VIII - EFFECT OF WATER CONTROL PLAN

8-01. General

Alamo Dam is operated for flood control, water conservation, and recreation and wildlife enhancement. The effects of operating for these purposes, along with flow and elevation frequencies are described in the following sections.

8-02. Flood Control

a. Spillway Design Flood. The original spillway design flood was based on the summer occurrence of a maximum probable flood with an antecedent flood which was equivalent to the reservoir design flood. The estimate of the probable maximum flood has since been superseded, however, it still remains as the spillway design flood. The antecedent flood had a peak inflow of 220,000 cfs (6,230 cms) and a 3.54-day volume of 253,844 acre-feet (31,311 ha-m). The spillway design flood (summer maximum probable flood) had a peak inflow of 580,000 cfs (16,424 cms) and a 4-day volume of 847,144 acre-feet (104,495 ha-m). Flood routing was begun on the first day of the antecedent flood. The starting reservoir water surface elevation was assumed to be the top of the water conservation pool or 1160.4 feet (353.7 m). The peak reservoir water surface elevation of the combined antecedent-spillway design flood was 1259.6 feet (383.9 m). The peak discharge was 50,660 cfs (1,435 cms), as shown on Plate 8-01.

b. Standard Project Flood -- Original. The original standard project flood (SPF), which is the reservoir design flood, was based on a synthetic winter storm that was selected upon review as the most severe storm reasonably characteristic of the geographic area. The original SPF had a peak discharge of 317,000 cfs (8,976 cms) and a 7-day volume of 422,000 acre-feet (52,054 ha-m). In routing the original SPF through the reservoir, the controlled outflow was 7,000 cfs (198.2 cms) and the resultant peak reservoir water surface elevation attained was 1215.2 feet (370.4 m). Although conventional practice would have been to place the spillway crest at the 1215.2-foot

(370.4 m) elevation, further project studies (including routings and cost estimates) showed that there was no discernable difference in project cost from locating the spillway crest at an elevation anywhere between elevation 1215.2 (370.4 m) and 1235 feet (376.4 m). The basis for this conclusion was balancing of the deeper depth of cut required for lower elevation spillway crests balanced by the minimal increase in required dam embankment elevation for higher elevation spillway crests. The spillway crest was, accordingly, set at 1235 feet (376.4 m).

c. Standard Project Flood -- Revised. The revised standard project flood (SPF) has a peak discharge of 389,000 cfs (11,015 cms) and a 7-day volume of 613,000 acre-feet (75,613 ha-m), as referenced in the March 1986 "Interim Report on Hydrology and Hydraulic Review of Design of Existing Dams for Alamo and Whitlow Ranch Dams". The revised SPF was routed through the reservoir using the current operating plan, with the starting reservoir water surface elevation assumed to be the 1125-foot (342.9 m) target elevation. The maximum outflow was 7,000 cfs (198.2 cms), or the maximum allowable flood control release; the peak water surface elevation was 1222.1 feet (372.5 m), as referenced in the March 1999 "Alamo Dam Risk Assessment Study". The revised SPF routing is shown on Plate 8-02.

d. Probable Maximum Flood. Two methods of flood routing were used to determine the highest water surface elevation that could possibly occur during the spillway design flood. In one method, the October PMF and December PMF were routed with no antecedent flow using the top of the flood control pool as a starting water surface elevation. This is the typical routing procedure used for reservoir design because it is reasonably representative of "worst case" conditions. The other procedure used involved routing an antecedent flood prior to routing the PMF. This procedure assumes that any antecedent flow occurring prior to the PMF will not exceed the reservoir design capacity.

Referring to the "Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Alamo and Whitlow Dams," dated March 1986, the "worst case" condition was derived from routing the antecedent flood consisting of the revised

SPF, routed prior to the PMF routing. The reservoir water level would rise from the starting elevation of 1160.4 feet (net storage) and overtop the dam at elevation 1265. The revised December PMF peak discharge for Alamo Dam is 820,000 cfs (23,220 cms) with a 3-day volume of 1,390,000 acre-feet (171,456 ha-m). The revised October PMF peak discharge is 859,000 cfs (24,324 cms) with a 3-day volume of 1,180,000 acre-feet (145,552 ha-m). The original design PMF peak discharge was 580,000 cfs (16,424 cms) with a 3-day volume of 893,000 acre-feet (110,151 ha-m). The revised December PMF routing is shown on Plate 8-02a.

The revised December PMF, because of greater volume than the October PMF, was then used to evaluate current spillway adequacy and dam safety (Reference the March 1986 "Interim Report on Hydrology and Hydraulic Review of Design of Existing Dams for Alamo and Whitlow Ranch Dams" and the March 1999 "Alamo Dam Risk Assessment Study"). The December PMF was routed in association with the antecedent revised SPF, whose routing is summarized in section 8-02c. The PMF storm event was assumed to commence immediately after cessation of the SPF storm event. As such, the starting reservoir water surface elevation for the PMF was 1220.89 feet (372.1 m). The PMF was routed according to the revised operating plan assuming no transfer of flow to the spillway (maximum outlet release maintained above spillway crest). The routing, nevertheless, resulted in overtopping of the dam embankment. The maximum (theoretical) water surface elevation was 1281.3 feet (390.5 m); the maximum outflow was 282,142 cfs (7,989 cms). This routing assumes no flow over the top of the dam and the (maximum) water surface elevation assumes the dam embankment is constructed to this elevation plus the required freeboard. The spillway configuration (geometry) is assumed to also extend to the higher (theoretical) top of dam.

e. <u>Threshold Flood</u>. The flood that results in a peak reservoir water surface elevation equal to the maximum design reservoir water surface elevation, 1259.6 feet (383.9 m), is defined herein as the Threshold Flood. The Threshold Flood was determined by successive routings using varying percentages of the December PMF. The starting water surface elevation was identical to PMF starting conditions, as summarized

in section 8-02d. This event was determined to be 45 percent of the PMF, with an inflow peak of 369,000 cfs (10,449 cms) and a volume of 659,100 acre-feet (81,300 ha-m). Therefore, assuming an antecedent SPF routing, the spillway at Alamo Dam is capable of safely passing floods up to 45 percent of the PMF, occurring immediately after the SPF. The Threshold Flood routing is shown on Plate 8-03. The adopted water control plan produces an increase in dam safety, as compared to the GDM operation plan, by increasing the magnitude of the threshold flood capable of being passed safely from 33 percent to 45 percent of PMF. Reference paragraph 8-12.f. for a brief description of a risk assessment study performed for Alamo Dam.

f. Other Floods. The historic floods summarized in Sections 4-06f through 4-06k were routed according to the current water control plan. Plates 8-04 through 8-08 show the respective routings for these floods.

8-03. Recreation

With the current water control plan, recreational opportunities are enhanced by maintaining Alamo Lake at or near a maximum, the target elevation being 1125 feet (342.9 m), to the extent that reservoir inflow balances releases and evaporation losses from the lake. When the lake elevation is within the 1115-1125-foot (339.9-342.9 m) range, the functionality of the boat ramps is maximized. In addition, this elevation range maximizes access and recreational opportunity at other locations around the lake.

8-04. Water Quality

The current water control plan requires rapid lowering of the reservoir to the 1125-foot (342.9 m) target elevation after major flood events. With this operation, the reservoir evaporation rate is reduced. The result is prevention of an increase in reservoir salinity when the reservoir is at a higher elevation and storage. This, in turn, helps prevent high salinity loading into the lower Colorado River. During dry periods, when reservoir salinity normally increases due to low inflows, releases are limited to those

necessary for water rights and downstream riparian needs. These releases are small enough such that the impact of salinity on the lower Colorado River is negligible.

8-05. Fish and Wildlife

The lake surface area supports a fish population sufficient for the foraging requirements of the two pairs. The regulation at Alamo Dam supports the habitat of nesting pairs of bald eagles by maintaining minimum lake elevations. This also provides favorable conditions for the Southwestern Willow Flycatchers, which were declared as endangered without critical habitat in February 1995. Keeping the lake elevation from exceeding 1134 feet (345.6 m) prevents inundation of the lowest habitable nest site within the reservoir. Over the years, a downward trend of the local eagle population has been observed by the U.S. Fish and Wildlife Service (USFWS), and it is speculated that this was partially due to loss of occupied eagle snags from inundation. One solution suggested by the USFWS, in order to stimulate the growth of the eagle population, was that artificial perches be established within the lake area.

Between water surface elevations 1070 (326.1 m) and 1125 feet (342.9 m), baseflow releases are made which are designed to provide sufficient water for maintenance of riparian habitat along the Bill Williams River corridor, including within the National Wildlife Refuge. Baseflow releases range from 10 to 50 cfs (0.28 to 1.4 cms), depending on lake elevation and season. If necessary, hydrologic investigations will be made to more accurately define a sustainable baseflow regime that will better fulfill the riparian system's needs.

8-06. Water Supply

Based upon a 1961 Bureau of Reclamation study, operating Alamo Dam in conjunction with the Bureau's Hoover, Davis and Parker Dams can increase water supply in the Colorado River system by an average of 4,500 acre-feet (555 ha-m) per year. Under the present operating plan, conservation storage can be evacuated rapidly from

Alamo Lake. While evacuating storage from Alamo Lake, releases from Lake Mead are normally curtailed by an equivalent amount. The practice maximizes lower Colorado River system water supply for consumptive uses.

8-07. Hydroelectric Power

Although Alamo Dam has no hydroelectric power facilities, the 1961 USBR study concluded that coordination of Alamo Dam releases with releases from Hoover and Parker Dams can increase the average annual firm energy generation from those facilities as follows:

Hoover - 5 million kwh

Parker - 7.58 million kwh

The present operating plan provides the necessary flexibility in release patterns from Alamo Dam to achieve the predicted increase in energy generation. Coordination of Alamo Dam releases with USBR operation of mainstem lower Colorado River reservoirs is the key to achieving the power production increases.

8-08. Navigation

There are no benefits for or impacts on navigation from the operation of Alamo Dam.

8-09. Drought Contingency Plan

The Drought Contingency Plan for Alamo Dam and Lake was completed in June 1992 under the authority of ER 1110-2-1941, dated 15 September 1981, and available at the U.S. Army Corps of Engineers, Los Angeles District office. However, because there is presently no prescribed user for water stored in the water conservation pool, water released from Alamo Dam that reaches the Colorado River is distributed to water users in accordance with the laws and rights governing consumptive use of Colorado River water.

Water stored in Alamo Lake could be used to augment deliveries to the Central Arizona Project, the Metropolitan Water District of Southern California, and Mexico.

8-10. Flood Emergency Action Plan

The plan entitled, "Emergency Action and Notification Subplan for Alamo Dam", dated July 1986, implements the Corps' program to prepare emergency plans for all Corps projects and provides a guide for actions to identify impending and existing emergencies, and to notify other parties about impending or existing emergencies, emergency operations or repairs, and post earthquake response procedures. The plan also identifies downstream areas potentially subject to inundation in the case of dam failure at spillway crest elevation 1235 feet (376.4 m). A copy of the Emergency Action Plan is available in the Los Angeles District Office, Reservoir Operation Center and at the dam site.

8-11. Frequencies

The frequency analysis report was prepared by a contractor for the U.S. Army Corps of Engineers, Los Angeles District, as a part of a risk assessment study (see section 8-12f), which was performed in August 2000, for the period of record (1929-1998). In deriving the frequency curves, volume frequency curves were generated for the 1-, 2-, 3-, 5-, 10-, 20-, and 30-day. Balanced hydrographs for reservoir inflow were then constructed for the 1 in 50, 1 in 100, 1 in 200, 1 in 500, 1 in 5,000, 1 in 10,000, 1 in 50,000, 1 in 500,000, and 1 in 1,000,000, based on the volume frequency relationships and using the HEC-1 computer program. These balanced hydrographs and the SPF and PMF events were routed through the reservoir using the HEC-5 computer program and considered the Bill Williams River Corridor Technical Committee (BWRCTC) dam operation plan modified to reflect the Colorado River reservoir system operations for flood control.

a. Inflow Frequency. Plate 8-09 shows the volume inflow volume frequency curves for Alamo Lake. Plate 8-09a shows the 50-year balanced hydrograph, and Plate 8-09b shows the peak annual inflow frequency curve. The period of record data specifically used to generate the frequency plots are from the following sources: Alamo Dam and Lake operating records (1968-1999); USGS Gage No. 09426000 at Alamo Dam site (1940-1967); USGS Gage No. 09426500 at Planet, approximately 30 miles (48.2 Km) downstream from Alamo Dam. Flows were correlated for Alamo Dam site using linear regression (1927, 1929-1939).

Except for the extreme high events, recorded flows at Planet were adjusted for the Alamo Dam site using a correlation developed from the seven-year period (1940-1946) in which both the Alamo and Planet gages were concurrently in use.

b. Elevation Frequency. Plate 8-10 shows the Alamo Lake stage-frequency and outflow-frequency relationships for existing conditions and the existing dam without modifications. This data is from the risk assessment analysis performed in August 2000 (refer to section 8-12f).

c. Outflow Frequency. Plate 8-10 shows the outflow frequency in relation to stage for existing conditions at the existing dam for a range of Exceedance probabilities. This data is from the risk assessment analysis performed in August 2000 (refer to section 8-12f).

d. Elevation-Duration-Frequency. Plate 8-11 shows the elevation-duration curve for the period of record. This data is from the risk assessment analysis performed in August 2000 (refer to section 8-12f).

8-12. Other Studies

The following paragraphs summarize other various studies concerning Alamo Dam and lake:

a. The Los Angeles District conducted a Section 216 reconnaissance study (Flood Control Act of 1970) during Fiscal Year 1988-89 on potential reallocation of storage and re-operation of Alamo Dam. A final study report, published in July 1990, contained nine alternative operating plans.

b. The U.S. Bureau of Land Management (BLM) published a report, in December 1988, entitled "Assessment of Water Resources Conditions in Support of In-stream Flow Water Rights." The study recommended a monthly release schedule to satisfy instream water rights below Alamo Dam.

c. An interagency committee, known as the Bill Williams River Corridor Technical Committee (BWRCTC), was formed in 1991 for the purpose of developing a revised water control plan that would best meet the objectives of the member agencies. The water control plan presented in Chapter VII is the result of the various studies conducted and recommendations prescribed by the BWRCTC.

d. As a follow-up to the BWRCTC study and the recommended operating plan, the Corps, in 1996, completed a second reconnaissance study based on the 1970 Flood Control Act. The reconnaissance study was then followed by the Alamo Dam and Lake Feasibility Study. The Feasibility Study Report and the accompanying Environmental Impact Statement were completed in 1999.

e. The Corps' Hydrologic Engineering Center (HEC), in April 1998, conducted a computer simulation study for Alamo Dam and Lake operation using HEC's Prescriptive Reservoir Model optimization program. The objectives of the study were to optimize Alamo Dam and Lake operation for 1) protection of the in-lake bald eagle nests, 2) development of lake drawdown schemes for dam maintenance that would not conflict with other project purposes and 3) ascertain whether the recommended plan of the BWRCTC could be improved.

f. The Corps, in 1998-99, conducted a risk assessment study on Alamo Dam. The Alamo Dam Risk Assessment Study was a demonstration project in the development of risk assessment guidance for the Corps' Dam Safety Assurance Program. Some specific outcomes in the risk study included 1) an understanding of potential dam failure modes; 2) an evaluation of the risk posed by the existing dam against various risk-based criteria; and 3) an assessment of risk reduction and the cost effectiveness of risk reduction expected for various structural and non-structural measures. The Risk Assessment Study recognized that the existing spillway was deficient in that the PMF could not be passed without overtopping the dam, with the threshold flood being only 45% of the PMF (reference sections 8-02d and 8-02e). However, there are no current plans to modify the dam or the spillway, due to the extremely low probability of PMF occurrence and the low risk and impact to life and property downstream on the Bill Williams River and on the Colorado River main stem, should a PMF event occur.