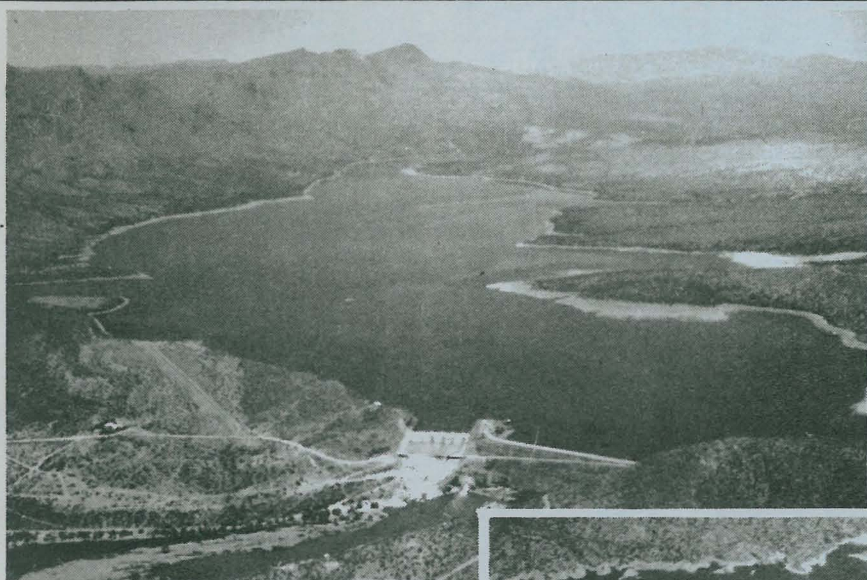
US Army Corps
of Engineers
[Lo]s Angeles District



# Study for Flood Control



# ALTERNATIVES TO CLIFF DAM

October 1988

**STUDY FOR FLOOD CONTROL**

**ALTERNATIVES TO CLIFF DAM**

Los Angeles Distict
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# TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

**INTRODUCTION**

The Central Arizona Project (CAP) was authorized by the Colorado River Basin Act (PL 90-537). Its purpose was to bring Arizona's entitlement of Colorado River water to central Arizona (Figure 1). In 1968, Orme Dam or a suitable alternative was authorized as a CAP feature. It would provide terminal storage in Phoenix as well as flood control along the Salt River. With the publishing of the draft EIS is 1976, overwhelming opposition to Orme Dam surfaced. These concerns and others caused the Bureau of Reclamation (Bureau) to reassess the merits of Orme Dam. Then in April 1977, President Carter recommended that Orme Dam be deleted from the CAP. The Bureau initiated renewed flood damage investigations in 1978 with the Central Arizona Water Control Study (CAWCS). Shortly thereafter, the Corps of Engineers (Corps) signed a Memorandum of Understanding with the Bureau to provide Corps' expertise in evaluating flood control benefits of the Bureau's alternative plans to Orme Dam and to position the Corps to evaluate the residual flood control problems in the Phoenix area with the Bureau's recommendation in place. However, because of the effectiveness of the Bureau's recommendation (Plan 6) in providing flood control, further studies by the Corps were terminated.

The Secretary of the Interior in 1984 selected Plan 6, out of nine possible plans, as the alternative to Orme Dam. The essential elements of Plan 6 were as follows (Figure 2):

* New Waddell Dam on the Agua Fria River to provide regulatory storage for CAP;

* Cliff Dam on the Verde River for water supply, flood control and to rectify dam safety problems at Horseshoe and Bartlett dams;

* Roosevelt Dam on the Salt River would be modified for dam safety and flood control, and;

* Stewart Mountain Dam on the Salt River would be modified for dam safety purposes.

Cliff Dam was one of four structures which comprised Plan 6. Cliff Dam became the object of controversy principally because of its potential adverse impacts on Sonoran desert nesting bald eagles and their habitat. Increasing opposition from a coalition of eleven national and local environmental organizations resulted in an agreement being reached between the Arizona Congressional delegation and the environmental coalition. This agreement is in the form of a "Statement of Principles' which appeared in the Congressional Record, June 24, 1987.

The Statement of Principles states that no further funds would be appropriated for the study or construction of Cliff dam and that Plan 6 would not include Cliff Dam or similar water conservation storage features on the Verde River as an element of the recommended plan. The environmental coalition agreed to terminate, without prejudice, it lawsuit against Plan 6 and to support appropriations of funds under the Reclamation Safety of Dam Act to complete safety related improvements at Horseshoe and Bartlett, modified Roosevelt and modified Stewart Mountain Dams. The Statement of Principles

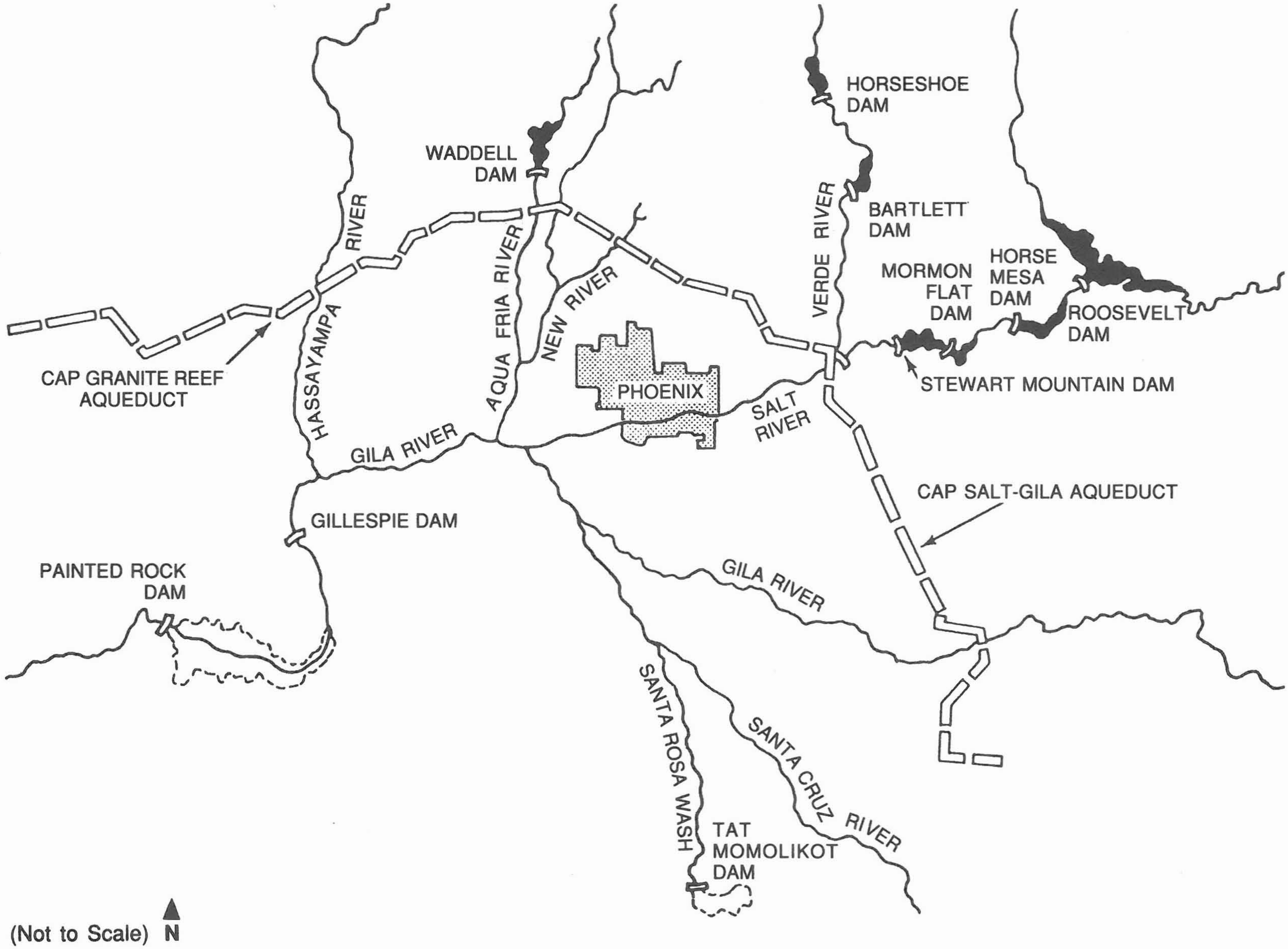
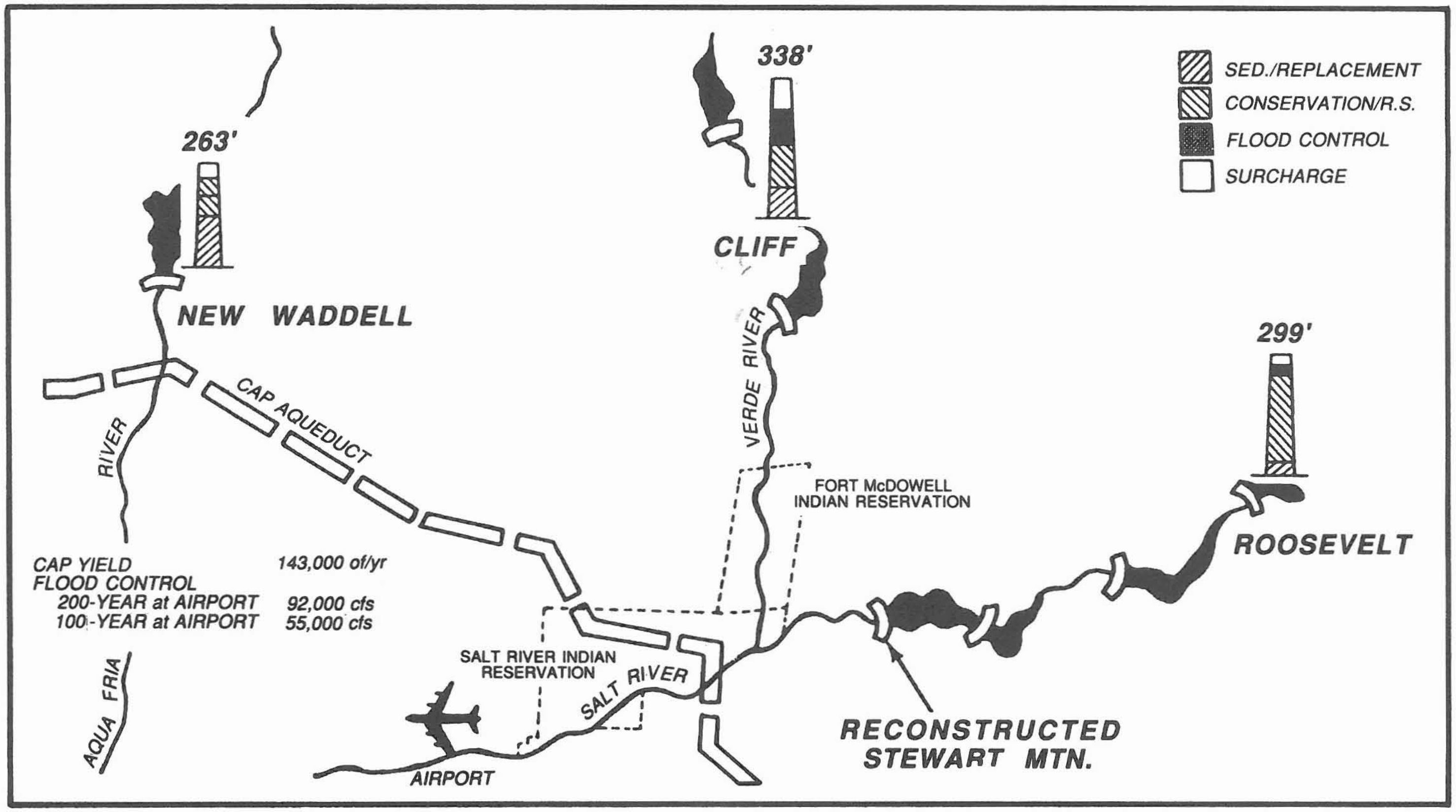



**Figure 1**
CAP Granite Reef and Salt-Gila Aqueduct




(Not to Scale) N

**Figure 2**

CAWCS Plan 6: New Waddell Dam, Cliff Dam, Roosevelt Dam and Reconstructed Stewart Mountain Dam stated that additional flood control measures may be needed on the Verde River to compensate for the loss of flood control features to have been provided by Cliff Dam, thus additional flood control storage at Bartlett and/or Horseshoe Dams may be required to meet the flood control deficit. The Agreement stipulated that the U.S. Army Corps of Engineers would be requested to undertake studies required to determine and identify appropriate flood control measures on the Verde River.

It was decided that the Corps of Engineers would provide specific economic and hydraulic data to the Bureau to evaluate flood control storage in Bartlett and Horseshoe Reservoirs in conjunction with the Bureau's dam safety modifications. In addition, a preliminary evaluation of downstream alternatives would be done to ensure that flood control measures more effective than storage in the two reservoirs were not being precluded by the reservoir alternatives themselves. This effort was to be accomplished in a one year time frame with funding being provided by the Bureau. After the Bureau had determined the amount of flood control to be provided by the reservoirs, the Corps would then undertake reconnaissance studies of the residual flooding problems.

## STUDY APPROACH

This analysis was initiated in November of 1987, after the completion of an Inter-Agency Agreement between the Corps and Bureau and the formulation of the Scope of Services. The original Scope of Services indicated that the Corps would develop benefits of the upstream alternatives (i.e. flood control storage at Horseshoe and Bartlett), preliminary benefits and costs of the downstream alternatives, and develop an environmental baseline for the downstream alternatives. As the study progressed, it became apparent that the probability of upstream flood control being justified was limited. Therefore the Scope of Services was revised to delete the benefits and costs of the downstream alternatives. The environmental baseline downstream was still completed as this analysis had already been initiated when the decision to delete downstream work was made. The Corps' analysis was conducted in three parts; the future without project conditions were established, alternatives for upstream storage were developed, and the benefits for upstream alternatives were evaluated. The analysis was conducted at a reconnaissance level of detail.

## FUTURE WITHOUT PROJECT

The future without project condition establishes the baseline from which the feasibility of flood control is measured. Currently there is no flood control storage on either the Salt or Verde Rivers. Under Plan 6, flood control storage would have been provided by two sources; 565,000 acre feet of storage on the Salt River from a modified Roosevelt Dam, and 465,000 acre feet of storage on the Verde River from the new Cliff Dam. The future without project condition for this analysis assumes Plan 6 will be constructed, but without Cliff Dam.

To evaluate the future without project conditions, the study area was defined as the Verde River to its confluence with the Salt River, the Salt River to its confluence with the Gila River, and the Gila River to Gillespie Dam (Figure 3). Discharge-frequency relationships were developed to determine the amount of flow expected in the rivers for various frequency storms and then overflows and floodways were developed to determine what areas were susceptible to flood damages.

## Discharge-Frequency Relationships

The future without project condition, Plan 6 minus Cliff Dam, was evaluated in the original CAWCS study as Plan 9. At that time, discharge-frequency values were prepared for Plan 9. The analysis assumed that 565,000 acre feet of flood control storage would be provided by modified Roosevelt Dam and that the outlet capacity of the modified dam would be 25,000 cfs. Discharge-frequency relationships were developed based on the following flood operation plan for Roosevelt.

| | |
|---|---|
| **Outflow = Inflow** | Inflow less than or equal to 25,000 cfs on the rising limb of the hydrograph |
| **Outflow = 25,000 cfs** | Inflow greater than 25,000 cfs |
| **Outflow = 25,000 cfs** | Inflow less than or equal to 25,000 cfs on the falling limb of the hydrograph |

Flow values were then determined using HEC-1 for the following locations on the Salt and Gila Rivers (Figure 4).

| | |
|---|---|
| **CP-40** | Salt River Below Confluence With Verde/Granite Reef Dam |
| **CP-110** | Salt River at Mill Avenue Bridge |
| **CP-113** | Salt River Above Confluence With The Gila River |
| **CP-1310** | Gila River Below Confluence With The Salt River |
| **CP-1218** | Gila River At Gillespie Dam |

In reevaluating the discharge-frequency relationships developed for Plan 9 during this analysis, the results supported most of the original CAWCS Plan 9 discharges, but indicated that there would be a greater peak flow reduction for floods exceeding a 50-year event. Discharge-frequency results for existing conditions (i.e. no flood control), Plan 6, Plan 9 under the original CAWCS study and the new plan 9 values are shown in Table 1. Under existing conditions (i.e. no flood control storage ) the 100-yr flow at the Mill Ave Bridge is 215,000 cfs. The current Plan 9, the without project condition, reduces the 100-yr flow to 160,000 cfs. Plan 6 if implemented would have reduced the flow to 55,000 cfs.

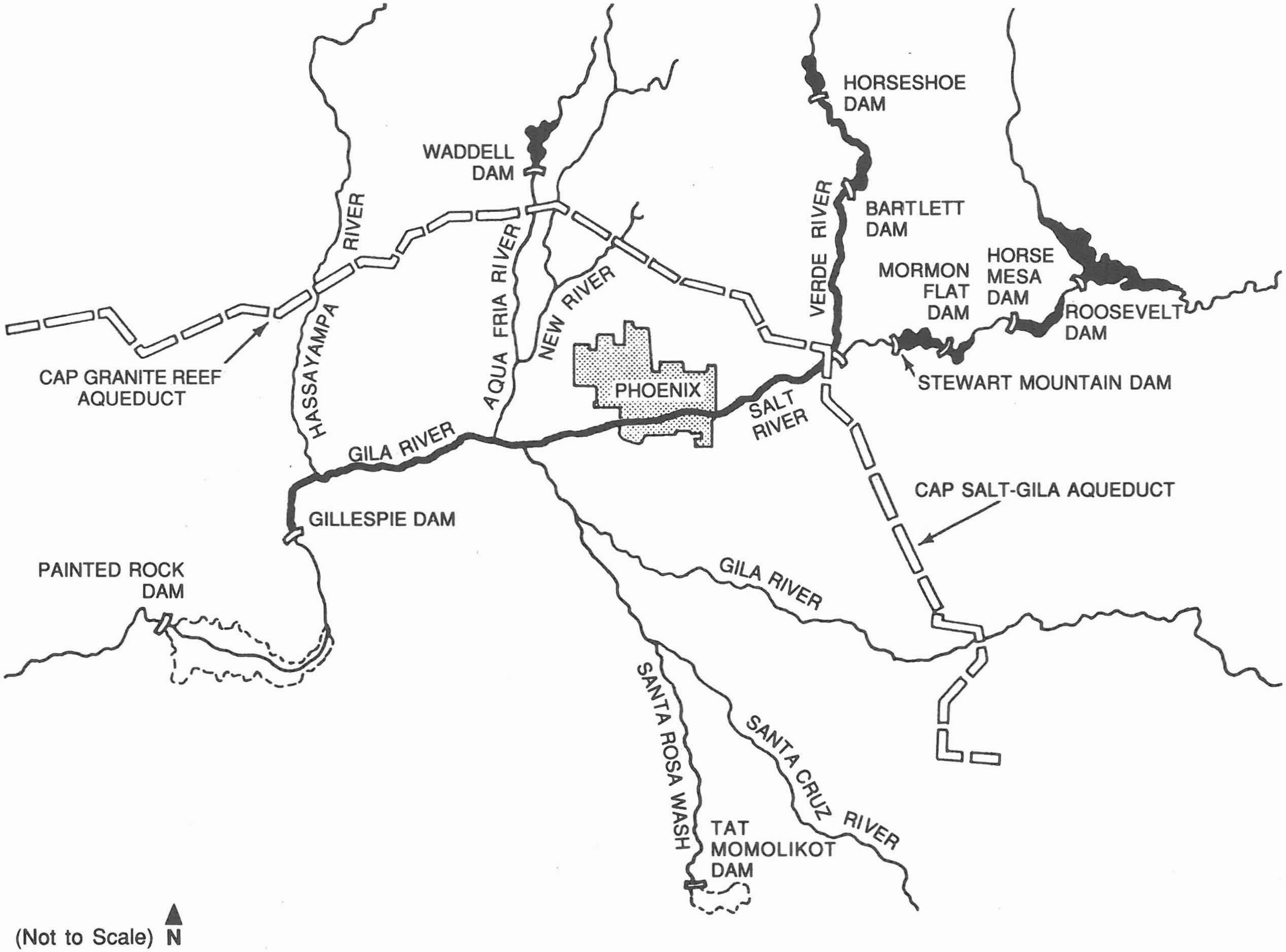



**Figure 3**
Alternatives to Cliff Dam-Study for Flood Control
Study Area

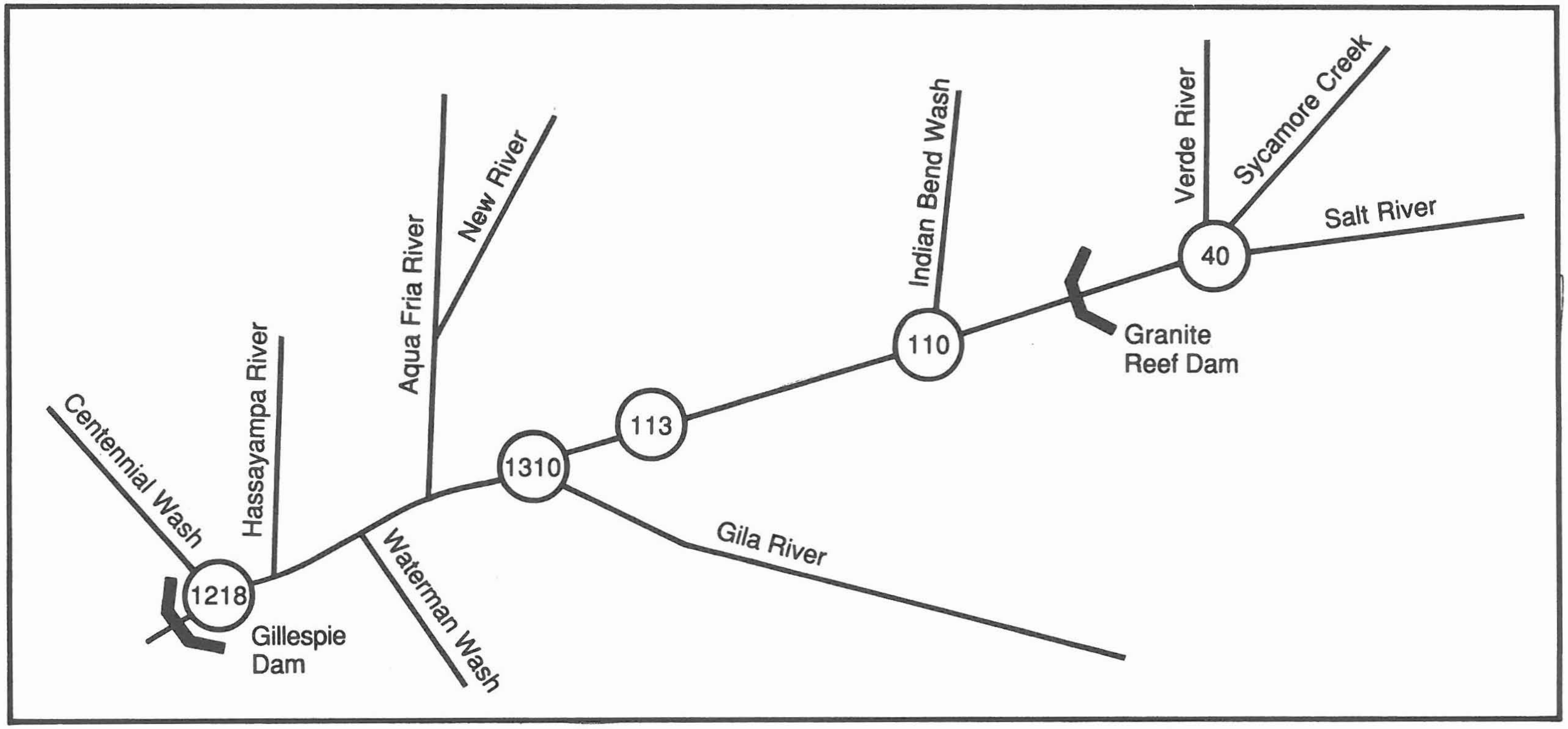



**Figure 4**
Salt-Gila Hydrology Control Points

Table 1: Without Project Discharge-Frequency Salt-Gila Rivers

| Frequency | No F.C. | Plan 6 | CAWCS Plan 9 | Current Plan 9 |
|---|---|---|---|---|
| **CP 40: Salt River Below Confluence Verde River/ Granite Reef Dam** | | | | |
| 5 | 44,500 | 44,500 | 45,000 | 45,000 |
| 10 | 102,000 | 50,000 | 85,000 | 85,000 |
| 20 | 141,000 | 50,000 | 115,000 | 115,000 |
| 50 | 175,000 | 55,000 | 150,000 | 145,000 |
| 100 | 245,000 | 78,000 | 185,000 | 175,000 |
| 200 | 290,000 | 110,000 | 245,000 | 210,000 |
| 500 | 360,000 | 190,000 | 310,000 | 275,000 |
| **CP 110: Salt River at Mill Avenue Bridge** | | | | |
| 5 | 40,000 | 40,000 | 44,000 | 44,000 |
| 10 | 93,000 | 50,000 | 84,000 | 84,000 |
| 20 | 135,000 | 50,000 | 110,000 | 110,000 |
| 50 | 160,000 | 50,000 | 140,000 | 135,000 |
| 100 | 215,000 | 55,000 | 170,000 | 160,000 |
| 200 | 275,000 | 92,000 | 215,000 | 190,000 |
| 500 | 330,000 | 170,000 | 265,000 | 250,000 |
| **CP 113: Salt River Above Confluence Gila River** | | | | |
| 5 | 36,000 | 36,000 | 40,000 | 40,000 |
| 10 | 85,000 | 45,000 | 75,000 | 75,000 |
| 20 | 125,000 | 45,000 | 100,000 | 100,000 |
| 50 | 145,000 | 45,000 | 130,000 | 125,000 |
| 100 | 185,000 | 50,000 | 165,000 | 150,000 |
| 200 | 250,000 | 80,000 | 200,000 | 185,000 |
| 500 | 310,000 | 150,000 | 250,000 | 240,000 |
| **CP 1310: Gila River Below Confluence Salt River** | | | | |
| 5 | 40,000 | 45,000 | 40,000 | 40,000 |
| 10 | 95,000 | 45,000 | 75,000 | 85,000 |
| 20 | 135,000 | 53,000 | 100,000 | 110,000 |
| 50 | 200,000 | 90,000 | 140,000 | 180,000 |
| 100 | 250,000 | 113,000 | 200,000 | 215,000 |
| 200 | 295,000 | 140,000 | 250,000 | 230,000 |
| 500 | 360,000 | 190,000 | 315,000 | 290,000 |
| **CP 1218: Gila River at Gillespie Dam** | | | | |
| 5 | 37,000 | Not Available | 37,000 | 37,000 |
| 10 | 78,000 | Not Available | 69,000 | 78,000 |
| 20 | 124,000 | Not Available | 91,000 | 100,000 |
| 50 | 186,000 | Not Available | 129,000 | 160,000 |
| 100 | 235,000 | Not Available | 186,000 | 200,000 |
| 200 | 277,000 | Not Available | 235,000 | 215,000 |
| 500 | 335,000 | Not Available | 290,000 | 270,000 |

**Overflows/Floodways**

The overflows for the study were developed using HEC-2 models obtained from three sources. The HEC-2 model for the middle section of the study area, Country Club Drive to Bullard Avenue, was obtained from the 1984 Maricopa County Flood Insurance Study, which was done by the Corps of Engineers. HEC-2 models depicting the upper and lower study reaches were developed by two consulting engineering firms for the Flood Control District of Maricopa County. The upper study reach, Granite Reef Dam to Country Club Drive, was developed in 1986 by Burgess and Niple. The lower study reach, Bullard Ave to Gillespie Dam, was developed in 1987 by Dames and Moore.

To reflect current conditions, the HEC-2 models were revised to reflect recent changes in the Salt and Gila Rivers. Changes incorporated included; channel clearing on the Gila River from 91st Avenue to Bullard Avenue, new levees (35th Avenue to 51st Avenue and 113 Avenue to 123rd Avenue), two new bridges (7th Avenue and I-10), channel excavation and filling associated with new industrial developments through metropolitan Phoenix, and the proposed Tempe Channel from Mill Avenue to I-10. After the changes were incorporated, the HEC-2 model was run with the Plan 9 discharges that had been developed for CAWCS. Five water surface profiles were plotted; 25-year, 50-year, 100-year, 200-year, and 500-year. Due to a change in the discharge-frequency relationships (i.e. CAWCS Plan 9 to current Plan 9), flood overflows greater then the 50-year flood actually represented slightly higher frequencies (i.e. 100-yr overflow is now actually the 120 year overflows). It was determined that this change would not significantly affect the benefits calculated.

As indicated by the 1984 Flood Insurance Study, the overflows through the metropolitan area have narrowed since the original CAWCS Study. Through the metropolitan area, the 100-year overflow is mostly confined to the channel. However, some breaks do occur. In Mesa, a large break occurs on the south side of the River where the 200 and 500-year floods inundate areas from Gilbert Road to Alma School Road. Some structures are also flooded from the 100-year event. The 500-year flood again leaves the Salt River Channel at Price Road and floods the south portion and some northern portion of the floodplain through Tempe. The 500-year flood continues to inundate areas on both the north and south side of the Salt River though Phoenix until 43rd Avenue where flooding from the 100-year flood also occurs. Flooding from the 100-year flood also occurs at the confluence of the Salt with the Gila River. Numerous structures are inundated, some from the 50-year event. Below the confluence of the Salt and Gila Rivers, the floodplain spreads out and both the 100 and 500-year inundate broad tracks of land.

In addition to the overflow analysis, a series of floodways (55,000, 90,000, 130,000, 170,000 cfs) were also developed. The purpose of calculating a series of floodways was to develop a floodway (cfs) vs location benefit curve for the economic analysis. To calculate the floodways, the natural water surface elevation was computed for each discharge. Conveyance was then reduced equally from both sides of the floodplain until the water surface elevation was raised no more than one foot higher then the natural water surface elevation. This new water surface elevation was then plotted as the floodway.

## UPSTREAM ALTERNATIVES

### Assumptions

Upstream alternatives examined adding flood control storage at the two existing Salt River Project Reservoirs, Horseshoe and Bartlett, on the Verde River. Currently, the storage in both Horseshoe and Bartlett Reservoirs is for water supply purposes only. The upstream alternatives were developed to minimize the 100-year flow through the metropolitan area. To develop the NED plan, an array of alternatives were developed which would reduce the 100-yr without project flow (160,000 cfs at Mill Avenue) to various lower discharges. The lowest discharge evaluated being 55,000 cfs that would have been provided by Cliff Dam. Alternatives examined included providing 100,000, 200,000, 300,000, and 465,000 acre feet of storage on the Verde River. These storages were evaluated for three different reservoir flood outlet capacities; 25,000, 60,000, and 100,000 cfs. This resulted in twelve alternatives being examined at each of the dams.

In addition to providing new storage at the reservoirs, the feasibility of reregulating those reservoirs (i.e. changing water supply space to flood control space) was also to be examined. It was decided that the benefits derived from the addition of new storage at the dams would be used to determine the benefits of reregulating the existing storage.

### With Project Discharge-Frequency Relationships

In comparing the reduction in flow between the without project condition and the with project conditions, most comparisons are made at CP 110, which is the Mill Ave Bridge. The 100-yr discharge at Mill Avenue is 160,000 cfs. When combined with flood control storage on the Verde River, that flow can be reduced to between 130,000 cfs (w/100,000 acre feet of flood control space on the Verde River) and 60,000 cfs (w/465,000 acre feet of flood control space on the Verde River). The 465,000 acre feet of storage only reduces the flow to 60,000 cfs, rather than the 55,000 cfs that would have been provided by Cliff Dam, because the reservoir operation in this analysis was designed to minimize the 100-year flood. The reservoir operation for Cliff Dam had been to control the Standard Project Flood to 50,000 cfs.

The 100,000 acre feet storage alternative reduced the flow for frequencies up to the 200-year. However, this alternative did not reduce the flow from the 500-year flood. The 200,000, 300,000, and 465,000 acre feet flood control storages reduced the 500-year peak flow approximately 40,000 cfs to 70,000 cfs. At low exceedance frequencies (i.e. less than 5-year), none of the storages evaluated reduced the without project flow. In addition, comparison of peak flows in the Salt River below the Verde River for flood control alternatives at Horseshoe or Bartlett Dams, indicated there was no discernible difference in impact between these sites. Therefore the with project results are presented for Horseshoe Dam only, but may also be used for Bartlett Dam.

**Table 2a: With Project Discharge-Frequency Horseshoe Outlet = 25,000 cfs**

**Without Project**

| Flood Freq. | CP 40 Confluence | CP 110 Mill Ave | CP 113 Above Gila | CP 1310 Below Gila | CP 1218 Gillespie |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 85,000 | 84,000 | 75,000 | 85,000 | 78,000 |
| 20 | 115,000 | 110,000 | 100,000 | 110,000 | 100,000 |
| 50 | 145,000 | 135,000 | 125,000 | 180,000 | 160,000 |
| 100 | 175,000 | 160,000 | 150,000 | 215,000 | 200,000 |
| 200 | 210,000 | 190,000 | 185,000 | 230,000 | 215,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 100,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 55,000 | 51,000 | 46,000 | 56,000 | 51,000 |
| 20 | 70,000 | 60,000 | 56,000 | 66,000 | 60,000 |
| 50 | 100,000 | 95,000 | 90,000 | 145,000 | 135,000 |
| 100 | 140,000 | 130,000 | 125,000 | 190,000 | 175,000 |
| 200 | 190,000 | 175,000 | 170,000 | 215,000 | 200,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 200,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 55,000 | 51,000 | 46,000 | 56,000 | 51,000 |
| 20 | 65,000 | 60,000 | 56,000 | 66,000 | 60,000 |
| 50 | 85,000 | 76,000 | 70,000 | 125,000 | 115,000 |
| 100 | 110,000 | 100,000 | 94,000 | 159,000 | 145,000 |
| 200 | 150,000 | 140,000 | 135,000 | 180,000 | 165,000 |
| 500 | 225,000 | 210,000 | 200,000 | 250,000 | 235,000 |

**Storage = 300,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 20 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 50 | 65,000 | 44,000 | 40,000 | 95,000 | 88,000 |
| 100 | 85,000 | 70,000 | 60,000 | 125,000 | 115,000 |
| 200 | 120,000 | 110,000 | 105,000 | 150,000 | 140,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

**Storage = 465,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 40,000 | 39,000 | 34,000 | 38,000 | 35,000 |
| 10 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 20 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 50 | 62,000 | 39,000 | 34,000 | 89,000 | 82,000 |
| 100 | 85,000 | 60,000 | 50,000 | 115,000 | 105,000 |
| 200 | 120,000 | 110,000 | 100,000 | 145,000 | 135,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

**Table 2b: With Project Discharge-Frequency Horseshoe Outlet = 60,000 cfs**

**Without Project**

| Flood Freq. | CP 40 Confluence | CP 110 Mill Ave | CP 113 Above Gila | CP 1310 Below Gila | CP 1218 Gillespie |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 85,000 | 84,000 | 75,000 | 85,000 | 78,000 |
| 20 | 115,000 | 110,000 | 100,000 | 110,000 | 100,000 |
| 50 | 145,000 | 135,000 | 125,000 | 180,000 | 160,000 |
| 100 | 175,000 | 160,000 | 150,000 | 215,000 | 200,000 |
| 200 | 210,000 | 190,000 | 185,000 | 230,000 | 215,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 100,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 85,000 | 84,000 | 75,000 | 85,000 | 78,000 |
| 20 | 98,000 | 94,000 | 86,000 | 96,000 | 88,000 |
| 50 | 110,000 | 105,000 | 98,000 | 153,000 | 140,000 |
| 100 | 125,000 | 115,000 | 110,000 | 175,000 | 160,000 |
| 200 | 160,000 | 150,000 | 140,000 | 185,000 | 170,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 200,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 70,000 | 66,000 | 62,000 | 72,000 | 66,000 |
| 20 | 70,000 | 66,000 | 62,000 | 72,000 | 66,000 |
| 50 | 80,000 | 74,000 | 65,000 | 120,000 | 110,000 |
| 100 | 105,000 | 95,000 | 90,000 | 155,000 | 140,000 |
| 200 | 140,000 | 130,000 | 125,000 | 170,000 | 155,000 |
| 500 | 240,000 | 220,000 | 210,000 | 260,000 | 240,000 |

**Storage = 300,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 20 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 50 | 65,000 | 44,000 | 40,000 | 95,000 | 88,000 |
| 100 | 85,000 | 70,000 | 60,000 | 125,000 | 115,000 |
| 200 | 120,000 | 110,000 | 105,000 | 150,000 | 140,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

**Storage = 465,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 40,000 | 39,000 | 34,000 | 38,000 | 35,000 |
| 10 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 20 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 50 | 62,000 | 39,000 | 34,000 | 89,000 | 82,000 |
| 100 | 85,000 | 60,000 | 50,000 | 115,000 | 105,000 |
| 200 | 120,000 | 110,000 | 100,000 | 145,000 | 135,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

**Table 2c: With Project Discharge-Frequency Horseshoe Outlet = 100,000 cfs**

**Without Project**

| Flood Freq. | CP 40 Confluence | CP 110 Mill Ave | CP 113 Above Gila | CP 1310 Below Gila | CP 1218 Gillespie |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 85,000 | 84,000 | 75,000 | 85,000 | 78,000 |
| 20 | 115,000 | 110,000 | 100,000 | 110,000 | 100,000 |
| 50 | 145,000 | 135,000 | 125,000 | 180,000 | 160,000 |
| 100 | 175,000 | 160,000 | 150,000 | 215,000 | 200,000 |
| 200 | 210,000 | 190,000 | 185,000 | 230,000 | 215,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 100,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 85,000 | 84,000 | 75,000 | 85,000 | 78,000 |
| 20 | 110,000 | 105,000 | 100,000 | 110,000 | 100,000 |
| 50 | 110,000 | 105,000 | 100,000 | 155,000 | 140,000 |
| 100 | 125,000 | 115,000 | 110,000 | 165,000 | 150,000 |
| 200 | 150,000 | 140,000 | 140,000 | 180,000 | 170,000 |
| 500 | 275,000 | 250,000 | 240,000 | 290,000 | 270,000 |

**Storage = 200,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 70,000 | 66,000 | 62,000 | 72,000 | 66,000 |
| 20 | 70,000 | 66,000 | 62,000 | 72,000 | 66,000 |
| 50 | 80,000 | 74,000 | 65,000 | 120,000 | 110,000 |
| 100 | 105,000 | 95,000 | 90,000 | 155,000 | 140,000 |
| 200 | 140,000 | 130,000 | 125,000 | 170,000 | 155,000 |
| 500 | 240,000 | 220,000 | 210,000 | 260,000 | 240,000 |

**Storage = 300,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 45,000 | 44,000 | 40,000 | 40,000 | 37,000 |
| 10 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 20 | 45,000 | 44,000 | 40,000 | 50,000 | 46,000 |
| 50 | 65,000 | 44,000 | 40,000 | 95,000 | 88,000 |
| 100 | 85,000 | 70,000 | 60,000 | 125,000 | 115,000 |
| 200 | 120,000 | 110,000 | 105,000 | 150,000 | 140,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

**Storage = 465,000 Acre Feet**

| | | | | | |
|---|---|---|---|---|---|
| 5 | 40,000 | 39,000 | 34,000 | 38,000 | 35,000 |
| 10 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 20 | 40,000 | 39,000 | 34,000 | 44,000 | 40,000 |
| 50 | 62,000 | 39,000 | 34,000 | 89,000 | 82,000 |
| 100 | 85,000 | 60,000 | 50,000 | 115,000 | 105,000 |
| 200 | 120,000 | 110,000 | 100,000 | 145,000 | 135,000 |
| 500 | 200,000 | 180,000 | 180,000 | 230,000 | 215,000 |

## BENEFITS UPSTREAM ALTERNATIVES

### Study Approach

Several previous flood control benefit assessments have been conducted in the study area. Data from three of these studies was used in the economic analysis.

**CAWCS:** The Central Arizona Water Control Study examined all reasonable alternatives to provide regulatory storage for the Central Arizona Project (CAP) water and flood control along the Salt and Gila Rivers. The Corps of Engineers participated in the study and was responsible for the flood control planning and analysis. The study was completed in 1981.

**CAWCS Reevaluations:** Two additional studies, completed in November 1986 and March 1987, evaluated the effects of changes in hydraulic conditions demonstrated by the 1984 FEMA Flood Insurance Maps. The first paper explained the effects the changed conditions had on inundation reduction benefits and made adjustments to the original analysis for physical improvements such as larger bridges and levee protection around Sky Harbor Airport. The flow-damage relationships that resulted from these adjustments were used in the current analysis for minor benefit categories. The second work provided a thorough analysis of location benefits including an in-depth estimation of expected property values which was also used in the current analysis.

The original CAWCS analysis demonstrated that the location benefit category was the most influential due to the size, location and demand for floodway lands through the communities of Mesa, Tempe and Phoenix. Consequently, much of the effort put forth in this economic analysis was directed at providing a more accurate estimate of location benefits. Additionally, a new analysis was conducted of inundation damages and benefits due to the significant changes in hydraulics and hydrology. This analysis made use of Salt River Project's Land Use Model (LUM) in combination with a tax assessor-based real estate information database, to develop the inundation reduction data. For other categories of benefits, updates were first made for price level changes then modifications to existing flow-damage relationships were made to account for the changes in hydrology. The analysis uses the current Water Resource Council Discount Rate of 8 5/8% for all benefit assessments and a period of analysis of 100 years.

### Flood Control Analysis

The benefits of flood hazard reduction plans are based on a careful analysis of the difference in the with and without project conditions. The without project condition is the land use and related conditions likely to occur under existing improvements, laws, and policies. The with project condition is the most likely condition expected to exist in the future if a specific project is undertaken. The changes in the with and without project condition are the benefits to the project. The economic study area encompasses the floodplain along the Salt River from Granite Reef Dam to its confluence with the Gila River and along the Gila River to Gillespie Dam. The original flood control benefit analysis was performed by subdividing the study area into nine economic reaches (Figure 5). The nine reaches were defined as follows:

Reach 1 - Granite Reef Dam to Country Club Drive
Reach 2 - Country Club Drive to Pima Road
Reach 3 - Pima Road to 48th Street
Reach 4 - 48th Street to I-10
Reach 5 - I-10 to 35th Avenue
Reach 6 - 35th Avenue to the confluence with the Gila River
Reach 7 - The confluence to 115th Avenue
Reach 8 - 115th Avenue to Old Route U.S. 80
Reach 9 - Old Route U.S. 80 to Gillespie Dam

The reaches for the current analysis remain the same with the exception of the combination of reaches 7 through 9 into one reach for damage analysis purposes. There are three major types of benefits; inundation reduction benefits, location benefits, and other benefits catagories. Other benefits include savings in capital costs, savings in fill, and business and emergency losses.

**Inundation Reduction Benefits**

Inundation reduction benefits result from reducing flood losses to activities which would use the floodplain without any plan. Inundation reduction benefits are measured as the reduction in the amount of flood damages or related costs. There are two general sub-categories of benefits under inundation reduction: General Property Inventory Benefits (where benefits depend on property inventory and hydraulic information) and Specific Case Benefits (where benefit information requires an in-depth analysis and additional information).

**General Property Inventory Benefits:**

Inundation Reduction benefits were reanalyzed for this study. The analysis made use of the Salt River Project's (SPR) Land Use Model (LUM). Land and improvement values were estimated by the LUM for the five flood inundation areas, from Granite Reef Dam to 180th Avenue. Input variables included tax assessor data purchased from the TRW Real Estate Information Services Division, land use acreage estimated by the LUM, and flood inundation boundaries provided by the Corps.

Depth-damage relationships were used to evaluate the impact of the anticipated flows on development in the floodplains. These relationships were developed from nation-wide flood insurance claims and provided by the Federal Emergency Management Agency (FEMA). The depth-damage curves applied to damageable property, were used to develop flood damages on a section level.

The Expected Annual Flood Damage Computation Program (EAD), developed by the Hydrologic Engineering Center (HEC), was used to compute annual damages in this analysis. The damages expected to result from each size flood were weighted by the probability of occurrence of that flood by combining the

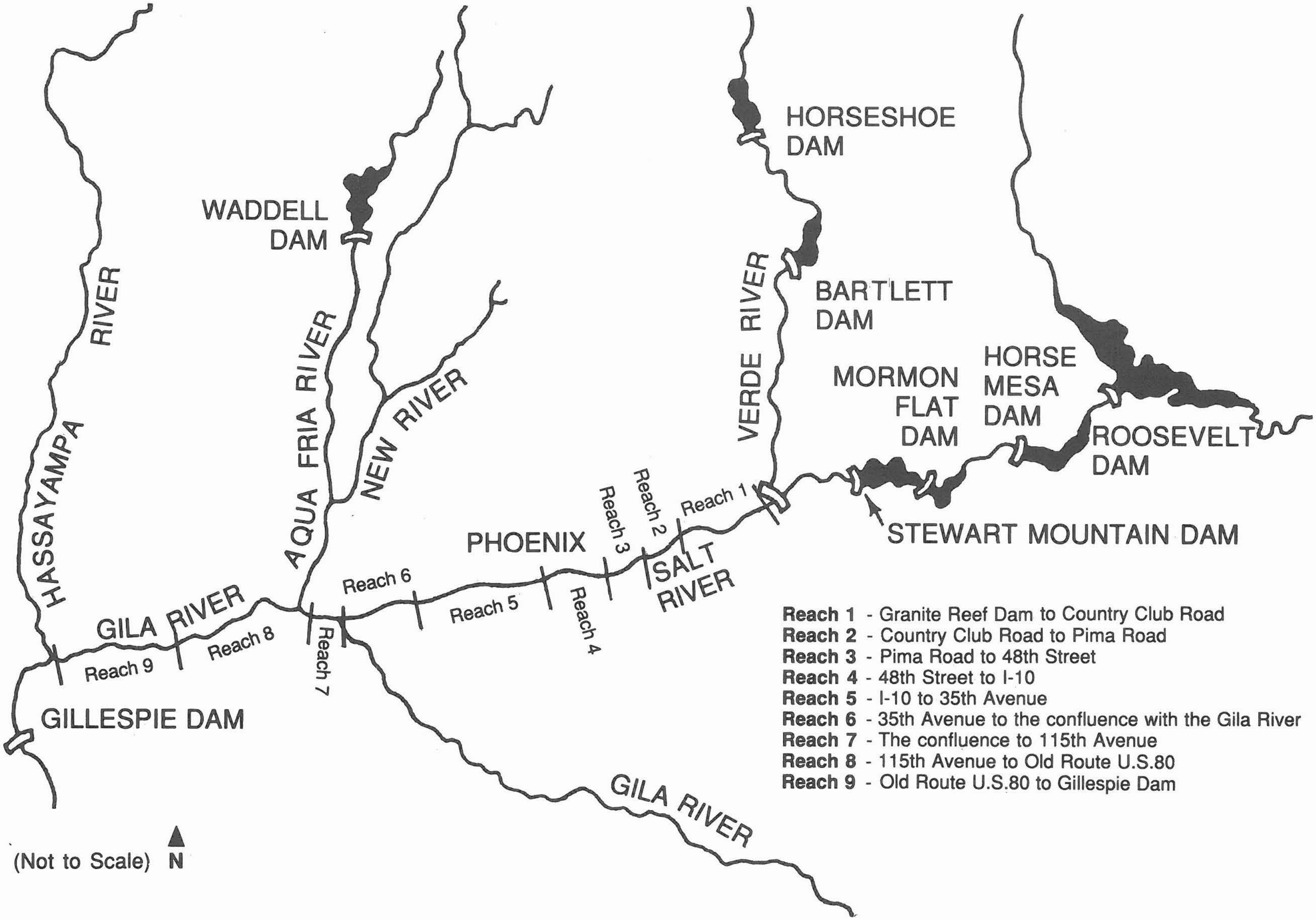



**Figure 5**
Economic Study Reaches

damage-discharge and discharge-frequency curves. Average annual damages werethen calculated by using standard damage-frequency integration techniques. Equivalent annual damages were computed next by summing the present worth of annual damages and applying the capital recovery factor (partial payment series) for an 8-5/8 percent discount rate. Flood damages for the General Property Inventory equal $ 1,017,200.

**Specific Case Damages:**

The Specific Case area of benefits are those structures where traditional use of standardized depth-damages relationships cannot adequately determine damages. These areas require in-depth analysis to determine the flow-damage relationships. Included in this category are unique structures such as dams, power plants, and electric transmission towers; sand and gravel operations, agricultural activities and business and emergency costs.

**Unique Structures:** This area of benefit determination was divided into two areas: 1) Unique Structures in a Specific Reach where adjusting the flow-damage relationship is appropriate, and 2) Unique Structures (not dependent on hydraulic information) where in-depth analysis is required for adjustment.

1) **Unique Structures in a Specific Reach:** The unique structures were first separated into their appropriate reach. These consisted of damages to: electrical transmission towers, telephone lines, the Ocotillo Power Plant, water and sewer Lines, gas lines, storm drains, and irrigation facilities. Expected damages to these structures were examined. The existing flow-damage relationship was adjusted for price level changes for all structures with the exception the Ocotillo Power Plant where additional damages for the 500-year event were included based on new information. Flow-damage relationships were aggregated by reach and then input into the EAD program. Annual damages are estimated at $142,400.

2) **Unique Structures (not dependent on hydraulics):** This sub-category consists of damages to SRP Dams on the Verde River, the CAP siphon and SRP's Underground Storage and Recovery Project. Damages for this sub-category are computed as a function of hydrology and are not reach-specific. The flow-damage relationships for SRP dams and CAP siphons was updated for price level changes. Additionally, damages to SRP Dams on the Salt River were removed from the flow-damage relationship as they could not be protected by flood control measures on the Verde. Damages to SRP's Underground Storage and Recovery Project were added since this proposed project will be in place before completion of any project alternative. Equivalent annual damages for this area equal $302,100.

**Sand And Gravel Operations:** Flow-Damage relationships for this area of benefits were updated for price level changes and then input into the EAD program. Equivalent annual damages equal $124,100.

**Agriculture:** The 1987 study adjusted flow-damage relationships for all reaches except reaches 1,8 and 9. In these reach the current analysis reduced the 1981 flow-damage relationships by the percentage reduction in overflow area from 1981 to 1988. The resultant flow-damage relationship was then updated for price level changes and input into the EAD program. Annual damages total $45,700.

**Transportation Delays:** For this category of damages a new bridge failure and delay scenario was developed in the 1987 analysis. The flow-damage relationships were modified for price level changes and then input into the EAD program. Because the transportation flow-damage relationship is a stepped function large swings in with project damages occur. Equivalent annual damages equal $40,500.

Table 3 presents the total without project expected annual damages for the study. Damage to General Property total $1,017,200 and damage to specific case structures total $654,860. This amounts to $1,672,060 in Average Annual Damages.

To evaluate the impacts of proposed flood control measures on the Verde River, the discharge-frequency curves associated with the improvements were input into the EAD run as alternative plans. Flood damages prevented were calculated by comparing the damages that would be expected to occur without a project to those damages that would be expected to occur with a project in place. Because several of the plans could not be distinguished due to hydrologic considerations, the final plans were evaluated as follows:

| | |
|---|---|
| **RHA1** | 100,000 acre feet storage with 25,000 cfs outlet |
| **RHA2** | 100,000 acre feet storage with 60,000 cfs outlet |
| **RHA3** | 100,000 acre feet storage with 100,000 cfs outlet |
| **RHB1** | 200,000 acre feet storage with 25,000 cfs outlet |
| **RHB2/3** | 200,000 acre feet storage with 60,000 cfs or 100,00 cfs outlet |
| **RHC** | 300,000 acre feet storage with 25,000, 60,000 or 100,000 cfs outlet |
| **RHD** | 465,000 acre feet storage with 25,000, 60,000,or 100,000 cfs outlet |

Inundation reduction benefits are provided in Table 4.

## Location Benefits

Location benefits occur when a reduction in the level of flood risk makes it possible for a new activity to locate in the floodplain. In this study location benefits occur only in land freed for development, the acreage between the with and without project floodways as defined by the current hydraulic analysis.

### Methodology:

To determine location benefits the market value of land method was used. The market value method assumes the value of property will increase by an amount equivalent to the increase in net income. To determine market values, local appraisers were contacted and provided land values for similar developable sites rendered out of the floodway. Care was taken to obtain values of similar unimproved areas lacking infrastructure. These values were

**Table 3**

**Inundation Damages Without Project ($1,000)**

| | | |
|---|---|---|
| **General Property Inventory** | | |
| | Residential | 533.37 |
| | Commercial | 62.28 |
| | Industrial | 322.43 |
| | Mobile Homes | 21.35 |
| | Public | 77.77 |
| **Subtotal** | | **1,017.20** |
| **Specific Case** | | |
| | Unique Structures (1) | 142.44 |
| | Unique Structures (2) | 302.14 |
| | Sand and Gravel Operations | 124.13 |
| | Agricultural | 45.67 |
| | Transportation Delays | 40.48 |
| **Subtotal** | | **654.86** |
| **TOTAL** | | **1,672.06** |

(1) Unique Structure In Reach
(2) Unique Structures Not Reach Specific

then compared to recent sales information from Maricopa County. Current fair market value of floodway land ($5,000 per acre) was also provided by the Assessor. The difference between developable land and floodway land values is the net increase per acre.

Adjustments to the net increase per acre must be made to calculate the location benefit. First, all without project floodway acreage is assumed to remain in the FEMA designated 100 year floodplain. Since development in floodplains is precluded by FEMA regulations unless the development is elevated on fill above the 100-year water level, the cost of fill must be subtracted from the net increase per acre. Additionally, since removal of floodway restrictions induces development into floodplains and since location benefits hinge on the assumption that land values capitalize expected flood damages, the expected flood damages from the induced development must also be subtracted.

To evaluate the effects of alternate plans, location benefits were analyzed for four floodways including the without project 170,000 cfs. A location benefit - 100-year discharge curve was produced (Figure 6) using discharge at the Tempe Bridge as a reference point. Location benefits were then determined by comparing the plan's 100-year discharge at the Tempe Bridge to the benefit curve. Table 4 presents location benefits for the various alternatives developed.

**Other Benefits**

**Savings In Capital Costs:**

Savings in Capital Costs can be claimed as project benefits when flood control measures allow for a savings in costs by permitting the building of smaller, less expensive structures. The 1987 analysis concluded that savings in capital costs could accrue to two bridges, Price Road and Bullard Avenue. The current analysis assumes these bridges will be constructed to withstand the 100-year flood of 170,000 cfs if flood control measures on the Verde are not constructed. Annual benefits for each alternative are shown in table 4.

**Savings In Fill:**

Any development in the 100-year floodplain must be filled one foot above the 100-year flood elevation in accordance with the Flood Insurance Act of 1973. If a project reduces or eliminates the amount of fill required without a project, the savings in the cost of fill is then a direct benefit attributable to the project. The savings in fill benefit is difficult to quantify given the lack of with project overflows. However, due to the rapid growth the Phoenix area is experiencing, this area of benefits is fairly substantial. Quantification of these benefits was made on a cursory level given the available information.

Without a project, there would be approximately 8,100 acres of land in the 100-year floodplain 1995 (project year 1) with the potential to develop. Based on the future development scenario, fifteen to twenty five percent of the 8,100 acres will be covered by structures. This analysis assumes the high end of the range, twenty five percent will be filled. The average depth of fill is 3 feet and the cost of fill is $4.50 per cubic yard. The total cost of fill was

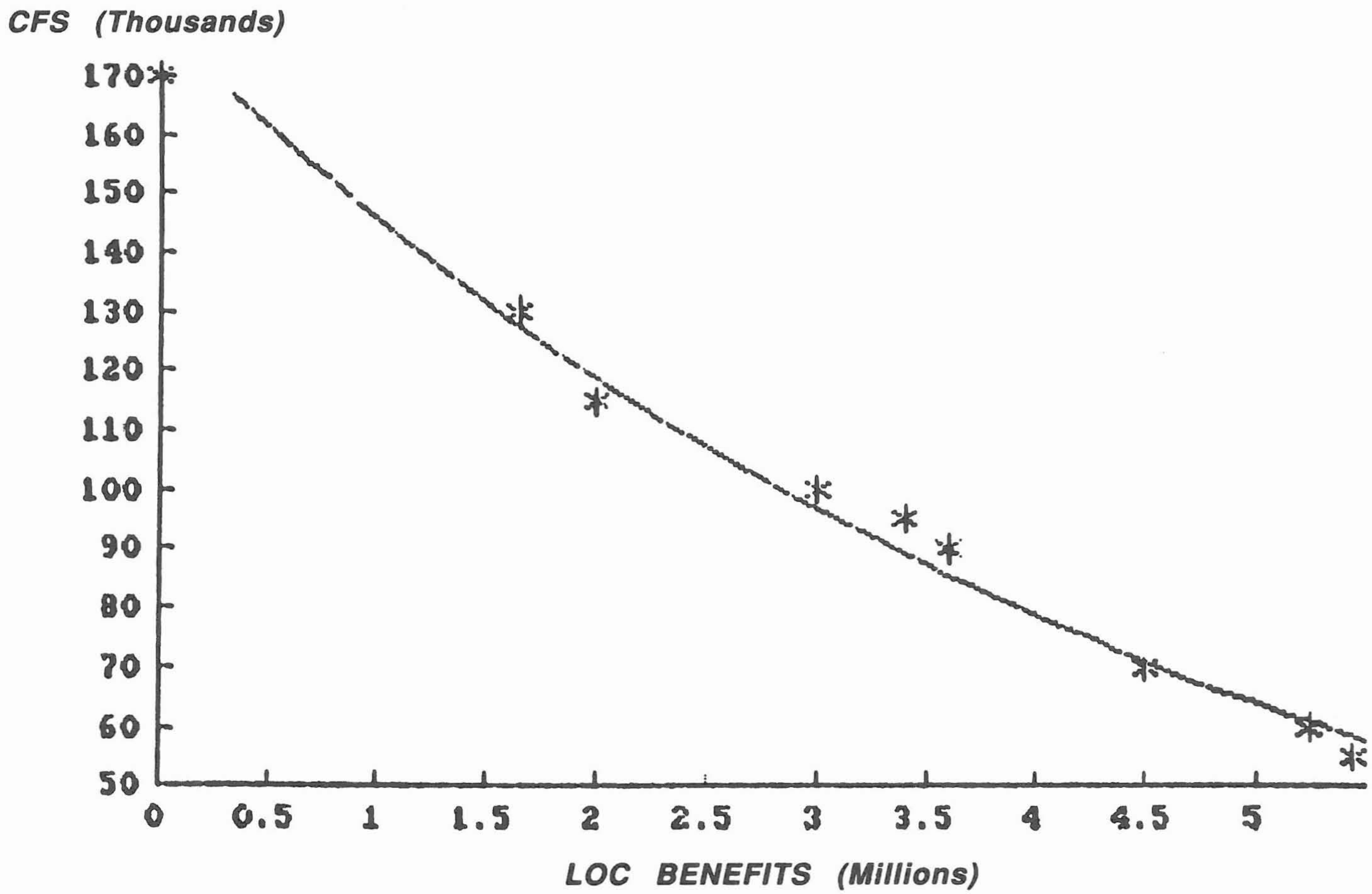



**Figure 6**
Cliff Dam Alternative
Floodway (CFS) vs. Location Benefits

divided into equal payments over the 100-year life of the project. To evaluate alternatives, it was assumed that the targeted 55,000 cfs 100-year discharge would eliminate all fill requirements in the 100-year floodplain. Benefit calculations were then based on percentage reductions in the acreage of the without project floodway resulting from the alternative plans.

**Business And Emergency Losses:**

The land uses inundated in the 1981 analysis have changed due to extensive localized protection in the commercial and industrial areas through Phoenix. Consequently, the flow-damage relationship created in 1981 for this category of benefits is no longer applicable to the current inundation areas. Quantification of this area of benefits would require extensive surveys of the new inundation areas. Because of the small magnitude of benefits ($83,000 in the 1981 analysis) these benefits are not claimed in this study.

## CONCLUSIONS

Table 4a presents the results of this analysis at the current Water Resource Council interest rate of 8 5/8%. Table 4b presents the results of the analysis at an interest rate of 3 1/4%. The results indicate plan RHD (465k acre feet storage) produces the most benefits. The location benefits analysis indicates there are considerably less location benefits than were estimated in the 1987 analysis. The decrease in location benefits results from four factors:

1) The inclusion of Arizona Department Of Transportation's proposed Tempe channel between Mill Avenue and I-10 eliminates significant vacant land previously claimed for location benefits. The channel is expected to be completed before 1995 (project year one) allowing these areas to develop regardless of any flood control storage on the Verde River. This change reduces annual benefits approximately $1,400,000.

2) The previous analysis misidentified the boundary of the Salt River Indian Reservation and included location benefits on the reservation. Because the tribe has no legal requirement to follow FEMA land restrictions and because ample flood free land exists on the reservation, these benefits can not be claimed. This change reduces annual benefits approximately $1,500,000.

3) Demand for floodway areas in all parts of Reach 7 (confluence with the Gila River to 115th Ave) cannot be demonstrated at the present time. Although the Phoenix area is experiencing rapid development, the cost of fill requirements in this area would make any land value increase negligible at present. This change reduces annual benefits approximately $500,000.

4) Differences in the land available for development between the Corps generated floodway and the Maricopa County floodways used for the March 1987 analysis result in a decrease in higher valued devlopable land. Although the net difference in developable lands is not substantial, the Maricopa County floodways tend to place the larger openings of land in areas where the zoning is more favorable to development. An example would be the area around the 91st Street sewage treatment plant. The Maricopa County floodways show an area of land opening for development on the north side of the river, where the zoning is low-density residential. The Corps' floodways show a similar parcel opening on the south side of the river. This land is on the Gila River Indian Reservation and not subject to location benefits. The net effect in the

overall change in floodways is a reduction of approximately $600,000 in location benefits.

**Table 4a: Annual Flood Control Benefits ($1,000) i=8.625%**

| **BENEFIT CATEGORY** | | | | **ALTERNATIVES** | | | |
|---|---|---|---|---|---|---|---|
| **Inundation Reduction** | **RHA1** | **RHA2** | **RHA3** | **RHB1** | **RHB2/3** | **RHC** | **RHD** |
| General Property | | | | | | | |
| Residential | 74.3 | 122.6 | 128.1 | 240.7 | 189.6 | 284.3 | 331.9 |
| Commercial | 13.8 | 23.0 | 24.3 | 33.1 | 30.2 | 38.4 | 41.7 |
| Industrial | 60.0 | 101.9 | 107.5 | 161.0 | 140.4 | 188.2 | 209.1 |
| Mobile Homes | 3.0 | 4.8 | 5.0 | 9.6 | 7.5 | 11.3 | 13.3 |
| Public | 9.9 | 12.3 | 12.4 | 39.9 | 23.9 | 52.5 | 59.8 |
| Specific Case | | | | | | | |
| Unique Structures (1) | 38.3 | 51.8 | 52.8 | 84.5 | 70.1 | 102.9 | 111.5 |
| Unique Structures (2) | 122.5 | 99.6 | 58.9 | 155.7 | 145.8 | 157.5 | 157.8 |
| Sand & Gravel | 51.4 | 69.4 | 74.6 | 84.5 | 83.5 | 98.9 | 102.0 |
| Agriculture | 24.3 | 19.8 | 14.9 | 32.8 | 31.0 | 38.3 | 39.0 |
| Transportation | 1.9 | 2.9 | 2.9 | 36.7 | 3.6 | 37.4 | 37.6 |
| **Location Benefits** | 1,646.2 | 2,000.0 | 2,000.0 | 3,000.0 | 3,400.0 | 4,500.0 | 5,200.0 |
| **Other Benefits** | | | | | | | |
| Savings In Capital | 68.0 | 100.0 | 100.0 | 133.0 | 145.0 | 202.0 | 224.0 |
| Savings In Fill | 132.0 | 189.0 | 189.0 | 251.0 | 273.0 | 380.0 | 420.0 |
| **TOTAL** | 2,245.6 | 2,797.1 | 2,770.4 | 4,262.5 | 4,543.6 | 6,091.7 | 6,947.7 |

**RHA1** 100,000 acre feet storage with 25,000 cfs outlet
**RHA2** 100,000 acre feet storage with 60,000 cfs outlet
**RHA3** 100,000 acre feet storage with 100,000 cfs outlet
**RHB1** 200,000 acre feet storage with 25,000 cfs outlet
**RHB2/3** 200,000 acre feet storage with 60,000 or 100,000 cfs outlet
**RHC** 300,000 acre feet storage with 25,000, 60,000 or 100,000 cfs outlet
**RHD** 465,000 acre feet storage with 25,000, 60,000 or 100,000 cfs outlet

(1) Unique structures in reach
(2) Unique structures not reach specific

Table 4b: Annual Flood Control Benefits ($1,000) i=3.25%

| BENEFIT CATEGORY | ALTERNATIVES | | | | | | |
|---|---|---|---|---|---|---|---|
| **Inundation Reduction** | RHA1 | RHA2 | RHA3 | RHB1 | RHB2/3 | RHC | RHD |
| General Property | | | | | | | |
| Residential | 111.6 | 184.9 | 192.8 | 374.1 | 290.9 | 442.6 | 519.7 |
| Commercial | 13.8 | 23.0 | 24.3 | 33.1 | 30.2 | 38.4 | 41.7 |
| Industrial | 77.7 | 131.4 | 138.1 | 224.2 | 189.4 | 263.1 | 297.9 |
| Mobile Homes | 3.0 | 4.8 | 5.0 | 9.6 | 7.5 | 11.3 | 13.3 |
| Public | 10.1 | 12.6 | 12.6 | 40.4 | 24.3 | 53.0 | 60.3 |
| Specific Case | | | | | | | |
| Unique Structures (1) | 38.3 | 51.8 | 52.8 | 84.5 | 70.1 | 102.9 | 111.5 |
| Unique Structures (2) | 122.5 | 99.6 | 58.9 | 155.7 | 145.8 | 157.5 | 157.8 |
| Sand & Gravel | 51.4 | 69.4 | 74.6 | 84.5 | 83.5 | 98.9 | 102.0 |
| Agriculture | 22.4 | 18.4 | 13.8 | 30.0 | 28.5 | 35.1 | 35.8 |
| Transportation | 1.9 | 2.9 | 2.9 | 36.7 | 3.6 | 37.4 | 37.6 |
| **Location Benefits** | 646.5 | 785.5 | 785.5 | 1,178.3 | 1,335.4 | 1,767.4 | 2,042.3 |
| **Other Benefits** | | | | | | | |
| Savings In Capital | 26.0 | 39.5 | 39.5 | 52.5 | 57.0 | 79.0 | 88.0 |
| Savings In Fill | 132.0 | 189.0 | 189.0 | 251.0 | 273.0 | 380.0 | 420.0 |
| **TOTAL** | 1,275.2 | 1,612.8 | 1,589.8 | 2,554.6 | 2,539.2 | 3,466.6 | 3,927.9 |

**RHA1** 100,000 acre feet storage with 25,000 cfs outlet
**RHA2** 100,000 acre feet storage with 60,000 cfs outlet
**RHA3** 100,000 acre feet storage with 100,000 cfs outlet
**RHB1** 200,000 acre feet storage with 25,000 cfs outlet
**RHB2/3** 200,000 acre feet storage with 60,000 or 100,000 cfs outlet
**RHC** 300,000 acre feet storage with 25,000, 60,000 or 100,000 cfs outlet
**RHD** 465,000 acre feet storage with 25,000, 60,000 or 100,000 cfs outlet

**(1)** Unique structures in reach
**(2)** Unique structures not reach specific

# Appendix A Hydrology

# HYDROLOGIC ANALYSIS

# OF

# CLIFF DAM ALTERNATIVES

U.S. Army Corps of Engineers
Los Angeles District
September 1988

TABLE OF CONTENTS



TABLES

CONTENTS (Continued)

TABLES (Continued)



FIGURES



PLATES

CONTENTS (Continued)

PLATES (Continued)

CONTENTS (Continued)

PLATES (Continued)

# HYDROLOGIC ANALYSIS OF CLIFF DAM ALTERNATIVES

## I. INTRODUCTION

### 1-01. BACKGROUND

The Cliff Dam Alternatives study is a follow-up to the Central Arizona Water Control Study (CAWCS) during which Plan 6--a new or modified Roosevelt Dam along with a new Cliff Dam, both with dedicated flood control functions--was selected as the recommended plan to control floodflows on the Salt and Verde Rivers through the City of Phoenix, Arizona. Subsequently, Arizona's congressional delegation, Plan 6 advocates, and Plan 6 opponents, reached an agreement which dropped the Cliff Dam element from further study, but retained the Roosevelt Dam element. The Roosevelt Dam element, which had been briefly investigated during the original CAWCS Study, was known as Plan 9. By virtue of the above agreement, Plan 9 would be constructed, and thereafter become the base condition. Flood control on the Verde River at sites other than Cliff was authorized for study purposes, and benefits were to be based upon the flood reduction compared to Plan 9. A map of the Gila River Basin with major existing structures is shown on plate 1.

### 1-02. PURPOSE

This report presents a discharge frequency analysis of flood control storage alternatives on the Verde River considered in conjunction with Plan 9. The impoundment sites investigated were at the pre-existing Horseshoe and Bartlett Dams. A schematic of the proposed sites along with the old Cliff site is shown on plate 2. The alternative elements were melded with the

Plan 9 Roosevelt into an integrated system with flood control releases from the separate elements based upon downstream channel capacity as well as upstream inflow and relative space in the flood pools. The results, along with costs of reservoir modifications at Horseshoe and Bartlett, and benefits resulting from reduced downstream discharges, can be used in order to determine: (a) the feasibility of Verde River flood control, and (b) if feasible, the NED plan.

1-03. SCOPE

Discharge frequency analyses over the range of proposed Verde River flood control storage were conducted using methodology and data developed in support of the Bureau of Reclamation (BUREC) CAWCS investigation during the period from 1978 through 1982, culminating in the May 1982 Hydrology Report (ref. 1). This report is written and presented as an addendum to that report. The level of detail of the current study is reconnaissance per the agreement between the Los Angeles District (LAD) and the BUREC. Consequently, project analyses were conducted using discrete event hydrology - Balanced Hydrographs - to determine reservoir outflow. These outflows were combined at the Salt-Verde confluence and routed downstream using nomographs determined from period-of-record simulated flood routings from reference 1 studies. These nomographs were based upon channel data for the Verde, Salt, and Gila Rivers for the period prior to the February 1980 flood. The analyses were conducted using the HEC-5 "Simulation of Flood Control and Conservation Systems" computer program. Area-capacity data and dedicated water supply pools were unchanged from reference 1 definitions. Flood control pool sizes, outlets, and operational objectives were redefined for this study. Balanced Hydrographs, based upon statistical analysis of recorded inflow to the reservoirs under consideration, represent flows which have the same frequency of being equalled or exceeded for all durations. Thus the resulting reservoir outflow retains the same frequency (when properly adjusted for starting storage) as the inflow. Balanced Hydrographs are discussed further in chapter 2. The Verde River alternatives addressed in this report comprise a 2 x 4 x 3 matrix:

2 sites,

4 flood control allocations, and

3 flood control outlet sizes.

The proposed alternative flood control sites are at Horseshoe and Bartlett Dams on the Verde River (pl. 1). The flood pool size allocations are 100-, 200-, 300-, and 465-thousand (K) acre feet, the latter being equivalent to the former Plan 6 Cliff Dam. Flood outlets considered were 25-, 60-, and 100-K cubic feet per second (cfs). In addition, the results of the smaller three storage allocation alternatives (100-, 200-, and 300-K acre feet) were to be used to provide basic hydrologic information to evaluate the possibility of re-regulating existing Horseshoe and/or Bartlett Dams (total present storage about 310,000 acre-feet).

1-04. RESULTS

Discharge frequency results for Plan 9 as well as project alternatives were determined for the following locations on the Salt River:

a. Below the Verde River confluence/at Granite Reef Dam (CP-40).

b. At Tempe Bridge/at Skyharbor Airport (CP-110).

c. At the mouth/above the Gila River (CP-113).

Also, with project frequency discharges were determined for the following Gila River locations:

a. Below the Salt River confluence (CP-1310).

b. At Gillespie Dam (CP-1218).

A schematic diagram of the Gila River basin, including the Salt-Verde tributaries along with the SRP system and downstream control points, appears on plate 3. Plate 4 shows discharge-frequency profiles for the Salt-Gila Rivers for Plan 9. The critical location, due to the economic consequences of innundation of the airport, was CP-110. Plan 9 reduces the 100-year discharge here to 160,000 cfs. When combined with the Verde River alternatives, that flow can be further reduced to between 130,000 cfs (w/100-K acre feet of flood control space on the Verde River) and 60,000 cfs (w/465-K acre feet of flood control space on the Verde River). For floods as great as the 500-year, the 100-K acre-foot storage alternative provides no additional peak flow reduction beyond Plan 9; however, the remaining three Verde River flood control allocations (200-, 300-, and 465 K acre feet) do provide a reduction in 500-year peak flow compared to Plan 9, ranging from 40,000 cfs to 70,000 cfs. At low exceedance frequencies (i.e., smaller runoff events, less than 5-year frequency) Verde River flood control storage did not impact Plan 9 results. In addition, comparison of peak flows in the Salt River below the Verde River for flood control alternatives at Horseshoe or Bartlett Dams, indicated there was no discernible difference in impact between these sites. Thus, with project results are presented for one Verde element only - Horesehoe Dam - but may be used interchangeably hereafter. The following table presents the results of the Cliff Alternatives study, including Plan 9, for the Salt River near Skyharbor Airport/Tempe Bridge (CP-110).

Table 1. Discharge Frequency Values For Project Alternatives (in cfs).[2]

| Alter-native | 100-Year[1] Minimum Target | Frequency, Years: Salt River at Tempe Bridge (CP-110) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 20 | 50 | 100 | 200 | 500 |
| PLAN 9 | NONE | 44000 | 84000 | 110000 | 135000 | 160000 | 190000 | 250000 |
| RHA1. | *90000 | 44000 | 51000 | 60000 | 95000 | 130000 | 175000 | 250000 |
| RHB1. | 80000 | 44000 | 51000 | 60000 | 76000 | 100000 | 140000 | 210000 |
| RHC1. | 45000 | 44000 | 44000 | 44000 | 44000 | 70000 | 110000 | 185000 |
| RHD1. | 40000 | 39000 | 39000 | 39000 | 39000 | 60000 | 110000 | 185000 |
| RHA2. | 110000 | 44000 | 84000 | 94000 | 105000 | 115000 | 150000 | 250000 |
| RHB2. | 70000 | 44000 | 66000 | 66000 | 74000 | 95000 | 130000 | 220000 |
| RHC2. | 45000 | 44000 | 44000 | 44000 | 44000 | 70000 | 110000 | 185000 |
| RHD2. | 40000 | 39000 | 39000 | 39000 | 39000 | 60000 | 110000 | 185000 |
| RHA3. | 110000 | 44000 | 84000 | 105000 | 105000 | 115000 | 140000 | 250000 |
| RHB3. | 70000 | 44000 | 66000 | 66000 | 74000 | 95000 | 130000 | 220000 |
| RHC3. | 45000 | 44000 | 44000 | 44000 | 44000 | 70000 | 110000 | 185000 |
| RHD3. | 40000 | 39000 | 39000 | 39000 | 39000 | 60000 | 110000 | 185000 |

NOTE: Targets were set to make maximum use of available flood control space without spilling; "RHA1" spilled during the 100-year flood even with continuous outflow of 25,000 cfs.

DEFINITIONS:

RH = Roosevelt "Plan 9" element and Horseshoe element
A = 100,000 Ac. Ft. of Flood Control on the Verde River
B = 200,000 Ac. Ft. of Flood Control on the Verde River
C = 300,000 Ac. Ft. of Flood Control on the Verde River
D = 465,000 Ac. Ft. of Flood Control on the Verde River

1 = 25,000 cfs Flood Outlet, Verde element
2 = 60,000 cfs Flood Outlet, Verde element
3 = 100,000 cfs Flood Outlet, Verde element

(1) U/S Release + Contemporaneous Local Flow at Salt-Verde Confluence.
(2) Includes Uncontrolled Local Runoff Non-Coincident w/ U/S Release.
* This target produced minimum flow, but was not achieved.

# II. DISCHARGE FREQUENCY ANALYSIS

## 2-01. PREVIOUS WORK

The basis for the current study was the report of May 1982, " Gila River and Tributaries, Central Arizona Water Control Study, Hydrology", Los Angeles District, U.S. Army Corps of Engineers. That report - hereinafter referred to as the "CAWCS Hydrology" - and associated studies covered three areas especially pertinent to this study:

a. Existing conditions discharge frequency analysis;

b. Plan 6 - with project discharge frequency analysis (New Roosevelt and Cliff Dam);

c. Plan 9 - with project discharge frequency analysis (new or modified Roosevelt only).

Each of these subjects and their link to the current study are discussed in the following sections.

### 2-01.1 Existing Conditions

In the CAWCS Hydrology the hydrologic response of the Salt River basin through the city of Phoenix and westward to Painted Rock Dam on the Gila River was determined. The basis for the existing conditions was that the six water supply and hydropower dams, owned and operated by the Salt River Project (SRP), were in place and operating according to their current schedule. The results--frequency discharges--were determined by simulated routing of period-of-record hydrographs through the SRP system, and combining and routing the resulting outflow hydrographs along with estimated contemporaneous downstream tributary flow to Painted Rock Dam. Interpretation of the discharge-frequency relationships was supplemented by development of Balanced Hydrographs from the inflow data at each upstream reservoir: Roosevelt Dam on the Salt River and Horseshoe Dam on the Verde River. These Balanced Hydrographs were utilized to help define the resulting outflow from rare events, i.e. those greater than or equal to the 100-year flood. The difficulty in making use of Balanced Hydrographs to evaluate downstream flow is in determining the starting storage at the beginning of the synthetic runoff event, if reservoirs have large storage pools (other than flood control) which have a high variance in relative fullness. Since inflow and storage are generally independent, there is no deterministic way to establish a storage condition given an inflow condition. However, since outflow and storage are linked, it is possible to arrive at a probabalistic storage by examining the inter-relationship between outflow and inflow based upon varying storage levels. In the most simplistic case, the range of starting storages during flood routing might prove to be very insensitive to the resulting outflow. In other cases, e.g. the SRP reservoirs, an entire flood might be captured or significantly attenuated by the available water supply pool; in such cases a sensitivity analysis might be fruitless, since the variation in resulting outflow would be between 0 and a potentially large flow. Compound or combined probability concepts may also prove unwieldy. Inflow frequency is ordinarily determined using an extreme value series composed of annual maxima. However, a 200-year flood (for example) might occur on a day or over a brief period of time (for the Salt River a ten day period was determined to be critical). The storage at the beginning of such a flood has a probability of being equalled or exceeded based upon a daily elevation frequency relationship.

Therefore, the inflow flood frequency might have to be re-evaluated in a manner that produces daily exceedance probabilities. This could be accomplished by establishing seasonal and/or monthly inflow probabilities, and then converting these to daily averages: the seasonal inflow sample might be summer vs. winter, or rainy season(s) vs. dry season(s), etc. The sample delineation might involve snowmelt, or reservoir operation--water is stored in winter, released in summer. These types of hydrometeorologic and operating characteristics might be used to establish seasonal boundaries; or the daily discharge probabilities might be derived entirely from record, if available.

## HYPOTHETICAL EXAMPLE FOR SRP RESERVOIR SYSTEM

The January sample of maximum annual inflow may indicate that a 200-year annual inflow (0.5 percent chance of being equalled or exceeded in any year on the average) has a 0.1 percent chance of being equalled or exceeded in January in any year. Stated another way, there is about a 20 percent chance that a 200-year inflow would occur in January. Likewise, based upon an examination of monthly storages, it might be determined that there is a 10 percent chance of the SRP system being "full" in January. "Full" may have the interpretation of being greater than 90 percent of maximum storage. Thus, the probability of a 200-year inflow occuring in January with "full" system would be the product of these probabilities,

$$Pr(Q_{Jan} \geq Q_{200}) = .001 \times .10 = .0001 = .01\%$$

The outflow which results from this combination of circumstances--for this example 295,000 cfs--has this same "partial" probability of occurrence. However, the actual probability of occurrence for the example outflow would have to be determined by integration of all the possibilities for which this is an outcome. In other words, 295,000 cfs may result from other combinations of circumstance such as a .05 percent chance inflow and a "half-full" reservoir (20 percent chance),

$$Pr(Q_{Jan} \geq Q_{200}) = .0005 \times .20 = .0001 = .01\%$$

By pursuing the "partial" probability of a specified outflow being equalled or exceeded by some average or central value approach, an outflow frequency curve could be constructed for January. In a similar manner, outflow frequency curves could be established for other months of the year. Finally, the outflow frequency curves for the months (or seasons, if the subset is based on seasonal flow delineation) could be combined statistically to yield an annual outflow frequency relationship.

This type of combined frequency analysis would require massive amounts of data collection, and subsequent reduction of the data to provide the intended results. Yet, the results would be very much dependent on the initial assumptions as to the independence of data--consequently serial correlation between storage and inflow could force inaccuracies into even such a rigorous analysis unless included quantitatively in such a study.

As an alternative to a combined frequency analysis, an iterative process was used to link starting storage with balanced inflow hydrographs in order to produce outflow frequency discharges. HEC-5 was used to model the reservoir operations.

Step 1. Natural Flow.

a. Balanced Coincident Component Hydrographs were developed for inflow to the SRP system based upon a volume frequency analysis of available gauged streamflow (pls. 3-1, and 3-2, Appendix 3, 1982 CAWCS Hydrology). Figures 1 and 2 contain the component Balanced Hydrographs of Combined Coincident Inflow to both Horseshoe and Roosevelt Dams.

b. Natural flow, i.e., downstream discharge at the Salt-Verde Confluence without SRP reservoirs, was computed for the largest simulated period-of-record runoff events. The resulting peak flows were ranked, ordered, and plotted using median plotting positions. Since the analysis was not a rigorous statistical work-up of all inflow data, a graphically fit frequency curve was constructed (pl. 13, CAWCS Hydrology).

c. In addition, Balanced Hydrographs for coincident component inflow to the SRP system (step 1a) were routed downstream without the SRP system in-place, combined with local runoff, and the resulting natural peak flow plotted with the same frequency as the inflow. These peak flows were a combination of routed SRP inflow and local flow. Local flow was estimated (based upon observed runoff) to be in the same proportion to upstream runoff as the relative drainage areas - approximately 8 percent. The results were synonomous with the "natural conditions" discharge frequency results from the period-of-record analysis, and served as a confirmation of the suitability of single event hydrology--Balanced Hydrographs--in describing the continuous discharge frequency function. The natural flow balanced hydrographs at Granite Reef Dam are shown on figure 3.

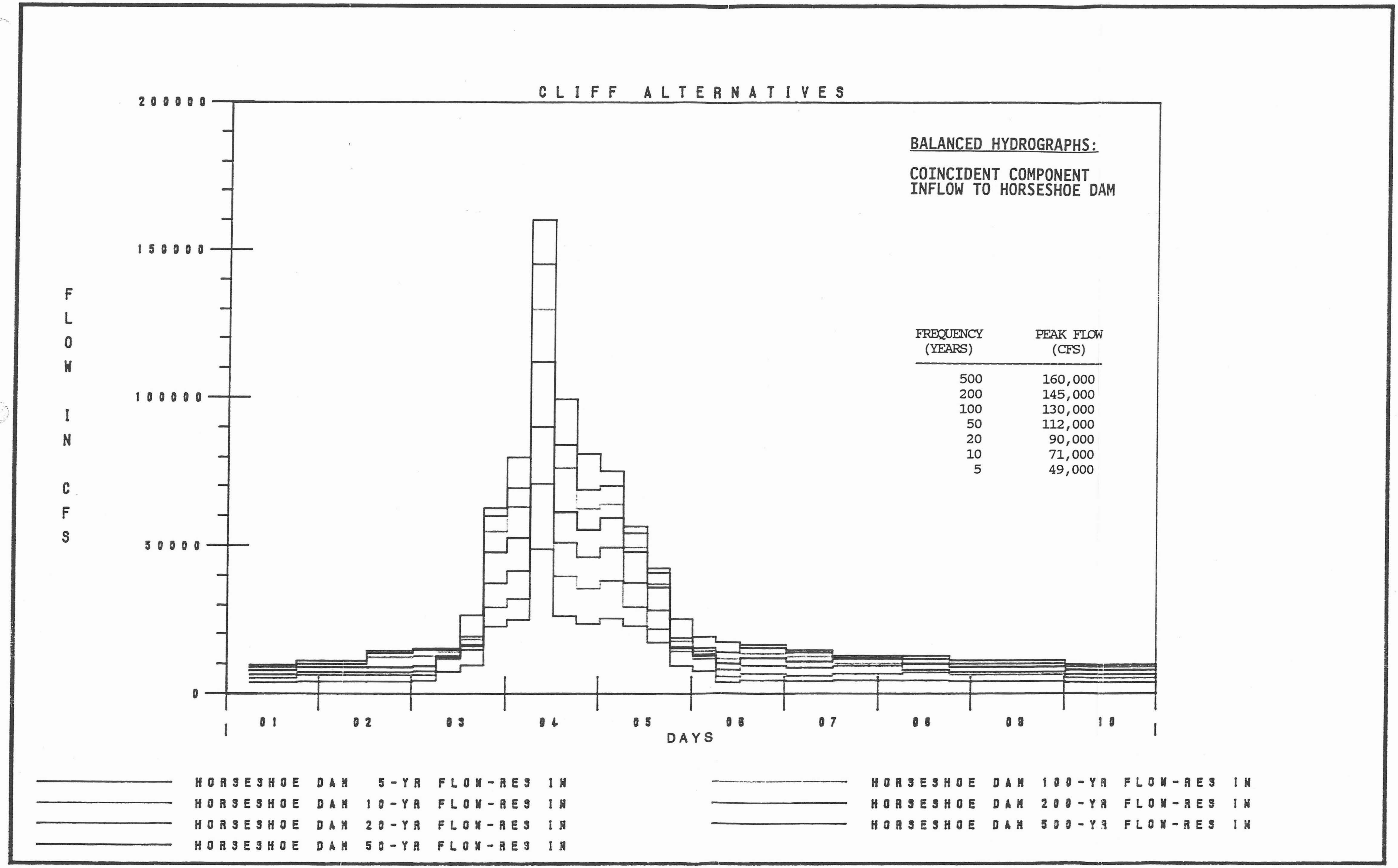

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS:
COINCIDENT COMPONENT INFLOW TO HORSESHOE DAM
FREQUENCY (YEARS)
PEAK FLOW (CFS)
500 160,000
200 145,000
100 130,000
50 112,000
20 90,000
10 71,000
5 49,000
FLOW IN CFS
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAYS
HORSESHOE DAM 5-YR FLOW-RES IN
HORSESHOE DAM 10-YR FLOW-RES IN
HORSESHOE DAM 20-YR FLOW-RES IN
HORSESHOE DAM 50-YR FLOW-RES IN
HORSESHOE DAM 100-YR FLOW-RES IN
HORSESHOE DAM 200-YR FLOW-RES IN
HORSESHOE DAM 500-YR FLOW-RES IN

FIGURE NO. 1

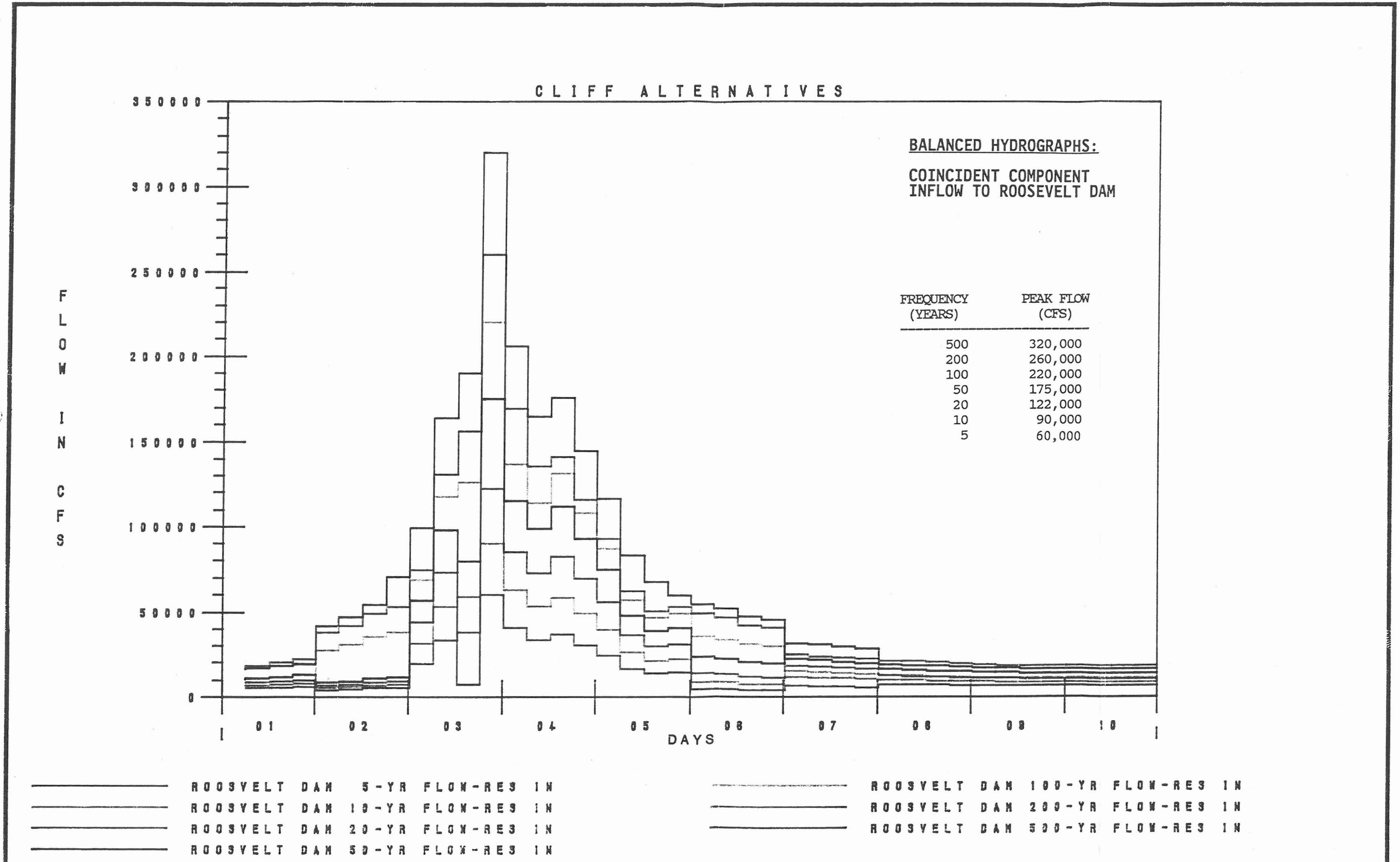

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS:
COINCIDENT COMPONENT INFLOW TO ROOSEVELT DAM
FREQUENCY (YEARS)
PEAK FLOW (CFS)
500 320,000
200 260,000
100 220,000
50 175,000
20 122,000
10 90,000
5 60,000
FLOW IN CFS
350000
300000
250000
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAYS
ROOSVELT DAM 5-YR FLOW-RES IN
ROOSVELT DAM 10-YR FLOW-RES IN
ROOSVELT DAM 20-YR FLOW-RES IN
ROOSVELT DAM 50-YR FLOW-RES IN
ROOSVELT DAM 100-YR FLOW-RES IN
ROOSVELT DAM 200-YR FLOW-RES IN
ROOSVELT DAM 500-YR FLOW-RES IN

FIGURE NO. 2

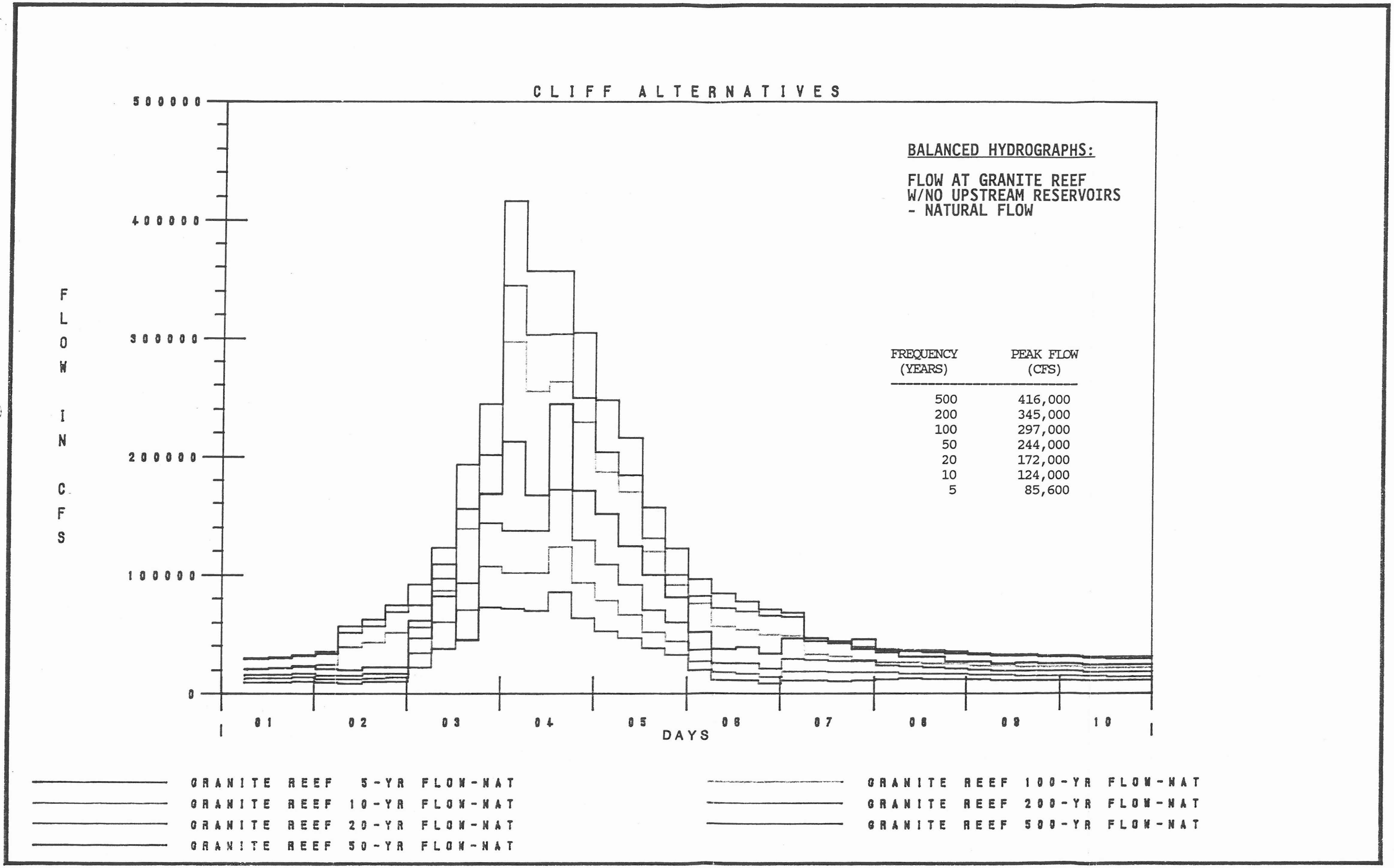

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS:
FLOW AT GRANITE REEF
W/NO UPSTREAM RESERVOIRS
- NATURAL FLOW
FREQUENCY (YEARS)
PEAK FLOW (CFS)
500 416,000
200 345,000
100 297,000
50 244,000
20 172,000
10 124,000
5 85,600
FLOW IN CFS
500000
400000
300000
200000
100000
0
01
02
03
04
05
06
07
08
09
10
DAYS
GRANITE REEF 5-YR FLOW-NAT
GRANITE REEF 10-YR FLOW-NAT
GRANITE REEF 20-YR FLOW-NAT
GRANITE REEF 50-YR FLOW-NAT
GRANITE REEF 100-YR FLOW-NAT
GRANITE REEF 200-YR FLOW-NAT
GRANITE REEF 500-YR FLOW-NAT

FIGURE NO. 3

Step 2. Existing Conditions.

a. Balanced Hydrographs for coincident component inflow were again routed downstream and combined with local flow determined in step 1c, but this time the SRP system was incorporated into the model. Starting storage for each of the six reservoirs (table 2 below) was assumed to be at the Normal Water Surface (NWS), i.e. full conservation pools. (See pl. 3-5, CAWCS Hydrology). An example of the 100-year Balanced Hydrograph flood routing at NWS is shown in figure 4.

Table 2. Initial Assumptions, SRP System.

| Reservoir | Salt River Starting Storage (ac. ft.) | NWS (NGVD) | Reservoir | Verde River Starting Storage (ac. ft.) | NWS (NGVD) |
|---|---|---|---|---|---|
| Roosevelt | 1,381,580 | 2136 | Horseshoe | 131,427 | 2026 |
| Horse Mesa | 245,138 | 1914 | Bartlett | 178,186 | 1798 |
| Mormon Flat | 57,852 | 1660.5 | | | |
| Stewart Mtn. | 69,765 | 1529 | | | |

The downstream peak flows were plotted at the same probability as the inflow to the system, along with the results of the period-of-record flood routings. Based upon the natural flow frequency curve and a comparison with period-of-record data, a determination was made that for flood events less than 100-year frequency (50-, 20-, 10-, 5-year), the SRP system should be less than full to reproduce the period-of-record downstream frequency discharges. Also, for flood events equal to or greater than 100-year frequeny (100-, 200-, 500-year), the assumption that the SRP system is full produces downstream peak flows which agree with the period-of-record results, and fit the shape and upper bound of the discharge frequency relationship defined by the "Natural Flow".

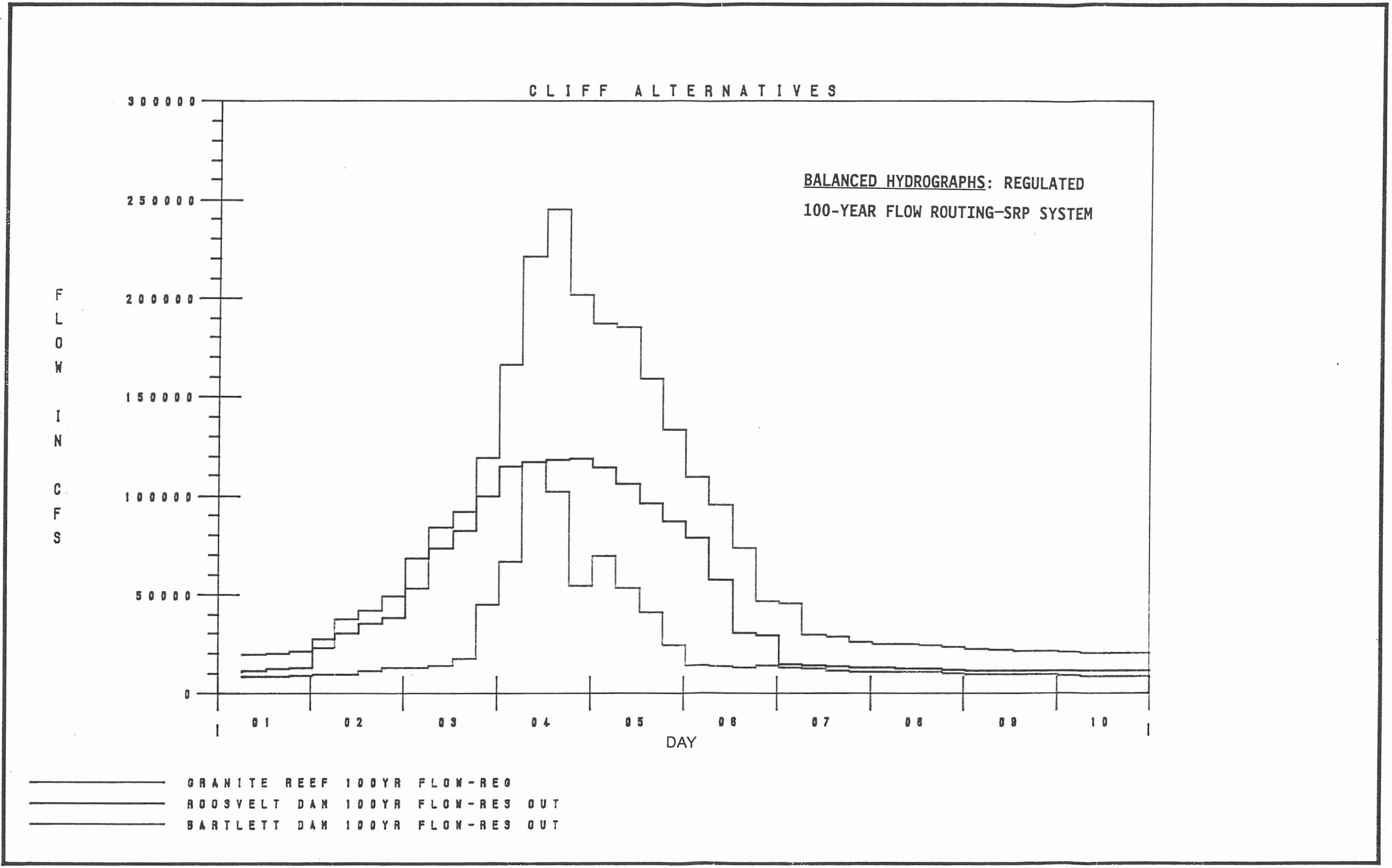

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS: REGULATED
100-YEAR FLOW ROUTING-SRP SYSTEM
FLOW IN CFS
300000
250000
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAY
GRANITE REEF 100YR FLOW-REG
ROOSVELT DAM 100YR FLOW-RES OUT
BARTLETT DAM 100YR FLOW-RES OUT

FIGURE NO. 4

b. The sensitivity to the "full" assumption is not as great as first appears:

1. Thirty-nine events during the simulation period (1888-1980, 92 years) were identified as spilling, i.e. the NWS was exceeded, and downstream releases spilled over Granite Reef Dam to the Salt River. Since 1980, spills or flood releases have occurred in several other years.

2. The objective of the SRP system is to capture as much surface runoff as possible.

3. During the flood season, demand is less (peak demand accompanies the dry, hot summer months both for water consumption and hydropower--especially air conditioning). Thus reservoirs are more likely to be full during the later part of the flood season when most runoff occurs.

4. Many flood events are correlated with antecedent runoff events which fill, or nearly fill the reservoirs. As a consequence the floods causing the greatest downstream flow often occur with reservoirs full or nearly full.

5. The three downstream SRP reservoirs on the Salt River are operated for hydropower with pumpback storage capability, and are maintained at 90 percent full or greater if possible (approximately 370,000 acre-feet at NWS).

6. The larger the inflow, the less sensitive outflow is to the degree of fullness of the SRP system.

Thus, although the probability of rare inflows (less than 10 percent chance events) is small, the correlation between large downstream flow and "full" reservoirs is so strong that the "full" assumption produces single event runoff which agrees with the simulation of observed flows.

2-01.2 Project Conditions

Subsequent to the establishment of the applicability of using single event hydrology--Balanced Hydrographs--to reproduce continuous period-of-record frequency discharges, project alternatives were investigated using those same procedures.

Plan 6. A combination of Verde River flood control storage at Cliff Dam--465,000 ac. ft.--and Salt River flood control storage at Roosevelt Dam--565,000 ac. ft.--operating in parallel to control downstream runoff during the SPF to 50,000 cfs, had been selected as the recommended plan. Plan 6 was evaluated in a 2-stage process:

a. Discharge frequency analysis for Plan 6 based upon Balanced Coincident Component Inflow Hydrographs to the SRP reservoirs were combined with contemporaneous local runoff (Appendix II, CAWCS Hydrology).

b. Non-contemporaneous local runoff (Appendix I, CAWCS Hydrology) was later combined with Plan 6 upstream reservoir releases (CAWCS Hydrology) using probabilistic methods.

Plan 9. No flood control storage on the Verde River, and the Plan 6 Roosevelt element on the Salt River operating to release up to 25,000 cfs, had been evaluated in 1983 after CAWCS Hydrology was completed. The basis of the discharge frequency analysis of Plan 9 was:

a. An external* evaluation of simulated period-of-record reservoir inflow and resulting downstream runoff was performed. Adjustments to Roosevelt outflows, based upon the proposed Plan 9, were made for each flood, and these adjusted outflows were then combined with Verde River out flows for existing conditions to produce downstream with project runoff. The results were ranked, ordered, and plotted using median plotting positions.

b. Balanced Hydrographs for rare inflow events (greater than 100-year) were also evaluated externally, and plotted at the same probability as the upstream inflow.

c. A graphical discharge frequency curve was constructed using existing conditions as an upper limit and guide for shape. A statistical analysis of the results would have been invalid since the distribution of outflows is not log normal, and the releases from the reservoirs are not random independent events.

*external here refers to an arithmetic adjustment of previously simulated results without benefit of computer modeling.

The final results of the Plan 9 analysis--discharge frequency estimates for the Salt River between the Verde River and the Gila River, and for the Gila River between the Salt River and Gillespie Dam--were provided to the Bureau of Reclamation in 1983. After Plan 9 was determined to be the new base condition in 1987, those results were reviewed for adequacy as discussed in the following section.

## 2-02. BASE CONDITIONS, 1988.

### 2-02.1 General

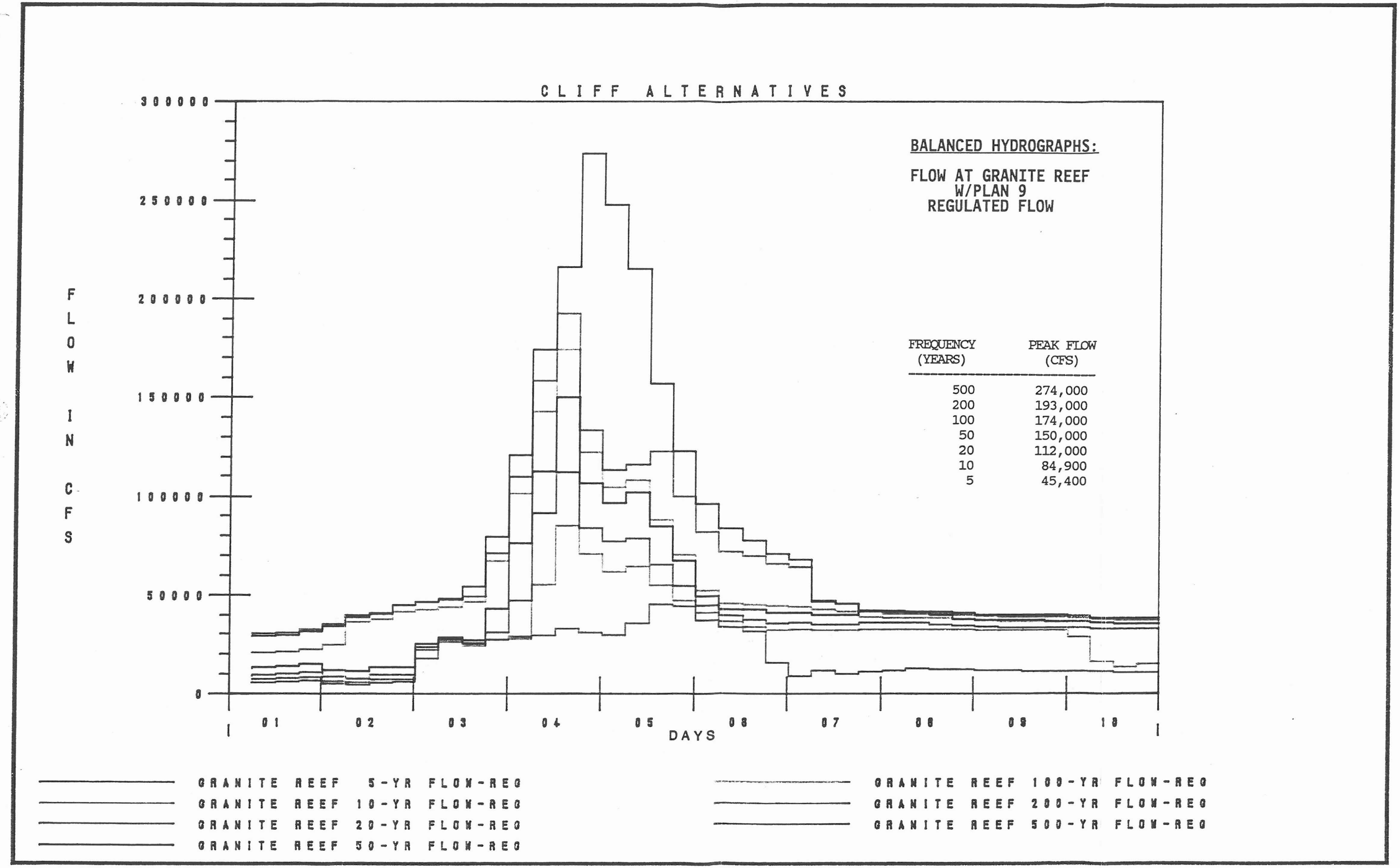
Existing conditions for the Cliff Dam alternatives includes the six SRP reservoirs, with a flood control allocation of 565,000 acre feet at Roosevelt. The current study had 2 objectives.

a. Review Plan 9 discharge frequency results from the 1983 investigation

b. Based upon the results of this review, analyze proposed projects and compare to Plan 9.

### 2-02.2 Plan 9 Review

The period-of-record results produced in Plan 9 hydrology in 1983 were accepted as an adequate evaluation of project outflows given those same sequence of inflows. Balanced Coincident Component Hydrographs were also reviewed for adequacy. Computer simulation of these "balanced hydrographs" using the HEC-5 program "Simulation of Flood Control and Conservation Systems" revealed several inconsistencies in the 1983 determinations. Figure 5 shows the routed Balanced Hydrograph at Granite Reef for Plan 9. Figure 6 shows the actual simulation of the 100-year flood routing for Plan 9.



CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS:
FLOW AT GRANITE REEF
W/PLAN 9
REGULATED FLOW
FREQUENCY (YEARS)
PEAK FLOW (CFS)
500 274,000
200 193,000
100 174,000
50 150,000
20 112,000
10 84,900
5 45,400
FLOW IN CFS
300000
250000
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAYS
GRANITE REEF 5-YR FLOW-REG
GRANITE REEF 10-YR FLOW-REG
GRANITE REEF 20-YR FLOW-REG
GRANITE REEF 50-YR FLOW-REG
GRANITE REEF 100-YR FLOW-REG
GRANITE REEF 200-YR FLOW-REG
GRANITE REEF 500-YR FLOW-REG


FIGURE NO. 5

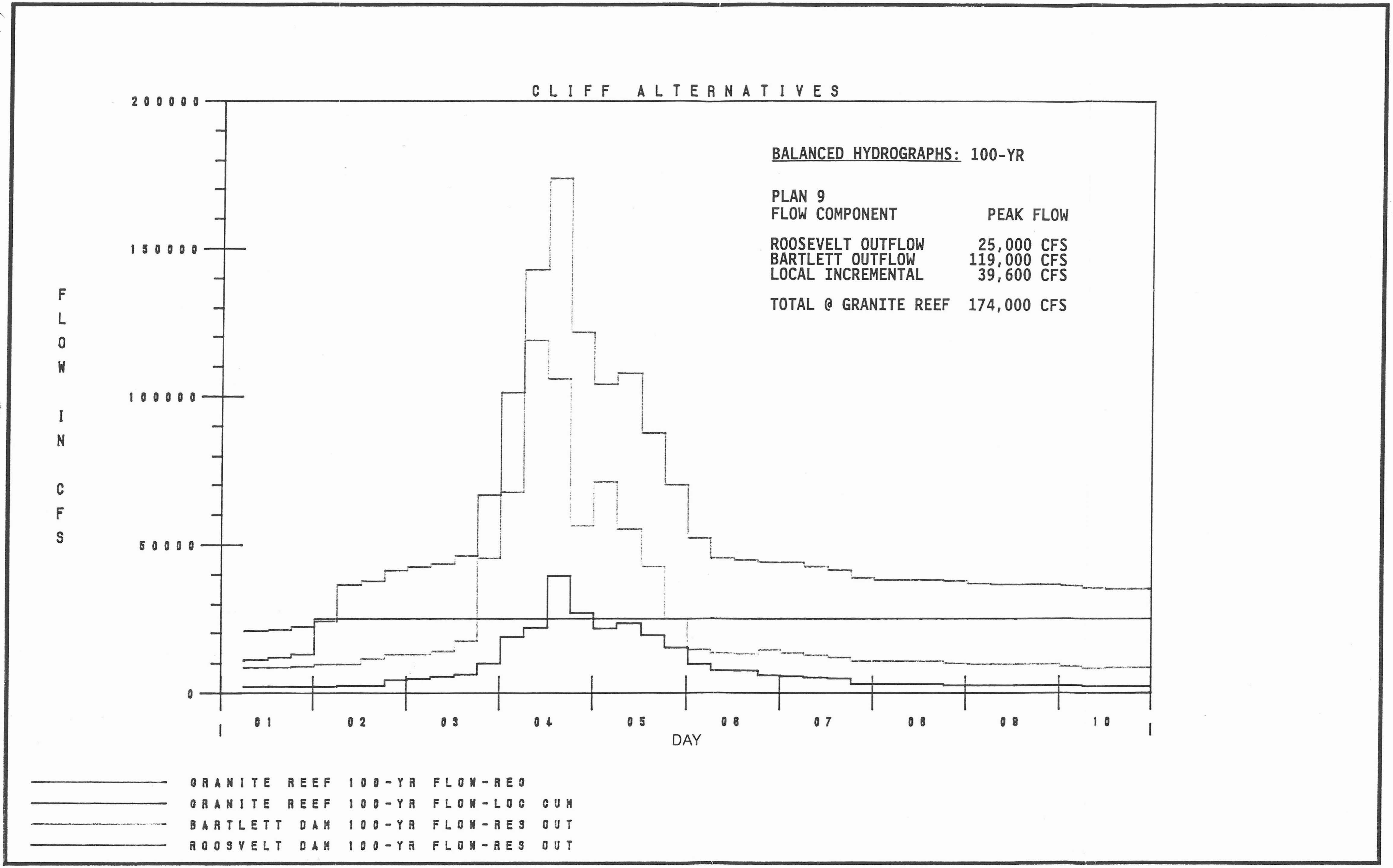

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS: 100-YR
PLAN 9
FLOW COMPONENT PEAK FLOW
ROOSEVELT OUTFLOW 25,000 CFS
BARTLETT OUTFLOW 119,000 CFS
LOCAL INCREMENTAL 39,600 CFS
TOTAL @ GRANITE REEF 174,000 CFS
FLOW IN CFS
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAY
GRANITE REEF 100-YR FLOW-REG
GRANITE REEF 100-YR FLOW-LOC CUM
BARTLETT DAM 100-YR FLOW-RES OUT
ROOSVELT DAM 100-YR FLOW-RES OUT

FIGURE NO. 6

The main focus of the changes was in the 200-year flood. The Plan 9 discharge frequency curve along with systematic and synthetic data is shown on plate 5. Since the simulated downstream runoff checked for both the "natural" and "existing"--prior to Plan 9--discharge frequency relationships (inflow to SRP, as well as downstream peak flow at the Salt-Verde confluence), the simulated Plan 9 results were used to modify the 1983 discharge frequency relationship for the Salt-Gila Rivers from Granite Reef to Gillespie Dam. The results of calibration of Plan 9 Balanced Hydrographs using the natural flow frequency curve is shown on plate 6. A comparison of "natural", "existing"--prior to Plan 9--and Plan 9 discharge frequency relationships is shown on plate 7 for the Salt River below the Verde River confluence.

## 2-03. PROPOSED ALTERNATIVES TO CLIFF DAM

### 2-03.1 General

Flood control allocations on the Verde River were evaluated at two sites--Horseshoe Dam and Bartlett Dam. The following matrix of storage and flood control outlets was examined at both locations, operating in conjunction (parallel) with the Plan 9 Roosevelt:

Table 3. Cliff Dam Alternative Matrix.

| Storage (ac. ft.) | Flood Outlet Capacity (cfs) | | |
|---|---|---|---|
| 100,000 | 25,000 | 60,000 | 100,000 |
| 200,000 | 25,000 | 60,000 | 100,000 |
| 300,000 | 25,000 | 60,000 | 100,000 |
| 465,000 | 25,000 | 60,000 | 100,000 |

2-03.2 Operating Plan Description

The objective of each of the 4 x 3 alternatives was to minimize the 100-year discharge at the airport (CP-110). This was accomplished by a system operation of the flood control pools at Roosevelt (Plan 9) and at the Verde site, again using HEC -5. Each system (2 x 4 x 3 = 2 sites, 4 storage allocations, and 3 flood outlet sizes) was operated to control the 100-year inflow to a target discharge at the Salt-Verde confluence. Upstream releases were combined with contemporaneous local flow between the flood control sites and the target location. A +20 percent contingency was assumed in the value of local flow for each time step of the hydrograph evaluation due to uncertainty in quantifying local flow under "real" conditions (i.e., if $Q_{Local}$ = 30,000 cfs, an upstream release decision assumes $Q_{Local}$ = 1.2 x 30,000 = 36,000 cfs). The reservoir systems were operated in such a manner that Roosevelt outflow was less than or equal to 25,000 cfs (Plan 9 size) and the Verde controlled release was less than or equal to outlet capacity until spillway flows were reached. Releases were made in a manner that resulted in the reservoir with the lowest level making the highest release. The reservoir level is a linear representation of the amount of flood control space occupied at any time step in the simulation: e.g., if level 3 = top of water supply pool, and level 4 = top of flood control pool, when a reservoir has 1/4 of its flood pool empty, the level = 3.75. If the other component reservoir level is greater than 3.75, i.e. less relative flood control space available, releases will be made from that reservoir, with the objective being to "balance" the system by making both levels equal. Total reservoir releases are then combined with local flow to achieve the following result:

$$Q_{Target} \geq Q_{Release} + 1.2\ Q_{Local}$$

2-03.3 Operating Plan Performance.

a. <u>Design Flood</u>. The "systems" evaluated are listed in the following table:

Table 4.

System Nomenclature with Storage Allocation/Outlet Size

| Outlet Size, cfs | Storage Allocation, ac. ft. 100 K | 200 K | 300 K | 465 K |
|---|---|---|---|---|
| 25 K | RHA1 | RHB1 | RHC1 | RHD1 |
| 60 K | RHA2 | RHB2 | RHC2 | RHD2 |
| 100 K | RHA3 | RHB3 | RHC3 | RHD3 |

DEFINITIONS:
K = 1,000 units
RH = Roosevelt "Plan 9" element + Horseshoe element
A = 100 K ac. ft. flood control allocation for Verde element
B = 200 K ac. ft. flood control allocation for Verde element
C = 300 K ac. ft. flood control allocation for Verde element
D = 465 K ac. ft. flood control allocation for Verde element
1 = 25 K cfs flood outlet for Verde element
2 = 60 K cfs flood outlet for Verde element
3 = 100 K cfs flood outlet for Verde element

NOTE: "RB" may be substituted for "RH" in nomenclature to mean Plan 9 plus Bartlett element.

Each "system" was evaluated to achieve a nominal target discharge in an iterative process;

1. If the initial target was exceeded, or if either the Roosevelt or Verde element reached level 4.0 or greater (spillway crest), the target was increased, usually in 5,000 cfs increments, until that target was achieved without reaching level 4; this target was then the final target discharge.

2. If the initial target was met without reaching level 4.0 for either element, the target was decreased in 5,000 cfs increments until the target was exceeded or either element reached level 4.0. When this point was determined, the next higher target was used as the final target discharge. This process was done for each of the 24 "systems". In some cases, such as RHA1 and RBA1, the 100-year component inflow was too large for that storage allocation/flood outlet size on the Verde River such that even if the maximum release (25,000 cfs) were continuous throughout the flood, that element still spilled. In these instances the criteria were relaxed, so that the only objective was the smallest target discharge. In most cases, however, the smallest target and not reaching level 4.0 were synonymous goals.

The 100-year Balanced Hydrographs at Granite Reef for systems RHB1 and RHD1 are compared to Plan 9 in figure 7. The actual 100-year design routing of Combined Coincident Component Inflow to Horseshoe and Roosevelt Dams is shown in figures 8 and 9 for both RHB1 and RHD1.

As discussed in the 1982 CAWCS Hydrology, (Appendix 3), two types of reservoir inflow data were developed:

1. Coincident Component Inflow--a deterministic evaluation of reservoir inflow in which a given probabilistic inflow to the SRP system, e.g. a 100-year inflow, has defined Salt and Verde River components designated by that same frequency on Coincident Component Frequency Curves (pls. 3-1 and 3-2 of Appendix 3, 1982 CAWCS Hydrology). For example, the 100-year SRP inflow has a Salt component with a peak flow of 215,000 cfs, and a Verde component with a peak flow of 128,000 cfs. These peaks are the maximum instantaneous values of 100-year inflow to the project components.

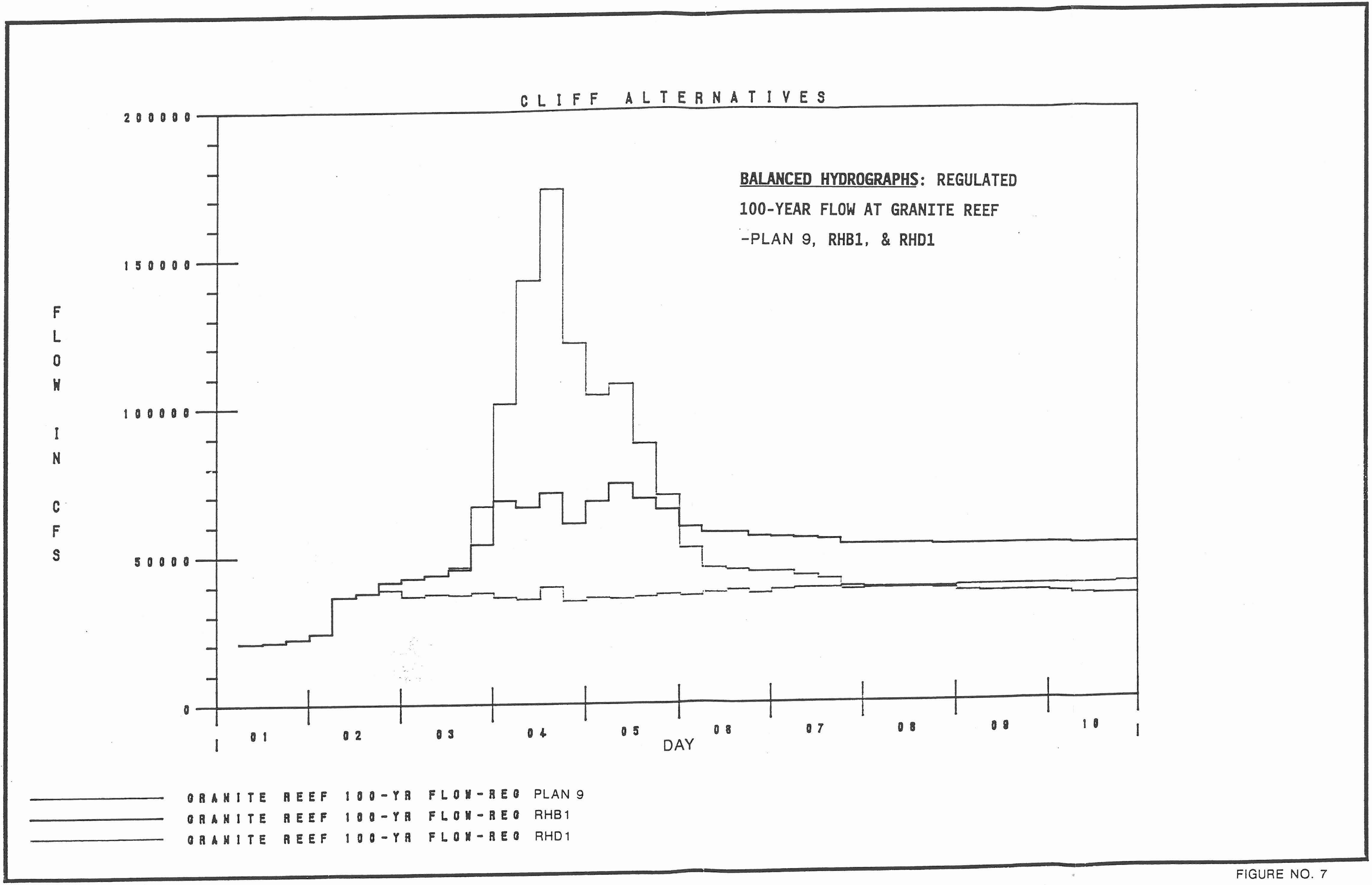

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS: REGULATED
100-YEAR FLOW AT GRANITE REEF
-PLAN 9, RHB1, & RHD1
FLOW IN CFS
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAY
GRANITE REEF 100-YR FLOW-REG PLAN 9
GRANITE REEF 100-YR FLOW-REG RHB1
GRANITE REEF 100-YR FLOW-REG RHD1

FIGURE NO. 7

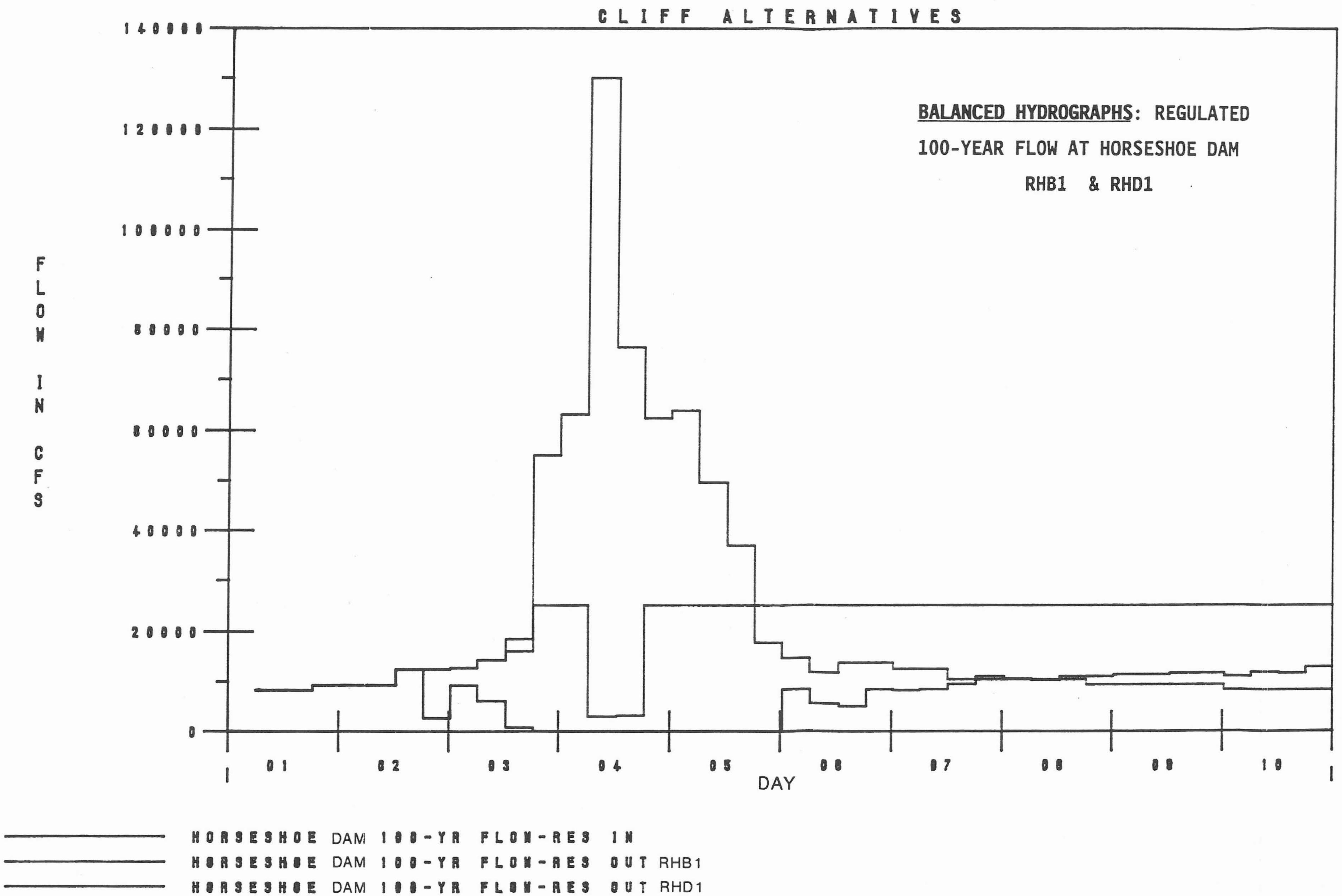

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS: REGULATED
100-YEAR FLOW AT HORSESHOE DAM
RHB1 & RHD1
FLOW IN CFS
140000
120000
100000
80000
60000
40000
20000
0
01
02
03
04
05
06
07
08
09
10
DAY
HORSESHOE DAM 100-YR FLOW-RES IN
HORSESHOE DAM 100-YR FLOW-RES OUT RHB1
HORSESHOE DAM 100-YR FLOW-RES OUT RHD1

FIGURE NO. 8

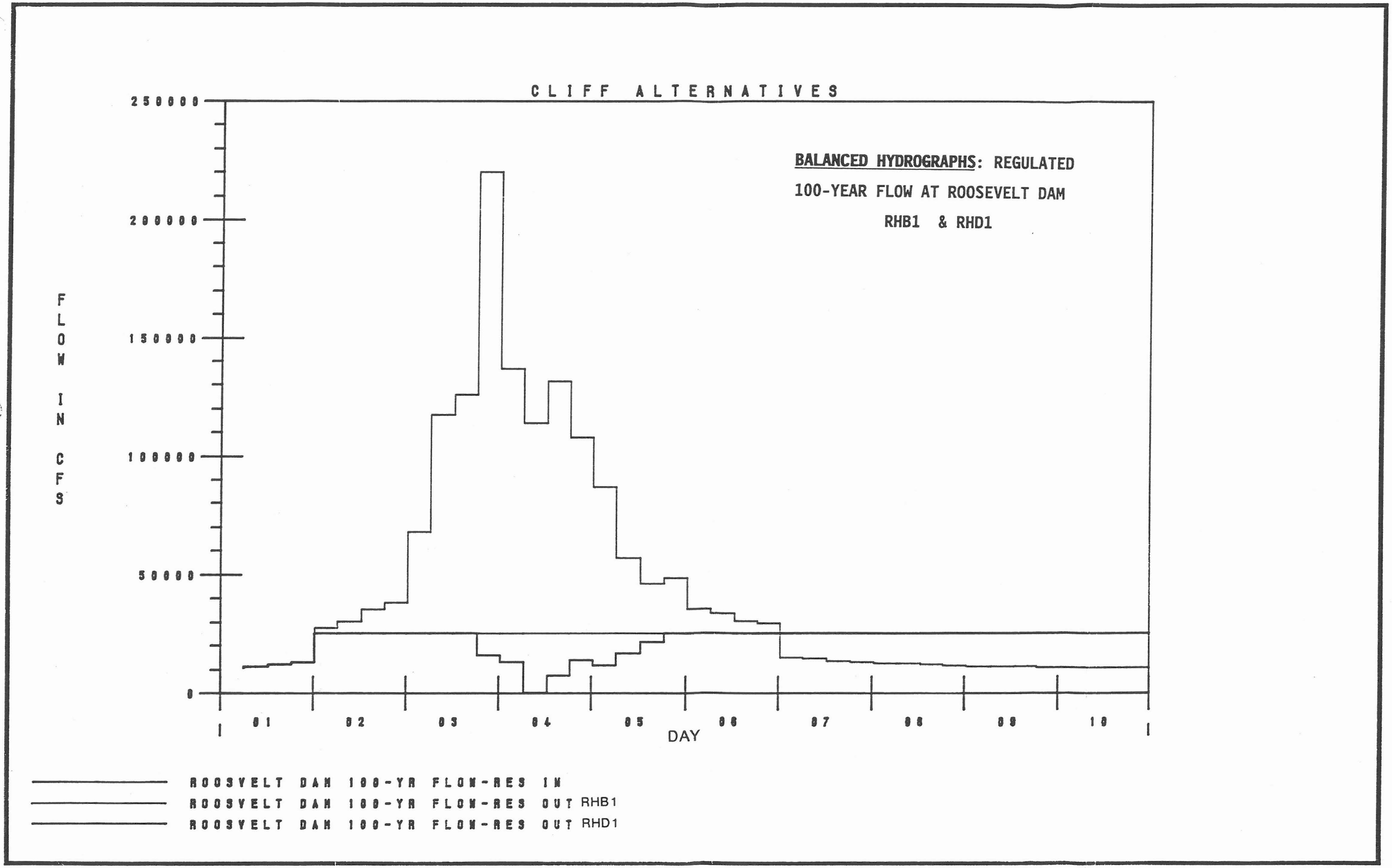

CLIFF ALTERNATIVES
BALANCED HYDROGRAPHS: REGULATED
100-YEAR FLOW AT ROOSEVELT DAM
RHB1 & RHD1
FLOW IN CFS
250000
200000
150000
100000
50000
0
01
02
03
04
05
06
07
08
09
10
DAY
ROOSEVELT DAM 100-YR FLOW-RES IN
ROOSEVELT DAM 100-YR FLOW-RES OUT RHB1
ROOSEVELT DAM 100-YR FLOW-RES OUT RHD1

FIGURE NO. 9

(The project evaluations were based upon the combination of the Balanced Inflow Hydrographs of these coincident components constructed from these Volume Frequency curves--plates 3-1 , 3-2--and referred to as Combined Coincident Component Balanced Inflow Hydrographs in this report.)

2. Station Inflow--a probabilistic evaluation of reservoir inflow to either branch of the SRP system, but not to both (not coincident) simultaneously. This data is based solely on station data and is represented by Volume Frequency Curves shown on plates 3-3 and 3-4 of Appendix 3, CAWCS Hydrology. As discussed in Appendix 3, these curves are composed of all annual maxima, and are thus by definition, greater than or equal to the coincident components. However, the total of Salt-Verde River Combined Coincident Inflow to the SRP system is greater than either of these. Tables 5-8 which follow provide peak flow rates and other duration inflows for Coincident Components and Station Inflow. Figures 10 and 11 show the component Balanced Hydrographs for Station Inflow to Horseshoe and Roosevelt Dams.

Table 5. Salt River Combined Coincident Component Inflow to Roosevelt (Ref. Plate 3-1, CAWCS Hydrology)

| | Peak Flow, cfs | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration | 5-yr. | 10-yr. | 20-yr. | 50-yr. | 100-yr. | 200-yr. | 500-yr. |
| Peak | 60000 | 90000 | 122000 | 175000 | 215000 | 260000 | 320000 |
| 1-Day | 43000 | 66000 | 90000 | 125000 | 150000 | 180000 | 220000 |
| 2-Day | 37000 | 58000 | 80000 | 109000 | 130000 | 150000 | 180000 |
| 3-Day | 30000 | 47000 | 65000 | 88000 | 105000 | 125000 | 150000 |
| 5-Day | 20000 | 32000 | 45000 | 63000 | 77000 | 90000 | 110000 |
| 10-Day | 13000 | 20000 | 27500 | 38000 | 46000 | 55000 | 64000 |

Table 6. Verde River Combined Coincident Component Inflow to Horseshoe.
(Ref. Plate 3-2, CAWCS Hydrology)

| | Peak Flow, cfs | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration | 5-yr. | 10-yr. | 20-yr. | 50-yr. | 100-yr. | 200-yr. | 500-yr. |
| Peak | 49000 | 71000 | 90000 | 112000 | 128000 | 145000 | 160000 |
| 1-Day | 31000 | 46000 | 59000 | 72000 | 83000 | 92000 | 101000 |
| 2-Day | 26500 | 37000 | 47500 | 59000 | 67000 | 73000 | 82000 |
| 3-Day | 20500 | 29000 | 36500 | 44000 | 50000 | 55000 | 62000 |
| 5-Day | 14000 | 20000 | 25500 | 31000 | 35000 | 39000 | 43000 |
| 10-Day | 9000 | 13000 | 16200 | 19800 | 22000 | 24500 | 27000 |

Table 7. Salt River Station Inflow to Roosevelt.
(Ref. Plate 3-3, CAWCS Hydrology)

| | Peak Flow, cfs | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration | 5-yr. | 10-yr. | 20-yr. | 50-yr. | 100-yr. | 200-yr. | 500-yr. |
| Peak | 55000 | 90000 | 130000 | 200000 | 270000 | 355000 | 490000 |
| 1-Day | 39000 | 63000 | 90000 | 140000 | 185000 | 235000 | 315000 |
| 2-Day | 32000 | 58000 | 78000 | 119000 | 155000 | 195000 | 265000 |
| 3-Day | 27000 | 46000 | 62000 | 94000 | 125000 | 155000 | 210000 |
| 5-Day | 20000 | 32000 | 45000 | 66000 | 86000 | 105000 | 140000 |
| 10-Day | 12000 | 20000 | 27500 | 38000 | 48000 | 58000 | 75000 |

Table 8. Verde River Station Inflow to Horseshoe
(Ref. Plate 3-4, CAWCS Hydrology)

| | Peak Flow, cfs | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration | 5-yr. | 10-yr. | 20-yr. | 50-yr. | 100-yr. | 200-yr. | 500-yr. |
| Peak | 47000 | 70000 | 95000 | 132000 | 165000 | 200000 | 250000 |
| 1-Day | 30000 | 49000 | 65000 | 94000 | 118000 | 142000 | 180000 |
| 2-Day | 24000 | 37000 | 51000 | 72000 | 90000 | 110000 | 140000 |
| 3-Day | 20000 | 30000 | 40000 | 56000 | 70000 | 85000 | 105000 |
| 5-Day | 14000 | 21000 | 28000 | 38000 | 47000 | 57500 | 71000 |
| 10-Day | 9000 | 13500 | 17500 | 23500 | 28000 | 33000 | 40000 |

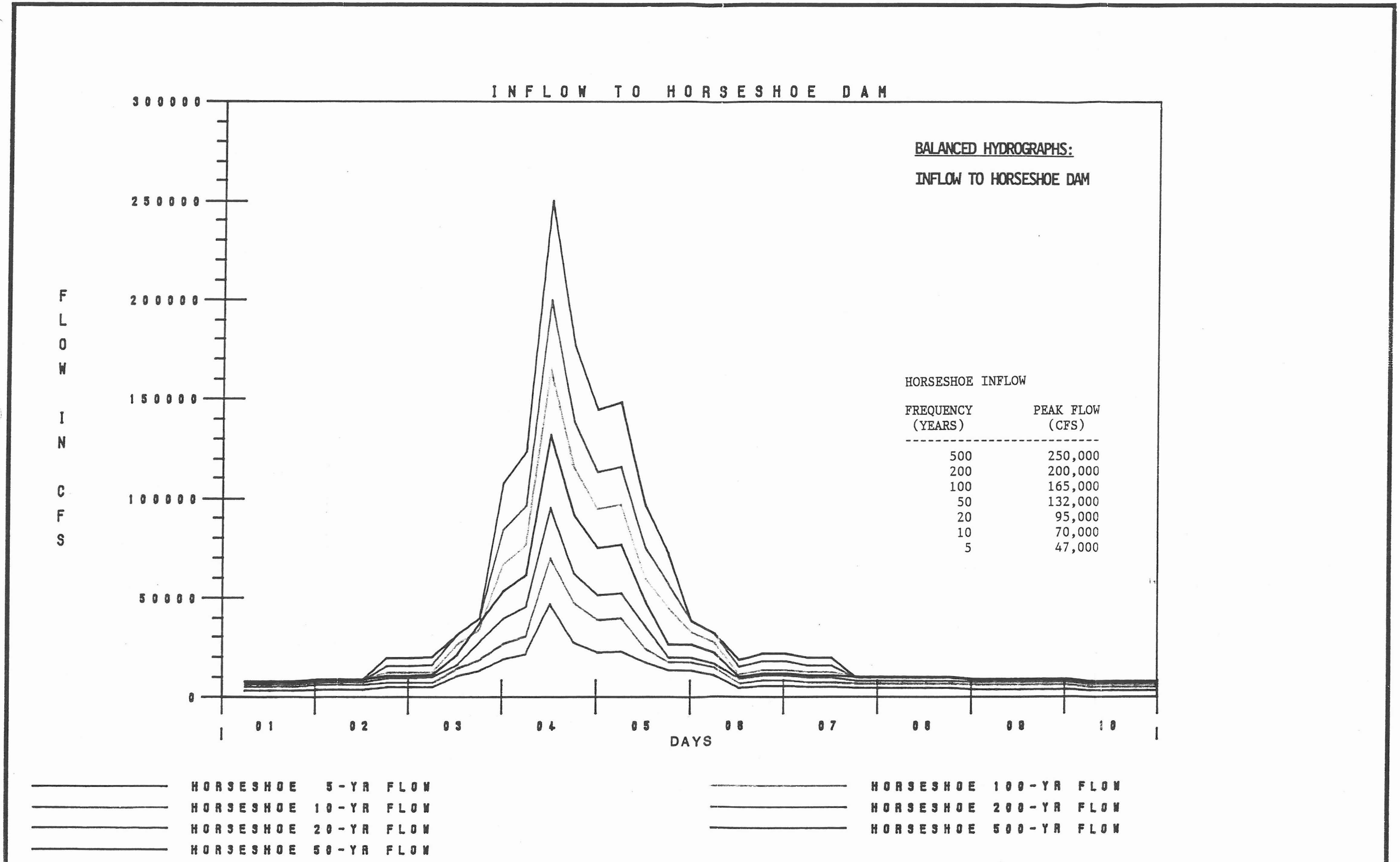

INFLOW TO HORSESHOE DAM
BALANCED HYDROGRAPHS:
INFLOW TO HORSESHOE DAM
HORSESHOE INFLOW
FREQUENCY (YEARS)
PEAK FLOW (CFS)
500 250,000
200 200,000
100 165,000
50 132,000
20 95,000
10 70,000
5 47,000
300000
250000
200000
150000
100000
50000
0
FLOW IN CFS
01
02
03
04
05
06
07
08
09
10
DAYS
HORSESHOE 5-YR FLOW
HORSESHOE 10-YR FLOW
HORSESHOE 20-YR FLOW
HORSESHOE 50-YR FLOW
HORSESHOE 100-YR FLOW
HORSESHOE 200-YR FLOW
HORSESHOE 500-YR FLOW

FIGURE NO. 10

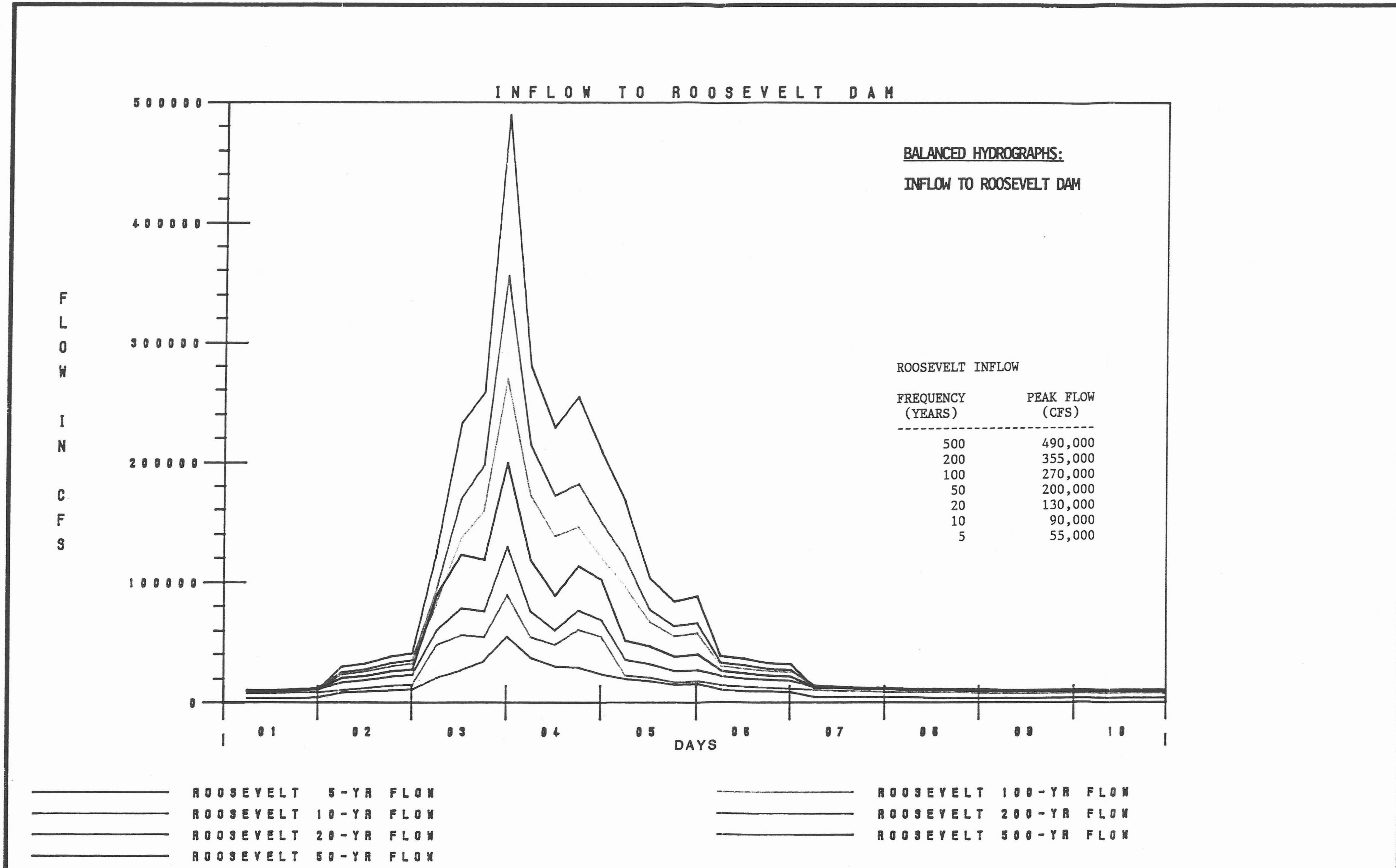

INFLOW TO ROOSEVELT DAM
BALANCED HYDROGRAPHS:
INFLOW TO ROOSEVELT DAM
ROOSEVELT INFLOW
FREQUENCY (YEARS) | PEAK FLOW (CFS)
500 490,000
200 355,000
100 270,000
50 200,000
20 130,000
10 90,000
5 55,000
FLOW IN CFS
500000
400000
300000
200000
100000
0
01 02 03 04 05 06 07 08 09 10
DAYS
ROOSEVELT 5-YR FLOW
ROOSEVELT 10-YR FLOW
ROOSEVELT 20-YR FLOW
ROOSEVELT 50-YR FLOW
ROOSEVELT 100-YR FLOW
ROOSEVELT 200-YR FLOW
ROOSEVELT 500-YR FLOW

FIGURE NO. 11

To ensure that the downstream discharge based on minimizing the 100-year flow was an accurate portrayal of the range of possibilities, the 100-year Station Inflows were also examined. This was done because some of the Verde River system components had such small flood control allocations and outlet capacities, that a runoff event confined to the Verde River (peak Station Inflow for a 100-year event = 165,000 cfs, 10-day volume = 550,000 ac. ft.) might produce a greater downstream peak due to spillway flow, than the larger total Combined Coincident Component Inflow (100-year peak Verde Component Inflow = 128,000 cfs, 10-day volume = 430,000 ac. ft.). Verde River Station Inflows for all alternatives were evaluated, and where these resulted in greater downstream peak runoff than the Combined Coincident Components, these peak discharges were used to supplant the "combined" results. Since the Roosevelt component inflow coincident with the 100-year Station Inflow to Horseshoe was unknown, two extremes were defined: the downstream flow was greater than or equal to the Verde release + local flow, but less than or equal to the Verde release + local flow + 25,000 cfs--since 25,000 cfs is the Roosevelt Dam Plan 9 outflow. Since the range of downstream peak flows was usually limited to 25,000 cfs, and the balance between the low and high end of the range was unknown, an arithmetic average of the high and low peak flows was used to represent the peak flow resulting from Verde Station Inflow.

The results of these analyses for the 100-year event are presented in the following table.

Table 9. 100-Year Operational Results for Cliff Alternative Systems.

| Alternative | RHA1 | RHA2 | RHA3 | RHB1 | RHB2 | RHB3 | RHC1 | RHC2 | RHC3 | RHD1 | RHD2 | RHD3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum 100-yr. Discharge, 1,000 cfs | 140 | 125 | 125 | 105 | 100 | 100 | 65 | 65 | 65 | 40 | 40 | 40 |

NOTE: No combinations of storage/outflow could control the 100-year Verde River inflow component without spilling, except RHD1, 2, and 3.

b. Impact on Other Floods. Each "system" was evaluated for the following n-year runoff events, in addition to the 100-year flood:

n = 5-, 10-, 20-, 50-, 200-, 500-year frequency.

The analyses were conducted in a similar manner to the 100-year runoff evaluation. Combined Coincident Component Balanced Inflow Hydrographs were routed through each system, the objective being to control the maximum downstream flow to the target discharge at the Salt-Verde confluence. As in the design flood analysis, Verde River Station Inflow Balanced Hydrographs were also studied to determine whether downstream runoff might be greater when a flood was centeralized over the Verde River, even though that flood might be smaller than the n-year total "system" inflow. Station inflows produced higher downstream peak flow for the 100- and 200-year floods than combined coincident inflows except for the largest storage alternatives--RHD1, RHD2, and RHD3. A table of controlling floods is presented below for clarification.

Table 10. Controlling Flood for With Project Frequency Analysis.

| | Frequency (years) | | | | | | |
|---|---|---|---|---|---|---|---|
| Alternative System | 5 | 10 | 20 | 50 | 100 | 200 | 500 |
| RHA1 | CC | CC | CC | V | V | V | CC |
| RHA2 | CC | CC | CC | CC | V | V | CC |
| RHA3 | CC | CC | CC | CC | V | V | CC |
| RHB1 | CC | CC | CC | CC | V | V | CC |
| RHB2 | CC | CC | CC | CC | V | V | CC |
| RHB3 | CC | CC | CC | CC | V | V | CC |
| RHC1 | CC | CC | CC | CC | V | V | CC |
| RHC2 | CC | CC | CC | CC | V | V | CC |
| RHC3 | CC | CC | CC | CC | V | V | CC |
| RHD1 | CC | CC | CC | CC | CC | CC | CC |
| RHD2 | CC | CC | CC | CC | CC | CC | CC |
| RHD3 | CC | CC | CC | CC | CC | CC | CC |

CC = Combined Coincident Componet Inflow
V = Verde Inflow

The 500-year maxima were generated by Combined Coincident Component Inflow, since both Roosevelt and Verde flood control structures spilled during this simulation. Station Inflow and Coincident Component Inflow are nearly identical for floods of 20-year frequency or less (preceding tables 5-8). Variation in outlet capacities and operational targets are responsible for the 50-year station inflow controlling downstream flow for the 50-year simulation. A tabulation of operational targets for Combined Coincident Inflows, which produced the minimum peak runoff at the Salt-Verde River confluence, follows for comparison with the actual 100-year operational results based upon both Coincident Component and Station Inflow.

Table 11. 100-Year Operational Targets at Salt-Verde Confluence, CP-40, for Cliff Alternative Systems.

| Alter-native | RHA1 | RHA2 | RHA3 | RHB1 | RHB2 | RHB3 | RHC1 | RHC2 | RHC3 | RHD1 | RHD2 | RHD3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100-yr. Target Discharge, 1,000 cfs | 90K* | 110K | 110K | 80K | 70K | 70K | 45K | 45K | 45K | 40K | 40K | 40K |

*NOTE: Targets are set for Combined Coincident Component Inflow Hydrographs and are intended to achieve those results without spilling. RHA1 spills for 100-year inflow even with outlets fully open.

In addition to frequency hydrographs, the SPF developed in the 1982 CAWCS Hydrology (pp. 14-15), was used to provide further information about the ability of the proposed upstream alternative systems to control downstream runoff. Plan 9 reduces the SPF to 205,000 cfs at the Salt-Verde confluence; this would be equivalent to a 200-year flood based upon the discharge frequency relationship for Plan 9. Each system was operated for the Target defined in the previous table during the SPF simulation, and the resulting peak flow rates were plotted on log-frequency paper using the 200-year frequency intercept. A table of the SPF routing results for alternative systems follows.

Table 12. Results of SPF Routing for Alternative Systems at Salt-Verde Confluence, CP-40.

| Alter-native | RHA1 | RHA2 | RHA3 | RHB1 | RHB2 | RHB3 | RHC1 | RHC2 | RHC3 | RHD1 | RHD2 | RHD3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPF Peak, 1,000 cfs | 185 | 153 | 130 | 165 | 152 | 131 | 159 | 165 | 165 | 125 | 124 | 124 |

The SPF discharges are generally larger for small flood control allocations with small outlets. However, the magnitude of the resulting outflow is also dependent upon the downstream target discharge (see previous table). Thus in some cases, an operation which attempts to control the 100-year flood to a smaller target results in higher peak flows during larger events such as the SPF. For example the SPF with RHB3 results in a downstream peak of 131,000 cfs, while for RHC3, the SPF results in a downstream peak of 165,000 cfs. This occurs, even though the RC3 system includes an additional 100,000 ac. ft. of flood allocation at Horseshoe compared to the RHB3 system, because the 100-year target is 45,000 cfs for the former and 70,000 cfs for the latter. Since the SPF is about a 200-year frequency flood, and is thus greater than the 100-year inflow, all systems designed for a 100-year event will spill. The downstream peak is generally greatest for those systems which lose control soonest. An exception to this general guideline is evident in comparing the downstream peak flows when the SPF is routed through the 'C' systems. The peak flow for RHC1 is 159,000 cfs, while it is 165,000 cfs for RHC2, and RHC3. The difference in these cases is due to the smaller outlet capacity for RHC1 than the others, but in an inverse manner as discussed hereafter:

- RHC1 has a 25,000 cfs Verde outlet.

- RHC3 has a 100,000 cfs Verde outlet.

- As a consequence RHC3 is able to evacuate more space during the flood routing prior to reaching spillway crest.

- This results in spillway flow occuring later for RHC3 than RHC1.

- Since the spill is later, it occurs further down on the recession limb of the inflow hydrograph, thus the spill for RHC3 is smaller than RHC1. See figure 12 for a comparison of Verde River SPF outflows.

- However, Roosevelt outflow is about the same for RHC1 and RHC3, and since there is more available space (300,000 ac. ft. for the Verde, 565,000 ac. ft. for Roosevelt), Roosevelt spills later than the Verde. Salt River outflows for RHC1 and RHC3 are compared in figure 13.

- Thus, although RHC3 has a smaller Verde spill than RHC1 (125,000 cfs to 155,000 cfs), RHC3 results in a higher dowstream peak because that spill times more closely with the Salt spill. Figure 14 compares the regulated SPF hydrographs for RHC1 and RHC3 at Granite Reef. The operation of the system elements during the synthetic flood simulation may result in apparent incongruities in downstream flow. Different reservoir system objectives and resulting operational plans would produce different downstream flow.

The simulated frequency discharges at CP-40 were plotted at the same frequency as inflow (SPF plotting position = .005) on log frequency paper, and smooth curves were constructed through the data, using the greater of Combined Coincident Component or Station Inflow peaks as guides. The resulting discharge frequency curves of reservoir outflow plus coincident local runoff are shown on plates 8-11 and labeled as Phase 1 results. Non-coincident local flow is also shown on these plates and a discussion pertaining to Phase 2 - the combination of Phase 1 and non-coincident local flow - is included in section 2.04. Plates 8-11 show examples of Balanced Hydrograph and SPF simulations for systems RHA1, RHB1, RHC1, and RHD1.

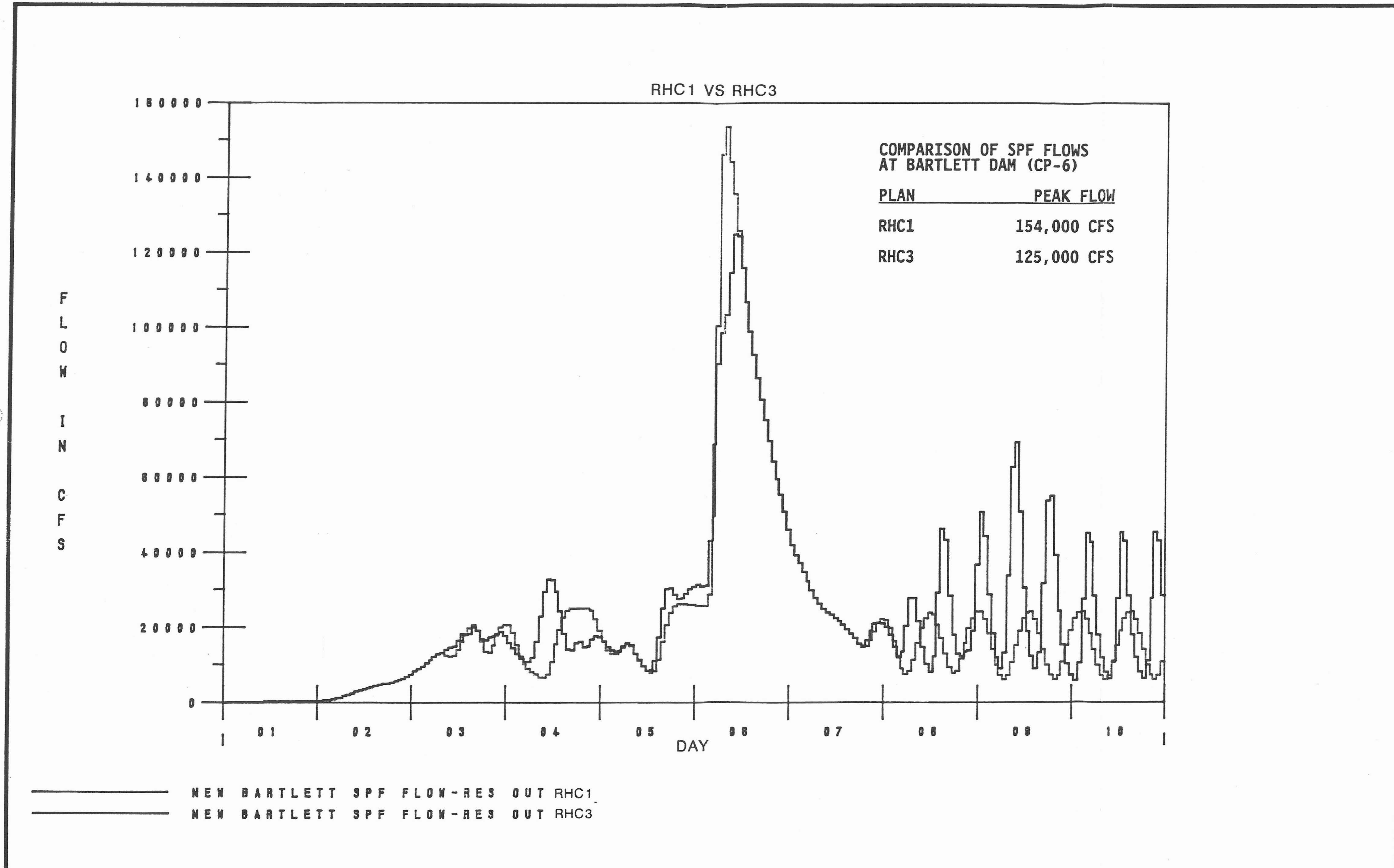

RHC1 VS RHC3
COMPARISON OF SPF FLOWS
AT BARTLETT DAM (CP-6)
PLAN
PEAK FLOW
RHC1
154,000 CFS
RHC3
125,000 CFS
FLOW IN CFS
180000
140000
120000
100000
80000
60000
40000
20000
0
01
02
03
04
05
06
07
08
09
10
DAY
NEW BARTLETT SPF FLOW-RES OUT RHC1
NEW BARTLETT SPF FLOW-RES OUT RHC3

FIGURE NO. 12

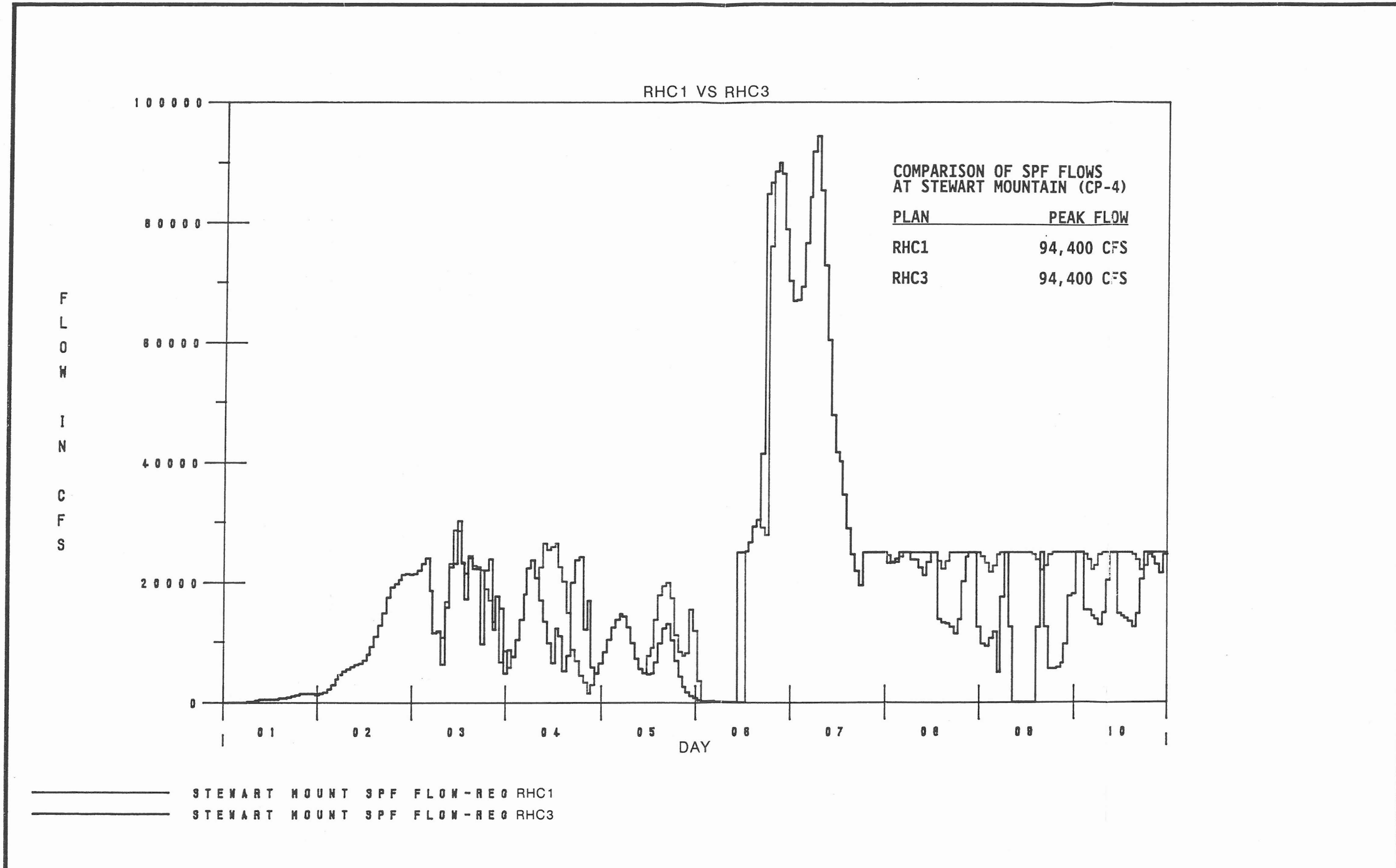

RHC1 VS RHC3
100000
80000
60000
40000
20000
0
FLOW IN CFS
01
02
03
04
05
06
07
08
09
10
DAY
COMPARISON OF SPF FLOWS
AT STEWART MOUNTAIN (CP-4)
PLAN
PEAK FLOW
RHC1
94,400 CFS
RHC3
94,400 CFS
STEWART MOUNT SPF FLOW-REG RHC1
STEWART MOUNT SPF FLOW-REG RHC3

FIGURE NO. 13

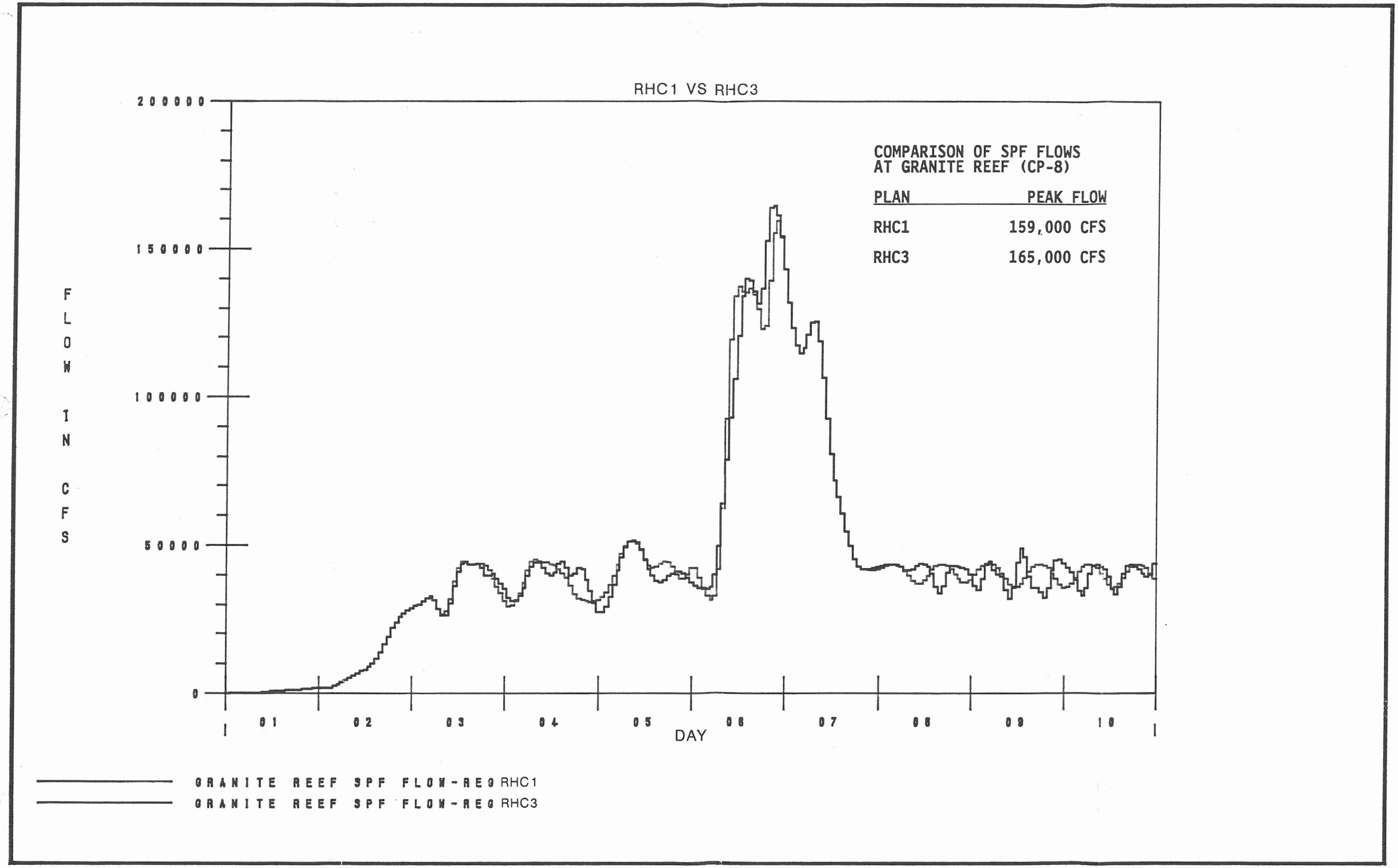

RHC1 VS RHC3
COMPARISON OF SPF FLOWS
AT GRANITE REEF (CP-8)
PLAN
PEAK FLOW
RHC1
159,000 CFS
RHC3
165,000 CFS
200000
150000
100000
50000
0
FLOW IN CFS
01
02
03
04
05
06
07
08
09
10
DAY
GRANITE REEF SPF FLOW-REG RHC1
GRANITE REEF SPF FLOW-REG RHC3

FIGURE NO. 14

c. Flood Control at Horseshoe versus Bartlett: Analysis of alternative systems RH's vs. RB's resulted in no apparent advantage in flood reduction by choosing one site over the other. Any preference, then, should be based on costs, or socio-environmental reasons, etc., which support the selection of one site.

d. Reservoir Routing Criteria: No actual designs were currently available for modified Horseshoe and/or Bartlett Dams. Thus, performance criteria were built-in to the alternative systems to enable flood control simulation to be completed. Elevation-capacity information was based upon data used for the previous study, discussed in the May 1982 CAWCS Hydrology. The data used for the sites is presented in the following table. No surface area information is listed since no evaporation computations were made during simulation of flood events.

Table 13. Elevation-Capacity Data for Verde River Alternative Sites.

| Horseshoe Dam Site | | | Bartlett Dam Site | | |
|---|---|---|---|---|---|
| Elevation (NGVD) | Location of Spillway Crest | Capacity (Ac. Ft.) | Elevation (NGVD) | Location of Spillway Crest | Capacity (Ac. Ft.) |
| 1930 | | 0 | 1610 | | 0 |
| 1940 | | 3,000 | 1650 | | 1,237 |
| 1960 | | 14,000 | 1680 | | 10,642 |
| 1980 | | 37,000 | 1700 | | 21,452 |
| 2000 | | 63,000 | 1725 | | 42,251 |
| 2020 | | 119,000 | 1748 | | 72,073 |
| 2026 | (Existing) | 131,427 | 1760 | | 91,808 |
| 2040 | | 170,000 | 1770 | | 110,848 |
| 2050 | | 200,000 | 1780 | | 132,439 |
| 2060 | (RHA) | 231,427 | 1786 | | 146,606 |
| 2070 | | 270,000 | 1790 | | 156,642 |
| 2085 | (RHB) | 331,427 | 1792 | | 161,842 |
| 2094 | | 380,000 | 1794 | | 167,166 |
| 2103 | (RHC) | 431,427 | 1796 | | 172,616 |
| 2116 | | 520,000 | 1798 | (Existing) | 178,186 |
| 2125 | (RHD) | 596,427 | 1830 | (RBA) | 278,186 |
| | | | 1855 | (RBB) | 378,186 |
| | | | 1875 | (RBC) | 478,186 |
| | | | 1900 | (RBD) | 643,186 |

Verde River reservoir releases were made according to the following schedule:

- Below Top-of-Conservation Pool (Normal Water Surface - NWS)
  no release during flood simulation

- Above NWS, Below Spillway Crest
  release less than or equal to flood outlets*, depending on reservoir level, local runoff, and target discharge.

- At Spillway Crest
  outflow = inflow, until inflow less than flood outlet capacity, at that time flood outlet resumes release according to criteria previously described.

Setting outflow = inflow above the spillway crest ensured that each proposed alternative was evaluated on an equal basis, and that downstream flows for actual spillway designs would be less than or equal to those resulting from this analysis. The Roosevelt Dam element was operated in a similar manner, except that (1) the spillway design from Plan 6/Plan 9 was used to route flows when the spillway crest was equalled or exceeded, and (2) the only flood outlet evaluated was 25,000 cfs (release less than or equal to 25,000 cfs throughout the flood pool), which was taken from Plan 6/Plan 9 also.

Ensuing Reservoir releases were routed downstream to the Salt-Verde Confluence (CP-40) using criteria described in table 8, CAWCS Hydrology, and combined with simultaneous local inflow from the area downstream of the flood control sites.

*flood outlets = 25,000 cfs (1), 60,000 cfs (2), or 100,000 cfs (3) throughout this range.

## 2-04. LOCAL INFLOW ANALYSIS

Non-coincident local flows downstream of the proposed flood control sites were analyzed in the same manner as in the CAWCS Hydrology and described therein on pages 27-29. An example of the development of with project discharge frequency relationships, including non-coincident local runoff is shown on plates 12a through 12c. Total uncontrolled local runoff, both coincident and non-coincident, is compared to the Phase 1 runoff (u/s reservoir release + coincident local flow) on plate 12a. The minimum flow at the Salt-Verde confluence is the greater of Phase 1 runoff or the total local flow. As discussed in reference 1, this is based on a very restrictive criteria, that all local flow and Phase 1 flow occur in the same water year and even the same flood. Thus these events are Dependent - the occurrence of one always is accompanied by or results in the occurrence of the other. The other most extreme possibility - the maximum flow at the Salt-Verde confluence - results when the Phase 1 runoff and local flow never occur at the same time. Thus, the occurrence of one event has no bearing on the occurrence of the other, and the events are Independent. A simplified procedure for determining the frequency of Independent events follows:

- a flow of 55,000 cfs at the confluence of the Salt and Verde Rivers will be equalled or exceeded 0.9 times per 100-years for Phase 1 flows

- the same flow will be equalled or exceeded 2.2 times per 100-years for local flow

- since these flows are Independent (never occurring simultaneously) the total number of times 55,000 cfs is equalled or exceeded per 100-years is thus 3.1 times, the sum of each Independent occurrence.

- the probability of the range of flows can be determined in the same manner

Plate 12b compares the Dependent and Independent extremes for RHD1. Since some of the total uncontrolled local flows are included in Phase 1 runoff, the Phase 2 final with project discharge frequency curve must be less than the Independent results. However, since these local flows are not always included in or simultaneous with an upstream flood control release or spill, the Phase 2 curve must be greater than the Dependent results. A concensus discharge frequency curve for the RHD1 example (in which local flow has the most profound effect) is shown on plate 12c and labeled Phase 2.

In general, local inflow has the most impact on the alternatives which reduced the upstream releases the most, i.e., RHC' and RHD' systems. Plates 13 through 16 show the increasing impact of local flow on final frequency discharge relationships at CP-40 as the project level of protection increases. For comparison purposes, a table of target 100-year peak flows and 100-year peak flows including local flow is included for the Salt-Verde Confluence.

Table 14. Impact of Local Uncontrolled Inflow on 100-year Peak Discharge, Salt River Below Verde River, CP-40. (all flows in cfs).

| Alternative System | RHA1 | RHA2 | RHA3 | RHB1 | RHB2 | RHB3 | RHC1 | RHC2 | RHC3 | RHD1 | RHD2 | RHD3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100-year Upstream Release | 140,000 | 125,000 | 125,000 | 105,000 | 100,000 | 100,000 | 65,000 | 65,000 | 65,000 | 40,000 | 40,000 | 40,000 |
| 100-year U/S + local, Flow | 140,000 | 125,000 | 125,000 | 110,000 | 105,000 | 105,000 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 |
| % Increase | 0 | 0 | 0 | 4.8 | 5 | 5 | 30.8 | 30.8 | 30.8 | 112 | 112 | 112 |

The smallest achievable 100-year peak flow at CP-40 is 85,000 cfs when non-coincident local flow is included--the 100-year peak local inflow to CP-40 is 73,000 cfs.

The impact of local runoff on with project flows in the Salt River decreases for increasing magnitude floods, and for increasing distance downstream (see pls. 17 through 24 for comparisons). At the airport (CP-110) the minimum 100-year with project peak flow, including local runoff, was reduced to 60,000 cfs, and the 100-year peak local inflow decreased to 42,000 cfs. Here the maximum impact of local flow (RHD' systems) is 53.8 percent--the regulated peak flow of 39,000 cfs increased to 60,000 cfs including local flow. Above the Salt-Gila Confluence (CP-113) the 100-year peak local inflow is 32,000 cfs, and the minimum regulated 100-year peak flow (regulated plus non-coincident local flow) is 34,000 cfs. The minimum combined peak flow is 50,000 cfs at this point, and the maximum impact of local flow is 47.1 percent. The decrease in influence of local inflow is due to the separable method of analysis implemented to evaluate the effects of non-coincident uncontrolled tributary inflow on upstream flood control releases. That method was selected because the flows themselves were separate by definition. Thus, upstream reservoir releases and coincident local flow were routed from point-to-point along the Salt River (Granite Reef Dam, CP-8, to the Tempe Bridge/Airport, CP-110, to the Gila River, CP-113); likewise non-coincident local flow had been routed separately from point-to-point along the Salt River (Appendix 1, May 1982 CAWCS Hydrology). Because the volume of local flow is much less than that of the upstream releases, the attenuation of local flows is much greater, and consequently, the influence of local flow decreases in the downstream direction.

## 2-05. CHANNEL ROUTING

### 2-05.1 Salt River, Granite Reef to Gila River

Channel routing relationships (percolation, and storage vs. discharge at normal depth), based upon Salt River available topography were developed during the previous CAWCS study. These parameters are shown in the CAWCS Hydrology, table 9. Results of simulated flood routings for existing conditions, based upon an HEC-5 model incorporating these table 9 parameters were collected for each of the 39 events (spills over Granite Reef to the Salt River) analyzed in that study. Peak flow rates for each simulated event were plotted in pairs, inflow to Granite Reef (CP-8) vs. flow at downstream location, e.g. Tempe Bridge/Airport (CP-110). Then best-fit curves were constructed through the data points (pls. 25 and 26). These curves represented the attenuation resulting from the storage routing of a variety of hydrograph shapes and magnitudes. The use of these curves to route project alternative releases should produce attenuations that are similar to what would have resulted using the channel parameters developed for the previous study. Thus, the peak flows from Balanced Hydrographs of upstream releases plus coincident local flow at Granite Reef Dam (CP-8) were routed downstream to CP-110, and then CP-113 using these curves.

Non-coincident local flows had previously been developed for these same concentration points. The two separate components of downstream peak flow were then combined probabilistically at each of these 3 locations as discussed in the CAWCS Hydrology, section 8-05 "Project Conditions (stage III)" pages 27-29. The following tables contain the cumulative discharge frequency relatinships defining all flow conditions for the Salt River below the Salt-Verde Confluence (CP-40) and above the Gila River Confluence (CP-113) based upon Plan 9 as well as the Cliff alternatives. The final results for the Salt River at Skyharbor Airport (CP-110) were provided in table 1.

Table 15. Discharge Frequency Values For Project Alternatives in cfs. (2)

| Alternative | 100-Year (1) Minimum Target | Frequency, Years: Salt River below Verde River (CP-40) 5 | 10 | 20 | 50 | 100 | 200 | 500 |
|---|---|---|---|---|---|---|---|---|
| PLAN 9 | NONE | 45000 | 85000 | 115000 | 145000 | 175000 | 210000 | 275000 |
| RHA1. | *90000 | 45000 | 55000 | 70000 | 100000 | 140000 | 190000 | 275000 |
| RHB1. | 80000 | 45000 | 55000 | 65000 | 85000 | 110000 | 150000 | 225000 |
| RHC1. | 45000 | 45000 | 45000 | 45000 | 65000 | 85000 | 120000 | 200000 |
| RHD1. | 40000 | 40000 | 40000 | 40000 | 62000 | 85000 | 120000 | 200000 |
| RHA2. | 110000 | 45000 | 85000 | 98000 | 110000 | 125000 | 160000 | 275000 |
| RHB2. | 70000 | 45000 | 70000 | 70000 | 80000 | 105000 | 140000 | 240000 |
| RHC2. | 45000 | 45000 | 45000 | 45000 | 65000 | 85000 | 120000 | 200000 |
| RHD2. | 40000 | 40000 | 40000 | 40000 | 62000 | 85000 | 120000 | 200000 |
| RHA3. | 110000 | 45000 | 85000 | 110000 | 110000 | 125000 | 150000 | 275000 |
| RHB3. | 70000 | 45000 | 70000 | 70000 | 80000 | 105000 | 140000 | 240000 |
| RHC3. | 45000 | 45000 | 45000 | 45000 | 65000 | 85000 | 120000 | 200000 |
| RHD3. | 40000 | 40000 | 40000 | 40000 | 62000 | 85000 | 120000 | 200000 |

NOTE: Targets were set to make maximum use of available flood control space without spilling; "RHA1" spilled during the 100-year flood even with continuous outflow of 25,000 cfs.

DEFINITIONS: RH = Roosevelt "Plan 9" element and Horseshoe element
A = 100,000 Ac. Ft. of Flood Control on the Verde River
B = 200,000 Ac. Ft. of Flood Control on the Verde River
C = 300,000 Ac. Ft. of Flood Control on the Verde River
D = 465,000 Ac. Ft. of Flood Control on the Verde River

1 = 25,000 cfs Flood Outlet, Verde element
2 = 60,000 cfs Flood Outlet, Verde element
3 = 100,000 cfs Flood Outlet, Verde element

(1) U/S Release + Contemporaneous Local Flow at Salt-Verde Confluence.
(2) Includes Uncontrolled Local Runoff Non-Coincident w/ U/S Release.
* This target produced minimum flow, but was not achieved.

Table 16. Discharge Frequency Values For Project Alternatives (in cfs).[2]

| Alternative | 100-Year[1] Minimum Target | Frequency, Years: Salt River above Gila River (CP-113) 5 | 10 | 20 | 50 | 100 | 200 | 500 |
|---|---|---|---|---|---|---|---|---|
| PLAN 9 | NONE | 40000 | 75000 | 110000 | 125000 | 150000 | 185000 | 240000 |
| RHA1. | *90000 | 40000 | 46000 | 56000 | 90000 | 125000 | 170000 | 240000 |
| RHB1. | 80000 | 40000 | 46000 | 56000 | 70000 | 94000 | 135000 | 200000 |
| RHC1. | 45000 | 40000 | 40000 | 40000 | 40000 | 60000 | 105000 | 180000 |
| RHD1. | 40000 | 34000 | 34000 | 34000 | 34000 | 50000 | 100000 | 180000 |
| RHA2. | 110000 | 40000 | 75000 | 86000 | 98000 | 110000 | 140000 | 240000 |
| RHB2. | 70000 | 40000 | 62000 | 62000 | 65000 | 90000 | 125000 | 210000 |
| RHC2. | 45000 | 40000 | 40000 | 40000 | 40000 | 60000 | 105000 | 180000 |
| RHD2. | 40000 | 34000 | 34000 | 34000 | 34000 | 50000 | 100000 | 180000 |
| RHA3. | 110000 | 40000 | 75000 | 100000 | 100000 | 110000 | 140000 | 240000 |
| RHB3. | 70000 | 40000 | 62000 | 62000 | 65000 | 90000 | 125000 | 240000 |
| RHC3. | 45000 | 40000 | 40000 | 40000 | 40000 | 60000 | 105000 | 180000 |
| RHD3. | 40000 | 34000 | 34000 | 34000 | 34000 | 50000 | 100000 | 180000 |

NOTE: Targets were set to make maximum use of available flood control space without spilling; "RHA1" spilled during the 100-year flood even with continuous outflow of 25,000 cfs.

DEFINITIONS:

RH = Roosevelt "Plan 9" element and Horseshoe element
A = 100,000 Ac. Ft. of Flood Control on the Verde River
B = 200,000 Ac. Ft. of Flood Control on the Verde River
C = 300,000 Ac. Ft. of Flood Control on the Verde River
D = 465,000 Ac. Ft. of Flood Control on the Verde River

1 = 25,000 cfs Flood Outlet, Verde element
2 = 60,000 cfs Flood Outlet, Verde element
3 = 100,000 cfs Flood Outlet, Verde element

(1) U/S Release + Contemporaneous Local Flow at Salt-Verde Confluence.
(2) Includes Uncontrolled Local Runoff Non-Coincident w/ U/S Release.
* This target produced minimum flow, but was not achieved.

To show transition points for project alternatives discharge freqeuncy relationships, table 17 presents the frequency at which target discharges are actually exceeded--referred to as level of protection--at locations CP-40, CP-110, and CP-113 for each project alternative. The impact of local uncontrolled runoff as stated previuosly, diminished in the downstream direction. This is evident by the increase in "protection" at CP's-110, and 113 compared to CP-40.

Table 17. Level of Protection for Project Alternatives(1)

| Alternative | 100-Year Minimum Target (CFS) | Salt R. below Verde R. (CP-40) | Salt R. @ Tempe Br. (CP-110) | Salt R. @ Mouth (CP-113) |
|---|---|---|---|---|
| PLAN9 | NONE | NA | NA | NA |
| RHA1. | 90000(110K)(2) | 59-yr. | 67-yr. | 71-YR. |
| RHB1. | 80000 | 40-yr. | 56-yr. | 67-yr. |
| RHC1. | 45000 | 25-yr. | 67-yr. | 71-yr. |
| RHD1. | 40000 | 22-yr. | 71-yr. | 83-yr. |
| RHA2. | 110000 | 50-yr. | 71-yr. | 100-yr. |
| RHB2. | 70000 | 33-yr. | 40-yr. | 59-yr. |
| RHC2. | 45000 | 25-yr. | 67-yr. | 71-yr. |
| RHD2. | 40000 | 22-yr. | 71-yr. | 83-yr. |
| RHA3. | 110000 | 50-yr. | 71-yr. | 100-yr. |
| RHB3. | 70000 | 33-yr. | 40-yr. | 59-yr. |
| RHC3. | 45000 | 25-yr. | 67-yr. | 71-yr. |
| RHD3. | 40000 | 22-yr. | 71-yr. | 83-yr. |

(1) Level of protection indicates the frequency at which the target discharge is equaled or exceeded.

(2) Special Case: To minimize the 100-yr flood releases, 90K cfs was used as a target, although a spill occurred on the Verde side. For Comparison purposes 110K cfs is used as a target discharge for exceedance frequency.

2-05.2 Gila River, Salt River Confluence to Gillespie Dam. Gila River frequency discharges were produced in a similar manner to that used in determining project discharges in the CAWCS Hydrology, section 8-05, "Project Conditions (Stage III)", pages 30-31. As discussed in that section, the discharges for the Gila River below the Salt for each project, $Q_{Lower\ Gila}$, are equal to the discharge in the lower Gila without the project, $Q_{Lower\ Gila}$, minus the decrease in Salt River flow at CP-113 due to the project, $\Delta Q_{Salt}$. This relationship has been shown to be a valid representation of the systematic adjustments resulting from proposed projects (see pls. 17a and 17b, CAWCS Hydrology, for basis), and is probabilistically stated as follows:

$$Q'(Pr_i)_{Lower\ Gila} = Q(Pr_i)_{Lower\ Gila} - \Delta Q(Pr_i)_{Salt},$$

where $Pr_i$ = given probability.

An example of the use of this relationship is shown in table 18.

Table 18. Example with Project Adjustment to Lower Gila River Discharge Frequency Relationship, Gila River below Salt River for Plan 9.

| PR (%) | FREQUENCY (YRS) | $Q_{Lower\ Gila}$ (CFS) | $\Delta Q_{SALT}$ (CFS) | $Q'_{Lower\ Gila}$ (CFS) |
|---|---|---|---|---|
| 0.2 | 500 | 360,000 | 70,000 | 290,000 |
| 0.5 | 200 | 295,000 | 65,000 | 230,000 |
| 1.0 | 100 | 250,000 | 35,000 | 215,000 |
| 2.0 | 50 | 200,000 | 20,000 | 180,000 |
| 5.0 | 20 | 135,000 | 25,000 | 110,000 |
| 10.0 | 10 | 95,000 | 10,000 | 85,000 |
| 20.0 | 5 | 40,000 | 0 | 40,000 |

The with project discharge data points computed using the equation for $Q'(Pr_i)_{Lower\ Gila}$ were then plotted on log-probability paper and a smooth curve fit to these data using the without project frequency relationship at this location and the with project frequency relationship for the Salt River above the Gila River as guides.

Frequency discharges for the succeeding downstream location of interest, the Gila River at Gillespie Dam (CP-1218), were determined by routing the peak frequency discharges computed at CP-1310, downstream, using a routing curve derived from simulated peak discharges from the previous CAWCS Hydrology (pl. 27). Those simulated peak discharges had been computed using continuity or hydrologic routing procedures, incorporated into an HEC-5 model of the Gila River basin. Rather than route hydrographs downstream to determine attenuation, the previous frequency discharges for each Gila River 'CP' were plotted as dependent (downstream, CP-1218) and independent (upstream, CP-1310) variables. The reason discrete flood hydrographs were not routed downstream for each frequency is that there are no composite frequency hydrographs available which have all the characteristics of the upstream with project runoff. The actual population of Gila River flood flows includes the following.

- Salt River reservoir releases.

- Coincident local uncontrolled inflow above the Gila River on the Salt.

- Non-coincident local uncontrolled inflow above the Gila River on the Salt.

- Gila River mainstem flows: spill/release at Coolidge Dam and/or San Pedro flood flows and/or Santa Cruz flood flows and/or flow in Gila downstream of Coolidge and/or Agua Fria flows.

Since no single hypothetical flood hydrograph can retain all these permutations in flow sources and types, routing of peak frequency discharges to the next downstream location of interest, based upon the entire period-of-record simulations, was the best substitute. Gila River with project frequency discharges appear in tables 19 and 20 which follow, and examples are shown on plates 28 through 35.

Table 19. Discharge Frequency Values For Project Alternatives (in cfs).(2)

| Alternative | 100-Year(1) Minimum Target | Frequency, Years: Gila River below Salt River (CP-1310) 5 | 10 | 20 | 50 | 100 | 200 | 500 |
|---|---|---|---|---|---|---|---|---|
| PLAN 9 | NONE | 40000 | 85000 | 120000 | 175000 | 210000 | 240000 | 290000 |
| RHA1. | *90000 | 40000 | 55000 | 80000 | 140000 | 190000 | 230000 | 290000 |
| RHB1. | 80000 | 40000 | 55000 | 78000 | 130000 | 165000 | 200000 | 250000 |
| RHC1. | 45000 | 40000 | 50000 | 50000 | 90000 | 130000 | 165000 | 230000 |
| RHD1. | 40000 | 38000 | 44000 | 44000 | 90000 | 120000 | 155000 | 230000 |
| RHA2. | 110000 | 40000 | 85000 | 105000 | 150000 | 175000 | 200000 | 290000 |
| RHB2. | 70000 | 40000 | 72000 | 72000 | 120000 | 155000 | 200000 | 260000 |
| RHC2. | 45000 | 40000 | 50000 | 50000 | 90000 | 130000 | 170000 | 230000 |
| RHD2. | 40000 | 38000 | 44000 | 44000 | 90000 | 120000 | 155000 | 230000 |
| RHA3. | 110000 | 40000 | 85000 | 120000 | 155000 | 170000 | 200000 | 290000 |
| RHB3. | 70000 | 40000 | 72000 | 72000 | 120000 | 155000 | 200000 | 260000 |
| RHC3. | 45000 | 40000 | 50000 | 50000 | 90000 | 130000 | 165000 | 230000 |
| RHD3. | 40000 | 38000 | 44000 | 44000 | 90000 | 120000 | 155000 | 230000 |

NOTE: Targets were set to make maximum use of available flood control space without spilling; "RHA1" spilled during the 100-year flood even with continuous outflow of 25,000 cfs.

DEFINITIONS: RH = Roosevelt "Plan 9" element and Horseshoe element
A = 100,000 Ac. Ft. of Flood Control on the Verde River
B = 200,000 Ac. Ft. of Flood Control on the Verde River
C = 300,000 Ac. Ft. of Flood Control on the Verde River
D = 465,000 Ac. Ft. of Flood Control on the Verde River

1 = 25,000 cfs Flood Outlet, Verde element
2 = 60,000 cfs Flood Outlet, Verde element
3 = 100,000 cfs Flood Outlet, Verde element

(1) U/S Release + Contemporaneous Local Flow at Salt-Verde Confluence.
(2) Includes Uncontrolled Local Runoff Non-Coincident w/ U/S Release.
* This target produced minimum flow, but was not achieved.

Table 20. Discharge Frequency Values For Project Alternatives (in cfs).(2)

| Alternative | 100-Year(1) Minimum Target | Frequency, Years: Gila River at Gillespie Dam (CP-1218) 5 | 10 | 20 | 50 | 100 | 200 | 500 |
|---|---|---|---|---|---|---|---|---|
| PLAN 9 | NONE | 37000 | 72000 | 110000 | 160000 | 190000 | 225000 | 270000 |
| RHA1. | *90000 | 37000 | 50000 | 70000 | 130000 | 175000 | 210000 | 270000 |
| RHB1. | 80000 | 37000 | 50000 | 65000 | 115000 | 150000 | 180000 | 230000 |
| RHC1. | 45000 | 37000 | 46000 | 46000 | 90000 | 120000 | 160000 | 215000 |
| RHD1. | 40000 | 35000 | 40000 | 40000 | 80000 | 110000 | 150000 | 215000 |
| RHA2. | 110000 | 37000 | 72000 | 95000 | 135000 | 160000 | 190000 | 270000 |
| RHB2. | 70000 | 37000 | 66000 | 66000 | 110000 | 140000 | 170000 | 240000 |
| RHC2. | 45000 | 37000 | 46000 | 46000 | 90000 | 120000 | 160000 | 215000 |
| RHD2. | 40000 | 35000 | 40000 | 40000 | 80000 | 110000 | 150000 | 215000 |
| RHA3. | 110000 | 37000 | 72000 | 105000 | 140000 | 155000 | 180000 | 270000 |
| RHB3. | 70000 | 37000 | 66000 | 66000 | 110000 | 140000 | 170000 | 240000 |
| RHC3. | 45000 | 37000 | 46000 | 46000 | 90000 | 120000 | 160000 | 215000 |
| RHD3. | 40000 | 35000 | 40000 | 40000 | 80000 | 110000 | 150000 | 215000 |

NOTE: Targets were set to make maximum use of available flood control space with out spilling; "RHA1" spilled during the 100-year flood even with continuous outflow of 25,000 cfs.

DEFINITIONS: RH = Roosevelt "Plan 9" element and Horseshoe element
A = 100,000 Ac. Ft. of Flood Control on the Verde River
B = 200,000 Ac. Ft. of Flood Control on the Verde River
C = 300,000 Ac. Ft. of Flood Control on the Verde River
D = 465,000 Ac. Ft. of Flood Control on the Verde River

1 = 25,000 cfs Flood Outlet, Verde element
2 = 60,000 cfs Flood Outlet, Verde element
3 = 100,000 cfs Flood Outlet, Verde element

(1) U/S Release + Contemporaneous Local Flow at Salt-Verde Confluence.
(2) Includes Uncontrolled Local Runoff Non-Coincident w/ U/S Release.
* This target produced minimum flow, but was not achieved.

# III. SUMMARY AND CONCLUSIONS

## 3-01. SUMMARY

Plan 9, flood control at Roosevelt Dam only, has been authorized, and its impact on downstream flooding in Maricopa County was evaluated in this report. In addition, flood control alternatives for two Verde River sites--Horseshoe and Bartlett Dams--have been investigated for a matrix of 4 storage and 3 outlet combinations. The resulting 24 systems, incorporating Plan 9 along with a Verde River element, were analyzed as alternatives to the Plan 6 which included Cliff Dam. The goal of the various alternative systems was to minimize the 100-year peak flow in the Salt River without spilling--in other words, to maximize the use of the available flood pool allocations during a 100-year event. A discrete analysis was made using balanced hydrographs of 500-, 200-, 100-, 50-, 20-, 10-, and 5-year frequency. Uncontrolled local runoff was combined probabilistically with upstream reservoir releases, and peak attenuation relationships for channel conditions prior to the February 1980 flood were used to route the peak flows downstream. Local non-coincident runoff and upstream releases were routed separately. Plates 36 through 47 compare final project alternative discharge frequency curves to Plan 9 for RHA1, RHB1, RHC1, and RHD1 at CP's -40, -110, and -113, on the Salt River. Gila River peak flow rates were determined by dividing the lower Gila River flow into two components--Salt River inflow, and Gila River above the Salt inflow (upper Gila River flow). For each discrete frequency described above, the reduction in Salt River inflow due to the various systems was subtracted from the lower Gila River peak flow; the upper Gila River flow remained unaltered by proposed projects on the Salt and Verde Rivers. Finally, the lower Gila River with project peak flows were routed to Gillespie Dam using results of previous flood routings, since frequency hydrographs encompassing all the characteristics of runoff at the upstream location were not available.

3-02. CONCLUSIONS

Local uncontrolled runoff (100-year peak at airport = 41,000 cfs) has a significant impact on downstream runoff in the Salt River for large, remotely-located upstream flood control projects which attempt to limit peak runoff in the Salt River through the City of Phoenix to small quantities, i.e., less than 80,000 cfs. For example, two alternative systems, one with Plan 9 Roosevelt plus 300,000 ac. ft. of flood space on the Verde (RHC's), the other with Plan 9 Roosevelt plus 465,000 ac. ft. of flood space on the Verde (RHD's), were able to control the 100-year Salt-Verde reservoir inflow to 60,000 cfs and 39,000 cfs, respectively, at the Salt River near the airport. However, combination of these regulated flows with non-coincident local runoff resulted in 100-year peak flows of 70,000 cfs and 60,000 cfs at this location, increases of 17 percent for the large storage allocation and 54 percent for the smaller. Thus, relocation benefits which might be made available by shrinking the 100-year floodplain, may be unachievable, because of the uncontrolled local inflow.

In addition, the increased floodway capacity resulting from local initiatives has decreased the amount of damage for flows less than the newly constructed bridge capacities (+180,000 cfs), and may have changed the amount of flood attenuation. Thus, it may no longer be efficient to attempt to achieve large reductions in flow, using ever increasing Verde River storage: e.g., for the previous example the Verde element of RHC' plans have only

64.5 percent of the allocated flood control space of RHD' plans, yet can reduce the 100-year peak flow at the airport 82 percent from Plan 9 flows (115,000 cfs) of the amount provided with the largest plan.

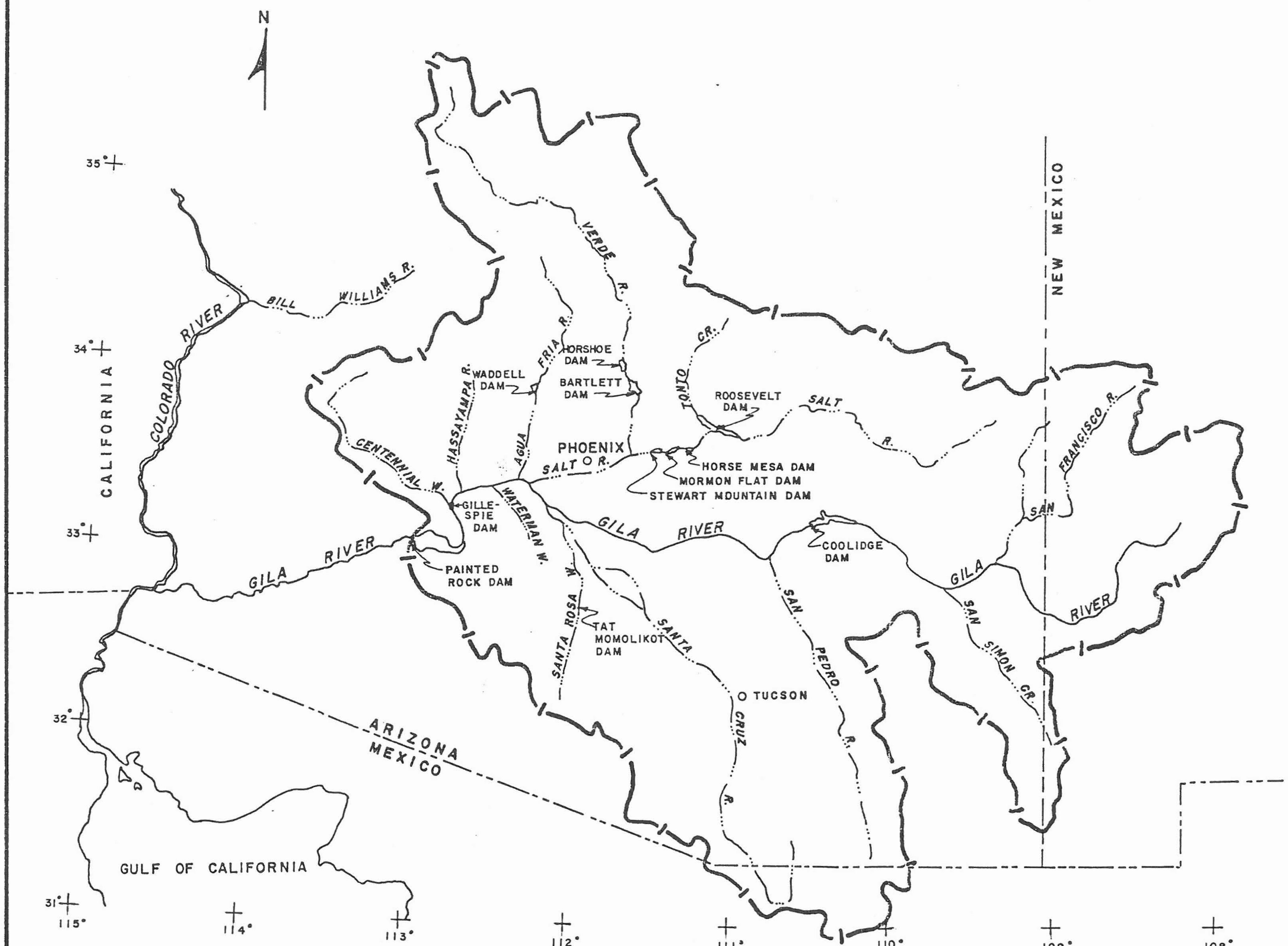
In addition, there is no benefit to what may be an increased cost in either construction (for new flood outlets) or operation and maintenance (for use of existing spillways), associated with large flood control outlets for the Verde site. The 25,000 cfs outlet generally performs as well as the 60,000 cfs and 100,000 cfs outlets.

3-03. Adequacy of Results. Generally, this study was conducted in accordance with data and procedures developed for the CAWCS Hydrology. Balanced Hydrographs developed previously from 92 years of record were evaluated to ensure that upstream inflows satisfied downstream constraints for both "natural"--no SRP dams--and "existing"--SRP dams operated for water supply and hydropower only--conditions. These inflow hydrographs were then routed through the proposed systems. All data, such as local inflow, and routing criteria for the Salt-Gila Rivers, was either developed for the previous report, or based upon the results of that study. Plan 6 was compared to the equivalent current system, RHD1, and found to achieve similar results. The differences result from the changes in operating criteria:

- Plan 6 - Control SPF to 50,000 cfs.

- RHD1 - Minimize 100-year runoff (40,000 cfs).

To provide further validation of the results, the preferred plan should be investigated using period-of-record data as well as redefined channel conditions.

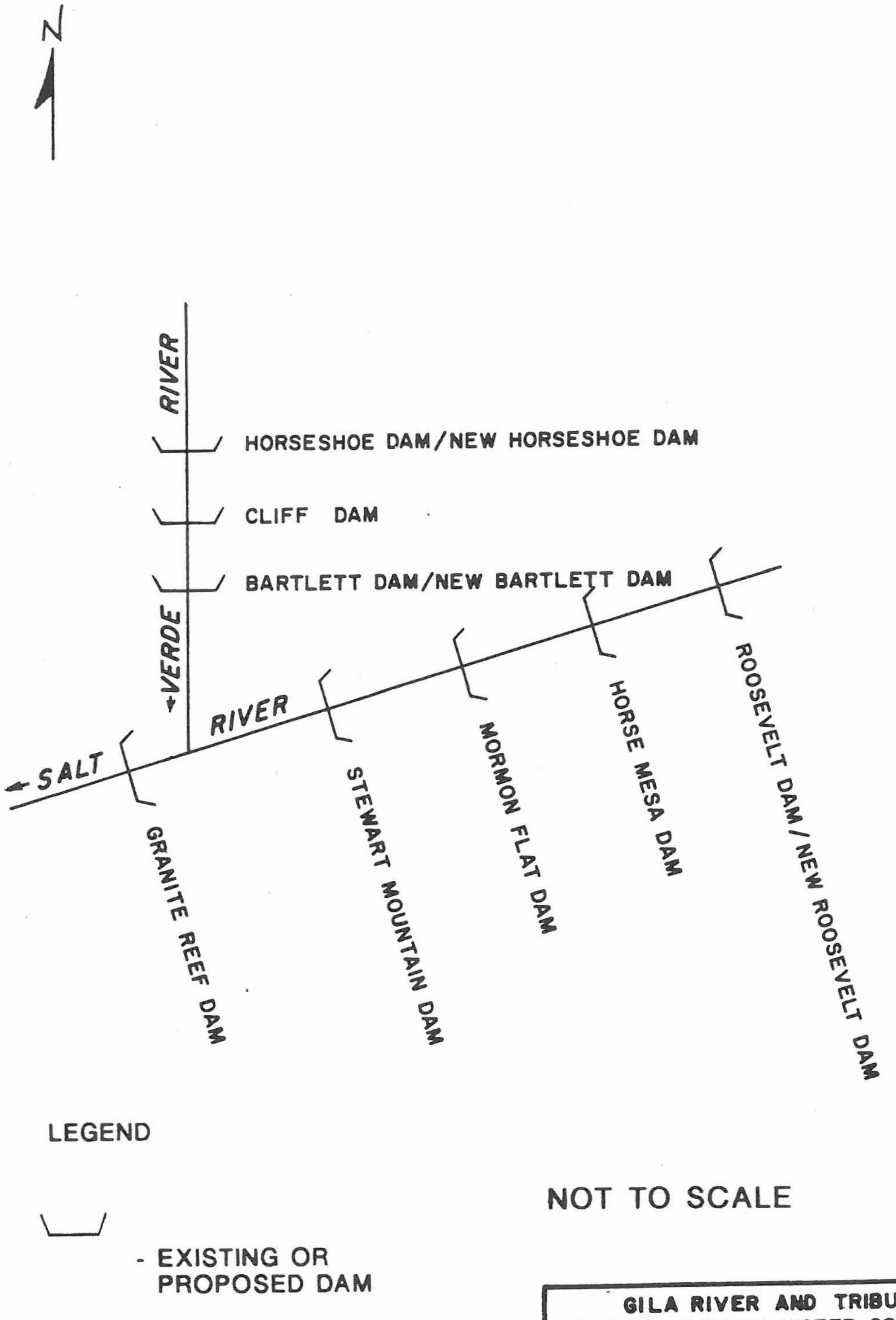



GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

GILA RIVER AND TRIBUTARIES WITH MAJOR STRUCTURES

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED:

PLATE 1




GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

LOCATIONS OF PROJECT SITES

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 2

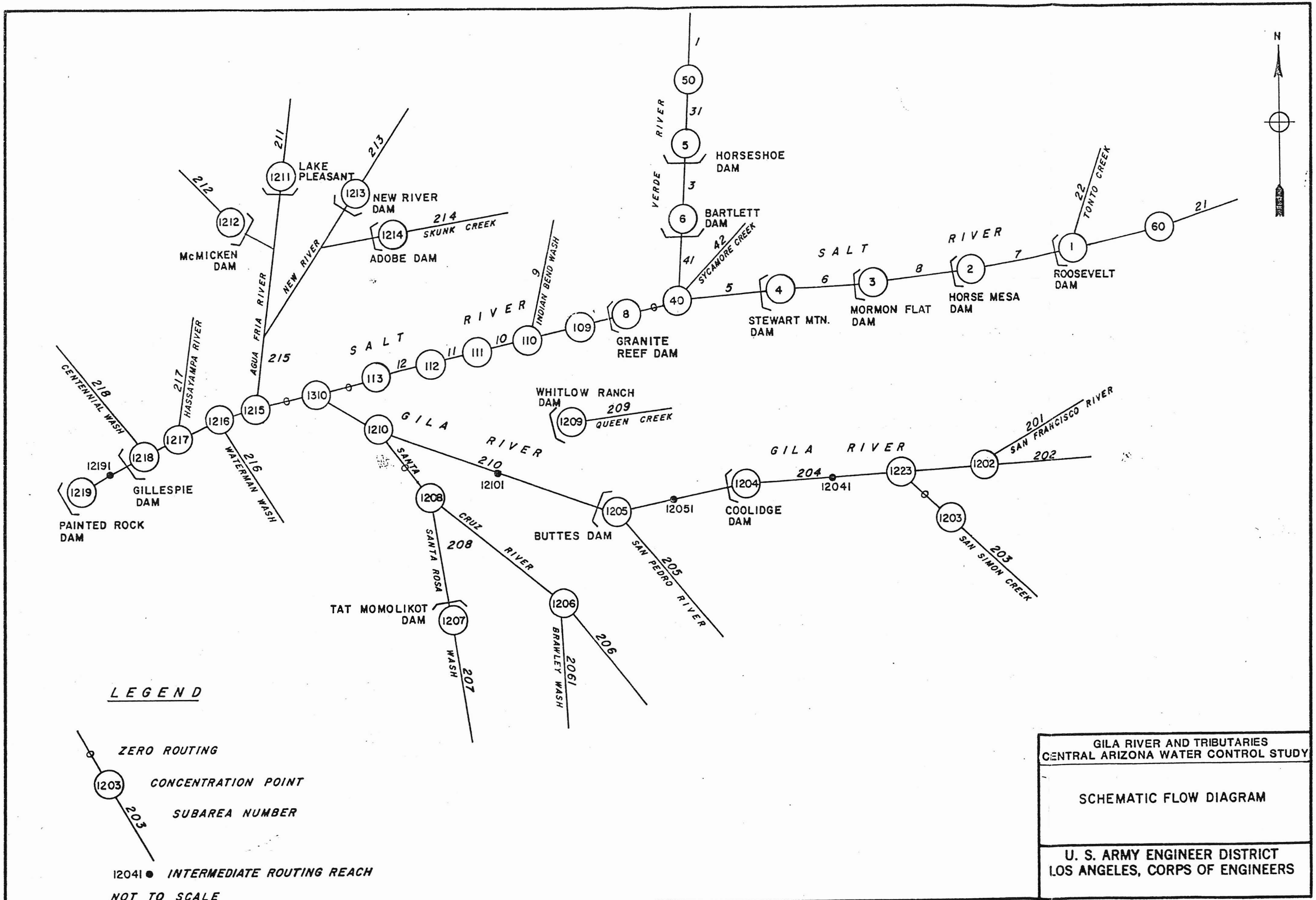
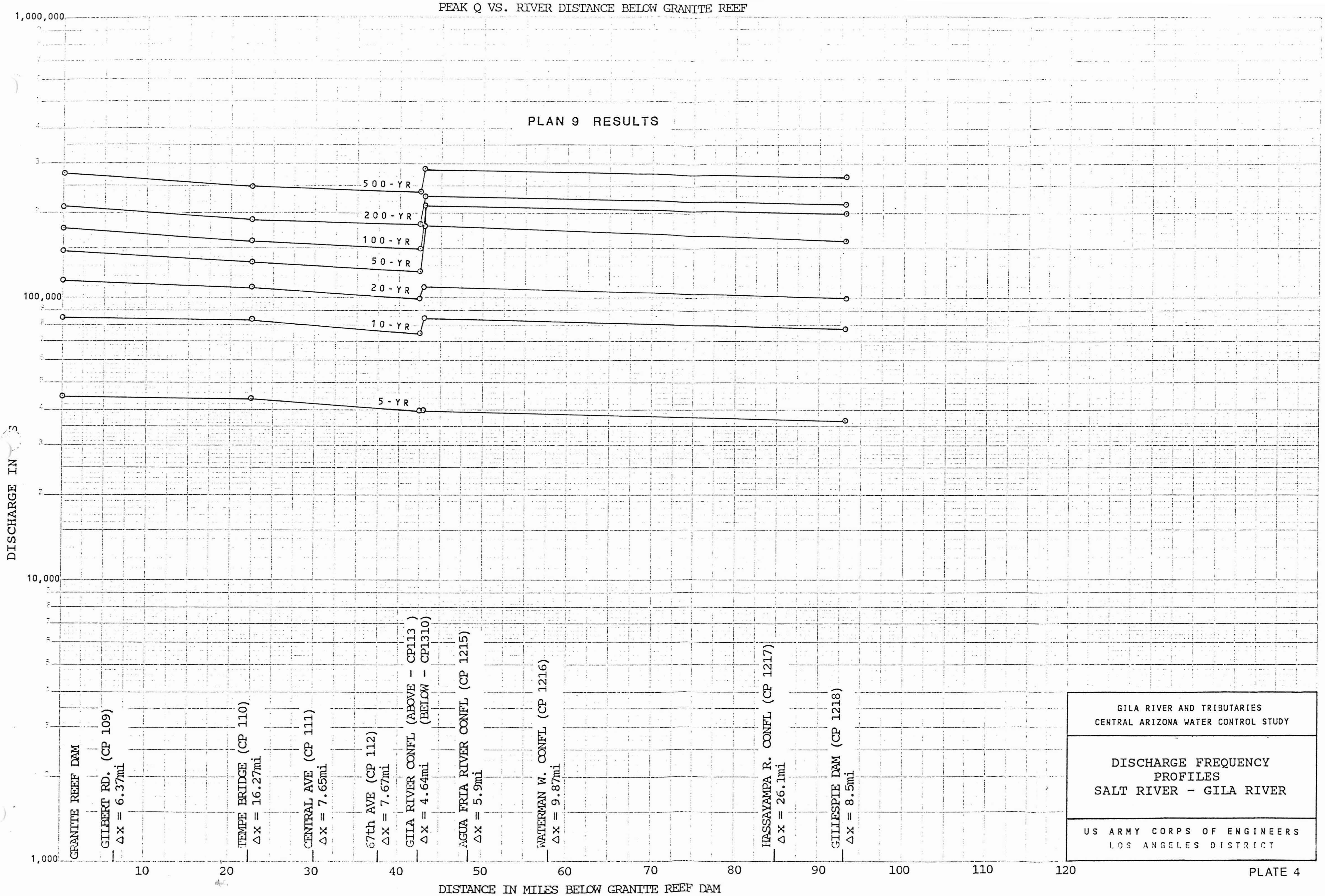

N
LAKE PLEASANT
NEW RIVER DAM
ADOBE DAM
McMICKEN DAM
HORSESHOE DAM
BARTLETT DAM
VERDE RIVER
SYCAMORE CREEK
SALT RIVER
ROOSEVELT DAM
TONTO CREEK
HORSE MESA DAM
MORMON FLAT DAM
STEWART MTN. DAM
GRANITE REEF DAM
INDIAN BEND WASH
SKUNK CREEK
NEW RIVER
AGUA FRIA RIVER
HASSAYAMPA RIVER
CENTENNIAL WASH
WATERMAN WASH
GILLESPIE DAM
PAINTED ROCK DAM
WHITLOW RANCH DAM
QUEEN CREEK
GILA RIVER
SAN FRANCISCO RIVER
COOLIDGE DAM
SAN SIMON CREEK
BUTTES DAM
SAN PEDRO RIVER
SANTA CRUZ RIVER
SANTA ROSA WASH
TAT MOMOLIKOT DAM
BRAWLEY WASH
1 50 31 5 3 6 41 42 40 5 4 6 3 8 2 7 1 22 60 21
8 109 9 110 10 111 11 112 12 113 1310 1215 215 1211 211 1213 213 1214 214 1212 212
1216 216 1217 217 1218 218 12191 1219
1210 210 12101 1205 12051 1204 204 12041 1223 1202 201 202 1203 203 1209 209
1208 208 1207 207 1206 206 2061 205
LEGEND
ZERO ROUTING
1203 CONCENTRATION POINT
203 SUBAREA NUMBER
12041 INTERMEDIATE ROUTING REACH
NOT TO SCALE
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY
SCHEMATIC FLOW DIAGRAM
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

PLATE 3

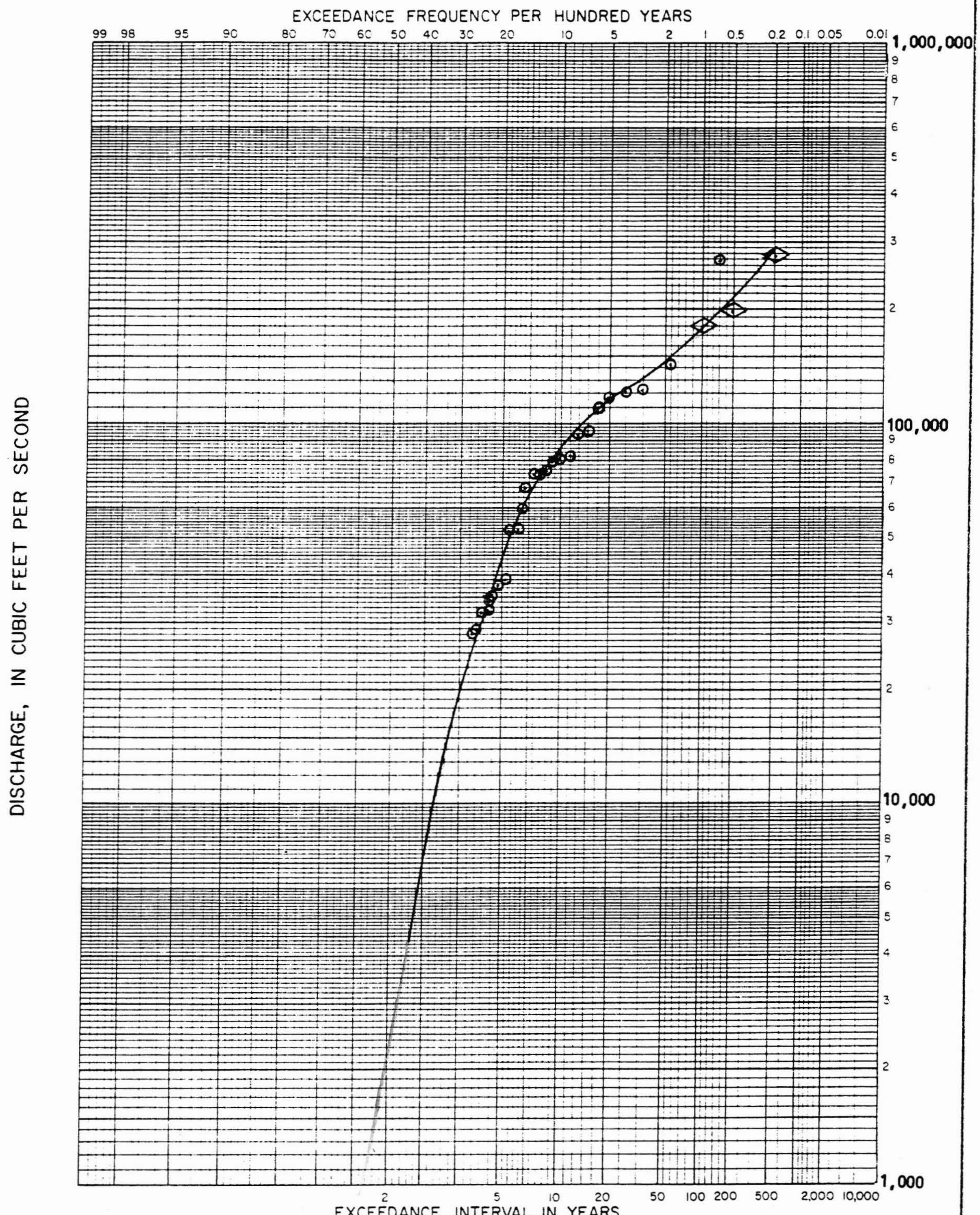



GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY PROFILES
SALT RIVER - GILA RIVER

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 4




NEW ROOSEVELT Qout = 25,000 CFS

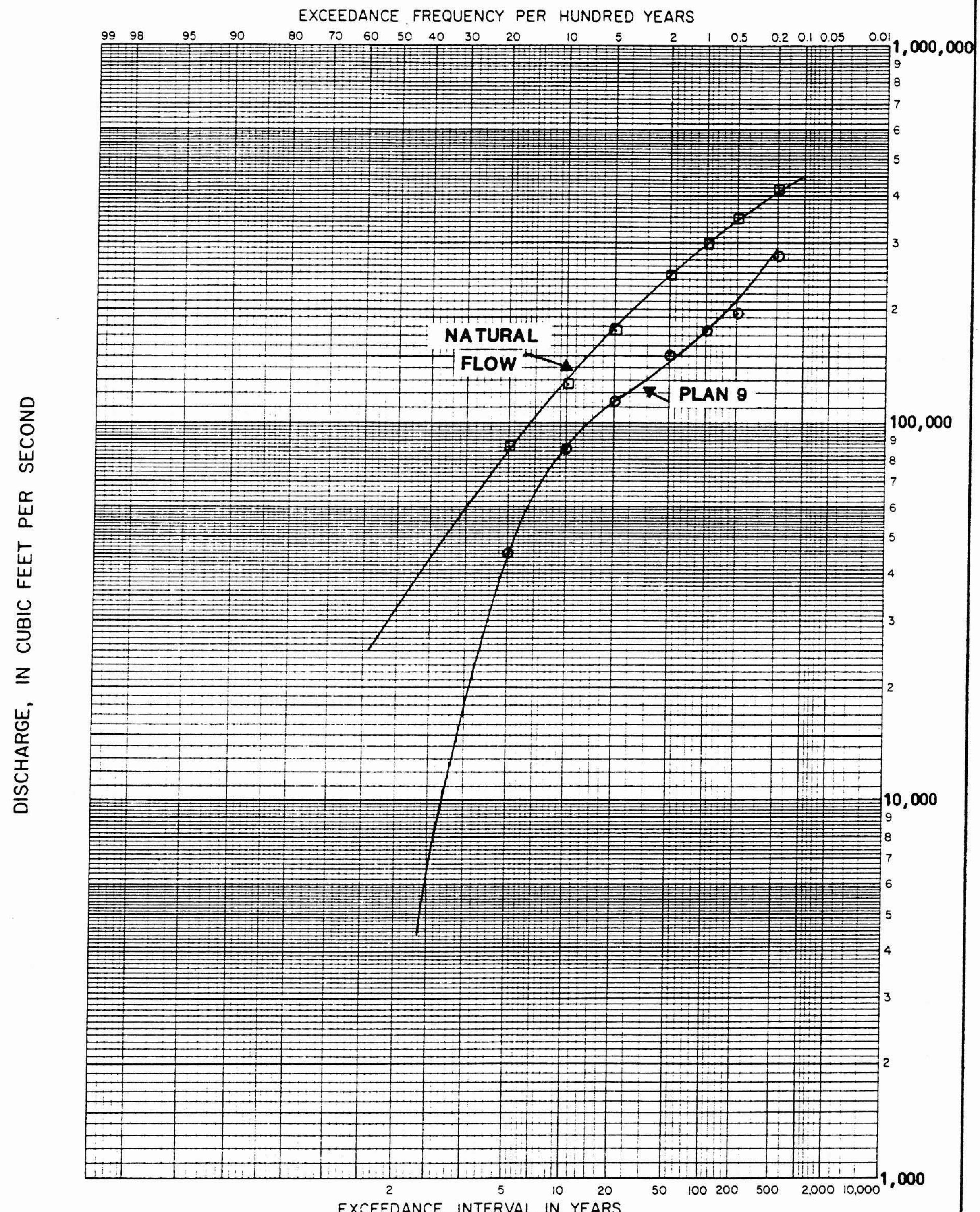
◇ CP 40 (COMPUTED FROM BALANCED HYDROGRAPHS - OCT 1987 UPDATE)

⊙ CP 40 (ESTIMATED FROM PERIOD-OF-RECORD)

**GILA RIVER AND TRIBUTARIES**
**CENTRAL ARIZONA WATER CONTROL STUDY**

**DISCHARGE FREQUENCY CURVE**
**SALT RIVER BELOW CONFLUENCE**
**W/VERDE RIVER**
**PLAN 9**

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



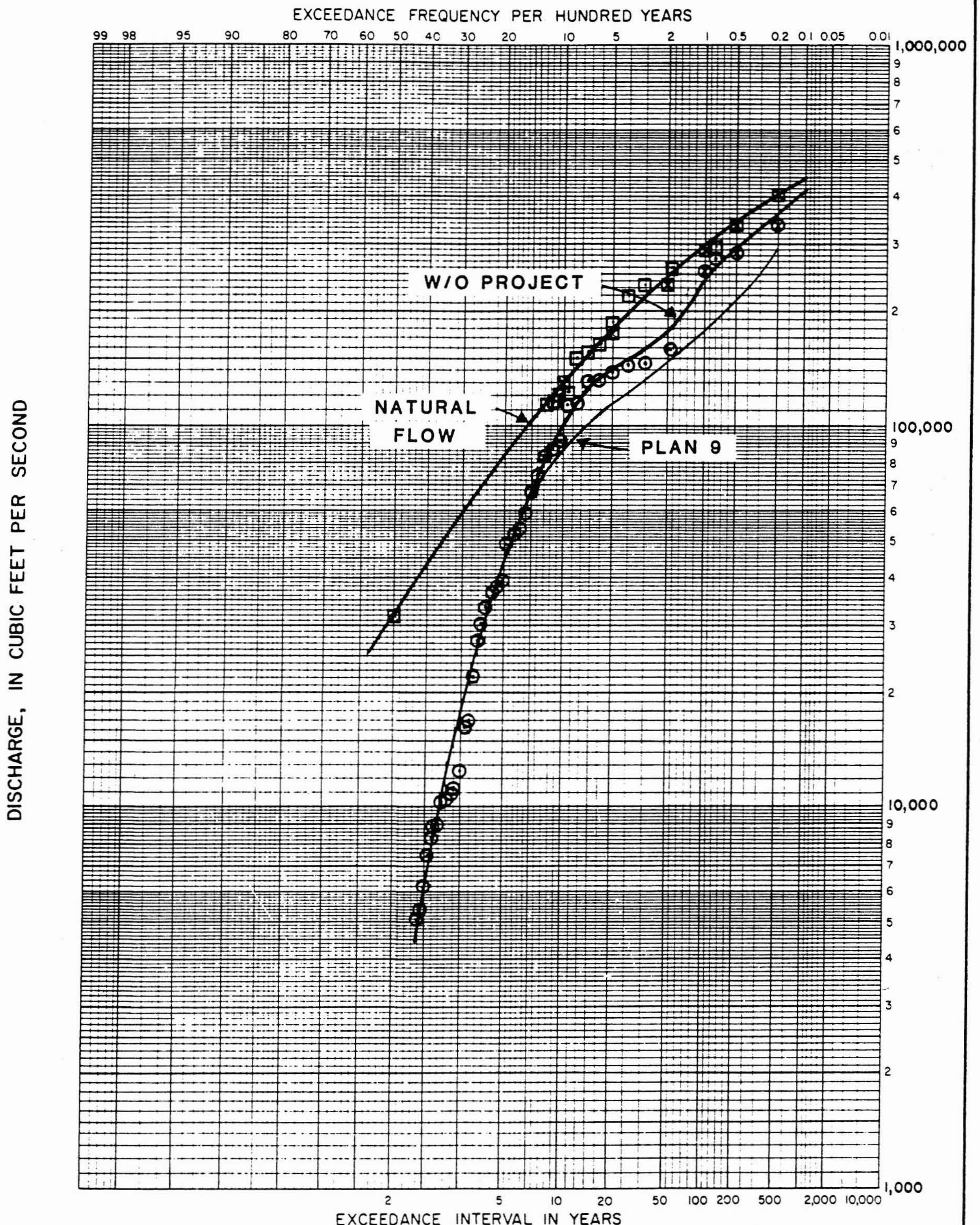

CALIBRATED BALANCED HYDROGRAPH SIMULATIONS

- ⊡ NATURAL FLOW AT GRANITE REEF W/NO UPSTREAM RESERVOIRS
- ⊙ PLAN 9 REGULATED FLOW

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
Calibration of Balanced Hydrographs
Natural Flow and Plan 9
SALT RIVER AT GRANITE REEF

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




## LEGEND

A. MEDIAN PLOTTING POSITIONS FOR N=91 YRS USING PERIOD-OF-RECORD FLOWS INPUT TO HEC-5 SIMULATION MODEL.

- ⊙ REGULATED DISCHARGES
- ⊡ NATURAL DISCHARGES.

B. BALANCED HYDROGRAPH RESULTS USING HEC-5 SIMULATION MODEL.

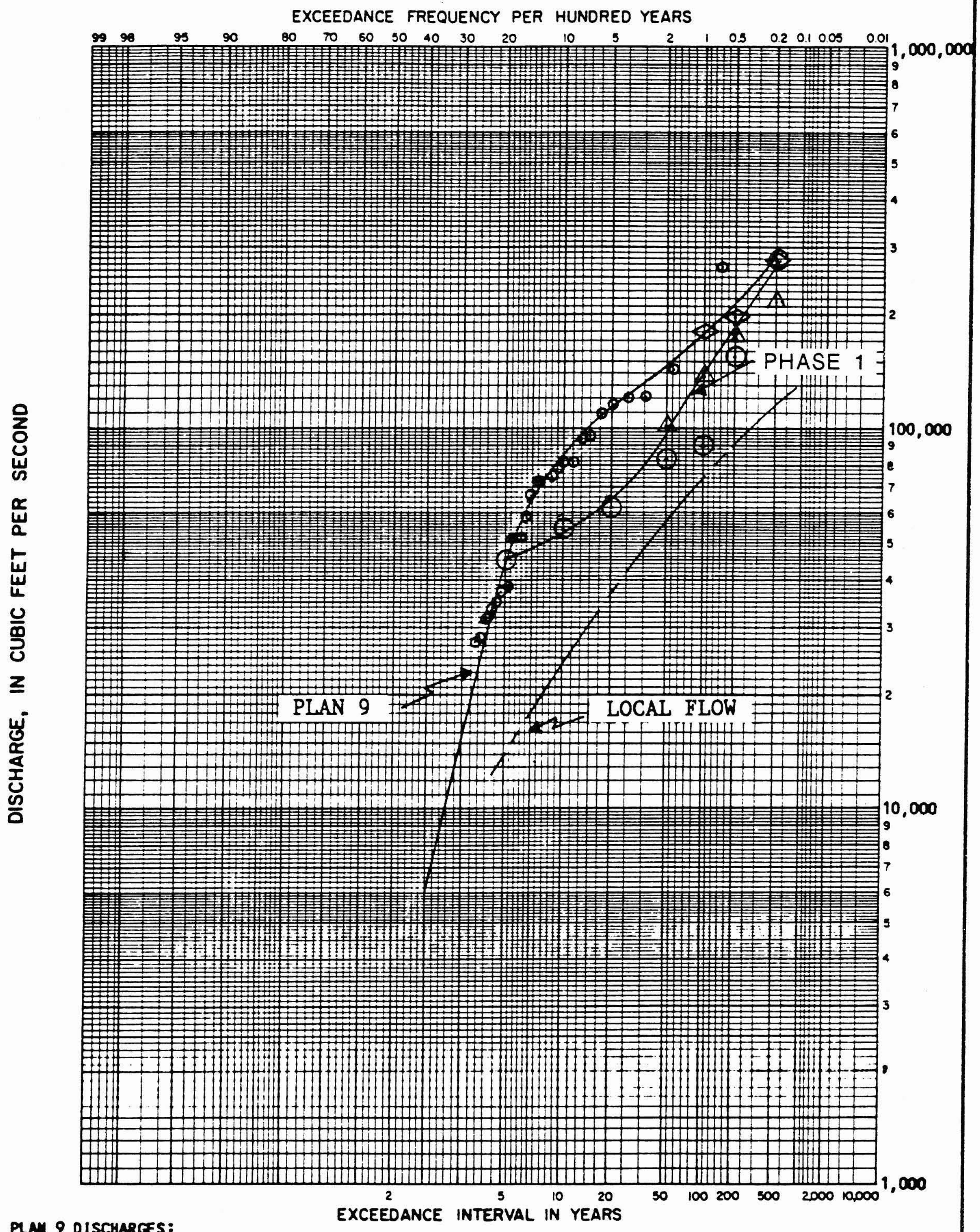
- ⊗ REGULATED DISCHARGES
- ⊠ NATURAL DISCHARGES.

**GILA RIVER AND TRIBUTARIES**
**CENTRAL ARIZONA WATER CONTROL STUDY**

## DISCHARGE - FREQUENCY

SALT RIVER BELOW CONFLUENCE WITH VERDE RIVER

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




**PLAN 9 DISCHARGES:**

◇ FROM BALANCED HYDROGRAPHS - OCT 1987 UPDATE

⊙ ESTIMATED FROM PERIOD-OF-RECORD

**W/PROJECT DISCHARGES (PHASE 1 RESULTS):**

○ FROM BALANCED HYDROGRAPHS-COMBINED COINCIDENT COMPONENTS

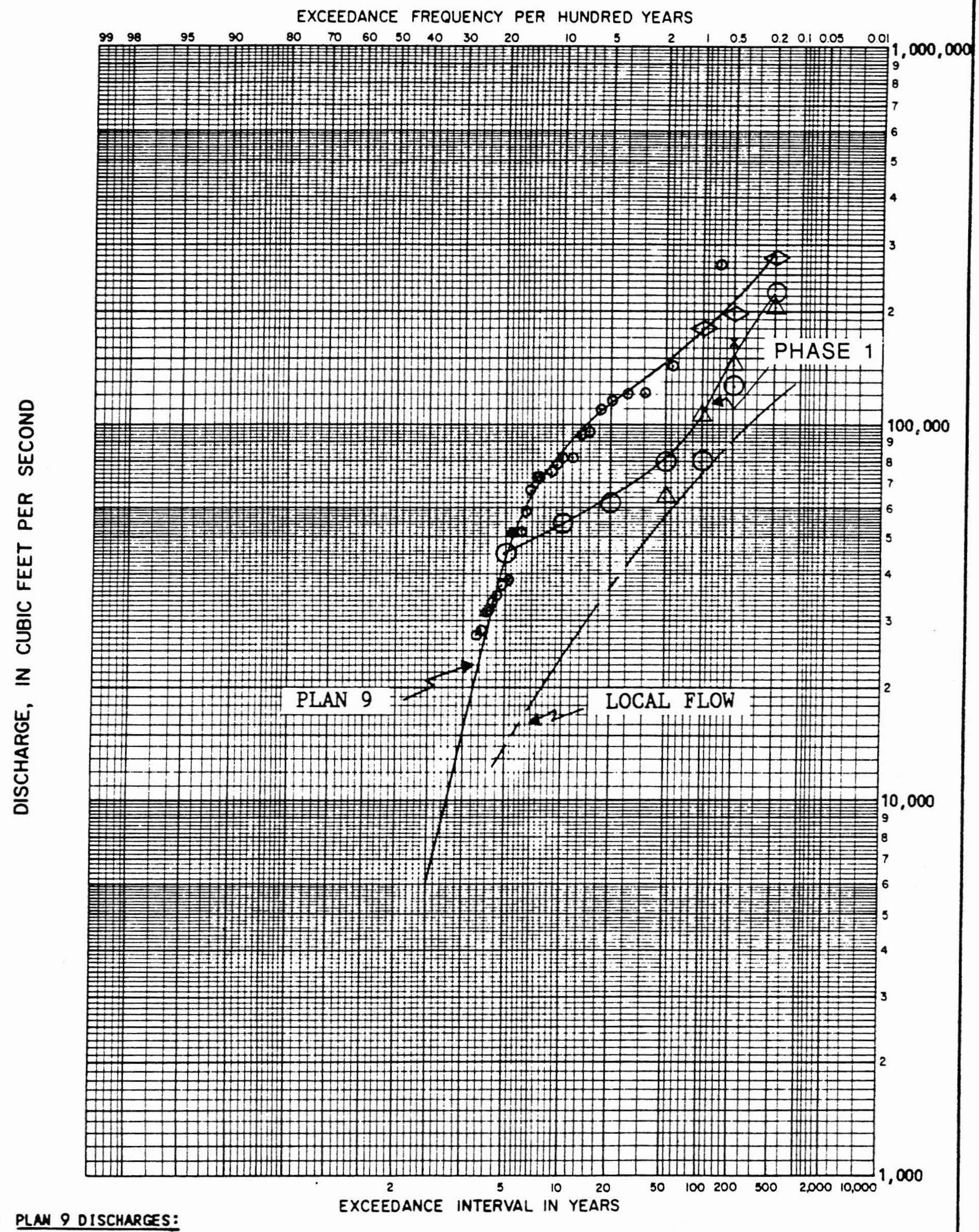
△ FROM BALANCED HYDROGRAPHS-VERDE INFLOW

x - SPF

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

**DISCHARGE FREQUENCY CURVES**
SALT RIVER BELOW CONFLUENCE
W/VERDE RIVER
PLAN: "RHA1.100" =90K CFS

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




PLAN 9 DISCHARGES:

◇ FROM BALANCED HYDROGRAPHS - OCT 1987 UPDATE

o ESTIMATED FROM PERIOD-OF-RECORD

W/PROJECT DISCHARGES (PHASE 1 RESULTS):

○ FROM BALANCED HYDROGRAPHS-COMBINED COINCIDENT COMPONENTS

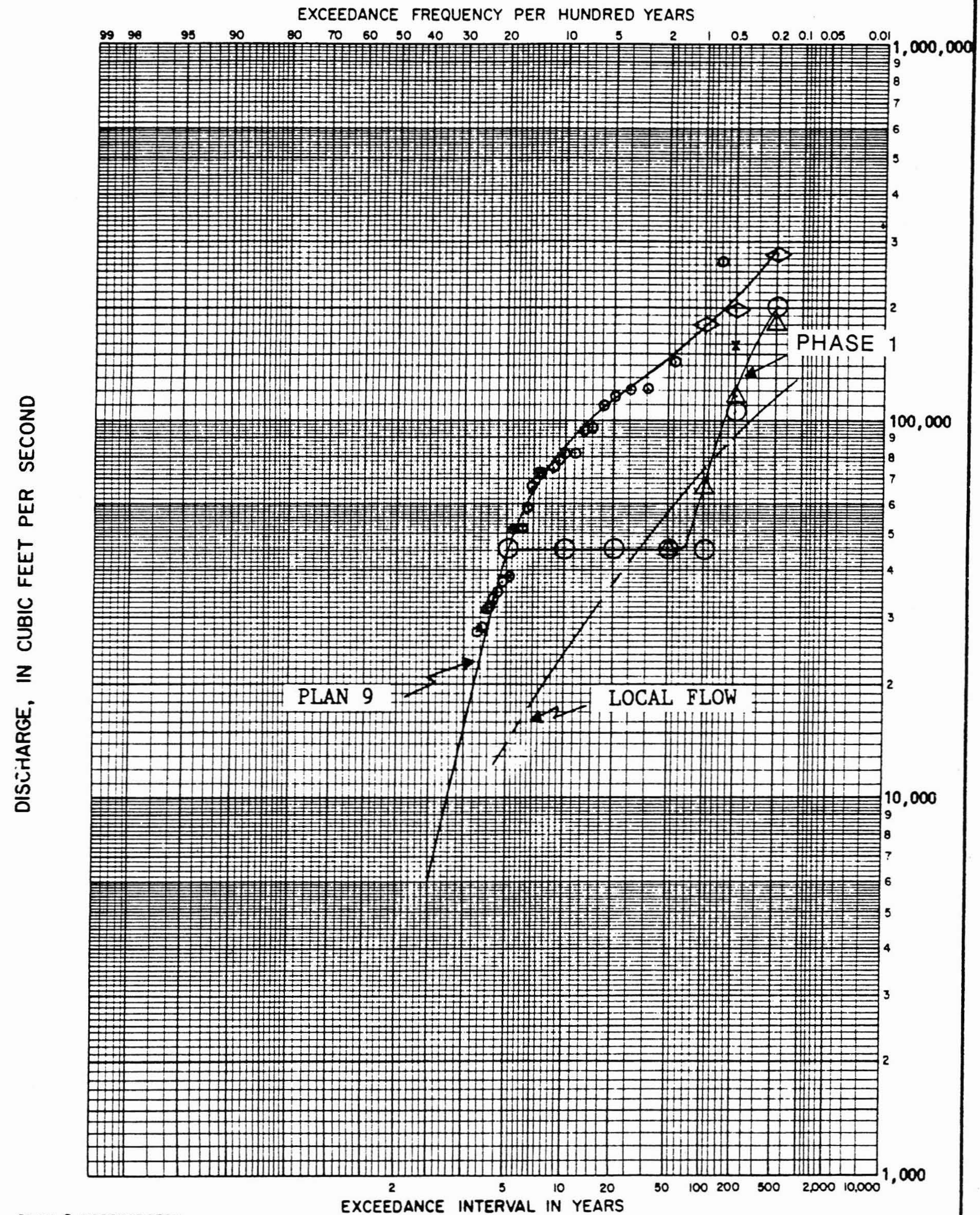
△ FROM BALANCED HYDROGRAPHS-VERDE INFLOW

x - SPF

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/VERDE RIVER
PLAN: "RHB1.100" =80K CFS

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




**PLAN 9 DISCHARGES:**

◇ FROM BALANCED HYDROGRAPHS - OCT 1987 UPDATE

⊙ ESTIMATED FROM PERIOD-OF-RECORD

**W/PROJECT DISCHARGES (PHASE 1 RESULTS):**

○ FROM BALANCED HYDROGRAPHS-COMBINED COINCIDENT COMPONENTS

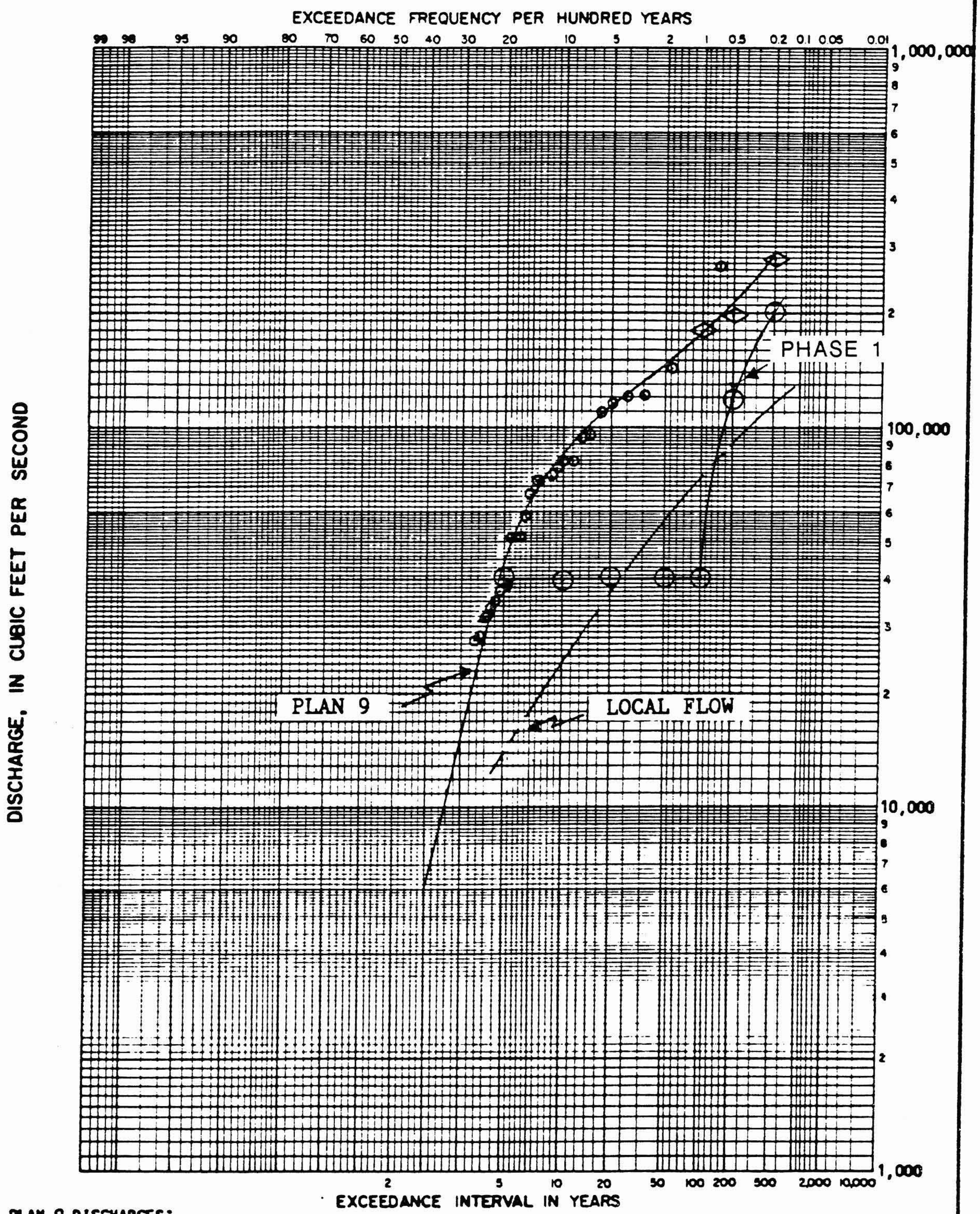
△ FROM BALANCED HYDROGRAPHS-VERDE INFLOW

x - SPF

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

**DISCHARGE FREQUENCY CURVES**
SALT RIVER BELOW CONFLUENCE
W/VERDE RIVER
PLAN: "RHC1.100" =45K CFS

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




PLAN 9 DISCHARGES:

◇ FROM BALANCED HYDROGRAPHS - OCT 1987 UPDATE

o ESTIMATED FROM PERIOD-OF-RECORD

W/PROJECT DISCHARGES (PHASE 1 RESULTS):

⊙ FROM BALANCED HYDROGRAPHS-COMBINED COINCIDENT COMPONENTS

△ FROM BALANCED HYDROGRAPHS-VERDE INFLOW

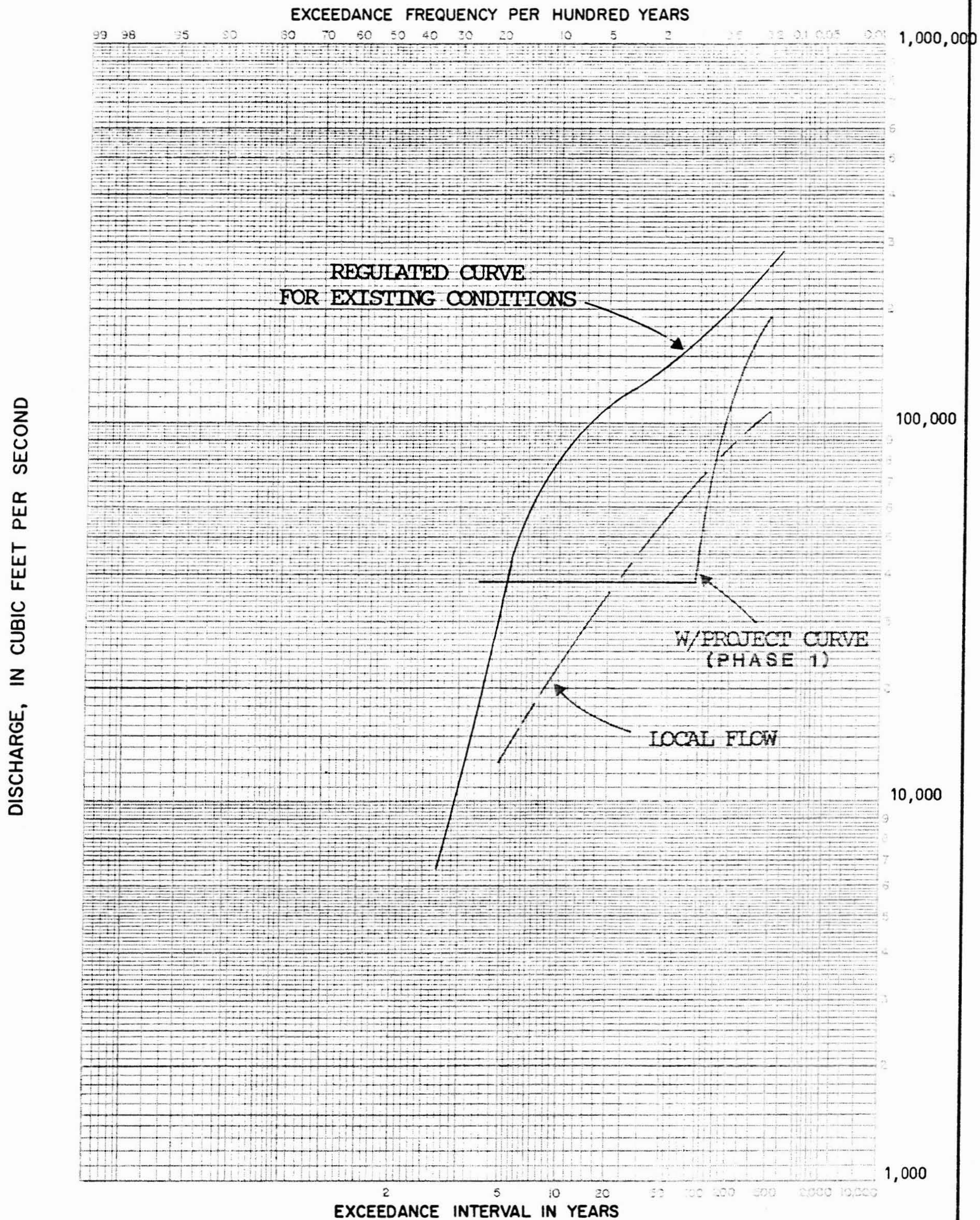
x - SPF

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/VERDE RIVER

PLAN: "RHD1.100" =40K CFS

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




**ALTERNATIVE = RHD1**

**DESIGN =** 100-YR

**TARGET = 40,000 CFS**

GILA RIVER AND TRIBUTARIES

CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES

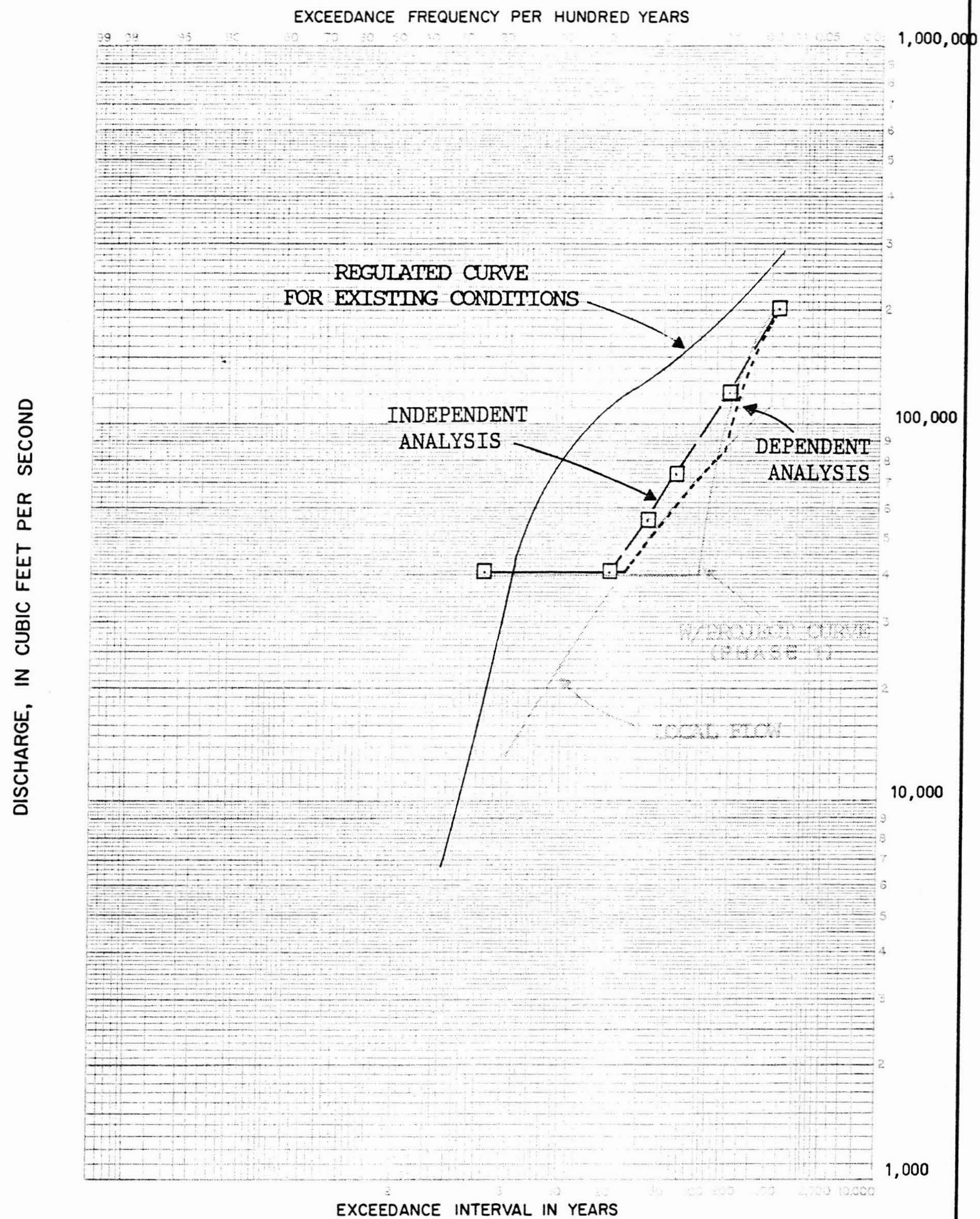
DISCHARGE-FREQUENCY CURVES

SALT RIVER BELOW CONFLUENCE WITH

VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS

LOS ANGELES DISTRICT




**ALTERNATIVE = RHD1**

**DESIGN =** 100-YR

**TARGET = 40,000 CFS**

⊡ **– INDEPENDENT ANALYSIS**

GILA RIVER AND TRIBUTARIES

CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES

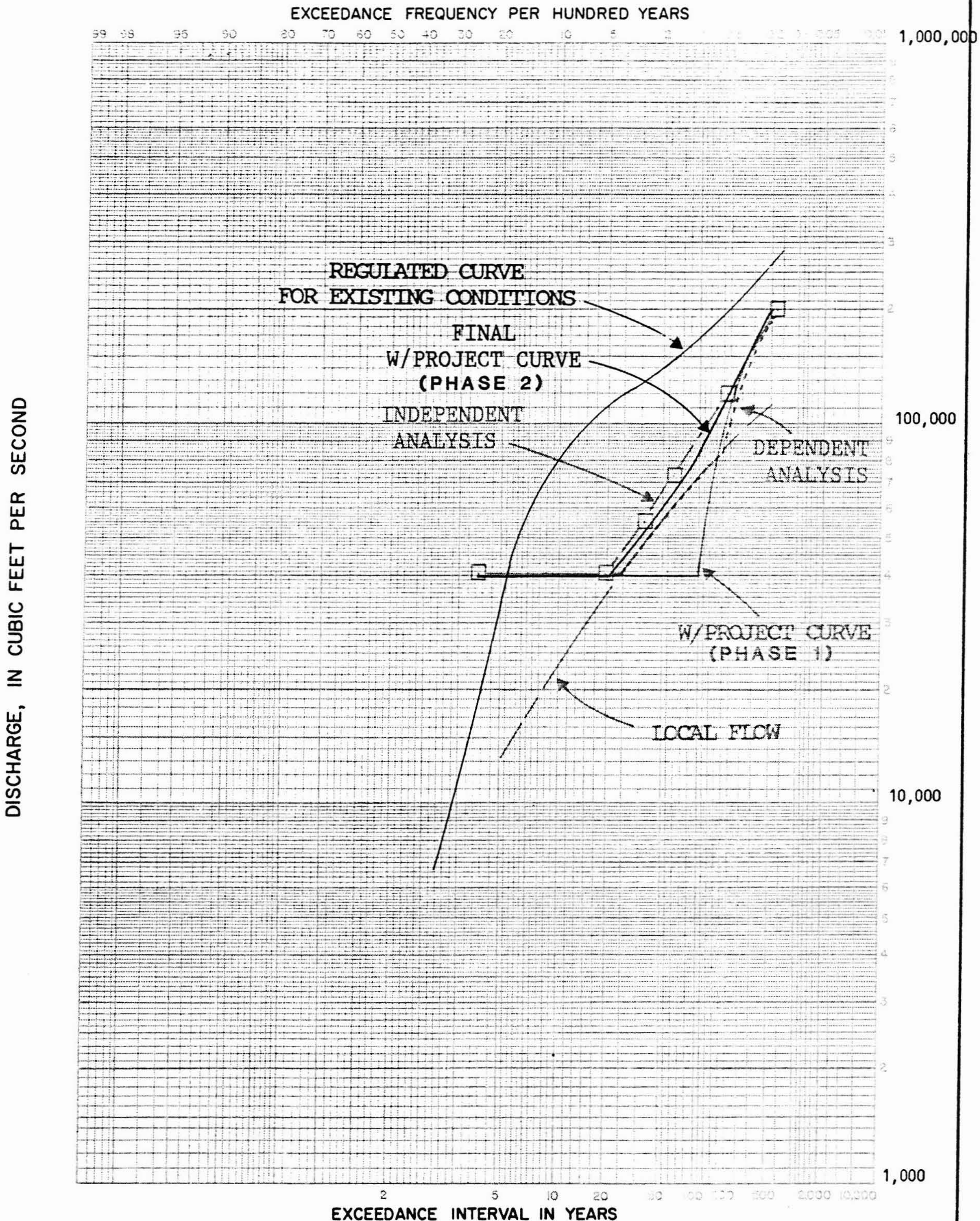
DISCHARGE-FREQUENCY CURVES

SALT RIVER BELOW CONFLUENCE WITH

VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS

LOS ANGELES DISTRICT



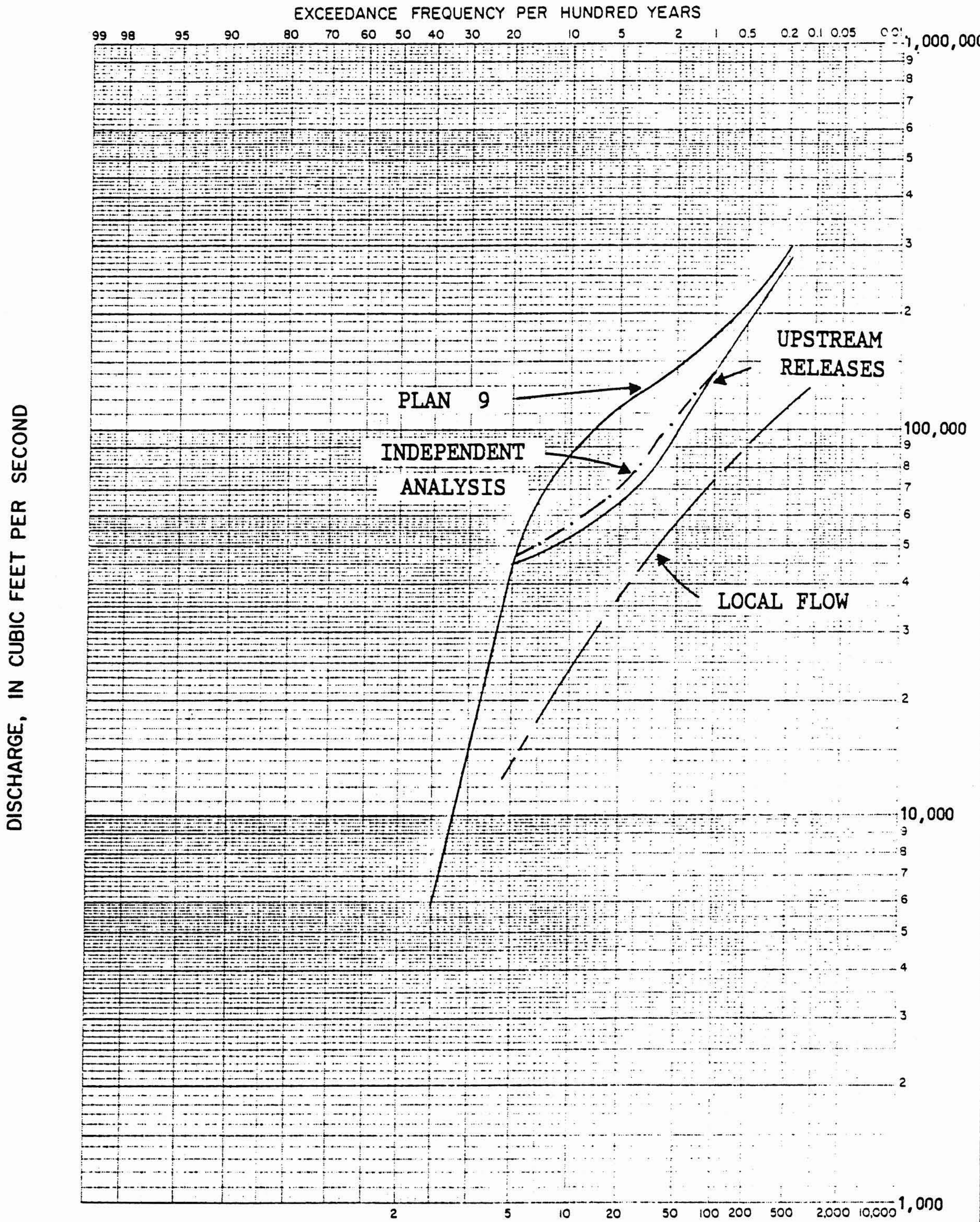

**ALTERNATIVE = RHD1**
**DESIGN =** 100-YR
**TARGET = 40,000 CFS**

☐ – **INDEPENDENT ANALYSIS**

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE WITH
VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1
DESIGN = 100 YR
TARGET = 90,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

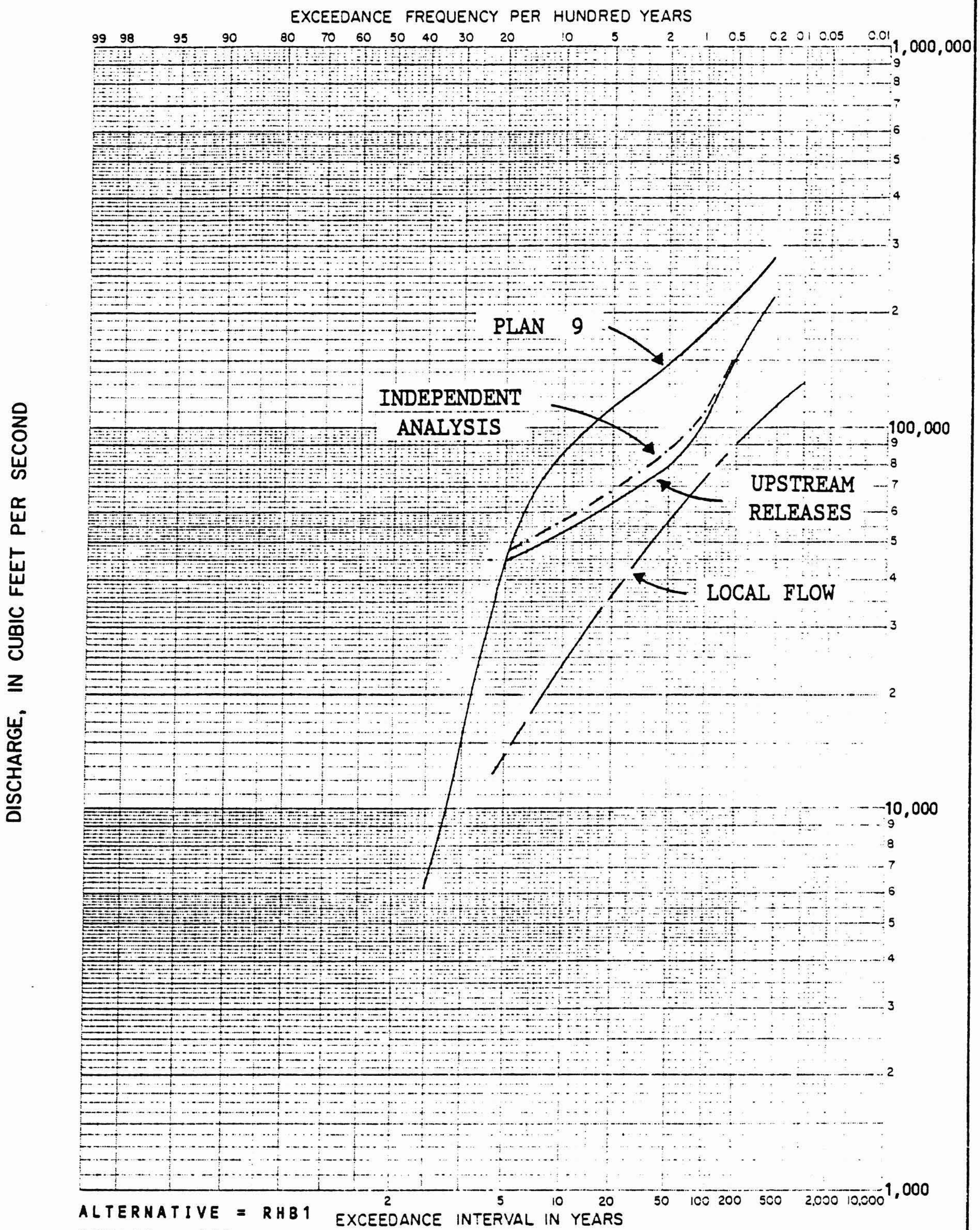
MINIMUM COMBINATION IS THE GREATER OF UPSTREAM RELEASES OR LOCAL FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES

SALT RIVER BELOW CONFLUENCE WITH VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1
DESIGN = 100 YR
TARGET = 80,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

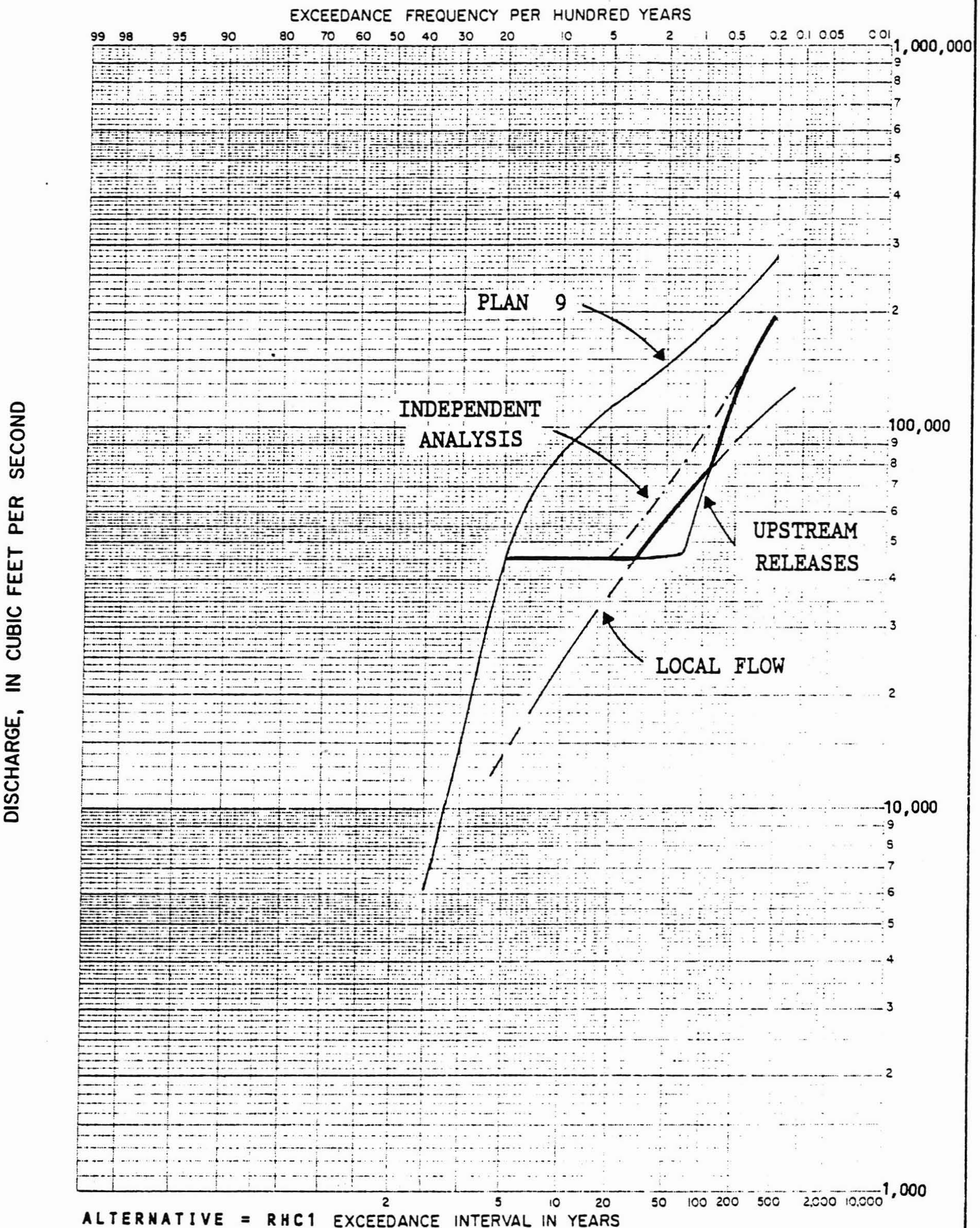
MINIMUM COMBINATION IS THE GREATER OF UPSTREAM RELEASES OR LOCAL FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES

SALT RIVER BELOW CONFLUENCE WITH
VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHC1

DESIGN = 100 YR

TARGET = 45,000 CFS

NOTE:

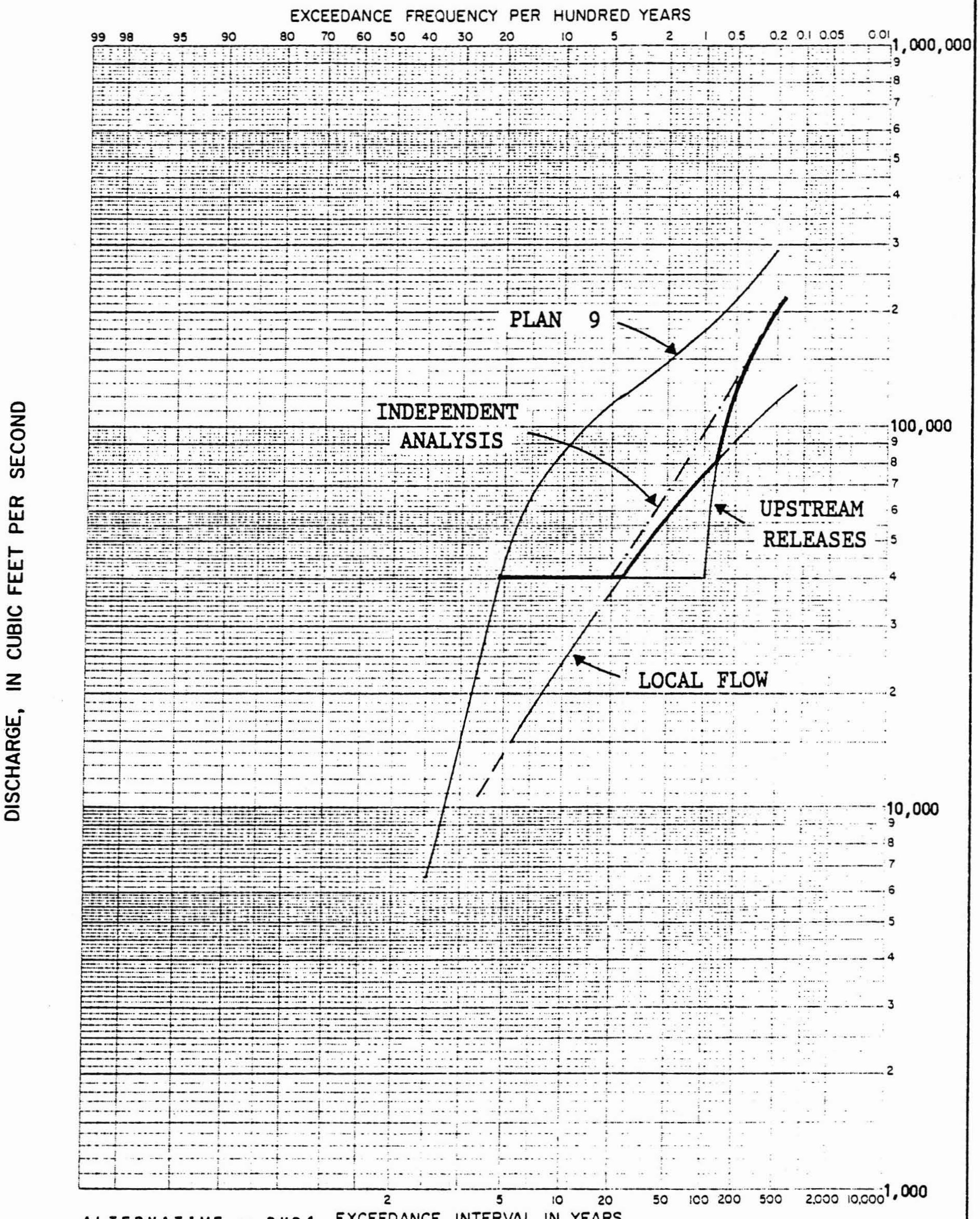
INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

MINIMUM COMBINATION IS THE GREATER OF UPSTREAM RELEASES OR LOCAL FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE WITH VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHD1
DESIGN = 100 YR
TARGET = 40,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

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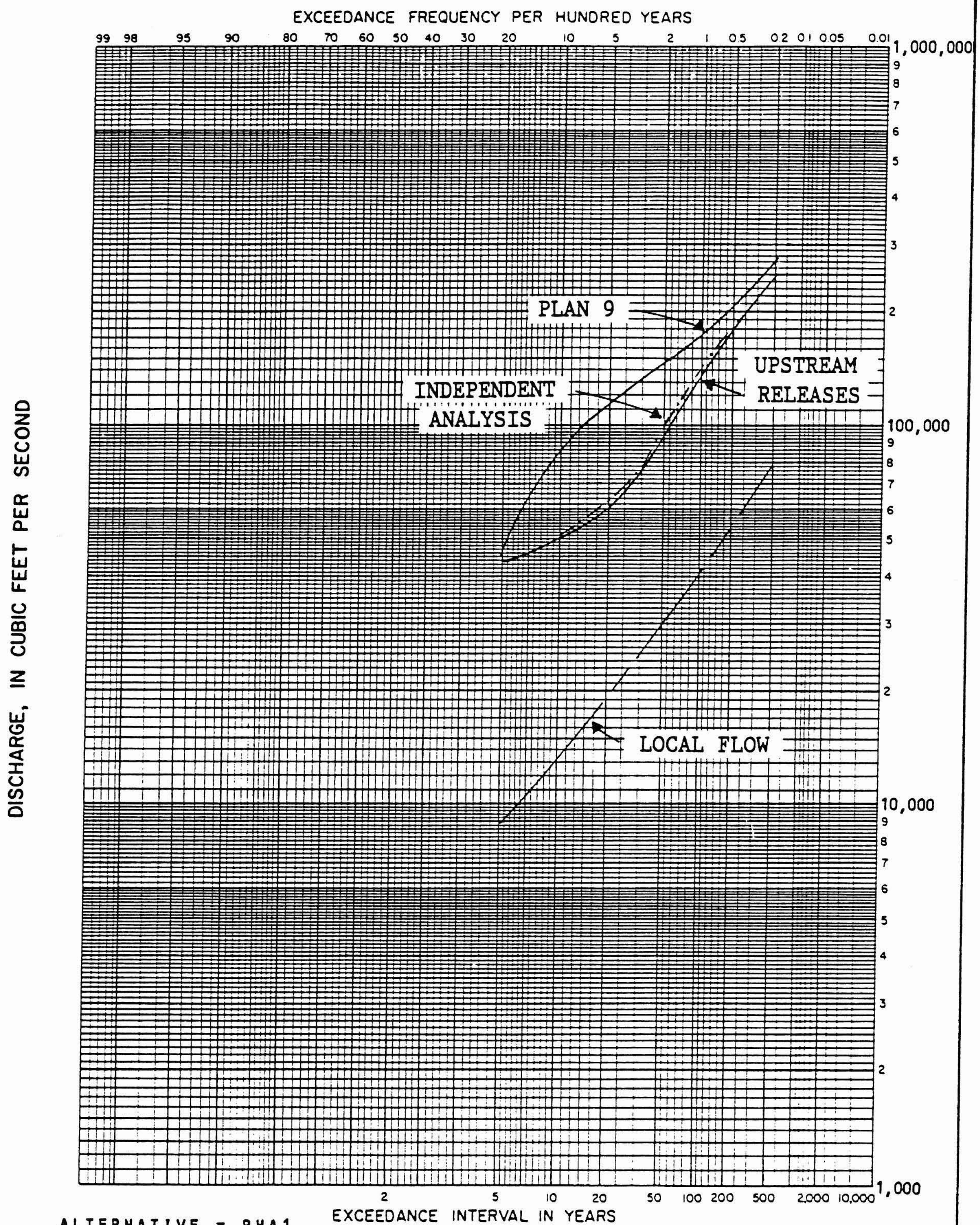
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE WITH VERDE RIVER (CP-40)

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1
DESIGN = 100 YR
TARGET = 90,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.
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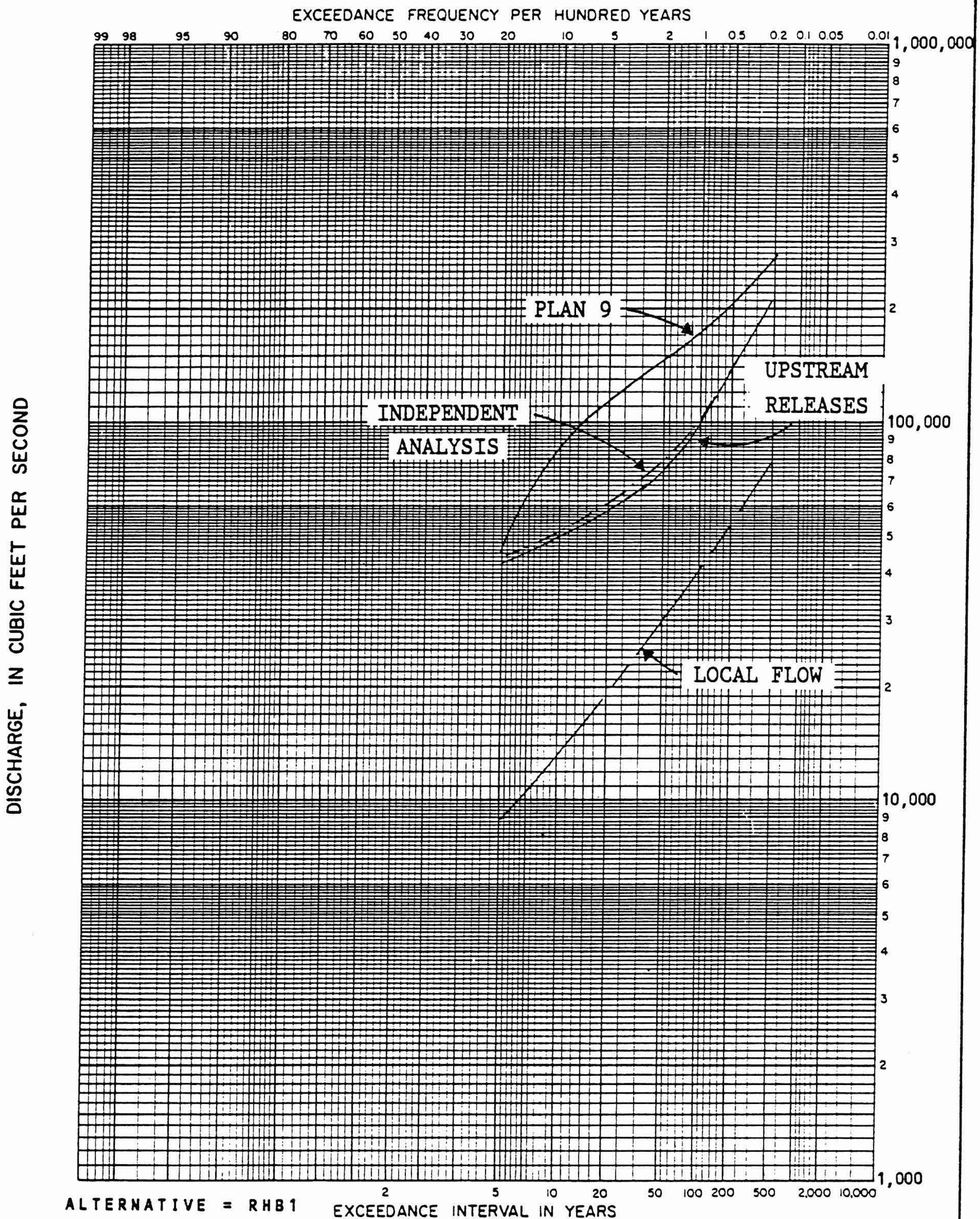
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1
DESIGN = 100 YR
TARGET = 80,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.
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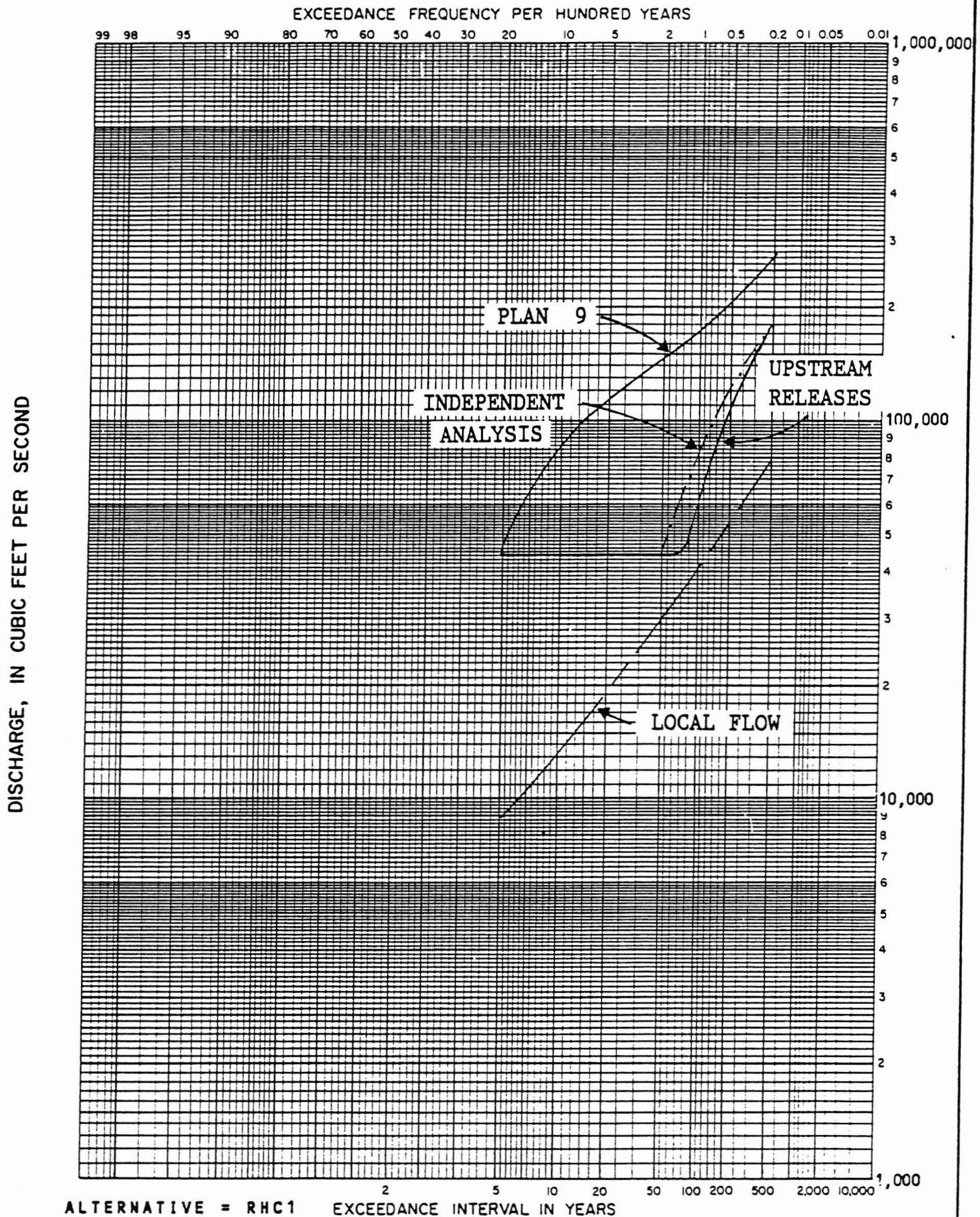
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHC1
DESIGN = 100 YR
TARGET = 45,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.
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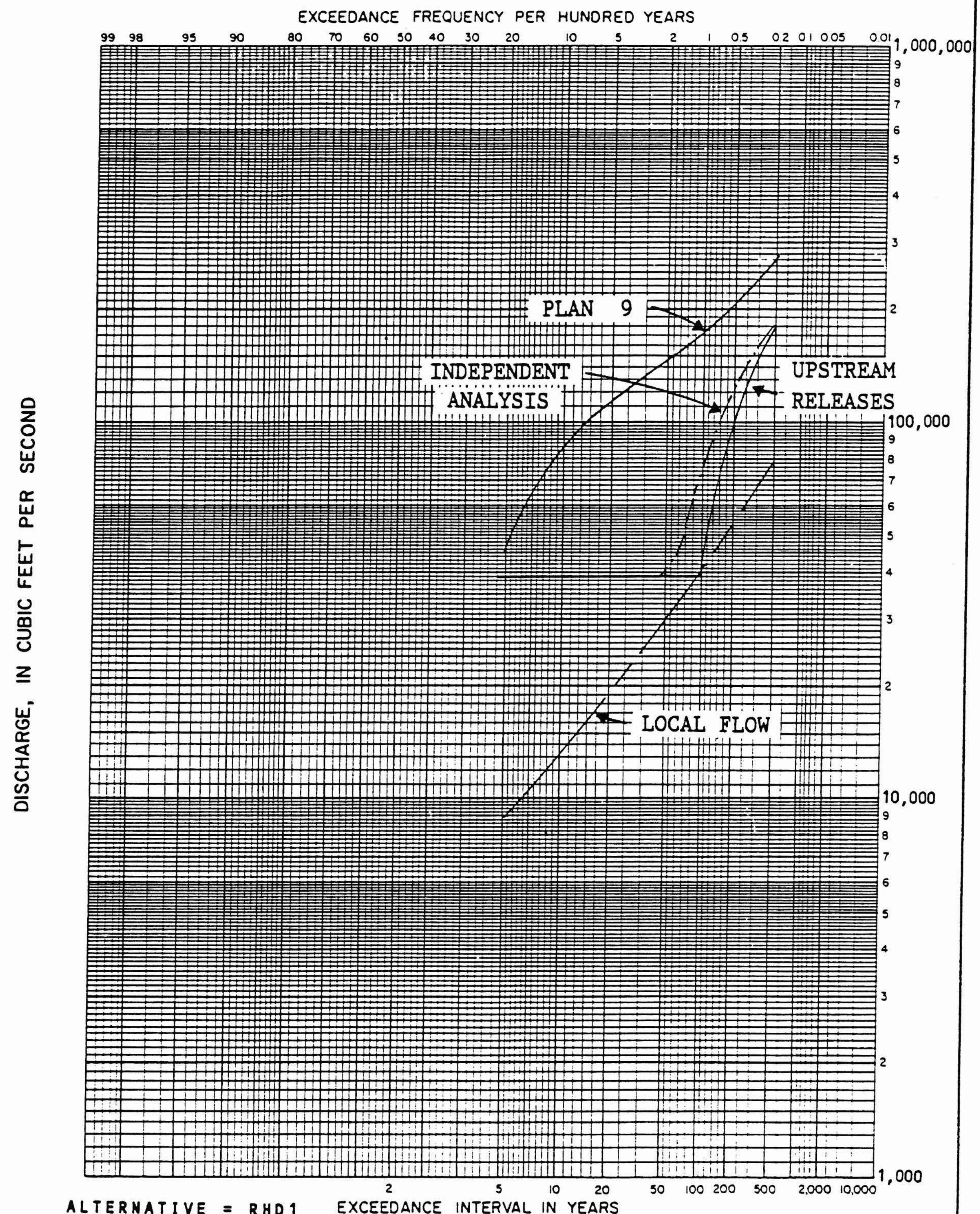
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHD1

DESIGN = 100 YR

TARGET = 40,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

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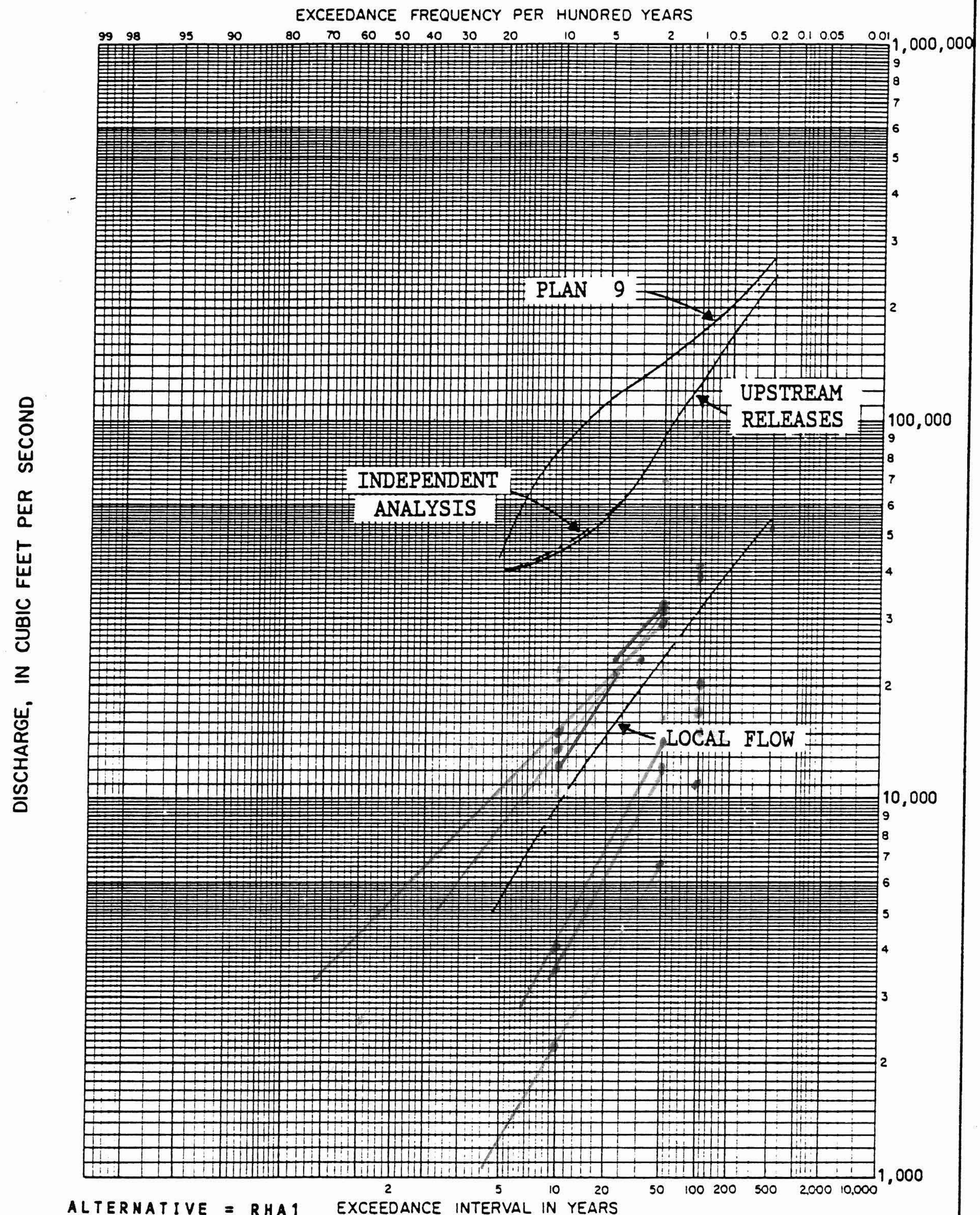
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES

DISCHARGE-FREQUENCY CURVES
SALT RIVER AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1

DESIGN = 100 YR

TARGET = 90,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

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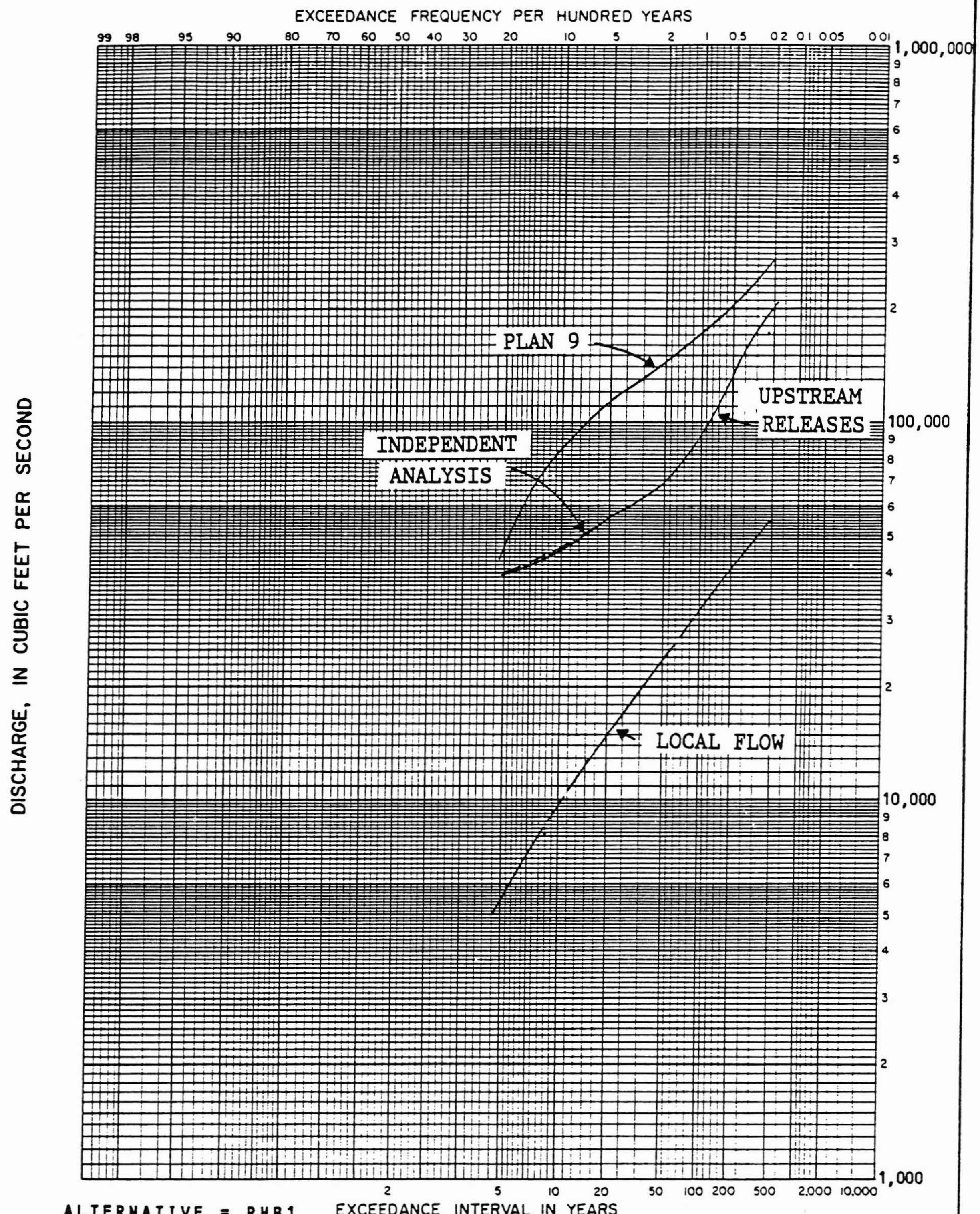
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1
DESIGN = 100 YR
TARGET = 80,000 CFS

NOTE:

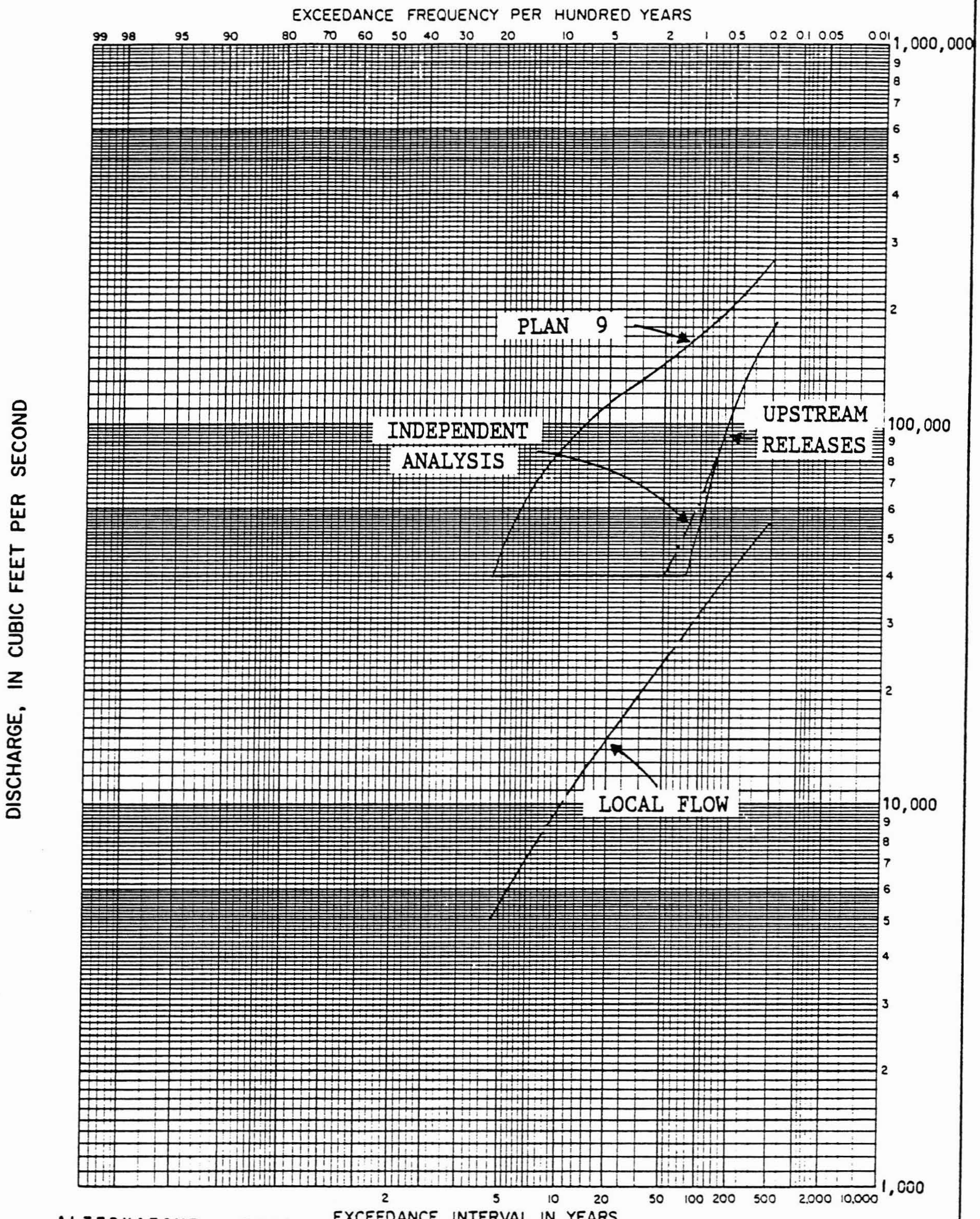
INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.

MINIMUM COMBINATION IS THE GREATER OF UPSTREAM RELEASES OR LOCAL FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




**ALTERNATIVE = RHC1**
**DESIGN = 100 YR**
**TARGET = 45,000 CFS**

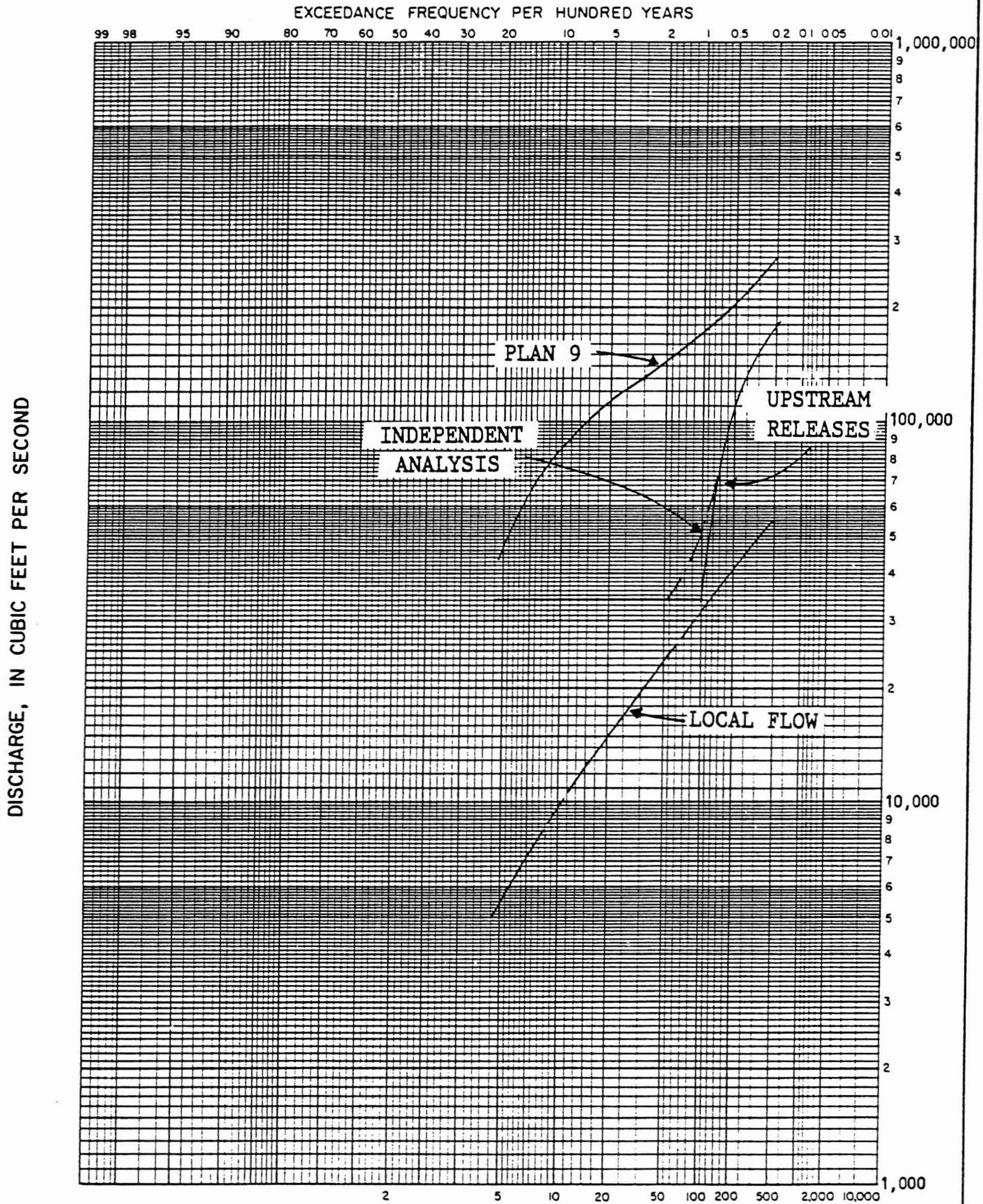
**NOTE:**

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.
MINIMUM COMBINATION IS THE GREATER OF UPSTREAM RELEASES OR LOCAL FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHD1
DESIGN = 100 YR
TARGET = 40,000 CFS

NOTE:

INDEPENDENT ANALYSIS = MAXIMUM COMBINATION OF UPSTREAM RELEASES + NON-COINCIDENT LOCAL FLOW.
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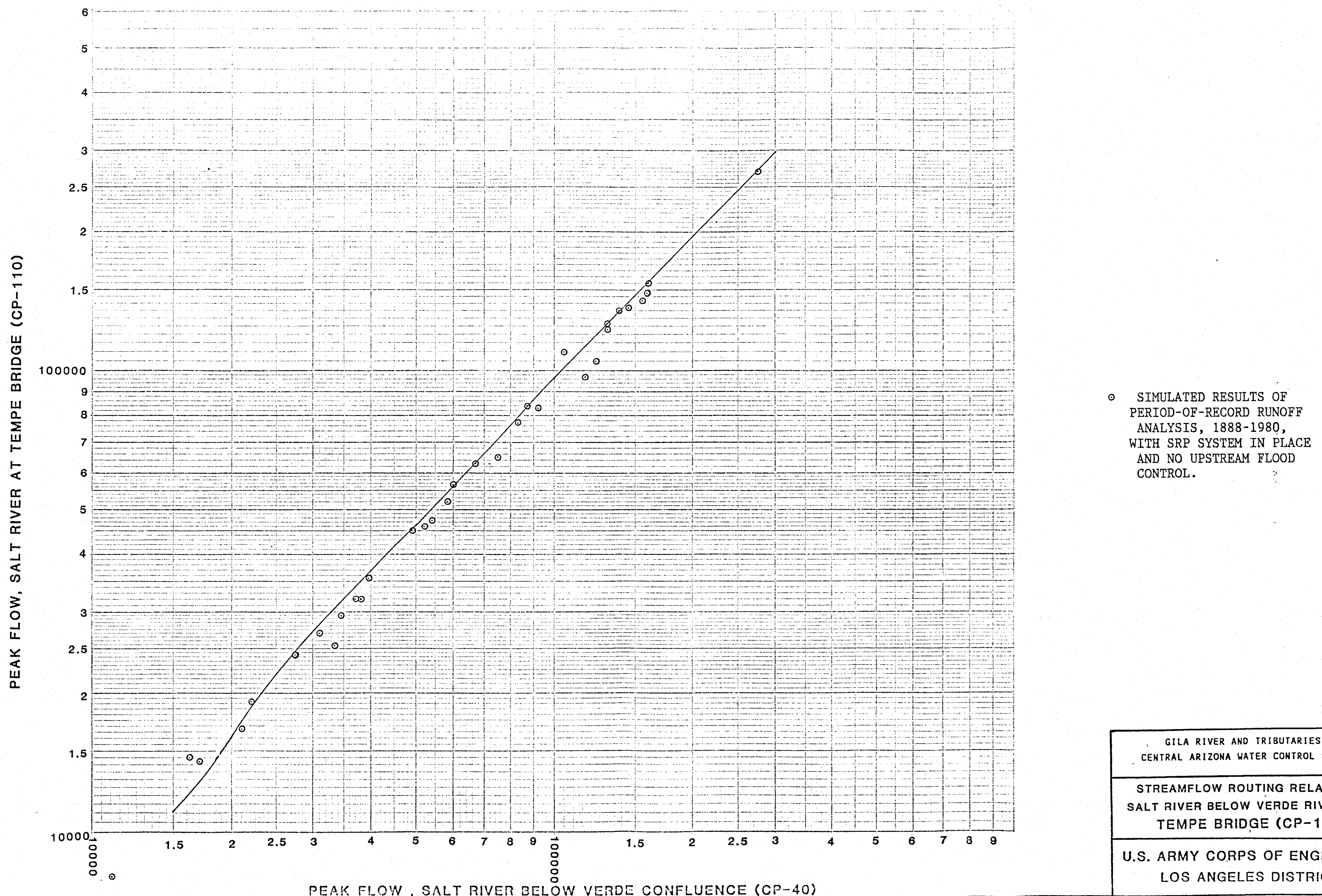
GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DEVELOPMENT OF PROJECT CURVES
DISCHARGE-FREQUENCY CURVES
SALT RIVER AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

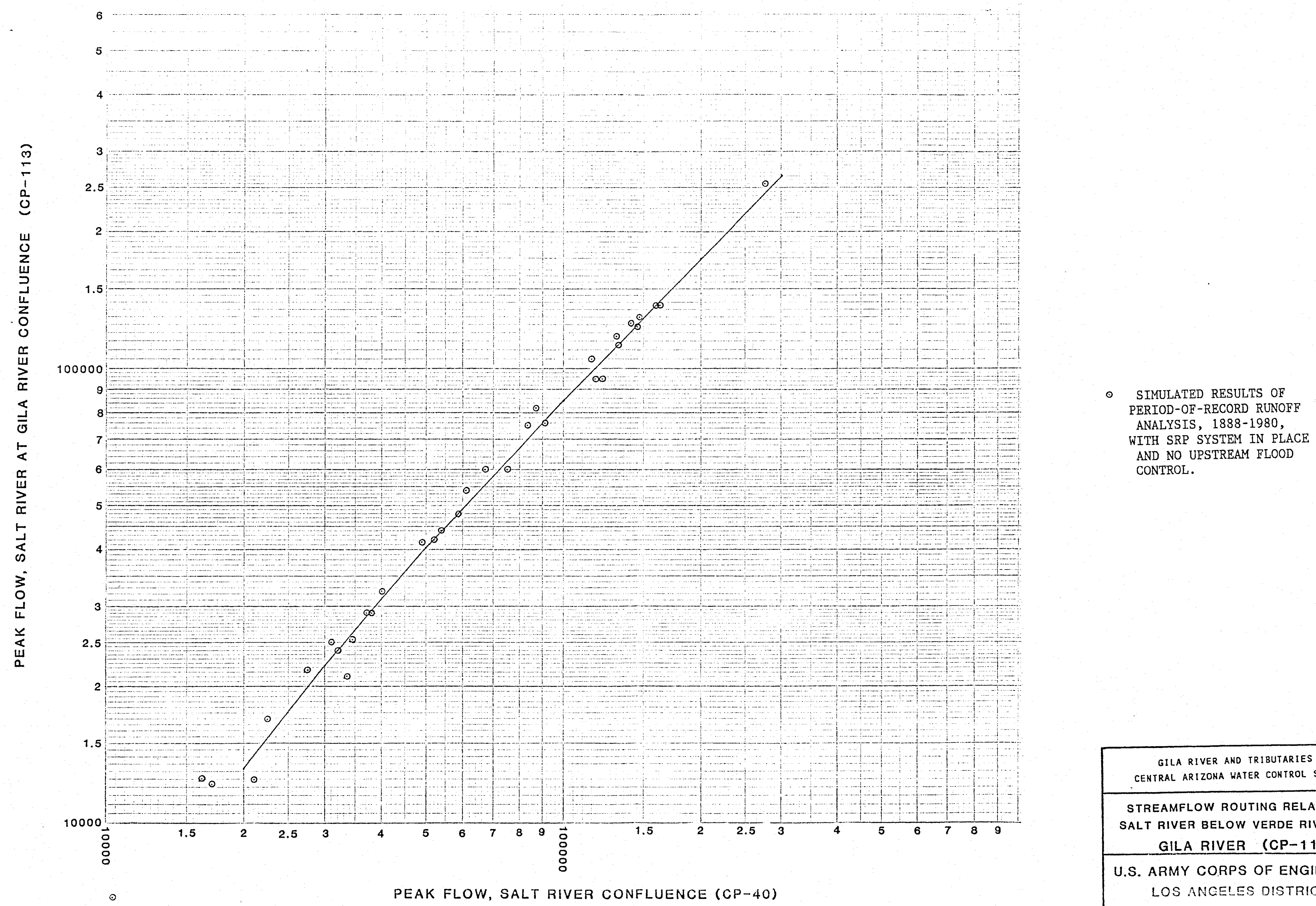



GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

STREAMFLOW ROUTING RELATION
SALT RIVER BELOW VERDE RIVER TO
TEMPE BRIDGE (CP-110)

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 25

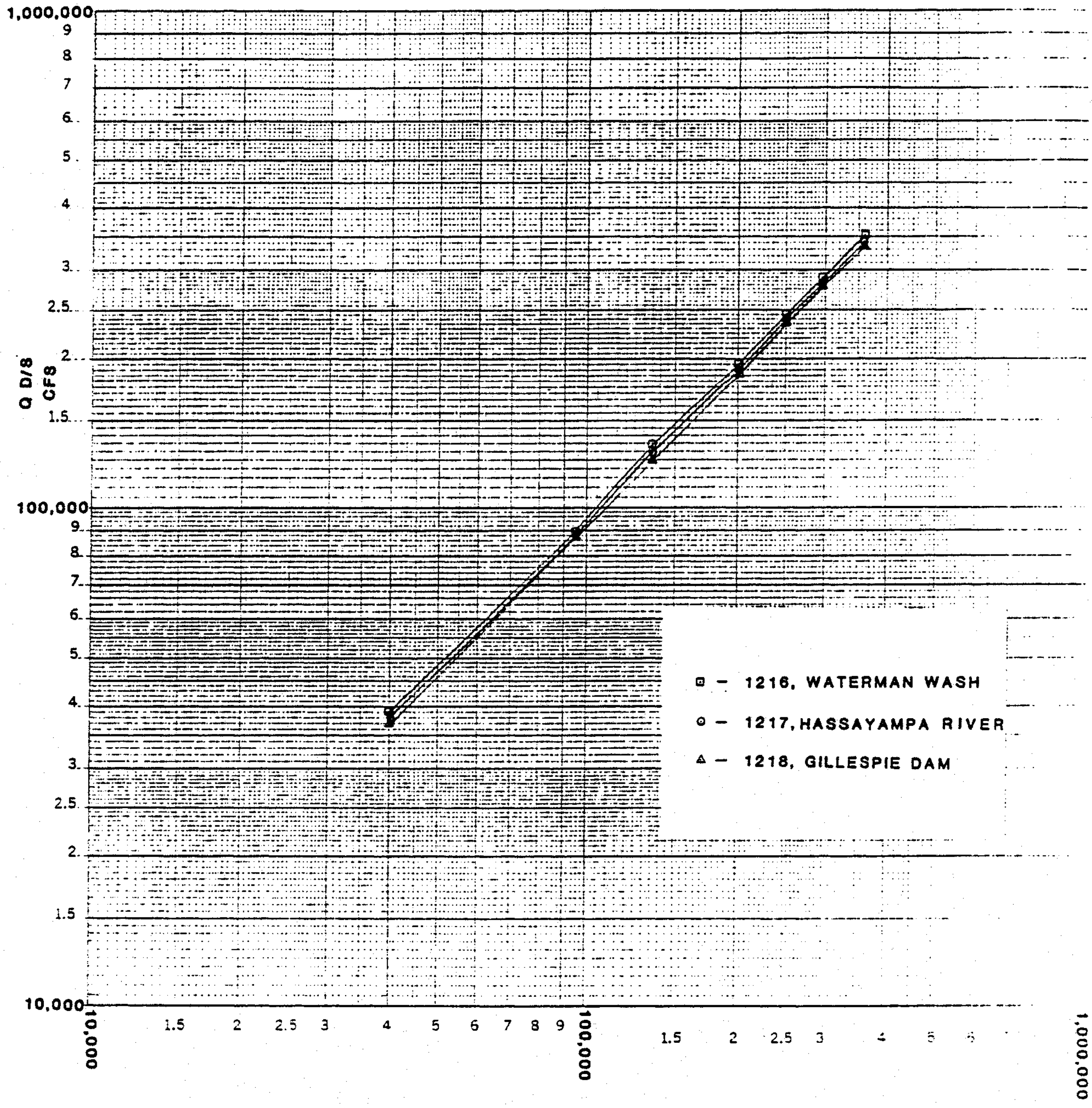



GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

STREAMFLOW ROUTING RELATION
SALT RIVER BELOW VERDE RIVER TO
GILA RIVER (CP-113)

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

GILA RIVER ROUTING RELATIONSHIPS : SALT RIVER CONFLUENCE TO GILLESPIE DAM



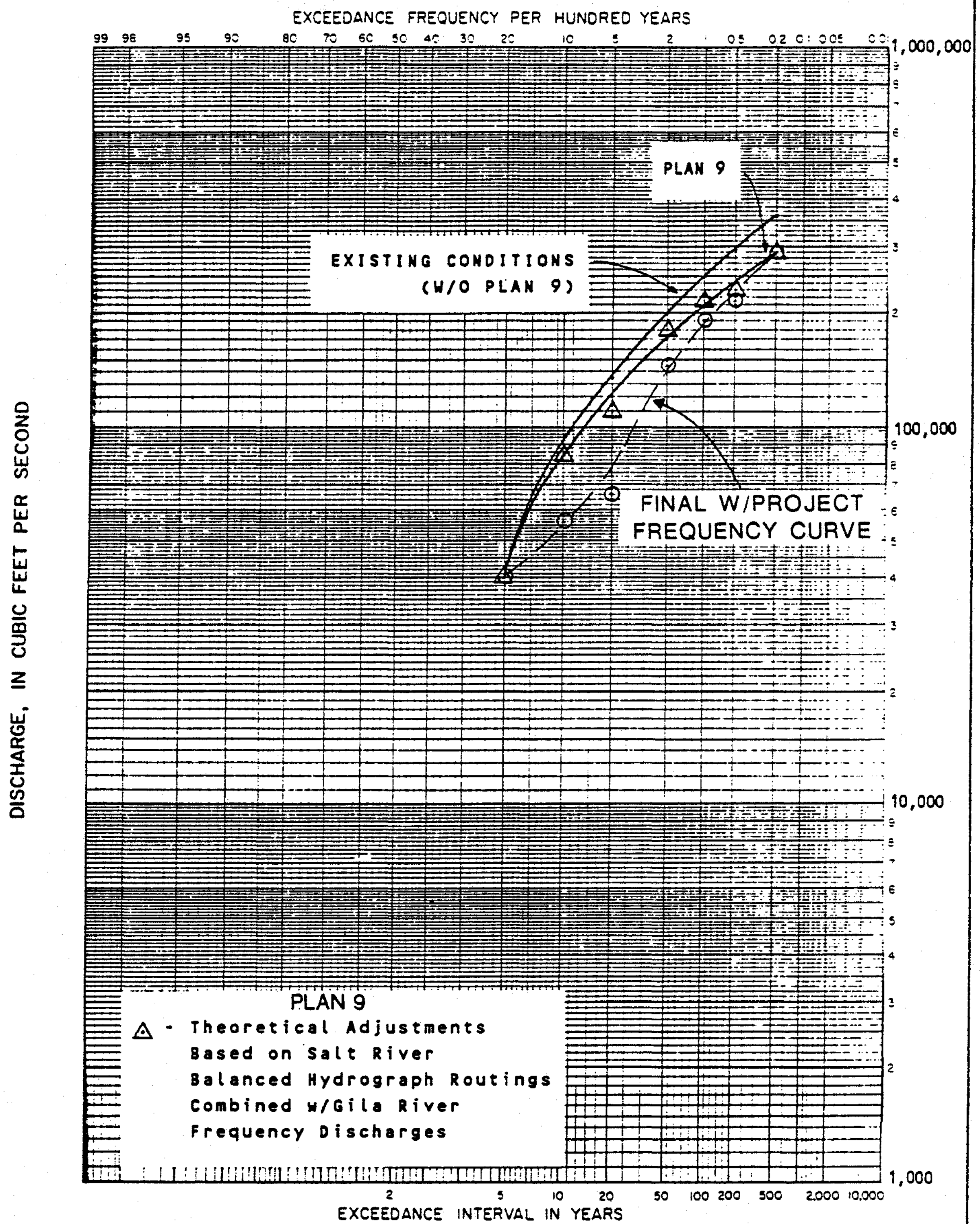

Q 1310, GILA RIVER BELOW SALT RIVER CONFLUENCE
CFS

NOTE: DISCHARGE INTERCEPTS FROM DISCHARGE FREQUENCY RESULTS FOR EXISTING CONDITIONS.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

GILA RIVER ROUTING RELATIONSHIPS :
SALT RIVER CONFLUENCE
TO GILLESPIE DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



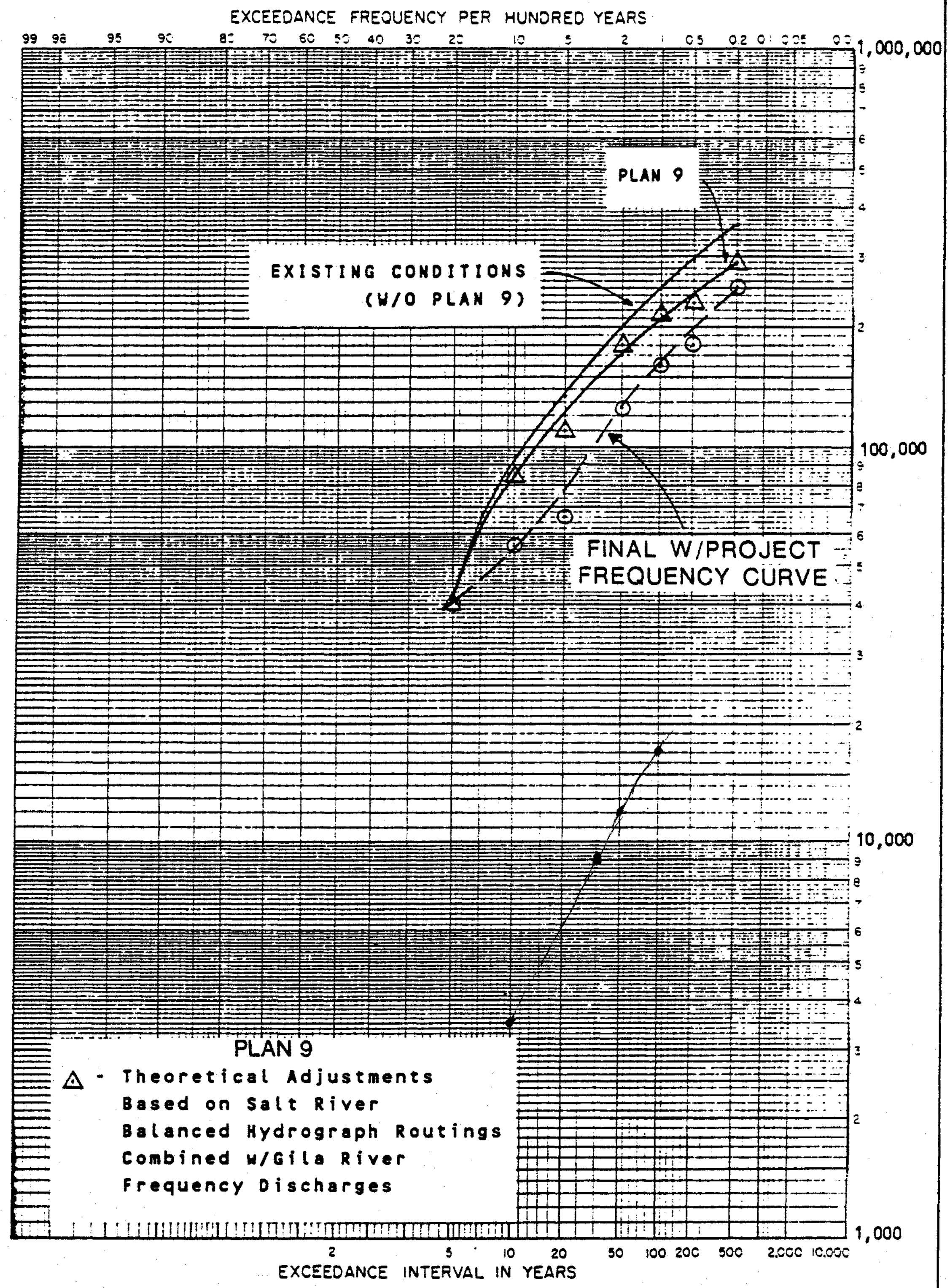

⊙ - PLAN = RHA1.

DATA POINTS BASED ON
BALANCED HYDROGRAPH
ROUTING THROUGH
PROPOSED PROJECT, LOCAL
FLOW, AND GILA RIVER.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

**DISCHARGE FREQUENCY CURVES**
GILA RIVER
@ SALT RIVER CONFLUENCE
**CP-1310**

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



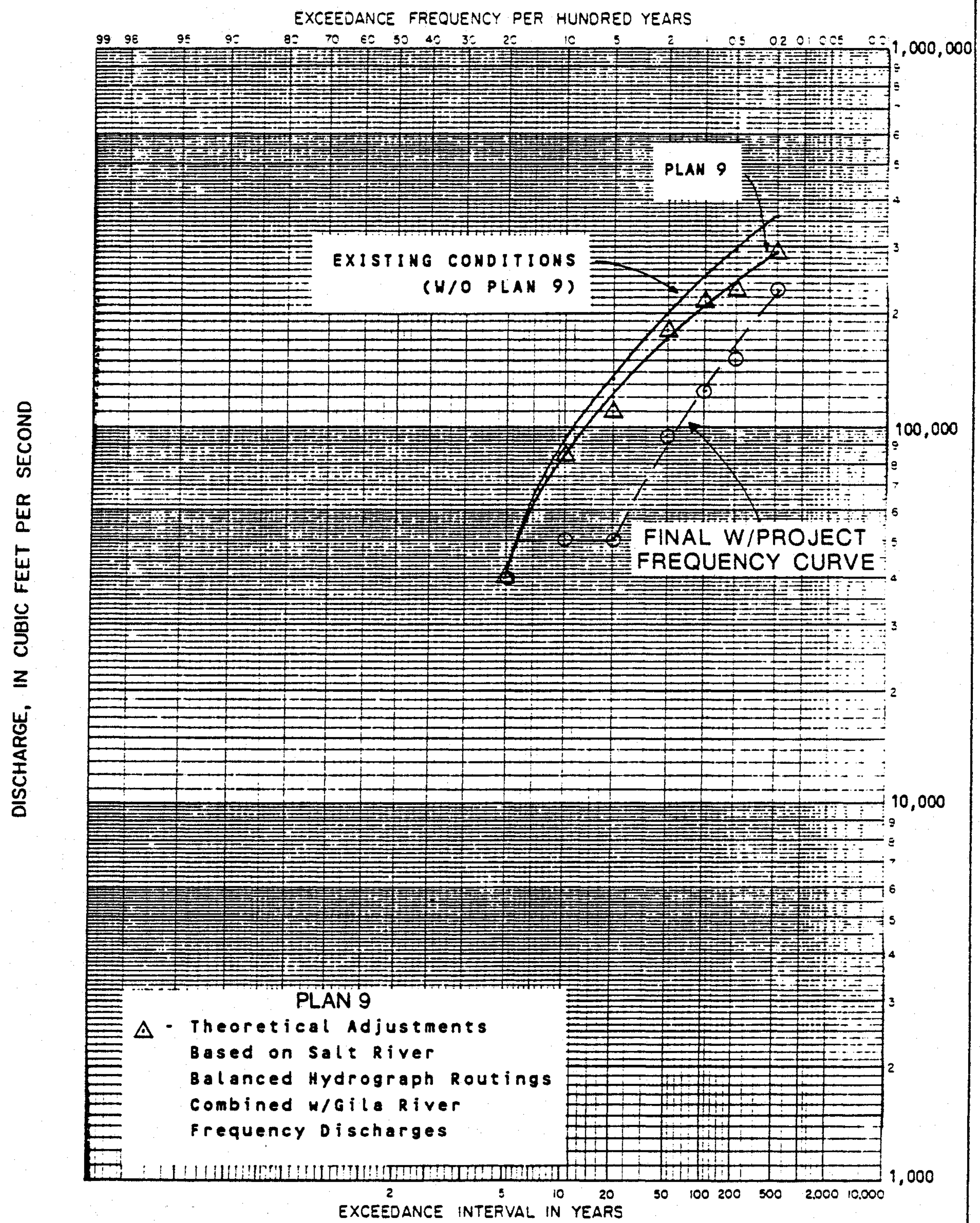

⊙ - PLAN = RHB1.

DATA POINTS BASED ON
BALANCED HYDROGRAPH
ROUTING THROUGH
PROPOSED PROJECT, LOCAL
FLOW, AND GILA RIVER.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

**DISCHARGE FREQUENCY CURVES**
GILA RIVER
@ SALT RIVER CONFLUENCE
CP-1310

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



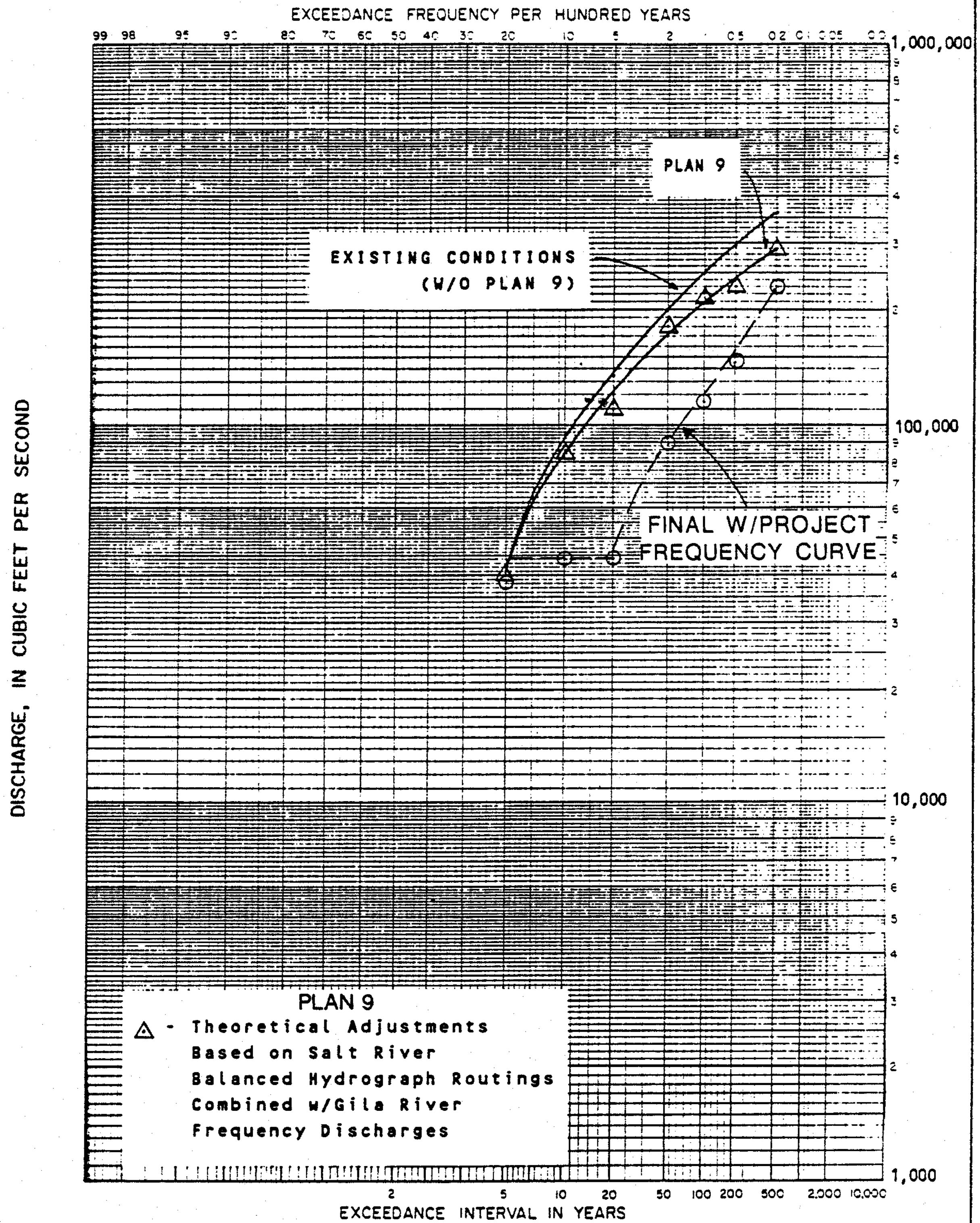

⊙ - PLAN = RHC1

DATA POINTS BASED ON
BALANCED HYDROGRAPH
ROUTING THROUGH
PROPOSED PROJECT, LOCAL
FLOW, AND GILA RIVER.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
GILA RIVER
@ SALT RIVER CONFLUENCE
CP-1310

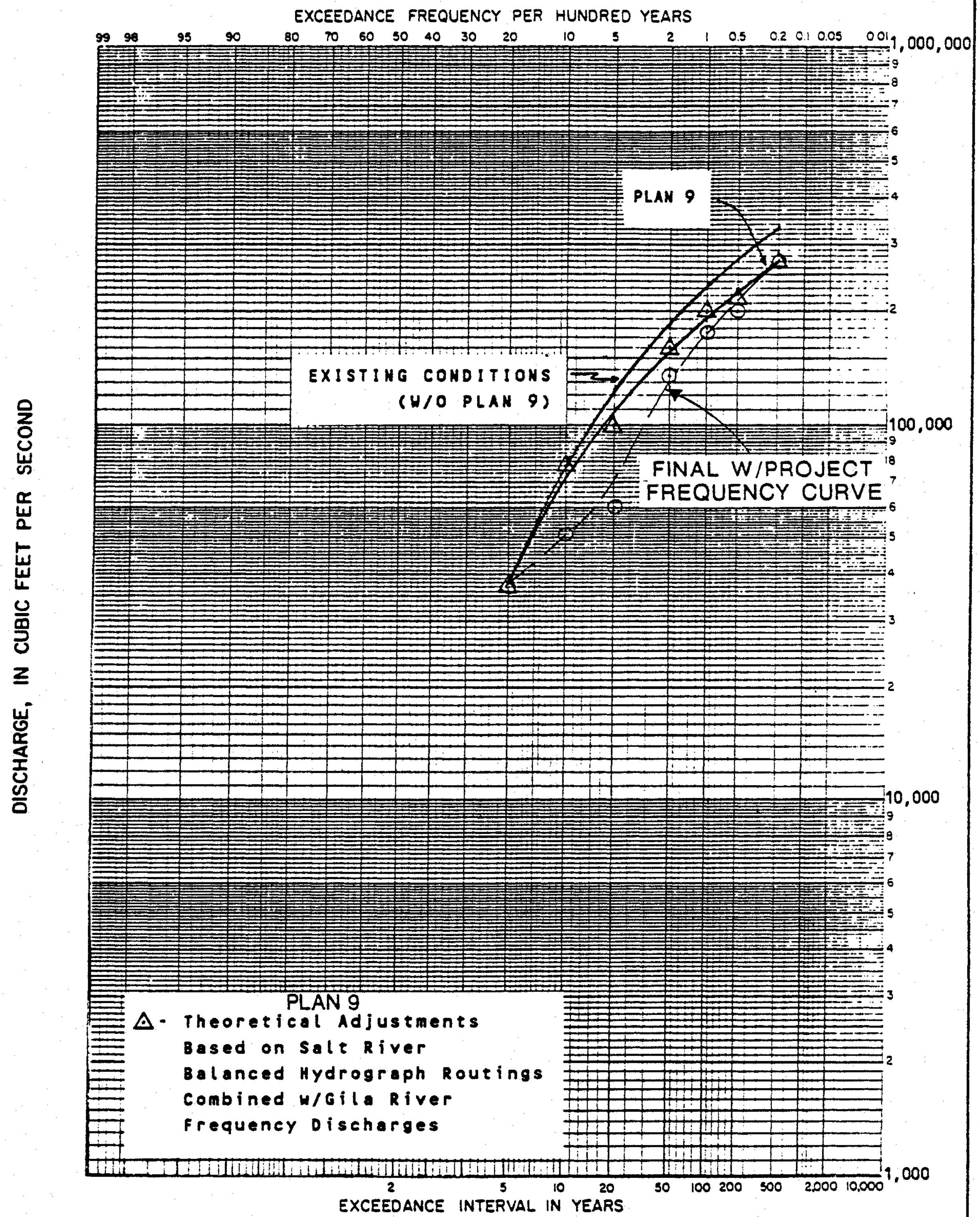
U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




⊙ - PLAN = RHD1.

DATA POINTS BASED ON BALANCED HYDROGRAPH ROUTING THROUGH PROPOSED PROJECT, LOCAL FLOW, AND GILA RIVER.

| |
|---|
| GILA RIVER AND TRIBUTARIES<br>CENTRAL ARIZONA WATER CONTROL STUDY |
| DISCHARGE FREQUENCY CURVES<br>GILA RIVER<br>@ SALT RIVER CONFLUENCE<br>CP-1310 |
| U S ARMY CORPS OF ENGINEERS<br>LOS ANGELES DISTRICT |

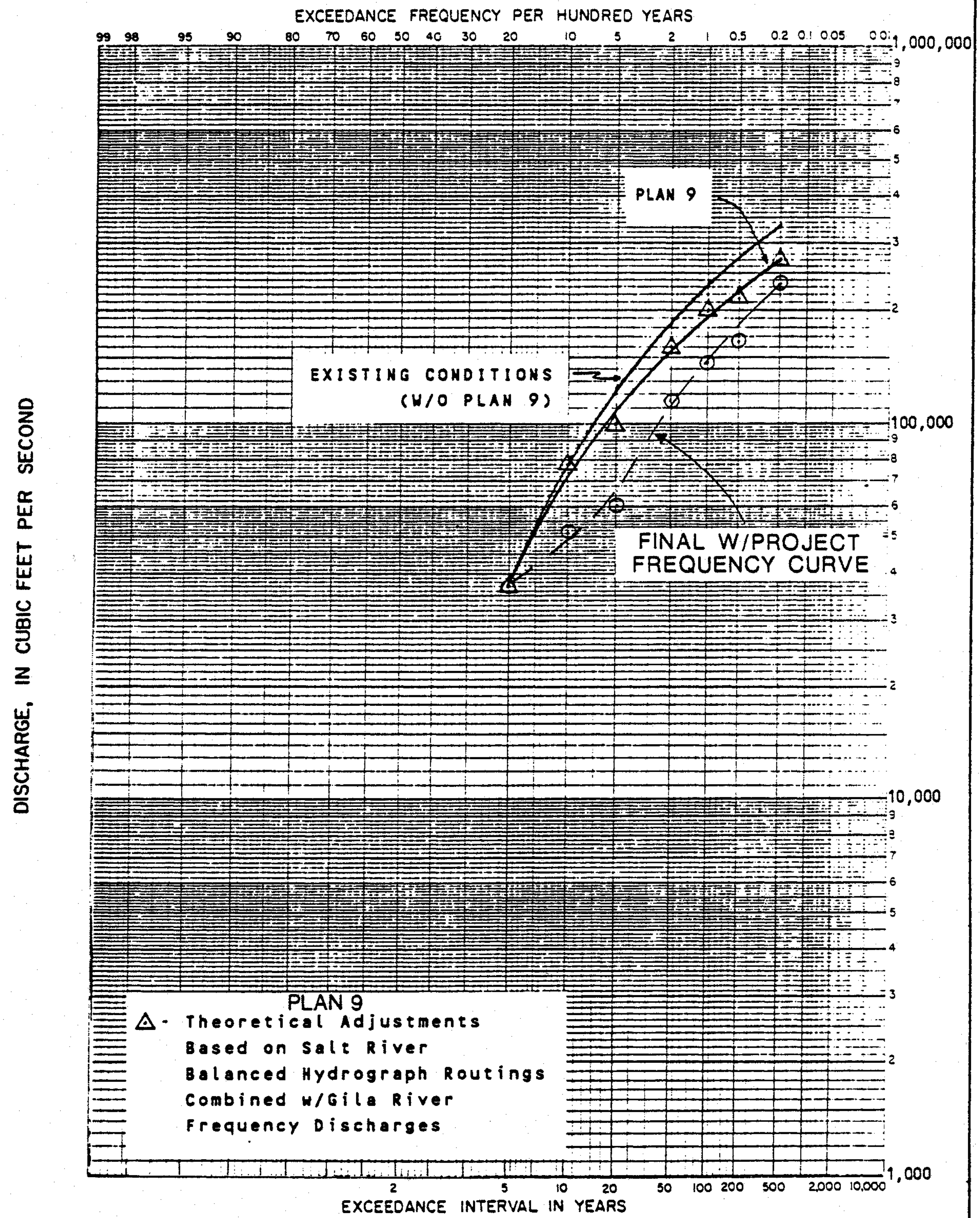



⊕ -PLAN = RHA1.
DATA POINTS BASED ON
BALANCED HYDROGRAPH
ROUTINGS THROUGH PROPOSED
PROJECT, LOCAL FLOW, AND
GILA RIVER FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
GILA RIVER
AT GILLESPIE DAM
CP-1218

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

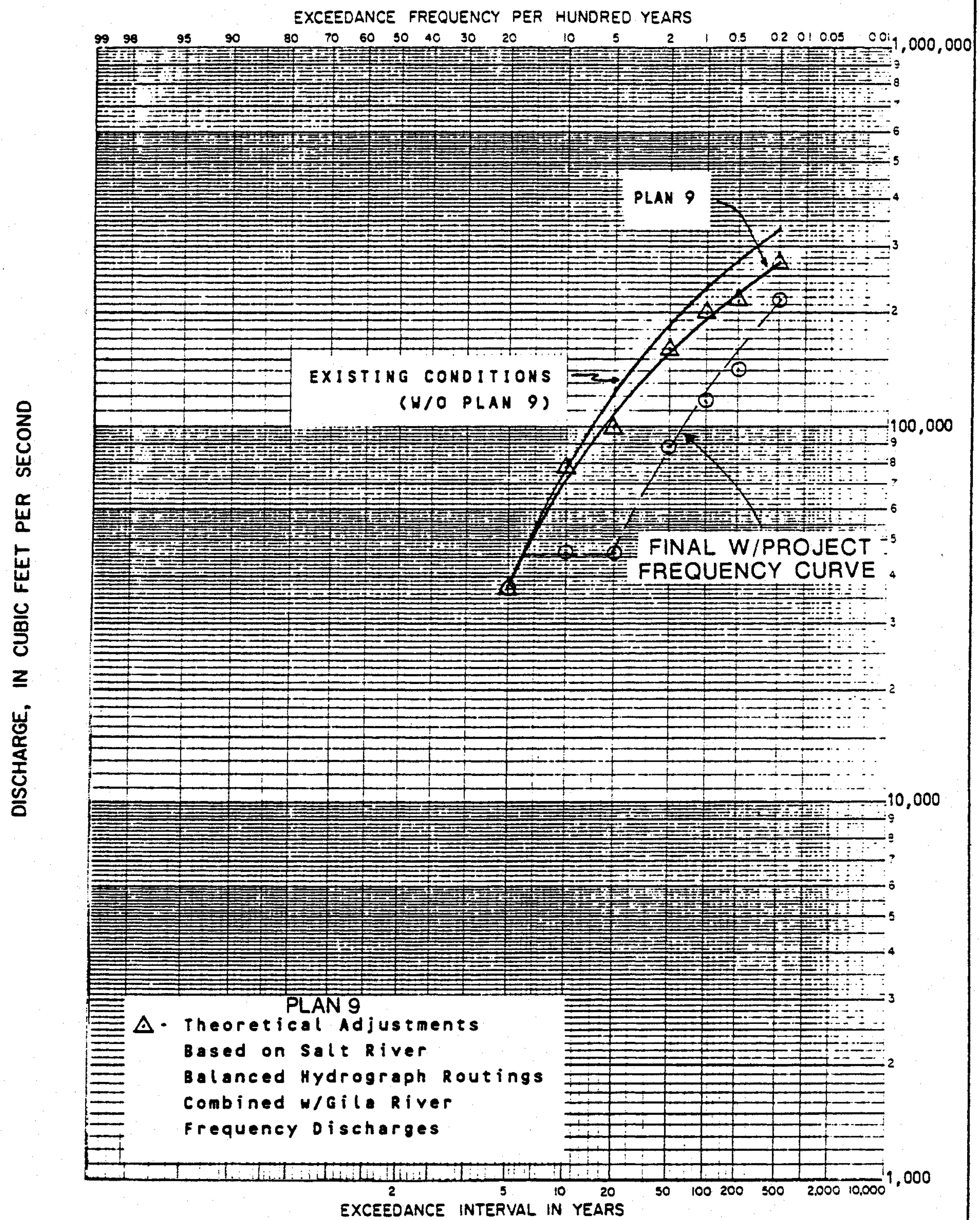



⊙ -PLAN = RHB1.
DATA POINTS BASED ON
BALANCED HYDROGRAPHS
ROUTING THROUGH PROPOSED
PROJECT, LOCAL FLOW, AND
GILA RIVER FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
GILA RIVER
AT GILLESPIE DAM
CP-1218

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

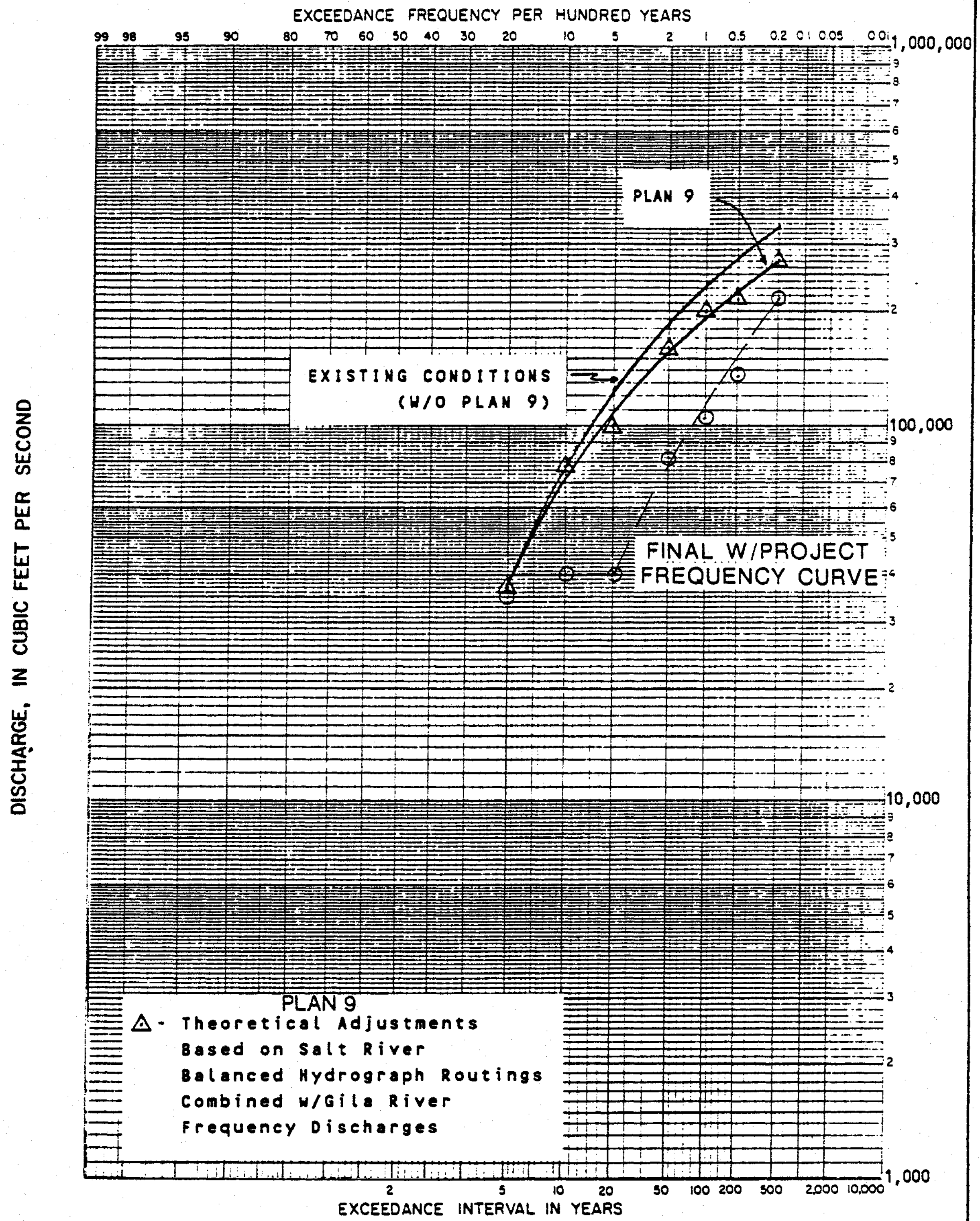



⊙ -PLAN = RHC1.
DATA POINTS BASED ON BALANCED HYDROGRAPHS ROUTING THROUGH PROPOSED PROJECT, LOCAL FLOW, AND GILA RIVER FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

**DISCHARGE FREQUENCY CURVES**
**GILA RIVER**
**AT GILLESPIE DAM**
**CP-1218**

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

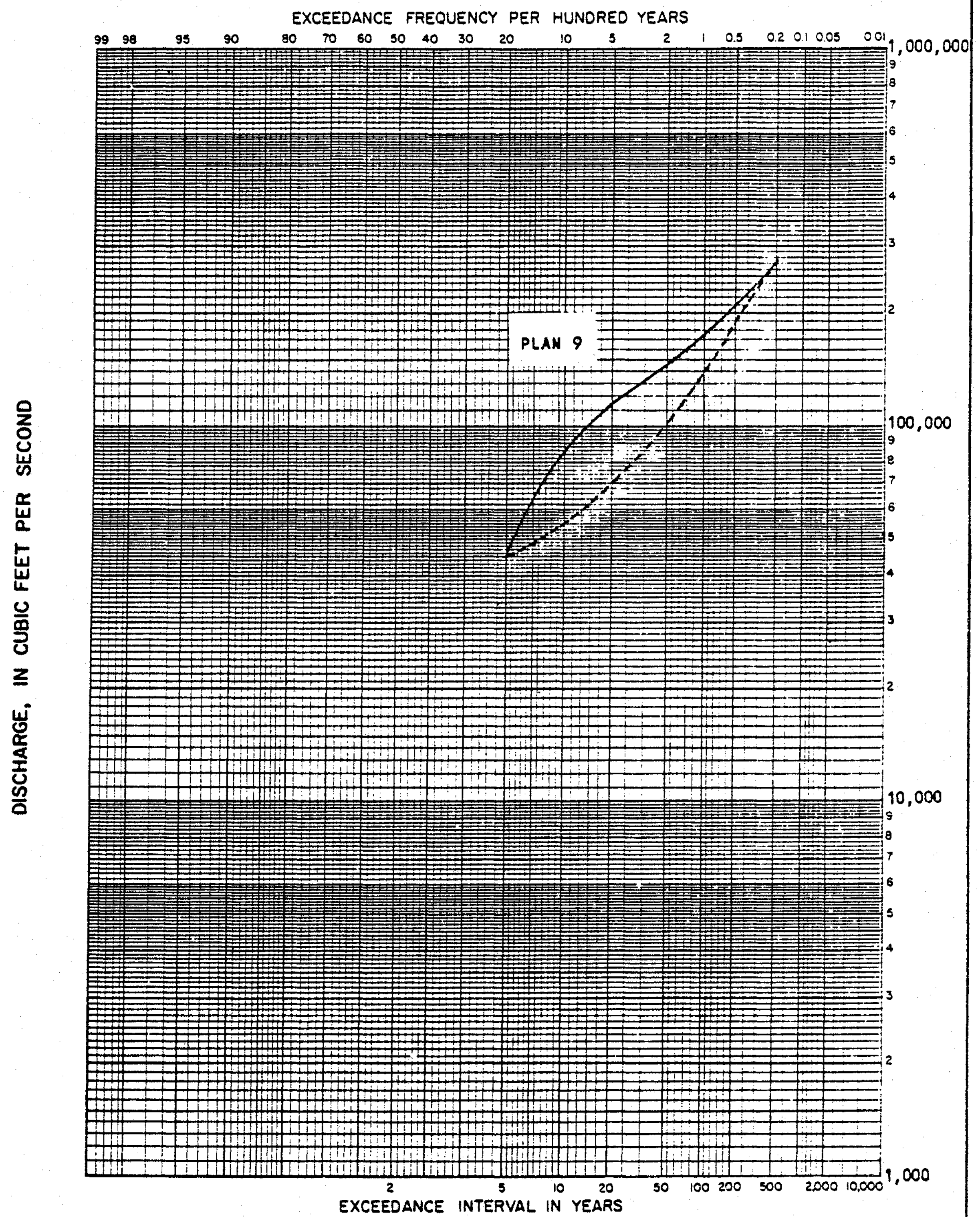



⊙ -PLAN = RHD1.
DATA POINTS BASED ON BALANCED HYDROGRAPH ROUTINGS THROUGH PROPOSED PROJECT, LOCAL FLOW, AND GILA RIVER FLOW.

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
GILA RIVER
AT GILLESPIE DAM
CP-1218

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1

DESIGN = 100-YEAR

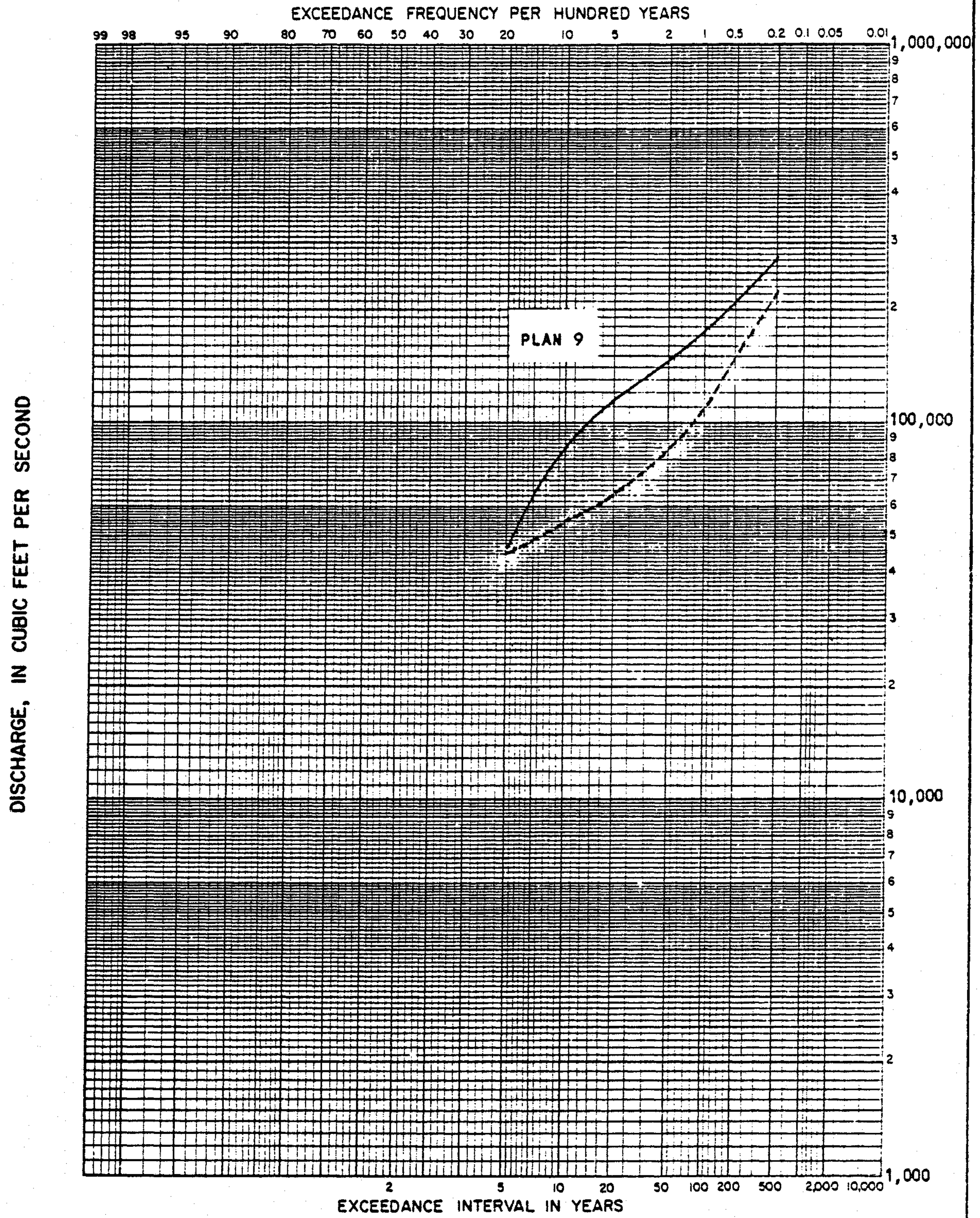
TARGET = 90,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/ VERDE RIVER
CP-40

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1

DESIGN = 100-YEAR

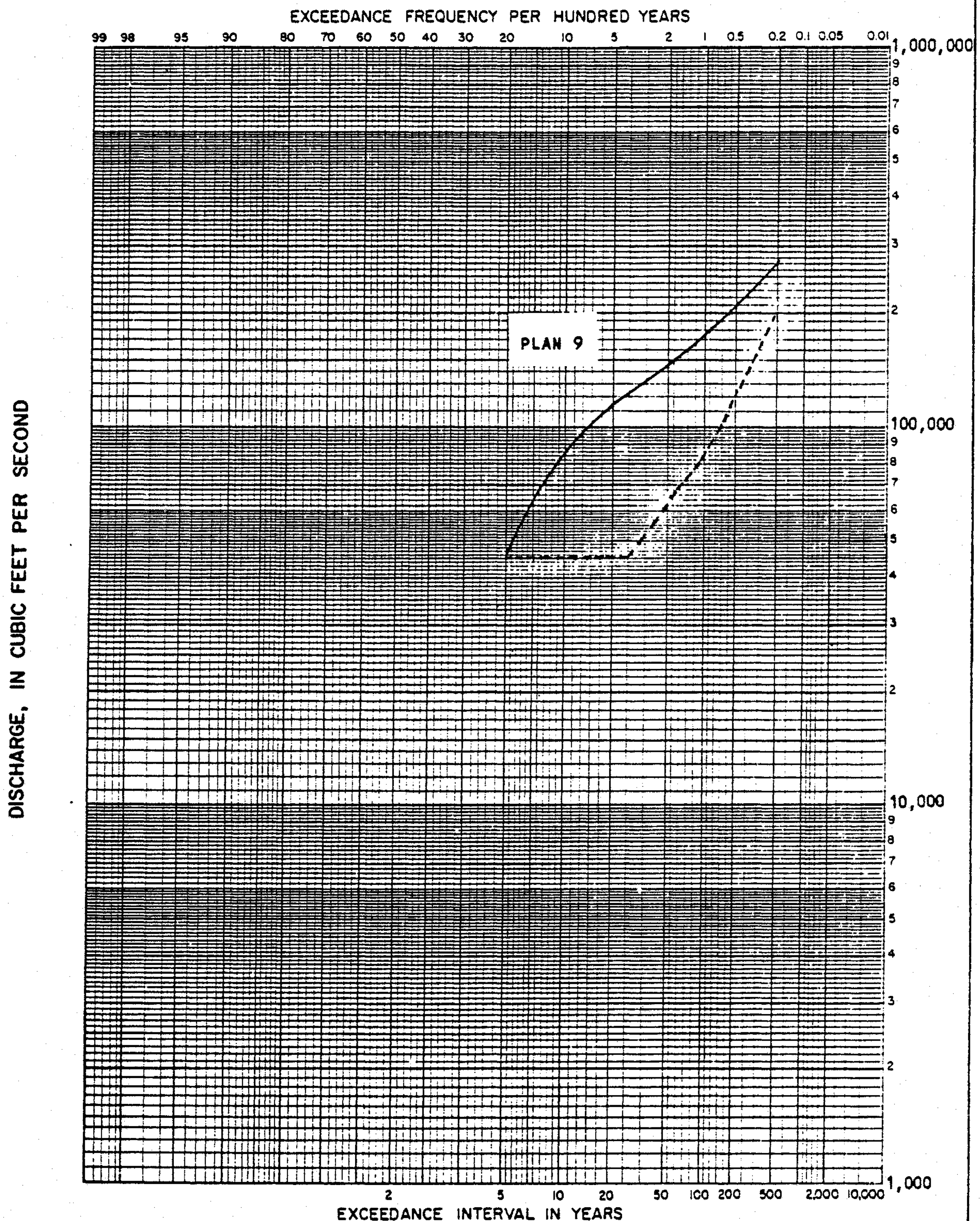
TARGET = 80,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/ VERDE RIVER
CP-40

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHC1

DESIGN = 100-YEAR

TARGET = 45,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/ VERDE RIVER
CP-40

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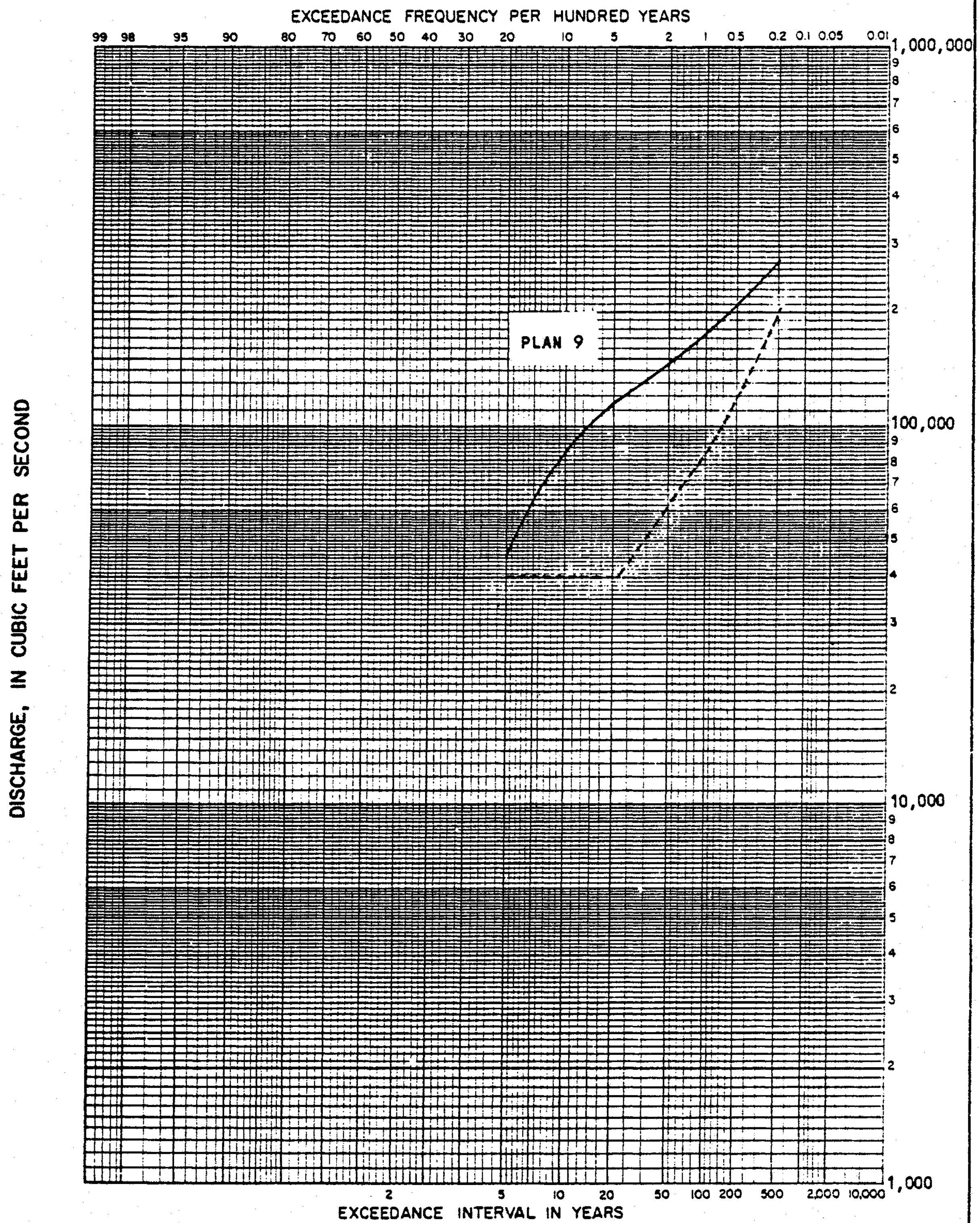



ALTERNATIVE = RHD1

DESIGN = 100-YEAR

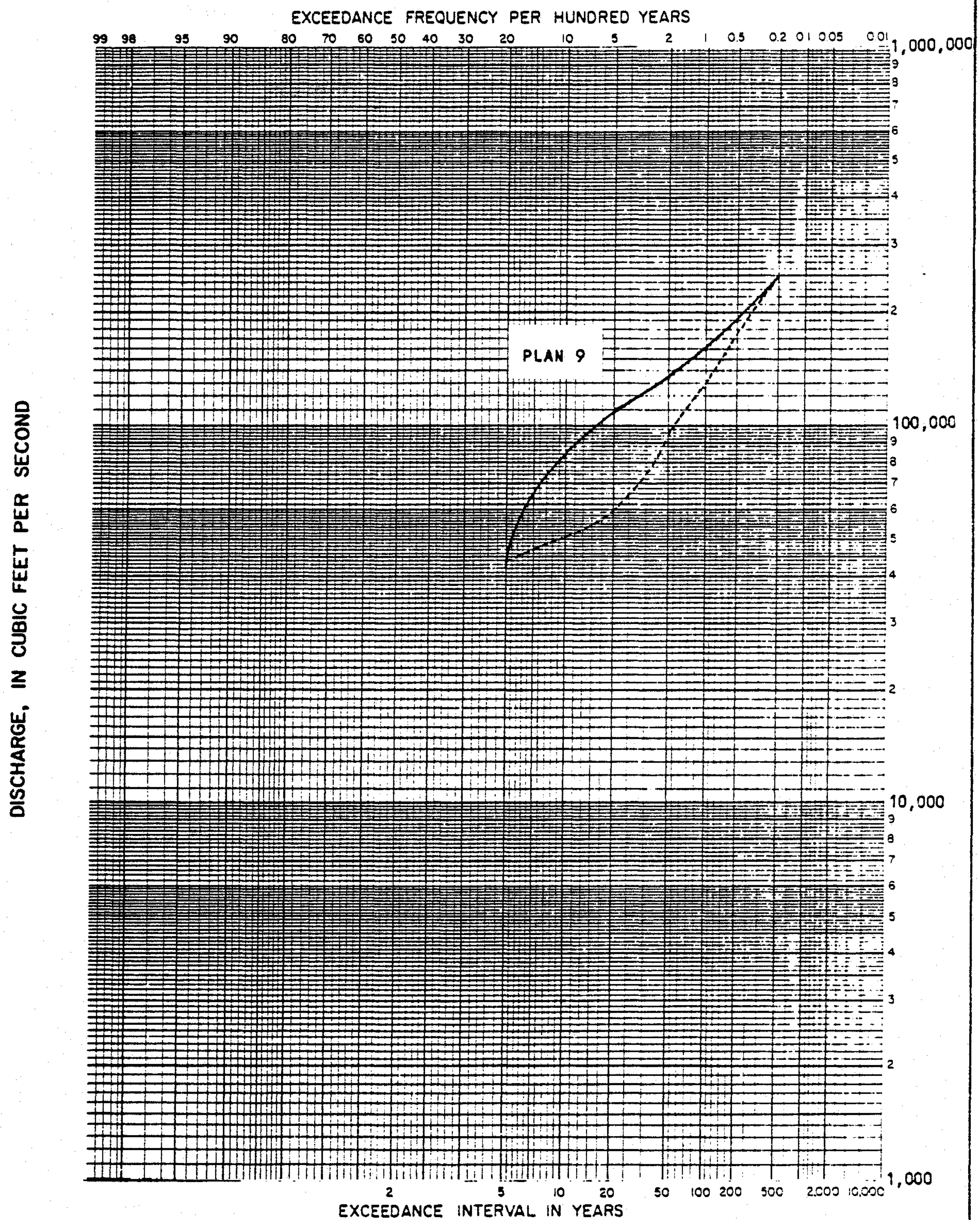
TARGET = 40,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER BELOW CONFLUENCE
W/ VERDE RIVER
CP-40

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1

DESIGN = 100-YEAR

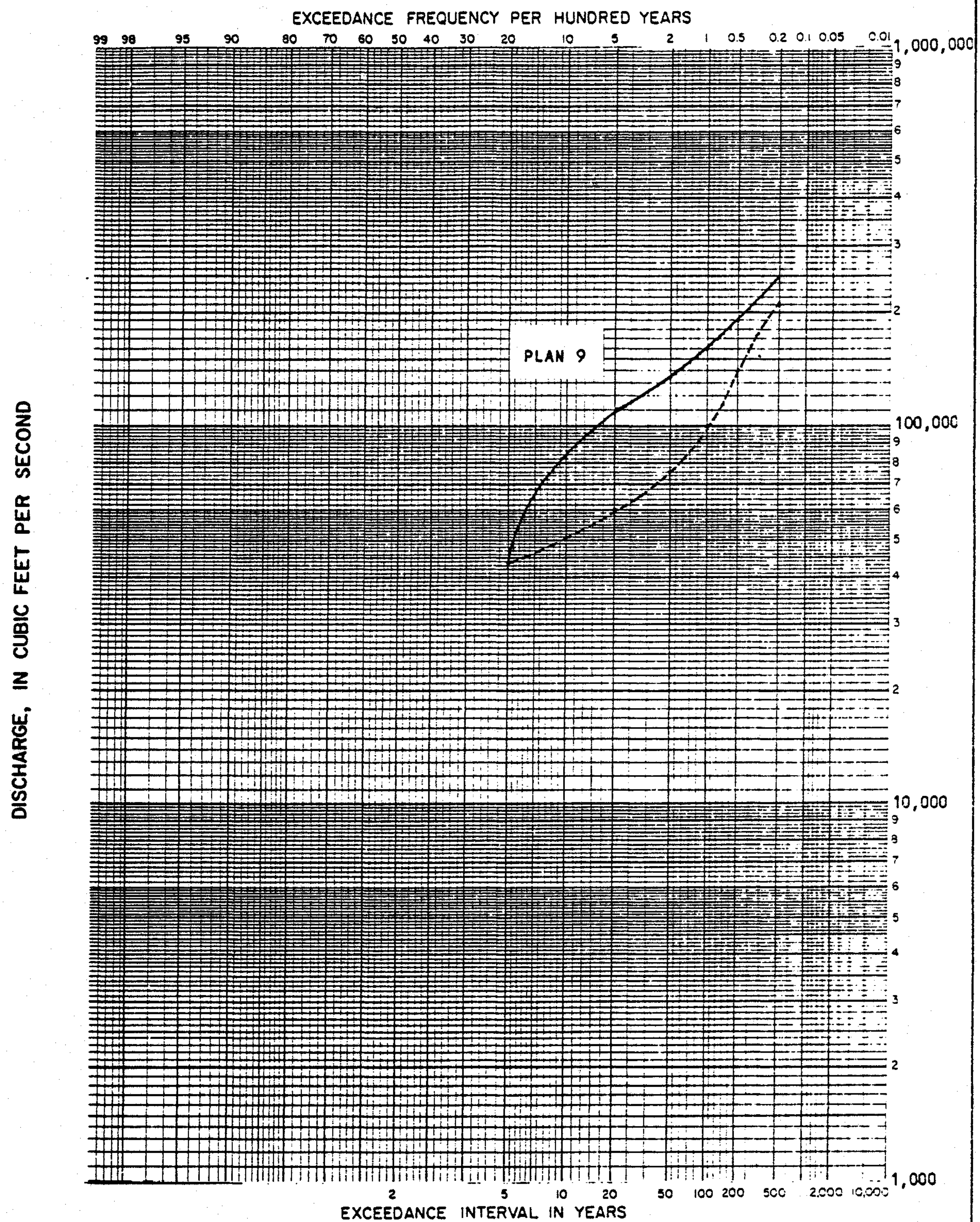
TARGET = 90,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1

DESIGN = 100-YEAR

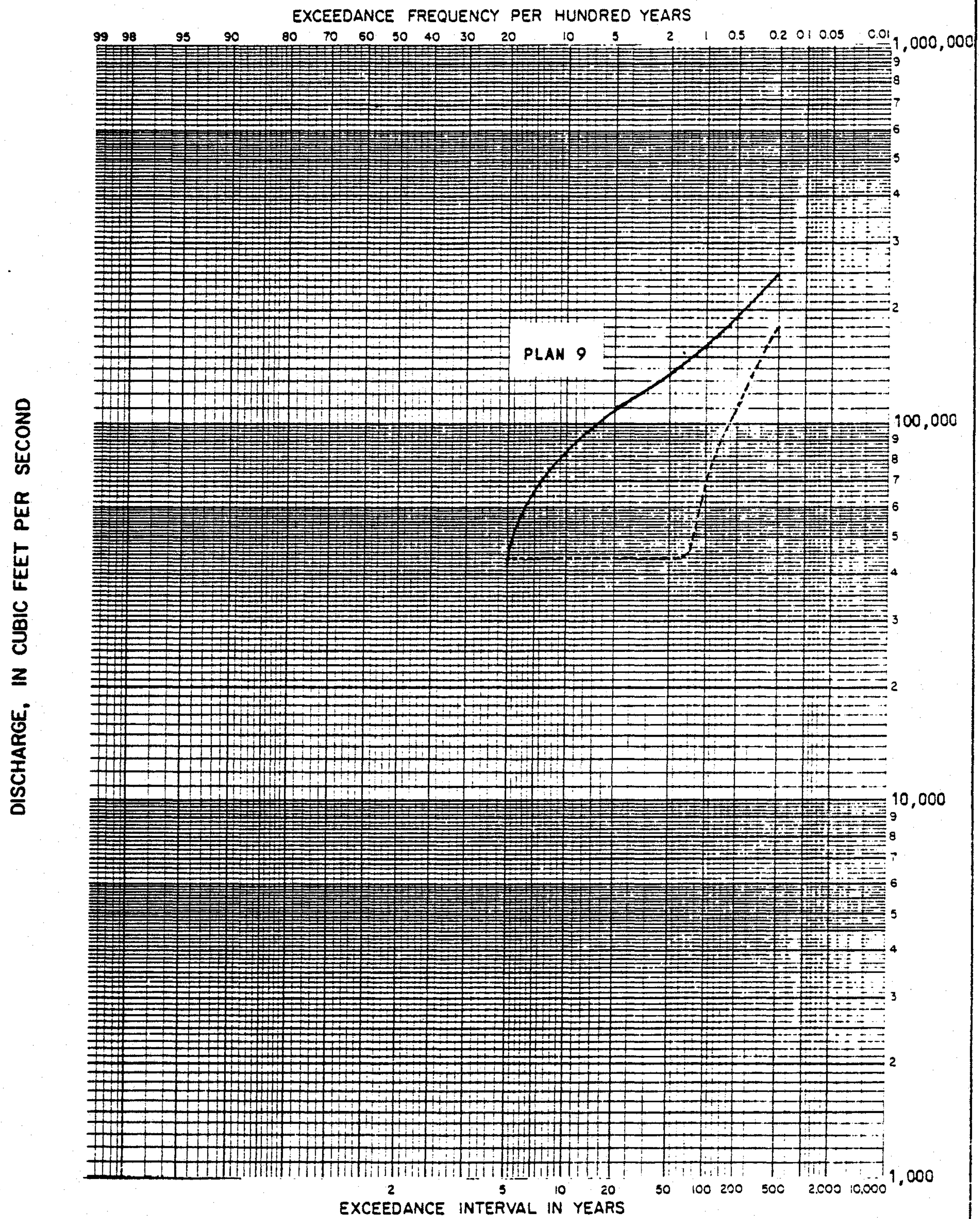
TARGET = 80,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHC1

DESIGN = 100-YEAR

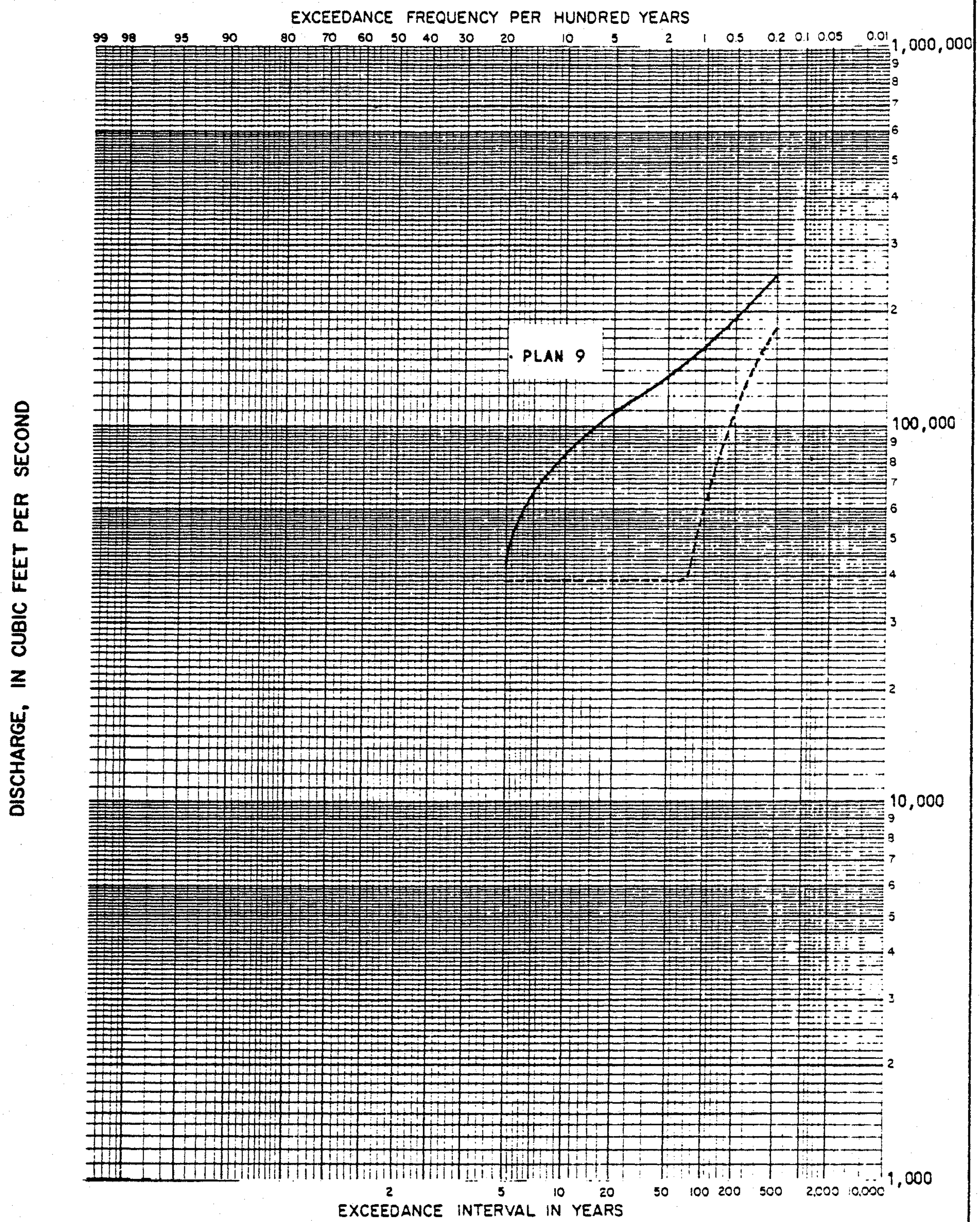
TARGET = 45,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHD1

DESIGN = 100-YEAR

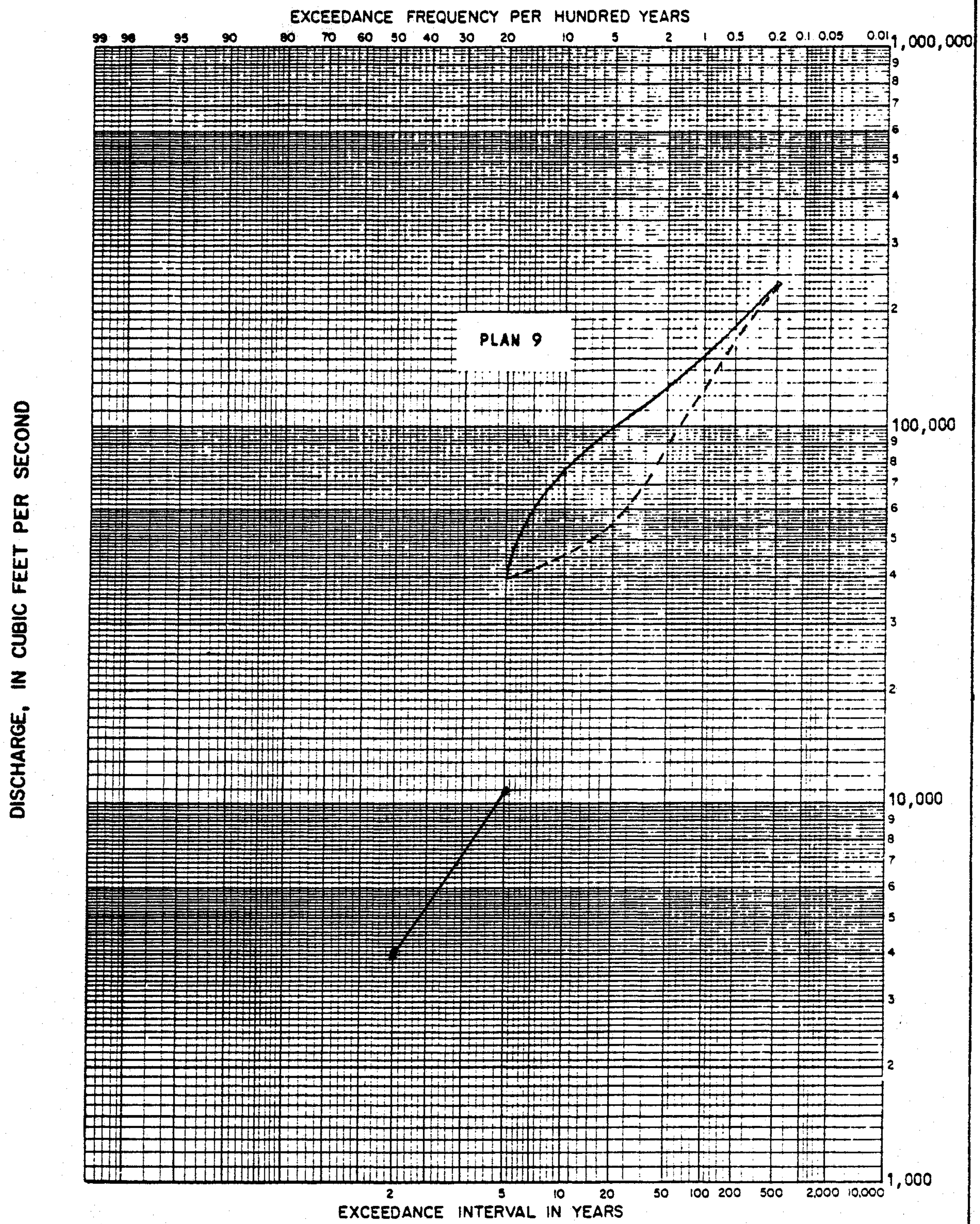
TARGET = 40,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT TEMPE BRIDGE
CP-110

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHA1

DESIGN = 100-YEAR

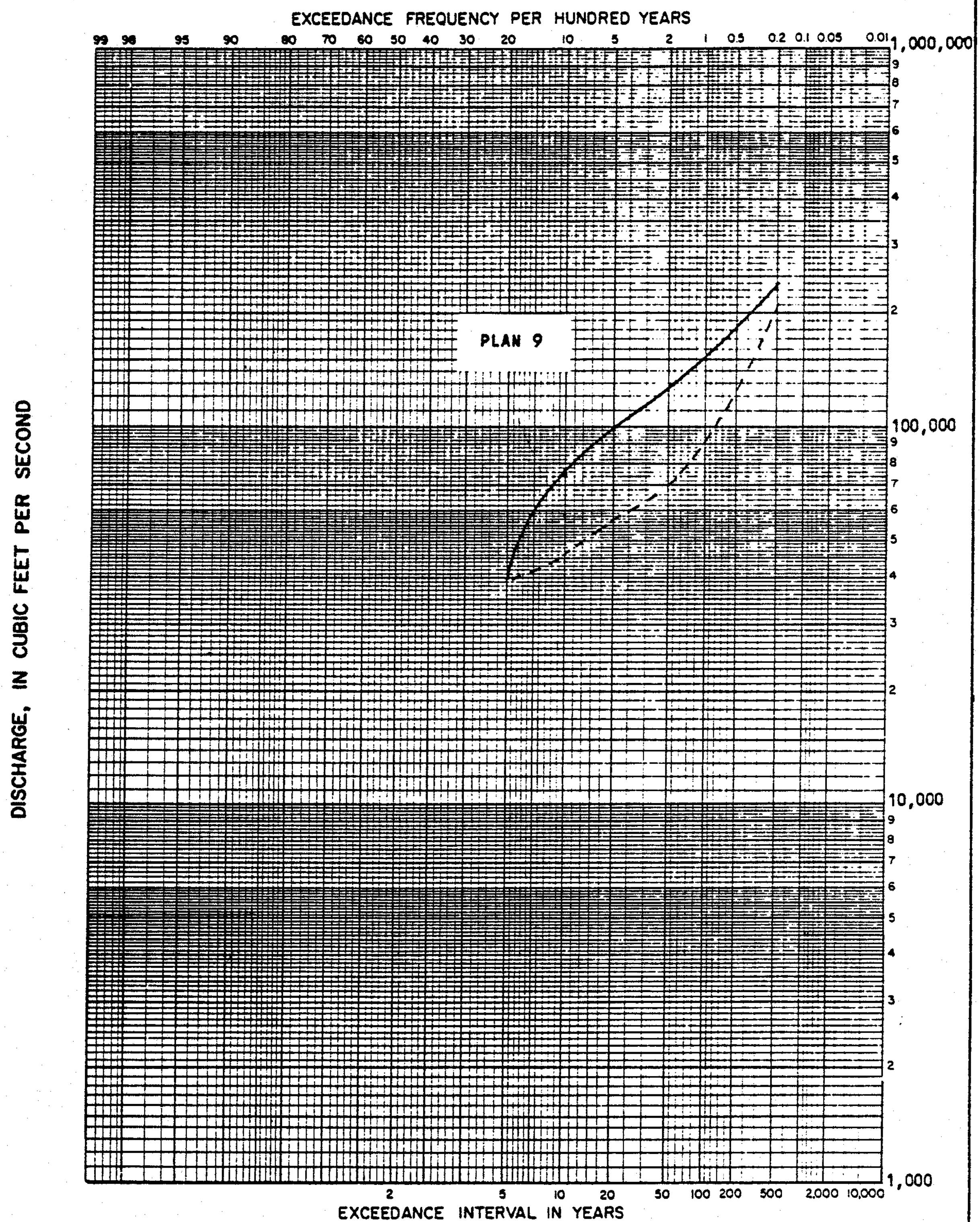
TARGET = 90,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHB1

DESIGN = 100-YEAR

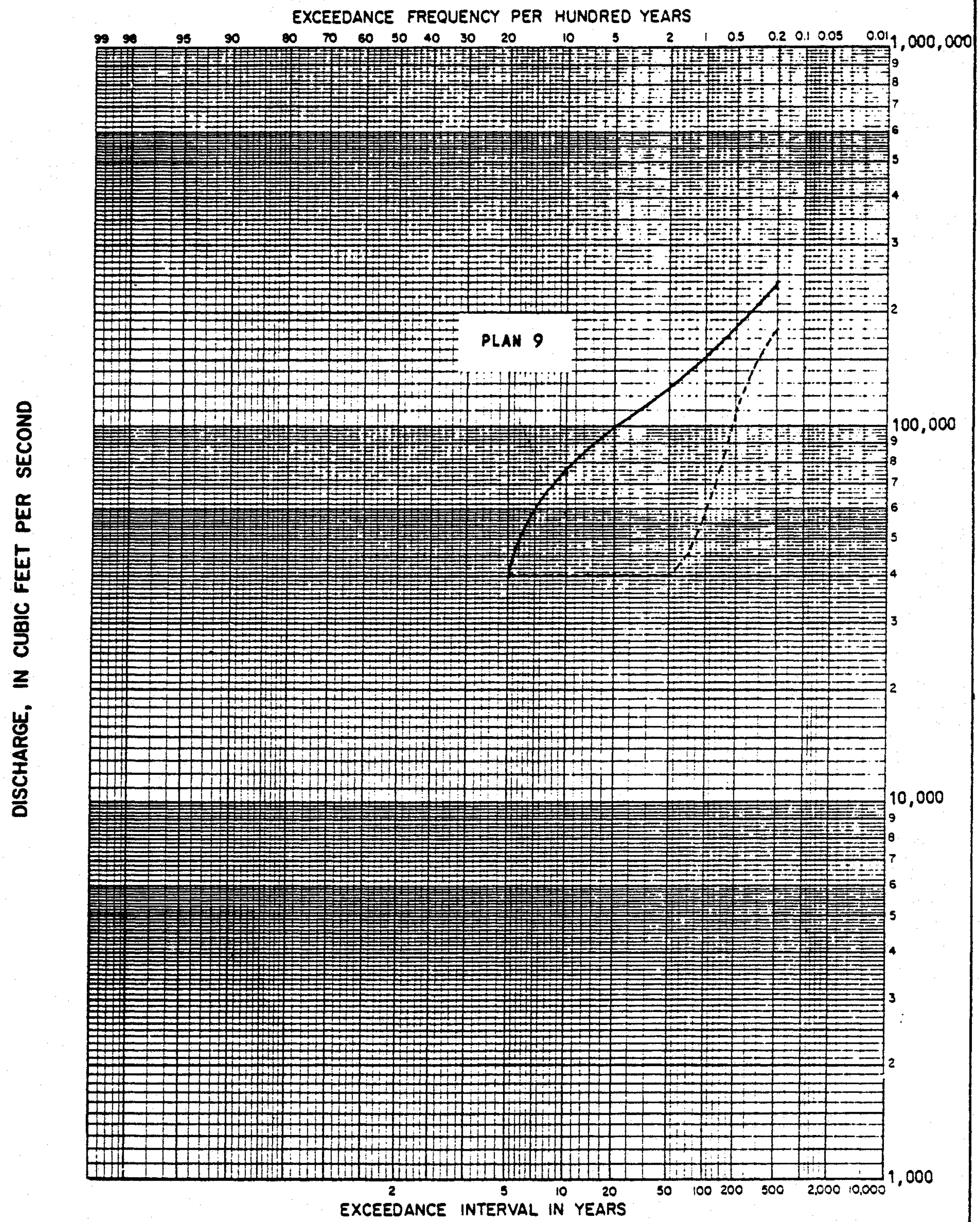
TARGET = 80,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




ALTERNATIVE = RHC1

DESIGN = 100-YEAR

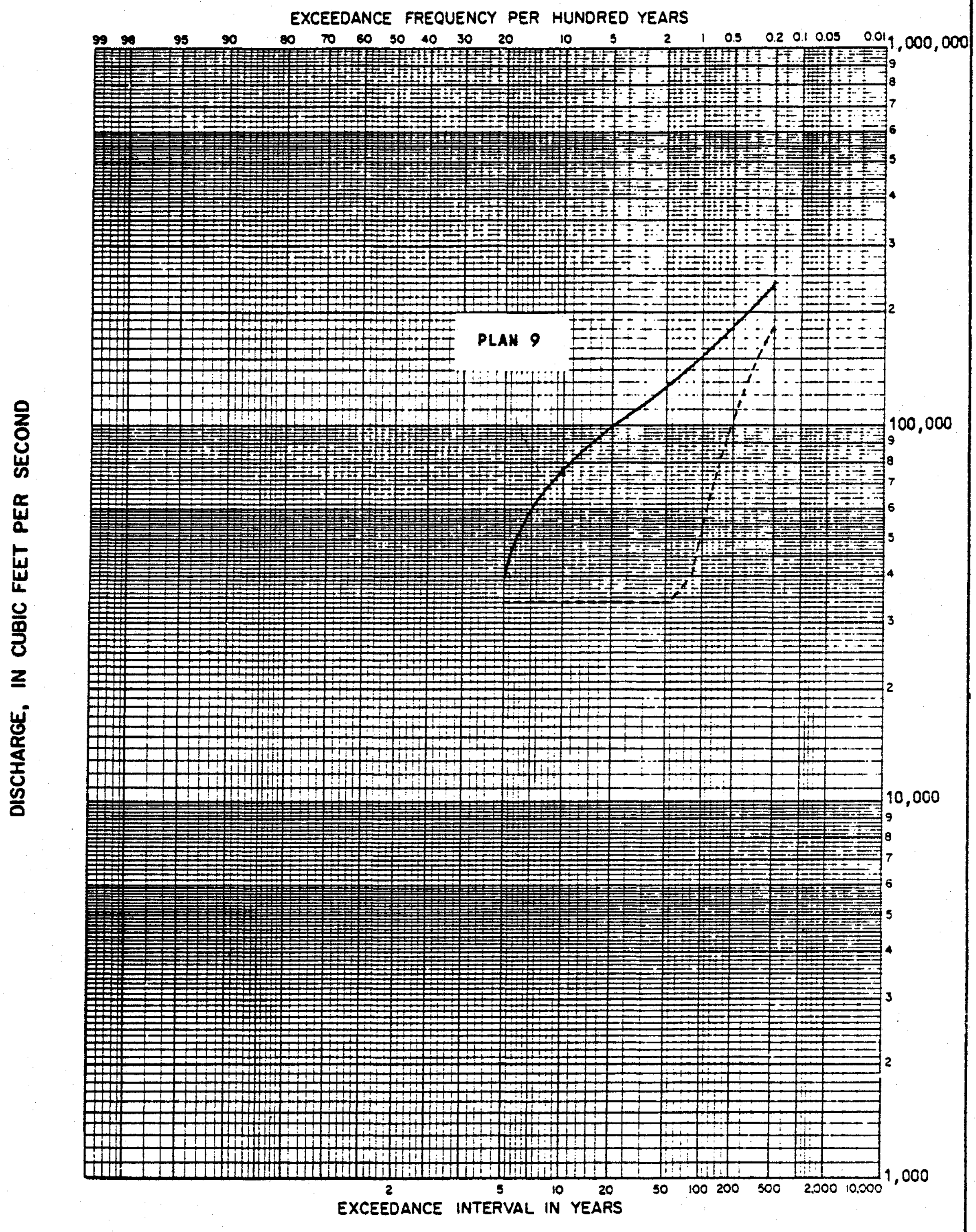
TARGET = 45,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT GILA RIVER
CP-113

U S ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT




**ALTERNATIVE =** RHD1

**DESIGN =** 100-YEAR

**TARGET =** 40,000 CFS

-------- WITH PROJECT FREQUENCY CURVE

GILA RIVER AND TRIBUTARIES
CENTRAL ARIZONA WATER CONTROL STUDY

DISCHARGE FREQUENCY CURVES
SALT RIVER
AT GILA RIVER
CP-113

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LOS ANGELES DISTRICT

# Appendix B Hydraulics

# SALT-GILA FLOODPLAIN ANALYSIS

# MARICOPA COUNTY, ARIZONA

U.S. ARMY CORPS OF ENGINEERS

SACRAMENTO DISTRICT

APRIL 1988

## TABLE OF CONTENTS



## LIST OF TABLES



## LIST OF FIGURES

# INTRODUCTION

## Purpose of Study

The U.S. Army Corps of Engineers, Los Angeles District, Hydraulics Section requested that the U.S. Army Corps of Engineers, Sacramento District, Hydrology Section perform a reconnaissance level overflow and floodway analysis of the Salt and Gila Rivers between Granite Reef and Gillespie Dams. The results of this study will be incorporated into the Bureau of Reclamation's "Study for Flood Control - Alternatives to Cliff Dam".

The Bureau is seeking a suitable alternative to Orme Dam which was strongly opposed for environmental reasons. Orme Dam was to store water for Phoenix users and for flood control on the Salt River. An alternative plan, Plan 6, was selected which called for, among other projects, the construction of Cliff Dam on the Verde River, a tributary of the Salt River. Cliff Dam, however, also was opposed because of adverse impacts on nesting bald eagles of the Sonoran Desert. The Bureau, therefore, is considering alternative to Cliff Dam. Updated overflow and floodway boundaries from this study will be compared with those of various flood control alternatives to evaluate potential benefits.

## Scope

Approximately 75 miles of river are modelled by 615 cross-sections, from Granite Reef Dam on the Salt River downstream to Gillespie Dam on the Gila

River. The wide floodplain of this reach is comprised of mostly sand, gravel, cobble, and thick vegetation, and is susceptible to scour and sediment deposition. Indeed, floodplain topography changes after flood flows are conveyed. Levees protect urban Phoenix on both North and South banks of the Salt River along a channelized downtown reach.

**Resources**

The Los Angeles District sent the Sacramento District seven roll of reproducible maps, one roll of United States Geological Survey (USGS) quadrangles, four HEC-2 computer models and their accompanying output, and a list of changes to be incorporated into the models to reflect current conditions. The HEC-2 models and reproducible maps, which span the entire 75-mile reach, originated from previous Maricopa County Flood Insurance Studies by the U.S. Army Corps of Engineers, Los Angeles District, and by two consulting engineering firms for the Maricopa County Flood Control District.

**General Procedure**

Sacramento District revised the HEC-2 models to reflect current conditions, interpreted the model output, then drew overflow and floodway boundaries on blue lines which were copied from the reproducible maps. A second 7-roll set of reproducible maps was copied from the first set. Finally, after revising the overflow and floodway boundaries on the blue lines, the overflow and floodway boundaries were carefully traced onto their respective set of reproducible maps.

Following is a detailed description of both overflow and floodway models, and a discussion of their implications. Numerous tables and figures enhance the study description.

## OVERFLOW MODEL

### Overflow Modelling Procedure

The first phase of the Salt-Gila River floodplain analysis was the overflow analysis. In the analysis five subcritical water surface profiles were computed by four HEC-2 overflow models (Figure 1).

Five water surface profiles were computed from 25-year, 50-year, 100-year, 200-year, and 500-year flows developed by the Los Angeles District (Table 1). Note the smaller flows at the downstream reaches because of the routing effect, and the increase in flow at the Salt-Gila River confluence. Flows were assumed to be identical at cross-sections within a given reach.

Beginning with the most downstream model, GILAOF, the water surface profiles were computed by the standard-step method. The five starting water surface elevations of GILAOF were the critical water surface elevations at Gillespie Dam for the starting flows. The ending water surface elevations of GILAOF became the starting water surface elevations of the next upstream model, VERNOF. This "linking" process continued for upstream models SALTMOF and USALTOF to yield five continuous water surface profiles up to Granite Reef Dam.

### Model N-Values

The Manning n-values adopted for the overflow models were generally those n-values used in previous Salt-Gila River Studies. GILAOF used n-values from a 1987 study by the consulting engineering firm Dames and Moore while VERNOF and

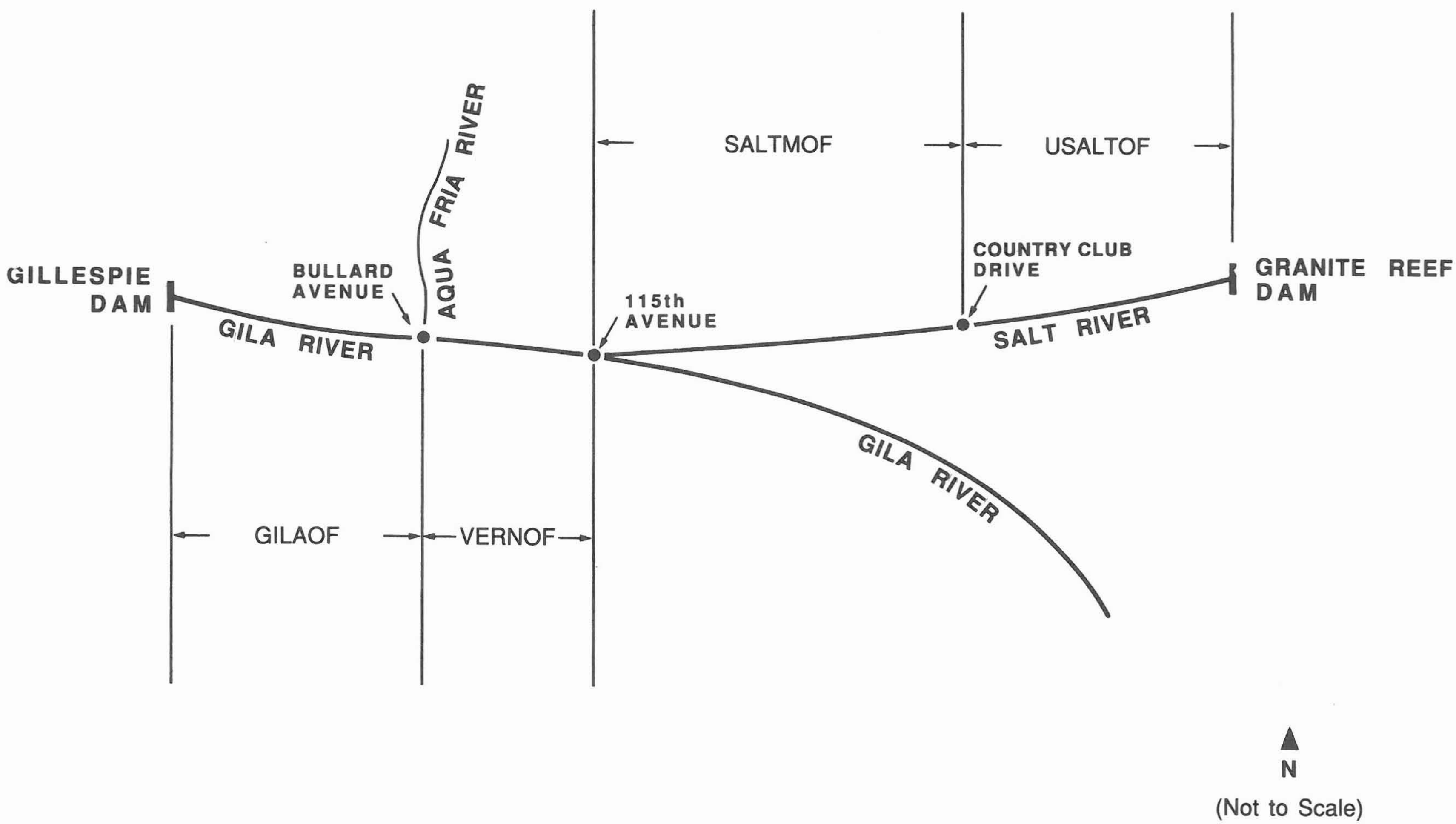


**Figure 1**
Salt-Gila River Overflow Models

**Table 1**

Flow-Frequency Values for Salt and Gila Rivers
Central Arizona Water Control Study (CAWCS) Plan 6, without Cliff Dam

| | Return Period | | | | |
|---|---|---|---|---|---|
| | 500-yr | 200-yr | 100-yr | 50-yr | 25-yr |
| **Salt River** | | | | | |
| below confluence with Verde River | 310,000 | 245,000 | 185,000 | 150,000 | 120,000 |
| at Gilbert Road | 265,000 | 215,000 | 170,000 | 140,000 | 115,000 |
| at Tempe Bridge | 265,000 | 215,000 | 170,000 | 140,000 | 115,000 |
| at Central Avenue | 265,000 | 215,000 | 170,000 | 140,000 | 115,000 |
| at 67th Avenue | 260,000 | 210,000 | 165,000 | 135,000 | 110,000 |
| above confluence with Gila River | 250,000 | 200,000 | 165,000 | 130,000 | 110,000 |
| **Gila River** | | | | | |
| below confluence with Salt River | 315,000 | 250,000 | 200,000 | 140,000 | 110,000 |
| below confluence with Waterman Wash | 305,000 | 245,000 | 195,000 | 138,000 | 106,000 |
| below confluence with Hassayampa River | 300,000 | 240,000 | 190,000 | 134,000 | 103,000 |
| at Gillespie Dam | 290,000 | 235,000 | 186,000 | 129,000 | 100,000 |

**Note:** These values were used to develop the overflows. Discharge-Frequency values have since been revised.

SALTOF used n-values from a 1984 Maricopa County flood insurance study. Some channel n-values in VERNOF and SALTMOF were reduced to reflect channel clearing. Some Manning n-values adopted for USALTOF were those used in a 1986 study by the consulting engineering firm Burgess and Niple, but many were not adopted because the Burgess and Niple n-values were judged too low. Higher n-values were subsequently chose. Manning n-values were coded predominantly on NH records in GILAOF and USALTOF and predominantly on NC records in VERNOF and SALTMOF. Table 2 compares average n-values from this reconnaissance study to average n-values from four previous Salt-Gila River studies.

**Model Cross-Sections**

Cross-sections in SALTMOF and USATOF were numbered according to their river mile location while cross-sections in GILAOF and VERNOF were numbered by some other system, a system developed by the original modelers. Table 3 compares the cross-section stationing of this reconnaissance study to the cross-section stationing of an older Salt-Gila River study, the 1980 CAWCS study. Cross-sections were numbered exclusively by river miles in the CAWCS study. Note the 2.316 mile (39.116 mile - 36.8 mile) additional centerline alignment of the Salt River for this reconnaissance study.

Most cross-sections were described by four or five-year-old digitized data obtained from aerial surveys. Many cross-sections of VERNOF were described by more points than the 100-point maximum permitted by the HEC-2 program. Therefore, modifications were made to the program to allow 300 points per cross-section.

## Table 2

Comparison of Average N-Values (in thousandths)
Computed by Non-Weighted Averaging of All NC Records, Ignoring All NH Records

| | Channel | | | | | Left Overbank | | | | | Right Overbank | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | A | B | C | D | E | A | B | C | D | E | A | B | C | D | E |
| Gillespie Dam to Arlington Road | * 40 | ** 45 | -- | -- | 30 | * 35 | 50 | -- | -- | 50 | * 35 | 50 | -- | -- | 50 |
| Arlington Road to Salt-Gila River Confluence | * 45 | ** 45 | -- | -- | 30 | * 50 | 50 | -- | -- | 43 | * 48 | 50 | -- | -- | 43 |
| Salt-Gila River Confluence to Dobson Road | * 45 | -- | -- | 33 | 33 | * 45 | -- | -- | 45 | 44 | * 37 | -- | -- | 44 | 43 |
| Dobson Road to Granite Reef Dam | * 46 | -- | 31 | -- | 33 | * 50 | -- | 34 | -- | 38 | * 35 | -- | 32 | -- | 38 |

A 1980 CAWCS
B 1987 Dames & Moore Study
C 1986 Durgess & Niple Study
D 1984 Maricopa County Flood Insurance Study (FIS)
E 1987 Corps Reconnaissance Study (CRS)

* Not computed, see Reference 1
** Not computed, see Reference 2

**Table 3**

Cross-Section Stationing
1987 CRS
vs
1980 CAWCS

| Reach | 1987 CRS Stationing | Study Derived From | 1980 CAWCS Stationing |
|---|---|---|---|
| Gillespie Dam to Bullard Avenue | 45-386 | 1987 Dames & Moore | |
| | | | * >64.1-100.0 |
| Bullard Avenue to 115th Avenue | 189.07-193.5 | 1984 Maricopa Cnty FIS | |
| 115th Avenue to Country Club Drive | ** 0-28.358 | 1984 Maricopa Cnty FIS | |
| | | | ** >0-36.8 |
| Country Club Drive to Granite Reef Dam | 28.358-39.116 | 1986 Burgess & Niple | |

* Gila river miles
** Salt river miles

## Model Centerline Stationing

The centerline station for most cross-sections of GILAOF and USATOF was arbitrarily chose as 10,000 feet while the centerline station for most cross-sections of VERNOF was arbitrarily chosen as 20,000 feet. Model SALTMOF had a centerline station of 20,000 feet up to cross-section 13.627 and 10,000 feet thereafter. Some cross-sections near bridges and elsewhere had different stationing and thus a centerline other than 10,000 feet or 20,000 feet.

## Overflow Model Changes

Many changes were made to the four overflow models to reflect current conditions in the Salt-Gila study reach (Table 4). Table 4 lists the physical changes in the study reach and, to reflect those changes, lists the corresponding model changes. The changes include channel clearing near the Salt-Gila River confluence, new levees on the Salt and Gila Rivers, two new bridges, channel excavation at one downtown Salt River reach, and filling low ground at a South bank development.

## Problems Encountered

Problems were encountered, as could be expected, over the long 75-mile study reach. The major problem was the lack of compatibility between the models digitized cross-sections and the maps' representation of those cross-sections. The maps, having either 4-foot or 5-foot elevation contours, were

**Table 4**

List of Changes to Salt and Gila Rivers

| Physical Change | Location | Model Change |
|---|---|---|
| North Bank Levee | 113th Ave to 123rd Ave | X3 records added |
| 1000-Foot-Wide Channel Clearing | 91st Ave to Bullard Ave | "n" reduced to .03 |
| South Bank Levee | 35th Ave to 51st Ave | X3 records added |
| 7th Ave Bridge | 7th Ave | SB record added |
| North Bank Industrial Development | 7th St to 16th St | "n" reduced to .03 |
| Calmat Mining | 16th St to I-10 | X3 records added, GR elevations reduced |
| I-10 Bridge | I-10 | SB record added |
| Denro South Bank Development | I-10 to Airport Levee | "n" reduced to .03, GR elevations raised |
| Calmat North Bank Levee | I-10 to Airport Levee | GR elevations raised |

not nearly as detailed as the digitized data, which measured elevations to the nearest tenth of a foot. Therefore, when plotting overflow inundation boundaries by locating on the maps the water surface elevations from the HEC-2 output, some water surface topwidths from the HEC-2 output did not correspond the topwidths plotted on the maps. This discrepancy in topwidths was generally alleviated by either elimination non-effective flow areas (using ET or X3 records) for model topwidths greater than map topwidths, or by extending cross-sections for model topwidths smaller than map topwidths. Many, but not all, topwidth discrepancies were resolved.

For unexplained reasons, some cross-sections in the models were totally different from their corresponding cross-section on the maps and were dealt with as above. If the above adjustment did not reduce the topwidth discrepancy, then the digitized cross-sections were assumed good and the map contours assumed bad and, consequently, some map contours were ignored. Another problem was that some HEC-2 output revealed overflow inundation boundaries so wide that they could not be plotted on the existing maps. Additional topography was needed to extend cross-sections and overflow boundaries. USGS quadrangles were used to fill in missing floodplain areas, allowing overflow boundaries a few miles wide to be drawn. The USGS quadrangles, however, could not be easily spliced with the existing overflow maps because they lacked detail. The USGS quadrangles contained few landmarks to orient them adjacent to the existing overflow maps. The 10-foot elevation contours did not match well with the 4-foot or 5-foot contours on the existing maps. Still, the USGS quadrangles were added to the existing maps to complete the drawing of overflow boundaries at wide floodplain areas.

## Overflow Maps

With the overflow inundation boundaries drawn on blue lines throughout the 75-mile Salt-Gila study reach, the only remaining task was to trace the boundaries onto the seven rolls of reproducible overflow maps. All maps had a scale of one inch equal to 400 feet and, as mentioned earlier, either 4-foot or 5-foot contours, except for the USGS maps which had 10-foot contours. Table 5 describes all maps used in the study.

Before tracing the overflow boundaries, overflow and floodway boundaries from previous studies had to be erased from the reproducible maps first. The cross-sections from the previous studies, however, were left on the maps since their orientation did not change for this study. Small, insignificant islands were not traced onto the reproducible maps. Gila and Salt river miles were labelled on the channels centerline at one-mile intervals. Finally, when two or more overflow boundaries coincided, only the symbol for the boundary of the rarer event was shown. For example, if the 500-year, 200-year, and 100-year overflow boundaries were indistinguishable, only the symbol for the 500-year boundary was shown.

## Overflow Results

The final overflow maps show some interesting results. While all five flood events were generally contained, the 100-year, 200-year, and 500-year floods spread far into the floodplain at some locations. The 500-year flood, as expected, exhibited the most severe breakouts.

## Table 5

List of Salt and Gila River Topographic Maps

| Reach | Developed by | Features |
| --- | --- | --- |
| Gillespie Dam to Arizona Highway 85 | Kenney Aerial Mapping, 1984 | 1 in.=400 ft, 4-ft contours |
| Arizona Highway 85 to Bullard Avenue | Aerial Mapping Company, 1984 | 1 in.=400 ft, 4-ft contours |
| Bullard Avenue to 115th Avenue | ------------------ | 1 in.=400 ft, 4-ft contours |
| 115th Avenue to Central Avenue | City of Phoenix, 1983 | 1 in.=400 ft, 4-ft contours |
| Central Avenue to Scottsdale Road | Arizona Dept of Trans, 1983 | 1 in.=400 ft, 5-ft contours |
| Scottsdale Road to Country Club Drive | Arizona Dept of Trans, 1983 | 1 in.=400 ft, 5-ft contours |
| Country Club Drive to Granite Reef Dam | Kenney Aerial Mapping, 1984 | 1 in.=400 ft, 4-ft contours |
| Complete reach, for extensions | U.S. Geological Survey | 1 in.=400 ft, 10-ft contours |

One breakout occurred at about Salt River mile 33.2. A flow of about 11,000 cfs was estimated to be leaving the main flood channel, which conveyed the remaining 254,000 cfs. The 11,000 cfs estimate came after reviewing the HEC-2 flow distribution at Salt River mile 33.2.

The breakout water flowed Southwest into the Southern Salt River Floodplain, inundating such roads as McDowell, McKellips, and Lehi. The water was finally contained by a ridge after flowing more than 8,000 feet from the Salt River main channel, sending water into Alma School Road at about river mile 27.3. There, the water ponded and returned to the main flood channel.

Table 6 shows the computed water surface elevations of the main flood channel and the overbank "channel" at five Salt River cross-sections. The water surface elevations of the main channel were computed by the HEC-2 model USATOF. The water surface elevations of the overbank "channel" were initially computed by selecting five broad rectangular cross-sections approximately 3,500 feet apart, computing normal depth, and adding that depth to the invert elevation for each of the five cross-sections (see computations in Figure 2). These water surface elevations were later refined by specifying more detailed cross-sections in a small HEC-2 computer model.

Another breakout of the 500-year flow occurred just downstream of Mill Avenue at about Salt River mile 21.7. To determine the breakout flow, a 0.3-mile section of Hayden Road was assumed to act like a weir. This idealized weir then was coded into a small HEC-2 model using the split flow option. The output from this model showed a flow of about 8,000 cfs split into the Southern Salt River Floodplain and about 257,000 cfs remained in the main channel.

**Table 6**

500-Year Water Surface Elevations of Left Overbank and Main Channel
Salt River Miles 29.2 - 32.3

| Cross-Section | Left Overbank Water Surface Elevation | Previous Estimate of Left Overbank Water Surface Elevation | Main Channel Water Surface Elevation |
|---|---|---|---|
| 1 (river mile 29.2) | 1225.26 | 1227.1 | 1223.86 |
| 2 (river mile 29.8) | 1232.17 | 1231.1 | 1227.11 |
| 3 (river mile 30.5) | 1238.71 | 1238.9 | 1236.83 |
| 4 (river mile 31.6) | 1246.19 | 1224.0 | 1246.50 |
| 5 (river mile 32.3) | 1253.09 | 1253.3 | 1252.14 |

## Figure 2

**Computation Of Overbank Water Surface Elevations**
**Salt River Miles 29.2-32.3**

| Cross-Section No. | Length | Approximate Slope | Invert |
|---|---|---|---|
| 1 | 5,000 ft | 8/3700=0.00216 | 1226 ft |
| 2 | 5,200 ft | 4/2400=0.00167 | 1230 ft |
| 3 | 6,800 ft | 8/3500=0.00229 | 1238 ft |
| 4 | 6,400 ft | 5/3000=0.00167 | 1243 ft |
| 5 | 3,800 ft | 6/3000=0.00200 | 1252 ft |

**Q = 11,000 cfs**
**n = 0.035**

**Normal Depth Calculations**

$Q = (1.49/n)by^{5/3}s^{1/2}$ (For wide rectangular channels)

$y^{5/3} = Qn/(1.49bs^{1/2})$

**Section 1**
$y^{5/3} = 11000(0.035)/1.49(5000)(0.00216^{1/2})$
$y = 1.1$ ft
WSEL = 1226 + 1.1 = 1227.1 ft

**Section 2**
$y^{5/3} = 1.216$
$y = 1.1$ ft
WSEL = 1230 + 1.1 = 1231.1 ft

**Section 3**
$y^{5/3} = .794$
$y = .9$ ft
WSEL = 1238 + 0.9 = 1238.9 ft

**Section 4**
$y^{5/3} = 0.988$
$y = 1.0$ ft
WSEL = 1243 + 1.0 = 1244.0 ft

**Section 5**
$y^{5/3} = 1.520$
$y = 1.3$ ft
WSEL = 1252 + 1.3 = 1253.3 ft

The breakout water flowed westerly, flanking a levee beginning at about river mile 20.9 and inundating a South bank development by Denro, Ltd. The water flowed until it ponded against Interstate 10 and funneled back into the main flood channel at about river mile 16.9.

Table 7 shows the computed water surface elevations of the main flood channel and of the overbank "channel" at five cross-sections. The water surface elevations of the main channel were computed by the HEC-2 model SALTMOF while the water surface elevations of the overbank "channel" were computed by coding five overbank cross-sections into another small HEC-2 computer model.

At about Salt River mile 6.0 (near 67th Avenue), still another breakout of the 500-year flow occurred. Water flowed south of Baseline Road and over 10,000 feet into the southern Salt River Floodplain. High found eventually returned the water to the north side of Baseline Road around Salt River mile 4.5.

Other breakouts were determined over the 75-mile Salt-Gila study reach but are not discussed here. Instead, the reader is urged to review the Salt-Gila overflow maps.

## Table 7

500-Year Water Surface Elevations of Left Overbank and Main Channel
Salt River Miles 17.909 - 20.913

| Cross-Section | Left Overbank Water Surface Elevation | Main Channel Water Surface Elevation |
|---|---|---|
| 17.909 | 1114.64 | 1113.45 |
| 18.682 | 1131.66 | 1124.21 |
| 19.446 | 1136.98 | 1133.05 |
| 20.152 | 1137.98 | 1142.13 |
| 20.913 | 1148.66 | 1151.06 |

## FLOODWAY MODEL

### Floodway Modelling Procedure

The second phase of the Salt-Gila River floodplain analysis was the floodway analysis. Like the overflow analysis, the 75-mile Salt-Gila study reach was broken into four HEC-2 computer models. Beginning with the four HEC-2 overflow models - GILAOF, VERNOF, SALTMOF, and USATOF, revisions were made to obtain four floodway models. Each of the four floodway models was further broken into four separate models, one for each of four flows, for a total of 16 HEC-2 floodway models (Figure 3). These 16 floodway models computed four floodway boundaries and their corresponding subcritical water surface profiles for constant flows of 170,000 cfs, 130,000 cfs, 90,000 cfs, and 55,000 cfs throughout the Salt-Gila study reach. Only one flow per model could be used, otherwise, while individual water surface profiles would be correct, the floodway tables would be incorrect because water surface profiles of unlike flows would be compared.

Beginning with the 170,000 cfs downstream model, GILAFW1, two water surface profiles were computed - a water surface profile of a natural, unencroached floodplain, and a water surface profile of an encroached floodplain. The water surface profile of the natural floodplain was computed by the standard-step method first. GILAFW1 could then determine the floodway boundaries and water surface profile of an encroached floodplain by reducing conveyance equally from both sides of the floodplain until the water surface at each cross-section had raised no more than one foot higher than the natural

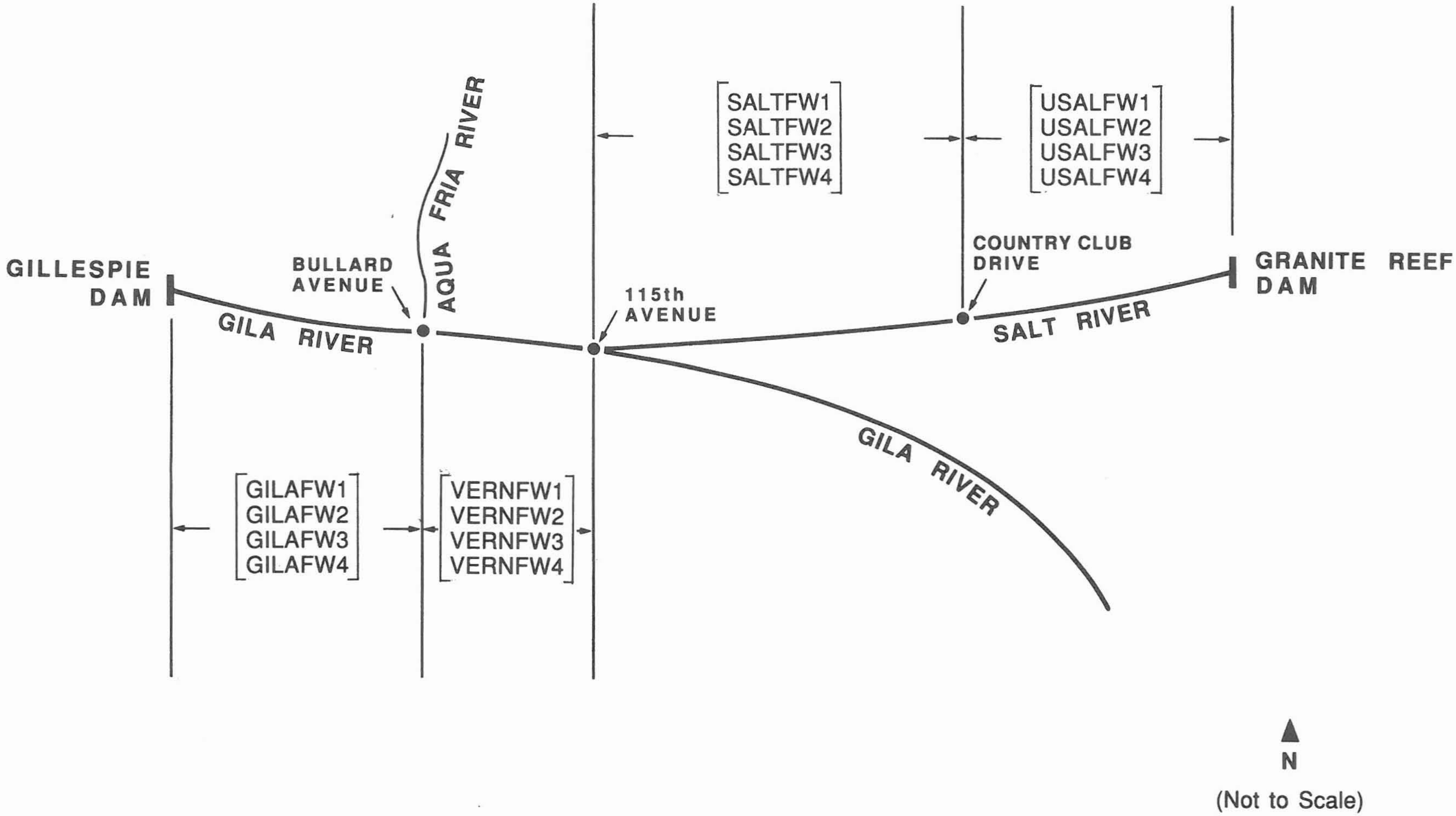


**Figure 3**
Salt-Gila River Floodway Models

water surface. That algorithm is HEC-2 encroachment Method Four, the equal conveyance reduction method with a one-foot target value.

The starting water surface elevation of GILAFW1 for the natural profile was the critical water surface elevation at Gillespie Dam for a flow of 170,000 cfs. The starting water surface elevation of GILAFW1 for the floodway profile, however, was assumed to be the target of one foot higher than the natural starting water surface elevation. The ending water surface elevation of GILAFW1 became the starting water surface elevation of the next upstream model, VERNFW1. Like with the overflow models, this "linking" process continued with the upstream models to yield a continuous floodway water surface profile up to Granite Reef Dam.

A similar procedure was used with the 12 other floodway models to compute water surface profiles of the three additional floodways having constant flows of 130,000 cfs, 90,000 cfs, and 55,000 cfs.

**Floodway Model Adjustments**

A few adjustments to the floodway models were necessary to compute the four floodways using encroachment Method Four. First, since Method Four dose not allow encroachments in the channel portion of a floodplain, left and right bank stations were artificially moved within about 100 feet of the channel centerline at many cross-sections with wide channels, creating a narrower channel and thus a wider portion of the floodplain that could be encroached. More of the floodplain was available for achieving the desired one-foot water surface increase.

When the bank stations were artificially moved closer to the channel centerline, Manning n-values for the left and right overbanks had more impact on the composite n-value than the channel n-value at these cross-sections. This of course, does not reflect the actual roughness at such cross-sections. An NH record, therefore, was added to these cross-sections to simulate the roughness of the original, unaltered cross-sections.

Finally, GR points and X3 records were eliminated from cross-section with X3 records. GR points were deleted from either or both ends of these cross-sections to eliminate the non-effective flow areas of the floodway models. Method One encroachments could not be used to eliminate the non-effective flow areas because they would apply only to the natural profiles and not also to the floodway profiles. Therefore, the equal conveyance reduction of encroachment Method Four would occur in non-effective flow areas, resulting in incorrect HEC-2 floodway calculations. The X3 records also were eliminated, otherwise X3 encroachments would override the Method Four encroachments computed for the four floodway profiles.

Two additional adjustments were made to the floodway models to refine the floodway boundaries. One adjustment was to make the target value greater than or less than one foot when the computed floodway water surface elevation far from the one-foot target. The target value was made greater one for when the computed floodway water surface elevation was less than one foot higher than the natural water surface elevation, and was made less than one foot when the computed floodway water surface elevation was greater than one foot higher. Another adjustment was to use encroachment Method Five which, essentially, is the same as encroachment Method Four except than an optimization procedure is used.

## Problems Encountered

Problems also were encountered with the floodway models. Since the floodway models were derived from the overflow models, the lack of compatibility also existed between the models digitized cross-sections and the maps representation of those cross-sections. For example, at some cross-sections the left and right bank stations had values greater than the center line value of 10,000 feet. This, of course, made no sense since the left bank station should be less than 10,000 feet, and contradicted estimates of the bank stations taken from the maps.

These unusual bank stations allowed the plotting of starting and ending floodway stations greater than 10,000 feet and, consequently, floodway boundaries that did not encompass the channel centerline. Upstream and downstream floodway boundaries were used, and the floodway widths of the problem cross-sections were used to help determine the floodway boundaries at such problem cross-sections.

Another problem, as could be expected, was the inability to compute floodway water surface elevations that were exactly one foot higher than the natural water surface elevations. While many floodway water surface elevations of the 75-mile Salt-Gila study reach did compute to within 0.1 feet of the one-foot target rise, some others did not. This means that some areas outside the computed floodway boundaries are less susceptible to flooding and other areas are more susceptible.

**Floodway Maps**

The four floodway boundaries were drawn on another set of blue lines made from the same seven rolls of reproducible maps as were the overflow blue lines. Some computed floodway starting and ending stations were ignored to permit the drawing of continuous, smooth floodway boundaries. These floodway boundaries were then traced onto the floodway set of reproducible maps. The lack of time and money for this preliminary reconnaissance study prevented more refined floodway boundaries from being computed.

**Floodway Results**

Contrary to the overflow inundation boundaries, the four floodway inundation boundaries did not extend far into the Salt and Gila River floodplains. The very nature of the floodway computations was to see how close to the channel development could extend. Also, the maximum floodway flow of 170,000 cfs was much less than the maximum overflow flow of between 250,000 cfs and 315,000 cfs.

## CONCLUSION

The U.S Army Corps of Engineers, Sacramento District performed a reconnaissance level overflow and floodway analysis of the Salt and Gila Rivers between Granite Reef and Gillespie Dams. The overflow analysis showed that flows as rare as the 500-year flow were generally contained, except at some locations where the 500-year flow spread extensively into the floodplain. The overflow maps are reasonable compatible with overflow maps from previous U.S. Army Corps of Engineers, Los Angeles District and Maricopa County Flood Control District studies, and tend to show less extensive overflow boundaries.

The floodway analysis defined floodway boundaries for flows of 170,000 cfs, 130,000 cfs, 90,000 cfs, and 55,000 cfs. These boundaries were much narrower than the overflow boundaries, and tended to be narrower than the floodway boundaries from previous studies. Hopefully, the results from this reconnaissance study will be valuable in helping to identify economically feasible flood control alternatives to Cliff Dam, if any.

## REFERENCES

1. Salt and Gila River Hydraulic Analysis for Central Arizona Water Control Study, 1980.

2. Dames & Moore Gila River Report, 1987.

3. Federal Emergency Management Agency Flood Insurance Study of Maricopa County Streams, 1984.

4. Burgess & Niple Salt River Flood Delineation Study, 1987.

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6. Memorandum for Record, Salt and Gila River 100-Year, 500-Year, and SPF Overflow Study, 1980.

# Appendix C Economics

# ECONOMIC SUPPLEMENT
# FOR THE ALTERNATIVE TO
# CLIFF DAM STUDY

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
JULY 1988

# TABLE OF CONTENTS



## LIST OF TABLES



## LIST OF FIGURES

## INTRODUCTION

This economic supplement presents a reconnaissance level benefit analysis of flood control improvements on the Verde River in Arizona. Specifically, flood control storage at two existing dams, Horseshoe and Bartlett, were evaluated as an alternative to Cliff Dam. Cliff was a proposed water supply and flood control dam recommended by the Secretary of the Interior as one of four structural elements in Central Arizona Water Control Study (CAWCS) Plan 6. Cliff Dam became the subject of controversy principally because of its potential adverse impacts on Sonoran desert nesting bald eagles and their habitat. Increasing opposition from a coalition of eleven national and local environmental organizations resulted in an agreement being reached between the Arizona Congressional delegation and the environmental coalition eliminating funding for the study or construction of Cliff Dam or similar water conservation storage feature on the Verde River. The agreement further directed that the U.S. Army Corps of Engineers will be requested to undertake studies required to determine and identify appropriate flood control measures on the Verde River.

## STUDY APPROACH

The economic analysis presented in this supplement was conducted at a reconnaissance level. The purpose of the analysis is to see if flood control measures could be justified on the Verde River. The analysis assumes all other elements of CAWCS Plan 6 are in place. Flood control improvements on the Verde are evaluated last-added to the other elements in Plan 6.

The original analysis demonstrated that the location benefit category was the most influential due to the size, location and demand for floodway lands through the communities of Mesa, Tempe and Phoenix. Consequently, much of the effort put forth in this study was directed at providing a more accurate estimate of location benefits. Additionally, a new analysis was conducted of inundation damages and benefits due to the significant changes in hydraulics and hydrology. This analysis made use of Salt River Project's Land Use Model (LUM) in combination with a tax assessor-based real estate information database, to develop the inundation reduction data. For other categories of benefits, updates were first made for price level changes then modifications to existing flow-damage relationships were made to account for the changes in hydrology. The analysis uses the current Water Resource Council Discount Rate of 8 5/8% for all benefit assessments and a period of analysis of 100 years.

## STUDY AREA

The economic study area encompasses the floodplain along the Salt River from Granite Reef Dam to its confluence with the Gila River and along the Gila River to Gillespie Dam. The original flood control benefit analysis was performed by subdividing the study area into nine economic reaches. The nine reaches are defined as follows:

Reach 1 - Granite Reef Dam to Country Club Rd.

Reach 2 - Country Club rd. to Pima Rd.

Reach 3 - Pima Rd. to 48th Street

Reach 4 - 48th Street to I-10

Reach 5 - I-10 to 35th Avenue

Reach 6 - 35th to the confluence with the Gila River

Reach 7 - The confluence to 115th Ave.

Reach 8 - 115th Ave. to Old Route U.S. 80

Reach 9 - Old Route U.S. 80 to Gillespie Dam

The reaches for the current analysis remain the same with the exception of the combination of reaches 7 through 9 into one reach for damage analysis purposes.

## ALTERNATIVE EVALUATION

The Bureau of Reclamation requested the COE to evaluate 4 levels of flood control storage on the Verde River with three flood outlets each. However, several alternatives cannot be distinguished due to hydrologic considerations. The final plans evaluated are:

RHD - 465k acre feet storage with 25, 60 or 100k outlet

RHC - 300k acre feet storage with 25, 60 or 100k outlet

RHB2/3 - 200k acre feet storage with 60 or 100k outlet

RHB1 - 200k acre feet storage with 25k outlet

RHA3 - 100k acre feet storage with 100k outlet

RHA2 - 100k acre feet storage with 60k outlet

RHA1 - 100k acre feet storage with 25k outlet

## PREVIOUS STUDIES

Several previous flood control benefit assessments have been conducted in the study area. Data from three of these studies is used in this analysis. The Central Arizona Water Control Study (CAWCS) examined all reasonable alternatives to provide regulatory storage for the Central Arizona Project (CAP) water and flood control along the Salt and Gila Rivers. The Corps of Engineers participated in the study and was responsible for the flood control planning and analysis. The study was completed in

1981 and recommended CAWCS/Plan 6.

Two additional studies, completed in November 1986 and March 1987, evaluated the effects of changes in hydraulic conditions demonstrated by the new FEMA Flood Insurance Maps. The first paper explained the effects the changed conditions had on inundation reduction benefits and made adjustments to the original analysis for physical improvements such as larger bridges and levee protection around Sky Harbor Airport. The flow-damage relationships that resulted from these adjustments are used in the current analysis for minor benefit categories. The second work provided a thorough analysis of location benefits including an in-depth estimation of expected property values which is used in the current analysis.

**OVERFLOW CHARACTERISTICS**

The overflow analysis demonstrates that all five routed flood events, the 25-year, 50-year, 100-year, 200-year and 500-year were generally contained. Some breakouts do occur; the 500-year naturally being the most severe. However, flood flows in recent years have deepened the river channel. In addition, there have been numerous levees, dikes, channels and bridges constructed or modified to withstand large flows. Both of these factors have resulted in a significant narrowing of floodplains through metropolitan Phoenix.

## FLOOD CONTROL BENEFITS

The benefits of flood hazard reduction plans are based on a careful analysis of the difference in the with and without project conditions. The without project condition is the land use and related conditions likely to occur under existing improvements, laws, and policies. The with project condition is the most likely condition expected to exist in the future if a specific project is undertaken. The changes in the with and without project condition are the benefits to the project.

### Location Benefits

Location benefits occur when a reduction in the level of flood risk makes it possible for a new activity to locate in the floodplain. In this study location benefits occur only in land freed for development, the acreage between the with and without project floodways as defined by the current hydraulic analysis.

#### Methodology

To determine location benefits the market value of land method was used. The market value method assumes the value of property will increase by an amount equivalent to the increase in net income. To determine market values, local appraisers were contacted and provided land values for similar developable sites rendered out of the floodway. Care was taken to obtain values of similar unimproved areas lacking infrastructure. These values were then compared to recent sales information from Maricopa County. Current fair market value of floodway land ($5,000 per acre) was also provided by the Assessor. The difference between developable land and floodway land values is the net increase per acre.

Adjustments to the net increase per acre must be made to calculate the location benefit. First, all without project floodway acreage is assumed to remain in the FEMA designated 100 year floodplain. Since development in floodplains is precluded by FEMA regulations unless the development is elevated on fill above the 100-year water level, the cost of fill must be subtracted from the net increase per acre. Additionally, since removal of floodway restrictions induces development into floodplains and since location benefits hinge on the assumption that land values capitalize expected flood damages, the expected flood damages from the induced development must also be subtracted.

To evaluate the effects of alternate plans, location benefits were analyzed for four floodways including the without project 170,000 cfs. A location benefit - 100-year discharge curve was produced (figure 3) using discharge at the Tempe Bridge as a reference point. Location benefits were then determined by comparing the plan's 100-year discharge at the Tempe Bridge to the benefit curve.

Conclusions

In many areas, the change in with and without project floodways did not produce areas large enough for development to take place. Location benefits were not claimed in ribbons of land less than 150 feet wide since their size precludes development. Additionally, parcel by parcel evaluations of all land free for development was not possible. Fill requirements or topographical constraints may make certain areas impossible to develop efficiently. Location benefits are summarized by reach in Table 2.

The location benefits analysis indicates there are considerably less location benefits than were estimated in the 1987 analysis. The decrease in location benefits result from four factors:

1) The inclusion of ADOT's proposed Tempe channel between Mill Avenue and I-10 eliminates significant vacant land previously claimed for location benefits. The channel is expected to be completed before 1995 (project year one) allowing these areas to develop regardless of any flood control storage on the Verde River. This change reduces annual benefits

approximately $1,400,000.

2) The previous analysis misidentified the boundary of the Salt River Indian Reservation and included location benefits on the reservation. Because the tribe has no legal requirement to follow FEMA land restrictions and because ample flood free land exists on the reservation, these benefits can not be claimed. This change reduces annual benefits approximately $1,500,000.

3) Demand for floodway areas in all parts of Reach 7 (confluence with the Gila River to 115th Ave) cannot be demonstrated at the present time. Although the Phoenix area is experiencing rapid development, the cost of fill requirements in this area would make any land value increase negligible at present. This change reduces annual benefits approximately $500,000.

4) Differences in the land available for development between the Corps generated floodway and the Maricopa County floodways used for the March 1987 analysis result in a decrease in higher valued devlopable land. Although the net difference in developable lands is not substantial, the Maricopa County floodways tend to place the larger openings of land in areas where the zoning is more favorable to development. An example would be the area around the 91st Street sewage treatment plant. The Maricopa County floodways show an area of land opening for development on the north side of the river, where the zoning is

low-density residential. The COE floodways show a similar parcel opening on the south side of the river. This land is on the Gila River Indian Reservation and not subject to location benefits. The net effect in the overall change in floodways is a reduction of approximately $600,000 in location benefits.

**Inundation Reduction Benefits**

Inundation reduction benefits result from reducing flood losses to activities which would use the floodplain without any plan. Inundation reduction benefits are measured as the reduction in the amount of flood damages or related costs. There are two general sub-categories of benefits under inundation reduction: General Property Inventory Benefits (where benefits depend on property inventory and hydraulic information) and Specific Case Benefits (where benefit information requires an in-depth analysis and additional information).

General Property Inventory Benefits

Inundation Reduction benefits were reanalyzed for this study. The analysis made use of the Salt River Project's Land Use Model (LUM). Land and improvement values were estimated by the LUM for the five flood inundation areas, form Granite Reef Dam to 180th Avenue. Input variables included tax assessor data purchased from the TRW Real Estate Information Services Division, land use acreage estimated by the LUM, and flood inundation boundaries provided by the COE.

Outlines of the five flood inundation areas were transferred to a form LUM could recognize:

- The 25, 50, 100, 200 and 500 year flood limits, determined by the COE, were color-coded on topographical maps.

- A series of LUM coordinates, forming a polygon for each of the flood areas within the LUM boundaries, was manually identified from the topographical maps and input to a file.

- The five flood polygons enabled the LUM to extract information from within the boundaries of each poly/flood area.

Tax assessed land and improvement values were separated into 98 improvement values were separated into 98 improvement codes. These 98 codes were aggregated into 11 major land use codes corresponding to the 11 major LUM land use classes:

-low-density residential

-medium-density residential

-high-density residential

-mobile homes

-low-density commercial

-medium-density commercial

-high-density commercial

-light industrial

-general industrial

-vacant available/agriculture

A problem arose with the use of data in the vacant / agriculture category. This category was found to include values for agriculture and sand and gravel operations. Standard depth-damage analysis cannot be performed on sand and gravel operations. In the 1981 analysis a flow-damage relationship was created for this area of benefits; however, it cannot directly relate value of property to damages. Additionally, agricultural structure damages were included as part of the 1981 agriculture flow-damage relationship. It is not possible to break the agricultural structure damages out of the other crop damages. The LUM does not distinguish between these two land uses which make up a high percentage of the improvement values in this category. Adjusted flow-damage relationships from the 1981 analysis were used to calculate damages in this category. The impact on the final benefit calculations is negligible.

TRW was requested to aggregate land and improvement values for Maricopa County to the section-level, a common denominator for the LUM land use data and the tax assessor database. Since the LUM is measured in 40-acre parcels, the section-level land and improvement values were disaggregated to the 40-acre parcel level. (Tax parcel-level data could not be aggregated to a forty-acre parcels level because a tax parcel is more likely to overlap two forty-acre parcels and a division of the tax parcel would create an unacceptable error term.)

-Acres for the 10 major land use classes were extracted by section using the LUM.

-A computer program divided a land use class' land value for a section by the land use's acreage for the section,and calculated the section's average land value per acre for the land use. A similar procedure was followed to calculate average improvement values for all 10 land uses for each section.

-The same computer program attached the 20 average land and improvement values for a section to each of the 16, 40-acre parcels within the section. (see Figure 1 below)

Figure 1. Calculation of an Average Land/Improvement Value For a Section

```
  section-level
LOW-DENSITY RESID.     avg low-den
total LAND value        res. land          applied to each of the
-----------------  =      value             16, 40-acre parcels
   section-level        per acre            in the section
LOW-DENSITY RESID.      for section
      acres
        .                   .                      .
        .                   .                      .
        .                   .                      .
        .                   .                      .
        .                   .                      .
  section-level
    VACANT/AG.
total LAND value       avg vacant/ag           applied to each of the
-----------------  =    land value     ->      16, 40-acre parcels
  section-level          per acre               in the section
    VACANT/AG           for section
      acres
```

Total land and improvement values for each of the five flood inundation areas were computed using the LUM Map Calculator. Figure 2 outlines the steps to calculate the 25-year low-density residential land value map.

Figure 2. Calculation of 25-year Low-density Residential Land Value Map

| | | | | |
|---|---|---|---|---|
| avg low-den res land value map by 40-acre parcel | * | low-den res acres map by 40-acre p. | = | total low-den res land value by 40-acre parcel map |

| | | | | |
|---|---|---|---|---|
| total low-den res land value by 40-acre parcel map | * | 25-year flood inundation map | = | total low-den res land value by 40-acre parcel within 25-year flood map |

An additional step: Extraction of low-density residential total land values, by section, from the final map to an output file. The above calculations were repeated for each land use class.

The LUM is accurate to a forty-acre parcel level. In most cases flood inundation boundaries split a forty-acre parcel which prompted the LUM to accept or reject the entire parcel. If the boundary included the forty-acre parcel's center point, the entire parcel was accepted; if the boundary excluded the parcel's center point, the entire parcel was rejected.

In summary, land and improvement values are accurate to the section level, but the acceptance or rejection of values within a flood inundation area is accurate to a forty-acre parcel level. Values provided by the LUM are summarized in Table 1.

The area between 180th Avenue and Gillespie Dam fell outside the geographic boundaries of the LUM. Full cash and improvement values for this area were provided by a contractor of Salt River Project using Assessor's data. Improvement values throughout the study area were then adjusted to market values using a normalization factor provided by the Assessor to attain the structural values used in the damage analysis. Content values were then estimated as a percentage of structure values based on relationships established in other COE studies.

Two areas in the 500-year floodplain were then checked to verify improvement values in the LUM. These areas, representing approximately 10 percent of the damageable property, included the Tempe-Mesa light industrial areas in reaches 2 and 3 and residential development in reaches 6 and 7. A drive-through of selected sections in both these areas was conducted by members of the study team. Land usage and physical condition of the structures were noted in each of these sections. Qualitative comparisons of the field information against the LUM values were then made. Based on these field checks, it appears the values contained in the Land Use Model accurately represented the actual 500 year overflow area. It should be noted that time constraints did not allow for a thorough evaluation of the LUM data. However, given the level of significance of inundation reduction benefits in this study the use of the LUM represented an acceptable reconnaissance level approach.

Depth-damage relationships were used to evaluate the impact of the anticipated flows on development in the floodplains. These relationships were developed from nation-wide flood insurance claims and provided by the Federal Emergency Management Agency (FEMA). The depth-damage curves applied to damageable property, were used to develop flood damages on a section level.

The Expected Annual Flood Damage Computation program developed by the Hydrologic Engineering Center (HEC) was used to compute annual damages in this analysis. The damages expected to result from each size flood were weighted by the probability of occurrence of that flood by combining the damage-discharge and discharge-frequency curves. Average annual damages were then calculated by using standard damage-frequency integration techniques. Equivalent annual damages were computed next by summing the present worth of annual damages and applying the capital recovery factor (partial payment series) for an 8-5/8 percent discount rate. Table 3 presents the without project expected annual damages for the study.

To evaluate the impacts of proposed flood control measures on the Verde River, the discharge-frequency curves associated with the improvements were input into the EAD run as alternate plans. Flood damages prevented were calculated by comparing the damages that would be expected to occur without a project to those damages that would be expected to occur with a project in place. Inundation reduction benefits are provided in table 4.

## Specific Case Benefits

The Specific Case area of benefits are those structures where traditional use of standardized depth-damages relationships cannot adequately determine damages. These areas require in-depth analysis to determine the flow-damage relationships. Included in this category are unique structures such as dams, power plants, and electric transmission towers; sand and gravel operations, agricultural activities and business and emergency costs.

Unique Structures. This area of benefit determination was divided into two areas: 1) Unique Structures in a Specific Reach where adjusting the flow-damage relationship is appropriate, and 2) Unique Structures (not dependent on hydraulic information) where in-depth analysis is required for adjustment.

1) Unique Structures in a Specific Reach: The unique structures were first separated into their appropriate reach. These consisted of damages to: electrical transmission towers, telephone lines, the Ocotillo Power Plant, water and sewer Lines, gas lines, storm drains, and irrigation facilities. Expected damages to these structures were examined. The existing flow-damage relationship was adjusted for price level changes for all

structures with the exception the Ocotillo Power Plant where additional damages for the 500-year event were included based on new information. Flow-damage relationships were aggregated by reach and then input into the EAD program. Annual damages are estimated at $142,400.

2) Unique Structures (not dependent on hydraulics). This sub-category consists of damages to SRP Dams on the Verde River, the CAP siphon and SRP's Underground Storage and Recovery Project. Damages for this sub-category are computed as a function of hydrology and are not reach-specific. The flow-damage relationships for SRP dams and CAP siphons was updated for price level changes. Additionally, damages to SRP Dams on the Salt River were removed from the flow-damage relationship as they could not be protected by flood control measures on the Verde. Damages to SRP's Underground Storage and Recovery Project were added since this proposed project will be in place before completion of any project alternative. Equivalent annual damages for this area equal $302,100.

Sand and Gravel Operations. Flow-Damage relationships for this area of benefits were updated for price level changes and then input into the EAD program. Equivalent annual damages equal $124,100.

Agriculture. The 1987 study adjusted flow-damage relationships for all reaches except reaches 1,8 and 9. In these reach the current analysis reduced the 1981 flow-damage relationships by the percentage reduction in overflow area from 1981 to 1988. The resultant flow-damage relationship was then updated for price level changes and input into the EAD program. Annual damages total $45,700.

Transportation Delays. For this category of damages a new bridge failure and delay scenario was developed in the 1987 analysis. The flow-damage relationships were modified for price level changes and then input into the EAD program. Because the transportation flow-damage relationship is a stepped function large swings in with project damages occur. Equivalent annual damages equal $40,500.

## OTHER BENEFITS

### Savings in Capital Costs

Savings in Capital Costs can be claimed as project benefits when flood control measures allow for a savings in costs by permitting the building of smaller, less expensive structures. The 1987 analysis concluded that savings in capital costs could accrue to two bridges, Price Road and Bullard Avenue. The current analysis assumes these bridges will be constructed to withstand the 100-year flood of 170,000 cfs if flood control measures on the Verde are not constructed. Annual benefits for each alternative are shown in table 4.

### Savings in Fill

Any development in the 100-year floodplain must be filled one foot above the 100-year flood elevation in accordance with the Flood Insurance Act of 1973. If a project reduces or eliminates the amount of fill required without a project, the savings in the cost of fill is then a direct benefit attributable to the project. The savings in fill benefit is difficult to quantify given the lack of with project overflows. However, due to the rapid growth the Phoenix area is experiencing, this area of benefits is fairly substantial. Quantification of these benefits was made on a cursory level given the available information.

Without a project, there would be approximately 8,100 acres of land in the 100-year floodplain 1995 (project year 1) with the potential to develop. Based on the future development scenario, fifteen to twenty five percent of the 8,100 acres will be covered by structures. This analysis assumes the high end of the range, twenty five percent will be filled. The average depth of fill is 3 feet and the cost of fill is $4.50 per cubic yard. The total cost of fill was divided into equal payments over the 100-year life of the project. To evaluate alternatives, it was assumed that the targeted 55,000 cfs 100-year discharge would eliminate all fill requirements in the 100-year floodplain. Benefit calculations were then based on percentage reductions in the acreage of the without project floodway resulting from the alternative plans.

Business and Emergency Losses

The land uses inundated in the 1981 analysis have changed due to extensive localized protection in the commercial and industrial areas through Phoenix. Consequently, the flow-damage relationship created in 1981 for this category of benefits is no longer applicable to the current inundation areas. Quantification of this area of benefits would require extensive surveys of the new inundation areas. Because of the small magnitude of benefits ($83,000 in the 1981 analysis) these benefits are not claimed in this study.

**SUMMARY**

Table 4 presents the results of this analysis at the current Water Resource Council interest rate of 8 5/8%. The results indicate plan RHD (465k acre feet storage) produces the most benefits. This analysis was conducted at a reconnaissance level and is consistent with federal guidelines and procedures.

TABLE 1
LUM DATA SUMMARY

Land Value ($)

| LAND USE CLASS | 50 YR | 100 YR | 200 YR | 500 YR |
|---|---|---|---|---|
| Low Dens Res | 883,277 | 1,870,994 | 2,147,223 | 6,923,382 |
| Med Dens Res | 972,207 | 2,332,259 | 4,215,219 | 48,346,118 |
| High Dens Res | 3,300 | 3,093,057 | 3,323,711 | 10,746,040 |
| Mobile Homes | 456,913 | 717,067 | 1,412,402 | 13,935,997 |
| Low Dens Com | 445,451 | 445,451 | 1,352,469 | 3,531,246 |
| Med Dens Com | 2,031,076 | 3,364,734 | 18,020,874 | 52,552,776 |
| High Dens Com | 0 | 0 | 0 | 1,091,194 |
| Light Ind | 967,474 | 1,389,282 | 1,576,802 | 2,080,813 |
| Gen Ind | 6,494,058 | 7,511,219 | 24,438,816 | 37,907,596 |
| Vacant/Agri | 96,830,901 | 107,366,659 | 119,064,679 | 183,908,084 |

Improvement Value ($)

| | | | | |
|---|---|---|---|---|
| Low Dens Res | 386,012 | 7,309,642 | 789,491 | 1,513,040 |
| Med Dens Res | 1,951,456 | 7,689,022 | 11,395,274 | 89,926,221 |
| High Dens Res | 71,029 | 10,263,890 | 10,694,621 | 37,180,981 |
| Mobile Homes | 16,543 | 37,520 | 175,191 | 7,656,997 |
| Low Dens Com | 632,439 | 632,439 | 1,785,020 | 4,017,530 |
| Med Dens Com | 1,481,116 | 2,854,058 | 11,264,009 | 31,620,524 |
| High Dens Com | 0 | 0 | 0 | 9,603,099 |
| Light Ind | 194,367 | 302,927 | 473,445 | 799,727 |
| Gen Ind | 14,105,874 | 16,265,331 | 57,490,647 | 86,781,949 |
| Vacant/Agri | 3,745,038 | 4,444,980 | 4,812,264 | 6,086,937 |

ACRES

| | | | | |
|---|---|---|---|---|
| Low Dens Res | 32 | 53 | 72 | 145 |
| Med Dens Res | 54 | 221 | 260 | 1,025 |
| High Dens Res | 1 | 36 | 40 | 83 |
| Mobile Homes | 4 | 11 | 18 | 248 |
| Low Dens Com | 22 | 22 | 48 | 156 |
| Med Dens Com | 107 | 142 | 198 | 465 |
| High Dens Com | 0 | 0 | 0 | 10 |
| Light Ind | 62 | 76 | 90 | 121 |
| Gen Ind | 244 | 269 | 714 | 958 |
| Vacant/Agri | 29,498 | 34,090 | 36,631 | 50,210 |
| TOTALS | 30,024 | 34,920 | 38,071 | 53,421 |

FIGURE 3
CLIFF DAM ALTERNATIVE
CFS vs. LOCATION BENEFITS

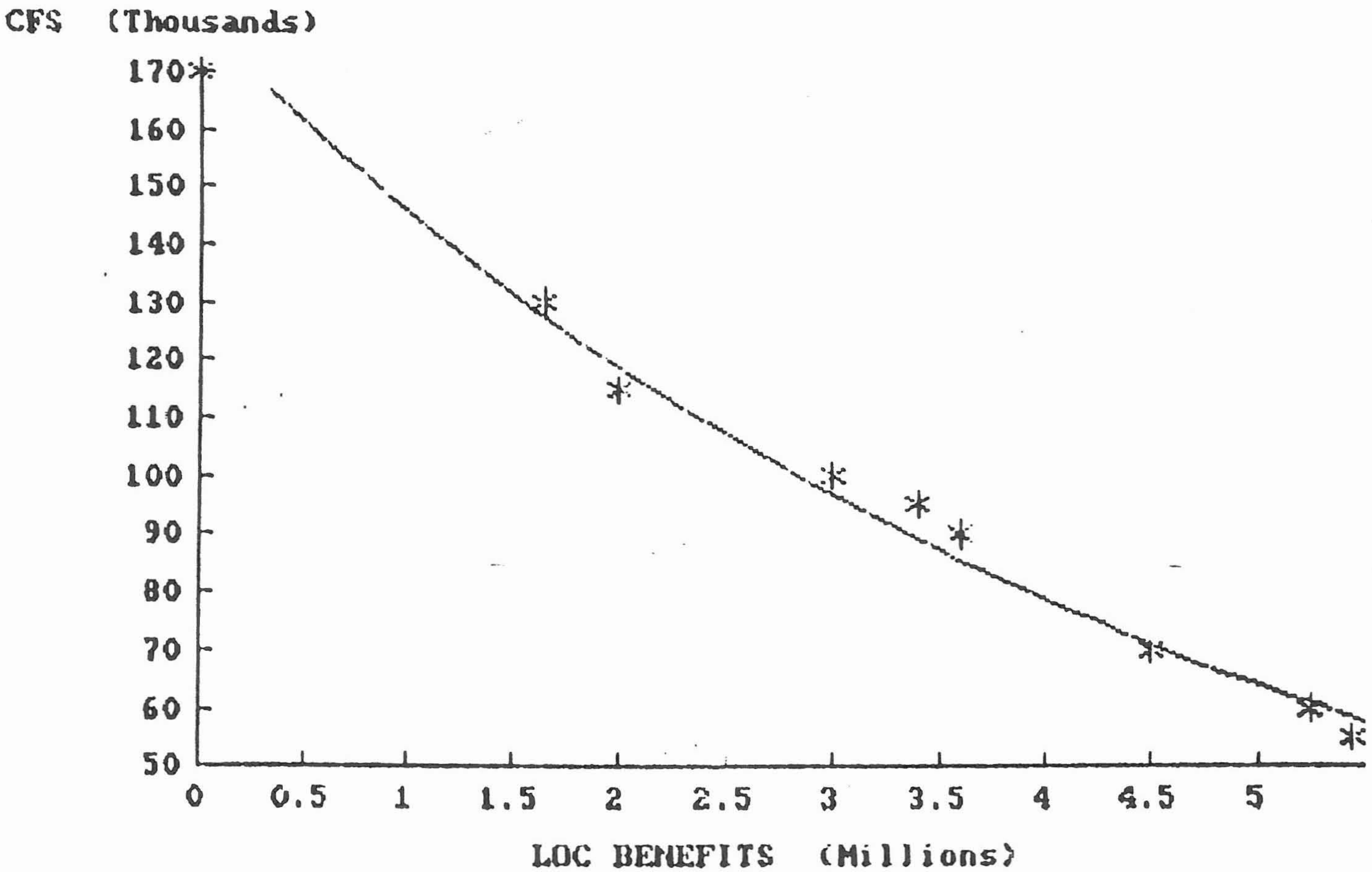

TABLE 2

ALTERNATIVE TO CLIFF DAM STUDY
LOCATION BENEFITS, 170k CFS FLOODWAY

| REACH | TYPE OF USE | ACRES | LAND VAL INCREASE PER ACRE | GROSS INCREASE | COST OF FILL | TOTAL NET LAND VALUE INCREASE |
|---|---|---|---|---|---|---|
| 2 | MED DEN RES | 9.85 | $105,000 | $1,034,250 | $112,998 | $920,610 |
| | | | | $1,034,250 | $112,998 | $920,610 |
| 3 | COMMERCIAL | 10.39 | 50,000 | 519,743 | 394,018 | 125,726 |
| | PARKING-ASU | 4.96 | 45,000 | 223,140 | 56,921 | 166,220 |
| | PARK (REC) | 7.57 | 5,000 | 37,833 | 0 | 37,833 |
| | | | | $780,716 | $450,939 | $329,779 |
| 4 | GEN INDUSTRIAL | 63.73 | 375,000 | 23,898,073 | 2,415,617 | 21,482,455 |
| | | | | $23,898,073 | $2,415,617 | $21,482,455 |
| 5 | GEN INDUSTRIAL | 63.33 | 375,000 | 23,746,555 | 1,406,460 | 22,340,096 |
| | INDUSTRIAL | 31.92 | 85,000 | 2,660,055 | 172,152 | 2,487,903 |
| | | | | $26,406,610 | $1,578,612 | $24,827,999 |
| 6 | INDUSTRIAL | 21.57 | 85000 | 1,832,690 | 118,607 | 1,714,083 |
| | MED DEN RES | 165.21 | 105,000 | 17,347,658 | 908,852 | 16,438,806 |
| | LOW DEN RES | 40.92 | 10,000 | 409,183 | 225,091 | 184,091 |
| | | | | $19,589,531 | $1,252,550 | $18,336,980 |

| | |
|---|---|
| GRAND TOTAL : | 65,897,823 |
| ANNUALIZED @ 8.625%, 100 YRS : | 5,685,139 |
| LESS CAPITALIZATION OF FLOOD THREAT : (4.2% of annual) | 238,776 |
| TOTAL LOCATION BENEFIT : | 5,446,363 |



NOTE: DISCREPANCIES DUE TO ROUNDING.

**TABLE 3**

INUNDATION DAMAGES
WITHOUT PROJECT ($1,000s)

| | |
|---|---|
| GENERAL PROPERTY INVENTORY | |
| RESIDENTIAL | 533.37 |
| COMMERCIAL | 62.28 |
| INDUSTRIAL | 322.43 |
| MOBILE HOMES | 21.35 |
| PUBLIC | 77.77 |
| SPECIFIC CASE | |
| UNIQUE STRUCTURES(1) | 142.44 |
| UNIQUE STRUCTURES(2) | 302.14 |
| SAND AND GRAVEL OPERATIONS | 124.13 |
| AGRICULTURAL | 45.67 |
| TRANSPORTATION DELAYS | 40.48 |
| TOTAL | 1672.06 |

(1) Unique structures in reach
(2) Unique structures not reach specific

## TABLE 4a

ANNUAL BENEFITS ($1000s)
BY ALTERNATIVE

| BENEFIT CATEGORY | ALTERNATIVE | | |
|---|---|---|---|
| INUNDATION REDUCTION | RHD | RHC | RHB2/3 |
| GENERAL PROPERTY | | | |
| RESIDENTIAL | 331.9 | 284.3 | 189.6 |
| COMMERCIAL | 41.7 | 38.4 | 30.2 |
| INDUSTRIAL | 209.1 | 188.2 | 140.4 |
| MOBILE HOMES | 13.3 | 11.3 | 7.5 |
| PUBLIC | 59.8 | 52.5 | 23.9 |
| SPECIFIC CASE | | | |
| UNIQUE STRUCTURES(1) | 111.5 | 102.9 | 70.1 |
| UNIQUE STRUCTURES(2) | 157.8 | 157.5 | 145.8 |
| SAND & GRAVEL | 102.0 | 98.9 | 83.5 |
| AGRICULTURAL | 39.0 | 38.3 | 31.0 |
| TRANSPORTATION | 37.6 | 37.4 | 3.6 |
| OTHER BENEFITS | | | |
| LOCATION | 5,200.0 | 4,500.0 | 3,400.0 |
| SAVINGS IN CAPITAL | 224.0 | 202.0 | 145.0 |
| SAVINGS IN FILL | 420.0 | 380.0 | 273.0 |
| | ======= | ======= | ======= |
| | 6,947.7 | 6,091.7 | 4,543.6 |

(1) Unique structures in reach
(2) Unique structures not reach specific

**TABLE 4b**

ANNUAL BENEFITS ($1000s)
BY ALTERNATIVE

| BENEFIT CATEGORY | ALTERNATIVE | | | |
|---|---|---|---|---|
| INUNDATION REDUCTION | RHB1 | RHA3 | RHA2 | RHA1 |
| GENERAL PROPERTY | | | | |
| RESIDENTIAL | 240.7 | 128.1 | 122.6 | 74.3 |
| COMMERCIAL | 33.1 | 24.3 | 23.0 | 13.8 |
| INDUSTRIAL | 161.0 | 107.5 | 101.9 | 60.0 |
| MOBILE HOMES | 9.6 | 5.0 | 4.8 | 3.0 |
| PUBLIC | 39.9 | 12.4 | 12.3 | 9.9 |
| SPECIFIC CASE | | | | |
| UNIQUE STRUCTURES(1) | 84.5 | 52.8 | 51.8 | 38.3 |
| UNIQUE STRUCTURES(2) | 155.7 | 58.9 | 99.6 | 122.5 |
| SAND & GRAVEL | 84.5 | 74.6 | 69.4 | 51.4 |
| AGRICULTURAL | 32.8 | 14.9 | 19.8 | 24.3 |
| TRANSPORTATION | 36.7 | 2.9 | 2.9 | 1.9 |
| OTHER BENEFITS | | | | |
| LOCATION | 3,000.0 | 2,000.0 | 2,000.0 | 1,646.2 |
| SAVINGS IN CAPITAL | 133.0 | 100.0 | 100.0 | 68.0 |
| SAVINGS IN FILL | 251.0 | 189.0 | 189.0 | 132.0 |
| | ======= | ======= | ======== | ======= |
| | 4,262.5 | 2,770.4 | 2,797.1 | 2,245.6 |

(1) Unique structures in reach
(2) Unique structures not reach specific

# Appendix D Environmental

# FINAL

# ENVIRONMENTAL LITERATURE REVIEW

# FOR

# FLOOD CONTROL ALTERNATIVES TO CLIFF DAM

# MARICOPA COUNTY, ARIZONA

Contract No. DACW09-87-D-0039
Delivery Order 016

Prepared for:

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT CORPS OF ENGINEERS
P.O. Box 2711
Los Angeles, CA 90053-2325

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MAY 2, 1988

ENVIRONMENTAL LITERATURE REVIEW FOR
FLOOD CONTROL ALTERNATIVES TO CLIFF DAM

TABLE OF CONTENTS

ENVIRONMENTAL LITERATURE REVIEW FOR
FLOOD CONTROL ALTERNATIVES TO CLIFF DAM

TABLE OF CONTENTS (Continued)



LIST OF FIGURES



LIST OF TABLES

# SECTION 1 - INTRODUCTION AND METHODS

## 1.1 INTRODUCTION

This document provides an environmental literature review for the identification of biological resources, cultural resources and known hazardous waste sites for an approximately 75 mile stretch of the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam. Figure 1.1-1 delineates the study area. The entire area is within Maricopa County, Arizona and includes that portion of the Salt River which runs through the Phoenix Metropolitan area.

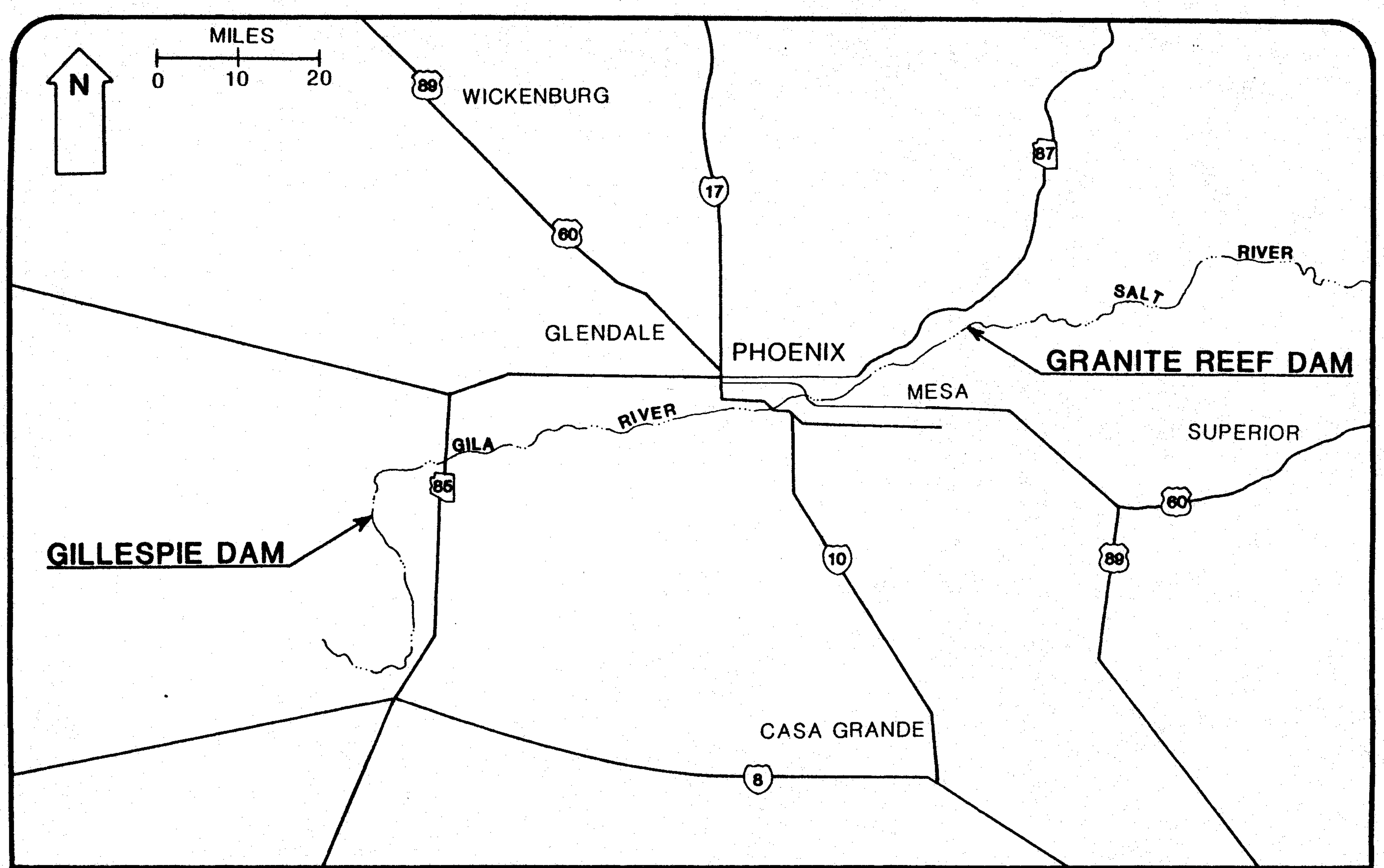
The literature review is intended to provide an overview of the existing environment of the area in order to identify particular environmental issues associated with alternatives to Cliff Dam. Because of public opposition to Cliff Dam, a component of the Central Arizona Project Selected Plan, the U.S. Bureau of Reclamation has been directed to study downstream flood control alternatives to Cliff Dam. The Bureau of Reclamation is studying flood control alternatives on the Verde River upstream from its confluence with the Salt River and the Corps of Engineers is assisting in the study of flood control alternatives downstream of this confluence (Granite Reef Dam).

This document is organized into three major sections. Section 2 discusses the biological resources of the study area. Section 3 provides an overview of the Cultural Resources of the area. Section 4 delineates and describes the hazardous waste sites found in the study area.

## 1.2 METHODS

### 1.2.1 **Biological Resources**

The biological literature review was prepared through the evaluation of the published and unpublished literature base as well as through contact with agency and other biologists knowledgeable about the area. The principal source of information was the data base maintained by the Arizona Game and Fish Department. Most published and unpublished data are compiled by the Department which functions as a clearinghouse. Additionally, personnel from the Arizona Game and Fish Department, U.S. Fish and Wildlife Service and the Bureau of Land Management were contacted in order to gain any recent information.




PROJECT LOCATION MAP

FIGURE 1.2-1

### 1.2.2 Cultural Resources

Information for this overview was collected from a variety of sources with numerous personal contacts made in Phoenix, Arizona. The list of people contacted in preparing this report include:

| | |
|---|---|
| Dr. Michael Barton | Arizona State University |
| Dr. Glen E. Rice | Arizona State University |
| Ms. Linda Williams | Arizona State University |
| Ms. Lynn Teague | Arizona State University |
| Mr. Doug Kules | Arizona State Historic Preservation Office |
| Ms. Theresa Hoffman | Arizona State Historic Preservation Office |
| Mr. Todd W. Bostwick | Pueblo Grande Museum |
| Dr. Richard Effland | Archaeological Consulting Services Ltd. |
| Dr. Margerie Green | Archaeological Consulting Services Ltd. |

These people provided guidance and direction to this research effort. They were particularly helpful in providing information on the state of archaeological research in an area where development is rapidly impacting cultural resources and knowledge is accruing at a speed which outstrips the rate of publication. The Phoenix area is going to provide new information on Hohokam archaeology in the near future and the results of this information may have a direct impact on some of the work discussed in this report.

### 1.2.3 Hazardous Waste Sites

Known hazardous waste sites were identified through contact with the U.S. Environmental Protection Agency and the Arizona Environmental Quality Department. Both agencies provided lists of known sites by zip codes within the study area. Addresses of these sites were plotted and those within one half mile of the river were delineated on the maps for this report. Agencies were then solicited to obtain additional information concerning site characteristics.

## SECTION 2 - BIOLOGICAL RESOURCES

### 2.1 DESCRIPTION OF STUDY AREA AND BACKGROUND

The study area includes the active floodplain of the Salt River from Granite Reef Dam in eastern Maricopa County downstream to its confluence with the Gila River and the Gila River from the Salt River confluence downstream to Gillespie Dam. The study area is 75 river miles long, averages two-thirds miles in width (about 32,000 acres), and ranges in elevation from 1305 ft. at Granite Reef Dam, to 950 ft. at the Salt and Gila river confluence (hereafter referred to as the Salt River section), and to 740 ft. at Gillespie Dam (hereafter referred to as the Gila River section.

The Granite Reef Dam, on the Salt River, is 3.5 river miles below the confluence with the Verde River. It diverts the Salt River into the Arizona Canal and the Southern Canal, north and south of the river, respectively. The river heads west-southwesterly in a floodplain from 1/2 to 3/4 miles wide for 39 miles where it joins the Gila River at the extreme northern foot of the Sierra Estrella Mountains. There is a short, 1-1.5 mile, reach immediately below Granite Reef Dam with perennial water. Otherwise there are no perennial flows in the Salt River until effluent from the City of Phoenix's 91st Avenue Wastewater Treatment plant joins the river, 3 miles above the Gila River confluence. Much of the dry 36 mile long Salt River section is characterized by exceedingly barren deposits of cobbles, gravel, and sand. The floodplain is extensively modified by transportation and gravel and sand mining operations through the Phoenix area.

At the Gila River confluence the active floodplain widens from 3/4 to 1 mile, although the only perennial water still derives from the 91st Avenue treatment plant. The Gila River assumes the west-southwesterly course of the tributary Salt River until it bends southerly around the western foot of the Buckeye Hills. Gillespie Dam lies at the extreme southwestern foot of the Buckeye Hills. The dam diverts the remaining flows of the Gila River into the Enterprise Canal on the west bank and the Gila Bend Canal on the east bank. The floodplain in the Gila River section still includes extensive cobble and gravel deposits, and even some low stabilized sand dunes, but there is considerable shrub and tree cover adjacent to the river channel.

The Salt and Gila rivers have been subjected to numerous flood control and water usage studies beginning nearly forty years ago. In 1951 the U.S. Army Corps of Engineers (ACE) informed the Arizona Game and Fish Department of their plans for flood control measures along the Salt and Gila rivers from McDowell Dam site (a predecessor of the Central Arizona Project's Orme Dam concept) to Gillespie Dam (Shuler 1951). The ACE concluded flood control studies and recommended channelization and riparian vegetation clearing from a 1000-2000 ft. wide channel from McDowell Dam site to Gillespie Dam. The project was never implemented because, in the meantime, Congress authorized the Central Arizona Project, which included Orme Dam as the primary flood control measure for the Phoenix area (ACE 1957).

In 1954 the U.S. Bureau of Land Management (BLM) created a 6896 acre wildlife preserve (in several tracts) on BLM land between Gillespie Dam and 91st Avenue (BLM 1954). These lands are known as PLO 1015 lands. In 1962 the Department of the Army granted sole management responsibilities over PLO 1015 lands to the Arizona Game and Fish Department (AGFD) (Dept. of the Army 1962). AGFD has been actively managing the lands for wildlife ever since then.

In 1967 BLM created the Gila River Greenbelt, now known as the Fred J. Weiler Greenbelt. It included all of the 6896 acres of the PLO 1015 lands plus an additional 55,839 acres (for a total of 62,735 acres) from 91st Avenue to Gillespie Dam. Much of the additional Fred J. Weiler lands include areas outside the active river floodplains.

AGFD now provides nearly all of the wildlife management in the Gila River section. The agency has acquired several parcels of lands and created permanent wildlife refuges. Established wildlife refuges include the Arlington State Wildlife Area, Powers Butte State Wildlife Area, Robbins Butte State Wildlife Area, and the Base and Meridian State Wildlife Area. These refuges include several thousand acres of wildlife habitat, the main purpose of which is to preserve and enhance waterfowl and white-winged dove foraging and nesting habitat. AGFD is engaged in an active lands acquisition program to augment the existing refuges.

The ACE flood control project was resurrected in the late 1960s and by 1973 an environmental impact statement was issued (Haase 1973), Once again, the project was never implemented. In 1981 ACE completed a several year long, comprehensive study of flood control needs, measures, and consequences in a series of volumes under the title of "Phoenix Urban Study" (Water Resour. Res. Ctr. and Univ. Arizona 1979, 1981a, 1981b, 1981c). The study included consideration of channelization and vegetation clearing of the Gila and Salt Rivers. By 1981 the Maricopa Control Flood Control District (MCFCD) and ACE completed clearing of vegetation from a 1000 foot wide channel between 91st Avenue and Gillespie Dam.

In the mid-1970s the U.S. Bureau of Reclamation initiated pilot projects to reduce Colorado River salinity. Part of the mitigation for the project included Mumme Farm, a wildlife habitat development, in property adjacent to Arlington State Wildlife Area (Sharpe et al. 1979). A 160 acre tract of land, also adjacent to Arlington State Wildlife Area, was purchased by ACE and deeded to AGFD as part of its mitigation commitments for The Phoenix, Arizona and vicinity (including New River) Project (AGFD undated). The Flood Control District of Maricopa County (FCDMC) leased 400 acres adjacent to Robbins Butte State Wildlife Area in fulfillment of mitigation commitments for the Gila and Salt river channelization and clearing project. Wildlife management responsibilities have been assumed by AGFD (AGFD undated).

In the 1980s MCDFC took a lead role in flood control planning and by 1981 the U.S. Fish and Wildlife Service (FWS) released a final environmental impact statement on clearing of a 1000 ft. channel. The EIS was amended with an environmental assessment in 1986 (FWS 1986) to address channelization of that same portion of the study area. Both the channel clearing and channelization have been completed.

## 2.2 VEGETATION

### 2.2.1 Non-Riparian Vegetation

The non-riparian vegetation bisected by the Gila and Salt rivers is dominated by Sonoran Desertscrub. Three subdivisions of Sonoran Desert-scrub are recognized (classification of Brown, et al. 1979, and Brown and Lowe (map), 1980):

1. Sonoran Desertscrub, Arizona Upland Subdivision, Palo Verde-Mixed Cactus Series -- A desert foothills community dominated by foothills paloverde (Cercidium microphyllum), triangleleaf bursage (Ambrosia deltoidea), brittlebush (Encelia farinosa), creosotebush (Larrea divaricata), and range ratany (Krameria parviflora). Small areas of this vegetation type occur in mostly rocky soils adjacent to the Salt River section floodplain at Granite Reef Dam and adjacent to the Gila River section floodplain at Estrella Mountain County Park (3 miles below the Gila-Salt river confluence), Robbins Butte (south of Palo Verde), Powers Butte (southeast of Arlington), and on the Buckeye Hills at Gillespie Dam.

2. Sonoran Desertscrub, Lower Colorado Subdivision, Creosotebush-Bursage Series -- A plains community dominated almost exclusively by creosotebush alone or by creosotebush with white bursage (Ambrosia dumosa). This community type dominates non-saline soils of relatively fine texture, principally in the eastern portions of the Salt River section.

3. Sonoran Desertscrub, Lower Colorado Subdivision, Creosotebush-Bursage Series, Mesquite (Prosopis juliflora)-Allscale (Atriplex polycarpa) Association -- A valley plains community found on saline soils adjacent to the Gila River section, especially in the Arlington area. Associated species include wolfberry (Lycium spp.) and creosotebush.

### 2.2.2 Riparian Vegetation

The riparian vegetation of the Salt River section has been almost completely extirpated. A few miles of dry riparian scrub persist in the river channel below Granite Reef Dam and occasional pockets of riparian scrub may be found scattered along the river to near the 91st Avenue treatment plant. Otherwise three major vegetation types are recognized (Brown 1982; Brown, et al. 1979):

1. Sonoran Riparian and Oasis Forests, Cottonwood-Willow Series -- A greatly reduced vegetation type, nearly extirpated for many years. Recent flood flows have allowed regeneration of a few stands of young cottonwood (Populus fremontii) and Goodding willow (Salix gooddingii). Stands are scattered throughout the area, but mainly in the vicinity of the Salt - Gila river confluence.

2. Sonoran Riparian and Oasis Forests, Mesquite Series -- A largely defunct community in the study area. In small pockets it consists of tree-sized mesquite forming closed canopies in the floodplain generally adjacent to the wettest reaches. Clearing for agricultural development and reductions in river flows have severely restricted the extent of this community type in the past hundred years. Much of the undisturbed floodplains which once supported mesquite forests are now dominated by scrublands of shrub-sized mesquite which grade into creosotebush-bursage and mesquite-allscale communities at the floodplain edges.

3. Sonoran Deciduous Swamp and Riparian Scrub, Saltcedar Disclimax Series -- Saltcedar has invaded much of the riparian habitat along the Gila River section and now occupies the wettest habitats formerly dominated by mesquite forests and marshes and swamps. Although saltcedar often forms pure stands it is usually found in association with mesquite.

## 2.3 WILDLIFE RESOURCES

### 2.3.1 Wildlife Habitat

Wildlife biologists believe that more than half of the waterfowl nestings in Maricopa County occur in the Gila River section of the study area (Palmer 1988). Breeding waterfowl include mallard

(Anas platyrhynchos), ruddy duck (Oxyura jamaicensis), sora (Porzana carolina), pied-billed grebe (Podilimbus podiceps), black-bellied whistling duck (Dendrocygna autumnalis), common moorhen (Gallinula chloropus), cinnamon teal (Anas cyanoptera), least bittern (Ixobrychus exilis), green-backed heron (Butorides striatus), great blue heron (Ardea herodias), Virginia rail (Rallus limicola), American coot (Fulica americana), American avocet (Recurvirostra americana), and black-necked stilt (Himantopus mexicanus), among many others.

The area is also one of the most important nesting areas for white-winged dove (Zenaida asiatica) in Arizona (Neff 1940, Wigal 1973). The quality of this area as nesting habitat has already declined sharply due to water diversion, thinning of riparian forests, clearing for agriculture, flood control, and replacement of mesquite by saltcedar.

### 2.3.2 Threatened and Endangered Species

1. **Yuma clapper rail (Rallus longirostris yumanensis).** Federally endangered, recovery plan approved (March 11, 1967, 32 FR 4001; Anderson 1983); State listed Group 2 (Ariz. Game & Fish Commis. 1982). Although ornithologists suspect a historical presence in the study area, the first confirmed observation was not made until June 1976. A single Yuma clapper rail was sighted in the Salt River immediately below Granite Reef Dam in 1982, but the habitat has since been destroyed by floods and dredging (AGFD 1988). In 1982 AGFD biologists conducted an intensive survey of potential habitat in the Gila River section and found 13 nesting birds along a 3 mile reach southeast of Arlington. AGFD suspects this is a relictual population and is likely to view any loss of additional habitat as very serious. The U.S. Fish and Wildlife Service (Spiller 1988) also identified the species as nesting in the marshy areas along the Salt and Verde Rivers.

2. **Southern Bald Eagle (Haliaeetus leucocephalus leucocephalus).** Federally endangered (March 11, 1967, 32 FR 4001); State listed Group 2 (Ariz. Game & Fish Commis. 1982). Although there are few, if any, suitable nesting sites in the study area, bald eagles do nest in the Salt and Verde Rivers only a few miles from Granite Reef Dam. Foraging by these birds as well as others passing through the Gila River section can be expected (Fitzpatrick 1988). The U.S. Fish and Wildlife Service (Spiller 1988) considers the bald eagle as a transient and winter migrant within the study area.

3. **American peregrine falcon (Falco peregrinus).** Federally endangered (March 20, 1984, 49 FR 10526); State listed Group 3 (Ariz. Game and Fish Commis. 1982). White-winged and

mourning dove (Zenaida macroura) populations in the Gila River section could provide high quality foraging habitat for birds passing through or nesting in the nearby Sierra Estrella, although, to date, only occasional transients have been observed in the area (Fitzpatrick 1988). The species is also considered as a transient and winter migrant to the study area by the U.S. Fish and Wildlife Service (Spiller 1988).

4. **Fulvous whistling duck (Dendrocygna bicolor).** Federal candidate category 2 (Sept. 18, 1985, 50 FR 37958); no State listing. A rare visitor to south-central Arizona which is likely to utilize marshy areas with some open water in the study area. The U.S. Fish and Wildlife Service (Spiller 1988) has not identified this as a species of concern in the study area.

5. **Long-billed curlew (Numenius americanus).** Federal candidate category 2 (Sept. 18, 1985, 50 FR 37958); no State listing. A rare transient in the study area, particularly at the edges of open water. This species has not been identified as a species of concern in the study area by the U.S. Fish and Wildlife Service (Spiller 1988).

6. **Western yellow-billed cuckoo (Coccyzus americanus occidentalis).** Federal candidate category 2 (Sept. 18, 1985, 50 FR 37958); no State listing. An uncommon resident in the study area that would nest in mature cottonwoods. The U.S. Fish and Wildlife Service (Spiller 1988) did not list this species as occurring within the study area.

7. **Black-crowned night heron (Nycticorax nycticorax hoactle).** No federal status; State listed Group 3 (Ariz. Game & Fish Commis. 1982). Formerly resident in the areas containing larger trees and snags along the Salt and Gila rivers, but now locally extirpated due to severe habitat degradation.

8. **Black-bellied whistling duck (Dendrocygna autumnalis fulgens).** No federal status; State listed Group 3 (Ariz. Game & Fish Commis. 1982). Restricted to man-made and natural marsh habitats, probably infrequent visitors to the Gila River section and possibly breeding although no official observations.

9. **Razorback Sucker (Xyrauchen texanus).** Federal candidate category 2 (Sept. 18, 1985, 50 FR 37958); State listed Group 3 (Ariz. Game & Fish Commis. 1982). This species was recently reintroduced into the Salt and Gila rivers in the study area and there is some indication that the transplant is succeeding (Hendrickson 1988). To date no follow-up studies have been conducted and none are contemplated. The

U.S. Fish and Wildlife Service (Spiller 1988) has not identified the species as one of concern.

## 2.4 ENVIRONMENTAL ISSUES

The Gila River section is a valuable wildlife habitat that has undergone considerable habitat degradation in the past years. Further erosion of the wildlife habitat in this area would constitute a significant impact to biological resources in the area. Since the wildlife management areas in the Gila River sections were established specifically as mitigation measures for habitat destroyed by the salinity control project and other flood control projects, it would be expected to have stiff opposition to any channelization proposals in this area.

The Salt River portion of the study area is dominated by cobble, gravel and sand deposits and supports no perennial flows except for an approximately 1.5 mile stretch downstream of Granite Reef Dam and an approximately 3 mile stretch downstream of the 91st Avenue Wastewater Treatment Plant. Therefore biological impacts would be much less in this section of the river.

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[Indicates regulated and unregulated perennial and intermittent stream flow and existing and former swamps and marshes. Shows perennial wastewater flow in the Salt R. below 91st Avenue and in the Gila R. below the Salt R. confluence to Gillespie Dam. Also indicates a wastewater marsh on the Salt River at 91st Avenue and a former marsh at the Gila and Salt river confluence.]

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[Includes reduced duplications of the USGS Tolleson and Tempe 7.5 min. topographic quadrangles and orthophotoquads.]

Davis, Goode P., Jr.
1982 Man and wildlife in Arizona: the American exploration period, 1824-1865. Neil B. Carmony & David E. Brown, eds., Ariz. Game & Fish Dept., 232 p.
[Analysis and descriptions of exploration of the Gila and Salt rivers in the study area by several pioneers including James Ohio Pattie, who describes the Gila River at the Salt River confluence as "about 200 yards wide, with heavily timbered bottoms." Dr. John S. Griffin, a U.S. Army surgeon accompanied Col. Stephen W. Kearney, Lt. William H. Emory, and the "Army of the West" during the march to take California from Mexico in 1846. At the Salt River confluence Dr. Griffin noted that the Gila River was about 80 yards wide, three feet deep, and rapid. Davis' account is full of similar observations by early Arizona explorers.]

Emory, William H.
1848 Notes of a military reconnaissance, from Fort Leavenworth in Missouri, to San Diego in California, including part of Arkansas, Del Norte, and Gila Rivers. United States 30th Congress, 1st Session, Ex. Doc. 41, 614 p.
[Emory accompanied Col. Stephen W. Kearney and Kit Carson on the expedition to secure California during the Mexican War in 1846. He reports on the first detailed investigations of the biological, particularly botanical resources of the Gila River from headwaters to mouth.]

Engineering Science
1985 Biological assessment, threatened and endangered species, proposed Pacific Texas Pipeline Project. Engineering Sci. for U.S. Bureau of Land Manag.
[Mentions Yuma clapper rail population on the Gila River above Gillespie Dam.]

Fenner, Patricia, Ward W. Brady, and David R. Patton
1985 Effects of regulated water flows on regeneration of Fremont Cottonwood. J. of Range Manage. 38:135-138.
[This study conducted as a Master of Sci. Thesis at Ariz. State Univ., Tempe, Arizona. Study site located in the short perennial stretch of the Salt River channel immediately below Granite Reef Dam. The study's conclusions help explain the lack of riparian tree regeneration in the Gila River section.]

Fitzpatrick, Lesley
1988 Personal communication, March 25, 1988. Biologist, U.S. Fish and Wildlife Serv., Ecological Services Field Office, Phoenix, Arizona.

Haase, Edward F.
1973 Draft environmental study: Gila River from the confluence of the Salt River downstream to Gillespie Dam. Univ. Arizona, Office of Arid Lands Studies, Tucson, Arizona, 90 p.
[A final document was apparently never issued. This reports on flood control measures contemplated by ACE.]

Harper, W.G., and F.O. Youngs
1930 Soil survey of the Buckeye-Beardsley area, Arizona. USDA, Bureau of Chemistry & Soils, Series 1927, No. 3, 43 p. [Soils map (1:62,500) includes area between Agua Fria R. and White Tanks Mtns., White Tanks Mtns. and Gila R., and to the Hassayampa R.]

Harper, W.G., F.O. Youngs, A.T. Strahorn, S.W. Armstrong, and H.C. Schwallen
1931 Soil survey of the Salt River Valley area, Arizona. USDA, Bureau of Chem. & Soils, Series 1926, No. 32, 55 p.
[Maps showing alkali concentration (1:125,000) and soils (1:62,500). Includes area from Arizona and Main canals (north and east boundaries) to the Salt R. confluence with Agua Fria R., and south to the Maricopa-Pinal Co. line.]

Hendrickson, Dean
1988 Personal communication, March 21, 1988. Nongame Fisheries Specialist, Ariz. Game & Fish Dept., Phoenix, Arizona.

Horton, J.S. T.W. Robinson, and H.R. McDonald
1964 Guide for surveying phreatophyte vegetation. USDA, For. Serv., Agr. Handb. No. 266, 37 p.
[Contains data, observations, and one photograph from the Gila River section of the project.]

Horton, J.S., F.C. Mounts, and J.M. Kraft
1960 Seed germination and seedling establishment of phreatophyte species. USDA, For. Serv., Rocky Mtn. Forest & Range Exp. Stn., Stn. Pap. No. 48, 26 p.
[Excellent field study of germination and seedling establishment requirements of tamarisk, Fremont cottonwood, seepwillow (Baccharis salicifolia), desert broom (Baccharis sarothroides), and arrowweed (Pluchea sericea). The study was conducted in the Salt River immediately below Granite Reef Dam.]

Lee, W.T.
1905 Underground waters of the Salt River Valley, Arizona. U.S. Geol. Surv., Water-Supply Paper 136, 196 p.
[Good physical description of the Salt and Gila rivers prior to impoundment of waters. Descriptions of surface and groundwater resources of the Salt River Valley.]

Minckley, W.L., and David E. Brown
1982 Part 6. Wetlands. In David E. Brown, ed. Biotic communities of the American Southwest -- United States and Mexico. Desert Plants 4(1-4):1-342.
[Excellent general descriptions of riparian forests and scrublands of the major river systems of the Southwest, with a history of exploration and later exploitation. Discussions of the wildlife value of riparian plant communities of the major river systems.]

Neff, J.A.
1940 Range, population, and game status of the western white-winged dove in Arizona. J. Wildl. Manag. 4(2):117-127.
[General maps and discussion of white-winged dove distribution in southern Arizona, including the bottomlands of the Gila river section.]

Ohmart, R.D., and R.W. Smith
1973 North American clapper rail (Rallus longirostris) literature survey with special consideration being given to the past and current status of yumanensis in fulfillment of Bureau of Reclamation Contract No. 14-06-300-2409. Yuma, Arizona.
[This was produced several years prior to the discovery of Yuma clapper rail in the Gila RIver section. Numerous bibliographic references on the biology, biogeography, and ecology of the Yuma clapper rails.]

Palmer, Bruce
1988 Personal communication, March 21, 1988. Nongame Habitat Specialist, Ariz. Game & Fish Dept., Phoenix, Arizona.

Sharpe, F. Phillipe, M. Elkins, and Paul Strauss
1979 A case history -- unscheduled fish and wildlife mitigation PL-93-320, Title 1, Colorado River Basin Salinity Control Project. In U.S. Fish & Wildl. Serv. The Mitigation Symposium -- a national workshop on mitigation losses of fish and wildlife habitats. U.S. Fish & Wildl. Serv., Washington, D.C.
[The U.S. developed a plan to control salinity in the Colorado River in response to protests made by the Mexican government. Initially, almost no attention was paid to NEPA requirements. Mumme Farm, adjacent to the Arlington State Wildlife Area, was added as mitigation.]

Shuler, Lt. Col. W.R., U.S. Army Corps of Engineers
1951 Letter to Thomas L. Kimball, Director, Arizona Game & Fish Department, Feb. 26, 1951.
[Shuler notifies AGFD of a draft report on flood control and a flood survey of the Gila and Salt rivers from McDowell Dam site downstream to Gillespie Dam. This begins a 37 year long correspondence between ACE and the AGFD on flood control projects and conservation needs in the study area.]

Spiller, S.F.
1988 Letter to Robers S. Joe, U.S. Army Corps of Engineers, Los Angeles District, April 20, 1988.
[Letter identified the Yuma clapper rail as using marshy areas along Salt and Gila rivers and the bald eagle and peregrine falcon utilizing the area as transients and winter migrants. See Appendix A.]

Turner, Raymond M.
1974 Map showing vegetation in the Phoenix area, Arizona. USGS, Misc. Invest. Series, I-845-I.
[Shows general vegetation of the area covered by the USGS, 2° (1:250,000 scale), topographic map, sheet 30 x 40 inches. Vegetation of the Salt and Gila rivers mapped as "riparian".]

Turner, S.F., and H.E. Skibitzke
1952 Use of water by phreatophytes in 2,000-foot channel between Granite Reef and Gillespie Dams, Maricopa Co., Arizona. Amer. Geophys. Union Trans. 33(1):66-72.
[Results of a 1950 cooperative study by ACE and USGS comparing water losses in cleared channels to water losses in vegetated channels. Extensive vegetation descriptions from aerial photography and field surveys.]

U.S. Army Corps of Engineers
1957 Interim report on survey for flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona. U.S. Army Corps of Eng.
[ACE studied flood control projects and finally recommended clearing and channelization of the study area. Their project was never implemented due to Congressional authorization of the Central Arizona Project with Orme Dam as the principal flood control method.]

U.S. Army Engineer District, Los Angeles Corps of Engineers
1981 Phoenix Urban Study Final Report: Summary report. U.S. Army Eng. Dist., Los Angeles Corps of Eng.
[Summary of numerous interrelated studies of flood control feasibility, alternatives, and environmental impacts throughout the Phoenix Metropolitan area.

Includes the Rio Salado project and channelization and clearing of portions or all of the study area.]

U.S. Army Engineer District, Los Angeles Corps of Engineers
1981 Phoenix Urban Study Final Report: Background information appendix. U.S. Army Eng. Dist., Los Angeles Corps of Eng. [Physical, socioeconomic, environmental descriptions of the Salt RIver Valley. Descriptions of water resources, discussion of human needs, water rights issues, current studies and planning efforts.]

U.S. Army Engineer District, Los Angeles Corps of Engineers
1981 Phoenix Urban Study Final Report: Impact assessment and evaluation appendix. U.S. Army Eng. Dist., Los Angeles Corps of Eng.
[Reports on environmental baseline, water quality, flood control, and water conservation in the Metropolitan Phoenix area.]

U.S. Bureau of Land Management
1954 Public Land Order 1015.
[Reserves 6,896.14 acres of BLM land between Gillespie Dam and 91st Avenue for use by the Arizona Game & Fish Dept. for their Gila R. Waterfowl Proj.]

1979 Final Environmental Impact Statement, Southern California Edison Company proposed 500 kv Palo Verde-Devers power transmission line, Palo Verde Generating plant, Arizona, to Devers substation California.
[Study area includes a small portion of the study area in the vicinity of Arlington.]

1985 Lower Gila South Resources Management Plan, Final Environmental Impact Statement. U.S. Bureau of Land Manag., Phoenix District, Arizona,
[Mentions Fred J. Weiler Greenbelt and briefly discusses its history. States that a management plan will be developed by BLM in cooperation with FWS and AGFD at a later date.]

U.S. Bureau of Reclamation, Lower Colorado Region
1977 Central Arizona Project, geology and ground-water resources report, Maricopa and Pinal counties, Arizona. U.S. Bureau of Recl., Lower Colo. Reg.
[Descriptions of geological and hydrological cross-sections across major valley sections. Centers on the Salt River from Granite Reef Dam to Tempe.]

U.S. Dept. of the Army
1962 License, FOR: Conservation and management of wildlife and development of public access areas.

[Grants AGFD license to manage until the year 2012. Letter signed April 10, 1962.]

U.S. Fish and Wildlife Service
1981 Environmental Impact Statement, clearing of phreatopyhtic vegetation from the Salt and Gila rivers, Ninety-first Avenue to Gillespie Dam, Maricopa County, Arizona. U.S. Fish & Wildl. Serv., Reg. 2, Dec. 1985.
[EIS on flood control and water loss reduction by removal of riparian vegetation from a 1000 ft. wide channel.]

1986 Draft Environmental Assessment, Salt and Gila rivers, Ninety-first Avenue to Gillespie Dam pilot channel, Maricopa County, Arizona. U.S. Fish & Wildl. Serv., Reg. 2, Oct. 1986.
[Covers channelization through the study area. Channel planned to average 3 ft. deep, and carry 1000 cfs.]

van Hylckama, T.E.A.
1963 Growth, development and water use by saltcedar (_Tamarix pentandra_) under different conditions of weather and access to water. _In_ Gen. Assem. of Berkl., Aug. 19-31, 1963. Internat'l.

Union Geod. and Geophys. and Internat'l. Assem. Sci. Hydrol.
Publ. 62:75-86.
[Evapotranspiration field studies at a station on the Gila R. near Buckeye in 1959.]

Walters, M.A., R.O. Teskey, T.M. Hinckley
1980 Impact of water level changes on woody riparian and wetland communities. Vol. VII. Mediterranean region, western region, and semi-arid region. U.S. Fish & Wildl. Serv., Off. Biol. Serv., FWS/OBS-78/93, 83 p.
[Uses data from several previous studies of Gila and Salt rivers, but no new data offered.]

Water Resour. Res. Center and Univ. of Arizona, School of Renewable Natur. Resour.
1979 Phoenix Urban Study Final Report: Plan of study for a demonstration recharge project in the Salt River Valley. Prepared for U.S. Army Corps of Eng., Los Angeles Dist.
[Proposes a plan for recharging groundwater in the Salt River Valley.]

Webb, Paul
1967 Biological reconnaissance report of 150 acres of Gila River land located 2 miles southeast of Buckeye, Arizona. Unpubl. rep., Ariz. Game & Fish Dept., Phoenix, Arizona, 2 p.

[Brief description of wildlife and wildlife habitat in a tract of Gila R. land under consideration for purchase by AGFD.]

Wigal, D.D.
1973 A survey of the nesting habitats of the white-winged dove in Arizona. Ariz. Game & Fish Dept., Spec. Rep. 2, 37 p. [Overview and descriptions of major white-winged dove populations in southern Arizona, including the Gila R. in the study area.]

Wirth and Associates
undated Mumme Farm Mitigation Project, development alternatives. Wirth Assoc., Phoenix, Arizona, prepared for U.S. Bureau of Recl., Lower Colo. Reg. Off.
[Mumme Farm was intended to raise forage and provide nesting habitat for important waterfowl species as mitigation for habitat lost to BORs salinity control project. The preferred alternative, with some modification, was eventually approved and implemented.]

## SECTION 3 - CULTURAL RESOURCES

### 3.1 INTRODUCTION AND DESCRIPTION OF THE STUDY AREA ENVIRONMENT

The entire project area has been greatly modified by urbanization and early agricultural activities, as well as major modifications to the drainage systems associated with the Salt River. The present environmental data is very incomplete and information provided below includes information from the prehistoric and early historic environment. The climate, topography, and geology have not been radically altered; the hydrology, flora, and fauna have been greatly changed.

#### 3.1.1 Topography, Geology, and Hydrology

The Gila and Salt Rivers are the primary drainages in the project vicinity. Both rivers generally flow east to west and were perennial streams prior to damming for modern irrigation projects. The project study area lies within a broad alluvial floodplain of both the Verde, Salt, and Gila Rivers and their tributaries. The project area does contain some isolated buttes and mountains; however, in general, they do not play an important role in the study area.

Geologically the study area is dominated by Pleistocene silts and gravels derived by erosion from the surrounding mountains (Wilson et al. 1957). Soils are generally classified as recent alluvium although certain portions of the study area contain stable soil surfaces which date to the Late Pleistocene (Effland 1988, personal communication). Generally soils are moderately alkaline and slightly to strongly calcareous but extremely fertile when provided with adequate water (Yablon 1981:7). The soils associated with the Salt River can be divided into an upper overburden level and a lower river-run level. The overburden level consists of clays and silts with some sand present, while the river run consists of sand cobbles and boulders of igneous and metamorphic materials (Yablon 1981:7). The river is generally 10-20 feet below the present ground surface although this varies widely over the 80 mile stretch of the river within the project area.

#### 3.1.2 Flora and Fauna

The flora of the area is dominated by species of the Lower Sonoran Life Zone of the Basin and Range Province, interspersed with large expanses of cultivated fields and urban and residential vegetation. The alluvial floodplain was most likely characterized by a widespread desert scrub plant community dominated by creosote-saltbush-bursage forms (Lowe 1964:26-27). Better drained areas along the first and second terraces of the river would also contain saguaro, cholla, and barrel cactus, and palo verde trees.

Extensive marsh areas probably bordered the Salt River supporting cattail, reeds, bullrush, and arrow weed. Larger plants including cottonwood, willow, and dense stands of mesquite also grew along the river. Bohrer (1970:12) notes that dense shrub growth often crowds the margins of modern canals and evidence suggests that similar growth also occurred along the prehistoric canals. Within the now dry river channel and in areas of highly mineralized soils, desert saltbush was probably the most conspicuous plant, often accompanied by creosote bush.

Fauna in the area is now dominated by introduced domestic species and native species capable of tolerating urban development and changed floral conditions. Prehistoric fauna would have been typical of the Lower Sonoran Life Zone. Most abundant would have been small mammals such as rabbits, ground squirrels, rats, and mice. Larger animals including mule deer, javelina, and coyote would have been abundant (Cockrum 1964:249-259). Reptiles, particularly snakes and lizards, would have also been common (Lowe 1964:150-174). The bird population would have also been abundant with the marshy margins of the river attracting large numbers of migratory birds as well as supporting fish, turtles, and amphibians.

### 3.1.3 <u>Climate</u>

The project area, which includes the Phoenix metropolitan area, consistently has the hottest temperatures in the country during the summer months. The average annual temperature of Phoenix is 71.9°F with a range from 92°F in July to 53°F in January. Temperatures of 90°F and above occur 161 days per year; with values below 32°F occurring only six days per year (Sellers and Hill 1974:378).

Phoenix receives an annual rainfall of only 7.59 inches with August usually the rainiest month (1.52 inches) and May the driest (0.05 inch). Severe short-term thunderstorms provide the majority of the precipitation.

## 3.2 CULTURAL HISTORY

### 3.2.1 <u>Background Data</u>

Although Arizona bears evidence of at least 12,000 years of human culture, is likely that few resources predating 2,000 years old exist within the study area. The primary occupation within this portion of the Salt River is dominated by culture historical periods labeled Hohokam (2,000 to 500 years ago), Protohistoric (500 to 300 years ago), and Historic (300 years ago to present). The Archaic Culture, which dates between 8,000 and 2,000 years ago, turns up sporadically in Arizona but it is not a time period which has been extensively studied. Archaic sites within the project area are difficult to recognize but are definitely present (Effland 1988, personal communication). Discoveries of Late Pleistocene culture sites are almost always accidental, due to their rarity in an environment that has changed drastically in the past 8,000 years. Records at Arizona State University indicate that mammoth remains were encountered in the bed of the Salt River in 1956. No mention of human occupation was noted but the presence of Pleistocene fauna in the immediate environs of the project area indicates that potential Paleoindian remains could be encountered.

The archaeological literature of southern Arizona is extensive and forms a rich resource base. The Phoenix basin and metropolitan area is a region undergoing extensive development with the result being that information on cultural resources is increasing almost daily. Soil Systems, Inc. is currently involved in a multitude of projects located near the Salt River. In addition to these unpublished studies, the Office of Cultural Resource Management of Arizona State University has recently released a seven volume set on work at La Ciudad (Ackerly et al. 1987; McGuire 1987; Kisselburg et al. 1987; Rice 1987a; Wilcox 1987; Henderson 1987; and Rice 1987b). These volumes are in addition to the previous information on La Ciudad (Yablon 1981).

In addition to information on the large Hohokam platform mound complex at La Ciudad, similar work at Las Colinas is also nearing completion (Teague 1988, personal communication). This work again helps to summarize data from Hammack and Sullivan (1981) and Schreiber et al. (1981).

These specific studies, as well as overview data from Berry and Marmaduke (1982), Brown and Stone (1982), Teague and Crown (1982, 1984), Stone (1983), Cable et al. (1982, 1984), Gregory and McGuire (1980), and Marmaduke (1984), were utilized to produce this overview. These studies should be examined in detail to provide the full flavor of the variability of resources within the study area.

### 3.2.1 Archaic Cultures

Published knowledge on Archaic culture is somewhat sparse and generally tied into ideas established in the 1950s. Data from excavated Archaic sites in Arizona in general are few in number, with even less information available for the study area. Archaeologists originally believed that the lack of Archaic data was the result of limited occupation in the region due to difficult environmental conditions. The real cause, however, is related to a lack of interest in Archaic occupation, difficulty in identifying Archaic sites, and the fact that Archaic sites may lie buried beneath recent alluvial deposits. This lack of emphasis on Archaic sites in beginning to change (Downum et al. 1986; Bostwick 1988, personal communication).

Archaic cultures in southern Arizona have been divided into two regional variants: the Cochise Culture in the east and the Amargosa Culture to the west. Upon closer examination, the distinction between the two cultures is not readily apparent (Marmaduke 1984).

Both the Cochise and Amargosa Cultures have been divided into three temporal divisions which ostensibly represent an early-middle-late temporal sequence. The Cochise has been divided into Sulphur Springs (pre-6,000 years ago), Chiricahua (6,000-4,000 years ago), and San Pedro (4,000-2,000 years ago). Similar temporal divisions have been made for the Amargosa with a San Dieguito/Amargosa I (early,) Amargosa II (middle), and Amargosa III (late).

In general, the Sulphur Springs Stage of the Cochise represents an Archaic style of adaptation in which Late Pleistocene fauna were the primary prey species. As such the Sulphur Springs represents a Paleoindian type of adaptation rather than Archaic. This transition took place at different times across the western United States, but due to a lack of information, the interface between the two adaptations remains fuzzy at best.

The Chiricahua Stage represents a true Archaic assemblage of stone tools. Pressure-flaked projectile points, large millingstones, and bifacially percussion-flaked tools are hallmarks of the stage. Projectile point styles commonly associated with the Chiricahua Stage include the Pinto point series and the Chiricahua projectile point style. Both projectile point styles, however, have a wide geographic and temporal distribution (Heizer and Hester 1978; Meighan 1981; Berry and Marmaduke 1982).

The San Pedro Stage represents the late Archaic period in the Cochise. San Pedro points are the hallmark artifact for the stage. The remainder of the artifact assemblage is similar to earlier remains with one major exception; San Pedro stone tools are often finished with pressure flaking rather than percussion flaking only (Marmaduke 1984:24).

San Pedro Stage sites contain the earliest evidence of sedentism. Sites in the late San Pedro occasionally contain evidence of houses. Radiocarbon dates indicate that San Pedro State sites and the earliest recognizable Hohokam occupation may overlap temporally in southern Arizona and may support implications that the Hohokam culture is derived from in situ development out of the local Archaic base (Marmaduke 1984:25).

The Archaic culture within the project area is poorly known. Relatively few sites affiliated with the Archaic culture have been recorded. The lack of information as stated above is probably due to a lack of visibility and/or a lack of recognition of Archaic sites within the floodplain/terrace environment. It would be extremely surprising if no Archaic resources were present in an area containing a permanent water supply. Future research should be directed toward a survey in which areas of the Salt River Valley which have not been subjected to massive alluviation should be intensively examined for Archaic remains.

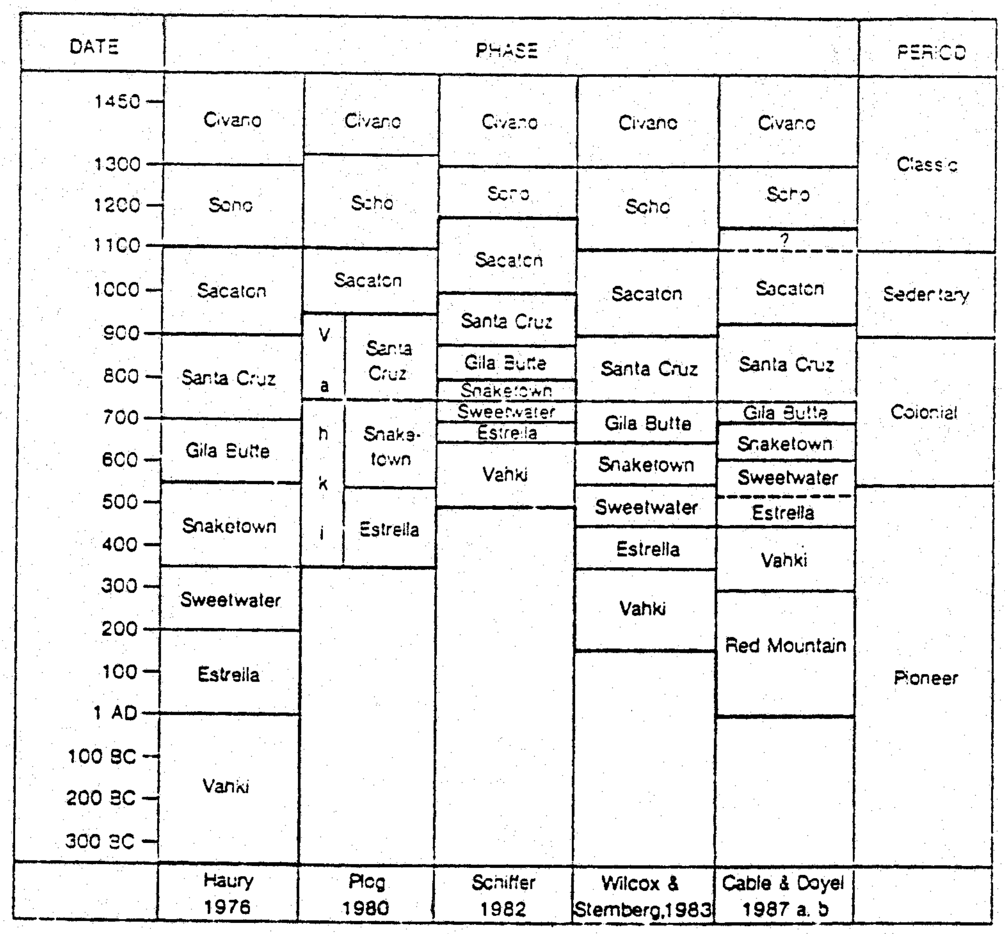
### 3.2.3 <u>Hohokam Culture</u>

The Hohokam were a ceramic making, agriculturalist people inhabiting much of central and southern Arizona late in the prehistoric era. The culture is first recognizable in the archaeological record as early as 300 BC (Haury 1976:338) or as late as AD 500 (Schiffer 1982:335) depending upon which set of radiocarbon dates are accepted. No matter what date proves to represent the truth, the beginning of Hohokam and the end of the Archaic appears to be almost simultaneous (Marmaduke 1984:25).

Hohokam culture has been defined based on a number of traits. These traits include a distinctive ceramic tradition, "irrigation agriculture, platform mounds, great houses, palettes and pyrite mirrors, ball courts, clay figurines, towns, cremations -- a Mesoamerican outpost in North America" (Marmaduke 1984:25-26).

Debates concerning the Hohokam chronology always start with and return to Haury's (1936) initial formulation of the Hohokam phase sequence and his subsequent reconfirmation of this sequence in the 1964-1965 excavations at Snaketown (Haury 1976). Haury devised a sequence with four periods divided into nine phases (Figure 3.1). His sequence begins with the Vahki phase in 300 BC and ends in the Civano phase in about AD 1450. Numerous variations of the model have been proposed with Schiffer (1982) providing a detailed summary and history of the debates and the reasons for modifications. These modifications represent a continuing controversy in Hohokam archeology with Eighmy and McGuire (1988) shedding new light on the controversy. This will be further discussed later in this section.

A second controversy concerning the Hohokam is with regard to origins. Gladwin (Gladwin and Gladwin 1929a, 1929b, 1930a, 1930b, 1935; Wilcox 1979) has argued that the Hohokam developed out of an indigenous base around 300 BC adopting agriculture and settling down to a sedentary lifeway founded on irrigation of dry desert lands. These early Hohokam lived in scattered, barely organized "rancherias" or rambling villages spending the 800 years of the Pioneer period simply developing their culture and expanding their population in situ (Marmaduke 1984:26). At the start of the Colonial period in AD 500 the culture expanded,




Proposed Hohokam chronologies for the Phoenix Basin (from Eighmy and McGuire 1988:Figure 2)

PROPOSED HOHOKAM CHRONOLOGIES

FIGURE 3.2-1

pushing out to establish new settlements in areas favorable to their economic endeavors. It was during the Colonial period expansion (AD 500-900) that the Hohokam made contact with other less developed cultures in the surrounding areas. The expansion ended at AD 900 and from then until AD 1100 the outlying Colonial period settlements collapsed inward on the Salt-Gila basins. This time period termed the Sedentary period resulted in the development of larger population aggregates and a resultant increase in social and technological complexity (Marmaduke 1984:27).

Around AD 1100 the Hohokam received infusion from a new culture, the so-called "Salado invasion". This infusion of outside influences from the Plateau and Mountain regions of Arizona apparently helped to bring about the Classic period. The Classic period includes the construction of the "Great Houses", platform mounds and other trappings generally associated with the Hohokam. The system collapsed around AD 1400 for unknown reasons. Haury (1976) suggests that irrigated fields became salinized or that an even more severe climatic regime forced the Hohokam to return to a less highly developed technological culture.

An alternative model of Hohokam origins is Di Peso's (1956) two culture theory. Di Peso argued that what has been called Hohokam is in reality a long history of relations between an indigenous population called the "Ootam" and an invading, better organized and more technologically competent Mexican population, the "Hohokam". These Mexican invaders controlled the river valleys where they could employ their already perfected irrigation technology and at the same time leaving the upland areas to the Ootam.

Di Peso saw the Ootam as developing in situ out of the Paleoindian/Archaic to sedentary nuclear family settlements by 1050 BC, and later into kin group settlements in Gladwin's Pioneer period at AD 400. The Mexican (Hohokam) invasion occurred around AD 900 and represents the Colonial period expansion as discussed by Gladwin. Di Peso further indicates strong diffusion by Anasazi groups around AD 1100. By AD 1200 the Hohokam irrigation technology failed. At this point the Ootam overthrew the Hohokam; an event which ushered in the Classic period. The later Classic period around AD 1400 may have seen either a return of the Hohokam in a more highly organized form or continued in situ development of the Ootam. The late efflorescence resulted in the construction of huge multi-settled villages with Great Houses. Di Peso indicates that this phase continued until possibly as late as AD 1690 at which time the Ootam/Hohokam were overthrown by surrounding groups.

A third alternative scenario for the Hohokam has been presented by Wilcox (1979) and Wilcox and Sternberg (1983). Wilcox agrees that the Hohokam were indigenous to the area, developing out of the San Pedro stage of the Cochise Culture. However, he believes that not all Cochise people became Hohokam: only those in the river basins where arable lands were extensive. The groups living outside of these basins continued to practice a hunter-gatherer (Archaic) subsistence strategy. The Hohokam farmers and hunter-gatherers according to Wilcox established a trading relationship for their mutual benefit by late Pioneer times. This exchange system was maintained even after peripheral groups had begun to convert their economics to semi-sedentary agricultural ones resembling the Hohokam. This is represented by the Colonial period. Wilcox suggests that this change in economy also precipitated changes in the exchange system. He cites the location of ball courts at the edges of only a few central Hohokam sites, along with differential distribution of exotic artifacts as evidence of a possible "trading fair" organization (Marmaduke 1984:29).

Ballcourts were implicated as being a focus for trading events, which were jointly sponsored by several villages. These types of activities probably reinforced status differentiation within the regional structure of Hohokam community. It could also in fact account for "Colonial Expansion" since newly agricultural participants in a Hohokam system would probably show considerable Hohokam material traits, transmitted by trade, the pressures of conformity and even intermarriage (Marmaduke 1984:29)

According to Wilcox (1979) and Wilcox and Sternberg (1983) the trade system apparently deteriorated in the Sedentary period primarily due to the increasing success of the peripheral economies. This increased success resulted in shifting alliances with closer neighbors, eventually excluding the core area in the Gila Basin. The Sedentary period also contains evidence of a greater number of dry farming settlements resulting in further fragmentation of the Hohokam regional system. Evidence also suggests that groups formed alliances with fewer communities, resulting in a more complex social stratification providing a more direct and less ambiguous system of decision making.

The Classic period continued the trend initiated in the Sedentary period. Fewer settlements banded together in alliance; these settlements were tightly organized drew greater numbers into their boundaries achieving new economics of scale through the consolidation of canal networks. During the Classic period, a single large central canal would have served two or three large settlements (Upham and Rice 1980). The consolidation of population under a restricted elite lent new wealth and power to locally smaller systems. This allowed long distance relations with other groups on the Plateau and in Mexico to become possible without economically ruining the community. The trade created more wealth and stratification and culminated in the construction of platform mounds and internally differentiated Great Houses.

This summary of the origins and expansion of Hohokam provided three different approaches with regard to the beginning and development sequence of the Hohokam in general. A brief description of the traits of the four major time periods of the Hohokam is presented below.

### 3.2.3.1 Pioneer Period (300 BC - AD 550)

The starting and ending date for all periods of the Hohokam has been the subject of much controversy (Figure 3.1). Even the study by Eighmy and McGuire (1988) has not shed light on the dating of the Pioneer period.

During the Pioneer period, dwellings were at first large and square with slightly depressed floors and walls of poles and brush. Some dwellings had two entryways which may be indicative of multiple family occupation (Cordell 1984:61). Later houses in the Pioneer period are either square with rounded corners or rectangular with right angle corners. This style remained consistent until the Classic period, although house size tended to decrease through time. One of the hallmarks of the early Hohokam culture is the use of cremation. Pioneer period cremations are secondary interments in pits or trenches accompanied by crushed burned pottery as grave offerings. In addition to cremation, flexed and extended burials were also found at sites of this period. The majority of Pioneer period ceramics are non-painted wares. Early Pioneer period ceramics consisted of undecorated brown or graywares. Painted ceramics first occurred in the later Pioneer period with red-painted geometric designs applied to a buff background. In addition to the red on buff designs, some vessels were decorated by incised lines or grooves. Simple ceramic figurines, stone bowls, stone palettes, stones axes and items made of shell obtained from the Gulf of California and the Pacific Ocean are also known (Cordell 1984:61-62).

### 3.2.3.2 Colonial Period (AD 600-900)

Estimations for the beginning of the Colonial Period range from AD 600 (Haury 1976) to AD 800 (Schiffer 1982). During the Colonial period, the Hohokam experienced considerable expansion. Domestic architecture basically remains unchanged; however, new architectural forms such as platform mounds and ballcourts are introduced. The former are caliche capped trash mounds; the latter are large elongated structures with expanded end fields and east-west orientations (Cordell 1984:62). Ballcourts have been interpreted as dance grounds, wells, or ballcourts similar to those used in Mesoamerica. Irrigation canals although present in the Pioneer period, became an important part of the Colonial system. Colonial period cremations include both primary and secondary burials. Grave offerings now include projectile points, stone vessels, slate palettes and stone axes, in addition to ceramics. Plainware ceramics continue with an increased utilization of painted styles and the dropping of incising and grooving.

### 3.2.3.3 Sedentary Period (AD 900-1100)

Starting dates for the Sedentary period range from AD 900 (Haury 1976) to AD 1000 (Schiffer 1982). Sedentary period sites continued with the same domestic architectural styles. Ballcourts were slightly modified, being smaller and more oval than those of the Colonial period. Platform mounds now show evidence of repair and/or remodeling. Cremations continued as before. Ceramic styles change slightly with the addition of a pronounced shoulder on jar forms and an increased complexity in geometric designs. Shell in the Sedentary period is more diverse with etched and painted styles common. An innovation of the period is the copper tinkler bell, a trait possibly imported from Mesoamerica.

### 3.2.3.4 Classic Period (AD 1100-1450)

The Classic period has been dated to begin between AD 1100 (Haury 1976) and AD 1176 (Schiffer 1982) with a general consensus on the ending date of AD 1450. The Classic period is characterized by the aggregation of the population into fewer but larger sites. Other dramatic changes occurred which have been at least partially attributed to incursions of non-Hohokam people into the Hohokam area; these include construction of multi storied Great Houses, introduction of polychrome pottery and more inhumations as opposed to cremations. Other aspects of the Classic period remain relatively unchanged. Villages continue to consist primarily of single unit houses with the addition of perimeter walls around the villages. Ceramics continue to be plainwares and red-on-buff styles with the addition of polychromes and other material culture items present, although not as elaborate or plentiful as the Sedentary Period (e.g., stone items, decorated shell, etc.).

At the end of the Classic period, Great Houses are no longer constructed, polychrome ceramics and inhumations are no longer common. Housing styles in general continue and other ceramic types degrade into plainwares of reddish color and greater porosity.

## 3.2.4 <u>The Dating Controversy</u>

As noted above in discussion on the assignment of periods to beginning and ending dates and as documented in Figure 3.1, the temporal sequence of the Hohokam is in a state of flux. Part of this controversy may be due to individual variations in time and space but other aspects are related directly to the usage of ceramic classification as a method of placing assemblages into a chronological context. Eighmy and McGuire (1988) have examined Hohokam chronologies from the aspect of archaeomagnetic dating. They have obtained approximately 700 dates and have made an

attempt to place phases within a tight chronologically controlled system.
The results of their studies in a way reinforce the disparity of chronologies for the Hohokam. They indicate that there is considerable overlap in the range of phase dates. They have determined that phase means are reasonable and significant in terms of order and age and they believe that these overlaps represent the true picture of the Hohokam phase system (Eighmy and McGuire 1988:49). They feel that overlapping distributions represent overlapping time ranges for the use of various pottery styles. Their archaeomagnetic chronology does not support any previously proposed chronology. With respect to the Phoenix Basin, little support is produced for the early portion (Gila Butte and Snaketown) of Haury's long chronology. On the other hand the Soho phase in the archaeomagnetic chronology is nearly 100 years longer than the Schiffer short chronology (Eighmy and McGuire 1988:54).

### 3.2.5 Hohokam Remains in the Study Area

The previous discussions have focused on the Hohokam as a regional entity. This portion of the report will briefly describe the state of Hohokam archaeology as it relates specifically to the Salt River.

The earliest well documented period within the project area occurred in the Pioneer period. Pioneer sites in the region are very simply composed of a few scattered households, with a general lack of differentiation. This lack of differentiation, a low settlement density and the absence of settlement hierarchies indicate relatively low levels of social integration and the possibility of high residential mobility (Cable and Doyel 1985, in Henderson 1987:297-298). Pioneer sites along both the Salt and Gila Rivers have a relatively low site density with sites along the Gila spaced at 5 km intervals (Upham and Rice 1980:94; Wilcox 1979:100).

The transition from the Pioneer to Colonial period encompassed changes in social organization. These changes reflect the emergence of a tribal level of social organization. Henderson (1987:124) suggests the change is triggered by a shift from floodwater farming to irrigation agriculture. During the Colonial period structural properties of the Sedentary Hohokam village came into being. This includes courtyard groups, village segments and cemetery plots. Upham and Rice (1980) suggest an increase in the number of Colonial sites along the Salt River.

The majority of the sites located along the portion of the Salt and Gila Rivers within the project area tend to be associated with the Sedentary and Early Classic periods. The culmination of occupation of the Hohokam includes the construction and habitation of large villages containing platform mounds and Great Houses. A map of the Phoenix area produced by Dr. Omar A. Turney in 1929 lists the presence of 25 major habitation sites in the general Phoenix area as well as hundreds of miles of canal systems.

Recent work in the Phoenix metropolitan area associated with road construction and redevelopment are increasing our knowledge of the Classic period Hohokam almost daily. The publishing of information of La Ciudad by Arizona State University, the publications by Soil Systems concerning the original townsite of Phoenix (Cable et al. 1982, 1984) and the imminent publication of data on Las Colinas (Teague 1988, personal communication), in addition to the previous works on Las Colinas (Hammack and Sullivan 1981) have greatly enhanced our knowledge.

Of particular interest was a study performed by Soil Systems Inc. (Cable et al. 1984) which identified small structures in downtown Phoenix. These structures probably represent fieldhouses and imply agricultural intensification. These structures tend to be smaller than traditional pithouses and are located up to 3 km from the nearest contemporaneous village. These sites and locations closer to the river indicate that the agricultural potential of the region was large from at least the early Colonial period to the end of the Classic.

Cable et al. (1984) state that the geographical setting of large villages in the Salt River Basin correspond consistently to the interface of the first and second terraces of the Salt River. The distances from these villages to the Salt River range from about 3.8 to 5.0 km.

Soils on the first terrace are much more conducive to agriculture, however, the first one kilometer of area away from the river is projected to have been mesquite forest. The implications of the field houses away from the villages and nearer the river may reflect a two fold subsistence strategy based upon agriculture as well as the collection and processing of mesquite. These types of issues concerning the smaller, less spectacular sites must see more research in the future in order to adequately address the Hohokam regional system. These types of sites have generally been ignored in the past, and yet as Cable et al. (1984) have pointed out, they contain valuable data which has not been previously explored.

### 3.2.6 Protohistoric Period

The Protohistoric period for the Phoenix Basin extend from the supposed collapse of Hohokam culture ca. AD 1450 to AD 1693 (Wilcox and Masse 1981). Since people were living in the basin at contact and because possibly post-classic houses have been intruding into Classic Hohokam deposits (Hammack 1969; Hayden 1957) it seems unlikely that the region was ever abandoned for any significant time between the demise of the Hohokam and the dawn of history. Data on this time period is extremely poor and the problem of prehistoric continuity has not yet been resolved

(Burrus 1971; Ezell 1963; Fritz 1977; Haury 1945, 1976; Masse 1981).

There are two opposing views concerning the continuity problems of the Hohokam - Pima/Papago. The first view is that the historic Pima/Papago are descendants of the prehistoric Hohokam (Bandelier 1892; Ezell 1963; Haury 1945, 1950, 1976; Rea 1974; Wilcox and Sternberg 1983), although the evidence supporting this conclusion is circumstantial. The continuity hypothesis is based upon comparison of specific material traits which show both cultures broadly similar.

The other viewpoint simply points out that the largest part of the Haury and Ezell evidence is subjective in nature and can be easily incorporated into an argument against continuity (Fontana et al. 1962; Fritz 1977). Specific differences between Hohokam and Pima/Papago exist and suggest that the Pima were 1) a non-Hohokam indigenous people (Di Peso 1956); 2) Sinaguan refugees (Schroeder 1940, 1947, 1952, 1953); 3) relict groups of the Trincheras Culture of Northern Mexico (Sauer and Brand 1931); or 4) relatively recent immigrants from Northern Mexico (Masse 1981). At this point in time none of the views either for or against cultural continuity have been proven beyond a reasonable doubt.

### 3.2.7 Historic Period

Three political epochs, Spanish, Mexican and Anglo-American comprise the historical record in central and southern Arizona. Only the Anglo-American settlement of the Phoenix Basin has produced any type of physical remains. During both the Spanish (1539-1821) and Mexican Periods (1821-1848) explorers may have passed through the Salt River valley but no traces of these exploration remain (Fryman et al. 1977). Between 1848 and 1865 no Anglo-American activities left a trace.

The Salt River valley has been inhabited for centuries by agriculturalists. In the nineteenth century native populations concentrated along the Gila River because of intense pressure from Apache and Yavapai raiders to the north and east. As Apaches were confined to reservations in the 1870s and 1880s Anglo settlements increased.

Official settlement of the Salt River Valley began in 1865 with the establishment of the U.S. Army post Camp McDowell (became a Fort in 1879) on the west bank of the Verde River six miles upstream from its confluence with the Salt River. At approximately the same time, John Y. T. Smith established a hay camp in the vicinity of the Fort and became the first American settler in central Arizona. Phoenix was established largely on the potential of reconstructing the long abandoned Hohokam system of irrigation canals (Wagoner 1970; Zarbin 1984). The Swilling Irrigation Canal Company was the first to organize in 1867 but was soon followed by a flurry of other private canal companies. Within a decade, eleven canal companies in the Salt River Valley were operating at least 10 ditches on the north side and 11 on the south side (Rogge and Myers 1987).

In 1882, the Arizona Canal Company began to open up an additional 100,000 acres of land on the north side of the Salt River by heading a 40 mile long canal, 25 miles east of Phoenix. Another technological advance was the construction of the Arizona Dam to divert water into the Arizona Canal. This project was completed in 1885 and survived for two decades until it was destroyed by a flood.

The building of dams and canals is a continuing activity within the central Arizona region even into the present (cf. Rogge and Myers 1987). During the early periods of development the population in Phoenix increased dramatically and rapidly. Population increased from 240 in 1870 to 20,000 in 1900 to over 850,000 today. Other key factors responsible for the rapid growth in Phoenix include connection to the railroad system in 1887 which provided an outlet for the citrus and other agricultural products and established of Phoenix as the territorial capitol in 1889 (Fryman et al. 1977).

## 3.4 POTENTIAL CULTURAL RESOURCES IN STUDY AREA

The literature review as well as preliminary reviews of archaeological site records at the Arizona SHPO's office and Arizona State University indicate the numerous cultural resources have been previously identified within the study area. Over one site per linear mile has been identified within the immediate vicinity of the Salt River and many portions of the study area have not yet been subjected to survey coverage at all. This suggests that the number of sites present may increase by a factor of 10 times.

A study completed by Stone (1983) for Maricopa County indicated that 2,343 archeological sites were recorded up to 1983. Of these sites, 11 have been entered on the National Register of Historic Places, 84 sites have been determined eligible for the National Register and two sites have been made National Historic Landmarks. The breakdown of sites consists of 2,020 prehistoric sites (86.2%), 86 sites with prehistoric and historic components (3.7%), and 236 historic sites (10.1%). The vast majority of the sites are associated with the Hohokam culture.

These types of distribution are further corroborated by an extensive survey along the Salt River between Granite Reef Diversion Dam and the confluence of the Salt and Gila Rivers. This survey, completed in 1963-64, recorded over 343 sites including 202 Hohokam sites along the Salt River (Ruppe 1966). Most of the sites recorded along the Salt River were attributed to the Sedentary or early Classic periods, with earlier sites extremely rare. In addition to the Hohokam remains, 18 Pima sites were also recorded.

Prehistoric sites located along the margins of the Salt River can be generally categorized as large Hohokam habitation sites which tend to be located at the interface of the first and second terraces of the river (Cable et al. 1984). These sites also tend to be located 3.8 to 5.0 km from the bed of the Salt River. Smaller sites may be present in areas closer to the river. If the vegetative reconstructions discussed in Cable et al. (1984) concerning a kilometer wide area of dense mesquite brush along the margins of the river is correct, it is unlikely that permanent habitation would occur in that zone; however, the edge of the mesquite zone would represent an ideal location for plant procurement camps.

Another archaeological resource which is particularly sensitive within the study area is the take-off points of prehistoric canals from the river floodplain. The map of prehistoric irrigation canals (Turney 1929) provides an interesting distribution of canals on both the north and south banks of the river. The presence of these canals may be obscured by recent disturbance in the area; however, at a minimum 16 prehistoric canal takeoff points were identified in 1929.

Finally a number of historic resources have been identified within the project area. Most prominent are the Granite Reef Diversion Dam built in 1906-1908; the Swilling Ditch Head built in 1867-1868; and the Old Tempe Bridge over the Salt River built in 1912 by convict labor. All three of these historic resources are potentially eligible for the National Register (Fryman et al. 1977).

At this point in time none of the prehistoric cultural resources within the study area have been nominated to the National Register. A number of these sites however should be considered as potentially eligible and it may be a matter of time before formal eligibility determinations are made.

The Gila River portion of the study area also is known to contain prehistoric resources similar to what has been documented along the Salt River. Since the Gila River area is less disturbed and has not been subjected to the high development pressure that the area along the Salt River has experienced, there have been fewer areas surveyed and consequently fewer sites identified.

## 3.5 CONCLUSIONS AND RECOMMENDATIONS

Results of the cultural resources overview and a preliminary records search indicate that the study area has the potential to contain a high number of cultural resources. These resources are primarily associated with the Hohokam occupation of the region which could have begun as early as 300 BC and lasted until approximately AD 1450. This occupation was generally represented by a sedentary population of ceramic producing agriculturalists who originally were grouped into small villages termed rancherias and eventually formed into large village aggregations consisting of platform mounds, ballcourts, multi-storied Great Houses and walled village compounds. The agricultural pursuits of this society would not have been possible without the presence of extensive networks of irrigation canals. At least 16 such canal heads have been identified along the portions of the Salt River within the study are.

It is unknown how many archaeological sites exist within the study area but estimates of between 10 and 17 sites/square mile have been proposed. These sites tend to be concentrated on the first and second terraces of the river although sites within certain portions of the floodplain may also occur. At present few sites have been found within the channel of the Salt and Gila Rivers and the likelihood of such finds is slim without major ground disturbing activities. It must be kept in mind however that the rivers have had a dynamic past and it may be possible that changes in the course of the river could have buried cultural resources in the past.

Determination of the number of sites potentially within the project area would be dependent upon obtaining information of the number of sites currently within the project area (rough estimate of 100) and the percentage of the project area that has been surveyed (rough estimate 15%). This figure could be further refined by including vegetation and/or physiographic zones and obtaining information on the number of areas which have been subjected to severe disturbance.

Prior to development of any preliminary flood control projects in the area, it is recommended that a complete records check be conducted on the area of concern and that field surveys be conducted subsequent to the records check. It is likely that any major project would significantly impact cultural sites which would require extensive mitigation.

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1987 _A Plan for Archaeological Investigations at Historic Dam Construction Camps in Central Arizona_. Dames and Moore, Phoenix, Arizona. Prepared for U.S. Bureau of Reclamation, Phoenix, Contract No. 6-CS-30-04360.

[This report summarizes information on the historic occupation of the central and southern Arizona area as it relates to water control devices.]

Sauer, C., and D. D. Brand
1931 Prehistoric Settlement of Sonora with Specific Reference to Cenos de Trincheras. University of California Publications in Geography 5(3):67-148.
[This report provides evidence that cultures other than Hohokam, Pima and Papago inhabited the region.]

Sayles, E. B., and Ernst Antevs
1983 The Cochise Cultural Sequence in Southeastern Arizona. Anthropological Papers of the University of Arizona, No. 42. University of Arizona Press, Tucson.
[This report represents revisions to an early study of the Cochise culture, one of the earliest archaeological manifestations in southern Arizona.]

Schiffer, M. B.
1982 Hohokam Chronology: An Essay on History and Method. In Hohokam and Patayan, Prehistory of Southwestern Arizona, edited by R. H. McGuire and M. B. Schiffer. Academic Press. New York.
[This study reviewed Hohokam chronology. It differs significantly from the other chronologies set up for the region in that starting dates for the beginning of the Pioneer phase are more recent.]

Schreiber, Katharina J., Carol H. McCarthy, and Brian Byrd
1981 Report of the Testing of Interstate 10 Corridor, Prehistoric and Historic Archaeological Remains Between Interstate 17 and 30th Drive (Group II, Las Colinas). Cultural Resource Management Division, Arizona State Museum, University of Arizona Archaeological Series, No. 156. Prepared for Arizona Department of Transportation.
[This study provides information on both prehistoric and historic resources found in the general vicinity of Las Colinas Ruins.]

Schroeder, A. H.
1940 A Stratigraphic Survey of Pre-Spanish Trash Mounds of the Salt River Valley, Arizona. M.A. thesis, University of Arizona. Tucson.

1947 Did the Sinagua of the Verde Valley Settle in the Salt River Valley? Southwest Journal of Anthropology 3(3):230-246.

1952 Documentary Evidence Pertaining to the Early Historic

Period of Southern Arizona. New Mexico Historical Review 27(2):137-167.

1953 The Bearing of Architecture on Development in the Classic Hohokam Period. Southwest Journal of Anthropology 9(2):174-192.

[These studies provide information on alternative ways to examining the Hohokam/Pima/Papago continuity.]

Sellers, William D., and Richard H. Hill
1974 Arizona climate, 1931-1972. University of Arizona Press, Tucson.
[This report provides general background data on the climate of the Phoenix region.]

Stone, Lyle M.
1983 An Inventory and Evaluation of Recorded Archaeological Sites in Maricopa County, Arizona. Prepared for Maricopa County Parks and Recreation Department, Phoenix.
[This comprehensive study provides information on every known site recorded in Maricopa County. These data have been divided into a number of categories. Conflicts with land usage are generally given and a listing of sites previously destroyed is also given.]

Teague, L. S., and P. L. Crown
1982 Research Design. Hohokam Archaeology Along the Salt-Gila Aqueduct, Central Arizona Project, Vol. 1. Arizona State Museum Archaeological Series, No. 150. Tucson.

1984 Synthesis and Conclusions. Hohokam Archaeology Along the Salt Gila Aqueduct, Central Arizona Project, Vol. IX. Cultural Resource Management Section, Arizona State Museum, University of Arizona, Archaeological Series, No. 150. Prepared for U.S. Bureau of Reclamation, Contract No. 0-07-32-V0101.
[These two studies provide expectations and conclusions on the massive Central Arizona Project, one of the largest archaeological projects ever undertaken in the United States.]

Turney, Omer A.
1929 Prehistoric Irrigation. Arizona Historical Review, Phoenix.
[This study provides an excellent map of the Phoenix Basin portraying the location of all of the major ruins and canal systems prior to the massive urban development of the Phoenix area.]

Upham, S., and G. Rice

1980 Up the Canal Without a Pattern: Modelling Hohokam Interaction and Exchange. In _Current Issues in Hohokam Prehistory_, edited by D. Doyel and F. Plog, pp. 78-105. Arizona State University Anthropological Papers, No. 23. Tempe.
[This report provides pertinent information on the distribution of sites along both the Gila and Salt Rivers from both a temporal and spatial perspective.]

Wagoner, Jay J.
1970 _Arizona Territory 1963-1912: A Political History_. University of Arizona Press, Tucson.
[This report provided historical background related to the original occupation of Phoenix in the 1970s.]

Wilcox, D. R.
1979 The Hohokam Regional System. In _An Archaeological Test of Sites in the Gila Butte-Santan Region, Arizona_. Arizona State University Anthropological Papers, No. 18. Tempe.
[This study provides information utilized in formulating the sequence of events which leads up to the major occupation of central Arizona by the Hohokam.]

1987 Frank Midvale's Investigation of the Site of La Ciudad. _Ciudad Monograph Series_, Vol. 4. Office of Cultural Resource Management, Department of Anthropology, Arizona State University, Anthropology Field Studies, No. 19. Prepared for Arizona Department of Transportation, Phoenix, Contract No. 82-11.
[This report provides a summary of the data collected by Midvale. This study includes information on sites which had not been previously published.]

Wilcox, D. R., and W. B. Masse
1981 _The Protohistoric Period in the North American Southwest A.D. 1450-1700_. Arizona State University Anthropological Research Papers, No. 24.
[This report provides information on the controversy concerning the cultural continuity of the Hohokam into the historic period.]

Wilcox, D. R., and C. Sternberg
1983 _Hohokam Ballcourts, A Comparative Study and its Implications Concerning Mesoamerican Connections_. Arizona State Museum Archaeological Series, No. 160. Tucson.
[This study provides further information on the cultural continuity problem]

Wilson, Eldred E., et al.

1957 Geological map of Maricopa County, Arizona. Prepared by the Arizona Bureau of Mines, University of Arizona, Tucson.
[This study provided general information on the geology, topography and soils of the study area.]

Yablon, Ronald K.
1981 Archaeological Investigations, Arizona Department of Transportation, Phoenix, Testing at La Ciudad (Group III), West Papago-Inner Loop (I-10), Maricopa County, Arizona. Museum of Northern Arizona, Department of Archaeology, Flagstaff.
[Another in a series of reports associated with the archaeological work at La Ciudad.]

Zarbin, Earl
1984 Roosevelt Dam: A History to 1911. Salt River Project, Phoenix.
[This report provided information on early dam construction in the general project area and how this construction helped in the growth of the Phoenix area in particular, and Arizona in general.]

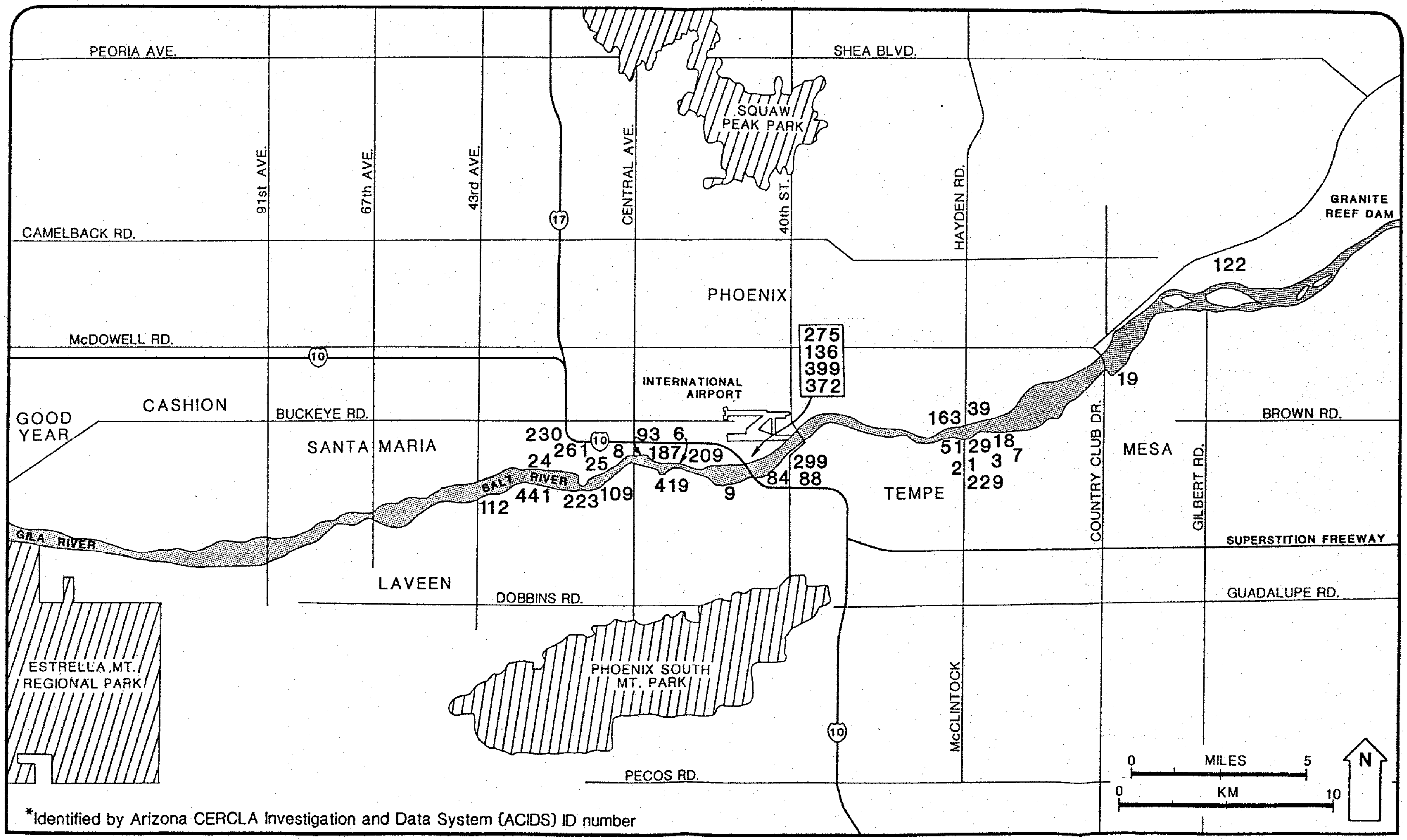
# SECTION 4 - HAZARDOUS WASTE SITES

The study area is characterized primarily by a mix of urban and industrial uses along its length running through the Phoenix/ Tempe and adjacent area. As such, the area contains a variety of land uses subject to past and present use and storage of contaminated waste materials. Information was acquired from publicly available listings of identified waste sites from the State of Arizona and information acquired under the Freedom of Information Act for an L.8 listing of CERCLIS sites and National Priority List sites from the U.S. Environmental Protection Agency.

## 4.1 GENERAL DESCRIPTION OF STUDY AREA ENVIRONMENT

The Salt River flows from Granite Reef southwest through the Salt River Indian Reservation through the central Phoenix/Tempe area parallel to the downtown area, and adjacent to Arizona State University (Tempe) and the Phoenix International Airport. This area is characterized by a mix of land uses including residential, commercial and industrial. West of the airport into the adjoining communities of Santa Maria, Laveen, Cashion, and Goodyear, the river passes through a mix of commercial and industrial uses.

Many businesses are operating in the area which generate and store hazardous waste. In addition, vacant sites exist which either potentially contain or are known to contain contaminated materials. The State of Arizona has responsibility for hazardous waste under their Environmental Quality Department, Site Discovery and Hazardous Evaluation Unit. The Unit publishes a "zipACIDS" [Arizona CERCLA Investigation and Data System (ACIDS)] listing of hazardous sites by zipcode. This listing contains locations subject to investigations concerning possible contamination of soil, surface water or groundwater. However, this does not mean that the location is contaminated or is causing contamination, or is in violation of State or Federal statutes or regulations. In addition, listings were acquired from the U.S. EPA for their SuperFund Program sites also within zipcode determinations. Those sites located within approximately 1/2 mile from the River were identified (see Table 4.1-1) and mapped (Figure 4.1-1). The table identifies the sites by ACIDS Identification Number (ID No.) and by the EPA ID No. If a preliminary assessment of the site has been conducted that is designated either by the date of the investigation or an "X" under the column "PA DATE." The complete listings acquired by the Arizona State Environmental Quality Department and the U.S. EPA are included in the Appendix B to this document.




HAZARDOUS WASTE SITES IDENTIFIED IN PROJECT VICINITY*

FIGURE 4.1-1

Table 4.1-1

SITES IDENTIFIED WITHIN ONE-HALF MILE OF SALT RIVER

| ACIDS I.D. No. | EPA ID No. | Name, Address | PA Date |
|---|---|---|---|
| 441 | Not available | 27th Avenue Landfill<br>27th Ave. & Salt River<br>Phoenix, AZ | in process |
| 8 | AZD980883680 | Central Avenue Landfill<br>Central Ave. & Watkins St.<br>Phoenix, AZ | 03/12/87 |
| 25 | AZD980883473 | 7th Avenue Landfill<br>7th Ave. & Lower Buckeye Rd.<br>Phoenix, AZ | 03/9/87 |
| 261 | AZD049314370 | Rinchem-15th Avenue<br>2402 S. 15th Avenue<br>Phoenix, AZ | X |
| 24 | AZD980883482 | 23rd Avenue Landfill<br>23rd Ave. & Lower<br>Buckeye Road<br>Phoenix, AZ | 03/04/87 |
| 230 | AZD981679640 | Old 23rd Avenue Sludge<br>Disposal Ponds<br>23rd Ave. &<br>Lower Buckeye Rd.<br>Phoenix, AZ | |
| 6 | AZD980883433 | 11th Street Landfill<br>11th St. & Gibson Lane<br>Phoenix, AZ | 03/20/87 |
| 93 | AZD980883425 | 14th Street Landfill<br>14th St. & Magnolia Ave.<br>Phoenix, AZ | 03/20/87 |
| 9 | AZD980883417 | 16th Street Landfill<br>(see Del Rio Landfill)<br>167th St. & Ellwood Ave.<br>Phoenix, AZ | 02/12/87 |
| 88 | AZD980813562 | 40th Street Landfill<br>2425 S. 40th Street<br>Phoenix, AZ | 12/23/83 |
| 372 | Not available | Arizona Air Natl Guard -<br>Sky Harbor<br>Sky Harbor Airport<br>Phoenix, AZ | |

Table 4.1-1 (Continued)

SITES IDENTIFIED WITHIN ONE-HALF MILE OF SALT RIVER

| ACIDS I.D. No. | EPA ID No. | Name, Address | PA Date |
|---|---|---|---|
| 209 | AZD009004862 | Arizona Sand & Rock<br>1801 E. University Drive<br>Phoenix, AZ | 01/14/83 |
| 121 | AZD980883417 | Del Rio Landfill<br>aka 16th Street Landfill<br>16th St. & Elwood Ave.<br>Phoenix, AZ | |
| 84 | AZD980637680 | Estes Landfill<br>40th St. & Salt River<br>Phoenix, AZ | X |
| 187 | AZD980735732 | Lower Buckeye Site<br>1500 Lower Buckeye<br>Phoenix, AZ | 04/01/83 |
| 136 | AZD981679889 | Phoenix Sky Harbor Airport<br>3400 E. Sky Harbor Blvd<br>Phoenix, AZ | 09/16/87 |
| 275 | AZD980636047 | Sky Harbor Arizona<br>Air Natl Guard Base<br>2001 S. 32nd St.<br>Phoenix, AZ | X |
| 399 | AZD982007825 | Surface Impoundment (pond)<br>at Sky Harbor<br>29th St. north of Gibson Ln<br>Phoenix, AZ | |
| 299 | AZD008394967 | Wayne Oxygen Co. Inc.<br>2615 S. 40th St.<br>Phoenix, AZ | X |
| 419 | Not available | Marina del Sol<br>Petroleum Recycling<br>Products, Inc.<br>1223 E. Elwood St.<br>Phoenix, AZ | |

Table 4.1-1 (Continued)

SITES IDENTIFIED WITHIN ONE-HALF MILE OF SALT RIVER

| ACIDS I.D. No. | EPA ID No. | Name, Address | PA Date |
|---|---|---|---|
| 223 | AZD980496780 | 19th Avenue Landfill<br>19th Avenue & Salt River<br>Phoenix, AZ | 10/01/79 |
| 109 | AZD081686107 | United Truck & Equipment<br>SE Corner Jones Ave. and 19th Ave.<br>Phoenix, AZ | |
| 112 | AZD981679822 | Reynolds Aluminum Plant Ponds<br>43rd Ave. & Salt River<br>Phoenix, AZ | |
| 213 | AZD980886287 | Mesa Area<br>T1N, R5E<br>Mesa, AZ | 08/01/85 |
| 19 | AZD981691496 | North Center St. Landfill<br>End of N. Center St. at Salt River<br>Mesa, AZ | X |
| 138 | AZD980636070 | Salt River Landfill Project<br>Route 1, Box 216<br>Scottsdale, AZ | |
| 122 | AZD980735781 | Tri-City Landfill<br>Beeline Highway<br>Salt River Indian Reservation, AZ | X |
| 39 | AZD068391564 | Beckman Instruments Inc.<br>aka Comtech Data<br>350 N. Hayden Road<br>Scottsdale, AZ | X |
| 57 | AZD068391564 | Comtech Data Corp<br>350 N. Hayden Road<br>Scottsdale, AZ | |
| 1 | AZD080667819 | Allstate Mine Supply<br>1926 E. 1st Street<br>Tempe, AZ | |

Table 4.1-1 (Continued)

SITES IDENTIFIED WITHIN ONE-HALF MILE OF SALT RIVER

| ACIDS I.D. No. | EPA ID No. | Name, Address | PA Date |
|---|---|---|---|
| 2 | AZD070254008 | Arizona Casting<br>115 Perry Lane<br>Tempe, AZ | |
| 3 | AZD077526127 | Bennett Brothers Recycling<br>1990 E. 1st Street<br>Tempe, AZ | |
| 7 | AZD068402643 | Circuit Technology<br>119 S. Industrial Drive<br>Tempe, AZ | |
| 29 | AZD008394355 | IMC Magnetics<br>1900 E. 5th Street<br>Tempe, AZ | 10/01/86 |
| 163 | AZD00902009 | Indianhead Mfg. Co.-Tempe<br>1318 Princess Drive<br>Tempe, AZ | 09/01/84 |
| 18 | AZD980883441 | Megatronics<br>229 Clark/2149 E. Fifth<br>Tempe, AZ | |
| 229 | AZD980813570 | Old Tempe Landfill<br>aka Kachina Redimix<br>1976 E. Pima St.<br>Tempe, AZ | 06/04/84 |
| 51 | AZD120317730 | Whitronics<br>209 N. Perry Lane<br>Tempe, AZ | |
| 97 | AZD982006660 | Boers Dairy DDT<br>T1N, R1-4W, T1S, R2-4W,<br>T2S, R2W<br>Buckeye, AZ | |

Of 57 landfill sites identified near the Salt River through Phoenix, 13 are located within approximately 1/2 miles of the River. Twelve of these sites have had at least preliminary investigations completed or underway. Of these, the 19th Avenue Landfill is designated by the U.S. EPA as a National Priority Site. The City of Phoenix is working with the U.S. EPA on plans for mitigation of this site. At present, the 19th Avenue Landfill (No. 223), the 27th Avenue Landfill (No. 441), and the Old Del Rio (16th Street) Landfill (No. 9) have preliminary investigations underway. A groundwater permit has been acquired for the Central Avenue Landfill (No. 8) and a monitoring program has been established. Investigations to various degrees are in process for the Estes/40th Street Landfill site (No. 88) and monitoring wells have been installed at the Old Tempe Landfill/Kachina Redimix (No. 229) site. The North Center Street Landfill (No. 19) is presently planned to have extended site inspections and some monitoring conducted beginning in 1989.

The Arizona Department of Transportation is in the process of extensive geotechnical studies including soil and gas borings to determine the extent of remediation which will be required in order to construct foundations for a new freeway system in the Mesa/Tempe area adjacent to the river. Other activity in the area has included studies conducted by the Salt River Project. Based on preliminary soil and gas measurements at six sites, further groundwater monitoring at three sites (67th and Salt River, 56th and Salt River, and Hayden Street and Salt River, not yet given identification numbers) have failed to show contamination.

None of the identified sites are undergoing extensive remediation at present. It is anticipated that remediation efforts will occur as part of the Arizona Department of Transportation's freeway system project.

## 4.2 CONCLUSIONS AND RECOMMENDATIONS

Results of this preliminary survey to identify contaminated sites shows that a significant number of sites are located within the project vicinity. Prior to development of any preliminary flood control projects in the area, it is recommended that a complete records check be conducted for identification of hazardous sites and for determination of those sites which may require additional site investigation, monitoring or possible remediation.
Extensive files are available for public review at the Arizona Department of Environmental Quality. Review and contact with the Arizona Department of Transportation and Salt River Project personnel will also give insight into the extent of investigations conducted for those projects and the subsequent amount of remediation required in specified areas.

## 4.3 REFERENCES

Arizona CERCLA Investigation and Data System January 1988 (ACIDS), zipACIDS List, Arizona Department of Environmental Quality, Office of Waste Programs.

U.S. EPA Superfund Program 1988 CERCLIS - LIST-1: Site Location Listing, L.1 Proposed and Final NPL Sites, Maricopa County.

U.S. EPA Superfund Program 1988 CERCLIS - LIST-1: Site Location Listing, L.1 Maricopa by City, Site Name

**Persons Consulted**

Mr. Bill Williams, Arizona Department of Environmental Quality, Site Discovery and Hazardous Evaluation Unit, Preliminary Investigations, personal communication, March 30 and April 1988.

Mr. Chuck Graf, Arizona Department of Environment Quality, Site Discovery and Hazardous Evaluation Unit, Hydrologic Investigations and Monitoring, April 20, 1988.

# APPENDIX A

# CORRESPONDENCE

ES/B

**UNITED STATES**
**DEPARTMENT OF THE INTERIOR**
**FISH AND WILDLIFE SERVICE**
ECOLOGICAL SERVICES
3616 W. Thomas, Suite 6
Phoenix, Arizona 85019

2-21-88-I-90

April 20, 1988

Robert S. Joe
U.S. Army Corps of Engineers
Los Angeles District
P.O. Box 2711
Los Angeles, California 90053-2325

Dear Mr. Joe:

This responds to your request of April 5, 1988 for information on species listed or proposed to be listed as threatened or endangered that may be located along the Salt or Gila Rivers between Granite Reef and Gillespie Dams, Maricopa County, Arizona.

The endangered Yuma clapper rail (Rallus longirostris yumanensis) utilizes marshy areas along the Salt and Gila Rivers. In addition, the bald eagle (Haliaeetus Leucocephalus) and peregrine falcon (Falco peregrinus) utilize the area as transients and winter migrants.

If we may be of further assistance, please contact Ms. Lesley Fitzpatrick or me (Telephone: 602/261-4720 or FTS 261-4720).

Sincerely,

Sam F. Spiller

Sam F. Spiller
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico
(Fish and Wildlife Enhancement)
Director, Arizona Game and Fish Department, Phoenix, Arizona

# APPENDIX B

## ARIZONA CERCLA INVESTIGTION AND DATA SYSTEM (ACIDS) ZIPACIDS LIST

## AND

## U.S. EPA SUPERFUND PROGRAM CERCLIS LIST-1 SITE LOCATION LISTING

DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF WASTE PROGRAMS

ARIZONA CERCLA INVESTIGATION AND DATA SYSTEM (ACIDS)

## zipACIDS LIST

This listing, titled "zipACIDS", is sorted by zip code. All of the sites located in a specific zip code area are grouped together. The sites within each area are listed in alphabetical order.

This listing consists of locations subject to investigations concerning possible contamination of soil, surface water, or groundwater. Inclusion of any facility or site on this list does not mean that the location is contaminated, is causing contamination, or is in violation of State or Federal statutes or regulations. If a site has been evaluated, the column labeled PA DATE will show either an "X" or a date. Specific information concerning the evaluation is available upon request.

2005 N. Central-Rm.400
Phoenix, AZ. 85004

Telephone: (602)257-2334

*Other formats for this listing are available upon request. If you have any questions concerning this list, please contact us.

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 441 | | 27TH AVE LANDFILL | | | | |
| 417 | | AERO APPLICATORS | AVE. C AND HWY 95 | | | |
| 117 | AZD982007460 | CAVE CREEK NORTH PHOENIX | AREA E. OF PHX WELL #226 STUDY AREA | PHOENIX | | |
| 418 | | CLEMENTINE PROJECT | 99TH AVE AND JOMAX | | | |
| 119 | | MARICOPA DUST & SPRAY | | | | |
| 416 | | OLD CHEVRON CHEMICAL FACILITY | 433 S. 83rd AVE | PHOENIX | | |
| 403 | | PEGGY SANDS PROPERTY | | | | |
| 443 | | PEORIA SPORTS COMPLEX | 15999 N. 81ST AVE. | PEORIA | | |
| 404 | | PRESCOTT LANDFILL | | | | |
| 442 | | TUBA CITY URANIUM MILL TAILING SITE | 6 MI EAST OF TUBA CITY | | | |
| 423 | | WQ--CHINO VALLEY WELL MONITORING | NE OF PRESCOTT | | | |
| 422 | | WQ--CHROME COMPANY | 415 E. GRANT RD. | TUCSON | | |
| 424 | | WQ--DBCP CONTAMINATION | FALCON FIELD WELL #2 | | | |
| 421 | | WQ--EAST CENTRAL PHOENIX | CAMELBACK X 56ST X THOMAS X 16ST | | | |
| 425 | | WQ--EASTLAKE PARK | THOMAS X 48ST X LOW.BUCKEYE X 7AVE | | | |
| 426 | | WQ--HASSAYAMPA LANDFILL | 10 MI W OF BUCKEYE | | | |
| 427 | | WQ--HEXCEL WASTE DISPOSAL | 5 MI FROM CASA GRANDE | | | |
| 428 | | WQ--HORIZON INVESTMENTS | 801 E. IRWIN ST | BUCKEYE | | |
| 429 | | WQ--MIRACLE MILE | UNDEF--N OF MIR. MILE EXIT--I-10--TUCSON | | | |
| 430 | | WQ--MONITORING WELL SYSTEM | WOODY MT. WELL FIELD--SW OF FLAGSTAFF | | | |
| 431 | | WQ--NITRATE REMOVAL | GLENDALE WATER SUPPLIES | GLENDALE | | |
| 432 | | WQ--NOGALES WASH | EAST SIDE OF NOGALES--SOUTH TO NORTH | | | |
| 433 | | WQ--NORTHEAST MESA | UNDEF--NEAR FALCON FIELD | MESA | | |
| 434 | | WQ--SOUTH MESA | UNDEF--CENTER ON MESA DR. & BASELINE RD. | | | |
| 435 | | WQ--SOUTHWEST PLATING | 1079 W. OLD MARICOPA HWY. | CASA GRANDE | | |
| 436 | | WQ--VAN BUREN TANK FARM | MCDOWELL X I-17 & 23AVE X SALT X 83AVE | | | |
| 437 | | WQ--WELL CONST. STUDY | VBTF & EASTLAKE PARK & WEST CENTRAL PHX. | | | |
| 438 | | WQ--WEST CENTRAL PHOENIX | CAMELBACK X I-17 X MCDOWELL X 83AVE | | | |
| 8 | AZD980883680 | CENTRAL AVENUE LANDFILL | CENTRAL AVE. & WATKINS ST. | PHOENIX | 85002 | 03/12/87 |
| 111 | AZD980890917 | VAN BUREN TANK FARM | SW CORNER 51ST AVE. & VAN BUREN | PHOENIX | 85003 | X |
| 205 | AZD009002908 | AZ PLATING AND ANODIZING | 618 S. CENTRAL AVE. | PHOENIX | 85004 | 09-01-82 |
| 344 | AZD982006785 | BAGDAD PLASTICS CO. | 625 S. 5TH ST. | PHOENIX | 85004 | |
| 351 | AZD982007148 | DESERT SPECIALTIES | 1020 S. 5TH ST. | PHOENIX | 85004 | |
| 368 | AZD982006975 | KARLSON MACHINE WORKS INC. | 605 E. GRANT | PHOENIX | 85004 | |
| 256 | AZD074440470 | QUALITY PRINTED CIRCUITS CORP | 1831 S. CENTRAL | PHOENIX | 85004 | X |
| 222 | AZD981679764 | 19TH AVE AIRSTRIP | NE CORNER 19TH AVE. & BROADWAY | PHOENIX | 85007 | |
| 25 | AZD980883474 | 7TH AVE. LANDFILL | 7TH AVE. & LOWER BUCKEYE RD. | PHOENIX | 85007 | 03/09/87 |
| 261 | AZD049314370 | RINCHEM- 15TH AVE. | 2402 S. 15TH AVE. | PHOENIX | 85007 | X |
| 26 | AZD980880876 | AZ NATL. GUARD SUPP. MAINT. SERV | 5636 E. McDOWELL RD. | PHOENIX | 85008 | 05-15-86 |
| 4 | AZD981688286 | CACTUS TRANSMISSION | 4737 E. McDOWELL RD. | PHOENIX | 85008 | |
| 218 | AZD009004177 | MOTOROLA INC 52ND ST PLANT | 5005 E. McDOWELL RD. | PHOENIX | 85008 | 01/20/84 |
| 48 | AZD981679095 | VACANT LOT | 40TH ST. & E. VAN BUREN | PHOENIX | 85008 | |
| 24 | AZD980883482 | 23RD AVE. LANDFILL | 23RD AVE. & LOWER BUCKEYE RD. | PHOENIX | 85009 | 03/04/87 |
| 196 | AZD008399750 | ANOCAD PLATING CO | 2540 W. CYPRESS AVE. | PHOENIX | 85009 | 01-20-83 |
| 198 | AZD980636039 | ARINDA AIRCRAFT | 2645 E. BUCKEYE | PHOENIX | 85009 | 11-28-83 |
| 379 | AZD981424468 | ASTROPLATE INC. | 2724 W. PALM LN. | PHOENIX | 85009 | |
| 378 | AZD009003104 | AZ HARD CHROME INC. | 2609 W. CYPRESS AVE. | PHOENIX | 85009 | |
| 56 | AZD009015512 | COMMERCIAL COMPANIES | 3206 W. LEWIS | PHOENIX | 85009 | 05-01-85 |
| 176 | AZD980496756 | KENWORTH MOTOR TRUCK DISTRIBUTOR | 2625 S. 19TH AVE. | PHOENIX | 85009 | 01/17/83 |
| [illegible]84 | AZD020117529 | LAWN AND GARDEN SUPPLY | 2222 S. 27TH AVE. | PHOENIX | 85009 | |
| 183 | AZD063295190 | LIQUID AIR INC | 3332 W. McDOWELL RD. | PHOENIX | 85009 | 04/01/83 |
| 387 | AZD982007817 | OHLINGER INDUSTRY | 2327 W. PALM LN. | PHOENIX | 85009 | |
| 230 | AZD981679640 | OLD 23RD AVE SLUDGE DISPOSAL PONDS | 23RD AVE. & LOWER BUCKEYE RD. | PHOENIX | 85009 | |
| 248 | AZD009010273 | PHOENIX HEAT TREATING INC | 2405 W. MOHAVE | PHOENIX | 85009 | X |
| 249 | AZD980818827 | PHOENIX WELL #71 | 3851 W. EARLL DR. | PHOENIX | 85009 | 11/30/83 |
| 389 | AZD990722738 | PYRAMID INDUSTRIES | 4300 W. 39TH AVE. | PHOENIX | 85009 | |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 260 | AZD008394249 | REYNOLDS METALS CO PHX EXTRUSION PLANT | 3501 W. VAN BUREN | PHOENIX | 85009 | X |
| 392 | AZT050010677 | SOUTHWEST TECHNOLOGICAL SERVICES INC | 1739 W. 28TH AVE. | PHOENIX | 85009 | |
| 393 | AZD009006917 | STEVENS DECAL CO. | 3336 W. McDOWELL RD. | PHOENIX | 85009 | |
| 115 | AZD982007346 | WEST PHOENIX INDUSTRIAL AREA | AREA N&W OF PHX WELL #71 STUDY AREA | PHOENIX | 85009 | |
| 258 | AZD980886402 | REDS TOOL & DIE | 9201 N. 9TH AVE. | PHOENIX | 85013 | |
| 335 | AZD982007676 | AIRDRAULICS | 3135 W. 29TH AVE. | PHOENIX | 85017 | |
| 328 | AZD982007973 | AZ MAGNESIUM & ALUMINUM FOUNDRY | 1/2 MI. NE OF 39TH & EARLL | PHOENIX | 85017 | |
| 330 | AZD982006611 | FRAZEE PAINT | 3212 W. THOMAS | PHOENIX | 85017 | |
| 329 | AZD008397242 | HILL BROTHERS CHEMICAL | 4450 W. 42ND AVE. | PHOENIX | 85017 | |
| 135 | AZD081707762 | LANSDALE ELECTRONICS | 3600 W. OSBORN | PHOENIX | 85017 | |
| 385 | AZD083718726 | MAXLIGHT OPTICAL WAVE-GUIDES | 3035 W. 33RD DR. | PHOENIX | 85017 | 08/27/87 |
| 333 | AZD035914084 | MAY INDUSTRIES | 3640 W. OSBORN | PHOENIX | 85017 | |
| 326 | AZD982006736 | MERRILL COMMUNICATIONS | 2949 W. OSBORN | PHOENIX | 85017 | |
| 386 | AZD045810553 | MOGUL CORP. | 3030 W. 30TH AVE. | PHOENIX | 85017 | |
| 334 | AZD982007874 | PARAFLEX MACHINE & TOOL CO. | 3829 W. 39TH AVE. | PHOENIX | 85017 | |
| 149 | AZD982007932 | PHOENIX DATA CO. | 3384 W. OSBORN RD. | PHOENIX | 85017 | |
| 327 | AZD982007338 | RINCHEM- W. TURNEY | 4115 W. TURNEY | PHOENIX | 85017 | |
| 390 | AZD980882997 | RODGERS, J. B. | 2701 W. THOMAS | PHOENIX | 85017 | |
| 286 | AZD980637979 | SENETRON | 28TH AVE. & INDIAN SCHOOL | PHOENIX | 85017 | |
| 391 | AZD009018748 | SIMPLE SPACE-RITE INC. | 3442 W. 29TH AVE. | PHOENIX | 85017 | |
| 336 | AZD982008005 | STEVENS ENGINEERING INC. | 3916 W. CLARENDON | PHOENIX | 85017 | |
| 308 | AZD982007940 | STORM PRODUCTS | 3047 W. 31ST AVE. | PHOENIX | 85017 | |
| 332 | AZD982007767 | SYNTEX OPTHALMICS | 29TH AVE. & FAIRMONT | PHOENIX | 85017 | |
| 331 | AZD982007700 | TARGET CHEMICAL CO. | 3420 W. WHITTON AVE. | PHOENIX | 85017 | |
| 394 | AZD058790957 | VANGUARD WEST INC. | 3001 W. 33RD AVE. | PHOENIX | 85017 | |
| 123 | AZD058786724 | WESTERN DYNEX | 3536 W. OSBORN | PHOENIX | 85017 | |
| 126 | | WESTERN ELECTRIC SERVICE CENTER | 3750 W. INDIAN SCHOOL RD. | PHOENIX | 85017 | |
| 339 | AZD982007619 | A TO Z RENTS | 4050 E. INDIAN SCHOOL RD. | PHOENIX | 85018 | |
| 340 | AZD982007445 | E. G. R. COMPANY | 4420 E. OSBORN RD. | PHOENIX | 85018 | |
| 338 | AZD981693419 | MAHONEY'S CLEANERS | 3192 E. INDIAN SCHOOL RD. | PHOENIX | 85018 | |
| 269 | AZD980882674 | SRP WELL 17E-8N | 32ND ST. & INDIAN SCHOOL RD. | PHOENIX | 85018 | X |
| 49 | AZD981674443 | VIKING CLEANERS | 4029 N. 32ND ST. | PHOENIX | 85018 | |
| 380 | AZD003913597 | AT&T TECHNOLOGY INC. | 2750 W. INDIAN SCHOOL RD. | PHOENIX | 85019 | |
| 381 | AZD035900729 | F & B MANUFACTURING CO. | 4316 N. 39TH AVE. | PHOENIX | 85019 | |
| 382 | AZD020696159 | GENERAL ELECTRIC | 3840 W. CLARENDON | PHOENIX | 85019 | |
| 383 | AZD080664881 | GEORGIA PACIFIC CORP- CHEM-PAC DIV | 4239 N. 39TH AVE. | PHOENIX | 85019 | |
| 233 | AZD008394637 | OSBORN PRODUCTS INC | 3632 W. CLARENDON | PHOENIX | 85019 | X |
| 410 | AZD020127411 | PAINT SPRAYING, INC. | 3829 N. 39TH AVE. | PHOENIX | 85019 | |
| 116 | AZD981680127 | PHOENIX DOWNTOWN- SW AREA | AREAS N. & W. OF EASTLAKE BORDERS | PHOENIX | 85019 | 11/20/87 |
| 226 | AZD981679582 | PHOENIX NORTHWEST SERVICE CENTER | 4020 W. GLENROSA | PHOENIX | 85019 | |
| 388 | AZD000026724 | PRECISE METAL PRODUCTS | 3839 N. 39TH AVE. | PHOENIX | 85019 | |
| 250 | AZD980818884 | PHOENIX WELL #226 | 3120 W. ACOMA DR. | PHOENIX | 85023 | X |
| 41 | AZD982006728 | BEARDSLEY ROAD MINES | BEARDSLEY RD. & 16TH ST. | PHOENIX | 85024 | 07-30-86 |
| 281 | AZD009004961 | SPERRY FLIGHT SYSTEMS- PHOENIX | 21111 N. 19TH AVE. | PHOENIX | 85027 | X |
| 145 | AZD980735542 | HONEYWELL | 2250 W. PEORIA AVE. | PHOENIX | 85029 | 02/08/83 |
| 158 | AZD054408794 | HONEYWELL DEER VALLEY COMPUTER PARK | 13430 N. BLACK CANYON HWY | PHOENIX | 85029 | 03/14/83 |
| 76 | AZD980695670 | 18 ACRE VACANT LOT | 51ST AVE. & THUNDERBIRD RD. | PHOENIX | 85031 | 01/12/82 |
| 105 | AZD980883300 | MOTOROLA 56TH ST PLANT | 3102 N. 56TH ST. | PHOENIX | 85031 | |
| 6 | AZD980883433 | 11TH ST. LANDFILL | 11TH ST. & GIBSON LN | PHOENIX | 85034 | 03/20/87 |
| 93 | AZD980883425 | 14TH ST. LANDFILL | 14TH ST. & MAGNOLIA ST. | PHOENIX | 85034 | 03/20/87 |
| 9 | AZD980883417 | 16TH ST. LANDFILL (SEE DEL RIO LDFL) | 16TH ST. & ELWOOD AVE. | PHOENIX | 85034 | 02/12/87 |
| 86 | AZD980813562 | 40TH ST. LANDFILL | 2425 S. 40TH ST. | PHOENIX | 85034 | 12/23/83 |
| 307 | AZD981680606 | 44TH & WASHINGTON ASSOC. SITE | 4444 E. WASHINGTON | PHOENIX | 85034 | |
| 354 | AZD098047285 | AERO MANUFACTURERS | 2902 E. WASHINGTON | PHOENIX | 85034 | |
| 362 | AZD982007734 | AIRLINE MAINTENANCE BUILDING | SKY HARBOR AIRPORT | PHOENIX | 85034 | |
| 355 | AZD008395998 | ARVIN INDUSTRIES | 500 S. 15TH ST. | PHOENIX | 85034 | |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 372 | | AZ AIR NATIONAL GUARD- SKY HARBOR | SKY HARBOR AIRPORT | PHOENIX | 85034 | |
| 209 | AZD009004862 | AZ SAND & ROCK | 1801 E. UNIVERSITY DR. | PHOENIX | 85034 | 01-14-83 |
| 360 | AZD089995856 | CANYON INDUSTRIES | 734 E. SOUTHERN PACIFIC DR. | PHOENIX | 85034 | |
| 374 | AZD009013368 | CAPITOL MACHINE CO. | 21 S. 32ND ST. | PHOENIX | 85034 | |
| 346 | AZD982006843 | CENTRAL PLASTIC & RUBBER CO. | 1015 S. 23RD ST. | PHOENIX | 85034 | |
| 373 | AZD982006900 | CHECKER CAB | 8TH PLACE & SHERMAN | PHOENIX | 85034 | |
| 376 | AZD057907883 | CHEMONICS LAB DIVISION | 734-A SOUTHERN PACIFIC DR. | PHOENIX | 85034 | |
| 342 | AZD050539675 | COLLINS METAL FINISHING INC. | 37 S. 42ND PL. | PHOENIX | 85034 | |
| 356 | AZD982007023 | CYPRUS SPECIALTY STEEL CO. | 1500 S. 7TH ST. | PHOENIX | 85034 | |
| 121 | AZD980883417 | DEL RIO LANDFILL aka 16TH ST. LDFL | 16TH & ELWOOD STS. | PHOENIX | 85034 | |
| 357 | AZD982007080 | D-VELCO MANUFACTURING OF ARIZ. | 401 S. 36TH ST. | PHOENIX | 85034 | |
| 75 | AZD980818769 | EAST LAKE PARK | 16TH ST. & JEFFERSON | PHOENIX | 85034 | X |
| 84 | AZD980637680 | ESTES LANDFILL | 40TH ST. & SALT RIVER | PHOENIX | 85034 | X |
| 350 | AZD982007387 | FIRESTIK ANTENNA CO. | 2614 E. ADAMS | PHOENIX | 85034 | |
| 89 | AZD980637664 | FMC CORP. PESTICIDE FORMULATING PLT. | 1450 E. BUCKEYE RD. | PHOENIX | 85034 | X |
| 371 | AZD982007213 | GARRETT PNEUMATIC SYSTEMS | 2801 E. WASHINGTON | PHOENIX | 85034 | |
| 94 | AZD009000050 | GARRETT TURBINE ENGINE CO | 111 S. 34TH ST. | PHOENIX | 85034 | 01/17/83 |
| 363 | AZD982007155 | HENES STAMPING INC. | 4301 E. MADISON | PHOENIX | 85034 | |
| 377 | AZD982007098 | HERTZ CORP. | 27TH ST. & BUCKEYE RD. | PHOENIX | 85034 | |
| 349 | AZD008397069 | ITT CANNON ELECTRIC CO. | 2801 E. AIR LN. | PHOENIX | 85034 | |
| 366 | AZD982006918 | KINO DRAPERIES | 2326 E. WASHINGTON | PHOENIX | 85034 | |
| 187 | AZD980735732 | LOWER BUCKEYE SITE | 1500 LOWER BUCKEYE | PHOENIX | 85034 | 04/01/83 |
| 375 | AZD982006850 | MACHINE TECH | 327 S. 27TH ST. | PHOENIX | 85034 | |
| 353 | AZD982006793 | McCOY'S LAUNDRY & CLEANERS | 1624 E. WASHINGTON | PHOENIX | 85034 | |
| 348 | AZD054399480 | MECH TRONICS CORP. | 2515 E. BUCKEYE RD. | PHOENIX | 85034 | |
| 370 | AZD981582331 | MODERN INDUSTRIES | 3229 E. WASHINGTON | PHOENIX | 85034 | |
| 364 | AZD982006678 | NELSON COMMUNICATIONS INC. | 3301 E. WASHINGTON | PHOENIX | 85034 | |
| 343 | AZD982007692 | NELSON ENGINEERING CO., INC. | 4020 E. AIR LANE | PHOENIX | 85034 | |
| 341 | AZD008399891 | PAPAGO PLATING CO. | 2312 E. WASHINGTON | PHOENIX | 85034 | |
| 359 | AZD982007999 | PHOENIX NEWSPAPERS INC. | 120 E. VAN BUREN | PHOENIX | 85034 | |
| 367 | AZD982007635 | PHOENIX PLASTICS, INC. | 215 S. 23RD ST. | PHOENIX | 85034 | |
| 136 | AZD981679889 | PHOENIX SKY HARBOR AIRPORT | 3400 E. SKY HARBOR BLVD. | PHOENIX | 85034 | 09/16/87 |
| 365 | AZD982007577 | PHOENIX TRANSFORMER CO. | 1818 E. MADISON | PHOENIX | 85034 | |
| 361 | AZD982007270 | RPS PRODUCTS OF ARIZONA | 3230 E. WASHINGTON | PHOENIX | 85034 | |
| 275 | AZD980636047 | SKY HARBOR ARIZ AIR NATL GUARD BASE | 2001 S. 32ND ST. | PHOENIX | 85034 | X |
| 347 | AZT050010016 | SOUTHERN PACIFIC TRANSP. CO. | 13TH ST. & HARRISON | PHOENIX | 85034 | |
| 345 | AZD982007882 | SUN PUBLISHING CO. | 2645 E. WASHINGTON | PHOENIX | 85034 | |
| 399 | AZD982007825 | SURFACE IMPOUNDMENT (POND) AT SKY HBR | 29TH ST. N. OF GIBSON LN. | PHOENIX | 85034 | |
| 369 | AZD982007643 | TURLEY INDUSTRIES | 2441 E. MADISON | PHOENIX | 85034 | |
| 299 | AZD008394967 | WAYNE OXYGEN CO INC | 2615 S. 40TH ST. | PHOENIX | 85034 | X |
| 358 | AZD982007528 | WESTERN AUTOMATIC MACHINE CO. | 1601 E. MADISON | PHOENIX | 85034 | |
| 352 | AZD072449788 | WESTINGHOUSE ELECTRIC CORP. | 1825 E. MADISON | PHOENIX | 85034 | |
| 17 | AZD035891316 | MARINA DEL SOL | 4931 E. McDOWELL RD. | PHOENIX | 85035 | 06/01/87 |
| 419 | | PETROLEUM RECYCLING PRODUCTS, INC. | 1223 E. ELWOOD ST. | PHOENIX | 85040 | |
| 223 | AZD980496780 | 19TH AVE. LANDFILL | 19TH AVE. & SALT RIVER | PHOENIX | 85041 | 10/01/79 |
| 98 | AZD980736300 | GILBERT NURSERY | 2301 W. SOUTHERN AVE. | PHOENIX | 85041 | 01/13/83 |
| 109 | AZD081686107 | UNITED TRUCK & EQUIPMENT | SE CORNER JONES & 19TH AVES. | PHOENIX | 85041 | |
| 112 | AZD981679822 | REYNOLDS ALUMINUM PLANT PONDS | 43RD AVE. AND SALT RIVER | PHOENIX | 85042 | |
| 47 | AZD982006967 | CHEVRON-PHOENIX TERMINAL | SW CORNER OF VAN BUREN AND 51ST AVE. | PHOENIX | 85043 | X |
| 259 | AZD042017954 | RESEARCH CHEM DIV OF NUCOR CORP | 8220 W. HARRISON ST. | PHOENIX | 85043 | X |
| [illegible]03 | AZD980883490 | TAYLOR, WILLIAM, FLYING SERVICE | T1S,R2E SEC 20 51ST AVE & GILA R. RES. | LAVEEN | 85043 | |
| 294 | AZD070259767 | UNION OIL CO OF CALIFORNIA | 10 S. 51ST AVE. | PHOENIX | 85043 | X |
| 81 | AZD000632323 | EL PASO NATURAL GAS TUCSON STATION | 35 MI. NW OF TUCSON | TUCSON | 85200 | 03-25-83 |
| 191 | AZD083716688 | AIR PRODUCTS & CHEMICAL CO. | 2200 W. BROADWAY | MESA | 85201 | 06-01-83 |
| 213 | AZD980886287 | MESA AREA | T1N,R5E | MESA | 85201 | 08/01/85 |
| 19 | AZD981691496 | NORTH CENTER ST. LANDFILL | END OF N. CENTER ST. AT SALT RIVER | MESA | 85201 | X |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 270 | AZD980818942 | SRP WELL SITE 28.5E,5N | NW CORNER HORNE & McKELLIPS RD. | MESA | 85201 | X |
| 124 | AZD020132502 | TALLEY INDUSTRIES | 4551 E. McKELLIPS RD. | MESA | 85201 | X |
| 440 | AZD980818108 | COOPER DRUM CO. | 116 E. BROADWAY RD. | MESA | 85202 | 30865 |
| 55 | AZD981996275 | CUSTOM ELECTRIC MOTORS | 257 W. BROADWAY | MESA | 85202 | |
| 314 | AZD981990278 | EMPIRE MACHINERY CO. | 1725 S. COUNTRY CLUB DR. | MESA | 85202 | |
| 59 | AZD072433816 | LEVINE, TED, DRUM CO. | 116 E. BROADWAY | MESA | 85202 | 09/01/84 |
| 104 | AZD091243402 | METAL REFINERS LTD | 255 S. EXTENSION RD. | MESA | 85202 | |
| 141 | AZD981680002 | SRP WELL 28E-8N | BASELINE & MESA DR. | MESA | 85202 | |
| 16 | AZD980883623 | FALCON FIELD MUNICIPAL AIRPORT | 4800 E. FALCON DR. | MESA | 85203 | |
| 320 | AZD149003683 | AMERICAN AUTO WRECKING | 220 E. BASELINE RD. | MESA | 85204 | |
| 319 | AZD982007791 | ANY COLOR AUTO BODY | 325 E. BASELINE RD. | MESA | 85204 | |
| 337 | | ANYWHERE AUTO REPAIR | 325 E. BASELINE RD. | MESA | 85204 | |
| 322 | AZD099378846 | AZ BLOCK MANUFACTURING | 301 E. BASELINE | MESA | 85204 | |
| 318 | AZD982007916 | AZ REPUBLIC/GAZETTE- MESA | 1840 S. LEWIS ST. | MESA | 85204 | |
| 316 | AZD074445586 | BASELINE AUTO RECYCLERS | 117 E. BASELINE RD. | MESA | 85204 | |
| 317 | AZD056899172 | CHANDLER READY MIX | 235 E. BASELINE RD. | MESA | 85204 | |
| 146 | AZD043848050 | MOTOROLA INC SEMICONDUCTOR GROUP | 2200 W. BROADWAY | MESA | 85204 | 05/09/84 |
| 313 | AZD982007510 | PHOENIX WELDING SUPPLY CO. | 154 E. BASELINE RD. | MESA | 85204 | |
| 400 | | MERCURY MINE ELEMENTARY SCHOOL | 9640 N. 28TH ST. | PHOENIX | 85208 | |
| 35 | AZD068397728 | ASARCO INC SACATON UNIT | MARICOPA RD 5 MI NW OF CASA GRANDE | CASA GRANDE | 85222 | 03-30-83 |
| 52 | AZD980817464 | CASA GRANDE LANDFILL | 1601 S. CHUICHU RD. | CASA GRANDE | 85222 | 04-01-83 |
| 398 | AZD982006603 | CASA GRANDE SATELLITE STRIP | 2 MI. E. OF CASA GRANDE | CASA GRANDE | 85222 | |
| 80 | AZD980695563 | EL PASO NATURAL GAS CASA GRANDE STAT. | 4 MI N OF US 84, 17 MI W OF CASA G. | CASA GRANDE | 85222 | 03-25-83 |
| 157 | AZD980636062 | HEXCEL WASTE DUMP | T5S,R5E, SEC 34 | CASA GRANDE | 85222 | 09/01/82 |
| 170 | AZD098039902 | INTERNATIONAL METAL RECYCLING CORP | 1508 VIP BLVD. | CASA GRANDE | 85222 | 02/16/83 |
| 12 | AZD130582224 | KOCIDE CHEMICAL | 1508 VIP BLVD. | CASA GRANDE | 85222 | 07/27/87 |
| 227 | AZD070255484 | OCCIDENTAL CHEMICAL CO CASA GRANDE | 447 W. FIRST ST. | CASA GRANDE | 85222 | X |
| 414 | | SOUTHWEST PLATING | 1079 WEST OLD MARICOPA HIGHWAY | CASA GRANDE | 85222 | |
| 282 | AZD043010735 | AMSTAR CORP-SPRECKLES SUGAR DIV | 11800 E. RIGGS RD. | CHANDLER | 85224 | 09-01-82 |
| 200 | AZT050010164 | AZ AGROCHEMICAL- CHANDLER | 11520 E. GERMANN RD. | CHANDLER | 85224 | 01-14-83 |
| 15 | AZD980883656 | CHANDLER MUNICIPAL AIRPORT | COOPER & QUEEN CREEK RD. | CHANDLER | 85224 | 03-20-87 |
| 70 | AZT050010339 | DOBSON BUSINESS PARK (67 #14) | 145 W. CHILTON DR. | CHANDLER | 85224 | 01-17-83 |
| 152 | AZD077536183 | GREAT WESTERN SILICON | 11515 E. RIGGS RD. | CHANDLER | 85224 | X |
| 168 | AZD091235457 | INTEL CORP PHOENIX CAMPUS | 5000 W. WILLIAMS FIELD RD. | CHANDLER | 85224 | 02/20/85 |
| 216 | AZT000611426 | MIDLAND ROSS; CAPITOL CASTING- CHANDLER | 24053 S. ARIZONA AVE. | CHANDLER | 85224 | 04/18/83 |
| 262 | AZD042018689 | ROGERS CORP CIRCUIT SYSTEMS DIV | 2001 W. WILLIAMS FIELD RD. | CHANDLER | 85224 | X |
| 293 | AZD088301213 | UNION MANUFACTURING INC | 6225 W. ALLISON | CHANDLER | 85224 | X |
| 302 | AZ7570028582 | WILLIAMS AIR FORCE BASE | WILLIAMS AIR FORCE BASE | CHANDLER | 85224 | X |
| 68 | AZD049315765 | DELA-TEK, INC | 2000 N. VAVAGES AVE. | COOLIDGE | 85228 | 02-01-83 |
| 251 | AZD980817407 | PIMA CHANDLER INDUSTRIAL PARK | I-10 INTG #162, N. OF CHANDLER | CHANDLER | 85228 | X |
| 272 | AZD079013801 | SAN CARLOS IRRIG PR COOLIDGE MAINT FAC | 120 S. 3RD ST. | COOLIDGE | 85228 | |
| 127 | AZD980882070 | AG-AERO | T8S,R8E ,SEC 5, NE/4 | ELOY | 85231 | 07-29-85 |
| 193 | AZD083719922 | AL-DON DUSTING SERVICE INC. | TUMBLEWEED RD., ELOY MUN. AIRPORT | ELOY | 85231 | |
| 113 | AZD981678947 | PIERCE AVIATION | WEST AZ 85 | BUCKEYE | 85231 | |
| 311 | AZD980895676 | ALL WESTERN OIL SERVICE | 1475 N. McQUEEN RD. | GILBERT | 85234 | |
| 315 | AZD982007858 | APACHE AUTO WRECKING | 631 W. COMMERCE AVE. | GILBERT | 85234 | |
| 312 | AZD073554511 | BINGHAM DRYWALL SPRAYING | 1459 N. McQUEEN RD. | GILBERT | 85234 | |
| 325 | AZD082628769 | CANUCK CONSTRUCTION CO. | 1465 N. McQUEEN RD. | GILBERT | 85234 | X |
| 321 | AZD982007452 | PURE-GRO CO.- GILBERT | 1450 N. McQUEEN RD. | GILBERT | 85234 | |
| [illegible]02 | | SOLAR TAP OF AMERICA | 1405 N. McQUEEN RD. | GILBERT | 85234 | |
| 324 | AZD982007585 | WAY LINE CABINET CO. | 1425 N. McQUEEN RD. | GILBERT | 85234 | |
| 323 | AZD982007031 | WAITE'S, JOE, AUTO REPAIR | 1525 N. McQUEEN RD. | GILBERT | 85234 | |
| 120 | AZD008397127 | ASARCO INC HAYDEN PLANT | 640 ASARCO AVE. | HAYDEN | 85235 | 03-31-83 |
| 174 | AZD000626606 | KENNECOTT MINERALS CO- MINES PLANT | AZ 77, 20 MI. E. OF HAYDEN | HAYDEN | 85235 | 02/11/83 |
| 175 | AZD008397184 | KENNECOTT MIN. CO- REDUCTION PLANT | AZ 177 | HAYDEN | 85235 | 02/27/80 |
| 85 | AZD980818165 | EVERGREEN AIR CENTER | T10S,R10E, SEC 33 | MARANA | 85238 | X |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 396 | AZ2570090025 | MT. LEMMON AIR FORCE STATION | MT. LEMMON | MT. LEMMON | 85238 | |
| 45 | AZD980818223 | PICACHO CONTAINER DISPOSAL SITE | T8S,R8E, SEC 34 | PICACHO | 85241 | X |
| 206 | AZD008394397 | AZ PORTLAND CEMENT | CASA GRANDE HWY | RILLITO | 85246 | 02-15-83 |
| 192 | AZD980445183 | AK CHIN INDUST. PARK | MARICOPA INDIAN RESERVATION | MARICOPA IND. RES. | 85247 | 04-01-83 |
| 210 | AZD074441676 | AZ TANNING CO | SANTAN INDUSTRIAL PARK | MOCK | 85247 | 03-04-83 |
| 69 | AZD980736177 | DIAMOND DRUM STORAGE SITE | GILA RIVER INDIAN RESERVATION | SACATON | 85247 | 08-01-80 |
| 31 | AZT000618512 | MOTOROLA INC PRICE RD PLANT | 7402 S. PRICE RD. | TEMPE | 85252 | |
| 263 | AZD089309462 | ROLAMECH CO INC | 3719 N. 75TH ST. | SCOTTSDALE | 85252 | |
| 138 | AZD980636070 | SALT RIVER LANDFILL PROJ | RTE 1, BOX 216 | SCOTTSDALE | 85252 | |
| 161 | AZD980695969 | INDIAN BEND WASH | McDOWELL RD. & HAYDEN | SCOTTSDALE | 85253 | 06/01/80 |
| 122 | AZD980735781 | TRI-CITY LANDFILL | BEELINE HIGHWAY | SALT RIVER IND. RES. | 85256 | X |
| 39 | AZD068391564 | BECKMAN INSTRUMENTS INC aka CONTECH DATA | 350 N. HAYDEN | SCOTTSDALE | 85257 | X |
| 57 | AZD068391564 | CONTECH DATA CORP aka BECKMAN INSTRMNTS | 350 N. HAYDEN RD. | SCOTTSDALE | 85257 | |
| 212 | AZD055646921 | MARRO PLATING | | SCOTTSDALE | 85257 | 12/01/82 |
| 214 | AZD980675433 | MICROSEMICONDUCTOR | 8700 E. THOMAS RD. | SCOTTSDALE | 85257 | |
| 219 | AZD008399636 | MOTOROLA INC GOVT ELECTONICS DIV | 8201 E. McDOWELL RD. | SCOTTSDALE | 85257 | X |
| 53 | AZT000612135 | C. G. CONN LTD. | 1 ARTLEY DR. | NOGALES | 85261 | 02-01-85 |
| 36 | AZD042370080 | ASARCO INC SILVER BELL MINE & MILL | AVRA VALLEY RD 40 MI NW OF TUCSON | SILVER BELL | 85270 | 03-30-83 |
| 395 | AZD063262752 | CUSTOM FARM SERVICE | PO BOX 338- AZ 84 | STANFIELD | 85272 | |
| 211 | AZD001886654 | MAGMA COPPER CO- SUPERIOR | MAIN STREET | SUPERIOR | 85273 | 06/01/83 |
| 1 | AZD080667819 | ALLSTATE MINE SUPPLY | 1926 E. 1ST ST. | TEMPE | 85281 | |
| 208 | AZT050010438 | APS OCOTILLO POWER PLT | 1500 E. UNIVERSITY | TEMPE | 85281 | 01-25-83 |
| 2 | AZD070254008 | AZ CASTING | 115 PERRY LN. | TEMPE | 85281 | |
| 3 | AZD077526127 | BENNETT BROTHERS RECYCLING | 1990 E. 1ST ST. | TEMPE | 85281 | |
| 5 | AZD058793696 | CIRCUIT SPECIALISTS | 738 S. PERRY LN. | TEMPE | 85281 | |
| 7 | AZD068402643 | CIRCUIT TECHNOLOGY | 119 S. INDUSTRIAL DR. | TEMPE | 85281 | |
| 28 | AZD038444154 | DCE CIRCUITS | 1310 E. 8TH ST. | TEMPE | 85281 | 10-01-85 |
| 29 | AZD008394355 | INC MAGNETICS | 1900 E. 5TH ST. | TEMPE | 85281 | 10/01/85 |
| 162 | AZD980883367 | INDIANHEAD MFG CO- SCOTTSDALE | 3612 N. SCOTTSDALE RD. | SCOTTSDALE | 85281 | 09/01/84 |
| 163 | AZD009020009 | INDIANHEAD MFG CO- TEMPE | 1318 PRINCESS DR. | TEMPE | 85281 | 09/01/84 |
| 18 | AZD980883441 | MEGATRONICS | 229 CLARK/2149 E. FIFTH | TEMPE | 85281 | |
| 229 | AZD980813570 | OLD TEMPE LANDFILL aka KACHINA REDIMIX | 1976 E. PIMA ST. | TEMPE | 85281 | 06/04/84 |
| 264 | AZD980816474 | SRP | 1521 PROJECT DR. | TEMPE | 85281 | X |
| 51 | AZD120317730 | WHITRONICS | 209 N. PERRY LN. | TEMPE | 85281 | |
| 180 | AZD000819607 | LABORATORY CONSULTANTS | 9213 S. HARDY DR. | TEMPE | 85282 | 06/11/83 |
| 232 | AZD042017590 | OMNI SPECTRA CO PALO VERDE IND PARK | 2626 S. HARDY DR. | TEMPE | 85282 | X |
| 33 | AZD005200613 | TRIUMPH CORP | 2130 S. INDUSTRIAL PARK AVE. | TEMPE | 85282 | 03/17/87 |
| 125 | AZD008397861 | MARATHON STEEL CO | KYRENE ST. AT ELLIOT | TEMPE | 85283 | 04/01/83 |
| 215 | AZD085453603 | MIDLAND ROSS; CAPITOL CASTING DIV-TEMPE | 5857 S. KYRENE RD. | TEMPE | 85283 | X |
| 439 | AZD009000076 | MIDLAND ROSS; CAPITOL CASTING- GUADALUPE | RT 2, BOX 551, KYRENE RD | GUADELUPE | 85283 | 01/18/83 |
| 267 | AZD000628628 | SRP KYRENE STEAM PLANT | S. KYRENE RD. | TEMPE | 85283 | X |
| 273 | AZD035954114 | SANDERS AVIATION | S. 51ST ST. | TEMPE | 85284 | X |
| 90 | AZD043848993 | FOREMOST McKESSON-GLENDALE | 4909 W. PASADENA AVE. | GLENDALE | 85301 | X |
| 99 | AZD980636088 | GLENDALE, CITY OF, LANDFILL | 115TH & GLENDALE AVE. | GLENDALE | 85308 | X |
| 188 | AZ0570024133 | LUKE AIR FORCE BASE/GUNNERY RANGE | AREA S. OF I-8, YUMA TO GILA BEND | LUKE AFB | 85309 | 04/01/83 |
| 142 | AZD980882062 | TANITA FARMS INC | T2N,R2W, SEC 12 NW/4 | GLENDALE | 85311 | |
| 20 | AZD980883565 | AGUILA DUMPSITE | T7N,R8W, SEC 33, SW/4 | AGUILA | 85320 | 10-01-85 |
| 246 | AZD081687063 | PD NEW CORNELIA BRANCH | MAIN STREET | AJO | 85321 | X |
| 97 | AZD982006660 | BOERS DAIRY DDT | T1N,R1-4W, T1S,R2-4W, T2S,R2W | BUCKEYE | 85326 | |
| [illegible]6 | AZD091244939 | FAITH-COOPERAGE COMPANY | 108 EASON AVE. | BUCKEYE | 85326 | 10-03-83 |
| [illegible]15 | AZD980817993 | HORIZON INVESTMENTS/FAITH COOPERAGE | 108 EASON AVE. | BUCKEYE | 85326 | 10/03/83 |
| 106 | AZD980884902 | PHOENIX WELL #193 | 1848 S. 107TH AVE. | CASHION | 85329 | |
| 130 | AZD981159601 | CAVE CREEK LANDFILL | 1.5 MI W. OF CAREFREE HWY/CAVE CK. RD | CAVE CREEK | 85331 | |
| 58 | AZD980695852 | CONGRESS CONSOL. GOLD MINING CO | OFF HWY 79, 3 MI N OF CONGRESS | CONGRESS | 85332 | 03-15-83 |
| 118 | AZD981680184 | PINAL CREEK MINING | T1NR15E SCS 4,5,9,10,14-16,20-24,29,30 | GLOBE-CLAYPOOL-MIAMI | 85332 | |
| 38 | AZD980883532 | AZTEC DUMPSITE | T7S,R11W, SEC 33 | AZTEC | 85333 | 03-29-85 |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 66 | AZD980882047 | DATELAND LANDFILL | 2.8 MI N. OF I-8 ON EXIT 67 | DATELAND | 85333 | 03-29-85 |
| 78 | AZD123907495 | EL MIRAGE INDUSTRIAL LANDFILL | WEST BANK OF AGUA FRIA RIVER | EL MIRAGE | 85335 | |
| 21 | AZD981460868 | PAINTED ROCK BORROW PIT | 20 MI. NE OF GILA BEND | GILA BEND | 85337 | |
| 237 | AZD980883557 | PALOMA RANCH AIRSTRIP | T6S,R6W SEC 17 SW/4 S OF PALOMAS EXIT | PALOMAS | 85337 | X |
| 274 | AZD980883607 | SENTINEL DUMPSITE | T6S,R9W, SEC 31, 3/8 MI N. I-10 EXIT | SENTINEL | 85337 | X |
| 190 | AZD005158852 | ADAPTO, INC. | 300 W. VAN BUREN | GOODYEAR | 85338 | 11-01-84 |
| 204 | AZD980813505 | AZ METAL PROCESSING SERVICES | 220 CAMINO ORO | GOODYEAR | 85338 | 11/01/84 |
| 10 | AZD981688062 | FARMERS AGRICULTURAL CHEM. CO. | 5015 LITCHFIELD RD. | AVONDALE | 85338 | |
| 184 | AZD980695902 | LITCHFIELD AIRPORT AREA | BETWEEN L. BUCKEYE RD. & VAN BUREN | GOODYEAR | 85338 | 11/01/81 |
| 185 | AZD072454036 | LITCHFIELD AVIATION | PHOENIX-LITCHFIELD AIRPORT | GOODYEAR | 85338 | |
| 50 | AZD102797651 | MEADOWS, W. R., OF ARIZONA | 1600 S. SARIVAL RD. | GOODYEAR | 85338 | 09/14/87 |
| 234 | AZD980636096 | OXYCHEM-GOODYEAR | 501 S. LITCHFIELD | GOODYEAR | 85338 | X |
| 236 | AZD980817761 | PACIFIC SOUTHWEST AIRLINES TRNG CTR | PHOENIX-LITCHFIELD AIRPORT | GOODYEAR | 85338 | X |
| 241 | AZD095916383 | PARKER-HANNIFIN & AEROSPACE GROUP | 680 N. LITCHFIELD RD. | GOODYEAR | 85338 | X |
| 114 | AZD046733135 | QUAKERMAID CABINETRY | 16025 TRICAR AVE. | GOODYEAR | 85338 | |
| 23 | AZD068399039 | RECLAIMED METALS | 1393 S. REEMS RD. | GOODYEAR | 85338 | |
| 30 | AZD981688005 | SAGUARO METALS | 2201 S. REEMS RD. | GOODYEAR | 85338 | |
| 32 | AZD063277651 | SAHARA INDUSTRIES | 200 CAMINO DE ORO | GOODYEAR | 85338 | |
| 46 | AZD981688369 | SOLAR FERTILIZER | SARIVAL RD. & HWY 80 | GOODYEAR | 85338 | |
| 280 | AZD021648779 | SPERRY FLIGHT SYSTEMS- GOODYEAR | PHOENIX LITCHFIELD AIRPORT | GOODYEAR | 85338 | X |
| 107 | AZD980685354 | SYNTEX | 501 S. LITCHFIELD RD. PO BOX 1090 | GOODYEAR | 85338 | |
| 292 | AZD008398620 | UNIDYNAMICS PHOENIX INC | 1000 N. LITCHFIELD RD. | GOODYEAR | 85338 | X |
| 101 | AZD020687547 | CATERPILLAR TRACTOR CO. PROV. GRND. | 195TH AVE. & INDIAN SCHOOL RD. | LITCHFIELD PARK | 85340 | |
| 100 | AZD008398786 | GOODYEAR AEROSPACE CORP | 101 S. LITCHFIELD RD. | LITCHFIELD PARK | 85340 | X |
| [illegible]55 | AZD980735666 | HASSAYAMPA LANDFILL | OLD WICKENBURG RD. | HASSAYAMPA | 85343 | X |
| 238 | AZT000624429 | PALO VERDE NUCLEAR GENERATING STATION | 5801 S. WINTERSBURG RD. | WINTERSBURG | 85343 | X |
| 54 | AZD078998762 | C & M ENTERPRISES | T7N,R21W, SEC 34 | YUMA | 85344 | 01-01-87 |
| 44 | AZD038437869 | CAMPOS A.G. ROTORS | T8N,R21W, SEC 31 | YUMA | 85344 | 04-02-86 |
| 173 | AZD980815732 | KAMBUROFF, JOHN, INC. | T6N,R21W, SEC 4; COL. R. IND. RES. | YUMA | 85344 | 11/01/86 |
| 217 | AZD980815740 | MORRIS FLYING SERVICE | T7N,R21W SEC 9, COL. R. IND. RES. | YUMA | 85344 | 07/01/85 |
| 240 | AZD981426901 | PARKER DUMPSITE | | PARKER | 85344 | |
| 61 | AZD980735609 | COUNTRY MEADOWS UNIT 9 | 107TH AVE. & NORTHERN | PHOENIX | 85345 | 01-12-82 |
| 131 | AZD981680366 | GLENDALE AIRPORT | 7742 W. OLIVE AVE. | PEORIA | 85345 | |
| 265 | AZD000628560 | SRP AGUA FRIA STEAM PLANT | 75TH AVE. & NORTHERN | PEORIA | 85345 | X |
| 154 | AZD000819581 | HARMAN, ROBERT, WAREHOUSE | AVENUE 38 E. 8TH ST. | ROLL | 85347 | X |
| 148 | AZD980882013 | ROLL LANDFILL | 6 MI. N. OF US 80, EXIT 38E | ROLL | 85347 | X |
| 276 | AZD980883615 | SOMERTON DUMPSITE | T9S,R23W SEC 32, 3.5 MI E OF SOMERTON | SOMERTON | 85350 | X |
| 277 | AZD980496798 | SOMERTON LANDFILL | 16TH ST. & AVE. B, S. OF AZ 95 | SOMERTON | 85350 | X |
| 201 | AZD000632844 | AZ AGROCHEMICAL- TOLLESON | 433 S. 83RD AVE. | TOLLESON | 85353 | 02-10-83 |
| 231 | AZD981679707 | OLD 91ST AVE SLUDGE DISPOSAL PONDS | 91ST AVE. AND SALT RIVER | PHOENIX | 85353 | |
| 255 | AZD000389445 | PURE GRO CO- TOLLESON | 99TH AVE. & HARRISON | TOLLESON | 85353 | X |
| 285 | AZD980358014 | SWIFT INDEPENDENT PACKING CO | 91ST AVE. | TOLLESON | 85353 | X |
| 288 | AZD000027805 | TOLLESON PLATING CO | 9119 W. POLK | TOLLESON | 85353 | X |
| 199 | AZD035986272 | APS YUCCA POWER PLT | 8TH ST. & SOMMERTON RD. | YUMA | 85364 | 02-14-83 |
| 72 | AZD980882054 | DOME LANDFILL | 4 MI. N. OF US 80 ON DOME RD. | DOME | 85364 | 03-29-85 |
| 225 | AZD980882021 | NORTH GILA VALLEY LANDFILL | 4 MI. N. OF AZ 95 ON AVE. 7E | NORTH GILA VALLEY | 85364 | X |
| 228 | AZD980881536 | OLD CITY OF YUMA LANDFILL | BETWEEN 22ND & 14TH AVES. AT COL. R. | YUMA | 85364 | X |
| 143 | AZD981680069 | YUMA HELICOPTER | 12533 S. 4TH AVE. | YUMA | 85364 | |
| 110 | AZD980894877 | YUMA INTERNATIONAL AIRPORT | US 80 | YUMA | 85364 | |
| [illegible]05 | AZ5213820991 | YUMA PROVING GROUND- U.S. ARMY | US ARMY | YUMA | 85364 | X |
| [illegible]44 | AZ0971590062 | YUMA MARINE CORPS AIR STATION | AVENUE 3E | YUMA | 85369 | X |
| 297 | AZD980880942 | VALLEY SPRAYER & DUSTER SERVICE INC | 12205 W. BELL RD. | SURPRISE | 85374 | X |
| 406 | AZD982007395 | WEST SALT RIVER VALLEY | GREENWAY & REEMS RDS. | EL MIRAGE | 85374 | |
| 37 | AZD980354856 | ASBESTOS MFG CO | US 70 & AZ 77 | GLOBE | 85501 | 12-01-86 |
| 408 | AZD981616147 | GLOBE DIOXIN | GLOBE RANGER DIST., TONTO N.F. | GLOBE | 85501 | |
| 172 | AZD077528354 | JAQUAYS ASBESTOS CO | OFF US 70 | GLOBE | 85501 | 12/01/79 |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 179 | AZD980813380 | KYLE ASBESTOS MILL | HAYSS CANYON ROAD | GLOBE | 85501 | 09/27/83 |
| 220 | AZD980735724 | MOUNTAIN VIEW MOBILE HOME ESTATES | AZ 77 | GLOBE | 85501 | X |
| 167 | AZD008398521 | INSPIRATION CNSLD COPPER INSPIR AREA | T1N,R15E, SEC 16-21 | INSPIRATION | 85537 | 02/25/83 |
| 165 | AZD980585806 | INSPIRATION CNSLD COPPER OX-HIDE AREA | T1N+S,R14E SEC 22-28, 33-36, 2-4 | INSPIRATION | 85537 | 02/25/83 |
| 166 | AZD980355689 | INSPIRATION CNSLD COPPER XMAS AREA | T4S,R16E, SECS 16-21 | INSPIRATION | 85537 | 02/25/83 |
| 252 | AZT050010040 | PINTO VALLEY COPPER (CITGO) | T1N,R15E, SEC 30, SE/4 OF NW/4 | MIAMI | 85539 | X |
| 257 | AZD007111065 | RANCHERS EXP & DEV CORP BLUEBIRD MINE | ON US 60 1 MI. W. OF MIAMI | MIAMI | 85539 | |
| 245 | AZD039055413 | PD MORENCI BRANCH | TEMP HIGHWAY 666 | MORENCI | 85540 | X |
| 243 | AZD074489469 | PD PLANTSITE SHOPPING CENTER | | MORENCI | 85540 | |
| 283 | AZD980813448 | STAR VALLEY LANDFILL | AZ 260 1 MI E. OF STAR VALLEY | STAR VALLEY | 85541 | X |
| 11 | AZD980881387 | PIMA LANDING STRIP | T6S,R24E, SEC 36 | PIMA | 85543 | |
| 420 | | JENNINGS ORCHARD | ROUTE 2, BOX 954 | SAFFORD | 85546 | |
| 271 | AZD981167125 | SAN CARLOS APACHE TRIBE ASBESTOS | 20 MINES AND TAILINGS PILES | SAN CARLOS | 85550 | |
| 197 | AZD008399263 | APACHE POWDER CO | T17S,R21E, SEC 7 | BENSON | 85602 | 30468 |
| 63 | AZD068428416 | CYPRUS JOHNSON COPPER CO | 2 MI N I-10 ON JOHNSON RD. | BENSON | 85602 | 02-01-80 |
| 79 | AZD980695621 | EL PASO NATURAL GAS BENSON STATION | 1/2 MI N. OF BENSON | BENSON | 85602 | 03-25-83 |
| 147 | AZD980883599 | SUNSITES DUMPSITE | T16S,R24E, SEC 28 NW/4 | SUNSITES | 85602 | X |
| 244 | AZD980817704 | PD COPPER QUEEN BRANCH | AZ 92 | BISBEE | 85603 | X |
| 22 | AZD981680242 | PD HISTORICAL SMELTER | AZ 92 | BISBEE | 85603 | 10/21/86 |
| 40 | AZD980388938 | BISBEE-DOUGLAS INTERNATL. AIRPORT | US 666 | DOUGLAS | 85607 | 04-01-83 |
| 247 | AZD008397143 | PD DOUGLAS REDUC WORKS | US 80 & US 666 | DOUGLAS | 85607 | X |
| 92 | AZ0210020434 | FORT HUACHUCA | FORT HUACHUCA | FORT HUACHUCA | 85613 | |
| 195 | AZD064946742 | ANAMAX MINING-TWIN BUTTES MINE | TWIN BUTTES MINING RD. | GREEN VALLEY | 85614 | 04-17-84 |
| [illegible]3 | AZD981428824 | GREEN VALLEY AREA | VARIOUS GROUNDWATER LOCATIONS | GREEN VALLEY | 85614 | 03/10/83 |
| [illegible]09 | AZD982007403 | NOGALES WASH | T23-4S,R14E | NOGALES | 85621 | |
| 296 | AZD980665814 | UNIV OF ARIZ WATER RESEARCH CENTER | T9S,R14E, SECS 27-34 | PAGE TROWBRIDGE RANCH | 85623 | X |
| 34 | AZT000623678 | ASARCO INC MISSION UNIT | WEST PIMA MINE RD. | SAHUARITA | 85629 | 06-01-83 |
| 64 | AZD068428598 | CYPRUS METALLURGICAL PROCESSES CORP | 800 E. PIMA MINE RD. | SAHUARITA | 85629 | 02-12-83 |
| 65 | AZD009836040 | CYPRUS PIMA MINING CO | PIMA MINE RD. | SAHUARITA | 85629 | 02-01-80 |
| 74 | AZD035940410 | DUVAL CORP-SIERRITA/ESPERANZA MINE | DUVAL MINE RD., 30 MI. S. OF TUCSON | SAHUARITA | 85629 | 04-04-83 |
| 401 | AZD097116362 | EERLEY MINING & CHEMICAL CO. | 2480 E. TWIN BUTTES | SAHUARITA | 85629 | |
| 189 | AZD001886597 | MAGMA COPPER CO- SAN MANUEL | AZ 76 | SAN MANUEL | 85631 | 06/01/83 |
| 397 | AZD982007759 | NEWMONT EXPLORATION- OLD RELIABLE MINE | 12 MI. NW OF SAN MANUEL | SAN MANUEL | 85631 | |
| 150 | AZD980389225 | HECLA MINING CO. LAKESHORE MINE | 32 MI. S. OF CASA GRANDE | CASA GRANDE | 85634 | X |
| 164 | AZD097118350 | INLAND MOTOR SPECIALTY PROD DIV | 4020 E. INLAND RD. | SIERRA VISTA | 85635 | 04/25/84 |
| 128 | AZD980813323 | ALANCO LIMITED | OFF CHARLESTON RD-3MI S OF TOMBSTONE | TOMBSTONE | 85638 | |
| 284 | AZD099378325 | STATE OF MAINE MINING CO | 1/2 MI W. OF CHARLESTON RD. | TOMBSTONE | 85638 | |
| 108 | AZD038443503 | TOMBSTONE EXPLORATION INC | 950 SKYLINE RD./OLD BISBEE HWY | TOMBSTONE | 85638 | |
| 290 | AZD980496830 | TUBAC LANDFILL | FRONTAGE RD. W. OF I-19 | TUBAC | 85640 | X |
| 82 | AZD980496749 | EL PASO NATURAL GAS VAIL STATION | RITA RD. & I-10 | TUCSON | 85702 | 01-24-83 |
| 413 | AZD981989684 | WASTE MGMT INC: GRANT RD. INDUST. CNTR. | GRANT RD. | TUCSON | 85703 | |
| 77 | AZD980813216 | EL CAMINO DEL CERRO LANDFILL | N. OF EL CAMINO DEL CERRO RD. | TUCSON | 85704 | X |
| 160 | AZD980813638 | INA RD LANDFILL | 1/2 MI. W. OF I-10 E. OF INA RD. | TUCSON | 85704 | 11/03/83 |
| 171 | AZD980813695 | JAIL ANNEX LANDFILL | SILVER BELL RD./POLICE ACADEMY | TUCSON | 85704 | 01/31/84 |
| 14 | AZD980883722 | TANNER WELL | 6601 N. CASA GRANDE HWY. | TUCSON | 85704 | |
| 310 | AZD050534593 | CHROME CUSTOM PLATING | 415 E. GRANT RD. | TUCSON | 85705 | |
| 91 | AZD045809019 | FOREMOST McKESSON-TUCSON | 2875 N. FLOWING WELLS RD. | TUCSON | 85705 | 02/16/83 |
| 13 | AZD980883664 | TRAVEL TRAILER COURT | 2070 W. FT. LOWELL RD. | TUCSON | 85705 | |
| 295 | AZT000646059 | UNIVERSAL WASTE CONTROL | 330 N. FIFTH AVE. | TUCSON | 85705 | X |
| [illegible]4 | AZD058792896 | ANACONDA COPPER CO | 8000 S. KOLB RD. | TUCSON | 85706 | 10-01-82 |
| [illegible]2 | AZ9573124055 | AZ AIR NATIONAL GUARD- TUCSON | TUCSON INTERNATIONAL AIRPORT | TUCSON | 85706 | 02/01/83 |
| 83 | AZT050010230 | ESCO | 7475 W. BOPP RD. | TUCSON | 85706 | 02-24-84 |
| 95 | AZD020703310 | GATES LEARJET CORP. | 7777 S. OLD NOGALES HWY | TUCSON | 85706 | X |
| 177 | AZD088301833 | KEYSTONE HELICOPTER CORP | TUCSON INTERNATIONAL AIRPORT | TUCSON | 85706 | 12/01/82 |
| 182 | AZD097113856 | LAMBDA ELECTRONICS DIV VEECO INST CORP | 1150 W. DREXEL RD. | TUCSON | 85706 | 12/01/82 |
| 186 | AZD980636104 | LOS REALES LANDFILL | 5300 E. LOS REALES RD. | TUCSON | 85706 | 06/01/83 |

| ID # | EPA ID # | NAME | ADDRESS | CITY | ZIP | PA DATE |
|---|---|---|---|---|---|---|
| 287 | AZD980496814 | TERMINAL STATIONS INC | JCT. WILMOT RD. & I-10 | LITTLETOWN | 85706 | X |
| 300 | AZD035974807 | WEST-CAP ARIZONA | 2201 E. ELVIRA RD. | TUCSON | 85706 | X |
| 304 | AZD980496848 | WILMOT ROAD SITE | 6701 S. WILMOT RD. | WILMOT | 85706 | X |
| 67 | AZ4570024055 | DAVIS-MONTHAN AIR FORCE BASE | T14S, R14E, SEC 34, NE/4 | TUCSON | 85707 | 02-14-83 |
| 409 | AZD981989569 | HARRISON RD. (OLD) LANDFILL | S. HARRISON RD. | TUCSON | 85708 | |
| 239 | AZD980883540 | PANTANO DUMPSITE | T14SR15E SEC35 IRVINGTON/HOUGHTON RDS | TUCSON | 85708 | X |
| 411 | AZD981990088 | PIMA COUNTY TRANS. OPS. | HOUGHTON RD. | TUCSON | 85708 | |
| 253 | AZD008397796 | PIONEER PAINT & VARNISH CO | 438 W. CONGRESS ST. | TUCSON | 85711 | X |
| 71 | AZD045157690 | DODGE IND. COMPLEX | 3231 S. DODGE BLVD. | TUCSON | 85713 | 03-14-83 |
| 102 | AZD980885297 | FLOWERS PROPERTY | 1859 W. KING AVE. | TUCSON | 85713 | |
| 235 | AZD045804325 | PACIFIC FRUIT EXPRESS CAR REPAIR SHOP | 2501 E. FAIRLAND AVE. | TUCSON | 85713 | X |
| 139 | AZD000628487 | SOUTHERN PACIFIC FUELING FACILITY | 2102 E. AVIATION HIGHWAY | TUCSON | 85713 | 11/03/87 |
| 298 | AZD980817340 | VEGA BIOCHEMICAL INC (OLD SITE) | 420 E. COLUMBIA ST. | TUCSON | 85719 | X |
| 224 | AZD980817829 | NOGALES LANDFILL | BANKARD RD. 100 FT. E. OF I-19 | NOGALES | 85721 | X |
| 405 | AZT050010685 | ALLIED PRECIOUS METAL RECYCLING | 5657 S. WILMOT RD. | TUCSON | 85726 | |
| 133 | AZD981680481 | HARRISON ROAD LANDFILL | N. OF IRVINGTON RD., ON HARRISON RD. | TUCSON | 85730 | |
| 134 | AZD981680549 | HOUGHTON/IRVINGTON LANDFILL | SW CORNER HOUGHTON & IRVINGTON RDS. | TUCSON | 85730 | 02/01/80 |
| 412 | AZD981997463 | USDA SANTA RITA EXP. RANGE H.Q. | HQ CORONADO N.F: 5 MI E OF CONTINENTAL | CONTINENTAL | 85732 | |
| 42 | AZD008394454 | BURR-BROWN RESEARCH CORP | 6730 S. TUCSON BLVD. | TUCSON | 85734 | 02-01-83 |
| 159 | AZD009005422 | HUGHES AIRCRAFT CO- USAF PLT 44 | NOGALES HWY; T15S,R14E, SEC 30 | TUCSON | 85734 | X |
| 291 | AZD980737530 | TUCSON AIRPORT AREA | NOGALES HIGHWAY | TUCSON | 85734 | X |
| 169 | AZT000623827 | IBM CORP | 6950 S. COUNTRY CLUB RD. | TUCSON | 85744 | X |
| 407 | AZD981989965 | AZ D.O.T. SERVICE YARD | 1444 W. GRANT RD. | TUCSON | 85745 | |
| 66 | AZD078986643 | SRP CORONADO PLANT | CORONADO GENERATING STATION | ST JOHNS | 85936 | X |
| 78 | AZD008398737 | SOUTHWEST FOREST IND. INC- SNOWFLAKE | AZ 277 | SNOWFLAKE | 85937 | X |
| 301 | AZD981167182 | WHITE MOUNTAIN APACHE TRIBE ASBESTOS | SOUTHWEST AREA OF RESERVATION | WHITE RIVER | 85941 | |
| 221 | AZ7213820635 | NAVAJO DEPOT ACTIVITY | I-40 | FLAGSTAFF | 86001 | X |
| 254 | AZD057017063 | PONDEROSA PAPER PRODUCTS INC | 1600 BUTLER AVE. | FLAGSTAFF | 86001 | X |
| 140 | AZD008398687 | SOUTHWEST FOREST IND. INC- FLAGSTAFF | 825 E. BUTLER AVE. | FLAGSTAFF | 86001 | 08/26/87 |
| 289 | AZT050010750 | TRANSWESTERN PIPELINE COMPRESSIVE STA | T22N,R5E, SEC 16 | FLAGSTAFF | 86001 | X |
| 203 | AZD043701945 | AZ FUELS CORP | OFF US 89-A | FREDONIA | 86002 | 02-14-83 |
| 43 | AZD980894497 | CAMERON ABANDONED URANIUM ORE PILE | T29N,R9E, SEC 22 | CAMERON | 86020 | 04-03-85 |
| 129 | AZD981680309 | BASS ASBESTOS MINE (GRAND CANYON) | HAKATI CANYON | GR. CANY. NATL.PK. | 86023 | |
| 132 | AZD981680424 | HANCE ASBESTOS MINE (GRAND CANYON) | T31N,R4E,SEC 26 NW,NW,SEC 27 E 1/2 NW | GRAND CANYON NATL PK | 86023 | |
| 242 | AZD980696124 | PEABODY COAL CO BLACK MESA MINE | 13 MI S OF US160, 29 MI SW OF KAYENTA | KAYENTA | 86033 | X |
| 60 | AZD980883011 | COPPER MINE ACID TANK ON NAVAJO RES. | IR 20, 25 MI S. OF PAGE | PAGE | 86040 | 02-01-86 |
| 151 | AZD981416977 | GRAY MOUNTAIN URANIUM CONCENTRATOR | 9 MI. S.E. US 89 | GRAY MOUNTAIN NR. | 86040 | 08/27/87 |
| 268 | AZD074452426 | SRP NAVAJO GENERATING STATION | AZ 22 | PAGE | 86040 | X |
| 279 | AZD008398703 | SW FOREST INDUST. WOOD TREATMENT PLT | E. OF US 89, 1 MI NE OF PRESCOTT | APACHE IND. RES. | 86302 | |
| 62 | AZD083717843 | CYPRUS BAGDAD COPPER CO | HWY 95 OFF BOULDER CREEK | BAGDAD | 86321 | |
| 306 | AZD980735682 | ZONIA COPPER MINE | STAR ROUTE | KIRKLAND | 86332 | X |
| 156 | AZD072430572 | HELENA CHEM CO | 5995 S. LITCHFIELD RD. | GOODYEAR | 86338 | X |
| 73 | AZD041456583 | DUVAL CORP MINERAL PARK PROP. | 14 MI. N. OF KINGMAN-US 93 | KINGMAN | 86401 | 09-23-82 |
| 96 | AZD043844083 | GENERAL CABLE CORP | 4900 INDUSTRIAL BLVD. | KINGMAN | 86401 | 02/08/83 |
| 103 | AZD980880678 | GOLDEN VALLEY LANDFILL | AZ 68, 1 MI. W. OF US 93 JCT | KINGMAN | 86401 | |
| 178 | AZD980695845 | KINGMAN AIRPORT INDUSTRIAL AREA | T22N,R16W | KINGMAN | 86401 | 07/01/82 |
| 27 | AZD980677116 | CITIZENS UTILITIES CO.STORAGE YD | AZ 95, SMOKETREE TO McCULLOCH | LAKE HAVASU CITY | 86403 | 02-01-86 |
| 181 | AZD980389175 | LAKE HAVASU SAN DISTRICT | 115 McCULLOCH BLVD. | LAKE HAVASU CITY | 86403 | 07/01/84 |
| 207 | AZD980636112 | AZ PROVING GROUND DEPT | I-40 & PROVING GROUND RD. | YUCCA | 86438 | 03-22-84 |
| 87 | AZD981426844 | FORT DEFIANCE LANDFILL | BOTH SIDES OF AZ & NM BORDER | FORT DEFIANCE | 86504 | |
| 37 | AZD981159080 | PUERCO RIVER SITE | NEAR SANDERS | SANDERS | 86512 | X |

RIN 9-398

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

REPORT OPTIONS: EXTERNAL REPORT
SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

WHERE CLAUSE: (C0305 EQ P OR C0305 EQ F) AND C0120
EQ MARICOPA AND C0002 EQ AZ AND C0001 EQ 09:

2.1 Proposed + Final
NPL Sites
Maricopa County

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980695902 | PHOENIX-GOODYEAR AIRPORT AREA<br>BET LWR BUCKEYE RD & VAN BUREN<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 ✓ | 01/96/06.0<br>112/21/27.0 | GEOGRAPH | 6200 | 15070102 |
| AZD980735666 | HASSAYAMPA LANDFILL<br>OLD WICKENBURG RD<br>HASSAYAMPA<br>MARICOPA | AZ<br>013 | 85343 | 33/22/15.0<br>112/45/00.0 | GEOGRAPH | 6200 | 15070101 |
| AZD980886287 | MESA AREA GROUND WATER CONTAMIN<br>T1N R5E<br>MESA<br>MARICOPA | AZ<br>013 | 85821 | | | | |
| AZD009004177 | MOTOROLA INC (52ND STREET PLANT)<br>5005 E MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85008 | 33/20/48.0<br>111/58/10.0 | GEOGRAPH | 6200 | 15060106 |
| * AZD980496780<br>#223 ACIDS | NINETEENTH AVENUE LANDFILL<br>19TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85041 | 33/20/05.0<br>112/02/25.0 | REGIONAL | 6200 | 15060106 |
| AZD980695969 | INDIAN BEND WASH AREA<br>MCDOWELL RD & HAYDEN<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85253 | 33/27/56.0<br>111/54/29.0 | GEOGRAPH | 6200 | 15060106 |

RIN 9-398

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

REPORT OPTIONS: EXTERNAL REPORT
SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

WHERE CLAUSE: C0120 EQ MARICOPA AND C0002 EQ AZ AND
C0001 EQ 09:

L.1 Maricopa County
by City, Site Name

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD980883565 | AGUILA DUMPSITE<br>SW 1/4 SEC 33 T7N R8W<br>AGUILA<br>MARICOPA | AZ<br>013 | 85320 | 33/56/30.0<br>113/10/36.0 | GEOGRAPH | 6200 | 15070104 |
| AZD091244939 | FAITH-COOPERAGE CO INC<br>108 EASON AVE<br>BUCKEYE<br>MARICOPA | AZ<br>013 | 85326 | 33/22/18.0<br>112/35/12.0 | GEOGRAPH | 6200 | 15070101 |
| AZD981679947 | PIERCE AVIATION<br>W STATE HWY 85<br>BUCKEYE<br>MARICOPA | AZ<br>013 | 85326 | 33/22/18.0<br>112/35/12.0 | GEOGRAPH | 6200 | 15070101 |
| AZD980884902 | PHOENIX WELL #193<br>1848 S 107 AVE<br>CASHION<br>MARICOPA | AZ<br>013 | 85329 | 33/26/06.0<br>112/18/00.0 | GEOGRAPH | 6200 | 15070102 |
| AZD981159601 | CAVE CREEK LDFL<br>1 1/2 MI W OF CAREFREE HWY<br>CAVE CREEK<br>MARICOPA | AZ<br>013 | 85331 | 33/49/18.0<br>111/54/48.0 | GEOGRAPH | 6200 | 15060106 |
| AZD043010735 | AMSTAR CORP SPRECKELS SUGAR DIV F-5<br>11800 E RIGGS RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZT050010164 | ARIZONA AGROCHEMICAL<br>11520 E GERMANN RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/17/00.0<br>111/50/00.0 | GEOGRAPH | 6200 | 15050100 |
| AZD980883656 | CHANDLER MUNICIPAL ARPT<br>COOPER RD & QUEEN CREEK RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZT050010339 | DOBSON BUSINESS PARK (67 #14)<br>145 W CHILTON DR<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/20/00.0<br>111/50/00.0 | GEOGRAPH | 6200 | 15050100 |
| AZD077536183 | GREAT WESTERN SILICON<br>11515 E RIGGS RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD091235457 | INTEL CORP PHOENIX CAMPUS<br>5000 W WILLIAMS FIELD RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZT000611426 | MIDLAND ROSS CORP CAPITOL CASTING DIV<br>24053 S ARIZONA AVE<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD980817407 | PIMA CHANDLER IND PARK<br>I-10/MARICOPA INTCHG #162 N OF<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/02/03.0<br>111/32/21.0 | GEOGRAPH | 6200 | 15050100 |
| AZD042018689 | ROGERS CORP CIRCUIT SYSTEMS DIV<br>2001 W WILLIAMS FIELD RD<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/53/00.0 | GEOGRAPH | 6200 | 15050100 |
| AZD088301213 | UNION MANUFACTURING INC<br>6625 W ALLISON<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/18/24.0<br>111/50/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZ7570028582 | WILLIAMS AIR FORCE BASE<br>WILLIAMS AFB<br>CHANDLER<br>MARICOPA | AZ<br>013 | 85224 | 33/17/31.0<br>111/40/30.0 | GEOGRAPH | 6200 | 15050100 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD123907495 | EL MIRAGE INDUSTRIAL LDFL<br>W OF AGUA FRIA RIV S OF GRAND<br>EL MIRAGE<br>MARICOPA | AZ<br>013 | 85335 | 33/36/24.0<br>112/18/42.0 | GEOGRAPH | 6200 | 15070102 |
| AZD982007395 | REEMS RD DBCP AREA<br>GREENWAY & REEMS RDS<br>EL MIRAGE<br>MARICOPA | AZ<br>013 | 85374 | 33/35/06.0<br>112/17/24.0 | GEOGRAPH | 6200 | 15070102 |
| AZD981460868 | PAINTED ROCK BORROW PIT<br>20 MI NW GILA BEND<br>GILA BEND (NR)<br>MARICOPA | AZ<br>013 | 85337 | 32/56/48.0<br>112/43/00.0 | GEOGRAPH | 6200 | 15070101 |
| AZD980895676 | ALL WESTERN OIL CO. INC.<br>1475 N MCQUEEN RD<br>GILBERT<br>MARICOPA | AZ<br>013 | 85234 | 33/21/12.0<br>111/47/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD982007858 | APACHE AUTO WRECKING<br>631 W COMMERCE AVE<br>GILBERT<br>MARICOPA | AZ<br>013 | | 33/21/12.0<br>111/47/24.0 | | 6200 | |
| AZD073554511 | BINGHAM DRY WALL SPRAYING<br>1459 N MCQUEEN RD<br>GILBERT<br>MARICOPA | AZ<br>013 | 85234 | 33/21/12.0<br>111/47/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD982007031 | JOE WAITER AUTO REPAIR<br>1525 N MCQUEEN RD<br>GILBERT<br>MARICOPA | AZ<br>013 | 85234 | 33/21/12.0<br>111/47/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD982007452 | PUREGRO CO<br>1450 N MCQUEEN RD<br>GILBERT<br>MARICOPA | AZ<br>013 | 85234 | 33/21/12.0<br>111/47/24.0 | GEOGRAPH | 6200 | 15050100 |

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007585 | VAY LINE CABINET CO<br>1425 N MCQUEEN RD<br>GILBERT<br>MARICOPA | AZ<br>013 | 85234 | 33/21/12.0<br>111/47/24.0 | GEOGRAPH | 6200 | 15050100 |
| AZD043848993 | FOREMOST MCKESSON-MCKESSON CHEMICAL CO<br>4909 W PASADENA AVE<br>GLENDALE<br>MARICOPA | AZ<br>013 | 85301 | 33/30/40.0<br>112/09/50.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980636088 | GLENDALE CITY OF LDFL<br>115TH AVE & GLENDALE AVE<br>GLENDALE<br>MARICOPA | AZ<br>013 | 85308 | 33/30/42.0<br>112/10/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980882062 | TANITA FARMS INC<br>NW1/4 SEC 12 T2N R2W<br>GLENDALE<br>MARICOPA | AZ<br>013 | 85311 | 33/32/30.0<br>112/14/48.0 | GEOGRAPH | 6200 | 15070102 |
| AZD980813505 | ARIZONA METAL PROCESSING SERVICES<br>220 CAMINO ORO<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 ✓ | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD072430572 | HELENA CHEM CO<br>599 S LITCHFIELD RD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 86338 ✓ | 34/30/12.0<br>112/41/18.0 | GEOGRAPH | | 15030203 |
| AZD980636096 | OXYCHEM-GOODYEAR<br>501 S LITCHFIELD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 ✓ | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD980817761 | PACIFIC SOUTHWEST AIRLINES TRAINING CTR<br>PHOENIX-LITCHFIELD ARPT<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 ✓ | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD095916383 | PARKER-HANNIFIN & AEROSPACE GROUP<br>680 N LITCHFIELD RD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD980695902 | PHOENIX-GOODYEAR AIRPORT AREA<br>BET LWR BUCKEYE RD & VAN BUREN<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 01/96/06.0<br>112/21/27.0 | GEOGRAPH | 6200 | 15070102 |
| AZD046733135 | QUAKERMAID CABINETRY<br>16025 TRICAR AVE<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD068399039 | RECLAIMED METALS<br>1393 S REEMS ROAD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD981688005 | SAGUARO METALS<br>2201 S REEMS RD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD063277651 | SAHARA INDUSTRIES<br>200 CAMINO DE ORO<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD981688369 | SOLAR FERTILIZER<br>SARIVAL RD & HWY 80<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD021648779 | SPERRY FLIGHT SYSTEMS<br>PHOENIX LITCHFIELD ARPT<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980885354 | SYNTEX<br>501 LITCHFIELD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD008398620 | UNIDYNAMICS PHOENIX INC<br>1000 N LITCHFIELD RD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/27/05.0<br>112/21/40.0 | GEOGRAPH | 6200 | 15070102 |
| AZD102797651 | W R MEADOWS OF AZ<br>1600 S SARIVAL RD<br>GOODYEAR<br>MARICOPA | AZ<br>013 | 85338 | 33/26/06.0<br>112/21/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD980735666 | HASSAYAMPA LANDFILL<br>OLD WICKENBURG RD<br>HASSAYAMPA<br>MARICOPA | AZ<br>013 | 85343 | 33/22/15.0<br>112/45/00.0 | GEOGRAPH | 6200 | 15070101 |
| AZD980883490 | TAYLOR WILLIAM FLYING SERV<br>T1S R2E SEC 20<br>LAVEEN<br>MARICOPA | AZ<br>013 | 85043 | 33/27/06.0<br>112/11/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD005158852 | ADAPTO INC<br>501 PLAZA CIR<br>LITCHFIELD PARK<br>MARICOPA | AZ<br>013 | 85340 | 33/29/24.0<br>112/21/12.0 | GEOGRAPH | 6200 | 15070102 |
| AZD020687547 | CATERPILLAR TRACTOR PROVING GROUND<br>195TH AVE & INDIAN SCHOOL RD<br>LITCHFIELD PARK<br>MARICOPA | AZ<br>013 | 85340 | 33/29/24.0<br>112/21/12.0 | GEOGRAPH | 6200 | 15070102 |
| AZD008398786 | GOODYEAR AEROSPACE CORP<br>101 S LITCHFIELD RD<br>LITCHFIELD PARK<br>MARICOPA | AZ<br>013 | 85340 | 33/25/48.0<br>112/21/35.0 | GEOGRAPH | 6200 | 15070102 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZ0570024133 | LUKE AIR FORCE BASE<br>S RT 8 YUMA THRU GILA BEND<br>LUKE AFB<br>MARICOPA | AZ<br>013 | 85309 | 33/32/17.0<br>112/19/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD982008005 | STEVENS ENGINEERING INC<br>3916 W CLARENDON<br>MARICOPA<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007528 | WESTERN AUTOMATIC MACHINE CO<br>1601 E MADISON<br>MARICOPA<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981621881 | GILA RIVER RESERVATION<br>MARICOPA COUNTY<br>MARICOPA COUNTY<br>MARICOPA | AZ<br>013 | | | | | |
| AZD083716688 | AIR PRODUCTS & CHEMICAL CO<br>2200 W BROADWAY<br>MESA<br>MARICOPA | AZ<br>013 | 85201 | 33/24/30.0<br>111/52/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD149003683 | AMERICAN AUTO WRECKING<br>220 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/18.0<br>111/48/06.0 | GEOGRAPH | 6200 | 15050100 |
| AZD982007791 | ANY COLOR AUTO BODY<br>325 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/18.0<br>111/48/06.0 | | 6200 | |
| AZD099378846 | ARIZONA BLOCK MFG<br>301 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | | 33/24/18.0<br>111/48/06.0 | GEOGRAPH | 6200 | |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007916 | ARIZONA REPUBLIC/GAZETTE<br>1840 S LEWIS ST<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/18.0<br>111/48/06.0 | GEOGRAPH | 6200 | 15050100 |
| AZD074445586 | BASELINE AUTO RECYCLERS<br>117 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | | 33/24/18.0<br>111/48/06.0 | | 6200 | 15050100 |
| AZD056899172 | CHANDLER READY MIX<br>235 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/18.0<br>111/48/06.0 | GEOGRAPH | 6200 | 15050100 |
| AZD981996275 | CUSTOM ELECTRIC MOTORS<br>257 W BROADWAY<br>MESA<br>MARICOPA | AZ<br>013 | 85202 | 33/24/12.0<br>111/50/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981990278 | EMPIRE MACHINERY CO<br>1725 S COUNTRY CLUB DR<br>MESA<br>MARICOPA | AZ<br>013 | 85202 | 33/24/12.0<br>111/50/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883623 | FALCON FIELD MUNI ARPT<br>4800 E FALCON DR<br>MESA<br>MARICOPA | AZ<br>013 | 85203 ✓ | 33/25/24.0<br>111/48/12.0 | GEOGRAPH | 6200 | 15060106 |
| AZD072433816 | LEVINE TED DRUM CO<br>116 E BROADWAY<br>MESA<br>MARICOPA | AZ<br>013 | 85202 | 33/24/12.0<br>111/50/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980886287 | MESA AREA GROUND WATER CONTAMIN<br>T1N R5E<br>MESA<br>MARICOPA | AZ<br>013 | 85821 | | | | |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD091243402 | METAL REFINERS LTD<br>255 S EXTENSION RD<br>MESA<br>MARICOPA | AZ<br>013 | 85202 | 33/24/12.0<br>111/50/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD043848050 | MOTOROLA INC SEMICONDUCTOR GROUP<br>2200 W BROADWAY<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/32.0<br>111/52/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981691496<br>#19 ACIDS | NORTH CENTER ST LDFL<br>END OF N CENTER ST @ SALT RIV<br>MESA<br>MARICOPA | AZ<br>013 | 85201 ✓ | 33/26/18.0<br>111/51/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007510 | PHOENIX WELDING SUPPLY CO<br>154 E BASELINE RD<br>MESA<br>MARICOPA | AZ<br>013 | 85204 | 33/24/18.0<br>111/48/06.0 | GEOGRAPH | 6200 | 15050100 |
| AZD980818942 | SALT RIV PROJ WELL SITE 28.5E & 5N<br>NW COR HORNE & MCKELLIPS RD<br>MESA<br>MARICOPA | AZ<br>013 | 85201 ✓ | 33/26/18.0<br>111/51/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981680002 | SALT RIVER PROJECT WELL 28E-0N<br>BASELINE & MESA DR<br>MESA<br>MARICOPA | AZ<br>013 | 85202 | 33/24/12.0<br>111/50/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD020132502 | TALLEY INDUSTRIES OF AZ<br>4551 E MCKELLIPS RD<br>MESA<br>MARICOPA | AZ<br>013 | 85201 ✓ | 33/29/30.0<br>111/42/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD058786724 | WESTERN DYNEX<br>3536 W OSBORN<br>NARICOPA<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980883557 | PALOMA RNCH AIRSTRIP<br>SW 1/4 SEC 17 T6S R6W<br>PALOMA<br>MARICOPA | AZ<br>013 | 85337 | 32/56/48.0<br>112/43/00.0 | GEOGRAPH | 6200 | 15070101 |
| AZD981680366 | GLENDALE AIRPORT<br>7742 WEST OLIVE AVE<br>PEORIA<br>MARICOPA | AZ<br>013 | 85345 | 33/34/54.0<br>112/14/18.0 | GEOGRAPH | 6200 | 15070102 |
| AZD000628560 | SALT RIV PROJ AGUA FRIA STEAM PLT<br>75TH AVE & NORTHERN<br>PEORIA<br>MARICOPA | AZ<br>013 | 85345 | 33/34/00.0<br>112/14/00.0 | GEOGRAPH | 6200 | 15070102 |
| AZD982007619 | A TO Z RENTS<br>4050 E INDIAN SCHOOL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85018 | 33/30/30.0<br>111/58/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD098047285 | AERO MANUFACTURERS<br>2902 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007676 | AIRDRAULICS<br>3135 N 29TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007734 | AIRLINE MAINTENANCE BLDG<br>SKY HARBOR AIRPORT<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008399750 | ANOCAD PLATING CO<br>2540 W CYPRESS AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 ✓ | 33/28/30.0<br>112/07/00.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980636039 | ARINDA AIRCRAFT<br>2645 E BUCKEYE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980880876 | ARIZONA AIR NAT GUARD SUPP MAINT SERV<br>5636 E MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85008 | 33/28/06.0<br>111/59/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982415788 | ARIZONA BARREL AND CAN COMPANY<br>ADJ NE CORNER 19TH AVE & BROAD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85007 | 33/27/06.0<br>112/05/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009003104 | ARIZONA HARD CHROME INC.<br>2609 W CYPRESS AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009002908 | ARIZONA PLATING & ANODIZING CO<br>618 S CENTRAL AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85004 | 33/26/30.0<br>112/04/25.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009004862 | ARIZONA SAND & ROCK<br>1801 E UNIVERSITY DR<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/25/05.0<br>112/02/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008395998 | ARVIN IND<br>500 S 15TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981424468 | ASTROPLATE INC.<br>2724 W PALM LANE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD003913597 | AT & T TECHNOLOGY INC<br>3750 W INDIAN SCHOOL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007973 | AZ MAGNESIUM & ALUMINUM FOUNDRY<br>1/2 MI NE OF 39TH AVE & EARLL<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006785 | BAGDAD PLASTIC CO<br>625 S 5TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85004 | 33/27/48.0<br>112/04/18.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006728 | BEARDSLEY ROAD MINES<br>BEARDSLEY RD & 16TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85024 | 33/40/24.0<br>112/02/00.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981688286 | CACTUS TRANSMISSION<br>4737 E MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85008 | 33/28/06.0<br>111/59/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD089995856 | CANYON INDUSTRIES<br>234 E SOUTHERN PACIFIC DR.<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009013368 | CAPITOL MACHINE CO<br>21 S 32ND ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007460 | CAVE CREEK NO PHOENIX<br>E OF PHOENIX WELL #226<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980883680 | CENTRAL AVE LDFL<br>CENTRAL AVE & WATKINS ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85003 | 33/27/48.0<br>112/04/48.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006843 | CENTRAL PLASTIC & RUBBER CO<br>1015 S 23RD ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006900 | CHECKER CAB<br>8TH PLACE & SHERMAN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD057907883 | CHEMONICS LAB DIV MCKENZIE<br>734 E SOUTHERN PACIFIC<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006967 | CHEVRON PHOENIX TERMINAL<br>SW CORNER VAN BKUREN & 51ST AV<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85043 | 33/27/06.0<br>112/11/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD050539675 | COLLINS METAL FINISHING INC<br>37 S 42ND PLACE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009015512 | COMMERCIAL COMPANIES<br>3206 W LEWIS AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/28/30.0<br>112/07/55.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980735609 | COUNTRY MEADOWS UNIT 9<br>107TH & NORTHERN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85039 | 33/29/18.0<br>112/17/12.0 | GEOGRAPH | 6200 | 15070102 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007023 | CYPRUS SPECIALTY STEEL CO<br>1500 S 7TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007148 | DESERT SPECIALTIES<br>1020 S 5TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85004 | 33/27/48.0<br>112/04/18.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007445 | E G R CO<br>4420 E OSBORN RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85018 | 33/30/30.0<br>111/58/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980818769 | EAST LAKE PARK<br>16TH ST & JEFFERSON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980637680 | ESTES LDFL<br>40TH ST & SALT RIV<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/25/26.0<br>112/59/15.0 | REGIONAL | 6200 | 15060106 |
| AZD035900729 | F & B MFG CO<br>4316 N 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007387 | FIRESTICK ANTENNA CO<br>2614 E ADAMS<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980637664 | FMC CORP PESTICIDE FORMULATING PLT<br>1450 E BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

#84 ACIDS

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982006611 | FRAZEE PAINT<br>3212 W THOMAS<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007213 | GARRETT PNEUMATIC SYSTEMS<br>2801 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009000050 | GARRETT TURBINE ENGINE CO<br>111 S 34TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/30.0<br>120/00/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD020696159 | GENERAL ELECTRIC<br>3840 W CLARENDON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD080664881 | GEORGIA PACIFIC CORP CHEM PAC DIV<br>4239 W 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980736300 | GILBERT NURSERY<br>2301 W SOUTHERN AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85041 | 33/24/24.0<br>112/06/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007155 | HENES STAMPING INC<br>4301 E MADISON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007098 | HERTZ CORP<br>27TH ST 7 BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD008397242 | HILL BROS CHEM CO<br>4450 N 42ND AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980735542 | HONEYWELL<br>2250 W PEORIA AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85029 | 33/35/42.0<br>112/06/18.0 | GEOGRAPH | 6200 | 15060106 |
| AZD054408794 | HONEYWELL DEER VALLEY COMPUTER PARK<br>13430 N BLACK CANYON HWY<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85029 | 33/36/30.0<br>112/07/15.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008397069 | ITT CANNON ELECTRIC CO<br>2801 E AIR LANE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006975 | KARLSON MACHINE WORKS INC<br>605 E GRANT<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85004 ✓ | 33/27/48.0<br>112/04/18.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980496756 | KENWORTH MOTOR TRUCK DISTRIBUTOR<br>2625 S 19TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 ✓ | 33/25/55.0<br>112/05/05.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006918 | KINO DRAPERIES<br>2326 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD081707762 | LANSDALE TRANSISTOR & ELEC<br>3600 W OSBORN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD020117529 | LAWN & GARDEN SUPPLY<br>2222 N 27TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD063295190 | LIQUID AIR INC<br>3332 W MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980735732 | LOWER BUCKEYE SITE<br>1500 LOWER BUCKEYE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/25/50.0<br>112/03/10.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006850 | MACHINE TECH<br>327 S 27TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD035891316 | MARINA DEL SOL<br>4931 E MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85035 | 33/28/30.0<br>112/11/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981693419 | MARONEYS CLEANERS<br>3192 E INDIAN SCHOOL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85018 | 33/30/30.0<br>111/58/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD083718726 | MAXLIGHT OPTICALS WAVE GUIDES<br>3035 N33RD DR<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD035914084 | MAY IND<br>3640 W OSBORN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982006793 | MCCOYS LAUNDRY & CLEANERS<br>1624 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD054399480 | MECH TRONICS CORP<br>2515 E BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006736 | MERRILL COMMUNICATIONS<br>2949 W OSBORN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981582331 | MODERN INDUSTRIES<br>3229 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD045810553 | MOGUL CORP<br>3030 N 30TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009004177 | MOTOROLA INC (52ND STREET PLANT)<br>5005 E MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85008 | 33/20/48.0<br>111/58/10.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883300 | MOTOROLA INC 56TH ST PLT<br>3102 N 56TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85031 | 33/29/42.0<br>112/10/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006678 | NELSON COMMUNICATIONS INC<br>3301 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007692 | NELSON ENGINEERING CO INC<br>4020 E AIR LANE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980496780<br>*223 Acres | NINETEENTH AVENUE LANDFILL<br>19TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85041 | 33/20/05.0<br>112/02/25.0 | REGIONAL | 6200 | 15060106 |
| AZD982007817 | OHLINGER IND<br>2327 W PALM AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679640<br>*230 Acres | OLD 23RD AVE SLUDGE DISPSL PONDS<br>23RD AVE & LOWER BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679707 | OLD 91ST AVE SLIDGE DISPOSAL PONDS<br>91ST AVE & SALT RIVER<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85353 | 33/26/54.0<br>112/15/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008394637 | OSBORN PRODS INC<br>3632 W CLARENDON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/29/35.0<br>112/08/10.0 | GEOGRAPH | 6200 | 15060106 |
| AZD020127411 | PAINT SPRAY INC<br>3839 N 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008399891 | PAPAGO PLATING CO<br>2312 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE<br>ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007874 | PARAFLEX MACHINE & TOOL CO<br>3829 N 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007932 | PHOENIX DATA<br>3384 W OSBORN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981680127 | PHOENIX DOWNTOWN SOUTHWEST AREA<br>NW BORDER OF EASTLAKE PARK SDY<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009010273 | PHOENIX HEAT TREATING INC<br>2405 W MOHAVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 ✓ | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007999 | PHOENIX NEWSPAPERS INC<br>120 E VAN BUREN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679582 | PHOENIX NORTHWEST SERVICE CENTER CITY OF<br>4020 W GLENROSA<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007635 | PHOENIX PLASTICS INC<br>215 S 23RD ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679889 | PHOENIX SKY HARBOR INTL AIRPORT<br>3400 E SKY HARBO9R BLVD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

* 136 Acids

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD982007577 | PHOENIX TRANSFORMER CO<br>1818 E MADISON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980818884 | PHOENIX WELL #226<br>3120 W ACOMA DR<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85023 | 33/38/36.0<br>112/06/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980818827 | PHOENIX WELL #71<br>3851 W EARLL DR<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000026724 | PRECISE METAL PRODUCTS<br>3839 N 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85019 | 33/30/12.0<br>112/08/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD990722738 | PYRAMID INDS<br>4330 N 39TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD074440470 | QUALITY PRINTED CIRCUITS CORP<br>1831 S CENTRAL<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85004 | 33/25/56.0<br>112/04/20.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980886402 | REDS TOOL & DYE<br>9201 N 9TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85013 | 33/30/36.0<br>112/04/54.0 | GEOGRAPH | 6200 | 15060106 |
| AZD042017954 | RESEARCH CHEM DIV OF NUCOR CORP<br>8220 W HARRISON ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85043 | 33/27/05.0<br>112/14/10.0 | GEOGRAPH | | |

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

RUN DATE: 04/05/88
RUN TIME: 20:29:39

VERSION: 1

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD981679822 *112 acres | REYNOLDS ALUMINUM PLANT PONDS<br>43RD AVE & SALT RIVER<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85042 ✓ | | | | |
| AZD008394249 | REYNOLDS METALS CO<br>3501 W VAN BUREN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 ✓ | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD049314370 *261 acres | RINCHEM<br>2402 S 15TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85007 ✓ | 33/25/30.0<br>112/05/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007338 | RINCHEM<br>4115 W TURNEY<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980882997 | RINCHEM<br>2701 W THOMAS<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007270 | RPS PRODS OF AZ<br>3230 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980882674 | SALT RIV PROJ WELL SITE 17E-8N<br>INDIAN SCHOOL RD & 32ND ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85018 | 33/30/30.0<br>111/58/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980637979 | SENTRON<br>3830 N 28TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING


RUN DATE: 04/05/88
RUN TIME: 20:29:39
VERSION: 1

REGION: 09

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|---|---|---|---|---|---|---|---|
| AZD009018748 | SIMPLE SPACE RITE INC<br>3442 W 29TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980636047 | SKY HARBOR ANG BASE<br>2001 S 32ND ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZT050010016 | SO PACIFIC TRANSP CO<br>13TH ST & HARRISON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZT050010677 | SOUTHWEST TECHNOLOGY<br>1739 N 28TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009004961 | SPERRY FLIGHT SYSTEMS DIV<br>21111 N 19TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85027 | 33/40/59.0<br>112/05/39.0 | GEOGRAPH | 6200 | 15070102 |
| AZD009006917 | STEVENS DECAL CO<br>3336 W MCDOWELL RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007940 | STORM PRODUCTS<br>3047 N 31ST AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007882 | SUN PUBLISHING CO<br>2645 E WASHINGTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

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|---|---|---|---|---|---|---|---|
| AZD982007825 * 399 ACTDO | SURFACE IMPOUNDMENT @ SKY HARBOR<br>29TH ST N OF GIBSON LANE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007767 | SYNTEX OPTHALMICS<br>29TH AVE & FAIRMONT<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007700 | TARGET CHEMICAL CO<br>3420 W WHITTON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007643 | TURLEY IND<br>2441 E MADISON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD070259767 | UNION OIL CO OF CA<br>10 S 51ST AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85043 ✓ | 33/27/06.0<br>112/11/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD081686107 | UNITED TRUCK & EQUIPMENT<br>SE COR OF JONES & S 19TH AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85041 ✓ | 33/24/24.0<br>112/06/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679095 | VACANT LOT<br>48TH ST & E VAN BUREN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85043 ✓ | 33/27/06.0<br>112/11/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980890917 | VAN BUREN TANK FARM<br>SW COR OF 51ST & VAN BUREN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85003 | 33/27/48.0<br>112/04/48.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

RUN DATE: 04/05/88
RUN TIME: 20:29:39
VERSION: 1

LIST-1: SITE LOCATION LISTING

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD058790957 | VANGUARD WEST INC<br>3001 N 33RD AVE<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85017 | 33/30/24.0<br>112/07/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007080 | VELCO D MFG OF AZ<br>401 S 36TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981674443 | VIKING CLEANERS<br>4029 N 32ND ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85018 | 33/30/30.0<br>111/58/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008394967 | WAYNE OXYGEN CO INC<br>2615 S 40TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/25/15.0<br>111/59/50.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982007346 | WEST PHOENIX IND AREA<br>AREA BORDERNG PHOENIX WELL #71<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD072449788 | WESTINGHOUSE ELECTRIC CORP<br>1825 E MADISON<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883433 | 11TH ST LDFL<br>11TH ST & GIBSON LN<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883425 | 14TH ST LDFL<br>14TH & MAGNOLIA STS<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |

# 299 ACIDS
# 6 Acids
#93 ACIDS

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

RUN DATE: 04/05/88
RUN TIME: 20:29:39
VERSION: 1

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980883417 | 16TH ST LDFL<br>16TH & ELWOOD STS<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980695670 | 18- ACRE VACANT LOT<br>51ST AVE & THUNDERBIRD RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85031 | 33/29/42.0<br>112/10/06.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981679764 | 19TH AVE AIRSTRIP<br>NE CORNER 19TH AVE & BROADWAY<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85007 ✓ | 33/27/06.0<br>112/05/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883482 | 23RD AVE LDFL<br>23RD AVE & LOWER BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85009 ✓ | 33/27/30.0<br>112/07/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980813562 | 40TH STREET LDFL<br>2425 S 40TH ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD981680606 | 44TH & WASHINGTON ASSOC<br>4444 E WASHINGTON ST<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85034 ✓ | 33/26/06.0<br>112/01/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883474 | 7TH AVE LDFL<br>7TH AVE & LOWER BUCKEYE RD<br>PHOENIX<br>MARICOPA | AZ<br>013 | 85007 ✓ | 33/27/06.0<br>112/05/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008397861 | MARATHON STEEL CO<br>KYRENE RD S AT ELLIOT<br>S TEMPE<br>MARICOPA | AZ<br>013 | 85283 | 33/21/36.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15050100 |

Handwritten notes: #9 AClbs (16TH ST LDFL); #230 acres (23RD AVE LDFL); #88 AClbs (40TH STREET LDFL); #25 AClbs (7TH AVE LDFL)

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

VERSION: 1

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP CODE | LATITUDE<br>LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD980735781<br>#122 ACWD | TRI-CITY LDFL<br>SALT RIV INDIAN RESV<br>SALT RIV INDIAN RESV<br>MARICOPA | AZ<br>013 | 85256 | 33/28/48.0<br>111/49/32.0 | GEOGRAPH | 6200 | 15060106 |
| AZD068391564 | COMTECH DATA CORP<br>350 N HAYDEN<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85257 | 33/30/06.0<br>111/55/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980695969 | INDIAN BEND WASH AREA<br>MCDOWELL RD & HAYDEN<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85253 | 33/27/56.0<br>111/54/29.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883367 | INDIANHEAD MFG CO<br>3612 N SCOTTSDALE RD<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85251 | 33/29/18.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD055646921 | MARRO PLATING<br>7811 E PIERCE ST<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85257 | 33/30/06.0<br>111/55/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980675433 | MICROSEMICONDUCTOR<br>8700 E THOMAS RD<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85257 | 33/30/06.0<br>111/55/24.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008399636 | MOTOROLA INC GOVT ELECTRONICS DIV<br>8201 E MCDOWELL ST<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85257 | 33/27/45.0<br>111/54/30.0 | GEOGRAPH | 6200 | 15060106 |
| AZD089309462 | ROLAMECH CO THE INC<br>3719 N 75TH ST<br>SCOTTSDALE<br>MARICOPA | AZ<br>013 | 85252 | 33/29/18.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

REGION: 09

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|---|---|---|---|---|---|---|---|
| AZD980883607 | SENTINEL DUMPSITE<br>3/8 MI N OF I-10 EXIT<br>SENTINEL<br>MARICOPA | AZ<br>013 | 85337 | 32/56/48.0<br>112/43/00.0 | GEOGRAPH | 6200 | 15070101 |
| AZD980880942 | VALLEY SPRAYER & DUSTER SERV INC<br>12205 W BELL RD<br>SURPRISE<br>MARICOPA | AZ<br>013 | 85374 | 33/35/06.0<br>112/17/24.0 | GEOGRAPH | 6200 | 15070102 |
| AZD080667819<br>#1 Acuos | ALLSTATE MINE SUPPLY<br>1926 E 1ST ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD070254008<br>#2 Acuos | ARIZONA CASTING<br>115 N PERRY LN<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZT050010438 | ARIZONA PUBLIC SERV OCOTILLO POWER PLT<br>1500 E UNIVERSITY<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/30.0<br>111/54/52.0 | GEOGRAPH | 6200 | 15060106 |
| AZD077526127<br>#3 Acuos | BENNETT BROTHERS RECYCLING<br>1990 E 1ST ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD058793696 | CIRCUIT SPECIALISTS<br>738 S PERRY LANE<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD068402643<br>#7 Acuos | CIRCUIT TECHNOLOGY<br>119 S INDUSTRIAL DR<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

U.S. EPA SUPERFUND PROGRAM

** C E R C L I S **

LIST-1: SITE LOCATION LISTING

RUN DATE: 04/05/88
RUN TIME: 20:29:39

VERSION: 1

REGION: 09

| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD038444154 | DCE CIRCUITS<br>1310 E 8TH ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD008394355<br>#29 Acids | IMC MAGNETICS<br>1900 E 5TH ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD009020009<br>#163 Acids | INDIANHEAD MFG CO<br>1318 PRINCESS DR<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980813570<br>#229 Acids | KATCHINA REDI-MIX<br>1976 E PIMA ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000819607 | LABORATORY CONSULTANTS<br>9213 S HARDY DR<br>TEMPE<br>MARICOPA | AZ<br>013 | 85282 | 33/23/42.0<br>111/55/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980883441<br>#18 Acids | MEGATRONICS<br>229 CLARK / 2149 E FIFTH<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD085453603 | MIDLAND ROSS CAPITOL CASTING DIV TEMPE<br>5857 S KYRENE RD<br>TEMPE<br>MARICOPA | AZ<br>013 | 85283 | 33/21/36.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15050100 |
| AZT000618512 | MOTOROLA INC PRICE RD PLT<br>7402 S PRICE RD<br>TEMPE<br>MARICOPA | AZ<br>013 | 85252 | 33/21/18.0<br>111/54/00.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
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LIST-1: SITE LOCATION LISTING

VERSION: 1

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| EPA ID | SITE NAME / STREET / CITY / COUNTY | STATE / COUNTY | ZIP CODE | LATITUDE / LONGITUDE | LAT/LONG SOURCE ACCURACY | SMSA | HYDRO UNIT |
|---|---|---|---|---|---|---|---|
| AZD042017590 | OMNI SPECTRA CO PALO VERDE IND PARK<br>2626 S HARDY DR<br>TEMPE<br>MARICOPA | AZ<br>013 | 85282 | 33/23/42.0<br>111/55/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD980816474 | SALT RIV PROJ<br>1521 PROJECT DR<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000628628 | SALT RIV PROJ KYRENE STEAM PLT<br>S KYRENE RD<br>TEMPE<br>MARICOPA | AZ<br>013 | 85283 | 33/21/15.0<br>111/55/30.0 | GEOGRAPH | 6200 | 15050100 |
| AZD035954114 | SANDERS AVIATION<br>S 56TH ST<br>TEMPE<br>MARICOPA | AZ<br>013 | 85284 | 33/19/30.0<br>111/56/06.0 | GEOGRAPH | 6200 | 15050100 |
| AZD005200613 | TRIUMPH CORP<br>2130 S INDUSTRIAL PARK AVE<br>TEMPE<br>MARICOPA | AZ<br>013 | 85282 | 33/23/42.0<br>111/55/42.0 | GEOGRAPH | 6200 | 15060106 |
| AZD120317730 (#51 Acids) | WHITRONICS<br>209 N PERRY LN<br>TEMPE<br>MARICOPA | AZ<br>013 | 85281 ✓ | 33/25/42.0<br>111/55/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000632844 | ARIZONA AGROCHEMICAL CO<br>433 S 83RD AVE<br>TOLLESON<br>MARICOPA | AZ<br>013 | 85353 | 33/26/50.0<br>112/14/05.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000389445 | PURE GRO CO<br>99TH AVE & HARRISON<br>TOLLESON<br>MARICOPA | AZ<br>013 | 85353 | 33/26/30.0<br>112/15/55.0 | GEOGRAPH | 6200 | 15060106 |

SELECTION: ** SPECIAL **
SEQUENCE: STATE, CITY NAME, SITE NAME

LIST-1: SITE LOCATION LISTING

VERSION: 1

REGION: 09

| EPA ID | SITE NAME<br>STREET<br>CITY<br>COUNTY | STATE<br>COUNTY | ZIP<br>CODE | LATITUDE<br>LONGITUDE | LAT/LONG<br>SOURCE<br>ACCURACY | SMSA | HYDRO<br>UNIT |
|---|---|---|---|---|---|---|---|
| AZD980358014 | SWIFT INDEPENDENT PACKING CO<br>91ST AVE<br>TOLLESON<br>MARICOPA | AZ<br>013 | 85353 | 33/26/54.0<br>112/15/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD000027805 | TOLLESON PLATING CO<br>9119 W POLK<br>TOLLESON<br>MARICOPA | AZ<br>013 | 85353 | 33/26/54.0<br>112/15/36.0 | GEOGRAPH | 6200 | 15060106 |
| AZD982006660 | BOERS DAIRY DDT<br>T1 NR 1W/2W/3W R PARTS OF T1 N<br>T1SR2W/3W/4W<br>MARICOPA | AZ<br>013 | 85000 | | | | |
| AZT000624429 | PALO VERDE NUCLEAR GENERATING STA<br>5801 S WINTERSBURG RD<br>WINTERSBURG<br>MARICOPA | AZ<br>013 | 85343 | 33/23/25.0<br>112/52/25.0 | GEOGRAPH | 6200 | 15070101 |