograph method using (a) runoff that would have resulted from the storm of January 1943 if the center of the storm had occurred over the basin above the dam when the ground conditions were conducive to maximum runoff, and if the observed moisture and wind values were increased to a maximum; (b) an infiltration rate varying from 0.30 inch per hour to 0.20 inch per hour for the upper Cuyama River basin and 0.20 inch per hour to 0.10 inch per hour for the rest of the drainage area; (c) a maximum base flow of 4,000 cubic feet per second; and (d) negligible effect from snowmelt.

22. The height of the dam was determined by the U. S. Bureau of Reclamation after routing their spillway design flood through the reservoir. The routing was based on the assumption that the reservoir water surface was at elevation 623 (conservation pool) at the beginning of the flood. Inflow was passed through the outlets up to 2,000 cubic feet per second and this discharge was maintained until the reservoir reached elevation 649.5. At this elevation, releases were uniformly increased to the capacity of the outlet works. A maximum water-surface elevation of 686.5 was attained and the top of the dam was established at elevation 692.

23. The standard project flood which was used for the design of the Santa Maria Valley levees has a peak flow of 160,000 cubic feet per second. The development of the flood is identical to the development of the reservoir design flood, with the exception that the design storm was centered over the Sisquoc River area and the uncontrolled area below Twitchell Dam.

24. The standard project flood for Bradley Canyon levees has a peak flow of 9,000 cubic feet per second above the confluence with the Santa Maria River. Estimates of the magnitude of the flood were based on (a) runoff that would result from the thunderstorm of March 1943, which occurred in the Los Angeles area, if that storm had occurred over the Bradley Canyon area (on the basis of studies indicating that dewpoint temperature decreases with an increase in latitude, precipitation amounts were decreased 10 percent), and if

the ground conditions had been conducive to fairly high rates of runoff; (b) constant infiltration rate of 0.20 inch per hour; and (c) constant base flow.

25. Sedimentation.--The amount of sediment expected to be deposited in Twitchell Reservoir was determined by the U. S. Bureau of Reclamation on the basis of an analysis of runoff samples. A relationship between sediment load and discharge was developed, and using a flow-duration curve, a long term sediment yield was determined. It was estimated that 400 acre-feet of sediment per year would be deposited. Under the assumption that this rate of deposition would continue during the 100-year period following completion of the dam, 40,000 acre-feet of storage was allocated to sedimentation. It was assumed that this sediment would fill the reservoir to elevation 504 at the end of a 100-year period. It is anticipated that the Regional Director of the Bureau of Reclamation will, at reasonable intervals, make necessary field surveys and office studies to prepare estimates of the volume and location of sediment deposits in the reservoir. If the results of such studies show that the 40,000 acre-feet of storage allocated to sedimentation has been depleted, and the net storage initially allocated to flood control (89,000 acre-feet) or conservation (110,000 acre-feet), respectively, is reduced by an amount exceeding, 10 percent of the allocation for either purpose, the operating plan described herein with respect to storage allocations shall be reviewed with the view of reestablishing an equitable distribution between the primary reservoir uses.

OPERATION

26. Project-document operation plan.--The plan of operation for Twitchell Dam as set forth in House Document No. 400, 83d Congress, 2d session, is described in detail in appendix 3 of the Corps' report titled "Report on Survey, Flood Control, Santa Maria River and Tributaries, California" and dated 10 February 1953. That plan provided for a conservation pool to be developed to elevation 612.0 at the start of a flood. Outflow would then be made equal to inflow to 2,000 cubic feet per second. The outflow would then be maintained at 2,000 cubic feet per second until the water surface reached elevation 641.5. Above this elevation the outflow would be increased 23,700 cubic feet per second for each foot of rise in water-surface elevation. The spillway gates would be wide open at water-surface elevation 646.5. Under this operation plan, the reservoir design flood at Twitchell Dam with a peak inflow of 95,000 cubic feet per second would be reduced to a peak outflow of 43,000 cubic feet per second. The standard project flood on the Santa Maria River at Fugler Point would be reduced from an uncontrolled peak of 230,000 cubic feet per second to a peak of 150,000 cubic feet per second.

27. Flood-operation plan.--Extensive changes in the design of Twitchell Dam since the project was authorized have resulted in

development of a revised flood-operation plan. The gate operation schedule for this plan is given in table 12. In this plan, the low port is assumed blocked and the outlet gates remain closed until a conservation pool is developed to elevation 623. Between elevations 623 and 624, the outlet discharge is increased in steps until the outlet gates are fully opened and discharging 11,630 cubic feet per second. Above elevation 624.0, the outlet gates remain fully opened. For optimum conservation of spillway surcharge space in maximum-type floods, the outlet discharge is not transferred to the spillway. The same schedule is used for rising and falling stages.

28. With the outlet gates fully opened, a discharge of 12,700 cubic feet per second is attained at spillway crest. This discharge causes no damage in flowing through the narrow undeveloped valley extending from the dam to Fugler Point. The unimproved channel reach from Guadalupe to the ocean will also carry the maximum release from the dam without damage. However, as previously stated, it is not economically feasible to improve this reach to carry the 150,000 cubic feet per second peak that would result from a channel design flood.

29. Routing the reservoir design flood.--The reservoir design (standard project) flood developed by the Corps of Engineers was routed through Twitchell Reservoir under the flood-operation plan. It was assumed that the reservoir water surface was at elevation 623 (top of conservation pool) and the low port blocked at the start of the routing. A plot of this routing is shown on plate 14. The peak inflow of 95,000 cubic feet per second is reduced to a peak outflow of 12,700 cubic feet per second and a water-surface elevation of 651.3 is reached.

30. Routing the spillway design flood.--The spillway design flood developed by the U. S. Bureau of Reclamation was routed through Twitchell Reservoir under the flood-operation plan. It was assumed that the reservoir water surface was at elevation 623 (top of conservation pool) and the low port blocked at the start of the flood. A plot of this routing is shown on plate 15. The peak inflow of 120,000 cubic feet per second is reduced to a peak outflow of 39,700 cubic feet per second and a water-surface elevation of 683.9 is reached.

31. Channel design flood at Fugler Point.--For the channel design (standard project) flood at Fugler Point (based on centering the January 1943 storm below Twitchell Dam), the outflow from the dam under the flood-operation plan was routed to Fugler Point and combined with the discharges from the Cuyama River below the dam and from the Sisquoc River as shown on plate 16. A peak discharge of 160,000 cubic feet per second was obtained at Fugler Point.

32. Conservation operation.--At the present time the conservation storage in Twitchell Reservoir consists of 151,050 acre-feet below elevation 623 including 40,000 acre-feet for sedimentation.

Floodwaters are retained below elevation 623 for subsequent release at the percolation capacity of the downstream channel, which is estimated to be 300 cubic feet per second or less.

33. Organization for flood-control operation.--The organization for effecting the flood-control operation of Twitchell Dam is shown on plate 17. The names and telephone numbers of key personnel are shown on plate 18. The Regional Director, Region 2, U. S. Bureau of Reclamation, is charged with the responsibility for the actual flood-control operation of Twitchell Dam. He is required to keep the District Engineer, U.S. Army Engineer District, Los Angeles, currently advised of hydrologic and hydraulic data for the Santa Maria River basin and Twitchell Dam. Specifically, such data will include: (a) precipitation amounts, (b) streamflow at critical locations, and (c) reservoir inflow, outflow, and storage. During normal periods, this information is transmitted by mail, but during emergencies, telephone or telegraph is used. The information received from the Bureau of Reclamation is analyzed in the Control Group, under the supervision of the chief, Hydraulic Operations Section.

34. Operation and maintenance of the Santa Maria project were transferred by contract from the U. S. Bureau of Reclamation to the Santa Barbara County Water Agency, which agency in turn transferred the operation and maintenance of Twitchell Dam to the Santa Maria Water Conservation District.

35. Modification of flood-control regulations.--The District Engineer, U.S. Engineer District, Los Angeles, may temporarily modify the flood-control regulations for Twitchell Dam (appendix A), if necessary, in time of emergency. Requests for and action on such modification may be made by any available means of communication to the Regional Director, Region 2, U. S. Bureau of Reclamation, and the action taken shall be confirmed in writing under date of the same day to the office of the Regional Director. In the event of danger of major damage to or failure of the downstream levee system, the Santa Maria Valley Water Conservation District may temporarily adjust releases required by the flood-control regulations upon request of the county of Santa Barbara, pending action by the District Engineer on the request for approval of such adjustment. The county of Santa Barbara is the agency responsible for the operation and maintenance of the levee system. Recommendations for revision of the flood - control regulations will be made to the Secretary of the Army upon mutual agreement of the Corps of Engineers and the Bureau of Reclamation.

Table 1

Summary of climatological data at Santa Maria (public airport), Santa Maria
River and tributaries, Calif.*

Month	Temperature			Precipitation		
	Mean	Record	Record	Mean	Maximum	Minimum
	monthly	highest	lowest	monthly	monthly	monthly
	Degrees	Degrees	Degrees			
	Fahrenheit	Fahrenheit	Fahrenheit	Inches	Inches	Inches
Jan.....	50.4	82	22	2.71	5.88	0.01
Feb.....	51.8	87	24	2.47	5.18	T
Mar.....	54.0	88	29	2.29	4.68	T
Apr.....	55.8	97	31	1.20	4.24	.07
May.....	57.7	93	34	.32	1.03	T
June.....	60.1	95	36	.14	.26	T
July.....	62.2	104	43	.03	.62	T
Aug.....	62.4	93	43	.03	.11	T
Sep.....	62.1	102	36	.12	1.57	T
Oct.....	60.0	103	30	.62	1.18	T
Nov.....	56.4	93	25	.94	3.41	0
Dec.....	52.4	90	26	2.61	4.82	.16
Period						
of	57.1	104	22	**13.48	5.88	0
record						

* Latitude 34° 54' N.; longitude 120° 27' W.; elevation 238 feet above mean sea level (see pl. 4).

** Mean seasonal.

Note.--

1. Period of record for maximum and minimum temperature and precipitation values 16 years. Period of record for mean temperature and precipitation values 30 years (1921-50). "T" represents trace.

2. Greatest snowfall reported during 16-year record was a trace.

Table 2

Summary of climatological data at Cuyama, Santa Maria River and tributaries,
Calif.*

Month	Temperature			Precipitation		
	Mean	Record	Record	Mean	Maximum	Minimum
	monthly	highest	lowest	monthly	monthly	monthly
	Degrees	Degrees	Degrees	Inches	Inches	Inches
	Fahrenheit	Fahrenheit	Fahrenheit			
Jan.....	43.2	79	7	1.09	3.47	T
Feb.....	46.1	81	15	.67	2.08	0.08
Mar.....	47.4	84	19	1.13	3.13	.03
Apr.....	54.6	92	22	.51	.97	0
May.....	60.3	102	27	.21	.92	0
June.....	67.0	108	32	.03	.25	0
July.....	74.6	109	39	.01	.07	0
Aug.....	73.0	108	36	.03	.25	0
Sep.....	69.1	109	12	.28	2.99	0
Oct.....	58.2	98	21	.27	1.27	0
Nov.....	50.4	89	15	.54	2.58	0
Dec.....	45.6	87	11	.95	2.94	0
Period						
of	57.5	109	7	**5.72	3.47	0
record						

* Latitude 34° 56' N.; longitude 119° 37' W.; elevation 2,240 feet above mean sea level (see pl. 4).

** Mean seasonal.

Note.--Period of record 14 years (1945-58). "T" represents trace.

Table 3

Existing stream-gaging stations and pertinent data, Santa Maria River and tributaries, Calif.

Station*	Drainage area	Period of record	Maximum recorded peak flow
	Square miles		Cubic feet per second
Santa Maria River at Guadalupe.	**1,728	January 1941-July 1959...	23,800
Huasna River near Santa Maria.	119	December 1929-July 1959..	11,400
Alamos Creek near Santa Maria.	88	October 1943-July 1959...	2,820
Cuyama River near Santa Maria.	912	November 1903-December 1905*** and December 1929-July 1959.	17,300
La Brea Creek near Sisquoc.	87	October 1943-July 1959...	3,320
Tepusquet Creek near Sisquoc.	29	October 1943-July 1959...	318
Sisquoc River near Garey (Gary).	442	February 1941-July 1959..	13,000

* (See pl. 4 for location)

** From latest quadrangle maps. The U. S. Geological Survey water supply papers show 1,763 square miles.

*** Station listed as Santa Maria River near Santa Maria, Calif., during this period.

Table 4

Runoff data, Santa Maria River at Guadalupe, Santa Maria River and tributaries, Calif.*

Season**	Maximum peak discharge	Date	Maximum mean daily discharge	Date
	<u>Cubic feet per second</u>		<u>Cubic feet per second</u>	
1940-41.....	14,700	5 Mar	10,800	5 Mar
1941-42.....	(***)	(***)	160	23 Apr
1942-43.....	13,800	23 Jan	7,940	23 Jan
1943-44.....	5,000	22 Feb	2,500	22 Feb
1944-45.....	3,700	2 Feb	1,130	3 Feb
1945-46.....	3,500	30 Mar	850	30 Mar
1946-47.....	(#)	.....	350	26 Dec
1947-48.....	(#)	.....	(#)	.....
1948-49.....	(#)	.....	(#)	.....
1949-50.....	3,600	7 Feb	1,150	7 Feb
1950-51.....	(#)	.....	(#)	.....
1951-52.....	23,800	16 Jan	14,400	16 Jan
1952-53.....	84	14 Jan	63	15 Jan
1953-54.....	2,090	25 Jan	431	25 Jan
1954-55.....	(#)	.....	(#)	.....
1955-56.....	(##)	27 Jan	1,100	27 Jan
1956-57.....	(#)	.....	(#)	.....
1957-58.....	21,500	3 Apr	(##)	.....

* Data from U. S. Geological Survey gaging station 0.5 mile north of Guadalupe, Santa Barbara County and 4.5 miles upstream from mouth (see pl. 4 for location). Prior to 12 August 1955, at site, 100 feet upstream. Drainage area 1,763 square miles.

** 1 October to 30 September, inclusive.

*** Records not available.

No flow.

Not determined.

Table 5

Runoff data, Huasna River near Santa Maria, Santa Maria River and tributaries, Calif.*

Season**	Maximum	Date	Maximum	Date
	peak discharge		mean daily discharge	
	Cubic feet per second		Cubic feet per second	
1929-30.....	10	14 Mar	7	15 Mar
1930-31.....	11	2 Jan	6	2 Jan
1931-32.....	4,000	28 Dec	1,620	28 Dec
1932-33.....	1,240	19 Jan	480	19 Jan
1933-34.....	37	31 Dec	16	1 Jan
1934-35.....	3,110	8 Apr	1,490	8 Apr
1935-36.....	2,360	23 Feb	1,560	23 Feb
1936-37.....	8,370	7 Feb	5,010	6 Feb
1937-38.....	11,400	11 Feb	4,630	11 Feb
1938-39.....	16	9 Mar	12	8 Feb
1939-40.....	493	10 Jan	227	29 Feb
1940-41.....	5,180	4 Mar	2,290	4 Mar
1941-42.....	701	28 Dec	336	28 Dec
1942-43.....	4,700	23 Jan	2,800	23 Jan
1943-44.....	1,500	4 Mar	575	5 Mar
1944-45.....	1,250	2 Feb	574	2 Feb
1945-46.....	550	30 Mar	380	30 Mar
1946-47.....	32	20 Nov	23	20 Nov
1947-48.....	6.5	24 Mar	4.8	10 Apr
1948-49.....	7.1	4 Mar	5.9	4 Mar
1949-50.....	900	6 Feb	381	6 Feb
1950-51.....	414	19 Nov	206	19 Nov
1951-52.....	4,060	15 Jan	2,220	15 Jan
1952-53.....	359	8 Jan	180	8 Jan
1953-54.....	811	25 Jan	316	25 Jan
1954-55.....	144	10 Jan	23	19 Jan
1955-56.....	2,260	25 Jan	1,000	27 Jan
1956-57.....	129	2 Dec	9	2 Dec
1957-58.....	4,230	3 Apr	2,660	3 Apr

* Data from U. S. Geological Survey gaging station on left bank 0.4 mile upstream from mouth and 8 miles NE. of Santa Maria, Santa Barbara County. (see pl. 4 for location). Drainage area 119 square miles.

** 1 October to 30 September, inclusive.

Table 6

Runoff data, Alamos (Alamo) Creek near Santa Maria, Santa Maria River and tributaries, Calif.*

Season**	Maximum peak discharge	Date	Maximum mean daily discharge	Date
	<u>Cubic feet per second</u>		<u>Cubic feet per second</u>	
1943-44.....	560	4 Mar	270	5 Mar
1944-45.....	700	2 Feb	216	2 Feb
1945-46.....	10	22 Dec	9	22 Dec
1946-47.....	8.7	20 Nov	4.8	20 Nov
1947-48.....	2.6	24 Mar	1.6	9 Apr
1948-49.....	4.1	26 Dec	1.9	27 Dec
1949-50.....	614	6 Feb	271	6 Feb
1950-51.....	248	27 Oct	75	19 Nov
1951-52.....	2,820	15 Jan	1,350	15 Mar
1952-53.....	124	14 Jan	70	14 Jan
1953-54.....	598	25 Jan	173	25 Jan
1954-55.....	8.8	18 Jan	5.9	18 Jan
1955-56.....	1,360	26 Jan	427	27 Jan
1956-57.....	2.3	17 Apr	2	23 Dec

* Data from U. S. Geological Survey gaging station on right bank just downstream from highway bridge, 1.2 miles upstream from mouth and 9 miles NE. of Santa Maria, Santa Barbara County (see pl. 4 for location). Drainage area 87.7 square miles.

** 1 October to 30 September, inclusive.

Table 7

Runoff data, Cuyama River near Santa Maria, Santa Maria River and tributaries, Calif.*

Season**	Maximum	Date	Maximum	Date
	peak		mean daily	
	discharge		discharge	
	Cubic feet		Cubic feet	
	per second		per second	
1929-30.....	101	14 Mar	60	16 Mar
1930-31.....	231	5 Feb	142	5 Feb
1931-32.....	4,480	9 Feb	2,410	9 Feb
1932-33.....	511	19 Jan	267	19 Jan
1933-34.....	382	2 Jan	195	2 Jan
1934-35.....	820	8 Apr	390	8 Apr
1935-36.....	492	16 Feb	340	23 Feb
1936-37.....	5,220	6 Feb	3,560	6 Feb
1937-38.....	17,300	3 Mar	5,350	3 Mar
1938-39.....	415	15 Dec	140	16 Dec
1939-40.....	224	26 Feb	82	27 Feb
1940-41.....	4,600	5 Mar	3,000	4 Mar
1941-42.....	782	22 Apr	168	22 Apr
1942-43.....	8,400	23 Jan	2,290	23 Jan
1943-44.....	1,900	22 Feb	1,520	22 Feb
1944-45.....	1,400	3 Feb	515	3 Feb
1945-46.....	1,000	22 Dec	250	22 Dec
1946-47.....	500	13 Nov	250	14 Nov
1947-48.....	23	26 Mar	19	6 Feb
1948-49.....	31	4 Mar	24	4 Mar
1949-50.....	150	6 Feb	78	6 Feb
1950-51.....	18	12 Jan	11	1 Mar
1951-52.....	6,200	16 Jan	2,930	16 Jan
1952-53.....	207	13 Jan	117	14 Jan
1953-54.....	1,350	24 Jan	181	24 Jan
1954-55.....	151	18 Jan	70	19 Jan
1955-56.....	770	25 Jan	325	27 Jan
1956-57.....	272	14 Jan	71	15 Jan

* Data from U. S. Geological Survey gaging station on right bank 3 miles upstream from Alamo Creek, and 10 miles NE. of Santa Maria, Santa Barbara County (see pl. 4 for location). Drainage area 912 square miles.

** 1 October to 30 September, inclusive.

Table 8

Runoff data, Sisquoc River near Garey (Gary), Santa Maria River and tributaries, Calif.*

Season**	Maximum peak discharge	Date	Maximum mean daily discharge	Date
	Cubic feet per second		Cubic feet per second	
1940-41.....	7,000	5 Mar	4,100	5 Mar
1941-42.....	875	22 Apr	512	22 Apr
1942-43.....	13,000	23 Jan	5,900	23 Jan
1943-44.....	6,600	22 Feb	3,350	22 Feb
1944-45.....	5,400	2 Feb	2,120	2 Feb
1945-46.....	4,000	30 Mar	1,900	30 Mar
1946-47.....	900	23 Nov	200	23 Nov
1947-48.....	(***)	.....	(***)	.....
1948-49.....	50	11 Mar	29	12 Mar
1949-50.....	900	6 Feb	250	6 Feb
1950-51.....	(***)	.....	(***)	.....
1951-52.....	8,910	15 Jan	3,270	16 Jan
1952-53.....	480	14 Jan	365	14 Jan
1953-54.....	(#)	25 Jan	##1,050	25 Jan
1954-55.....	137	17 Feb	60	18 Feb
1955-56.....	2,120	27 Apr	1,400	27 Apr
1956-57.....	105	18 Oct	28	19 Oct

* Data from U. S. Geological Survey gaging station 0.5 mile east of Garey and 3.5 miles downstream from Tepusquet Creek (see pl. 4 for location). Drainage area 442 square miles.

** 1 October to 30 September, inclusive.

*** No flow.

Records not available.

Approximate.

Table 9

Pertinent data, Twitchell Dam and Reservoir, Santa Maria River and tributaries, Calif.

Item	Quantity
Drainage area.....	1,125 sq. mi.
Reservoir:	
Elevation -	
Original streambed.....	476 ft., m.s.l.
Conservation pool.....	623 ft., m.s.l.
Flood-control pool (spillway crest).....	651.5 ft., m.s.l.
Area (survey of 1946, revised March 1959) -	
Conservation pool.....	2,620 ac.
Spillway crest.....	3,690 ac.
Top of dam.....	5,700 ac.
Capacity, gross (survey of 1946, revised March 1959) -	
Conservation pool.....	151,050 ac.-ft.
Spillway crest.....	240,120 ac.-ft.
Top of dam.....	426,000 ac.-ft.
Allowance for silting.....	40,000 ac.-ft.
Dam - type.....	Earth
Crest elevation.....	692 ft., m.s.l.
Maximum height above original streambed.....	216 ft.
Crest length.....	1,800 ft.
Spillway - type.....	Concrete tunnel, ungated
Crest - type.....	Ogee
Crest elevation.....	651.5 ft., m.s.l.
Crest length.....	50 ft.
Discharge tunnel - diameter.....	23 ft.
Maximum discharge capacity (elevation 692).....	28,000 c. f. s.
Terminal structure.....	Flip bucket
Outlet works:	
Gates - type.....	High pressure vertical lift
Number.....	4 (2 tandem pairs)
Size.....	7' x 12'
Sill elevation.....	473 ft., m.s.l.
Maximum discharge at spillway crest (low port blocked).....	12,700 c. f. s.
Maximum discharge at spillway crest (low port open).....	13,050 c. f. s.
Intake structure -	
Sill elevation.....	504 ft., m.s.l.
Top elevation.....	526 ft., m.s.l.

Table 9--Continued

Pertinent data, Twitchell Dam and Reservoir, Santa Maria River and tribu-
taries, Calif.--Continued

Item	Quantity
Conduit - type.....	Pressure
Diameter.....	15 ft.
Tunnel - type.....	Pressure
Diameter.....	15 ft.
Tunnel - type.....	Free flow
Size.....	19' x 17'
Terminal structure.....	Stilling basin
Reservoir design flood:	
Length of design storm.....	4 days
Inflow volume (1st through 3d day).....	139,100 ac.-ft.
Inflow peak.....	95,000 c. f. s.
Outflow peak.....	12,700 c. f. s.
Reduction in peak.....	82,300 c. f. s.
Spillway design flood:	
Length of storm.....	5 days
Inflow volume (1st through 3d day).....	368,000 ac.-ft.
Inflow peak.....	120,000 c. f. s.
Outflow peak.....	39,700 c. f. s.
Reduction in peak.....	80,300 c. f. s.

Table 10

Area and gross capacity data - Twitchell Dam and Reservoir, Santa Maria River and tributaries, Calif.*

Eleva- tion	Capac- ity	Area	Eleva- tion	Capac- ity	Area	Eleva- tion	Capac- ity	Area
Feet above mean sea level	Acre- feet	Acres	Feet above mean sea level	Acre- feet	Acres	Feet above mean sea level	Acre- feet	Acres
477	0	1	517	7,490	520	557	37,970	1,030
478	1	2	518	8,010	540	558	39,000	1,050
479	3	3	519	8,550	550	559	40,050	1,060
480	6	6	520	9,100	560	560	41,120	1,080
481	12	10	521	9,660	570	561	42,200	1,100
482	20	10	522	10,230	580	562	43,290	1,110
483	32	20	523	10,810	600	563	44,400	1,130
484	50	20	524	11,410	610	564	45,530	1,140
485	73	30	525	12,020	620	565	46,670	1,160
486	100	40	526	12,640	630	566	47,830	1,170
487	140	40	527	13,270	640	567	49,000	1,190
488	180	50	528	13,910	650	568	50,190	1,210
489	240	60	529	14,560	670	569	51,400	1,220
490	300	70	530	15,230	680	570	52,620	1,240
491	370	80	531	15,900	690	571	53,860	1,260
492	450	90	532	16,600	700	572	55,120	1,280
493	540	110	533	17,300	720	573	56,400	1,300
494	650	120	534	18,020	730	574	57,690	1,310
495	770	130	535	18,740	740	575	59,000	1,330
496	900	140	536	19,490	760	576	60,340	1,350
497	1,040	160	537	20,240	770	577	61,690	1,370
498	1,200	170	538	21,010	780	578	63,060	1,390
499	1,370	190	539	21,800	800	579	64,450	1,410
500	1,560	210	540	21,590	810	580	65,860	1,430
501	1,760	220	541	23,400	820	581	67,290	1,460
502	1,990	240	542	24,220	830	582	68,740	1,480
503	2,230	260	543	25,050	840	583	70,220	1,500
504	2,480	270	544	25,900	850	584	71,720	1,530
505	2,760	290	545	26,750	860	585	73,250	1,550
506	3,050	310	546	27,610	880	586	74,800	1,580
507	3,350	320	547	28,490	890	587	76,380	1,600
508	3,680	340	548	29,380	900	588	77,980	1,630
509	4,020	360	549	30,280	910	589	79,610	1,650
510	4,380	380	550	31,190	920	590	81,260	1,680
511	4,760	400	551	32,110	940	591	82,940	1,700
512	5,160	420	552	33,050	950	592	84,650	1,730
513	5,580	440	553	34,000	970	593	86,380	1,760
514	6,030	470	554	34,970	980	594	88,130	1,780
515	6,490	490	555	35,960	1,000	595	89,918	1,810
516	6,980	510	556	36,960	1,020	596	91,730	1,840

See footnote at end of table.

Table 10--Continued

Area and gross capacity data - Twitchell Dam and Reservoir, Santa Maria River and tributaries, Calif.*--continued

<u>Eleva- tion</u>	<u>Capac- ity</u>	<u>Area</u>	<u>Eleva- tion</u>	<u>Capac- ity</u>	<u>Area</u>	<u>Eleva- tion</u>	<u>Capac- ity</u>	<u>Area</u>
<u>Feet above mean sea level</u>	<u>Acre- feet</u>	<u>Acres</u>	<u>Feet above mean sea level</u>	<u>Acre- feet</u>	<u>Acres</u>	<u>Feet above mean sea level</u>	<u>Acre- feet</u>	<u>Acres</u>
597	93,570	1,870	629	167,290	2,830	661	276,790	4,080
598	95,430	1,890	630	170,120	2,870	662	280,870	4,130
599	97,330	1,920	631	172,990	2,900	663	285,000	4,170
600	99,250	1,950	632	175,900	2,940	664	289,170	4,220
601	101,200	1,970	633	178,840	2,980	665	293,390	4,270
602	103,170	2,000	634	181,820	3,020	666	297,660	4,310
603	105,170	2,030	635	184,830	3,060	667	301,980	4,360
604	107,200	2,050	636	187,890	3,090	668	306,340	4,410
605	109,250	2,080	637	190,980	3,130	669	310,750	4,460
606	111,330	2,110	638	194,110	3,170	670	315,210	4,510
607	113,430	2,130	639	197,280	3,210	671	319,720	4,560
608	115,570	2,160	640	200,490	3,250	672	324,280	4,620
609	117,730	2,190	641	203,730	3,280	673	328,900	4,680
610	119,910	2,210	642	207,020	3,320	674	333,590	4,740
611	122,130	2,240	643	210,330	3,360	675	338,330	4,800
612	124,370	2,270	644	213,690	3,390	676	343,130	4,860
613	126,640	2,300	645	217,090	3,440	677	347,980	4,920
614	128,950	2,330	646	220,520	3,470	678	352,900	4,980
615	131,280	2,360	647	223,990	3,510	679	357,880	5,040
616	133,640	2,390	648	227,510	3,550	680	362,910	5,090
617	136,030	2,420	649	231,060	3,590	681	368,010	5,180
618	138,450	2,450	650	234,650	3,630	682	373,160	5,210
619	140,910	2,480	651	238,280	3,670	683	378,370	5,270
620	143,390	2,520	652	241,950	3,710	684	383,650	5,330
621	145,910	2,550	653	245,660	3,750	685	388,980	5,390
622	148,460	2,580	654	249,410	3,790	686	394,370	5,400
623	151,050	2,620	655	253,190	3,830	**687	399,810	5,450
624	153,660	2,660	656	257,020	3,870	**688	403,000	5,500
625	156,320	2,690	657	260,890	3,910	**689	409,000	5,550
626	159,010	2,720	658	264,810	3,950	**690	414,000	5,600
627	161,730	2,760	659	268,760	3,990	**691	420,000	5,640
628	164,490	2,800	660	272,750	4,040	**692	426,000	5,700

* Table from data supplied by U. S. Bureau of Reclamation based on 1946 survey and revision of March 1959.

** Extrapolated values.

Table 11

Pertinent data, Santa Maria Valley levees and channel improvements, Santa
Maria River and tributaries, Calif.

Item	Quantity
Drainage areas and design discharges:	
Bradley Canyon levees at -	
Upper end:	
Drainage area.....	7.9 sq. mi.
Peak discharge.....	9,000 c. f. s.
Santa Maria River:	
Drainage area.....	12.6 sq. mi.
Peak discharge.....	9,000 c. f. s.
Santa Maria River levees at -	
Upper end:	
Drainage area.....	1,634 sq. mi.
Peak discharge.....	160,000 c. f. s.
Lower end:	
Drainage area.....	1,719 sq. mi.
Peak discharge.....	150,000 c. f. s.
General:	
Bradley Canyon levees and channel:	
Length of left levee.....	10,900 ft.
Length of right levee.....	900 ft.
Top width of levees.....	12 ft.
Height of levees - range.....	8 to 10.5 ft.
Thickness of revetments - range.....	1.5 to 2.0 ft.
Levee slopes.....	1 on 2
Height of revetments.....	11.6 to 15.4 ft.
Thickness of stone toe.....	3 ft.
Width of channel.....	80 ft.
Santa Maria River:	
Length of left levee.....	87,560 ft.
Length of right levee.....	25,420 ft.
Top width of levees.....	18 ft.
Height of levees - range.....	6 to 15 ft.
Levee slopes.....	1 on 2
Height of revetments - range.....	22.5 to 31.5 ft.
Thickness of revetments - range.....	1.5 to 2.0 ft.
Thickness of stone toe.....	6 ft.

Table 12

Outlet gate operation schedule for flood-control storage - Twitchell Dam and Reservoir, Santa Maria River and tributaries, Calif.*

Step No.	When reservoir water surface is between elevations		Gate setting for gates as indicated		Computed discharge**
			No. 1	No. 2	
	Feet above mean sea level		Feet of opening	Feet of opening	Cubic feet per second
1.....	504.0 -	623.0	0	0	0
2.....	623.0 -	623.2	.5	.5	500 - 510
3.....	623.2 -	623.4	1.5	1.5	1,500 - 1,510
4.....	623.4 -	623.6	3.0	3.0	3,000 - 3,010
5.....	623.6 -	623.8	5.0	5.0	5,000 - 5,010
6.....	623.8 -	624.0	8.0	8.0	7,800 - 7,820
7.....	624.0 -	***651.5	12.0	12.0	11,630 - 12,700

* Schedule applicable for rising or falling stages.

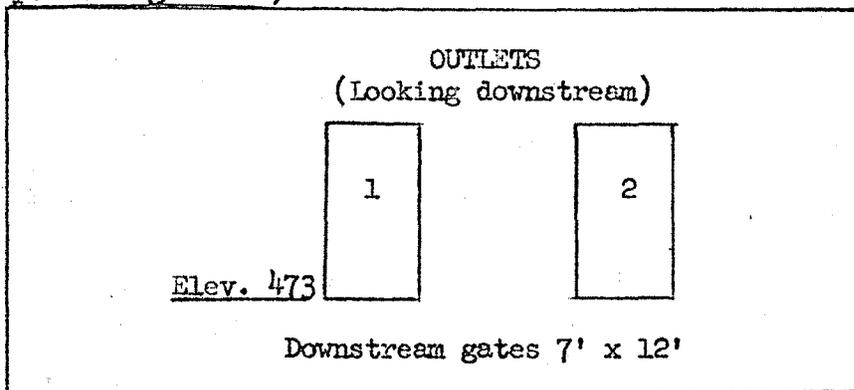
** Low port assumed blocked.

*** Spillway flow above elevation 651.5.

Note.--The outlet gates shall not be opened faster than 1 foot in 10 minutes.

INSTRUCTIONS

1. Schedule is for downstream gates. Normally upstream gates are wide open and function as guard gates.
2. If one of the downstream gates cannot be operated, adjust the other gate, if possible, so that its opening will equal the sum of the openings shown in the schedule. However, the operable gate should not be opened more than 80 percent (9.6 ft.).





PACIFIC OCEAN

LEGEND

- |—|—| BOUNDARY OF SANTA MARIA RIVER DRAINAGE AREA
- ||—||—|| BOUNDARY OF DRAINAGE SUBAREA
- |||—|||—||| BOUNDARY OF BRADLEY CANYON DRAINAGE SUBAREA
- +++++ PROJECT LEVEL



Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

TOPOGRAPHY
AND DRAINAGE AREAS

Office of the District Engineer
Los Angeles, California

To accompany report dtd, Aug. 1960

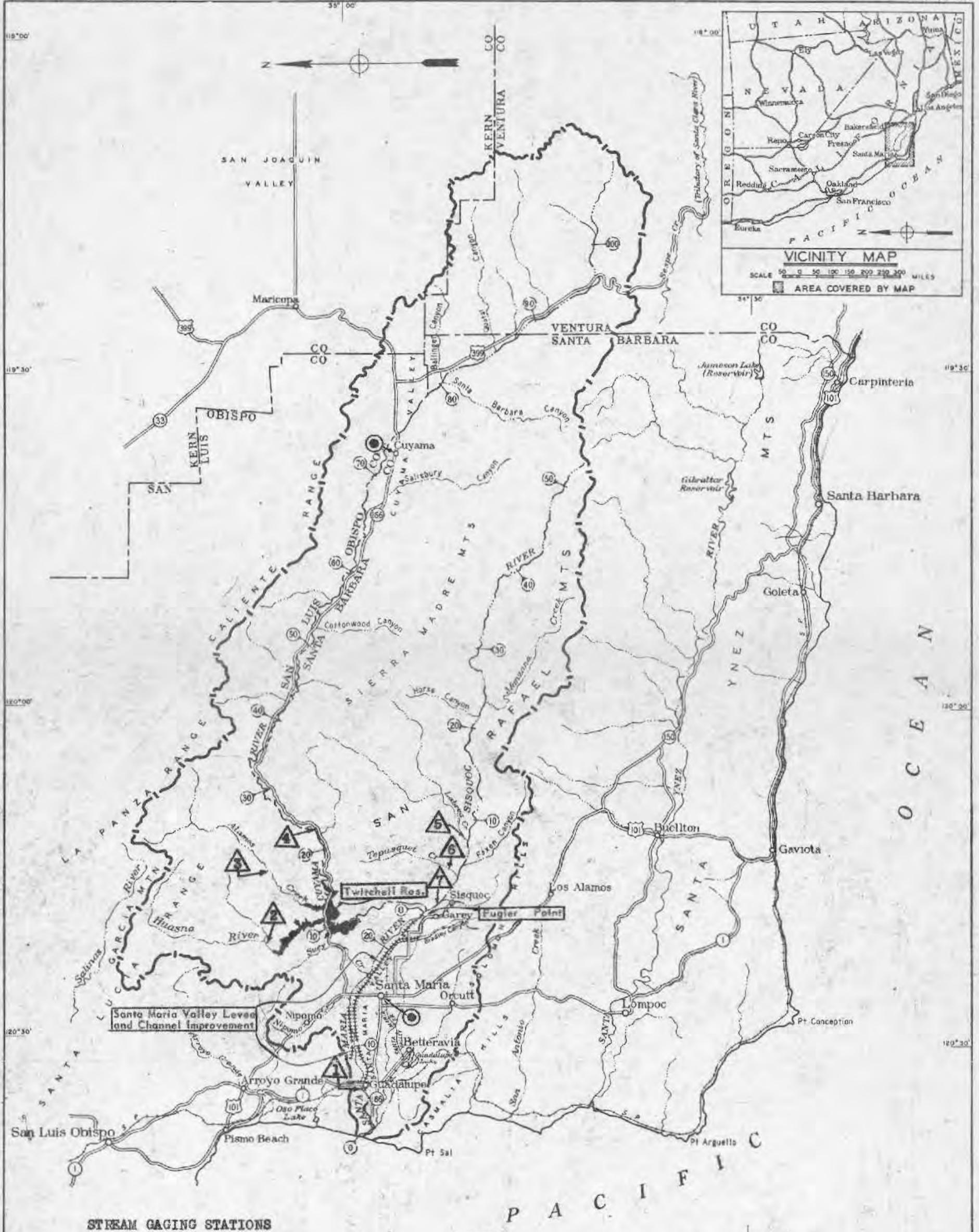


Santa Maria R. & Tributaries, Calif.
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 Twitchell Dam and Reservoir

RESERVOIR AREA

Office of the District Engineer
 Los Angeles, California
 To accompany report dtd: Aug. 1960

NOTE:
 BASE PLATE SUPPLIED BY U. S. BUREAU OF RECLAMATION

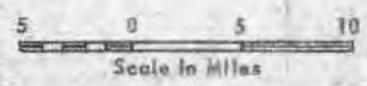


STREAM GAGING STATIONS

NO.	TITLE
1.	Santa Maria River at Guadalupe
2.	Huasna River near Santa Maria
3.	Alamos Creek near Santa Maria
4.	Cuyama River near Santa Maria
5.	La Brea Creek near Sisquoc
6.	Tebusquet Creek near Sisquoc
7.	Sisquoc River near Garey

LEGEND

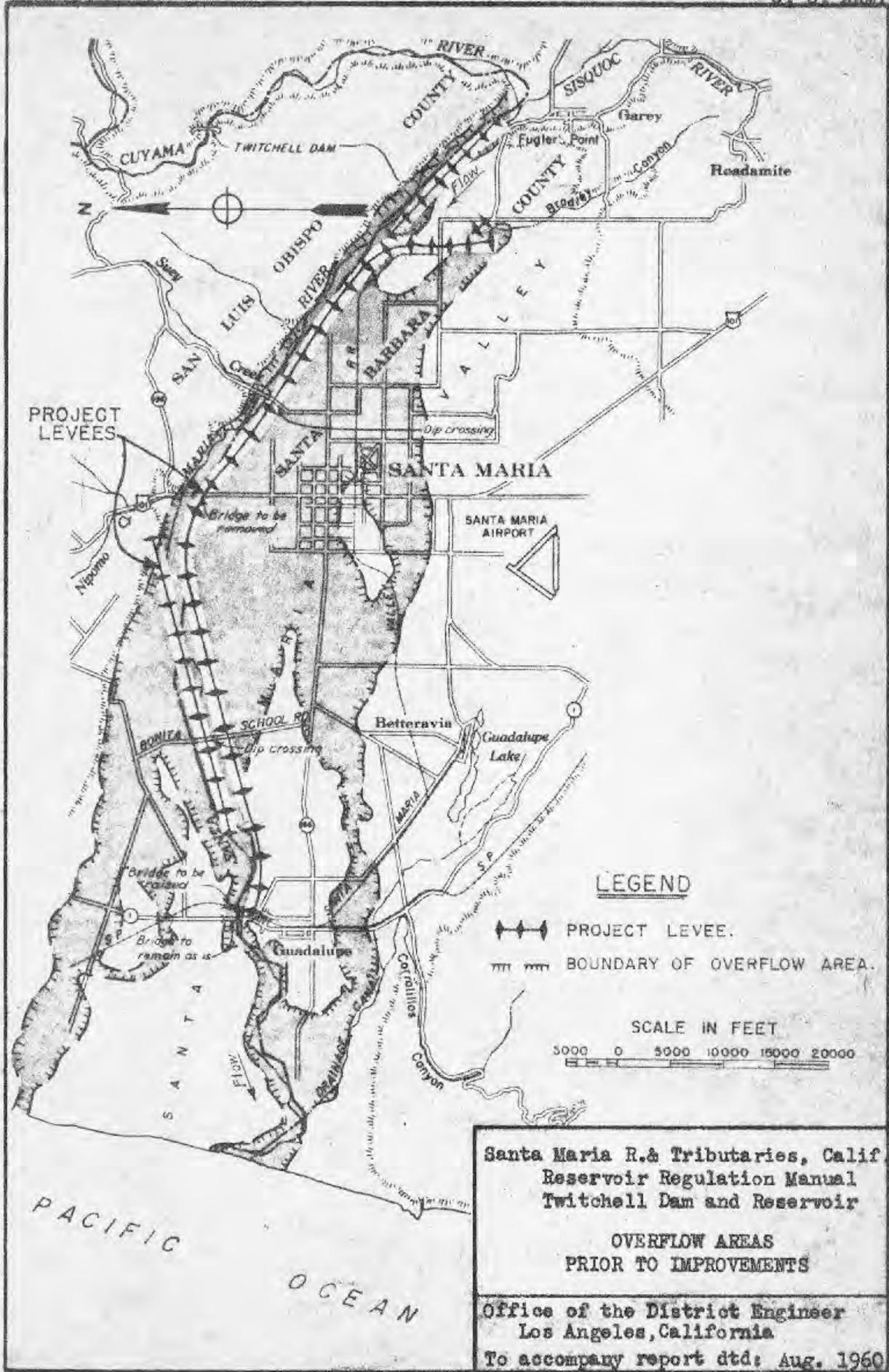
- Boundary of Drainage Area
- River Mile
- Levee and Channel Improvement
- Stream-Gaging Station
- Climatological Station



Santa Maria R. & Tributaries, Calif.
 Reservoir Regulation Manual
 Twitchell Dam and Reservoir

HYDROLOGIC MAP

Office of the District Engineer
 Los Angeles, California
 To accompany report dtd: Aug. 1960

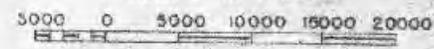


PROJECT LEVEES

LEGEND

- ◆◆◆ PROJECT LEVEE.
- - - - - BOUNDARY OF OVERFLOW AREA.

SCALE IN FEET



Santa Maria R. & Tributaries, Calif.
 Reservoir Regulation Manual
 Twitchell Dam and Reservoir

OVERFLOW AREAS
 PRIOR TO IMPROVEMENTS

Office of the District Engineer
 Los Angeles, California

To accompany report dtd: Aug. 1960

RESERVOIR STORAGE ALLOCATION

PURPOSE	ELEVATION	STORAGE ACRE-FEET
Flood Control	623 to 651.5	89,000
Conservation	474 to 623	150,000

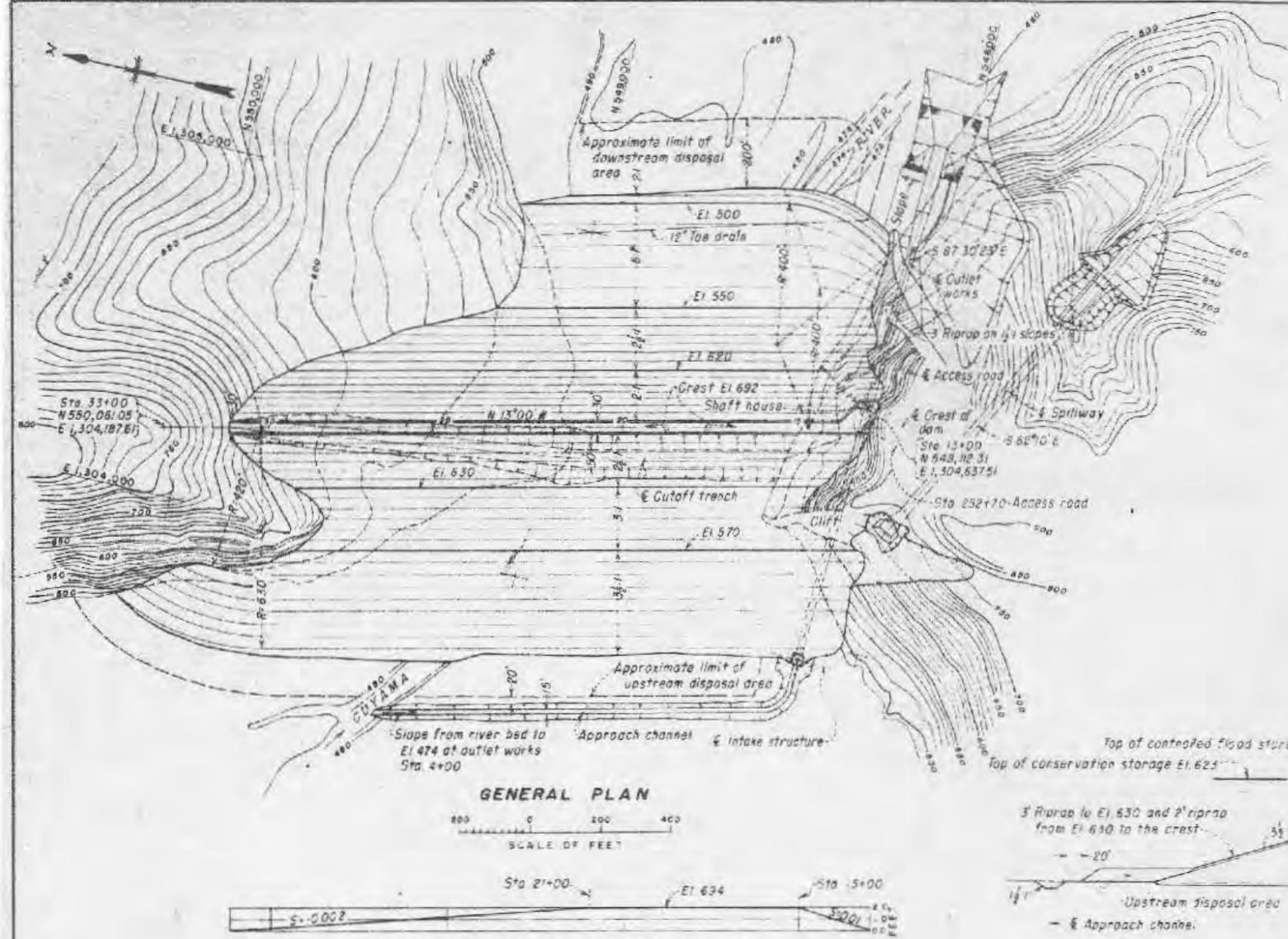
Surcharge of 158,000 A.F. (Max. W.S. 666.5) in combination with spillway capacity of 26,350 c.f.s. and outlet capacity of 12,700 c.f.s. is provided to protect against the inflow design flood having a peak of 120,000 c.f.s. and 5 day volume of 426,000 A.F. Capacity of 150,000 A.F. between elevations 474 and 623 includes an allowance of 40,000 A.F. for sediment.



EMBANKMENT TOE DRAIN DETAIL

EMBANKMENT EXPLANATION

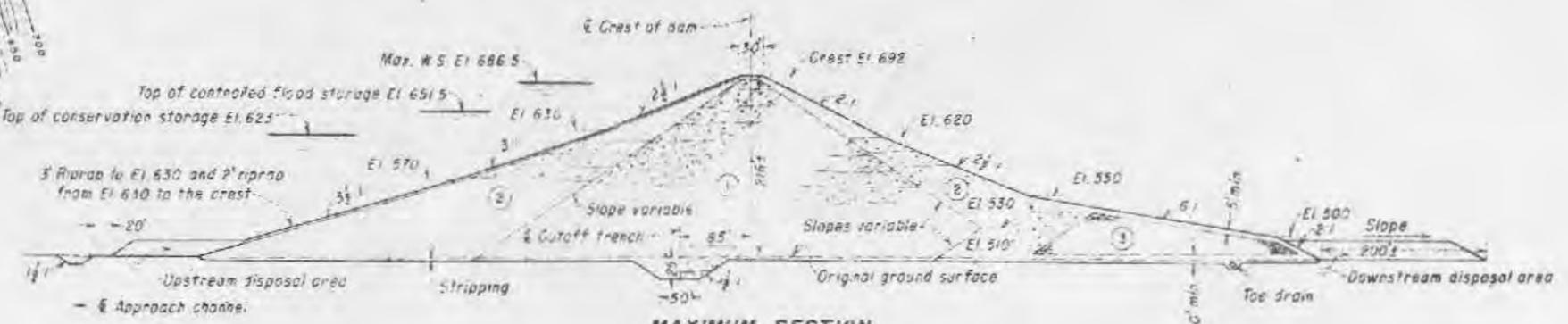
- ① Selected clay, silt, sand, and gravel compacted by tamping rollers to 6-inch layers
- ② Selected sand, gravel, and cobbles compacted by crawler-type tractor to 12-inch layers
- ③ Selected miscellaneous material compacted by equipment travel in 12-inch layers.



GENERAL PLAN

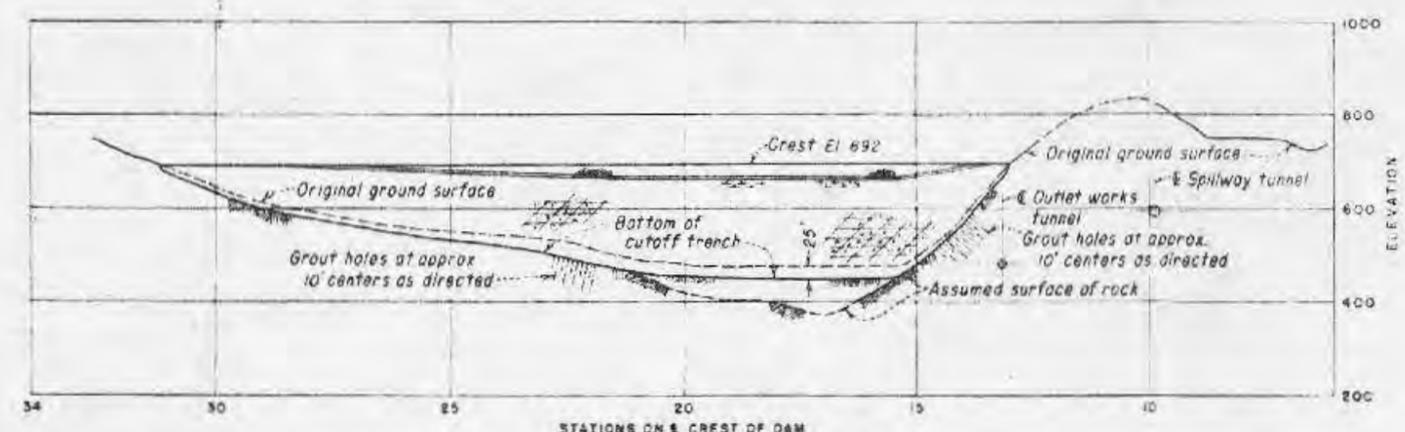
SCALE OF FEET
0 200 400

DIAGRAM FOR CAMBER ON CREST OF DAM

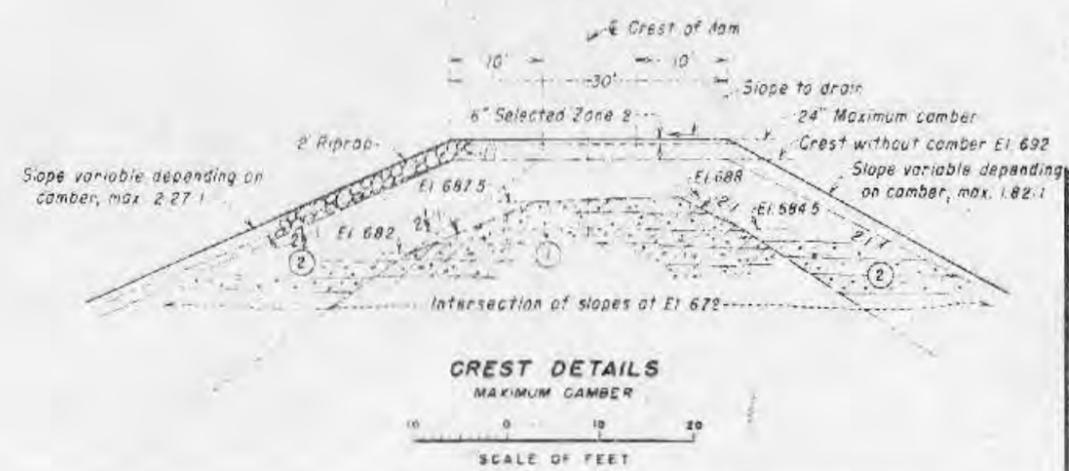


MAXIMUM SECTION

SCALE OF FEET
0 100 200



PROFILE ON & CUTOFF TRENCH



CREST DETAILS

MAXIMUM CAMBER
SCALE OF FEET
0 10 20

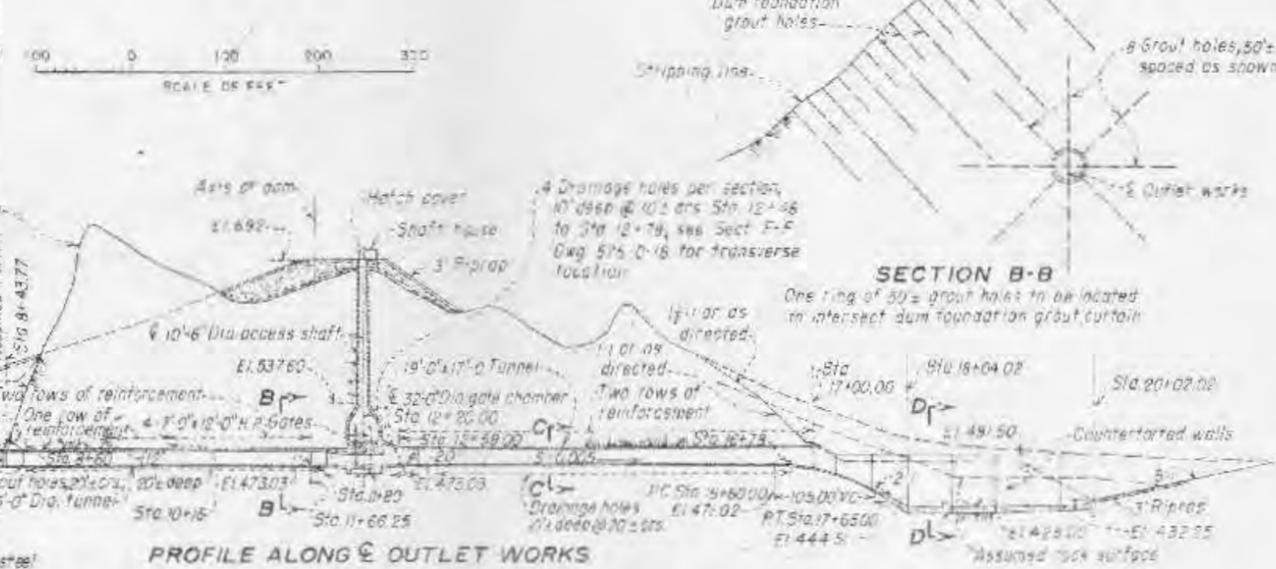
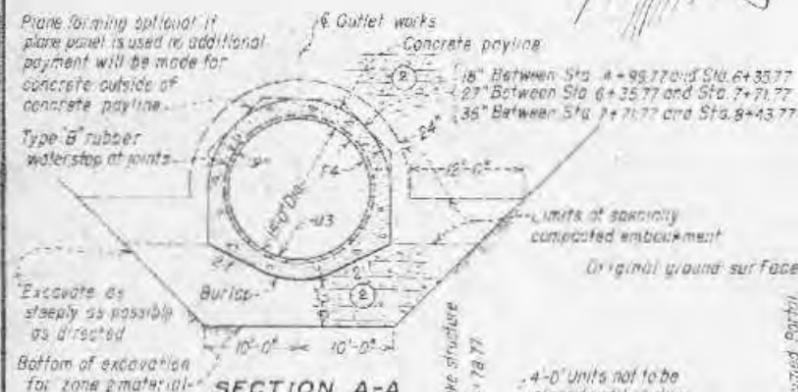
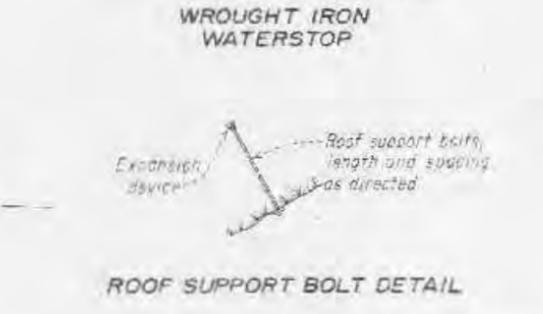
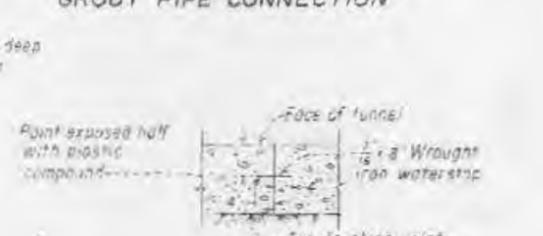
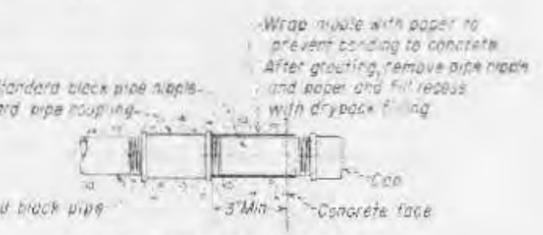
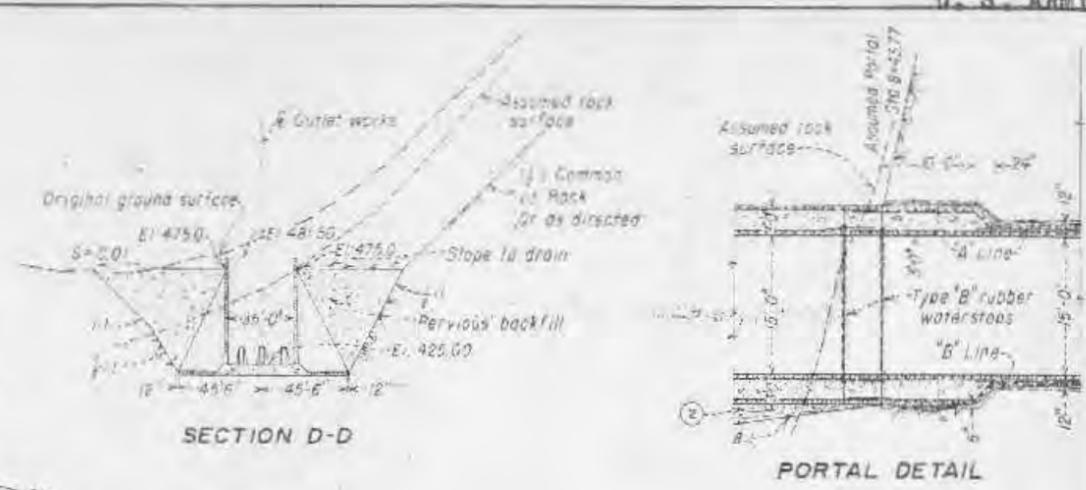
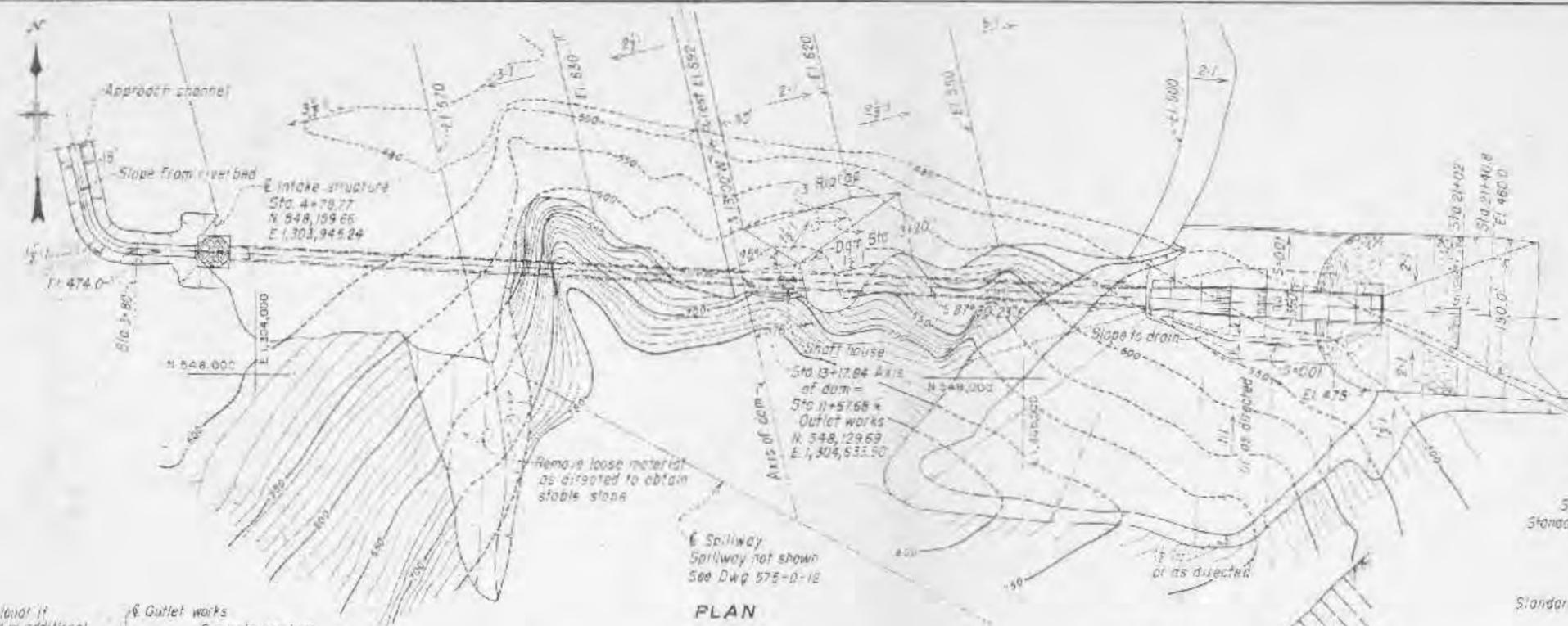
NOTE:

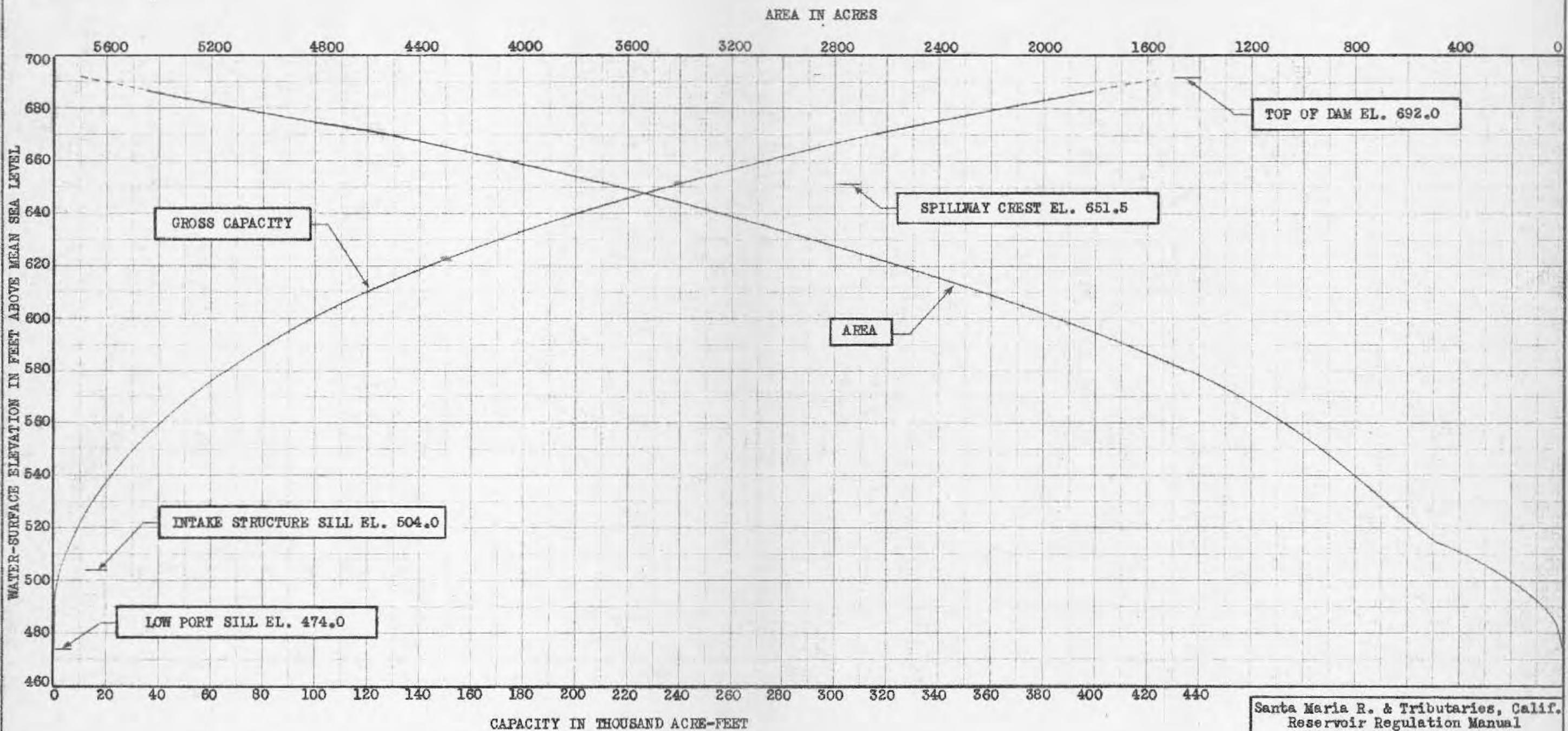
BASE PLATE SUPPLIED BY U. S. BUREAU OF RECLAMATION

Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

GENERAL PLAN AND SECTIONS

Office of the District Engineer
Los Angeles, California
To accompany report dtd. Aug. 1960



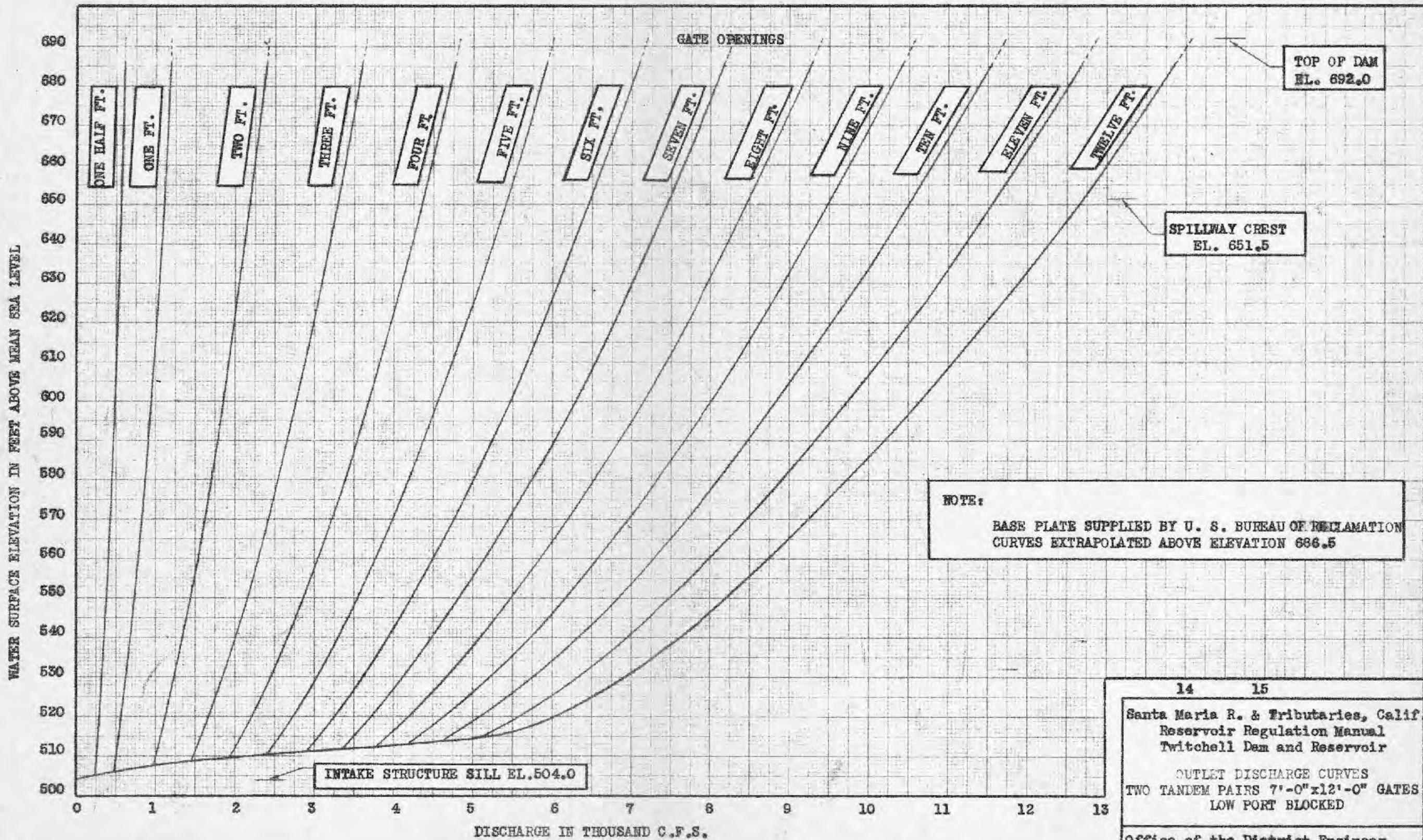


NOTE: BASIC DATA SUPPLIED BY U. S. BUREAU OF RECLAMATION
 CURVES EXTRAPOLATED ABOVE ELEVATION 686.9
 SURVEY OF 1946 (REVISED MARCH 1959)

Santa Maria R. & Tributaries, Calif.
 Reservoir Regulation Manual
 Twitchell Dam and Reservoir

AREA AND CAPACITY CURVES

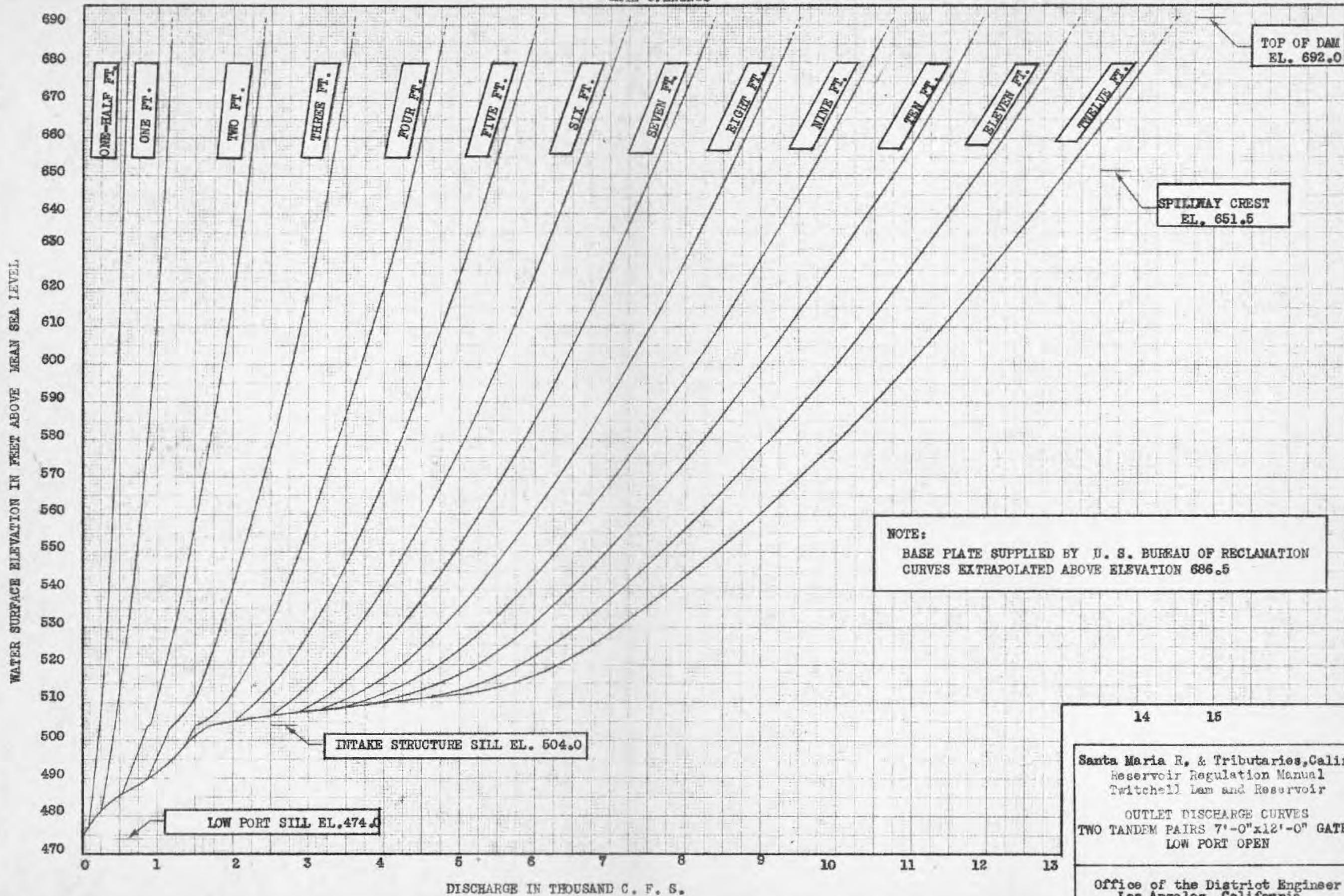
Office of the District Engineer
 Los Angeles, California
 To accompany report dtd: Aug. 1960



NOTE:
 BASE PLATE SUPPLIED BY U. S. BUREAU OF RECLAMATION
 CURVES EXTRAPOLATED ABOVE ELEVATION 686.5

14 15
 Santa Maria R. & Tributaries, Calif.
 Reservoir Regulation Manual
 Twitchell Dam and Reservoir
 OUTLET DISCHARGE CURVES
 TWO TANDEM PAIRS 7'-0" x 12'-0" GATES
 LOW PORT BLOCKED
 Office of the District Engineer
 Los Angeles, California
 To accompany report dtd: Aug. 1960

GATE OPENINGS

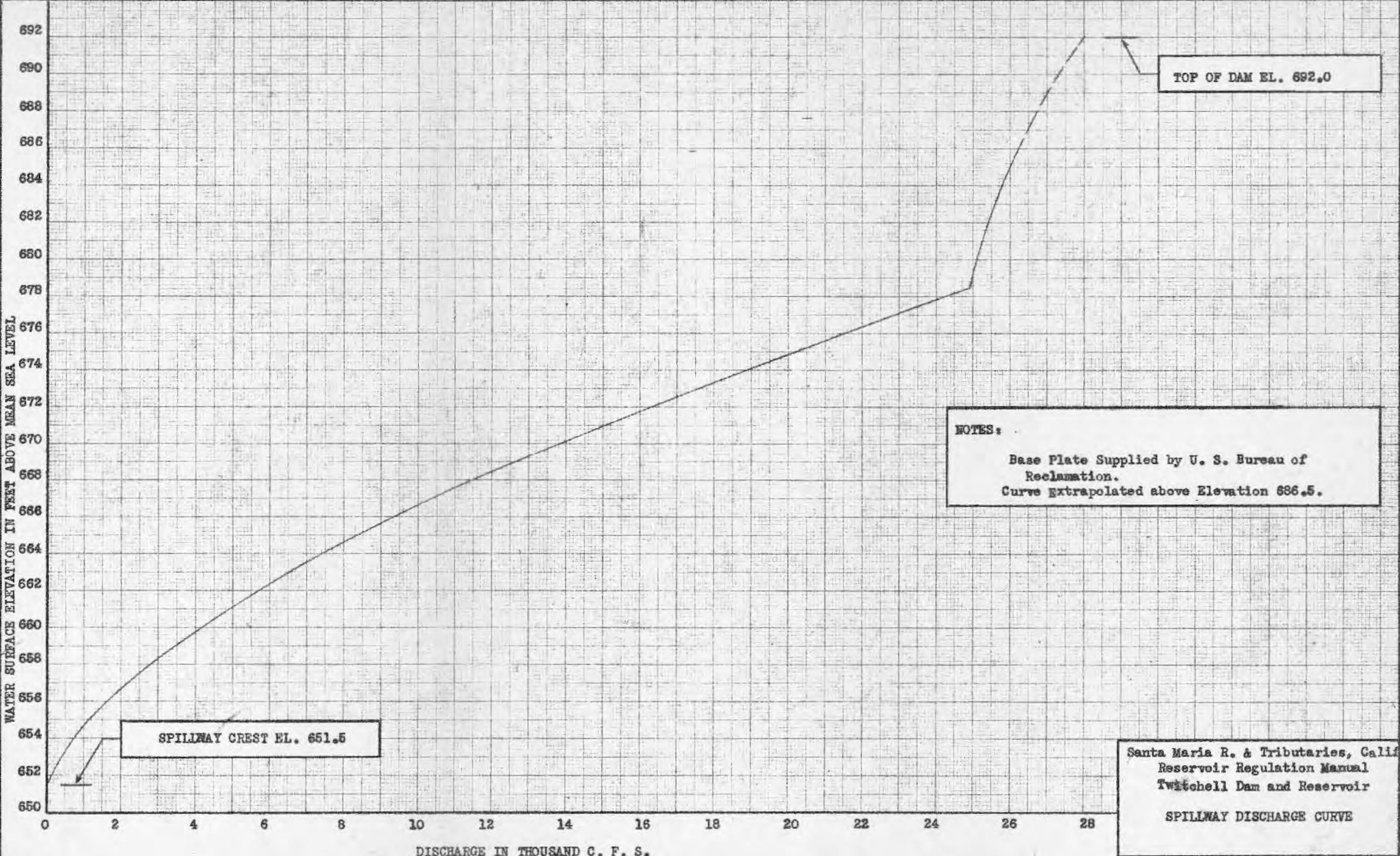


14 15

Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

OUTLET DISCHARGE CURVES
TWO TANDEM PAIRS 7'-0" x 12'-0" GATES
LOW PORT OPEN

Office of the District Engineer
Los Angeles, California
To accompany report dtd. Aug. 1960



SPILLWAY CREST EL. 651.5

TOP OF DAM EL. 692.0

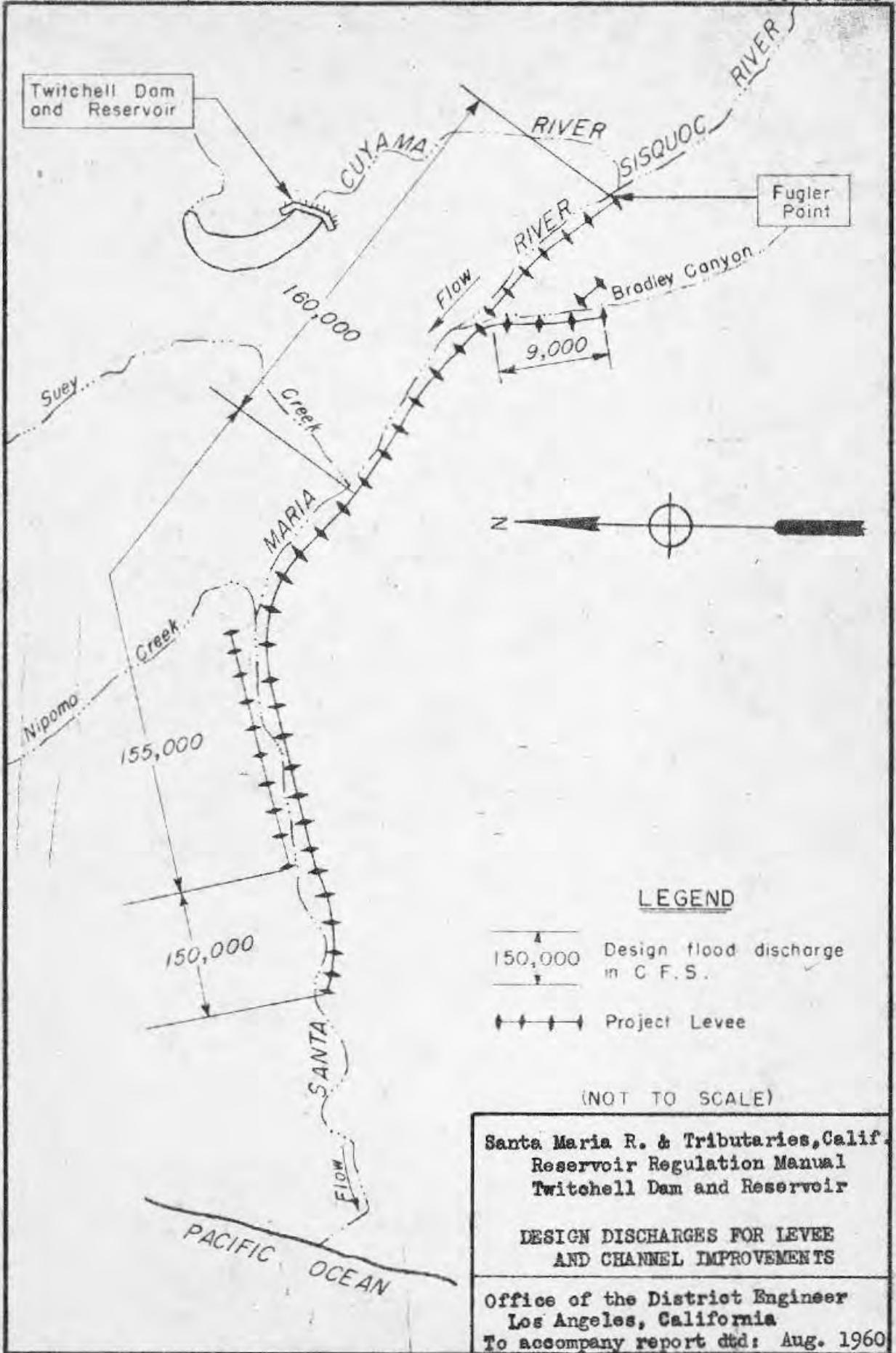
NOTES:

Base Plate Supplied by U. S. Bureau of Reclamation.
 Curve extrapolated above Elevation 686.5.

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 Twitchell Dam and Reservoir

SPILLWAY DISCHARGE CURVE

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 To accompany report dtd: Aug. 1960



LEGEND

150,000 Design flood discharge in C.F.S.

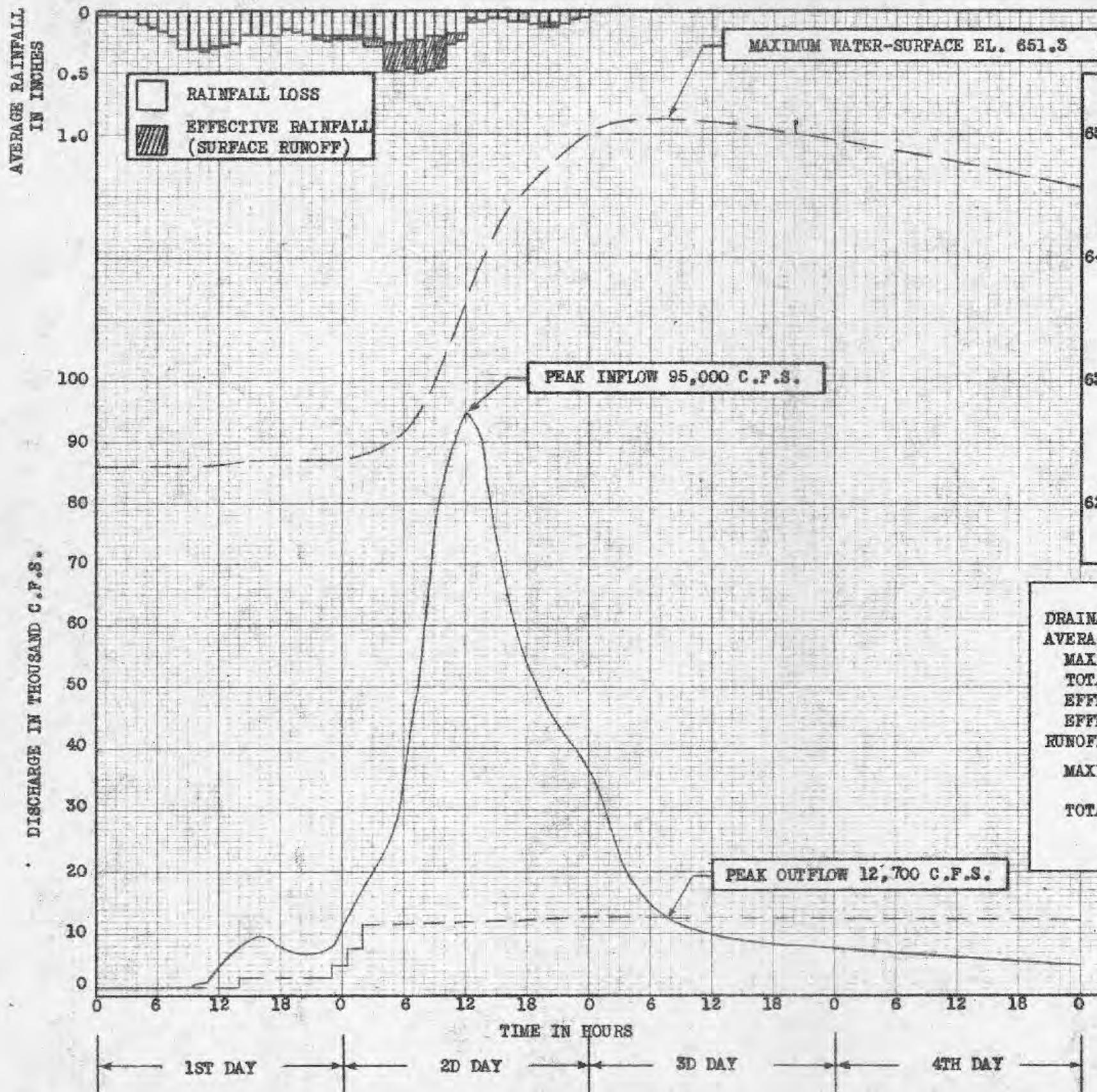
Project Levee

(NOT TO SCALE)

Santa Maria R. & Tributaries, Calif.
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Twitchell Dam and Reservoir

DESIGN DISCHARGES FOR LEVEE
AND CHANNEL IMPROVEMENTS

Office of the District Engineer
Los Angeles, California
To accompany report dtd: Aug. 1960



MAXIMUM WATER-SURFACE EL. 651.3

RAINFALL LOSS
EFFECTIVE RAINFALL (SURFACE RUNOFF)

PEAK INFLOW 95,000 C.F.S.

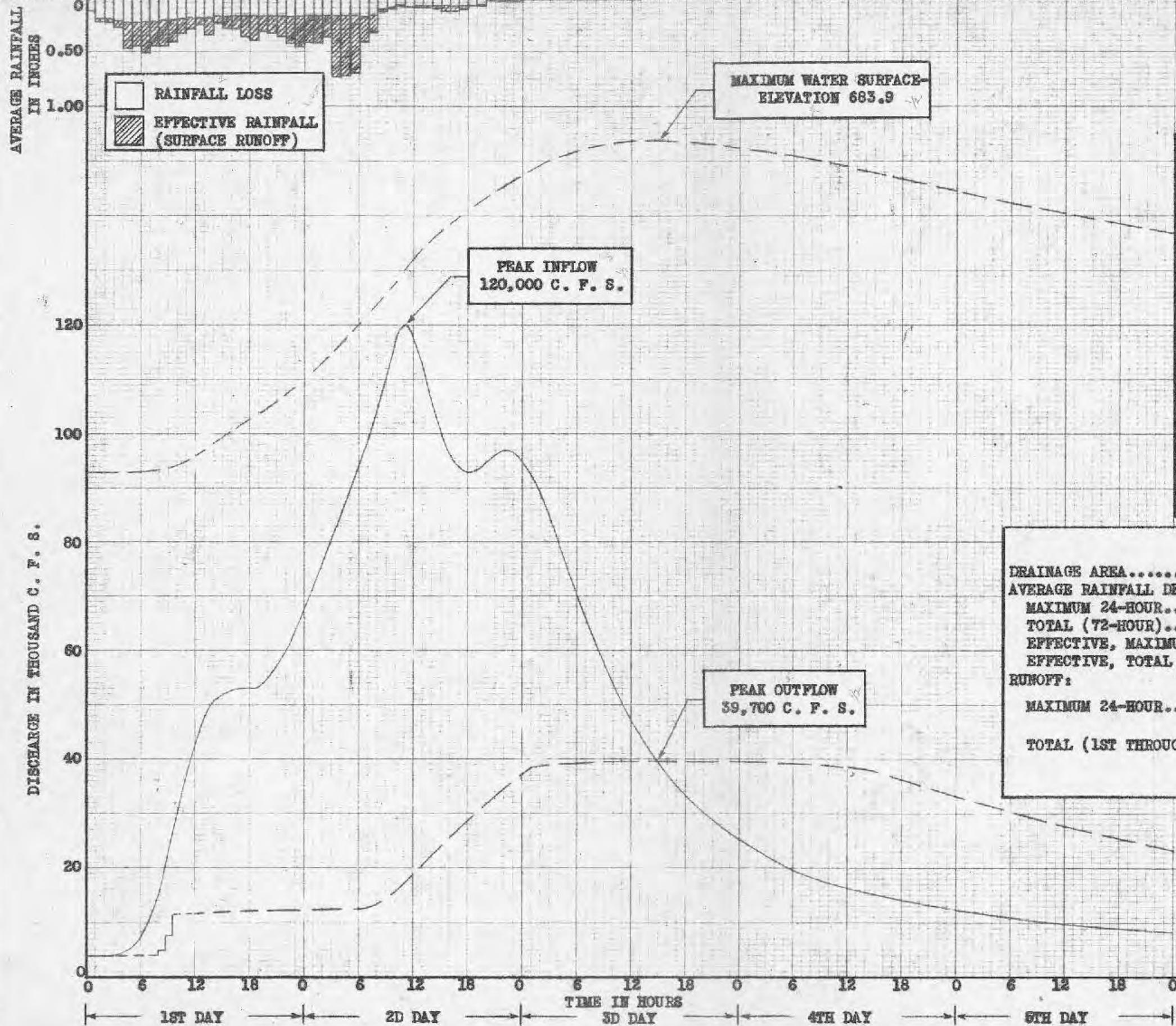
PEAK OUTFLOW 12,700 C.F.S.

DRAINAGE AREA.....	1,125 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
MAXIMUM 24-HOUR.....	7.17 INCHES
TOTAL (48-HOUR).....	10.07 INCHES
EFFECTIVE, MAXIMUM 24-HOUR.....	1.95 INCHES
EFFECTIVE, TOTAL STORM.....	2.07 INCHES
RUNOFF:	
MAXIMUM 24-HOUR.....	{ 107,500 AC.-FT. 1.79 INCHES
TOTAL (1ST THROUGH 3D DAY).....	{ 139,100 AC.-FT. 2.32 INCHES

Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

RESERVOIR DESIGN
FLOOD ROUTING

Office of the District Engineer
Los Angeles, California
To accompany report dtd: Aug. 1960

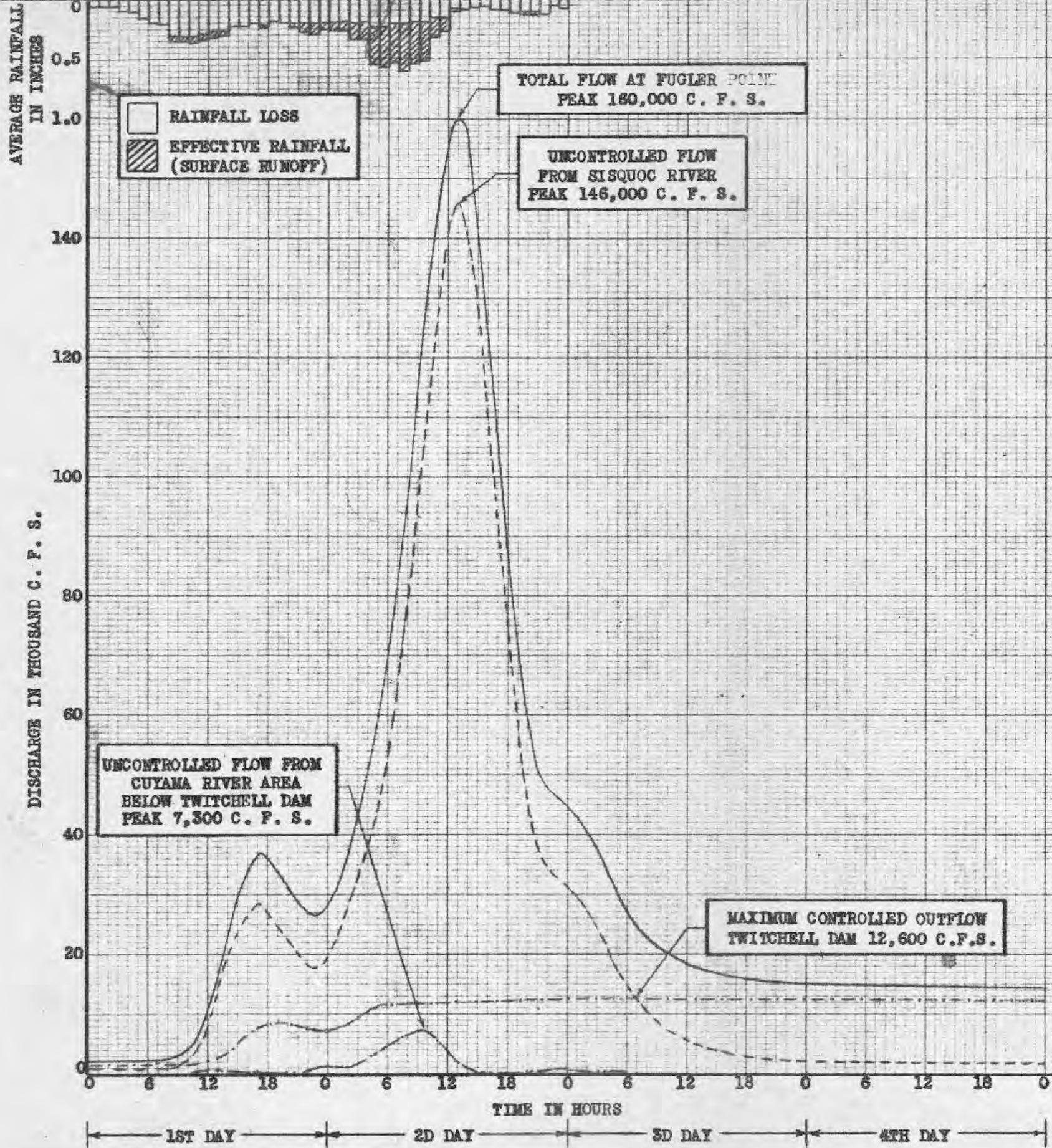


DRAINAGE AREA.....	1,125 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
MAXIMUM 24-HOUR.....	9.89 INCHES
TOTAL (72-HOUR).....	14.79 INCHES
EFFECTIVE, MAXIMUM 24-HOUR.....	5.48 INCHES
EFFECTIVE, TOTAL STORM.....	6.66 INCHES
RUNOFF:	
MAXIMUM 24-HOUR.....	195,248 AC.-FT. 3.25 INCHES
TOTAL (1ST THROUGH 3D DAY).....	368,000 AC.-FT. 6.13 INCHES

Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

**SPILLWAY DESIGN
FLOOD ROUTING**

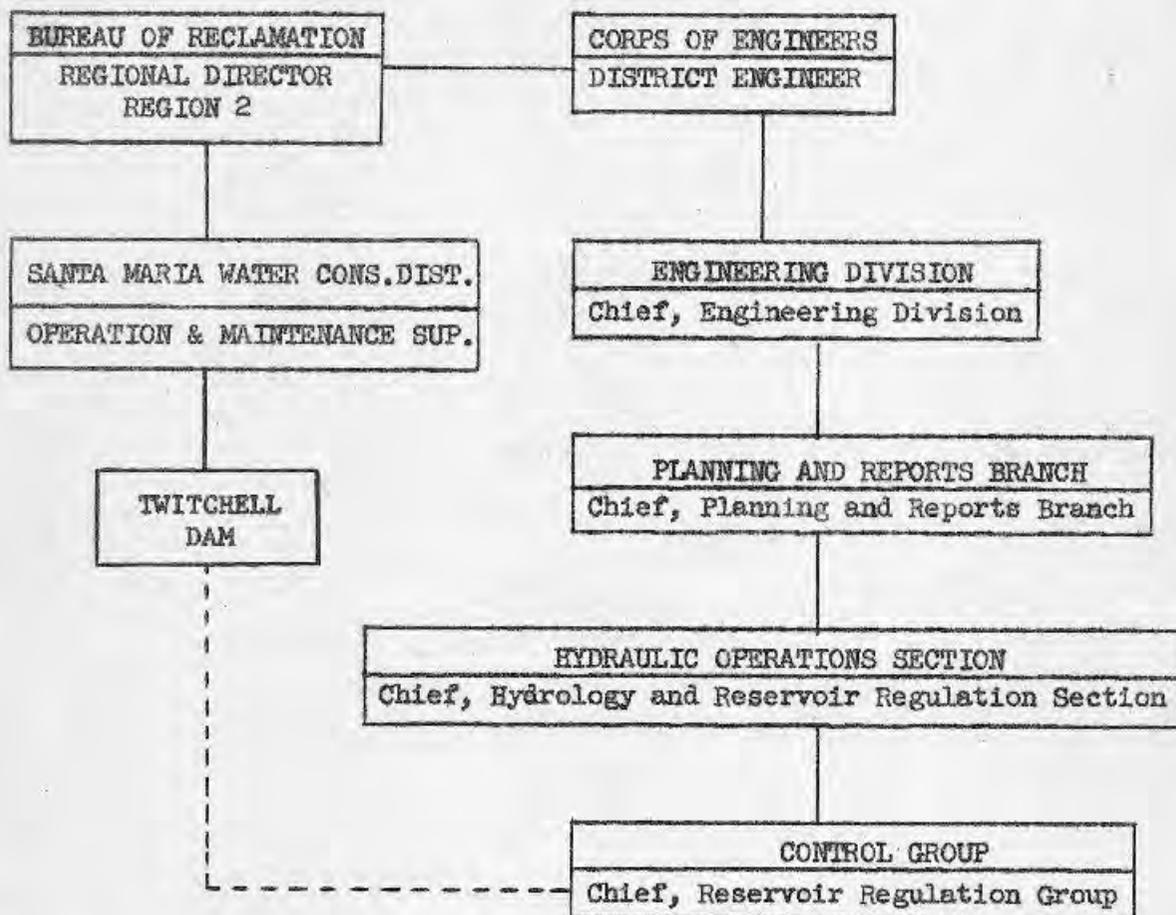
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To accompany report dtd: Aug. 1960



DRAINAGE AREA.....	1,630 SQ. MI.
AVERAGE RAINFALL DEPTH OVER AREA:	
MAXIMUM 24-HOUR.....	8.14 INCHES
TOTAL (48-HOUR).....	11.44 INCHES
EFFECTIVE, MAXIMUM 24-HOUR.....	3.09 INCHES
EFFECTIVE, TOTAL STORM.....	3.45 INCHES
RUNOFF:	
MAXIMUM 24-HOUR.....	175,369 AC.-FT. 2.02 INCHES
TOTAL (1ST THROUGH 3D DAY).....	250,659 AC.-FT. 2.88 INCHES

Santa Maria R. & Tributaries, Calif.
 Reservoir Regulation Manual
 Twitchell Dam and Reservoir
 CHANNEL DESIGN FLOOD
 AT FUGLER POINT

Office of the District Engineer
 Los Angeles, California
 To accompany report dtd: Aug. 1960

U. S. ARMY ENGINEER DISTRICT, LOS ANGELESCORPS OF ENGINEERSORGANIZATION FOR FLOOD-CONTROL OPERATION OF TWITCHELL DAM

NOTE:

Operation and maintenance of Twitchell Dam was transferred by contract from the Bureau of Reclamation to the Santa Barbara County Water Agency, which agency in turn transferred the operation and maintenance to the Santa Maria Water Conservation District.

Santa Maria River & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

ORGANIZATIONAL CHART

Office of the District Engineer
Los Angeles, California
To accompany report dtd: Aug. 1960

U. S. ARMY ENGINEER DISTRICT, LOS ANGELES

CORPS OF ENGINEERS

KEY PERSONNEL FOR FLOOD CONTROL OPERATION OF TWITCHELL DAM

TITLE	NAME	OFFICE TELEPHONE	HOME TELEPHONE
Regional Director	BUREAU OF RECLAMATION, REGION 2		Garden 1-2236 Sacramento, Calif.
	Martin, B. E. Dugan, H. P.	(PT) 8-468-4571, 4585 IVanhoe 9-7631 Sacramento, Calif.	
<u>SANTA MARIA VALLEY WATER CONSERVATION DISTRICT</u>			
Operation & Maintenance Supervisor	Lawrence, J. R.	Walnut 5-8989 Santa Maria, Calif. (Twitchell Dam)	Walnut 5-5493 Santa Maria, Calif.
District Engineer	<u>CORPS OF ENGINEERS</u>		
	Bradley, W.T., Col.	MADison 3-1311, Ext. 311 After duty hours: MADison 3-4760 Los Angeles, Calif.	ATLantic 6-1417 San Gabriel, Calif.
Chief, Engineering Division	Thompson, H. W.	MADison 3-1311, Ext. 493 Los Angeles, Calif.	Dickens 3-7062 Reseda, Calif.
Chief, Planning & Reports Branch	Cramer, S. F.	MADison 3-1311, Ext. 502 Los Angeles, Calif.	POplar 9-2422 No. Hollywood, Calif.
Chief, Hydraulics Operations Section	Tatum, F. E.	MADison 3-1311, Ext. 491 After duty hours: MADison 3-5141 Los Angeles, Calif.	CITrus 1-4772 Glendale, Calif.
Chief, Control Group	Levin, G. B.	MADison 3-1311, Ext. 345 After duty hours: MADison 3-5141 Los Angeles, Calif.	ATLantic 0-9879 Monterey Park, Calif.

NOTE:

Santa Maria Valley Water Conservation
District, telephone, WALnut 5-5212,
Santa Maria, Calif.

Santa Maria R. & Tributaries, Calif.
Reservoir Regulation Manual
Twitchell Dam and Reservoir

KEY PERSONNEL

Office of the District Engineer
Los Angeles, California
To accompany report dtd: Aug. 1960

U. S. ARMY ENGINEER DISTRICT LOS ANGELES

CORPS OF ENGINEERS

APPENDIX A
FLOOD-CONTROL REGULATIONS
TWITCHELL DAM AND RESERVOIR, SANTA MARIA RIVER BASIN
CALIFORNIA

To accompany Reservoir Regulation Manual for Flood-Control Storage
at Twitchell Dam and Reservoir

August 1960

TITLE 33--NAVIGATION AND NAVIGABLE WATERS

Chapter II--Corps of Engineers
Department of the Army.

PART 208--FLOOD CONTROL REGULATIONS

TWITCHELL DAM AND RESERVOIRS
SANTA MARIA RIVER BASIN, CALIFORNIA

Pursuant to the provisions of section 7 of the Act of Congress approved 22 December 1944 (58 Stat. 890; 33 U.S.C. 709), #208.79 is hereby prescribed to govern the use and operation of Twitchell Dam, and Reservoir on the Cuyama River, Santa Maria River basin, California, for flood-control purposes.

#208.79 Twitchell Dam and Reservoir, Santa Maria River basin, California. The Bureau of Reclamation shall supervise the operation of Twitchell Dam and Reservoir in the interest of flood control as follows:

(a) A storage space in Twitchell Reservoir of 89,000 acre-feet below elevation 651.5 shall be reserved for flood control at all times.

(b) Releases from the flood-control storage space shall be made in accordance with the "Outlet Gate Operation Schedule for Flood-Control Storage" currently in force. The schedule currently in force as of the promulgation of this section is dated January 31, 1962, File No. 373/123, and is on file in the Office of the Chief of Engineers, Department of the Army, Washington 25, D. C., and in the Office of the Commissioner of Reclamation, Washington, D. C. Revisions of the "Outlet Gate Operation Schedule for Flood-Control Storage" may be developed from time to time as necessary by the Corps of Engineers and the Bureau of Reclamation. Each such revision shall be effective upon the date specified in the approval thereof by the Chief of Engineers and the Commissioner of Reclamation and from that date until replaced shall be the "Outlet Gate Operation Schedule for Flood-Control Storage" currently in force for the purposes of this section. Copies of the "Outlet Gate Operation Schedule for Flood-Control Storage" currently in force shall be kept on file in and may be obtained from the Office of the District Engineer, Corps of Engineers and the Regional Director, Bureau of Reclamation, in charge of the locality.

(c) Nothing in this section shall be construed to require dangerously rapid changes in magnitudes of releases. The regulations of this section shall not be construed to require that releases be made in a manner that would be inconsistent with requirements for protecting the dam and reservoir from major damage.

(d) The Bureau of Reclamation shall see that the District Engineer, Corps of Engineers, Department of the Army in charge of the locality, is currently advised of reservoir release, reservoir storage and such other operating data as the District Engineer may request, and also of those basic operating criteria which affect the schedule of operation.

(e) The flood-control regulations of this section are subject to temporary modification by the District Engineer, Corps of Engineers, if found necessary in time of emergency. Request for and action on such modification may be made by any available means of communication and the action taken by the District Engineer shall be confirmed in writing under date of same day to the Office of the Regional Director, Bureau of Reclamation in charge of the operations.

(Regs., January 31, 1962, ENGCW-EY) (Sec. 7, 58 Stat. 890; 33 U.S.C. 709)

J. C. LAMBERT
Major General, U. S. Army
The Adjutant General

(F.R. Doc. 62-22,13; Filed, March 6, 1962; 8:45 a. m.)

Step No.	When reservoir water surface is between elevations		Gate setting for gates as indicated		Computed discharge**
			No. 1	No. 2	
	Feet above mean sea level		Feet of opening	Feet of opening	Cubic feet per second
1.....	504.0 -	623.0	0	0	0
2.....	623.0 -	623.2	.5	.5	500 - 510
3.....	623.2 -	623.4	1.5	1.5	1,500 - 1,510
4.....	623.4 -	623.6	3.0	3.0	3,000 - 3,010
5.....	623.6 -	623.8	5.0	5.0	5,000 - 5,010
6.....	623.8 -	624.0	8.0	8.0	7,800 - 7,820
7.....	624.0 -	***651.5	12.0	12.0	11,630 - 12,700

* Schedule applicable for rising or falling stages.

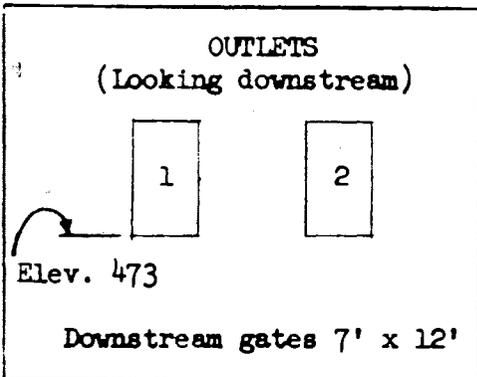
** Low port assumed blocked.

*** Spillway flow above elevation 651.5.

Note.--The outlet gates shall not be opened faster than 1 foot in 10 minutes.

INSTRUCTIONS

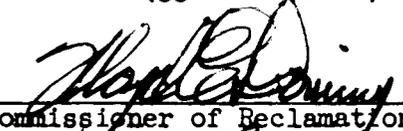
1. Schedule is for downstream gates. Normally upstream gates are wide open and function as guard gates.
2. If one of the downstream gates cannot be operated, adjust the other gate, if possible, so that its opening will equal the sum of the openings shown in the schedule. However, the operable gate should not be opened more than 80 percent (9.6 ft.).

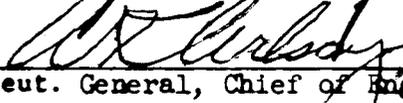


Twitchell Dam and Reservoir
Santa Maria River Basin, Calif.

OUTLET GATE OPERATION SCHEDULE
FOR FLOOD CONTROL STORAGE

Prepared Pursuant to Flood Control
Regulations for Twitchell Dam
and Reservoir (33 CFR 208.79)

APPROVED: 
Commissioner of Reclamation

APPROVED: 
Lieut. General, Chief of Engineers

Effective Date: 31 Jan. 1962 File No. 373/123