I. INTRODUCTION

A. PURPOSE AND NEED

In the mid to late 1980's, the Arizona Game and Fish Department (AGFD), Arizona State Parks (ASP), Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (USFWS) were working independently on a range of efforts to change Alamo Dam operations and/or secure water rights to achieve their resource agency goals. Many of these goals revolved around the availability and management of water in Alamo Reservoir and along the Bill Williams River downstream (Figure 1). Although agency perspectives regarding management of the Bill Williams River and Alamo Dam and Reservoir were perceived as conflicting, most agencies had similar or overlapping resource management objectives for Alamo Lake and the Bill Williams River. [NOTE: Alamo Lake and Alamo Reservoir are used interchangeably in this report.] It became evident that by working together cooperatively, agencies could best achieve meaningful and lasting improvements to Alamo Dam operations that would serve multiple resource purposes.

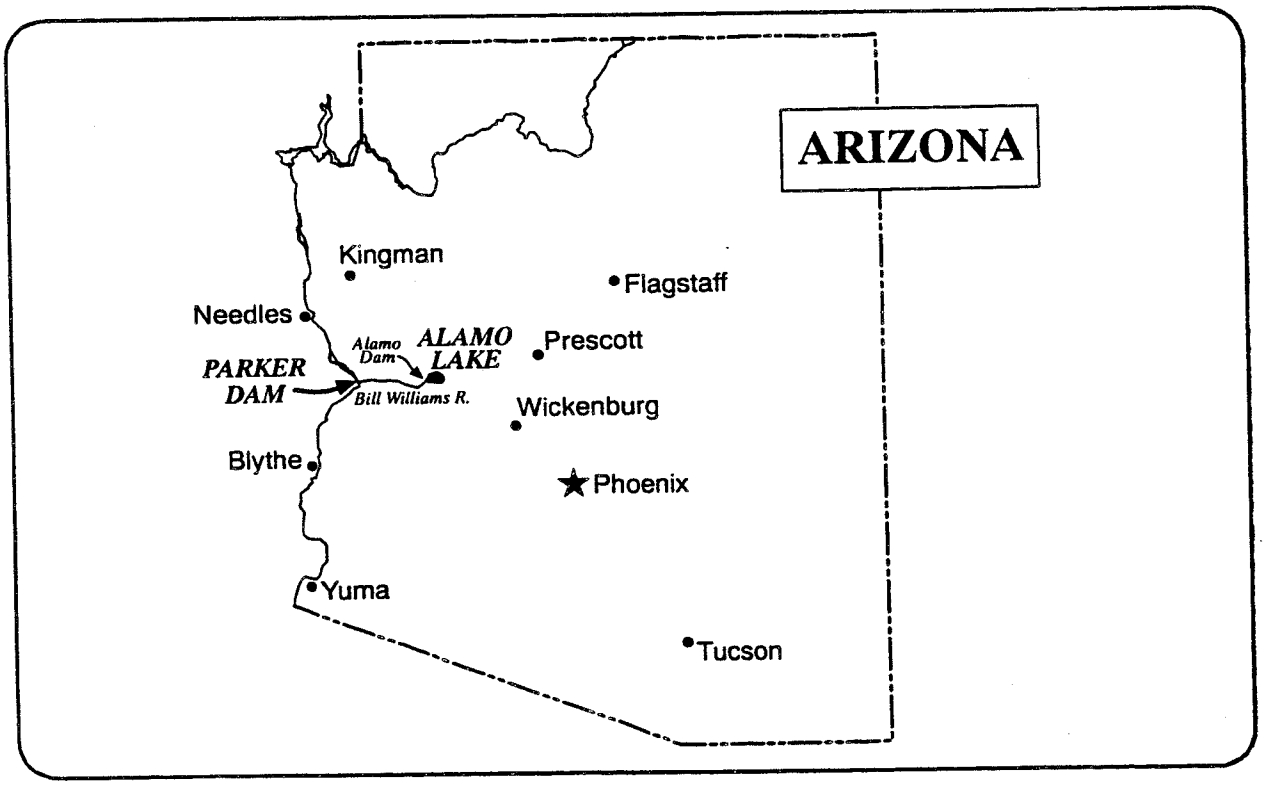

Figure 1. Bill Williams River corridor site location map.

Agency and public concerns have been expressed that lake elevation targets were impacting recreational use, and downstream releases resulting from the operations of Alamo Dam were degrading the aquatic ecosystem of the Bill Williams River. There was disagreement among

agencies over how the Army Corps of Engineers (Corps) was managing the water conservation pool at Alamo Lake, since conditions had changed from the dam's completion in 1968. Key concerns revolved around two nesting pairs of bald eagles at Alamo Lake, drawdown of lake levels for maintenance and inspection of the dam outlet works, increased demand for water-based recreation (especially fishing), water rights in the lake and downstream, and significant losses of riparian vegetation along the Bill Williams River. Riparian losses were attributed to a combination of low flow regimes affecting recruitment and extended inundation during flood flow releases resulting in mortality to mature trees.

In 1990, the Corps completed a Section 216 Reconnaissance Study for Alamo Lake that reevaluated reservoir operations for the purposes of water supply diversion to the Central Arizona Project, and water conservation, recreation, and environmental enhancement. The Arizona Department of Water Resources (ADWR) was the local sponsor for the study. Conclusions of this study were that the Corps could exercise existing authority to reallocate storage and reregulate the reservoir for the aforementioned purposes. The Corps recommended that all issues, problems, and opportunities identified in the Reconnaissance Study be evaluated in a Federally-funded Water Control Study--the goal of which is to establish the optimum storage allocation and operation schedule for all Alamo Lake project purposes. Shortly thereafter, ADWR issued a letter that provisionally agreed to the findings of the Reconnaissance Study. As the State's water management agency, ADWR requested that a coordinated effort be initiated among the affected agencies to resolve conflicts and seek common ground in the management and operation of water resources along the Bill Williams River.

In the spring of 1990, AGFD initiated dialogue among ASP, BLM, and USFWS regarding development of a coordinated, interagency planning effort focused on the management of water resources in Alamo Lake and the Bill Williams River. The agencies recognized that by working cooperatively, merging common interests, and negotiating conflicts, a comprehensive water management agreement could be achieved that would best optimize all agency management goals. In August 1990 a coordination meeting of upper level management from these four agencies and the Corps was held to establish an interagency planning team with instructions to develop a comprehensive water resource management plan for the Bill Williams River corridor. The area of concern was identified as the Bill Williams River at the Santa Maria and Big Sandy confluence, continuing downstream to include Alamo Lake, the Bill Williams River below Alamo, and the Bill Williams River National Wildlife Refuge (Refuge)(Figure 2). It was recognized that water resource management is the inextricable link that serves to protect the important and significant water-dependent uses and values within the Bill Williams River corridor. Water availability, either in the form of lake storage or stream flow, is the driving force behind all agency goals. Two interagency committees were established (Steering and Technical) to develop a corridor modeling approach for the Bill Williams River and Alamo Lake.

The agencies recognized that resolution of water level management issues at Alamo Lake, in conjunction with resource management issues involving the aquatic ecosystem of the Bill Williams River, would not be a simple process. Hydrological, biological, and recreational components of the Bill Williams River corridor must be thoroughly analyzed, and optimum resource management criteria developed. These components must be accommodated within the framework of a water

management plan that balances water level operations at Alamo Lake with downstream surface and groundwater needs in the Bill Williams River.

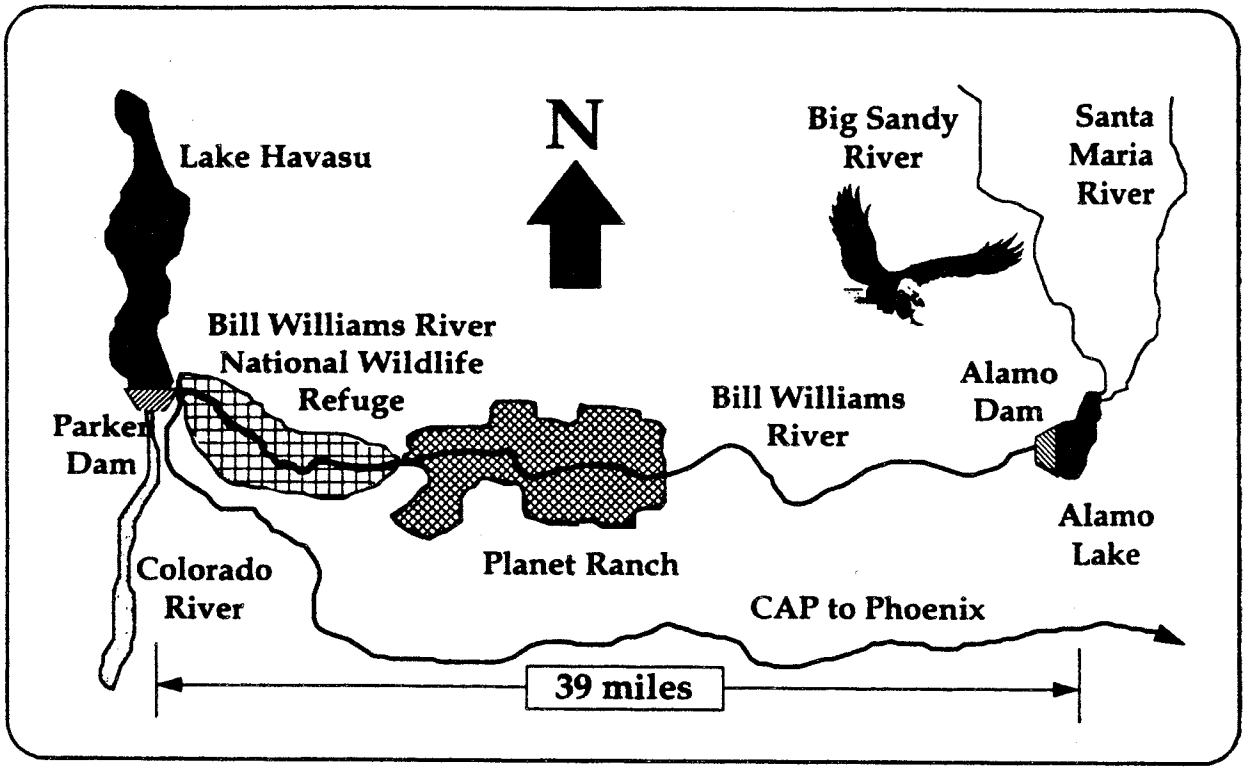

Figure 2. Bill Williams River corridor features site location map.

B. TECHNICAL COMMITTEE

The interagency planning team conceived by the five agencies became the Bill Williams River Corridor Technical Committee (Technical Committee). The Technical Committee was tasked with addressing a range of resource, recreation, and management issues, concerns, and opportunities related to Alamo Lake and the Bill Williams River. Figure 3 shows the primary resource categories of concern and how they are all tied to the operation of Alamo Dam. Alamo Dam operations, which affect threatened and endangered species, warmwater sportfisheries, water-based recreation, riparian habitat, and wildlife, is the one factor over which public agencies already have institutional control.

The goal of the Technical Committee is to carry out a coordinated interagency planning effort to develop an effective water management plan for Bill Williams River corridor resources.

The scope of the Technical Committee efforts were intentionally centered on water-dependent resources at Alamo Lake and the Bill Williams River corridor (flood plain). The Technical Committee did not address land management issues such as grazing or special protection designations (e.g. Wilderness Areas, Wild and Scenic Rivers), land acquisitions such as Planet Ranch, nor did it extend to the Big Sandy, Santa Maria, or adjacent watersheds.

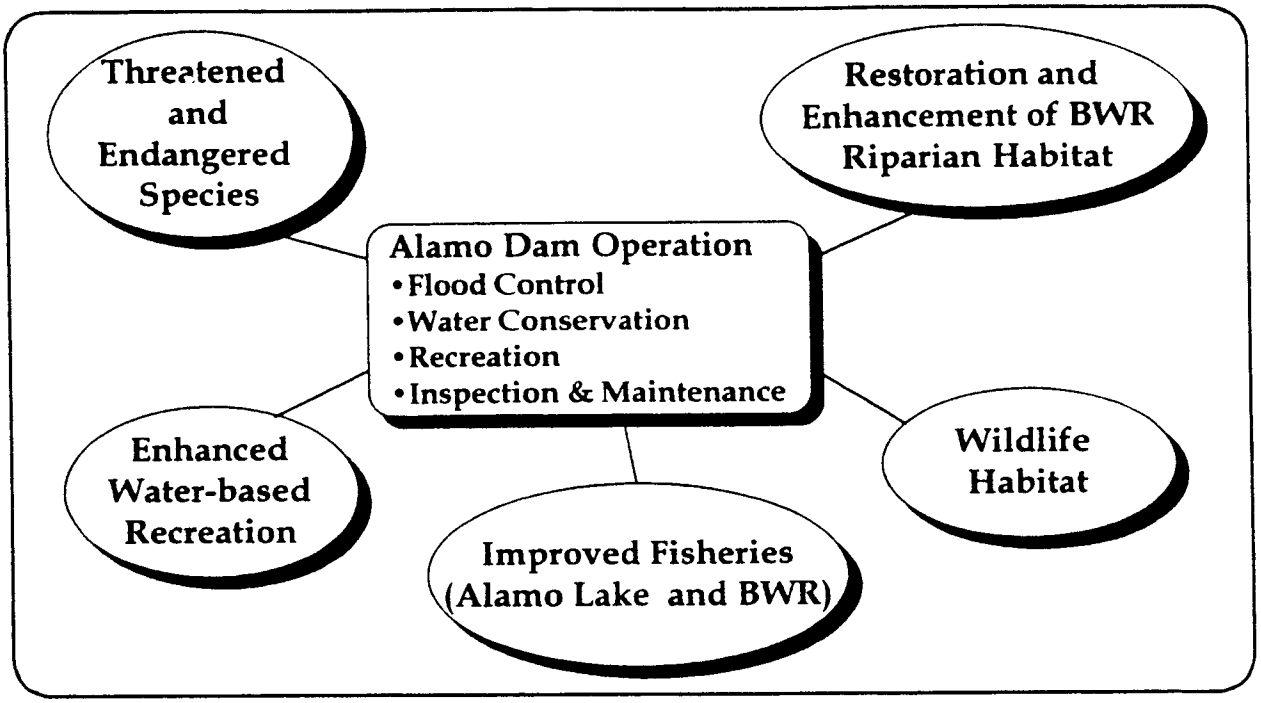

Figure 3. Resource issues, concerns, and opportunities related to Alamo Dam operations.

The Technical Committee was guided by a Steering Committee-approved 13 step process. All agencies expressed commitment to this decision-making process, which then served to focus and direct the efforts of the Technical Committee. Key steps in the process as followed by the Technical Committee are identified in Table 1. Finally, implementation steps to facilitate establishment of revised operation criteria for Alamo Dam are discussed in Chapter VI.

Table 1. Summarization of Bill Williams River Corridor Technical Committee Process.

- Each agency recognizes the importance of other agency objectives and commits to seek out potential management alternatives that would enhance the achievement of other agency objectives.
- Assemble a committee of representatives from each agency.
- Identify each agency's resource goals and objectives.
- Formulate independent water management prescriptions that optimize values and benefits for riparian, fisheries, wildlife, and recreation resources, while meeting reservoir operation requirements.
- Develop alternative reservoir operation plans that best meet collective resource goals.
- Analyze/evaluate alternative reservoir operation plans.
- Select the reservoir operation plan that best meets all agency resource objectives.
- Submit the recommended operation plan.

After a year of meetings, the Technical Committee was expanded to include the Bureau of Reclamation (USBR) and ADWR (Table 2). Appendix A lists agency personnel serving as Technical Committee members and those that participated in meetings.

Table 2. Agencies participating on the Bill Williams River Corridor Technical Committee.

- ARIZONA GAME AND FISH DEPARTMENT
- ARIZONA STATE PARKS DEPARTMENT
- ARIZONA DEPARTMENT OF WATER RESOURCES*
- U.S. BUREAU OF LAND MANAGEMENT
- U.S. BUREAU OF RECLAMATION
- U.S. ARMY CORPS OF ENGINEERS
- U.S. FISH AND WILDLIFE SERVICE

* ADWR participation is in an advisory role rather than as an advocate.

The ADWR, due to their responsibilities in State water rights and management, provided the following description of their role on the Technical Committee:

> "Participation by the Arizona Department of Water Resources (Department) in the Bill Williams River Interagency Planning Committee constitutes confirmation that it is the policy of the Department to assist in coordinating the planning activities of all governmental agencies related to the Bill Williams River to the extent the Department may do so in accordance with its responsibilities and authority under the law. It is not intended that the Department's participation on the committee shall be determinative of any decision to be made by the Department in any adjudicatory or rule-making proceeding. The Department's role, therefore, is primarily advisory to the Technical Committee."

C. STUDY AREA LOCATION

Alamo Lake is located on the Bill Williams River, 39 miles upstream from its confluence with the Colorado River in Lake Havasu (Figure 2). The lake is on the border of La Paz and Mohave Counties, Arizona. Paved access is from the town of Wenden, on U.S. Highway 60, approximately 36 miles south of the lake.

The Alamo Lake recreation area includes 22,856 acres of Corps-withdrawn lands of which approximately 16,400 acres represent the lake area for a probable maximum flood event. Fish and wildlife management responsibilities for the entire area have been turned over to the AGFD under a license agreement. Of the total 22,856 acres, 17,963 acres are specifically managed as the Alamo Wildlife Area by the AGFD, while recreation management of the remaining 4,893 acres is the responsibility of ASP under a separate lease agreement with the Corps.

Alamo Lake supports a productive warmwater fishery characterized by the popular largemouth bass. A quality fishery, coupled with other water-based recreational opportunities, supports substantial recreation use at the lake. Recreation facilities provided at Alamo Lake are operated by ASP and include an administration and service building, including offices for ASP and Corps staff. Other facilities include a 160-acre use area, trailer campsites with hookups, campsites, picnic areas with ramadas, swimming area, three boat launching facilities, and associated parking areas.

Alamo Lake is fed by two main tributaries, the Big Sandy and Santa Maria Rivers. These rivers merge to form the Bill Williams River, approximately 8 miles upstream of Alamo Dam. The Bill Williams River continues below Alamo Dam and flows westerly into the Colorado River immediately above Parker Dam.

The Bill Williams River riparian corridor contains the last extensive native woodland riparian habitat along the lower Colorado River. Riparian vegetation and the open surface waters of the Bill Williams River are the principle components of this unique desert habitat, supporting an abundance and diversity of wildlife, including fish. Flows in the river have been regulated by Alamo Dam since its completion in 1968. River flows in the lower 15 miles are also affected by water uses at Planet Ranch.

There are two BLM Wilderness Areas along the Bill Williams River, the Rawhide (2,700 acres) immediately below Alamo Dam and the Swansea (1,900 acres) immediately above Planet Ranch. The majority of landownership along the Bill Williams River is federal (BLM and USFWS), however a small number of private parcels occur along the 39 mile reach. The most notable private landowner is the City of Scottsdale, who purchased the 8,389 acre Planet Ranch in 1984 for its water rights. The Bill Williams River National Wildlife Refuge (Refuge) was established in 1941 and covers 6,105 acres along the lower 9 miles of the river. The Refuge was established following Parker Dam construction as mitigation for loss of riparian habitat along the mainstem lower Colorado River, and as a breeding ground and refuge for migratory birds and other resident wildlife.

D. ALAMO DAM AND RESERVOIR

1. PROJECT HISTORY

Alamo Dam was constructed as a multipurpose project under authorization of the Flood Control Act of December 22, 1944 (Public Law 534, 78th Congress, 2nd Session). The initial planning for Alamo Dam is contained in a January 15, 1941, report by the District Engineer, Los Angeles District. The report recommended a flood control dam be constructed at the Alamo site on the Bill Williams River. The report also recommended that the features of the dam and reservoir have the capability to meet water conservation and power developments, as well as changes in flood control requirements.

After formal authorization, the Corps conducted various hydrologic, topographic, and geologic studies from 1946 through 1963. The Corps entered into an agreement with the USBR for the

latter to assess water conservation and hydropower potential of the project. In a November 1961 report, the USBR (acting under agreement with the Corps) concluded that there was water conservation potential, but no feasible hydropower potential.

The original design concept was a concrete arch dam with an overflow spillway located in the center of the structure. However, following a restudy in the early 1960's, the final design consisted of an earthfill dam with a detached spillway in the right abutment. (Reference Design Memorandum No. 3, dated April 1964.) Construction of the dam and appurtenant works was started in March 1965 and completed in July 1968. Alamo Lake operations are directed according to a revised 1973 Reservoir Regulation (Water Control) Manual.

2. PROJECT PURPOSES

The various authorized purposes for which the project is operated (flood control, water conservation and supply, and recreation) are described below. Figure 4 shows current reservoir storage allocations for these purposes, along with release criteria.

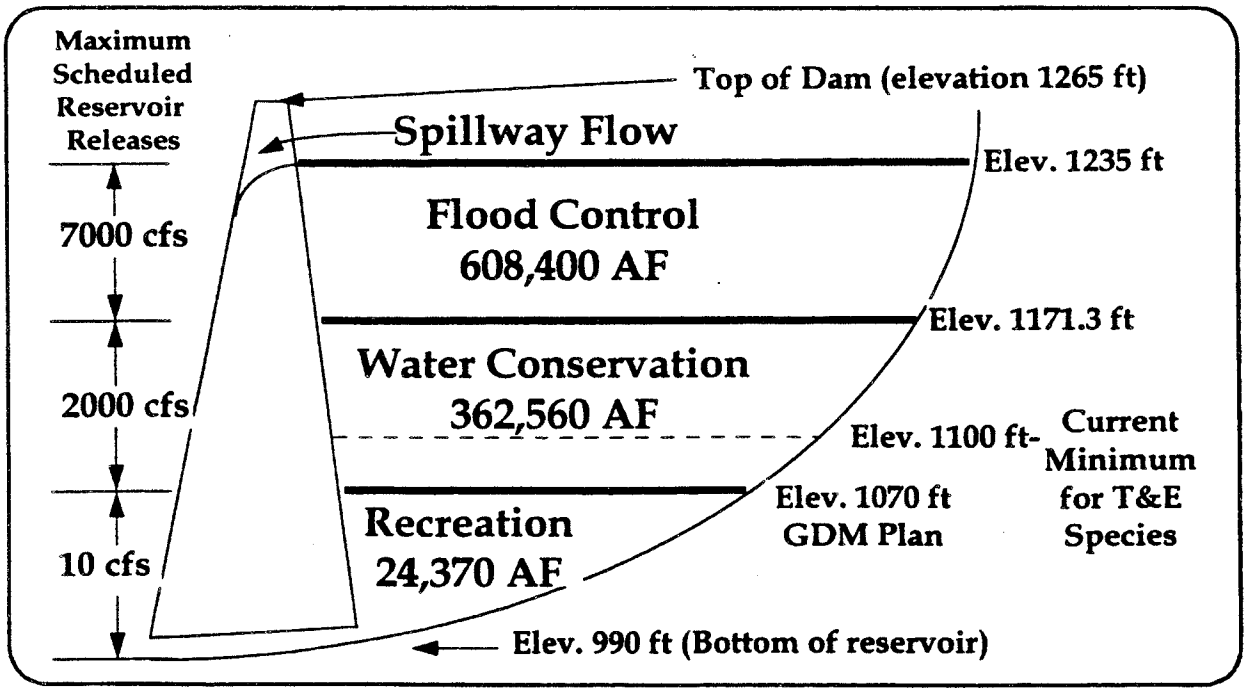

Figure 4. Alamo Dam storage allocations and current operation.

a. Flood Control

The dam was authorized to provide flood control for lower Colorado River communities downstream from Parker Dam (Lake Havasu), and to provide flood protection along the Bill Williams River corridor. At the time of the project's proposal, the Bill Williams River was the last major unregulated tributary to the lower Colorado below Hoover Dam. Alamo Dam was deemed necessary because the dams on the lower Colorado River, below

the Bill Williams River confluence, were not authorized for flood control. Alamo Dam flood control operation is accomplished by reducing flood flows on the Bill Williams River to a maximum reservoir release of 7,000 cubic feet per second (cfs), or less. Selection of 7,000 cfs is based on two factors: 1) the capacity of the Bill Williams River channel to carry this discharge without significant damage, and 2) the non-damaging Colorado River channel capacity below Parker Dam was about 25,000 cfs. In conjunction with the USBR dams on the Colorado River, Alamo Dam is operated to reduce lower Colorado River flood flows to non-damaging levels.

b. Water Conservation and Supply

To date, the Corps has not contracted with a water supply user for supply and conservation storage. In the past, the Corps has requested the State to act as a cooperator in the project, however, the State has been unable and unwilling to assume the financial responsibilities associated with such an arrangement. The conservation pool has been used for only short-term storage of water, which has been released to Lake Havasu. Potential local users of the water conservation pool have recently applied to the ADWR for rights to the unallocated water (see Chapter VI, Remaining Issues). Reservoir releases to satisfy water rights of downstream users presently consist of matching inflow up to a maximum of 10 cfs. These base flow releases (averaging 7,240 acre feet per annum) are necessary to provide sufficient flow in the downstream river system to meet water right withdrawals.

Prior to reaching Lake Havasu, the entire Bill Williams River water supply is considered solely as Arizona's entitlement. Once Bill Williams River flows reach the Colorado River, they are allocated in a manner consistent with the "Law of the River" including the U.S. Supreme Court Decree in Arizona v. California of March 1964. The decree provided that the first 7.5 million acre-feet available in the Colorado River main stem each year for consumptive use by Arizona, California and Nevada be apportioned as follows: 2.8 million acre-feet for Arizona; 4.4 million acre-feet for California; 300,000 acre-feet for Nevada. If more than 7.5 million acre-feet were available in a given year, California and Arizona are each apportioned 50 percent of the surplus, and the United States has the right to contract with Nevada for up to 4 percent of the surplus. This 4 percent is to come out of Arizona's surplus share.

c. Recreation

For Alamo Lake, a recreation pool was established immediately below the water conservation pool. The recreation pool is maintained, inasmuch as possible, by limiting releases to 10 cfs whenever the reservoir water surface elevation is within the pool. The AGFD currently holds water rights in the recreation pool for 25,000 acre-feet which, when using the Corps 1993 revised area-capacity tables, provides approximately 1,172 surface acres at a lake elevation of 1070.5 feet. These non-consumptive rights are for fish, wildlife, and recreational purposes and comprise a minimum recreational pool within the reservoir. Recreational facilities at Alamo Lake consist of boat launching ramps, campgrounds, and appurtenant structures. All facilities are operated and maintained by

ASP. Alamo Lake is one of the few water bodies in western-central Arizona, and as such is highly important for water-based recreation.

3. CURRENT ISSUES AND CONCERNS

Since 1978, the entire Colorado River basin has experienced several years of above-normal runoff. For the years 1983 through 1986, the natural flow at Lee's Ferry averaged over 22 million acre-feet per year, or about 150% of the 1906-1990 average. Runoff on the Bill Williams River system in 1980 totalled 503,800 acre-feet or 477 percent of the normal annual volume for the same period of record. To alleviate future flooding concerns on the lower Colorado River, a multi-agency meeting was convened in March 1980 to discuss what appropriate measures should be taken with respect to the Bill Williams River. A decision was made whereby the Corps would gradually lower the elevation in Alamo Reservoir to 1110 feet, and maintain that elevation as long as conditions warranted. The 1110 foot elevation was chosen because, at the time, it was determined to be an optimal value for flood control, water supply, and recreational interests. Because above-normal runoff in the Colorado river system continued into the mid-1980's, the reservoir water surface elevation was maintained at or near 1110 feet longer than originally anticipated. While making the Alamo Lake area an even more popular and valuable recreation resource, the higher lake elevations created a number of public and agency expectations which gave rise to issues and concerns surrounding the operation of Alamo Dam. These issues are summarized in the following paragraphs.

a. Lake Recreation

Arizona State Parks replaced boat launch ramps and other recreational facilities inundated by the higher lake elevation. Boat launch ramps and other recreation facilities constructed by ASP were designed for usage at water surface elevations above 1100 feet. The new facilities, coupled with the higher lake elevation, increased annual recreational usage because of greater lake surface area. Arizona State Parks has planned further expansion of the recreational facilities around the lake on the assumption that a minimum 1105-1110 foot lake elevation will be maintained.

b. Lake Fishery

The AGFD has established a successful and highly popular largemouth bass fishery at Alamo Lake. Largemouth bass spawning success can be negatively impacted by fluctuating lake levels during the spawning season. Recruitment of warmwater fish corresponds to available habitat and prey abundance which are affected by water surface elevation changes and lake inflows. In response to increased angling pressure and the associated impacts on fish populations, the AGFD enacted special "slot length" regulations on largemouth bass in 1989 to preserve and manage the quality bass fishery.

c. Bald Eagles

In the early 1980's a pair of Southern Bald Eagles, a Federally listed endangered species, was discovered nesting in a partially inundated tree within the upper reaches of Alamo

Lake. Subsequently, another pair was discovered nesting on a bluff in the canyon wall downstream from the dam. The use of the lake by the eagles for foraging prompted the USFWS to request that the lake elevation remain within the range of 1100-1135 feet for the preservation of the eagles. In a March 25, 1988, letter to the Corps, the USFWS requested that Alamo Lake not be drawn down below elevation 1100 feet. This request was made to ensure sufficient lake surface foraging area for the eagles living in the two nests. The request was in accordance with the National Environmental Policy Act (P.L. 91-190, 91st Congress, 1st Session) and the Endangered Species Act (P.L. 93-205, 93rd Congress, 1st Session). The 1135 foot maximum lake elevation was requested to prevent inundation of the reservoir nest. Lake operations since 1988 have attempted to comply with an 1100 foot minimum lake elevation--this essentially represents current conditions.

d. Riparian Habitat

Historic accounts of Bill Williams River flows estimate that the maximum peak flood flow past Planet Ranch was in excess of 200,000 cfs and occurred in 1891. Other pre-Alamo Dam flood events with peak flows past Planet Ranch of 100,000 cfs or more occurred in 1884, 1905, 1906, 1906, 1910, 1916, and 1927. Since construction of Alamo Dam in 1968, the highest peak flow (i.e., inflow to Alamo Reservoir) was 104,667 cfs in February 1993. Other peak flows in excess of 60,000 cfs occurred in 1978 (twice), 1980, 1983, and 1991. In the absence of Alamo Dam, these peak flows would have resulted in peaks of similar magnitude at Planet Ranch. However, since the completion of Alamo Dam, Bill Williams River flows past Planet Ranch have been limited to a maximum 7,000 cfs.

Unregulated flooding events have a beneficial flushing effect on the downstream riparian community and also tend to provide massive, almost instantaneous recharge to the alluvial aquifer system. A significant portion of the cottonwood tree stands along the Bill Williams River have been destroyed as a result of the pattern of past Alamo Dam releases. By 1978, 10 years after Alamo Dam completion, Ohmart (1978) estimated that riparian areas had decreased in extent by 70% over historic levels. The construction of Alamo Dam has resulted in greatly altered flow magnitude, duration, frequency, and timing in the Bill Williams River. Riparian communities are adversely affected by the lack of base flows, sustained inundation of their root zones during high flow events, lack of sediment, and general alteration of a natural flow regime.

Because riparian vegetation has diminished since the completion of Alamo Dam, various resource agencies have sought to modify release patterns from Alamo Dam to help restore the riparian area. Recommended releases have included requests that call for higher peaks (up to the 7,000 cfs authorized maximum), mimic natural pre-dam spring and summer (monsoon) flood events, avoid inundation mortality of mature trees, and provide adequate base flows that sustain downstream riparian habitat all the way to Lake Havasu.

e. Outlet Tunnel Inspection and Maintenance

Corps regulations prescribe that every five years a complete inspection and engineering evaluation of the condition of the dam be performed. Inspections in 1986 indicated that

the emergency and service gates were leaking and in need of repair. To inspect and/or maintain the gates, the outlet tunnel must be dewatered requiring lowering of Alamo Lake water levels. An Environmental Assessment, Alamo Lake Gate Rehabilitation Project, was prepared in September 1989 that determined that reservoir drawdown impacts associated with dewatering the outlet tunnel were insignificant. Reservoir drawdowns for the purposes of outlet tunnel inspections have never occurred at Alamo Lake due to: 1) already low lake levels, 2) high lake levels that prevented installation of the bulkhead, and 3) rehabilitation of the bulkhead and gates in 1991.

The outlet tunnel dewatering process is accomplished by: 1) closing all service gates; 2) placing a bulkhead gate over the outlet tunnel intake structure; and 3) opening one of the service gates. When the bulkhead gate is in place the reservoir water surface elevation cannot exceed 1110 feet. If the elevation exceeds 1110 feet, the hydrostatic pressure exerted against the bulkhead gate could cause failure of the bulkhead gate and/or intake structure concrete. During an extended maintenance period, sufficient reservoir storage space below elevation 1110 feet is necessary to prevent a flood from raising the pool above 1110 feet before the bulkhead can be removed (Appendix H). In recent years, a lake target elevation of 1100 feet has been identified to provide this safety "buffer". The scheduled period of reservoir drawdown for inspections is from June through November. In summary, approximately every five years an inspection of the outlet tunnel must be made that requires Alamo Lake elevations below 1110 feet--for high water years, this may require a reservoir drawdown.

f. Hydraulic Limitations of Dam Outlet Works

Operational criteria for the three pairs of outlet gates restrict the gate setting to 80 percent of the maximum 8.5 feet opening, or 6.8 feet. As a result of this restriction, the minimum elevation within the water conservation pool at which 7,000 cfs can be released (due to hydraulic head requirements) is 1148.4 feet. Minimum releases from the outlet gates are in the range of 150-180 cfs depending on lake elevation.

The outlet works also include a butterfly valve for discharging low flows from 1-105 cfs. The butterfly valve has a computed discharge capacity at maximum opening of 88-105 cfs, depending on reservoir pool elevation.

E. PREVIOUS STUDIES

A variety of studies, planning and operation documents, environmental assessments, and management plans and reports on the Bill Williams River and Alamo Lake have been prepared over the past 30 years. A listing of selected titles is included in the Bibliography (Chapter VII).