VIII - EFFECT OF WATER CONTROL PLAN

8-01 General

The primary propose of Santa Fe Dam is flood control, and the greatest effect and benefit of the dam is the protection of life and property downstream of the facility. The major aspects of flood control at Santa Fe Dam for both the reservoir and spillway design floods, as well as several major historical floods, are discussed in section 8-02. Any other effects or benefits of Santa Fe Dam are secondary to those of flood control, and they are briefly described in section 8-03 through 8-08.

8-02 Flood Control

a. Reservoir Design Flood (RDF). The original hydrologic design of Santa Fe Dam was based on the control of a hypothetical flood. The hydrologic basis used in the development of the RDF is briefly summarized from Reports No. 3 and 4 of Table 1-1 as follows:

1. The RDF was computed from the flood resulting from a four-day storm, with the maximum 24-hour rainfall and the highest intensities on the fourth day.

2. The design storm had a total storm rainfall of 26 inches, with 13 inches occurring on the fourth day.

3. Rainfall during the first three days was assumed to occur in consecutive ratios of 20, 30, and 59 percent of that on the maximum day, thereby obtaining the most adverse conditions of occurrence.

4. Runoff coefficients and infiltration were based on the rainfall to runoff relations computed for the upper San Gabriel River drainage area above Cogswell Dam (San Gabriel Dam No. 2), which indicated the highest runoff coefficients of the March 1938 flood. A runoff hydrograph was developed using the Modified Rational Method.

5. A base flow of 20 $ft^3/s/mi^2$ of drainage area was used in determining the ultimate discharge for the fourth day of the hydrograph.

6. Morris and Cogswell Dams were assumed full to spillway crest at the start of the storm with outlets inoperative, and San Gabriel Dam was assumed to have 34,700 ac-ft of flood storage available with outlets operative above the conservation pool of 12,400 ac-ft. The resulting RDF has a peak inflow of 81,600 ft^3/s and a total volume of 129,300 ac-ft.

7. Starting with a WSE of 442, (top of debris pool), the RDF was routed through Santa Fe Dam using the net area-capacity curve formulated for design purposes with the gates operated to maintain a maximum controlled release of 19,000 ft^3/s. The net area-capacity curve assumes the 50-year sediment allowance of 1000 ac-ft is filled. The maximum water surface elevation was 495.8 feet. The spillway crest was set at 496 feet.

b. Revised Reservoir Design Flood - Standard Project Flood (SPF). When Santa Fe Dam was originally designed, the SPF concept had not been developed yet. Following occurrence of the storm of 21-23 January 1943, a revised RDF using the SPF concept was determined for Santa Fe Dam. The revised RDF

presupposed ground conditions equivalent to those of the March 1938 storm, with rainfall amounts and intensities equal to those of the January 1943 storm. Report No. 8 in Table 1-1 gives the basis for unit hydrograph, loss rate, and baseflow determinations. The storm was transposed to the drainage area above Santa Fe Dam, using a transposition factor based upon the mean annual precipitation. During the storm, rain totaling 25.61 inches would fall in a 2.5-day period, with 17.51 inches in the maximum 24 hours. The storage and regulation assumptions related to Cogswell, Morris, and San Gabriel dams were the same as assumed in the original RDF in 1940. The maximum 4-day inflow to Santa Fe Dam was 171,400 ac-ft, and the 5-day inflow was 183,700 ac-ft. The peak inflow was 98,000 ft^3/s.

Improvement of the channel below Santa Fe Dam in 1961 increased channel capacity from 19,000 to 41,000 ft^3/s. About the same time, the SPF determined in 1944 was revised slightly to account for different regulation assumptions at Cogswell and San Gabriel Dams. Based on then-current regulation plans, Cogswell and San Gabriel Dams would have 9600 and 33,900 ac-ft of storage available, respectively, at the beginning of the SPF. This is a total of 43,500 ac-ft available, instead of the previously assumed total of 34,700 ac-ft. The effect of the extra available storage is illustrated by a decrease in the peak in flow from 98,000 to 96,000 ft^3/s, and the maximum 24-hour volume from 101,400 to 89,550 ac-ft.

Routing of the revised SPF using the current reservoir regulation plan are presented on plate 8-1 and table 8-2. These routings, which use the regulation schedule in Exhibit A, assume the following operation criteria: 1) operation of Santa Fe Dam in tandem with Whittier Narrows Dam and the Santa Fe reservoir storage capacity is based on the 1982 survey, 2) operation of Santa Fe Dam not in tandem with Whittier Narrows Dam, and assuming that the 50-year sediment allowance is filled, and 3) operation of Santa Fe Dam not in tandem with Whittier Narrows Dam, and assuming that the 100-year sediment

allowance is filled. Plate 8-1 depicts the standard project storm hyetograph (graph of incremental precipitation vs time), the inflow and outflow hydrographs, and the WSE for each of the routings. Table 8-2 shows the maximum inflow, resulting maximum outflow and maximum WSE for each of the routings.

In 1984, the regulation plan for Morris Dam was modified because of safety of dam requirements. The maximum elevation for long-term storage was set at WSE 1130 feet (16,016 ac-ft), instead of WSE 1152 (spillway crest - 22,758 ac-ft). Hence, Morris Dam would have 6742 ac-ft of available storage at the beginning of the SPF, increasing the total available from 42,500 ac-ft to 49,242 ac-ft. If the Santa Fe Dam SPF were revised to reflect the additional storage at Morris Dam, the maximum WSE reached in the routings through Santa Fe Dam would be about 3 feet less than when Morris Dam is assumed full to spillway crest. This conclusion is based on various routings made for the 1989 LACDA study (Report 17 of Table 1-1).

c. Spillway Design Flood. The original spillway design flood at Santa Fe Dam was based on a 24-hour rainfall of 20.5 inches, 60 percent greater that that for the fourth day of the original reservoir design storm. Derivation of the flood was the same as that of the fourth day of the RDF, except for an assumed base flow of 40 $ft^3/s/mi^2$, and all three upstream dams were assumed to be full to spillway crest at the beginning of the storm, with the outlets at San Gabriel Dam inoperative. Computation of the flood hydrograph resulted in a peak inflow of 238,000 ft^3/s and a 24-hour volume of 184,000 ac-ft. Routing the flood assuming the reservoir full to spillway crest elevation 496 ft, and 6 of the outlets plugged at the beginning of the flood, resulted in a maximum water surface elevation 508.4 and a peak outflow of 224,800 ft^3/s.

d. Revised Spillway Design Flood - Probable Maximum Flood (PMF). A revised spillway design flood was developed based on precipitation given in

the report titled, "Revised Report on Maximum Probable Precipitation, Los Angeles Area, California", dated 29 December 1945 and prepared by the Hydrometeorological Section of the United States Weather Bureau. In general, the January 1943 storm was used as a pattern for geographical and intensity distribution of rainfall. Precipitation values for that storm were multiplied by a computed ratio to obtain maximum values. During the 3-day storm, 36.59 inches of rain would fall, with 24.40 inches in the maximum 24 hours. Computation of the flood hydrograph resulted in a peak inflow of 194,000 ft^3/s, a 24-hour volume of 258,100 ac-ft, and a 72-hour volume of 447,100 ac-ft.

In a subsequent 1978 study (Report No. 16 table 1-1), the adequacy of the Santa Fe Dam was reviewed under current criteria. This led to the development of a revised PMF and reanalysis of the adequacy of Santa Fe Dam spillway. The average depths of precipitation for 6, 12, 24, 48, and 72 hours during the general winter probable maximum storm, using revised PMF criteria, for the drainage area above Santa Fe Dam were determined to be 10.9, 18.4, 29.0, 41.9, and 48.9 inches, respectively. Distribution of rainfall over each subarea was determined by taking the ratio of a 10-year, 3-day rain for each subarea to the 10-year, 3-day rain for the entire drainage area. A time interval of 1 hour was selected as the shortest time interval for which precipitation intensities would be required to define the flood hydrograph. The time distribution was based on figure 7-3D of the U.S. Weather Bureau's Hydrometeorological Report Number 36. A constant loss rate of 0.15 inches per hour was considered applicable for the drainage area. Average basins "n" values ranging from 0.030 to 0.050 and the Average Mountain S-Graph were used in developing the PMF hydrograph. Base flows for the drainage area were based on studies made of the 1938 flood. The resultant PMF peak inflow to Santa Fe Dam was 222,000 ft^3/s, with a volume of 556,000 ac-ft. Again, all upstream dams were assumed full to spillway crest at the beginning of the probable maximum storm.

The original spillway design flood had a peak outflow discharge of 224,800 ft^3/s, with a maximum WSE of 508.4 feet, and a freeboard of 4.6 feet, with 6 of 16 outlet assumed plugged or inoperative. Routing the revised PMF assuming the reservoir full to spillway crest and 6 of 16 gates plugged or inoperative, resulted in a maximum WSE of 509.2 feet, and a peak outflow of 221,800 ft^3/s. Plate 8-2 depicts the hyetograph of the revised probable maximum precipitation over the drainage area above Santa Fe Dam, the inflow hydrograph, reservoir water surface elevation, and outflow hydrograph that would result when the revised PMF is routed through Santa Fe Reservoir.

e. Other Floods. The results of routing the largest floods of record since 1916 through Santa Fe Reservoir are described briefly in the following subparagraphs. The inflow hydrographs were adjusted to the same upstream dam storage assumptions and regulation plans as assumed for the SPF. The regulation schedule used for each routing is similar to the operation schedule in Exhibit A. None of the adjusted historical floods occurring in the watershed prior to the dam construction, nor any actual floods since the dam was constructed, provided a severe test of the plan.

1. 1938 Flood Routing. The flood of 28 February-3 March 1938, the largest of record above Santa Fe Dam, was modified to reflect upstream development and control, and routed through the reservoir according to the flood regulation schedule. Assuming the reservoir full to debris pool elevation 456 at the beginning of the routing, the peak inflow of 28,000 ft^3/s was reduced to an outflow peak of 27,600 ft^3/s and a maximum water surface elevation of 460.9. Peak inflow during the actual 1938 flood was 65,700 ft^3/s. This represents the outflow from Morris Dam (peak 61,800 ft^3/s) augmented by side inflow. Current regulation plans for Morris Dam would produce much less outflow from Morris Dam.

2. January 1969 Flood Routing. The January 1969 flood routing

and appurtenant data are shown on plate 8-3. Assuming the reservoir full to debris pool elevation 456 at the beginning at the routing and using the flood regulation schedule, the peak inflow of 24,000 ft^3/s was reduced to an outflow peak of 23,100ft^3/s and a maximum WSE of 460.2 ft.

3. February 1969 Flood Routing. The February 1969 flood routing and appurtenant data are shown on plate 8-4. Assuming the reservoir full to debris pool elevation 456 at the beginning of the routing, the peak inflow of 26,900 ft^3/s was controlled to a peak outflow of 27,600 ft^3/s and a maximum WSE of 461.0 feet.

8-03 Recreation

The reservoir area behind Santa Fe Dam provides the open space for extensive recreational public development. However, none of the recreational facilities in Santa Fe Reservoir depend upon runoff water impounded behind the dam. Public law 78-534 (The Flood Control Act of 1944) provided the construction of recreational facilities within the reservoir.

The effects of the dam and its operation upon the recreational facilities within the reservoir area by necessity all negative; that is, some of these facilities are occasionally flooded by the impoundment of water behind the dam for flood control. These recreational facilities, however, were constructed and area operated with this understanding.

8-04 Water Quality

Santa Fe Dam retains flood waters in storage for relatively short periods of time (on the order of days). Therefore, Santa Fe Dam operation has very little effect on water quality other than to drop out sediment load carried by the flood inflow.

8-05 Fish and Wildlife

Wildlife in the Santa Fe Flood Control Basin is most concentrated and diverse in the riparian and alluvial scrub habitats. The coastal sage scrub provides wildlife habitat values intermediate between alluvial scrub and the more disturbed wash and ephemerally inundated ruderal communities which are relatively low in wildlife habitat values. The lake provides habitat for stocked game fish. Native fish are occasionally washed into the basin during storm flows and releases, but the basin provides no long-term natural habitat for the fish.

8-06 Water Supply

Santa Fe Dam has no authorized storage allocation for water supply. Santa Fe Dam is regulated for water conservation when the reservoir water surface elevation is at or below the debris pool level (WSE 456 feet). With this regulation, release rates can be completely recharged to groundwater, thereby benefiting the San Gabriel Valley and other parts of the greater Los Angeles Basin. Santa Fe Dam reduces the amount of water-borne sediment, and prolongs the duration of runoff to recharge facilities.

8-07 Hydroelectric Power

There is no existing or contemplated hydroelectric power generation at Santa Fe Dam.

8-08 Navigation

There is no navigation on the San Gabriel River or in Santa Fe Reservoir at any time.

8-09 Frequencies

a. Peak Inflow and Outflow Probabilities. Table 8-1 gives inflow and outflow frequency values at Santa Fe Dam, taken from the 1988 LACDA study (Report No. 17 in table 1-1). The values reflect the gate regulation schedule shown in Exhibit A. The values were determined from the calibrated rainfall-runoff model used in the LACDA study and reflect the revised regulation plan for Morris Dam discussed in Section 8-02.b.

b. Pool Elevation and Frequency. Plate 8-5 shows the elevation frequency curves for Santa Fe Dam determined from the calibrated rainfall-runoff model used in the LACDA study. The curve also reflect the gate regulation schedule in Exhibit A and the revised Morris Dam regulation plan. The values of the curves a specific return periods are also listed in table 8-1.

c. Key Control Points. Plate 8-6 is a stage-discharge rating curve for the outflow gauging station just downstream of Santa Fe Dam.

8-10 Other Studies

a. Examples of Regulation. Discharge frequency values presented in this manual were derived from ongoing (1989) investigations in the LACDA Study. Preliminary analyses in Part 1 of this study have been applied to evaluate Santa Fe Dam and have been considered in preparing the water control plan. The "Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Los Angeles County Drainage Area Dams," dated June 1978, presents the derivation of the PMF and SPF used in this manual.

b. Channel and Floodway Improvement. The channel between Santa Fe Dam and Whittier Narrows Dam was improved by the Corps of Engineers in 1961.

Channel capacity, representing the flow of the standard project flood, ranges from 41,000 to 98,000 ft^3/s. A flood insurance study for the city of South El Monte, covering the San Gabriel River from Santa Fe to Whittier Narrows Dam, was completed by LAD for the Federal Emergency Management Agency in March 1975. In November 1975, the area around the San Gabriel River from Santa Fe to Whittier Narrows was designated as Zone C, meaning there was no flood hazard. In 1989, the LACDA report (Report No. 17 in table 1-1) reported that the design channel capacity between the two dams was still valid. This study indicates an approximately 500-year level of protection in the reach between these two dams. The channel capacities are given in plate 3-2.

TABLE 8-1. Inflow, Outflow, and Elevation Frequency Values Using the Santa Fe Dam Gate Regulation Schedule in Exhibit A

RETURN PERIOD (years)	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Peak Inflow (ft^3/s)	5200	8000	29000	53200	80300	110000
Peak Outflow (ft^3/s)	3750 (6170)	6710 (18700)	27800 (31900)	32800 (37800)	38500 (41000)	41000 (41000)
Maximum Elev (ft-NGVD)	457 (459.5)	457.8 (462.5)	461.5 (470.4)	472.7 (487.1)	488.9 (497.9)	498.7 (500.3)

Notes:

1) Unparenthesized values were obtained from the 1988 LACDA Study (Report No. 17 in Table 1-1). Outflow is outlet works discharge.

2) Values in parenthesis were determined from the gate operation schedule in Exhibit A (regulation of Santa Fe Dam in tandem with Whittier Narrows Dam), in which Whittier Narrows Dam is operated according to the its present regulation plan.

3) For return periods with maximum water surface elevations exceeding 496 ft, spillway flow results and would be absorbed by the gravel pits located immediately downstream of the Santa Fe Dam spillway. A maximum release of 41,000 ft^3/s from the outlet works can be maintained under these conditions.

TABLE 8-2. REVISED SPF ROUTINGS USING THE GATE OPERATION SCHEDULE SANTA FE RESERVOIR

OPERATION CRITERIA	MAXIMUM INFLOW (ft^3/sec)	MAXIMUM WSE (ft-NGVD)	MAXIMUM OUTFLOW (ft^3/sec)	SPILLWAY FLOW (ft^3/sec)
1) *OPER. SNFE IN TANDEM WITH WNRH[1] & USING THE 1982 RESERVOIR STOR. CAP.	96,000	495.1	40,650	0
2) **OPERATING SNFE FOR IMMEDIATE DOWNSTREAM CHANNEL & USING 50-YEAR[2] SEDIMENT ALLOWANCE		494.9	40,700	0
3) **OPERATING SNFE FOR IMMEDIATE DOWNSTREAM CHANNEL & USING 100-YR[3] SEDIMENT ALLOWANCE		498.3	41,000[4]	13,700[5]

* SANTA FE DAM IS OPERATED SO AS TO BALANCE THE CONCURRENT FLOOD CONTROL STORAGE AT WHITTIER NARROWS DAM.

** SANTA FE DAM IS OPERATED BASED ON CURRENT WSE AT SANTA FE RESERVOIR AND AVAILABLE DOWNSTREAM CHANNEL CAPACITY (i.e., not in tandem with Whittier Narrows Reservoir).

Notes:

[1] Whittier Narrows Dam is designated as WNRH not WNRS because WSE is taken at the Rio Hondo side.

[2] Assuming the 50-year sediment allowance is filled.

[3] Assuming the 100-yr sediment allowance is filled.

[4] Max. SNFE downstream channel capacity.

[5] Existing gravel pits downstream of Santa Fe Dam are sufficient to preclude all but large sustained spillway flow from reaching the San Gabriel channel. A maximum outletworks release of 41,000 ft^3/sec can be maintained under these conditions.