VIII - EFFECT OF WATER CONTROL PLAN

8-01 General

The sole purpose of Carbon Canyon Dam is flood control, and by far 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 Carbon Canyon Dam for the reservoir and spillway design floods, and other floods, are discussed in section 8-2. Any other effects or benefits of Carbon Canyon Dam are decidedly secondary to those of flood control, but they are briefly described in sections 8-3 through 8-8.

8-02 Flood Control

a. Standard Project Flood/Reservoir Design Flood. The standard project flood (SPF), selected as the reservoir design flood for Carbon Canyon Dam, was based on the assumed occurrence of a general winter type storm. The storm of December 1933-January 1934, which centered in the San Gabriel Mountains and foothills about 32 miles northwest of Carbon Canyon Dam, was transposed to the drainage area above Carbon Canyon Dam on the basis of rainfall amounts expressed as a percentage of mean seasonal rainfall. The maximum 24-hour rainfall of this two-day duration storm was 11.31 inches. A variable loss rate averaging in 0.20 inches per hour was used to determine rainfall excess. The unit hydrograph was determined from the average of two S-graphs: East Basin n-value was 0.04. An average base flow of 10 ft^3/s per square mile was considered appropriate. The resulting peak inflow was 9300 ft^3/s; the total inflow volume, including baseflow, was 8030 acre-feet.

The spillway crest elevation was determined by routing the SPF (reservoir design flood) through the reservoir, assuming the starting water surface elevation was at elevation 419 (top of debris pool) and the outlet gates initially closed. Above elevation 419, the outflow was controlled to a maximum of 1000 ft^3/s. Using the design sediment allowance (50-year accumulation) of 1500 acre-feet, the maximum water surface elevation was determined to be 474.7 feet. On this basis, the spillway crest elevation was set at 475 feet. For a 100 year sediment allowance (3000 acre-feet), the maximum water surface elevation is 479 feet, with a maximum outflow of 3720 ft^3/s (2720 ft^3/s spillway discharge).

Plate 8-1 depicts the standard project flood hyetograph, the SPF inflow and outflow hydrographs, and the water surface elevation for routings with both 50 and 100 year sediment allowances.

b. Spillway Design Flood.

(i). Original Design Criteria. The spillway at Carbon Canyon was designed in 1957 for a peak inflow of 56,000 ft^3/s, having a surcharge of 18.7 feet above spillway crest elevation. An additional 5.3 feet of freeboard to handle runup by waves set the top of dam elevation at 499 feet.

The original spillway design flood was based on a convective type storm using probable maximum precipitation provided by the Hydrometeorological Branch of the U.S. Weather Bureau (now the National Weather Service). The hypothetical 3-hour storm produce an average of 10.4 inches of rain (10.10 inches of effective rain) over the drainage area above Carbon Canyon Dam. The unit hydrograph was determined in the same manner as for SPF, except that basin lag was reduced by 15 percent and the loss rate was taken as a constant equal to 0.10 in/hr. The resulting flood produced a peak inflow of 56,000 ft^3/s and a total volume of 10,300 ac-ft including base of 15 ft^3/s per square mile.

The original spillway design flood routing assumed a starting water surface elevation at spillway crest with the outlet gates closed. The maximum water surface elevation reached was 493.7 feet, with peak outflow of 36,800 ft^3/s.

(ii). Revised Criteria (PMF). In a subsequent 1978 study (table 1-1, #7), the adequacy of the spillway was reviewed under modern criteria. This led to the development of a revised PMF.

The updated probable maximum precipitation (PMP) is based on a hypothetical 6-hour rain storm derived from the criteria published in a Hydrometeorological Report entitled, “Preliminary Draft - Probable Maximum Thunderstorm Precipitation Estimates - Southwest States”, (1972, revised 1973). This storm was critically centered over the drainage area above Carbon Canyon Dam. The 6-hour, basin-average PMP had maximum 1/4-, 1/2-, 1-, 3-, and 6-hour amounts of 2.20, 3.71, 5,92, 9.11, and 11.69 inches, respectively, compared with original 1/2-, 1-, and 3-hour amount of 2.7, 4,8, and 10.4 inches. The unit hydrograph and base flow assumptions were the same as those used originally.

The revised PMF generates a maximum inflow to Carbon Canyon Reservoir of 52,000 ft^3/s about 4-1/2 hours after the start of the storm. The runoff flood volume is 11,800 ac-ft of water. The maximum water surface elevation in the reservoir rises to 491.9 feet. The maximum outflow is 31,200 ft^3/s.

Plate 8-2 depicts the revised PMF hyetograph, the PMF inflow and outflow, and the water surface elevation or the PMF routing through Carbon Canyon Reservoir.

A comparison of the peak discharges and volumes for the standard project and probable maximum floods computed under original and revised criteria for Carbon Canyon Dam are give in table 8-1.

(iii). Freeboard. The freeboard allowance for wind tides and wave set up was determined using the procedure described in ETL 1110-2-221. Based on design speed of 45 mph from the northeast, the calculated freeboard was 1.9 feet. However, the required minimum freeboard for a Standard 1 dam without downstream slope protection is 5.0 feet. The available freeboard is 7.1 feet.

c. Other Floods. RDF and PMF were routed through the reservoir to test

the adequacy of the flood operation plan. It was assumed the storage allocation for debris was full (1500 ac-ft). Observed floods were not large enough to warrant routing. For example, the largest flood of record on Carbon Canyon Creek, which occurred 27 February-3 March 1938, produced an estimated peak discharge of only 1760 ft^3/s at the gauge located at the Rose Drive Bridge, Olinda, California.

8-03 Recreation

None of the recreational facilities in Carbon Canyon Reservoir depend upon runoff water impounded behind the dam. Thus there are no direct recreation benefits that result from the dam or its regulation. The recreational facilities were constructed because the land within the reservoir could not be used for other purposes. Hence, there is an indirect recreation benefit associated with the project. The effects of the dam and its regulation upon the recreational facilities within the reservoir are 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 are operated with this understanding.

8-04 Water Quality

There are no benefits of Carbon Canyon Dam to water quality of Carbon Canyon Creek. On the other hand, Carbon Canyon Dam and its regulation should not in any way contribute to the degradation of the water quality of the stream.

8-05 Fish and Wildlife

There are no benefits of Carbon Canyon Dam to any fish and wildlife activities.

8-06 Water Supply

Since Carbon Canyon Dam is not regulated for water supply, there are no direct effects or benefits of the dam or its regulation upon the water supply of the coastal plain of Orange County or other parts of Orange County. There are no practical indirect benefits of Carbon Canyon Dam upon the downstream groundwater spreading facilities even though the flow rates on Carbon Creek channel past these facilities are at times reduced, and the duration of runoff prolonged, by the dam.

8-07 Hydroelectric Power

There is no existing or contemplated hydroelectric power generating at Carbon Canyon Dam.

8-08 Navigation

There is no navigation on Carbon Canyon Creek nor in Carbon Canyon Reservoir at any time.

8-09 Frequencies

a. Peak Inflow and Outflow Probabilities. Plate 8-3 is a graph of the inflow frequency and plate 8-4 is a graph of the peak outflow frequency at Carbon Canyon Dam. The inflow volume-frequency curves for peak, and 1-, 2-, and 3-day maximum flows were determined using data from 39 years of record (1931-1980) which were ranked and plotted using median plotting positions. The outflow frequency curve is derived from the elevation frequency curve (pl. 8-5) and reflects the gate regulation schedule in Exhibit A. Table 1-1, #13 provides a more detailed description of the procedure followed. The addition of additional data accumulated since 1980 would not change the curves. Values of these curves at specific return periods are listed in table 8-2.

b. Pool Elevation Frequency. Plate 8-5 is the adopted elevation frequency curve for Carbon Canyon Dam. This curve was derived from 21 years of WSE data (1961-1980) and the results of balanced hydrograph routings (derived from the inflow volume-frequency curves), and reflects the water control plan in Exhibit A. The current conditions curve is derived from the elevation-storage curve using the 1969 sediment survey. The future conditions curve accounts for the 50-year design sediment allowance of 1500 ac-ft. Table 1-1, #13 describes in more detail the data used and procedures followed in determining these curves. The values of the present conditions curve at the specific return periods are listed in table 8-2.

c. Key Control Points. Table 8-3 is a stage/discharge rating table for the stream gauge just downstream from the dam, Carbon Creek below Carbon Canyon Dam.

8-10 Other Studies

The “Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Carbon Canyon, San Antonio, and Tahchevah Dams,” dated August 1978, presents the derivation of the PMF and SPF used in this manual.

Table 8-1

SUMMARY OF HYDROLOGY FOR CARBON CANYON DAM

	Original Design	Revised Design
Standard Project Flood		
Volume.....ac-ft	8030	no change
Time.....days	3	no change
Peak Outflow.....ft^3/s	1000	no change
Probable Maximum Flood		
Peak Inflow.....ft^3/s	56,000	52,000
Volume.....ac-ft	10,600	11,800
Time.....hours	8	15
Peak Outflow.....ft^3/s	36,800	31,200

Table 8-2

Inflow, Outflow, and Filling Frequency Values
Carbon Canyon Reservoir

Return Period (years)	Peak Inflow (ft^3/s)	Peak Outflow (ft^3/s)	Maximum Filling Elevation (present conditions) (feet, NGVD)
2	105	50	419.6
5	445	160	421.6
10	900	250	425.0
20	1650	525	429.5
50	3050	695	438.3
100	4600	880	448.3
200	6700	1000	460.4
500	10500	1000	477.0

NOTE: These values were obtained from the inflow and outflow frequency curves of plates 8-3 and 8-4, and from the filling frequency curve of plate 8-5.

Table 8-3

Stage/Discharge Rating Table For the Stream Gauge Downstream From Carbon Canyon Dam Along Carbon Creek

11075720 Carbon Cr. below Carbon Canyon Dam, CA

USGS Rating Table No. 6

Gauge Height (ft)	Discharge (ft^3/S)	Gauge Height (ft)	Discharge (ft^3/S)	Gauge Height (ft)	Discharge (ft^3/S)
2.00	0	3.70	254.100	5.40	619.700
2.10	0.553	3.80	274.100	5.50	642.500
2.20	2.600	3.90	294.400	5.60	665.500
2.30	6.000	4.00	315.000	5.70	688.700
2.40	11.100	4.10	335.200	5.80	712.000
2.50	19.300	4.20	355.800	5.90	735.500
2.60	31.900	4.30	376.500	6.00	759.100
2.70	48.800	4.40	397.600	6.10	782.800
2.80	70.500	4.50	418.800	6.20	806.800
2.90	97.600	4.60	440.300	6.30	830.800
3.00	124.000	4.70	462.100	6.40	855.000
3.10	143.000	4.80	484.000	6.50	879.000
3.20	160.400	4.90	506.200	6.60	903.000
3.30	178.300	5.00	528.600	6.70	927.000
3.40	196.600	5.10	551.200	6.80	951.000
3.50	215.000	5.20	574.000	6.90	975.000
3.60	234.600	5.30	597.000	7.00	999.000