VIII - EFFECT OF WATER CONTROL PLAN

8-01 General. The water control plan presented in this manual gives the water control manager the flexibility needed to optimize diverse and often conflicting objectives under a variety of conditions. With the judicious use of weather and runoff forecasts, Prado Dam is currently able to provide 70-year flood protection to the cities bordering the Santa Ana River in Orange County. In addition, the water control plan increases the quantity of water available for downstream groundwater recharge by carefully managing and coordinating releases from the debris and buffer pools with the OCWD. The needs of the LBVI and its habitat within the Prado Flood Control Basin are also addressed.

8-02 Flood Control. The November 1969 report entitled "Interim Report on Design Features of Existing Dams, Hydrology and Hydraulic Review for Prado, Brea, Fullerton, and Salinas Dams" documents the deficiency which currently exits at Prado Dam. Improved hydrologic methods and data, as well as the increased urbanization of the "Inland Empire" have caused an increase in the Probable Maximum Flood (PMF) and the Reservoir Design Flood from the original design values.

a. Probable Maximum Flood. The PMF is the flood that can be expected from the most severe combination of meteorological and hydrologic conditions reasonably possible in the region. PMF, as the name implies, is an estimate of the upper bound of flood potential for a drainage area. A PMF is required to determine the spillway capacity for a dam.

The PMF is based upon a general winter event for the probable maximum storm (PMS). Data for the storm were obtained from the Hydrometeorological Branch of the U.S. Weather Bureau (i.e., enclosures one and two of a letter dated December 2, 1968; subject: PMP for 18 Los Angeles Basins). The average depths of precipitation for 6, 12, 24, 48, and 72 hours during the PMS for the drainage area above Prado Dam were 5.6, 10.6, 16.5, 23.1, and 26.3 inches, respectively. A time interval of one hour was selected as the shortest interval for which precipitation intensities would be required to define the flood hydrograph.

The PMS has a duration of 72 hours with a total average areal precipitation depth of 26.3 inches. In general, the precipitation runoff relationships used for the SPF, as described in the following section, were judged applicable for use in developing the PMF, with two exceptions. First, the basin lag time is reduced by 15 percent to account for the reduction in time of concentration, a characteristic of large floods where the hydraulic efficiency of the drainage area is increased by the depths of flow. Second, loss rates considered applicable for ground conditions conducive to maximum runoff were used for the PMS.

Plate 8-01 shows the hyetograph of the PMS, and the outflow hydrograph at Prado Dam. The routing assumed that the reservoir is at a WSE of 490.0-ft at the beginning of the PMF. The peak inflow to Prado Dam under current conditions is 670,000 cfs which would cause the reservoir to rise to WSE 570.3-ft. This elevation is 4.3-ft. above the top of dam. Assuming that the dam does not fail, the estimated outflow from Prado Dam would reach 603,000 cfs.

b. **Standard Project Flood**. The SPF represents the flood that would result from the most severe combination of meteorologic and hydrologic conditions considered reasonably characteristic of the geographical area. The SPF is normally larger than any past recorded flood in the area and would be exceeded in magnitude only on rare occasions. The SPF, therefore constitutes a standard for design or redesign that would provide a high degree of flood protection.

The critical storm for the Santa Ana River is based upon the assumed occurrence of a storm equivalent in magnitude to that of January 21-24, 1943, in which the maximum 24-hour precipitation was transposed and centered in the San Bernardino and San Gabriel Mountains. The maximum 1-, 6-, 24-, and 48-hour (total storm) average precipitation over the total area was 0.64, 3.36, 8.25, and 11.59 inches, respectively.

The SPF has a duration of 48 hours with a total average areal precipitation depth of 12.15 inches. The general storm variable loss rate used for the San Gabriel, San Bernardino, and San Jacinto Mountains and Foothills had an equivalent average of 0.35 in/hr and a minimum of 0.15 in/hr. The valley portions of the watershed (i.e., 60% of the 2,450 sq-mi watershed) had a constant loss-rate of 0.40 in/hr, reduced by the percentage of impervious cover where appropriate. Snow melt was considered to be a negligible factor during the SPF event.

Plate 8-02 shows the hyetograph of the Standard Project Storm (SPS) and the inflow and outflow hydrographs at Prado Dam. Flood routing begins with the reservoir's debris pool full to WSE 490.0-ft. The peak inflow of 282,000 cfs causes the reservoir to rise to a maximum WSE of 554.59-ft. This spillway surcharge of 11.59-ft. results in a peak outflow of 150,000 cfs. The four day flood volume for the SPF is 488,000 ac-ft.

c. **Other Floods**. The largest inflows (i.e., inflows greater than 30,000 cfs) to Prado Reservoir occurred in 1943, 1965, 1966, 1969, 1978, 1980, and 1983. However, the first flood control releases were not made until the January-February floods of 1969. The initial 28 years of operation (i.e., from 1941-1969) was accomplished, for the most part, by passing inflows through the ungated outlets for water conservation purposes downstream. Note, that the last ungated outlet was sealed after the 1969 flood event. Plate 8-03a-e shows the operational history of Prado Dam from 1941 through 1990.

8-03 Recreation. Recreation facilities within the flood control basin and downstream of Prado Dam are adversely affected during periods of high WSE (i.e., above 494.0 ft.) or when outflows from Prado Dam exceed 2,500 cfs. Consequently, the water control plan minimizes the duration at which the reservoir is above WSE 494.0 ft. The downstream recreational facilities are within the Santa Ana River flood plain and are therefore subject to flooding during major flood control releases.

8-04 Water Quality. The effect of impoundments on reservoir water quality can be beneficial or adverse depending on duration and season of impoundment. Impoundment of water for short periods of time, with rapid drawdown (as for normal flood control operations), has little or no adverse effect on water quality. In fact, when water is impounded behind the dam, the concentration of suspended solids, nitrates, and iron are lower downstream of Prado Dam than upstream. The mean daily TDS of reservoir outflow is also reduced as a result of the dilution of base flow with higher quality runoff. This effect is dependent on the period and amount of storage.

Extended impoundment would be more likely to result in adverse water quality effects. Water quality may be degraded by long storage of deeper, more stable pools, especially over the summer months when higher temperatures cause thermal stratification and associated low concentration of dissolved oxygen. An appropriate example is the situation which occurred at Prado reservoir during the summer of 1980 when water was held over an eight month period, from February through September. The pool was found to be highly stratified, with anaerobic conditions in the bottom half of the storage pool. This could affect the Corps' ability to meet local and State water quality standards. Under anaerobic conditions, heavy metals, concentrated in the bottom sediments, may be released and the generation of hydrogen sulfide can result in odor problems and increased operation and maintenance costs by corroding the outlet works.

8-05 Fish and Wildlife. The flood control basin supports a diversity of resources which makes it a unique and significant area biologically. The most important biological resources of the flood control basin are the extensive and productive riparian and wetland habitats, and the special status species and migratory waterfowl which utilize the area.

In general, extended storage for water conservation would spatially extend and intensify the effects on biological resources which would be associated with normal flood control operations. These include both beneficial and adverse effects. The periodic presence of abundant open water and flooded willow woodland is an extremely unusual situation in southern California, and one that has contributed to the flood control basin's attractiveness to many rare and important species of wildlife.

Water storage for both flood control and water conservation has served to benefit certain species, mostly water-associated birds, at the expense of terrestrial habitat and to the detriment of certain terrestrial species.

Adverse effects can occur to vegetation from extended periods of submersion associated with water conservation storage. Although the mature willows which dominate the wetlands can survive inundation for several months, shrubby riparian undergrowth is more sensitive. It is this shrubby understory growth which provides nesting habitat for the LBVI. The Prado Basin population is one of only four sizeable populations of this species remaining in California. Prolonged inundation within the buffer pool may adversely affect the habitat, while flooding during the nesting season would eliminate suitable nesting habitat.

The magnitude and suddenness of releases and fluctuations in water levels are also important. Rapid lowering of water level during the nesting season of certain water-associated birds may strand nests, eggs, and young in emergent branches which were close to the water level but become suspended too far above the water. Potential impacts of this type of situation were illustrated in the spring of 1983, when an abrupt drop in the water level stranded the nests of a sizeable population of Pied-billed Grebes, a water associated bird. This resulted in the general failure of that year's reproductive efforts of the large nesting populations of this species in southern California. This type of impact could devastate local populations of many of the water-associated bird species for which the Prado Basin wooded wetlands are a primary nesting habitat.

Degraded water quality can also have detrimental effects on fish and wildlife resources. Fisheries may be affected by low levels of dissolved oxygen. Algal and bacterial problems may also occur as a result of high nutrient levels and water temperatures.

8-06 Water Supply. The water control plan increases the water conservation storage capacity by 4,500 ac-ft during the flood season. This is accomplished by careful management and coordination between the Corps and the OCWD when water exists within the debris and buffer pools. This water control plan minimizes wasting of flood waters to the Pacific Ocean.

8-07 Frequencies.

a. Peak Inflow and Outflow Probabilities. Plate 8-04 presents the inflow and outflow discharge frequency curves for Prado Dam. The curves were taken from the Phase II GDM on the Santa Ana River Mainstem dated August 1988. The frequency curves were derived from a discharge frequency analysis of historical flows on the

Santa Ana River.

b. Filling Frequency. Plate 8-05a presents the annual filling-duration frequency curves and Plate 8-05b presents the exceedance filling frequency curve. The curves were derived from a representative set of flows which were adjusted for the urbanization and wastewater effluent to the basin. Plate 8-06 presents the maximum pool elevations for the period of record.

8-08 Other Studies. The "Design Memorandum No. 1, Phase II General Design Memorandum on the Santa Ana River Mainstem, including Santiago Creek", dated August 1988, is comprised of a Main Report and 9 accompanying volumes. This extensive report evaluates a wide range of alternative flood control measures to alleviate potential flood problems within the Santa Ana River system. The report and the progress of the Santa Ana River Mainstem project should be closely followed and appropriate changes and updates noted in future revisions of this water control manual.