

# TABLE OF CONTENTS

	<b>Page</b>
LIST OF FIGURES	iii
LIST OF TABLES	v
EXECUTIVE SUMMARY	vii
I. INTRODUCTION	1
A. Purpose and Need	1
B. Technical Committee	3
C. Study Area Location	5
D. Alamo Dam and Reservoir	6
1. Project History	6
2. Project Purposes	7
3. Current Issues and Concerns	9
E. Previous Studies	11
II. IDENTIFIED RESOURCE GOALS	11
III. FORMULATION OF ALTERNATIVE RESERVOIR OPERATION PLANS	13
A. Synopsis/Highlights of Subcommittee Reports	13
1. Riparian	13
2. Fisheries	17
3. Wildlife	19
4. Recreation	20
5. Reservoir Operations	22
B. Evaluation/Blending of Subcommittee Reports	22
C. Development of Alternatives	23
IV. EVALUATION OF ALTERNATIVE RESERVOIR OPERATION PLANS	25
A. Evaluation Tools: HEC-5 Model	25
1. General Description	26
2. Program Capabilities and Limitations	26
3. Model Inputs in Technical Committee Study	27
4. Model Outputs in Technical Committee Study	29

## TABLE OF CONTENTS (continued)

	<b>Page</b>
B. Evaluation Criteria	30
C. Evaluation of Alternatives	30
1. Alternatives Considered	32
2. Unacceptable Alternatives	35
3. Proposed Alternative	35
4. Special Runs	35
V. PROPOSED PLAN	40
A. Plan Components	40
1. Lake Elevation	40
2. Prescribed Releases	40
3. Release Considerations	43
B. Benefits of Plan	44
VI. IMPLEMENTATION OF PLAN	51
A. Immediate Steps	51
B. Remaining Issues	51
C. Future Actions, Activities	53
D. Future of Technical Committee	54
VII. BIBLIOGRAPHY	55
VIII. APPENDICES	57
A. Technical Committee Membership and Participant List	57
B. Chronology of Technical Committee Activities	59
C. Agency Goals	60

### VOLUME II: APPENDICES

D. Riparian Subcommittee Report	
E. Fisheries Subcommittee Report	
F. Wildlife Subcommittee Report	
G. Recreation Subcommittee Report	
H. Reservoir Operations Subcommittee Report	
I. HEC-5 Summary Statistics for 14 Alternative Reservoir Operating Plans	

## LIST OF FIGURES

Figure	Page
1. Bill Williams River corridor site location map.	1
2. Bill Williams River corridor features map.	3
3. Resource issues, concerns, and opportunities related to Alamo Dam operations.	4
4. Alamo Dam storage allocations and current operation.	7
5. Generalized process to formulate water operation plan alternatives from subcommittee optimal recommendations.	23
6. Hydrologic schematic of Bill Williams Reservoir and River system.	27
7. Alamo Dam historic monthly inflows (1890-1993).	28
8. Comparison of current and recommended Alamo Dam operations.	45
9. Comparison of success in meeting flood control goals by GDM, current operation, and recommended 1125' target. FC1 = Number of days WSE above 1171.3' during period of record; FC2 = Maximum percent of flood control space used during period of record. NOTE: values for A1125D05 for both FC1 and FC2 are zero during period of record.	46
10. Comparison of success in meeting water conservation goals by GDM, current operation, and recommended 1125' target. WC1 = Average annual delivery of water to lower Colorado River (Lake Havasu); WC2 = Average annual Alamo Reservoir evaporation in Acre Feet for period 1929-93.	47
11. Comparison of success in meeting recreation goals by GDM, current operation, and recommended 1125' target. RE3 = Percent of time water surface elevation at or above 1108'; RE4 = Percent of time water surface elevation between 1115' and 1125'.	47
12. Comparison of success in meeting fisheries goals by GDM, current operation, and recommended 1125' target. F1 = Percent of time water surface elevation between 1110' and 1125'; F2 = Percent of time in March 15-May 31 water surface elevation fluctuates more than 2" per day.	48

## LIST OF FIGURES (continued)

Figure		Page
13.	Comparison of success in meeting riparian goals by GDM, current operation, and recommended 1125' target. RA3 = Percent of time Alamo Dam releases greater than or equal to 25 cfs in November through January; RA4 = Percent of time Alamo Dam releases greater than or equal to 40 cfs in February through April and in October; RA5 = Percent of time Alamo Dam releases greater than or equal to 50 cfs in May through September.	48
14.	Comparison of success in meeting wildlife goals by GDM, current operation, and recommended 1125' target. W1 = Percent of time water surface elevation at or above 1100'.	49

## LIST OF TABLES

Table	Page
1. Summarization of Bill Williams River Corridor Technical Committee Process.	4
2. Agencies participating on the Bill Williams River Corridor Technical Committee.	5
3. Consolidated list of agency resource goals for the Bill Williams River corridor.	12
4. Matrix of agency resource or management concerns.	12
5. Riparian Subcommittee minimum and acceptable base flow seasonal recommendations for Alamo Dam releases.	15
6. Recommendations for spring flushing flows from Alamo Dam.	16
7. Summary of Alamo Lake fish spawning and growing season criteria.	19
8. Summary of recreation-based lake and river operational criteria.	22
9. Generalized Alamo Dam release schedule. Based on target elevations for alternative operating plans.	25
10. Estimated percolation of Bill Williams River surface flow into the Planet Ranch aquifer. (Correlation based on daily average surface flows recorded at both the Alamo Dam site and near Planet Ranch from 1940-46. Inflows in excess of 3,200 cfs were assumed to lose a constant 1,000 cfs to percolation. Flows in excess of those percolated were treated as surface flows through the Planet Ranch area.)	29
11. Codes, "target" lake elevations and descriptions of Technical Committee alternative operation plans modeled using HEC-5.	30
12. Listing of criteria evaluated in the HEC-5 model for riparian, fisheries, wildlife, recreation, water conservation and flood control categories.	31
13. HEC-5 model evaluation criteria summary. Descriptions of the Alternative Operation Plans are in Table 11. WSE = Water Surface Elevation.	33
14. HEC-5 model evaluation criteria special runs for target elevation 1125 feet. Descriptions of the Alternative Operation Plans are in Table 11. WSE = Water Surface Elevation.	37

## LIST OF TABLES (continued)

Table		Page
15.	Modeled Alamo Reservoir elevations for current operations and for the proposed 1125 foot plan using hydrologic data from the 1928-93 period of record.	41
16.	Generalized Alamo Dam release schedule based on recommended 1125' target elevation operating plan.	43
17.	Summarization of effects/impacts of recommended reoperation plan.	45
18.	Remaining issues for the implementation of a revised Water Control Manual for Alamo Dam.	51

## EXECUTIVE SUMMARY

In 1991, at the direction of the Steering Committee, the Arizona Game and Fish Department, Arizona State Parks, Bureau of Land Management, Fish and Wildlife Service, and the Corps of Engineers formed the Bill Williams River Corridor Technical Committee. The purpose of the Technical Committee was to cooperatively develop a revised water management operations proposal for Alamo Lake and the Bill Williams River. The Bureau of Reclamation joined the Technical Committee a year later as did the Arizona Department of Water Resources which served only in an advisory capacity. The agencies 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. While water availability, either in the form of lake storage or stream flow, is the driving force behind all agency resource goals, it was also an issue of controversy among the resource agencies.

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 and, by doing so, to resolve perceived agency water management conflicts. The Technical Committee was guided by a Steering Committee-approved process that called for the selection of a reservoir operation plan that best meets collective agency resource objectives. In meeting these objectives, riparian, fisheries, wildlife, and recreational resource values and benefits are to be optimized while meeting Alamo Dam project purposes for flood control, water conservation and supply, and recreation.

Subcommittees were established to develop independent water management prescriptions for Alamo Lake and the Bill Williams River for each of five categories: riparian, fisheries, wildlife (including threatened and endangered species), recreation, and reservoir operations. The prescriptions were blended to create alternative operation plans for Alamo Dam that balanced all resource objectives. Streamflow requirements for riparian habitat, as recommended by the Riparian Subcommittee, were the key to establishing the reservoir release pattern for alternative operation plans. Based on each Subcommittee's recommendations, evaluation criteria were developed for each resource category to determine how well the alternative plans maximized benefits to resources in Alamo Lake and the Bill Williams River.

The principal water management evaluation tool used in the Technical Committee study was the Corps of Engineers' HEC-5 computer program. This program simulated river flow and reservoir system operation on a continuous basis using observed flow records from 1929-93 as input. Using the HEC-5 program, a range of operational alternatives were simulated to identify performance in meeting optimal resource evaluation criteria. Each alternative sought to operate the lake between a minimum 1100 foot elevation and a target lake elevation ranging from 1115 to 1171.3 feet (top of Water Conservation Pool). These target elevations determined the point at which Alamo Dam releases would be changed from base flows (25-50 cfs) to high release "flushing" flows (1,000-7,000 cfs). The operational alternatives were compared to the original authorized operations at 1070 feet (General Design Memorandum or GDM) and current operations, which attempt to retain the lake at the 1100 foot minimum elevation.

When compared to the current (1100 foot) operations, a significant improvement in nearly all evaluation criteria categories was realized for each of the alternatives considered. By consensus, the 1125 foot target elevation water management alternative was selected by the Technical Committee as the plan which optimizes resource objectives within operational constraints and objectives of Alamo Dam. While the 1125 foot plan is the preferred alternative of the Technical Committee, the 1120, 1123, and 1127 foot plans performed similarly in nearly all resource categories evaluated. The 1125 foot plan provides 80,000 acre-feet of lake storage above the 1100 foot minimum lake level that represents current operations. This large-volume storage is available for riparian, fish, wildlife, and recreational benefits. While this proposal is referred to as the 1125 foot plan, attention should be focused on resource benefits realized from a revised Alamo Dam operational scheme, not on the target 1125 foot lake elevation itself.

The preferred 1125 foot target elevation proposal provides sufficient water storage for downstream flows, while keeping lake elevations  $\geq$  1100 feet for a majority of the time. When reservoir pool levels are below the target elevation, reduced reservoir releases are made to maintain seasonal base flows ranging from 25-50 cfs throughout the Bill Williams River corridor at levels beneficial to riparian habitat. For reservoir pool levels above the 1125 foot elevation, a rapid transition is made to high releases (1,000-7,000 cfs) that mimic natural pre-dam flood flows to the extent practicable. These operations maintain relatively stable lake elevations suitable for fisheries and recreational resource objectives. Additional benefits to riparian, wildlife, and water conservation resources can be realized with reduced or diminished pumping activities at Planet Ranch. Additional enhancements to riparian, fisheries, and recreation resources also occur when outlet tunnel inspection and maintenance activities are conducted so that reservoir drawdowns are not required as frequently, or at all.

Benefits of the recommended 1125 foot reoperation plan are substantial for flood control, recreation, fisheries, riparian habitat, wildlife and threatened and endangered species categories. For flood control, lake elevations are predicted never to reach the flood control pool elevation of 1171.3 feet. The recommended plan maintains higher lake elevations over a greater period of time, which translates into greater utilization of the existing boat ramps and recreational facilities at Alamo Lake. For fisheries, lake elevations are held more consistently between 1110 and 1125 feet, and the incidence of harmful lake fluctuations during the spawning season are reduced more than 50%. Riparian resources will greatly benefit from significant increases in base flow amounts and duration for all seasons. Recommended flushing flow releases will provide benefits similar to a natural flooding event and eliminate mortality of riparian vegetation due to extended inundation. For wildlife, dramatic improvement is achieved in keeping the lake above 1100 feet and restoring riparian communities downstream. Bald eagles will benefit from an improved fish forage base and the restoration of cottonwood and willow habitats for nesting and perching activities. While the recommended plan will increase inundation frequency of historically used nest sites in the upper lake, the significance of the inundation may be less than previously believed since bald eagles used alternative sites away from lake disturbances in 1993 and 1994. A less than 10% reduction in mean annual water delivered to Lake Havasu (5,561 acre-feet) is realized due to evaporation losses caused by retaining more water in the Water Conservation Pool of Alamo Lake over time.



Implementation of the proposed water management plan for Alamo Dam and the Bill Williams River will require numerous steps and the resolution of various issues. The Technical Committee recommends a public involvement process begin after Steering Committee approval of a final water management plan proposal. Public involvement would be preceded by briefings with state, regional, and local political entities and downstream landowners. Meetings should be held to advise the public of the interagency process to date, the proposed Alamo Dam operation changes and probable implementation strategies. Any operational changes to Alamo Dam will require formal documentation by the Corps which will necessitate full public disclosure and National Environmental Policy Act compliance. Thus, a more formal public involvement process will occur prior to any changes in Alamo Dam operations.

Water rights and water conservation are significant issues to resolve. At present there are four water right applications for Alamo Lake storage and Bill Williams River instream flows. It may be necessary to modify or withdraw these applications so that a single (or joint) entity may pursue water rights that secure the recommended lake storage and base flows under this proposal. Various studies have demonstrated that a considerable amount of unappropriated public water is available for beneficial use from the Bill Williams River system.

There are specific institutional and procedural implications if the recommended operational changes are considered reoperation or reallocation. It is the opinion of the Corps that they cannot formally reoperate Alamo Dam until the State of Arizona agrees to change the allocation of the Water Conservation Pool to threatened and endangered species, fish and wildlife, downstream riparian habitat, and recreation purposes. The Corps anticipates five sequential administrative steps for reallocation: 1) preparation of an Initial Appraisal Report, 2) preparation of a Reconnaissance Study Report, 3) preparation of a Feasibility Report, 4) approval of Feasibility Report by Corps Office of Chief of Engineers and Secretary of Army, and 5) Congressional reallocation approval. Following Congressional reallocation of Alamo storage, the final step for formal reoperation is to revise the Water Control Manual for Alamo Dam. It is estimated that these steps may take from 3-5 years. These steps may be reduced or expedited by specific Congressional actions in the future. During the interim period, the Technical Committee recommends the Corps exercise operational flexibility, as legally allowed, under the current Manual to operate Alamo Dam in a manner approximating the proposed 1125 foot target plan.

While this 1125 foot target elevation proposal will best optimize the various resource objectives evaluated, it is important to recognize that reoperation of Alamo Dam itself may not be sufficient to fully achieve all resource potentials. Management and monitoring of environmental and recreational resources by agencies will continue to be a critical component in the overall optimization of resources associated with Alamo Lake and the Bill Williams River.

#### **Technical Committee Recommendations**

- Approve the proposed 1125 foot plan as the water management alternative which best meets optimal resource objectives within operational constraints and objectives of Alamo Dam.

- Following Steering Committee approval of a final water management plan proposal, a public involvement process should begin with the following elements: 1) briefings with state, regional, and local political entities and downstream landowners, 2) press release, and 3) if necessary, informational open house public meetings.
- The Steering Committee should aggressively pursue implementation of the proposed water management plan. This may include, but not be limited to, coordination with the Corps in development of a Feasibility Report and a revised Water Control Manual, and pursuit of congressional sponsorship of legislation that would expedite the reallocation and reoperation of Alamo Lake.
- Agencies should continue the cooperative, interagency framework of the Technical Committee to actively pursue resolution of the numerous remaining issues.
- A single (or joint) entity should obtain water rights that secure the recommended lake storage and base flows under this proposed plan.
- Agencies should continue to emphasize management and monitoring activities that enhance resource benefits associated with Alamo Lake and the Bill Williams River.
- While reallocation and reoperation procedures are being implemented, the Corps should exercise operational flexibility, as legally allowed, to operate Alamo Dam in a manner approximating the proposed 1125 foot target plan. The Technical Committee could be used as a forum for collaborative input to the Corps on "interim" lake level management and Alamo Dam release prescriptions.