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FLOOD DAMAGE REPORT
STATE OF ARIZONA

FLOODS OF 1993

US ARMY CORPS
OF ENGINEERS
Los Angeles District
South Pacific Division

AUGUST 1994

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY/FEBRUARY 1993

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1. OVERVIEW

1.01 INTRODUCTION

From late December 1992 through February 1993, a series of winter storms produced record breaking amounts of precipitation and severe weather across Arizona. At this time the state was in its third consecutive year of above average precipitation, upper watersheds were saturated, and record breaking snowpacks were recorded statewide.

Heavy rains in January, estimated at 520% above normal, combined with the rapid melting of the snowpack, caused intense runoff and flooding of streams and rivers throughout the state. The 15 day period of heavy rain and high flood stages in early January 1993 was one of the most damaging and extensive wet winter periods witnessed in recent times.

Governor Symington proclaimed a statewide emergency, and on January 19, 1993, a Presidential Disaster Declaration was issued for 10 counties in Arizona: Apache, Coconino, Gila, Graham, Greenlee, Maricopa, Navajo, Pima, Pinal, and Yavapai. On January 26, Cochise and Santa Cruz Counties were added, and on February 5, Yuma County was added. The Federal Emergency Response Plan was activated to provide individual and public assistance.

February 1993 storms followed after a brief respite, bringing precipitation of 400% above normal for the month. Streams and rivers statewide, still partially full from January runoff, experienced additional high flows for periods of up to 10 days. In some areas of the state, the additional runoff caused flooding in areas not affected by the January storms.

Damages were widespread and significant. Total public and private damages are estimated to exceed $400 million. Eight deaths and 112 injuries were reported by the Red Cross. Total Federal flood related expenditures exceeded $220 million.

The agriculture industry alone, which accounts for about one-sixth of the Arizona economy, suffered direct damages of approximately $70 million in lost crops, eroded or destroyed land and buildings, and short term lost income. The consequences of reduced yields on inundated acreage, associated job losses, and reductions in tax basis, will continue for years.

Flooding caused widespread damage to public infrastructure and facilities, impacted people in over 100 communities, and affected the economy of Arizona in numerous ways. Tourism, an important part of the economy in many counties, was below normal in many areas during months of usually high activity. The mining industry suffered extensive physical damage, lost production, and increased expenses. Environmental and economic impacts resulted from sewage spills, loss of vegetation and wildlife in floodplains, and sedimentation and debris deposition within Arizona rivers.

Painted Rock Dam and Alamo Dam, flood control projects built by the Corps of Engineers, prevented in excess of $113 million in additional damages. A total of 15 other Corps of Engineers built projects statewide, operated by others, prevented significant damages of an unspecified amount.

1.02 SCOPE OF REPORT AND QUALIFICATION STATEMENT

1.02.1 Scope of Report

The Scope of this Flood Damage Report is to document the hydrologic, hydraulic, and meteorologic parameters and associated response costs, damages, and impacts of the 1993 storm events and floods in the State of Arizona. The report is intended to serve as a reference for the Corps of Engineers, and others.

The report includes damages sustained by public and private entities, documents flood response costs, and includes brief descriptions of impacts on local communities. Primary damage centers are identified.

1.02.2 Qualification Statement

This Report is based upon information supplied by others. It is a summary report and much of the data is preliminary in nature, however, every effort has been made to ensure the accuracy of the information. No attempt has been made to catalog damages, costs, and impacted areas on a comprehensive basis, but only to report information which was readily available. As such, this report serves to indicate major areas of damage and show the relative statewide magnitude of the 1993 Floods. Actual damages and impacted areas are likely more numerous than listed herein.

1.03 ACKNOWLEDGEMENTS

Throughout the preparation of this report, numerous individuals participated by supplying information and data on an ongoing basis. Representatives at the local, county, state, and federal levels all provided input. Many thanks and acknowledgements are due to numerous individuals of the following agencies for their input and continuing coordination through review of the draft Report and the significant assistance provided:

U.S. Bureau of Reclamation, Arizona Projects Office
U.S. Bureau of Reclamation, Yuma Projects Office
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. Soil Conservation Service
U.S. Federal Highways Administration
U.S. Bureau of Indian Affairs
U.S. Federal Emergency Management Agency
U.S. Small Business Administration
U.S. Red Cross
U.S. National Weather Service
Arizona State Department of Environmental Quality
Arizona State Department of Water Resources
Arizona State Department of Transportation
Arizona State Division of Emergency Management

Arizona State Game and Fish Department
Salt River Project
Apache County Development and Community Services
Town of Camp Verde
Town of Clarkdale
Coconino County Flood Control District
City of Bullhead City
Cochise County Highway and Floodplain Department
Gila County Department of Emergency Services
Town of Globe
Graham County Engineering
Greenlee County Roads and Public Works Department
Town of Kearny
La Paz County Board of Supervisors
Town of Mammoth
Flood Control District of Maricopa County
Maricopa County Department of Transportation
The Navajo Nation
City of Phoenix Water Resources Department
Pima County Department of Transportation and Flood Control District
Pinal County Department of Civil Works
Santa Cruz County Flood Control District and Floodplain Administration
Santa Cruz County Planning and Zoning Department
Wellton-Mohawk Irrigation and Drainage District
Yavapai County Flood Control District
Yuma County Development Services Department
Yuma County Emergency Management

2. DRAINAGE AREA DESCRIPTIONS

2.01 GILA RIVER AND TRIBUTARIES.

2.01.1 Drainage Area.

The drainage area of the Gila River (see figure 1) covers approximately 58,000 sq. mi. and extends from the Continental Divide in southwestern New Mexico to the Colorado River at Yuma, Arizona, including practically all the southern half of the State of Arizona. The Gila River, which is 654 miles long, rises in an area of high mountains and plateaus and flows westward in a generally central course through the basin. The Gila River includes the following major tributaries:

- the Salt and Verde Rivers, combined drainage area of 13,000 sq. mi.
- the Santa Cruz River, drainage area of 8,600 sq. mi.
- the San Pedro River, drainage area of 4,500 sq. mi.
- the San Francisco River, drainage area of 2,800 sq. mi.
- the San Simon River, drainage area of 2,200 sq. mi.
- the Agua Fria River, drainage area of 2,000 sq. mi.
- the Centennial Wash, drainage area of 1,800 sq. mi.
- the San Carlos River, drainage area of 1,027 sq.mi.
- others, including Queen Creek, the Hassayampa River, and Waterman Wash.

Elevations in the basin range from more than 12,000 feet in the San Francisco Peaks in the Verde River basin to 130 feet in the vicinity of Yuma. Much of the northern part of the basin is extremely irregular and rugged with elevations ranging from 7,000 feet to 12,000 feet along the basin boundaries. This portion of the basin is mostly drained by the Salt River, which joins the Gila River at mile 198, near Phoenix. The eastern half of the southern part of the basin consists largely of long desert valleys lying between north-south ranges of rugged mountains; here the elevations are generally lower but in places are above 10,000 feet. The southwest third of the basin consists essentially of broad, flat, low-lying desert valleys and isolated mountains of relatively low relief; comparatively few localities are more than 4,000 feet in elevation, and a large part is below 1,000 feet; the elevation of the river mouth near Yuma is about 130 feet. The major streams are delineated in Figure 1. The climate of the Gila River Basin is semiarid as a whole, but, depending principally upon elevation, ranges from hot and arid to cool and humid. The average annual precipitation ranges from less than 4 inches in the lower desert to 30 inches or more in the highest mountains. Streamflow characteristics vary considerably throughout the basin. The streams in the southern deserts have very little flow other than immediately after the heavier rains, while the northern and headwater streams are perennial. During major storms, such as those described in this report, streamflow increases rapidly, and in combination with steep gradients and often-barren slopes, results in major floods. Snowmelt is a contributing factor in most winter floods.

Basin Location Map
State of Arizona

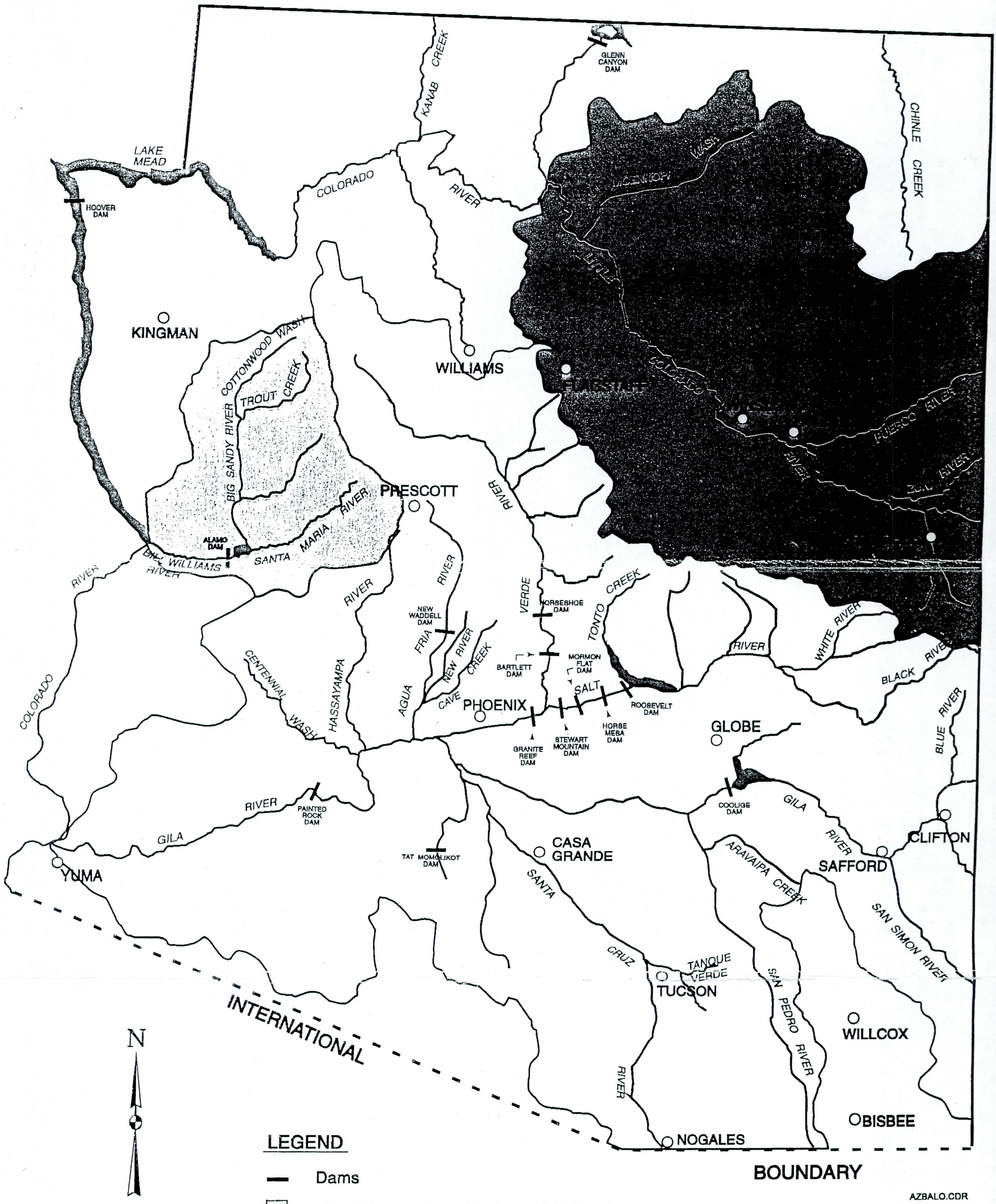


Figure 1

Within the Gila River Basin are numerous dams, but only a few of these will exert an appreciable influence on major floods:

- Roosevelt Dam on the Salt River, currently in the process of modification to increase the total storage (including an added flood pool of 565,000 ac-ft) to 2,100,000 ac-ft.
- Horse Mesa on the Salt River, with a storage of approximately 245,000 ac-ft.
- Mormon Flat on the Salt River, with a storage of approximately 58,000 ac-ft.
- Stewart Mountain on the Salt River, with a storage of approximately 70,000 ac-ft.
- Horseshoe on the Verde River with a storage of approximately 131,000 ac-ft.
- Bartlett on the Verde River with a storage of approximately 178,000 ac-ft.
- Coolidge on the Gila River with a storage of approximately 1,100,000 ac-ft (currently storage is restricted due to dam safety issues).
- New Waddell on the Agua Fria River, recently completed, with a total storage of approximately 1,000,000 ac-ft.
- Painted Rock on the Gila River, with a flood control pool of approximately 2,500,000 ac-ft.

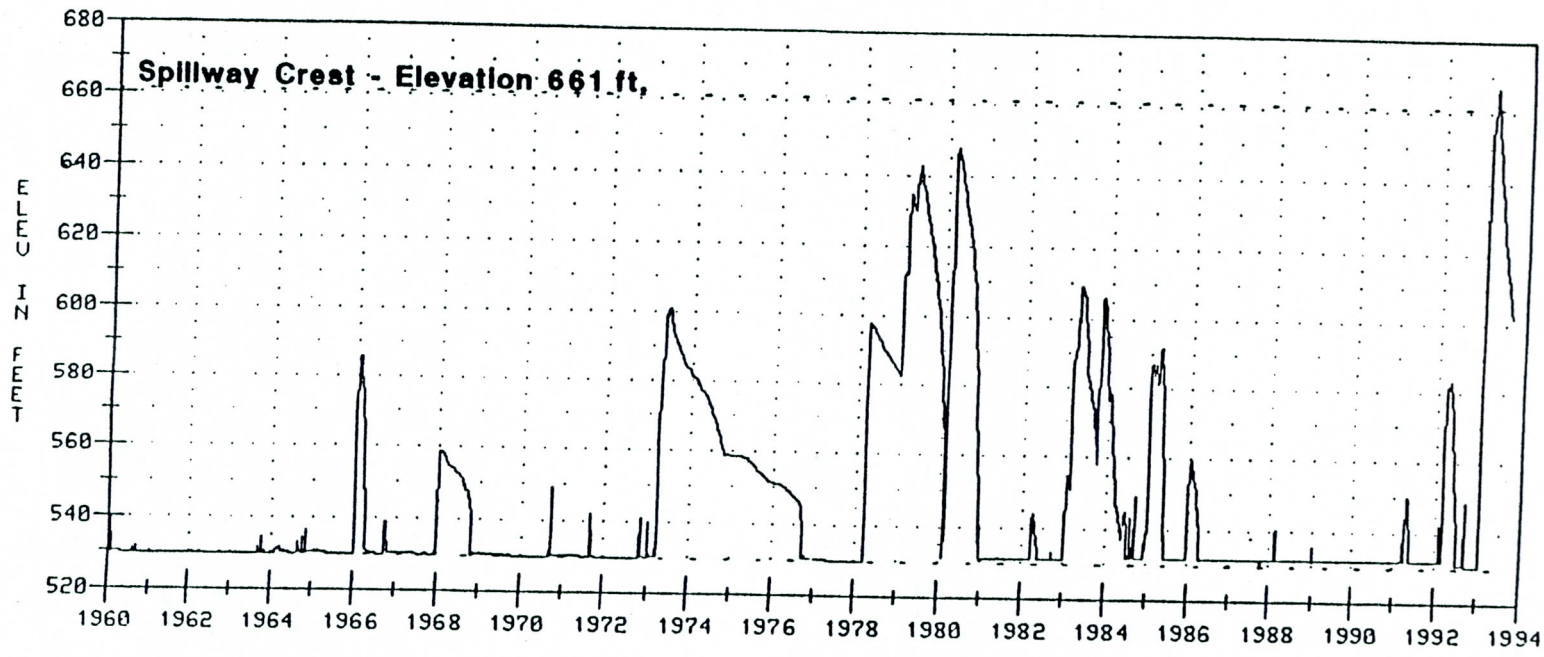
The location of these water impoundment facilities is shown on figure 1.

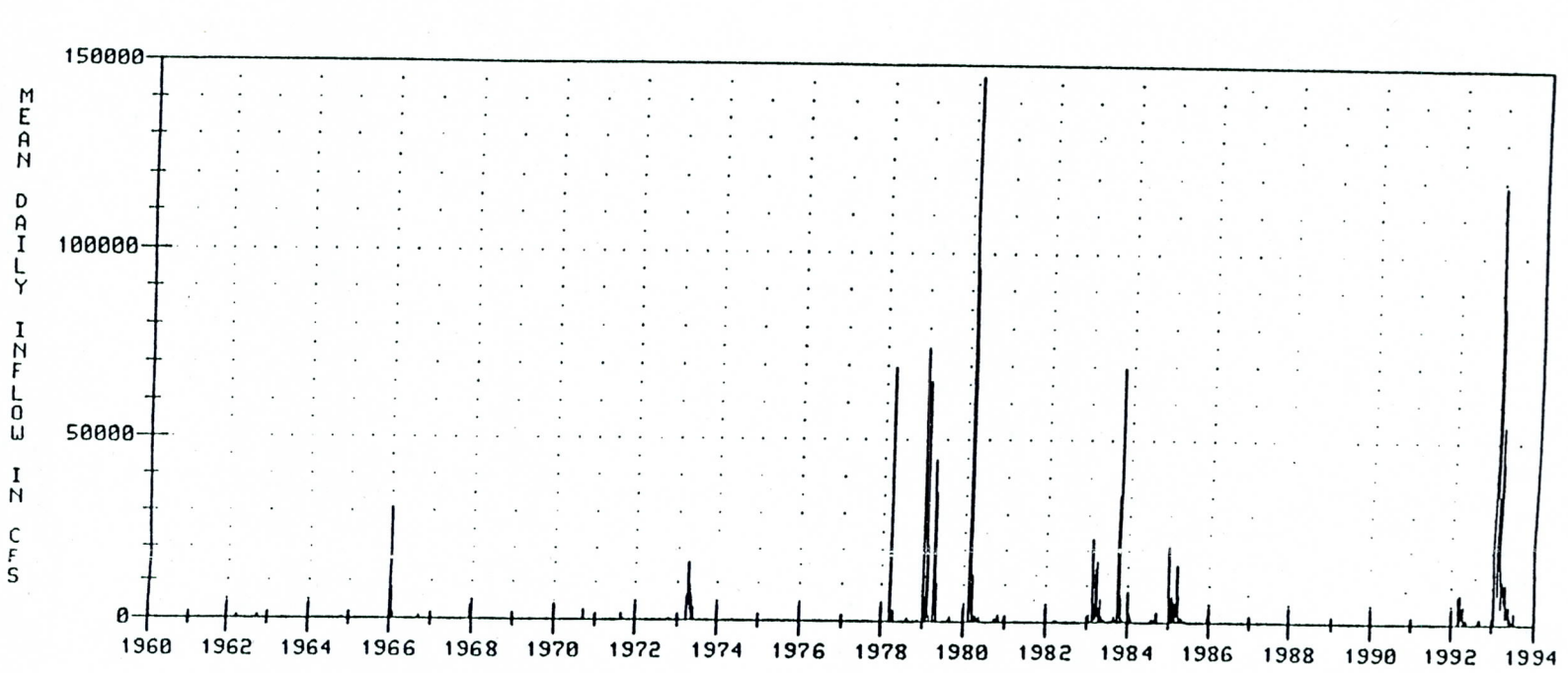
2.01.2 Painted Rock Dam.

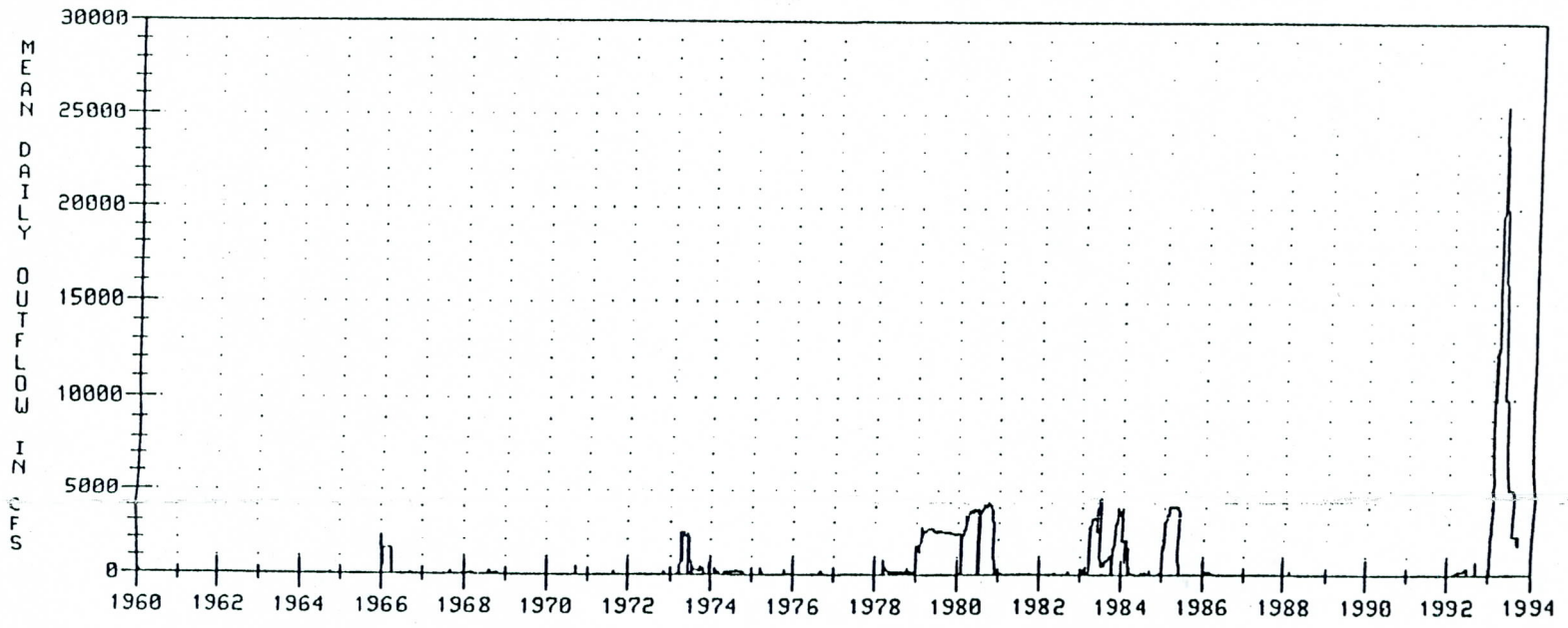
Painted Rock Dam is located in the southwest part of Maricopa County in the State of Arizona about 20 miles northwest of the town of Gila Bend. The dam is on the Gila River, and controls a drainage area of 50,800 sq. mi. Construction of Painted Rock Dam began in July 1957 and closure was made in April 1960. The dam has a rolled-fill earthen embankment with a crest length of 4,780 feet and crest width of 20 feet. The dam crest is at elevation 705 feet NGVD, which is 181 feet above the original streambed. The area and capacity of the reservoir formed by Painted Rock Dam are 53,200 acres and 2,476,300 ac-ft at spillway crest (elevation 661), respectively; the area and capacity at the top of the dam (elevation 705) are 90,100 acres and 5,575,000 ac-ft. The dam has gated flood outlets which are capable of releasing 30,000 ft^3/s at spillway crest - the maximum scheduled gated release is 22,500 ft^3/s - and which are connected to a 925 foot long, 25 foot diameter concrete-lined outlet conduit which discharges to an unlined trapezoidal rock channel 330 feet long. The spillway is a detached broad-crested weir, located 600 feet beyond the right abutment. The spillway crest is 610 feet in length at elevation 661 feet NGVD, and empties into a small canyon which enters the Gila River about 800 feet below the downstream toe of the embankment.

2.01.3 Flood History.

Since the completion of the dam in 1960, significant inflows occurred in March - May 1973, March 1978, December 1978 - April 1979, February 1980, February - May 1983, October 1983, December 1984 - March 1985 , and February - April 1992, in addition to 1993. Figure 2 presents the flood history of Painted Rock Dam since its completion; hydrographs depicting mean daily inflow and outflow, along with elevation, are provided.







Flood History of Painted Rock Dam

01 January 1960 - 10 June 1993

Figure 2

2.02 BILL WILLIAMS RIVER.

2.02.1 Drainage Area.

The drainage area (shown on figure 1) is bounded on the north by the Cottonwood Cliffs; on the east by the Juniper and Santa Maria Mountains; on the south by the Date Creek and Harcuvar Mountains; and on the west by the Hualapai Mountains. Elevations in the drainage area vary from about 400 - 450 feet above sea level (at Lake Havasu formed by Parker Dam on the Colorado River, which is the mouth of the Bill Williams River) to 8266 feet at Hualapai Peak on the northwest boundary.

The Bill Williams River is formed about 47 miles upstream from its mouth by the confluence of the Big Sandy and Santa Maria Rivers. From the confluence, the flow is southwest for about 8 miles on an average gradient of 18 feet per mile to Alamo Reservoir. Bullard Wash is the largest tributary along this reach. Below Alamo Reservoir, the river flows almost due west to the Colorado River.

The drainage area above Alamo Dam is approximately 4,770 sq. mi. consisting essentially of broad desert valleys and irregularly distributed ranges of rugged mountains. Relief is moderate to high. Surface soils in the southern and central parts of the area and in the district along the Big Sandy River vary in texture from fine gravels to clay with clayey soils occurring in approximately 40 percent of the drainage area. Shallow, rocky soils occur in a few small isolated areas near the mountain summits. The major watercourses are well entrenched with relatively mild gradients compared to the ruggedness of the area.

The Big Sandy and Santa Maria Rivers, which form the Bill Williams River, are essentially ephemeral. Segments of both rivers contain sandy beds which are dry most of the year. Low perennial flow occurs only where ground water is forced to the surface by bedrock constrictions.

The Big Sandy River, larger of the two main tributaries, drains an area of about 2,840 sq. mi. This river, which is formed by the confluence of Trout and Knight Creeks, flows southward about 49 miles on an average stream gradient of 38 feet per mile to the Santa Maria River confluence. Burro Creek is the largest tributary in this reach.

The Santa Maria River drains an area of about 1,550 sq. mi. This river, which is formed by the confluence of Kirkland and Sycamore Creeks, flows southwestward about 51 miles to its junction with the Big Sandy River. The stream gradient of the Santa Maria River is about 30 feet per mile. Date Creek is the largest tributary in this reach. The streambed gradients of many of the minor upstream tributaries in the Bill Williams River system are more than 100 feet per mile. Major streams in the Bill Williams River basin are also delineated on Figure 1.

Climatic conditions in the basin generally vary with elevation. The mean seasonal precipitation ranges from about 8 inches per year near the dam to about 22 inches in the mountains and averages 14.7 inches over the drainage area. Runoff is erratic, with most runoff occurring during and immediately after periods of heavy rain.

Precipitation records are available for 52 precipitation stations in and near the Bill Williams River drainage area. The longest is for the Prescott gage, which has 67 years of record (1905-1971). Normally, streamflow occurs only during and immediately following major storms, except for occasional snowmelt runoff from headwater areas.

Except for a few small temporary diversion structures built by farmers, there are no structures affecting runoff in the Bill Williams River basin above or below Alamo Dam.

2.02.2 Alamo Dam.

The multi-purpose project is located on the Bill Williams River on the border of La Paz and Mohave Counties, Arizona, 37 miles upstream from its confluence with the Colorado River in Havasu Lake, and about 2.5 miles downstream from Alamo Crossing. Figure 1 shows the project location. The dam controls a drainage area of 4,770 sq. mi., generally mountainous, in west-central Arizona.

Main access is from the town of Wenden, on U.S. Highway 60, approximately 36 miles south of the reservoir. Alamo Dam was designed for a gross storage capacity of 1,043,000 ac-ft of which 608,000 ac-ft was allocated for flood control, 200,000 ac-ft for sedimentation over a 100-year period, 230,000 ac-ft for water conservation, and 5,000 ac-ft for a recreation lake.

Construction of the project was initiated in July 1963 and completed in June 1968. The U.S. Army Corps of Engineers is responsible for operation and maintenance of the dam and reservoir, except that the Arizona State Parks Board and the Arizona State Game and Fish Department are responsible for the removal of brush and debris above the log boom.

The dam is a zoned earthfill structure with a top of dam elevation of 1,265 feet NGVD, a crest length of 975 feet, and a crest width of 30 feet. The height above the original Bill Williams River streambed is 283 feet. The unlined-detached spillway, which was excavated in rock at the north abutment, has a crest length of 110 feet at elevation 1,235 feet NGVD, and discharges into a gully separated from the right abutment by a rock ridge. Flow rejoins the Bill Williams River about 1,500 feet downstream from the toe of the dam.

The outlet works are located in the left, or southeast, abutment of the dam. The concrete-lined outlet tunnel is 1,290 feet long, and is 12 feet in diameter except through the gate conduit section. Discharge is controlled by 3 pairs of slide gates 5.5 feet wide by 8.5 feet high, installed in tandem. The outlet works are operated to release a maximum flow of 7,000 ft^3/s. When the water surface exceeds the spillway crest by sufficient depth that outflow exceeds 7,000 ft^3/s, the outlet works are opened completely, and the outlet release can exceed 7,000 ft^3/s.

2.02.3 Flood History.

Historical accounts indicate that there have been many floods in the drainage basin. The floods of 1891, 1916, and 1927 in the vicinity of Planet Ranch road (approximate drainage area = 5,140 sq. mi.) were the largest recorded flows, with estimated peak discharges of 200,000 ft^3/s, 175,000 ft^3/s, and 125,000 ft^3/s, respectively.

More recent floods of smaller magnitude have occurred in the vicinity of the Alamo Dam site in 1931, 1937, 1951, 1978, 1979, 1980, and 1983. The peak discharges associated with these events are 92,200 ft^3/s, 106,000 ft^3/s, 65,100 ft^3/s, 78,000 ft^3/s, 65,400 ft^3/s, 82,200 ft^3/s, and 69,200 ft^3/s respectively.

2.03 LITTLE COLORADO RIVER.

2.03.1 Drainage Area.

The Little Colorado River (see figure 1 for delineation of the drainage area) drains approximately 27,800 sq. mi. in northwestern New Mexico and northeastern Arizona, including 1,030 sq. mi. of closed basins. The river originates south of Springerville, Arizona, in the White Mountains, and flows northward to Saint Johns, then in a northwesterly direction to its confluence with the Puerco River upstream of Holbrook. From Holbrook, the river flows in a general westward direction to its confluence with Clear Creek and Cottonwood Wash upstream of Winslow. From Winslow it flows northwest past Cameron, Arizona, where it is joined by Cedar Wash and Moenkopi Wash, and continues approximately 40 miles until it enters the Colorado River and the Grand Canyon.

The Little Colorado River and its tributaries (see Figure 1 also for delineation of major streams) generally are intermittent and flow only after precipitation within their drainage areas. The only perennial water contributing to the drainage system comes from springs issuing from lava beds in Coyote Creek. In contrast, a few areas of interior drainage occur in the lava-capped plateaus of the easternmost portion of the basin. The largest area surrounds the region near Quemado, New Mexico and is approximately 830 sq. mi. in extent; another large area is around the town of El Moro, New Mexico, and is about 200 sq. mi. in extent. Elevations within the drainage area range from 11,500 feet at Mount Baldy, southwest of Springerville, Arizona, to approximately 3,000 feet at the mouth. The total length of the Little Colorado River is 320 miles with an average streambed slope of 26 feet per mile. The streambed slope varies from a maximum of over 270 feet per mile near the headwaters to a minimum of 3 feet per mile in the desert section below Winslow.

The Little Colorado River drainage basin includes part of the Colorado Plateau's physiographic province, characterized by nearly horizontal rock formations, high altitude, and broad valleys with extensive flat, mesa-like highlands. The southern boundary, known as the Mogollon Rim, is characterized by lava-capped mesas, cinder cones, and high volcanic peaks. Soils of the drainage area are closely related to the geology and topography. On the high volcanic mountains and lava plateaus are covers of heavy, tight soils, that are fertile, but thin. The transition from the lava fields and mountainous areas to the lower elevation desert-like region is marked by a transition in the soils from gravelly, sandy soils in the higher portions to sandy loams, and then clays near the floodplains.

The climate of the Little Colorado River drainage basin is dominated by topography, with average temperature decreasing with elevation, while precipitation generally increases with increased elevation. Most of the basin is arid to semiarid, although some of the higher mountains along the southern edge of the basin receive substantial precipitation. Normal annual precipitation ranges from less than 8 inches near Holbrook to more than 40 inches at Baldy Peak in the

southern part of the basin. Little streamflow occurs except during and immediately following intense rainfall, and during periods of snowmelt. Where streamflow occurs, it is of the flash-flood type with sharp peaks and short duration.

2.03.2 Flood History.

Larger floods on the main river and the major tributaries result mostly from general storms, usually occurring in the summer. Quantitative measurements of floods prior to 1950 on the Little Colorado River are meager. Significant flows occurred on the mainstem in December 1919, September 1923, September 1926, June 1927, April 1929, February 1932, February 1937, March 1938, July 1940, and August 1947. The peak flow of September 1923 near Cameron (drainage area = 26,459 sq. mi.) is estimated to be the largest discharge since 1870. Very little is known about floods in this region prior to 1900. There are accounts of major floods that occurred in the Gila River system and other Arizona watersheds in 1833, 1862, 1869, 1880, 1884, and 1891. Since 1950 there have been significant mainstem flows in January 1952, October 1971, October 1972, October 1974, and December 1978. 1993 discharge data is in Chapter 4 and Appendix B.

3. PRECIPITATION

3.01 METEOROLOGICAL DATA.

3.01.1 Antecedent Conditions.

The heavy rains of January and February 1993 in Arizona followed a heavy rainfall season in 1991-1992, in which much-above-normal precipitation was measured at many stations. Phoenix Airport, for example, recorded 11.70 inches of rain from July 1991 through June 1992, compared with an annual normal of 7.66 inches.

These heavy winter rains in the southwestern United States were concentrated from January through March and caused considerable flooding in Southern California and some in Arizona. The 1991-1992 storms were associated with an El Niño condition, in which warmer-than-normal ocean water in the eastern equatorial Pacific indirectly contributes to a strong low-latitude storm track across Southern California and Arizona from late December through early April.

3.01.2 Conditions During 1992-1993.

The 1992-1993 rainfall season was not driven by El Niño conditions. The water temperatures in the eastern equatorial Pacific Ocean had returned to near normal values by the beginning of the Northern Hemisphere fall of 1992.

The recurrence of heavy storms during the winter of 1992-1993 was caused in large part by abnormal water temperatures in the North Pacific Ocean. Warmer than normal water in the Aleutians energized storms passing over these waters, brought warm air northward from the subtropics, and built a warm high-pressure cell to the east of the region--over the Gulf of Alaska. At the same time, storms moving through cooler than normal water in the lower-latitude North Pacific drifted eastward to the south of the building high pressure cell.

As these low-latitude storms approached the West Coast, they intensified when they encountered warm water off the California and Baja California coast. They were further energized by cold air from northwestern Canada, streaming southward around the large northern high. These storms developed a large, persistent low-pressure center off the Northern California coast. Cold fronts and lines of thunderstorms were repeatedly driven directly into Southern California and eastward into Arizona by a moist flow of air just south of this low. Each of these features brought moderate to heavy rain to much of the southwestern United States.

3.01.3 December 1992 Precipitation.

The heavy rains of the winter of 1992-1993 began in early December, when the first major storm of the season moved across Arizona on the 8th, with 1 to 2 inches of precipitation at many stations and damaging winds at some locations. A minor storm moved into Arizona at the end of the month, with 0.2 to 0.3 inch of precipitation (some of it snow) at several mountain stations. These December rains and snows served to partially saturate the ground prior to the storms of January and February 1993.

3.01.4 Storm of 5-9 January 1993.

The storm of 5-9 January was set up by a large, nearly stationary high in the Gulf of Alaska and a deepening low off the Northern California coast. This resulted in an increasingly strong, moist flow of subtropical air across Southern California and Arizona. Following a few light showers on 3 January, a minor disturbance in this moist flow of air resulted in light to locally moderate showers on 5 and 6 January. Heavier precipitation began during the night of 6-7 January, as a well-developed warm front moved into Arizona from the southwest. Snow levels were mostly 7,000 to 8,000 feet, and areas above these elevations picked up 6 to 10 inches of new snow.

This warm front was followed by a strong cold front on 8 January that brought even heavier precipitation, with amounts exceeding 4 inches in the Salt and Verde River drainages. The storm had spread to the entire state by the end of 8 January, and areas around Tucson recorded 1-2 inches. Phoenix Airport measured 1.94 inches for the storm.

3.01.5 Storm of 10-11 January 1993.

The second significant storm of the month began on 10 January, as a complex low-pressure trough with a warm front and a pair of cold fronts moved into Arizona from the west. The heaviest precipitation spread across the central part of the state during the afternoon and evening of the 10th, with eastern mountains getting heavy rain and some snow during the night and into the early hours of the 11th. Precipitation totals ranged from about one-half inch in the deserts to 1.5 to 2.0 inches in the higher mountains. Snow levels were above 7,000 feet until near the end of the storm, when they dropped to about 5,500 feet.

3.01.6 Storm of 12-19 January 1993.

A series of closely spaced storms hammered Arizona during these eight days in the middle of January. A strong high, entrenched in the northern Gulf of Alaska, forced a deep low farther south than normal--just west of Northern California. A very strong west-to-east subtropical jet stream to the south of this low swept numerous storms through Central and Southern California and across Arizona and southern Utah.

a. Storm of 12-15 January. The first of these was associated with a very deep surface low-pressure system. Early on 13 January, the intense storm was centered just west of San Francisco, with a warm front along the southern border of Arizona and a cold front moving through Southern California. Light precipitation began late on the 12th in most of Arizona and became moderate on the 13th. Another warm-and-cold front combination brought additional rain and showers into the 14th. Light showers recurred into the morning of the 15th.

Precipitation amounts through the afternoon of 15 January ranged from 0.2 to 0.5 inch in the deserts to more than 1.5 inches in the mountains. Snow levels were mostly near 7,000 feet, and some high-elevation stations accumulated more than a foot of new snow.

b. Storms of 16-19 January. The afternoon and evening of the 15th were mostly dry, but another large swath of subtropical moisture was already sweeping into Southern California from

the southwest and was approaching Arizona. The precipitation moved into the northwestern part of Arizona on the 16th, with Bagdad measuring .21 by 8 a.m. and Kingman collecting .86 inch by 5 p.m. Most Arizona stations reported 1 to 3 inches of precipitation from the 16th through the 19th, as disturbances in the fast, moist flow over the region produced frequent periods of precipitation. On the 19th, the last front of this storm period moved eastward, and nearly all of the precipitation had ended by the afternoon of the 19th. Only isolated light showers continued into the early morning of the 20th in eastern Arizona. By now, the primary low-pressure system had weakened and had moved east of the Rockies, and a cool, dry northwesterly flow had developed over Arizona.

During the 72 hours from 5 p.m. on 16 January through 5 p.m. on the 19th, Payson received 3.01 inches of rainfall, including 1.47 inches during the first 24 hours. Flagstaff received a total of 2.37 inches, and 1.56 inches were recorded at Tucson. The higher mountains received even more precipitation, with snow levels dropping to 5,500-6,000 feet on the 18th and 19th. Flood warnings and flash flood watches were required on many streams as a result of this storm series, and a flash flood warning was prompted for the Santa Cruz River from Tucson northward on 19 January.

3.01.7 Storm of 8-10 February 1993.

After a minor storm of 30-31 January 1993, which produced little runoff, the next significant storm moved into western Arizona during the late evening of 7 February, as a deep low-pressure center, along with a warm front, cold front, and squall line, approached from the west. This storm--like those of January 1993--was driven far to the south of the normal eastern Pacific storm track by high pressure over the Gulf of Alaska and northwestern Canada.

Precipitation became moderate to locally heavy across the northern and western portions of Arizona by the morning of the 8th, as the cold front passed through. The front weakened as it moved into southern and eastern Arizona. The squall line that passed across Arizona on the 9th brought more precipitation to the west but also dropped moderately heavy precipitation on the east-central mountains of the state. The National Weather Service issued flood warnings on several major rivers and a flash flood watch for the entire state. The southeastern deserts of Arizona were spared this storm.

Precipitation totals for the 8-10 February storm period ranged from less than 0.25 inch in the southeastern deserts (0.16 at Tucson) to 4 inches or more in the northwestern areas of the state (Kingman measured 4.37 inches, and Bagdad recorded 3.87 inches). Most mountain stations received from 1.5 to 3.0 inches. Snow levels, which began the storm above 9,000 feet, lowered to about 6,000 feet toward the end of the precipitation, and heavy snow advisories were issued for areas above 6,500 feet.

3.01.8 Storm of 14-16 February 1993.

The next storm to hit Arizona resulted from a pair of fast-moving disturbances from out of the north. In a case opposite to that of the preceding storm, the northwestern portions of Arizona (e.g., Kingman and Bagdad) received zero precipitation, while the mountains of eastern

and central Arizona picked up 1-2 inches: Mt. Lemmon recorded 2.09 inches, while Hannigan Meadows had an incomplete total (one day missing) of 1.35 inches.

3.01.9 Storm of 19-20 February 1993.

Throughout mid-February 1993, a large high-pressure cell continued in the northern Gulf of Alaska. By the 17th, it had become very strong and cut off from the rest of the flow, and another deep low moved eastward in the low latitudes south of the high. This low and an associated cold front began to move into California on 18 February. By the morning of the 19th, precipitation was again falling in Arizona, as a pair of cold fronts began moving into the state. These fronts and the strong flow of moist air from the southwest brought widespread precipitation to all portions of the state through mid-day 20 February.

Like most of the other storms of the winter of 1992-1993, the snow levels during the heaviest part of this storm remained above 7,500 feet, lowering to about 6,500 feet near the end of the storm.

Totals for the two-day storm ranged from less than 0.10 inch in the western deserts to more than 5 inches at high-elevation stations. Flagstaff measured 5.08 inches. Bagdad picked up 3.22 inches. Numerous watches and warnings were issued by the National Weather Service.

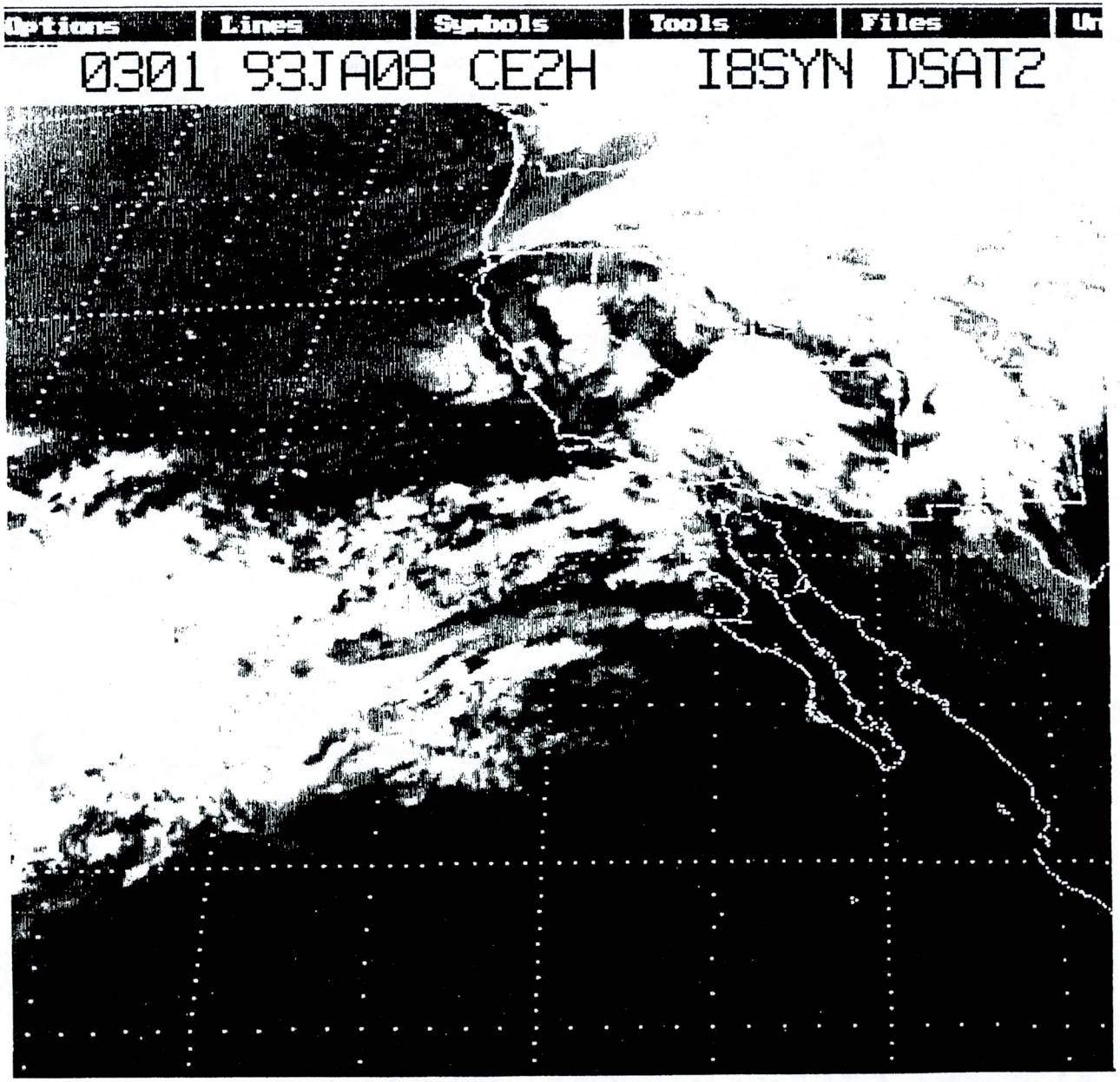
3.01.10 Storm of 24 February 1993.

On 22 February, a new disturbance in the low-latitude flow moved into Southern California. This progressed slowly eastward into Arizona by the 24th. A warm front and two cold fronts brought several periods of showers to various parts of the state during a half day, with snow above 6,000 to 6,500 feet. Most precipitation totals were less than one-half inch, but a few stations, such as Kingman, measured more than 1 inch.

3.01.11 Storm of 28 February 1993.

The last significant storm of February 1993 moved through Arizona on the 28th, as a cold front and several minor bands of precipitation raced from northwest to southeast. Precipitation amounts were mostly under 0.5 inch, with zero at some eastern mountain stations. A few stations in opposite corners of the state, however, received more than 1 inch of precipitation, with 1.41 at Kingman, 1.05 at Gila Bend, and 1.30 at Mt. Lemmon. The latter precipitation was almost all snow, as the snow depth at that station increased from 19 inches before the storm to 32 inches at the end. Snow levels were generally near 6,000 feet in this last storm of February 1993, with some snow falling below 5,000 feet at the very end.

Following this storm, the large high in the Gulf of Alaska moved southeast and formed a full-latitude high over the western United States, blocking out future storms for several weeks.



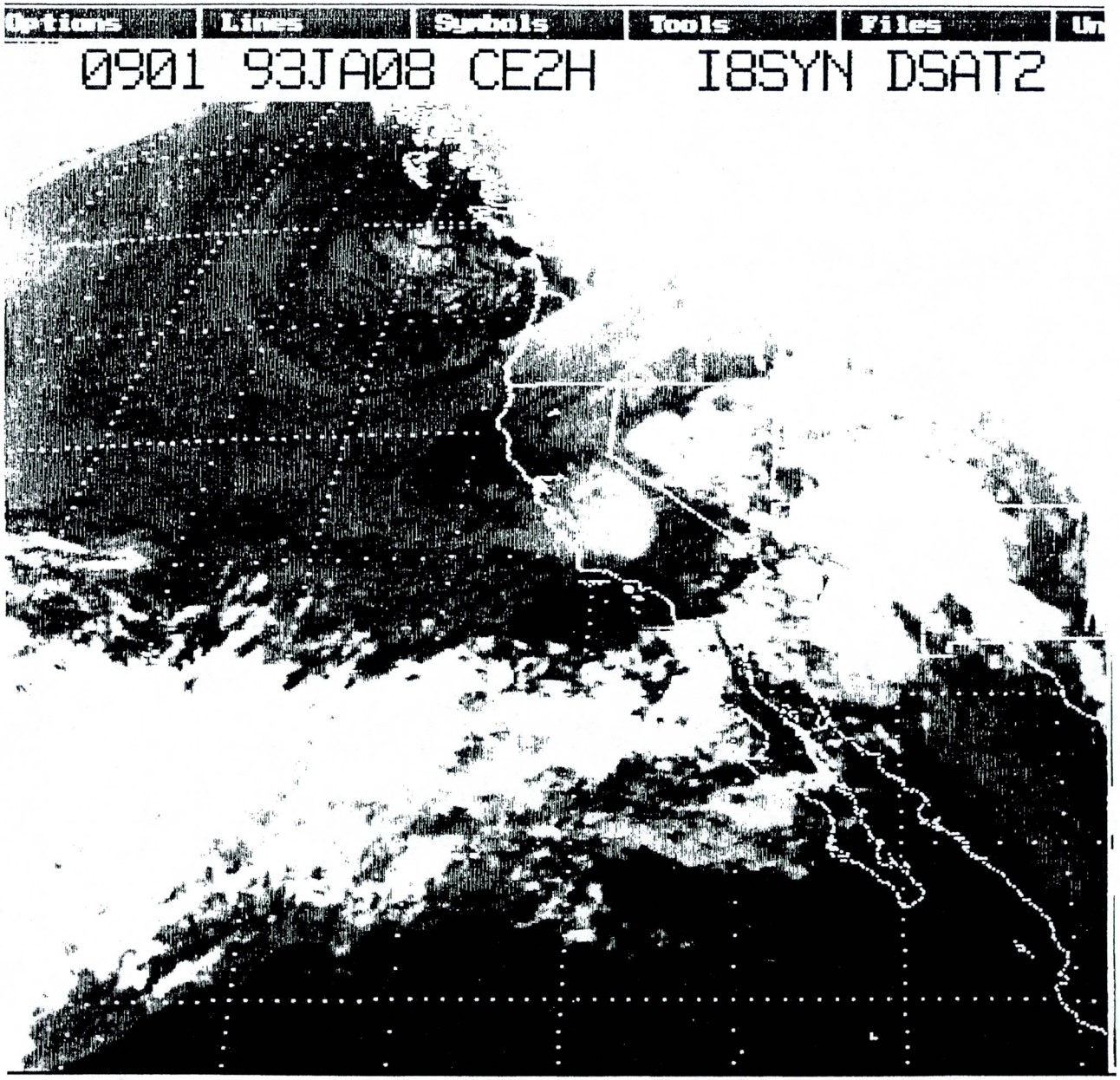
FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY - FEBRUARY 1993

STORM PATTERN

8 JAN 1993

3:01 A.M.

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION



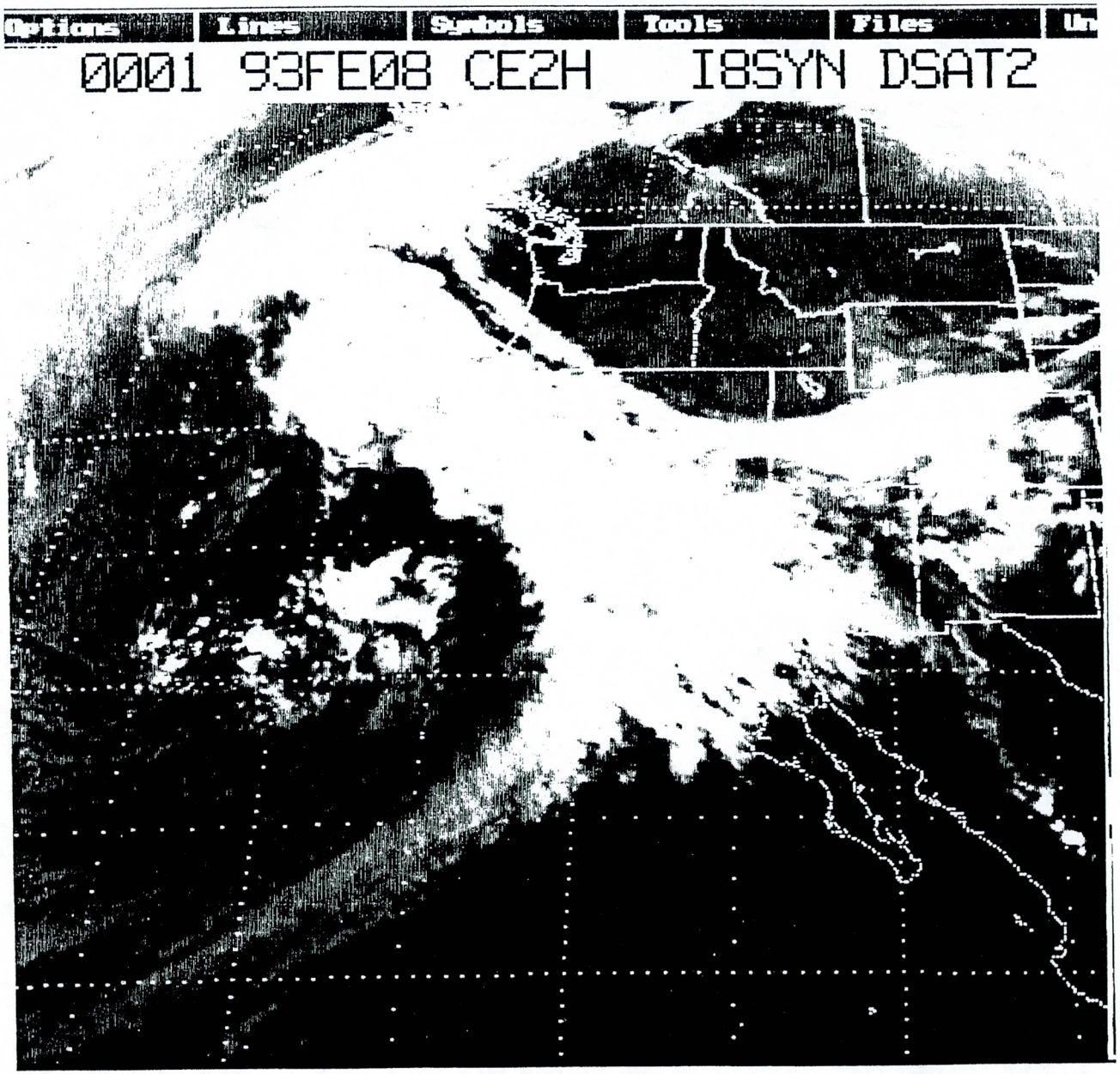
FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY - FEBRUARY 1993

STORM PATTERN

8 JAN 1993

9:01 A.M.

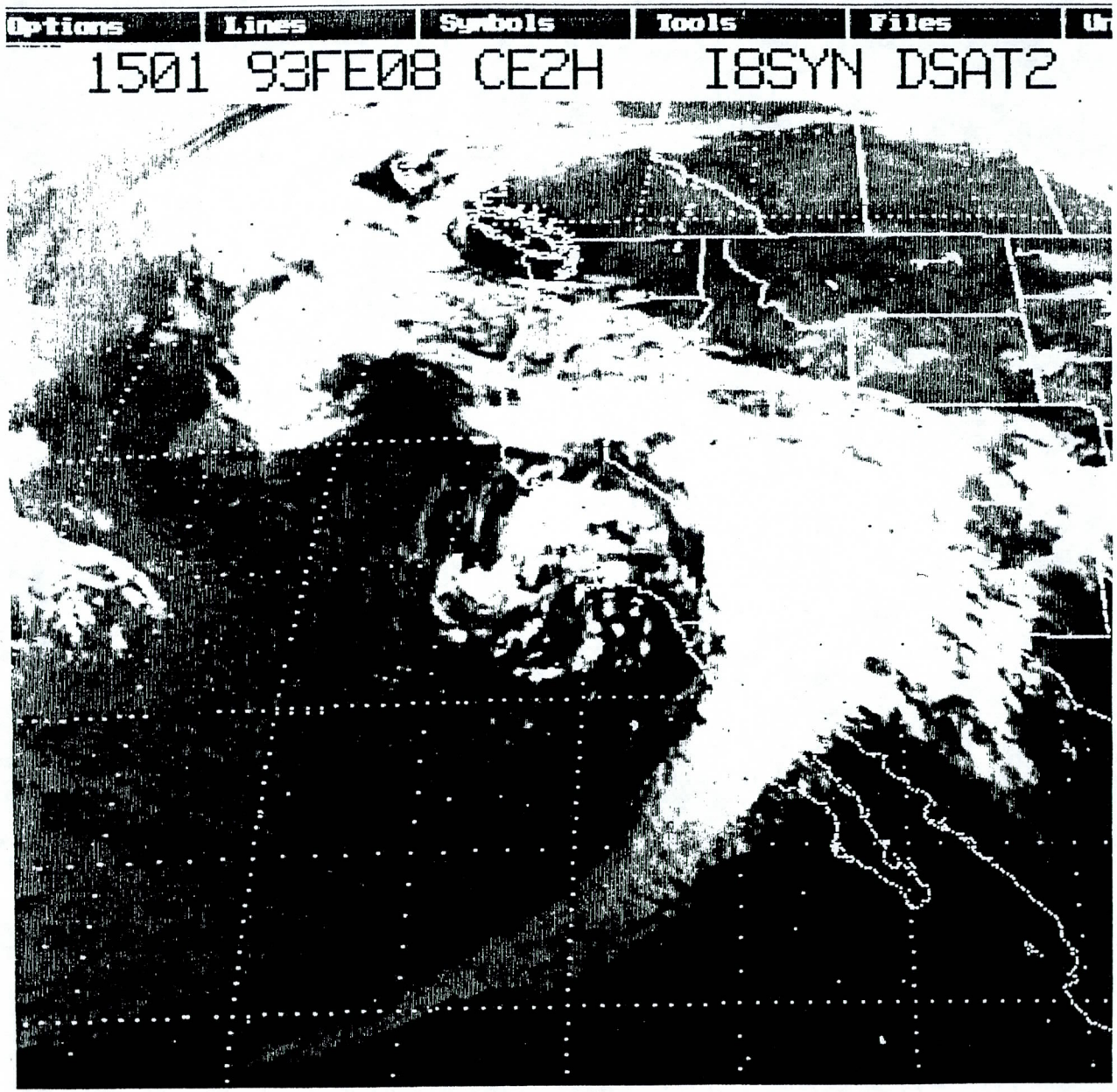
LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

STORM PATTERN
8 FEB 1993
12:01 A.M.

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

STORM PATTERN
8 FEB 1993
3:01 P.M.

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

3.02 PRECIPITATION DATA.

3.02.1 Total Storm Precipitation.

APPENDIX A lists the total precipitation at all available stations in Arizona and in the Gila River drainage of western New Mexico for the major storm periods 5-19 January and 8-28 February 1993. The stations are grouped by river drainage basin. These two periods cover nearly all of the precipitation that fell during these two months. Minor storms at the beginning and end of January, and at the beginning of March, occurred outside of these periods. Precipitation gaging stations are shown on Figure 3.

The January and February storm totals varied widely from the lower deserts, where very little precipitation fell at some locations, to the higher mountains, some of which received a total of more than 30 inches during the two storm periods because of the orographic uplift of the moist air caused by the mountains. The Salt River Project (SRP) estimated the basin average rainfall for the Salt and Verde River watersheds combined to be 8.76 inches for the month of January alone.

The following excerpts from APPENDIX A illustrate the centers of heaviest precipitation and the smallest reliable amounts that fell at some desert and northeast plateau stations.

Station	Agency	Drainage	5-19 Jan 93	8-28 Feb 93
Promontory Snotel	SCS	Little Colorado	21.40	10.50
Workman Creek Snotel	SCS	Gila	22.10	12.30
Tonto Creek Fish Hatchery	SCS	Gila	19.89	7.18
Santa Cruz R. @ Continental	PCFCD	Gila	2.87	1.04
Centennial Levee	FCDMC	Gila	1.89	1.46
Beaverhead Ranger Station, NM	SCS	Gila	2.80	1.60
Page	SCS	Bill Williams	1.38	1.25

Some of the totals in the 5-19 January 1993 storm period approach or even exceed the mean annual precipitation at the respective stations. A few of the 8-28 February 1993 totals approach the mean annual. The totals for the two periods, however, considerably exceed the mean annual precipitation at most stations.

Isohyetal maps showing total storm precipitation for the 5-19 January and 8-28 February 1993 periods are shown on figures 4 and 5, respectively.

3.02.2 Incremental Precipitation.

Selected graphs of January and February incremental and cumulative precipitation observed at 18 of the 290 gages are presented in Figures 6 through 23, at the end of this section. The graphs present precipitation on each of the 3 major watersheds: the Gila, the Bill Williams,

Isohyetal Map, 05-19 January 1993
State of Arizona

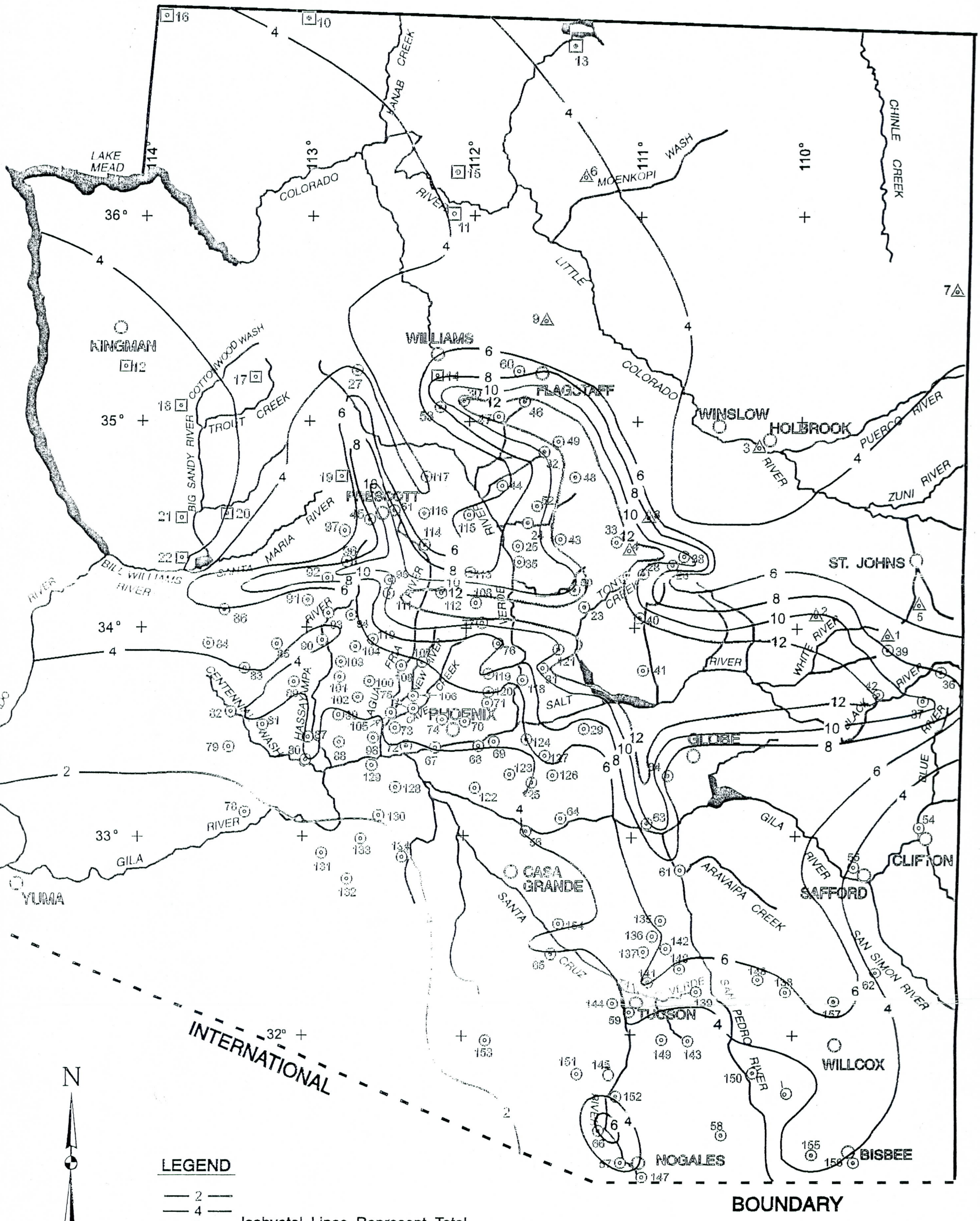
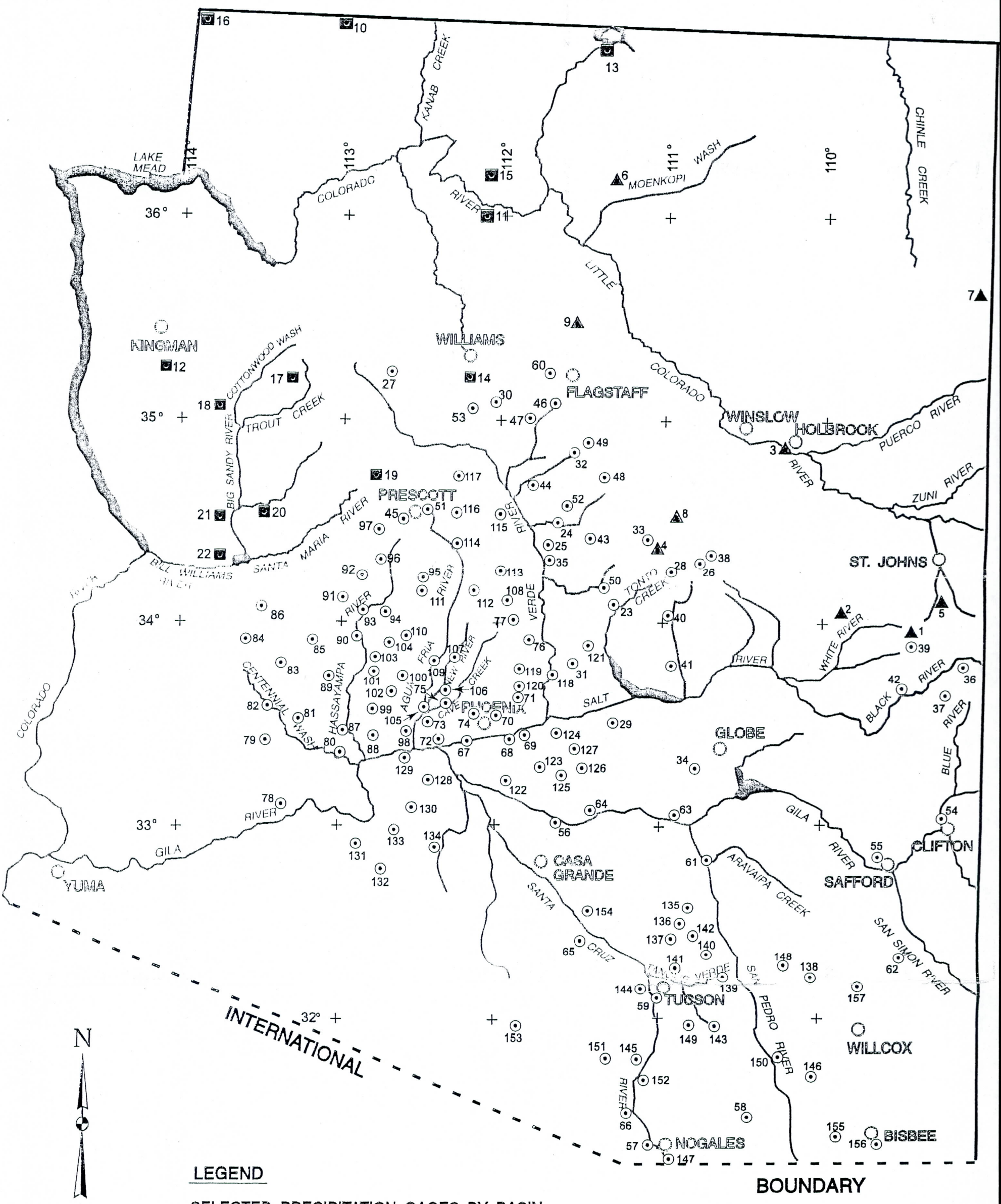


Figure 4

Selected Precipitation Gaging Stations
State of Arizona



LEGEND

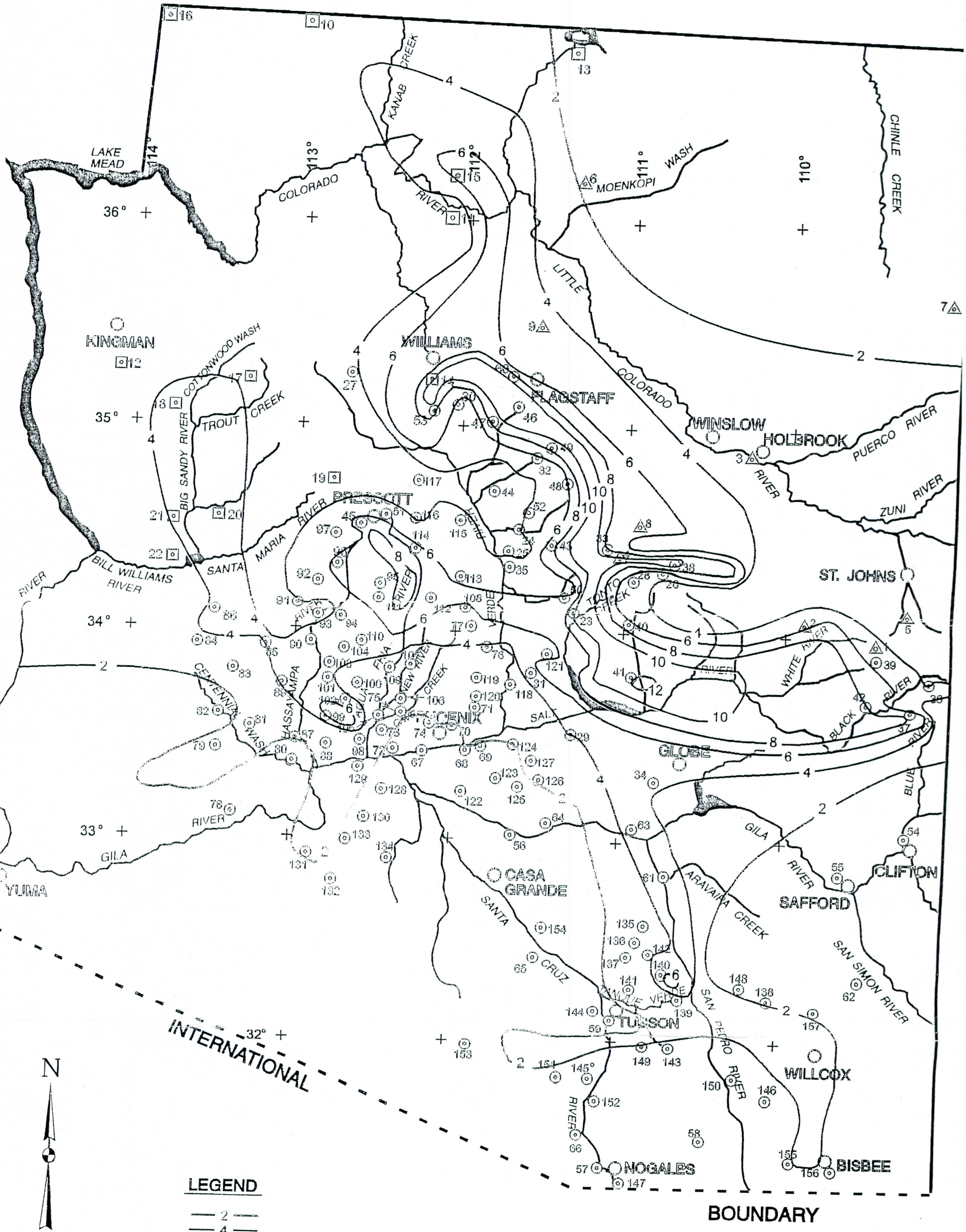
SELECTED PRECIPITATION GAGES BY BASIN

- Bill Williams River Basin and NW Arizona
- Little Colorado River Basin
- Gila River Basin and SE Arizona

AZPREGS.CDR

Figure 3

Isohyetal Map, 08-28 February 1993
State of Arizona



LEGEND

2 4 6 8 10 12 — Isohyetal Lines Represent Total Precipitation Depth In Inches

Bill Williams River Basin and NW Arizona

Little Colorado River Basin

Gila River Basin and SE Arizona

AZISOFE.CDR

Figure 5

and the Little Colorado. The Gila River Basin has been emphasized due to its large size, the severity of the observed precipitation (and runoff) at some locations within this watershed, and the spatial variability of the precipitation totals over the watershed. In these figures, precipitation is presented in 2-, or 24-hour (daily) increments, depending upon the data provided by the various agencies.

Of the 236 gages for which daily precipitation was available, daily totals of 2 inches or more were observed at 34 locations on a total of 54 gage-days. Three inches of precipitation or more was observed at 9 gages, and 4 inches or more was observed at 4 gages. No gage recorded a daily total equalling or exceeding 5 inches. The heaviest daily precipitation totals in January (see the tabulation following) were observed at White Tail on Mt Lemmon in the Tucson area, along Tonto Creek (a tributary to the Salt River at Roosevelt Lake), and in the vicinity of the confluence of the Verde and East Verde Rivers northeast of Phoenix. In the Bill Williams River watershed, the Bagdad gage recorded 3.01 inches on 10 February. The White Tail gage recorded 1.57 inches in a 2 hour period beginning at 6:00 AM on 7 January; 2.63 inches were observed over a 4 hour period beginning at 4:00 AM on the same day. However, short-duration precipitation records were not provided for most gages. Locations with 1 day totals exceeding 3 inches were:

Station	Agency	Drainage	Precip (in)	Date	Return Period*
E. Verde R. diversion nr Pine	SRP	Gila	4.56	8 Jan	25-50 yr
E. Verde R. - Childs	SRP	Gila	3.13	8 Jan	2-5 yr
Verde R. blw E. Verde	SRP	Gila	4.35	8 Jan	25-50 yr
Sunflower	SRP	Gila	4.12	8 Jan	5-10 yr
Tonto Fish Hatchery #2	SRP	Gila	3.86	8 Jan	2-5 yr
Kearny	NWS	Gila	3.01	9 Jan	10 yr
White Tail (Mt Lemmon)	PCFCD	Gila	4.88	7 Jan	50-100 yr
Cooks Mesa	FCDMC	Gila	3.07	7 Jan	5-yr
Mt Union	FCDMC	Gila	3.27	7 Jan	2-5 yr
Bagdad	NWS	Bill Williams	3.01	10 Feb	10-25 yr

*Return period range based upon NOAA Atlas II 24-hour rainfall. Location by latitude and longitude was not provided for all gages. Listed precipitation is total for day and may not be maximum 24-hour precipitation.

The Salt River Project (SRP) estimated the combined basin average precipitation for the Salt and Verde Rivers to be 1.83 inches on 8 January. Locations with 2 day totals exceeding 4.5 inches were:

Station	Agency	Drainage	Precip (in)	Dates
Cherry Creek - Globe	SRP	Gila	5.16	7-8 Jan
E. Verde R. diversion nr Pine	SRP	Gila	6.01	7-8 Jan
Kearny	NWS	Gila	5.10	9-10 Jan
Mt Union	FCDMC	Gila	4.68	7-8 Jan
Sunflower	SRP	Gila	6.30	7-8 Jan
Tonto Fish Hatchery #2	SRP	Gila	5.81	7-8 Jan
Verde R. blw E. Verde	SRP	Gila	5.52	7-8 Jan
White Tail (Mt Lemmon)	PCFCD	Gila	7.87	6-7 Jan

The highest basin-wide February rainfall on the Salt and Verde River watersheds combined, as estimated by SRP, was 1.66 inches for 19-21 February.

3.02.3 Snowfall.

December storms brought early snow to the Arizona mountains. The storm of 28-30 December was warm and produced rain in much of the snow zone, melting some of the snowpack. The remaining snowpack was full of free water. Snow surveys conducted just before 1 January throughout Arizona showed snow densities exceeding 35% on many snow courses. Despite the density of the snowpack, the San Francisco - Upper Gila River basin snowpack water equivalent measured only 69% of average at this time, due to snowmelt during the warm rain. Elsewhere in Arizona, the snowpack water equivalent measured between 96% and 167% of average. A tabulation of snowpack depths follows this narrative.

By the beginning of February the water equivalent depths of the snowpacks were well above average. In addition, average snowpack densities were 30 to 35%, higher than normal for this early in the season.

Seventeen snow courses in Arizona, half of the manual network, and ten snow courses in New Mexico that drain to Arizona, set records for snow water equivalent depth for 1 March.

Records were broken in all Arizona snowpack areas. Sites where records were set include the following:

		Snow Water Equivalent, inches	
	Elevation (ft)	1 March 1993	Previous Record
Little Colorado River Basin			
Baldy	9220	16.7	15.0
Bearpaw	10,100	45.0	33.6
Cheese Springs	8600	10.5	9.70
Snow Bowl #1 Alt.	10,260	34.2	18.2
Snow Bowl #2	11,000	45.4	32.9
Snowslide Canyon	9750	41.5	24.0
Bill Williams River Basin and NW Arizona			
Bright Angel	8400	25.8	22.5
Gila River Basin			
Hannagan Meadows	9090	27.0	20.4
Maverick Fork	9050	22.4	20.9

source: Soil Conservation Service, *Arizona Basin Outlook Report*, March 1, 1993.

A few storms brought additional snow during March, however, strong melting of the snowpacks began in the latter part of the month. The Verde River basin snowpack showed the

largest decline, with a water equivalent of only 66% of average by April 1. All other basins retained above average snowpacks.

Summaries of snowpack depths, water content, and comparisons to normal (average) conditions throughout the winter are presented below:

Basin and Location	Snow Depth, inches				Water Content, inches			
	Jan 1	Feb 1	Mar 1	Apr 1	Jan 1	Feb 1	Mar 1	Apr 1
Little Colorado River								
Baldy	20	42	54	36	4.7	11.2	16.7	13.9
Bearpaw	n/a	74	119	99	14.6E	26.5	45.0	43.4
Cheese Springs	14	30	37	17	3.7	8.7	10.5	6.3
Snow Bowl #1 Alt.	33	62	107	80	10.2	20.8	34.2	32.6
Snow Bowl #2	48	80	140	127	13.2	24.2	45.4	47.8
Snowslide Canyon	n/a	68	109	86	10.2E	22.0	41.5	39.0
Bill Williams River and NW Arizona								
Bright Angel	21	51	76	59	5.9	19.0	25.8	23.0
Gila River								
Hannagan Meadows	20	58	83	60	5.6	18.7	27.0	23.8
Maverick Fork	25	55	68	51	7.8	16.7	22.4	21.7

E: Estimated
n/a: Not available
source: Soil Conservation Service - Snow Course Data and Basin Snowpack Summary.

Basin	Snowpack, % of Average			
	Jan. 1	Feb. 1	Mar. 1	Apr. 1
Central Mogollon Rim	96	122	154	132
Chuska Mountains	128	215	198	241
Grand Canyon	150	255	272	202
Little Colorado River - Southern Headwaters	108	141	169	148
Salt River	128	189	233	182
San Francisco Peaks	167	217	284	227
San Francisco - Upper Gila River	69	166	224	188
Verde River	128	180	217	66

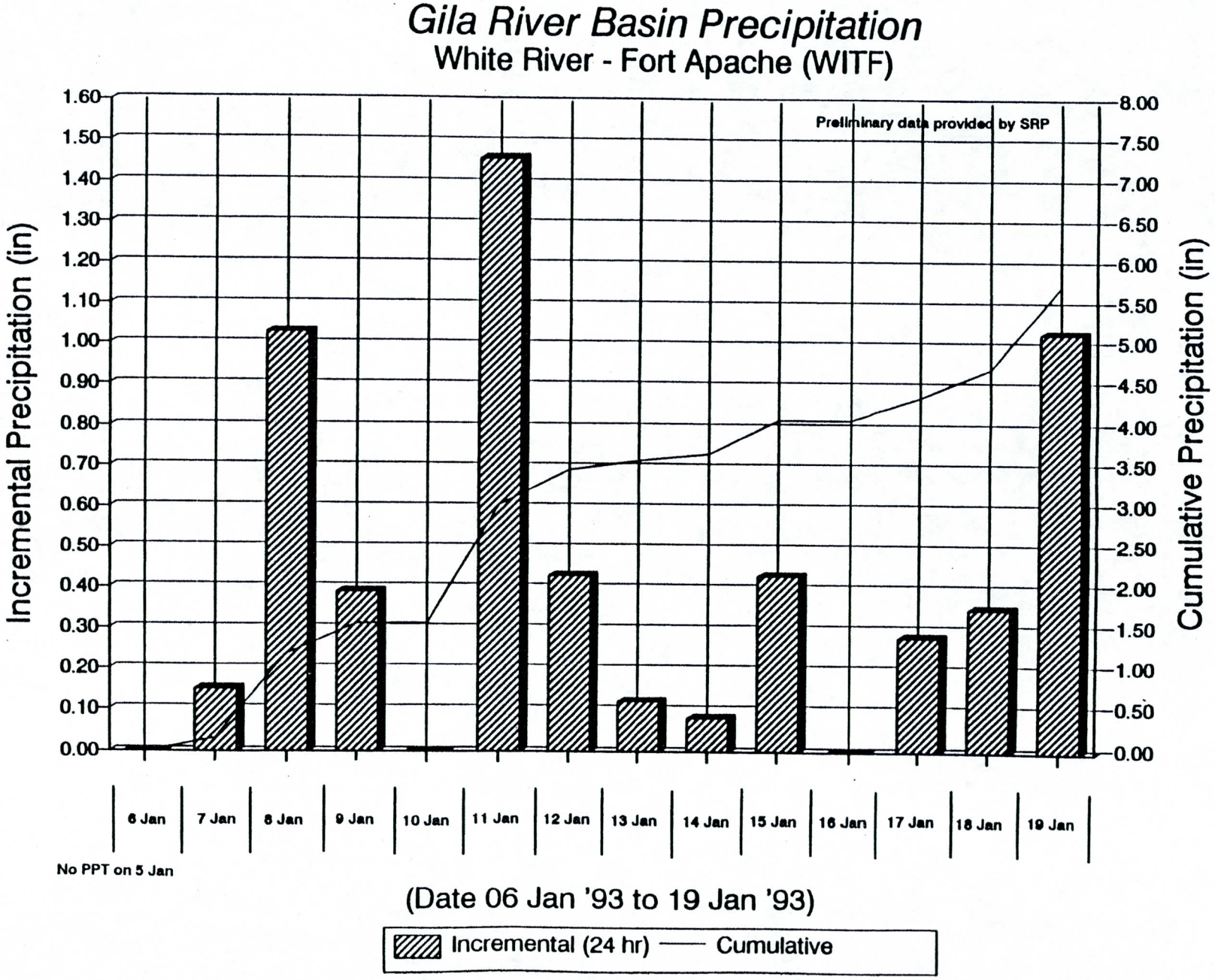

Gila River Basin Precipitation
White River - Fort Apache (WITF)
Preliminary data provided by SRP
Incremental Precipitation (in)
Cumulative Precipitation (in)
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 6

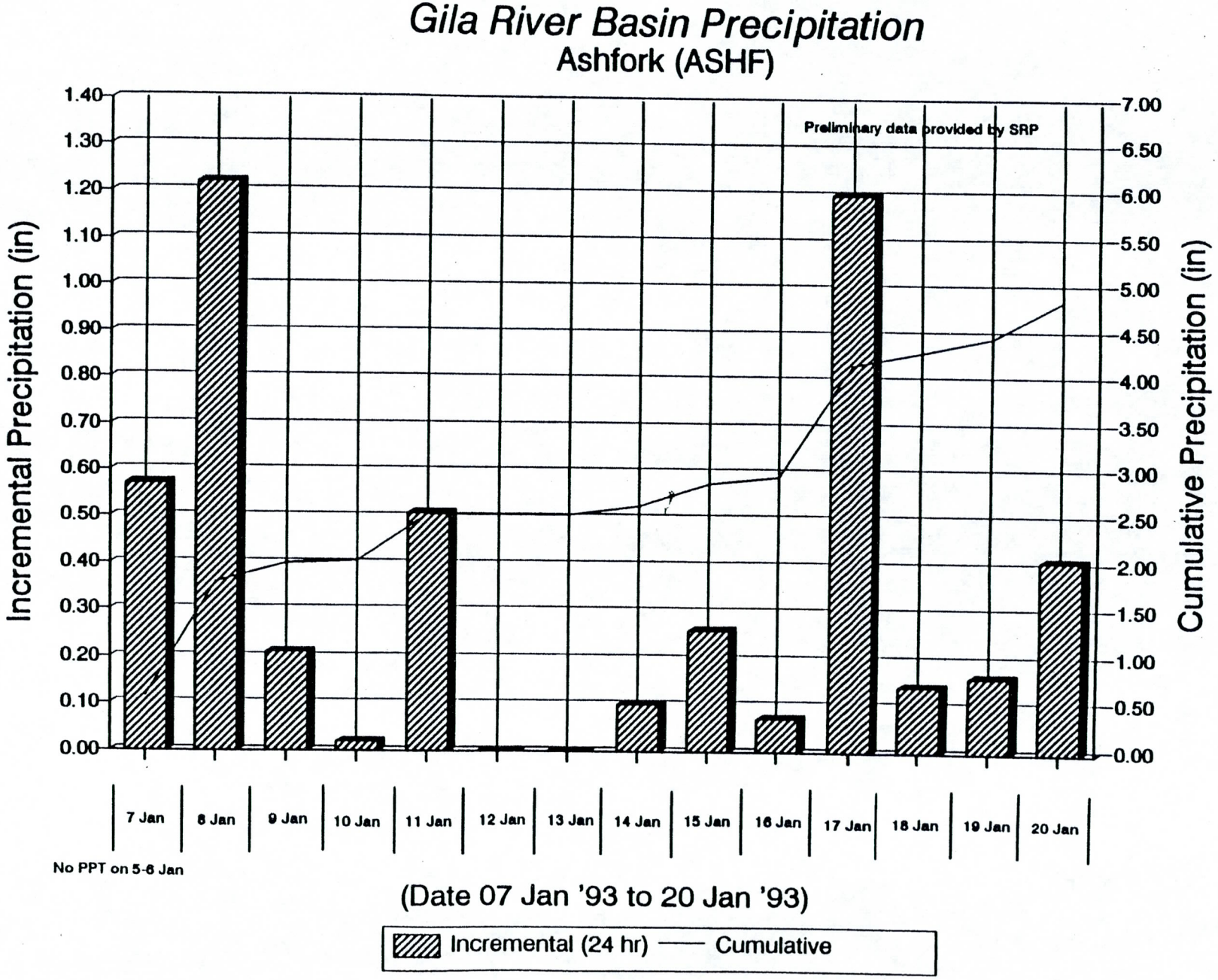

Gila River Basin Precipitation
Ashfork (ASHF)
Preliminary data provided by SRP
Incremental Precipitation (in)
Cumulative Precipitation (in)
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
20 Jan
No PPT on 5-6 Jan
(Date 07 Jan '93 to 20 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 7

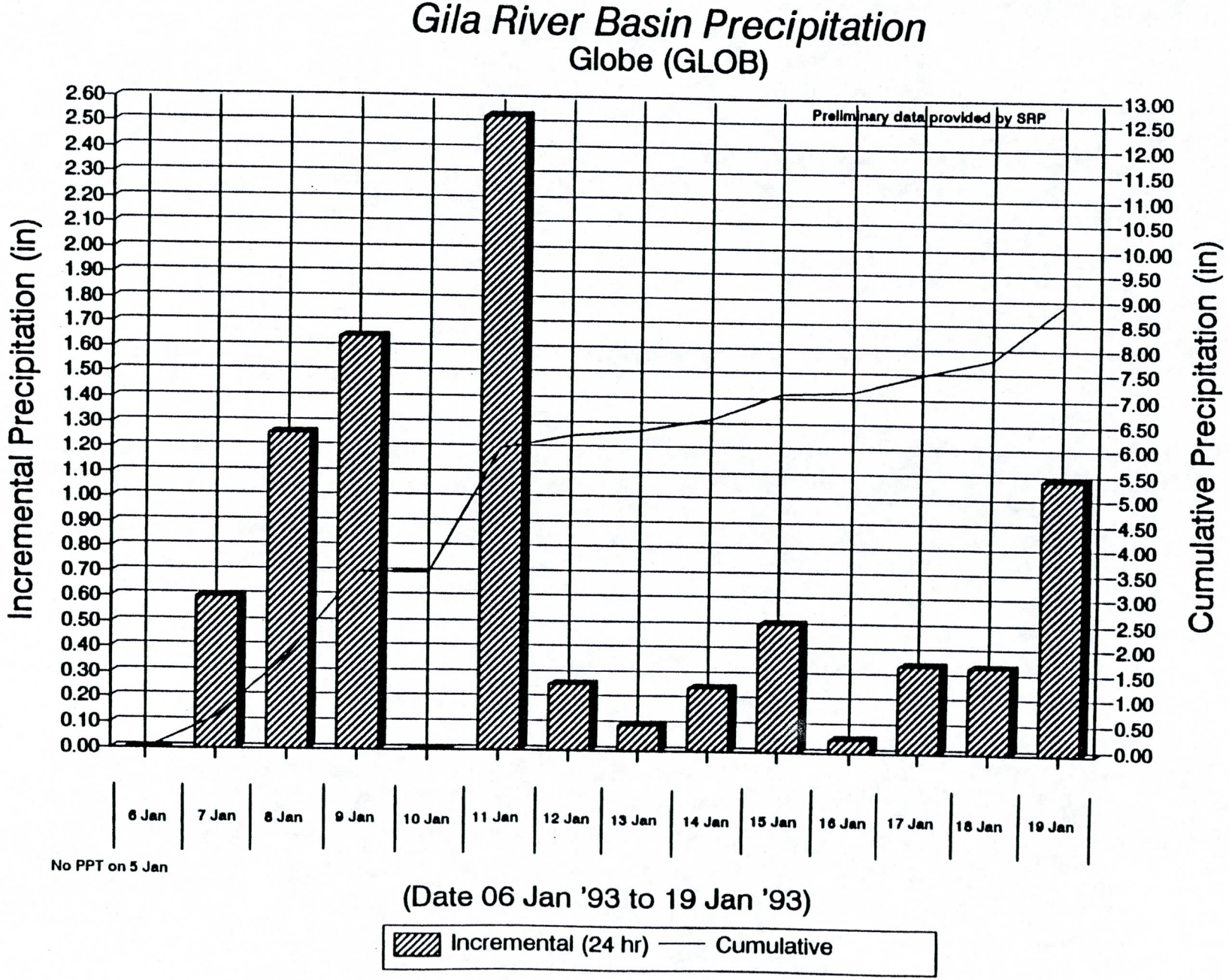

Gila River Basin Precipitation
Globe (GLOB)
Preliminary data provided by SRP
Incremental Precipitation (in)
Cumulative Precipitation (in)
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
13.00
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 8

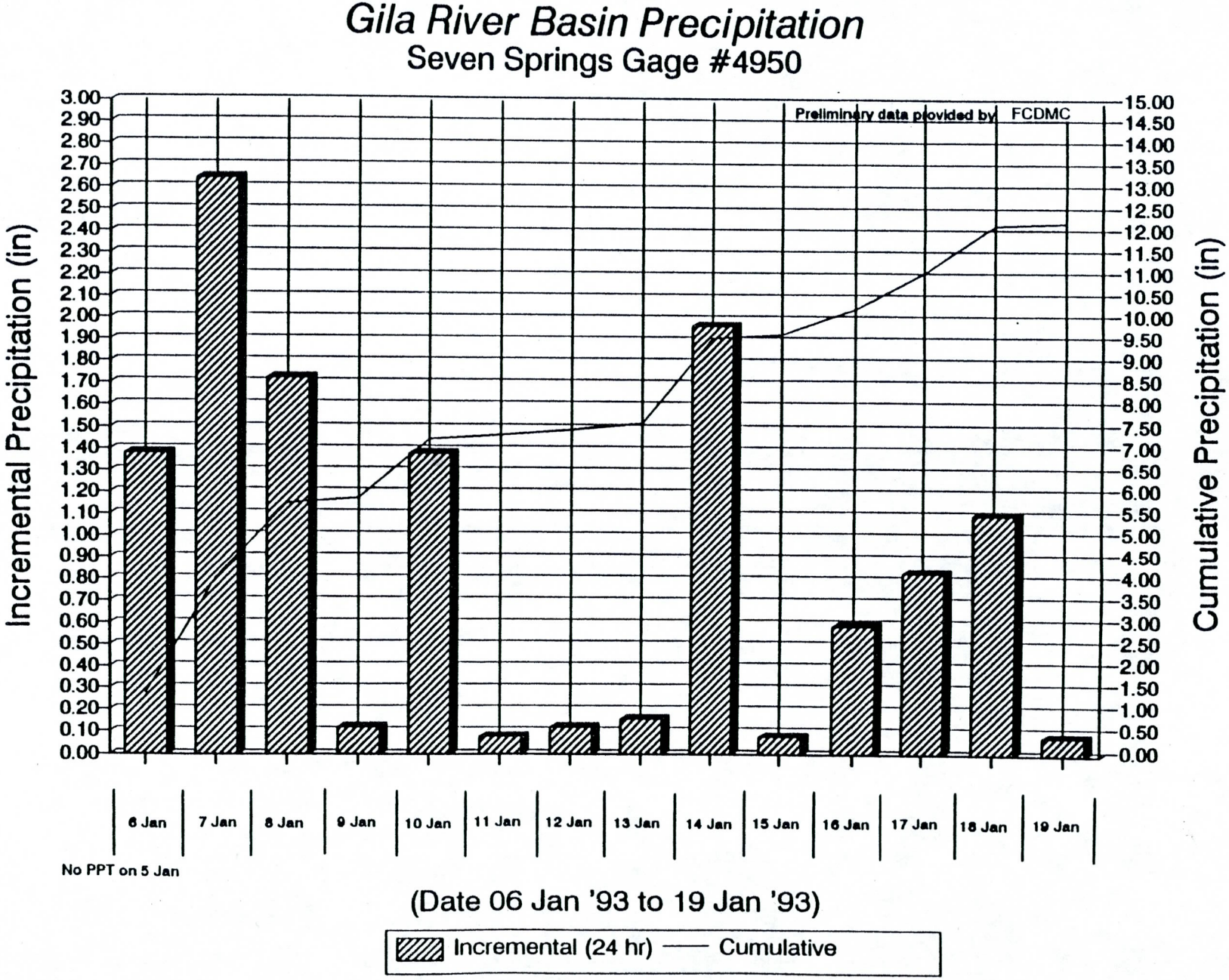

Gila River Basin Precipitation
Seven Springs Gage #4950
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 9

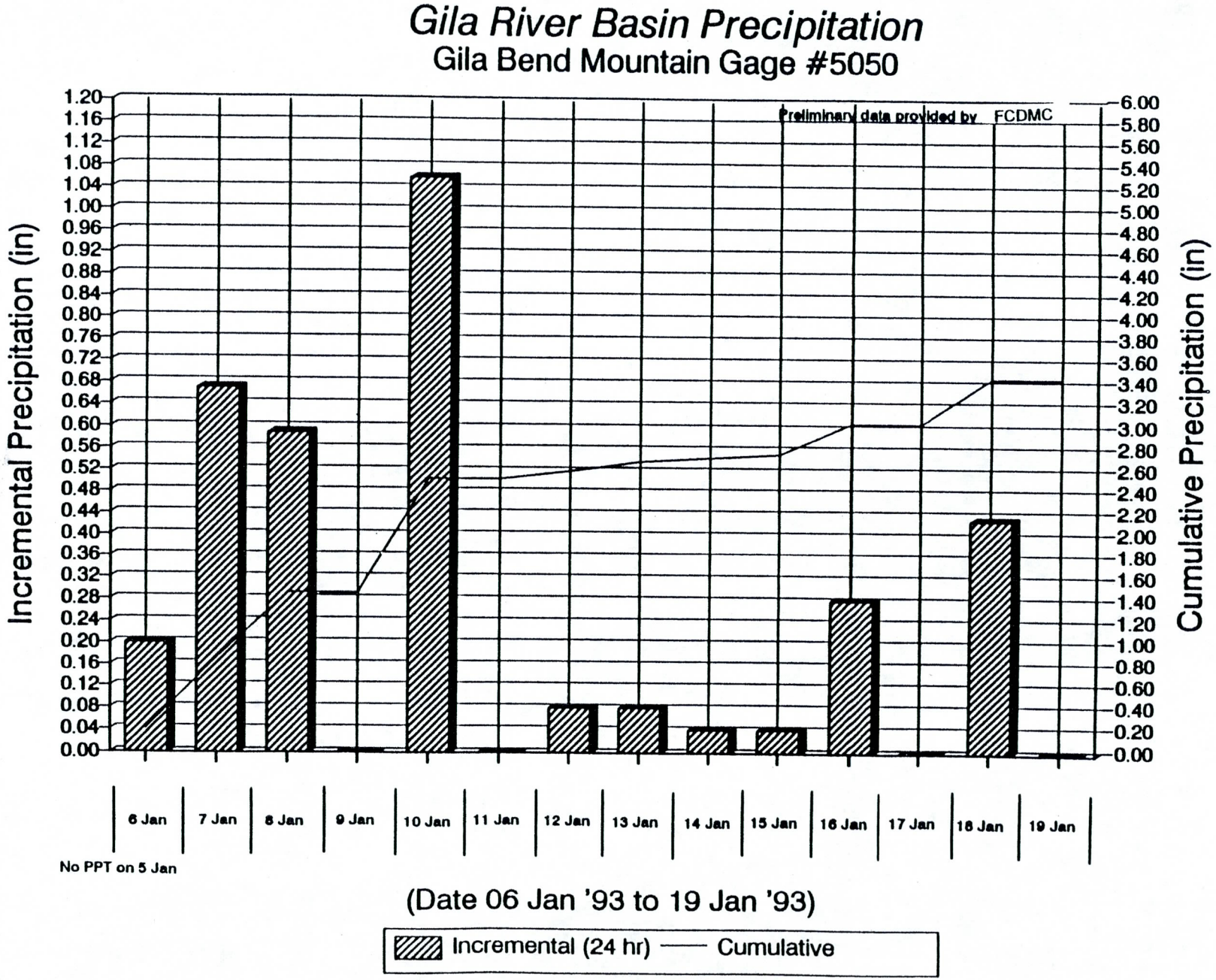

Gila River Basin Precipitation
Gila Bend Mountain Gage #5050
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
1.20
1.16
1.12
1.08
1.04
1.00
0.96
0.92
0.88
0.84
0.80
0.76
0.72
0.68
0.64
0.60
0.56
0.52
0.48
0.44
0.40
0.36
0.32
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 10

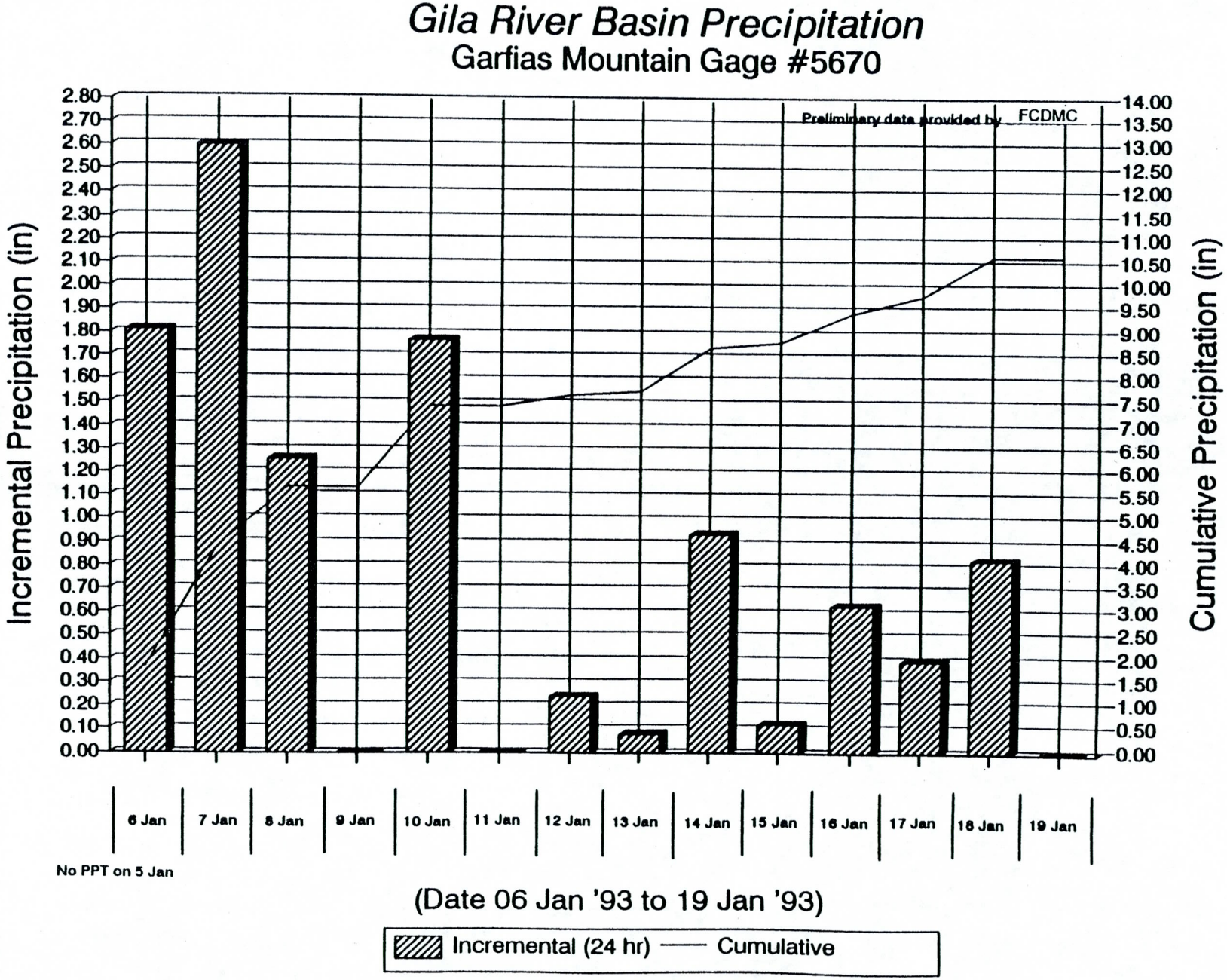

Gila River Basin Precipitation
Garfias Mountain Gage #5670
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 11

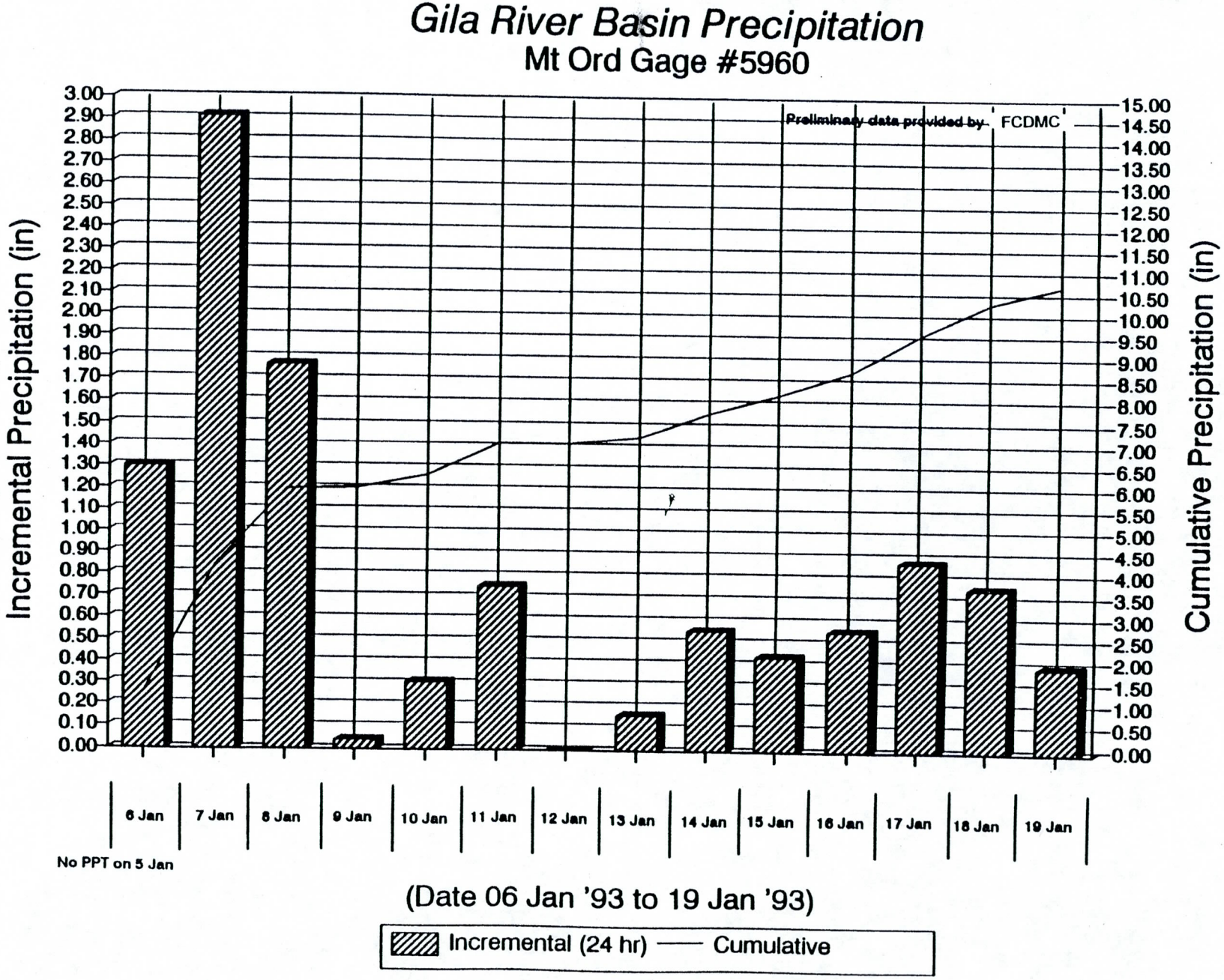

Gila River Basin Precipitation
Mt Ord Gage #5960
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 12

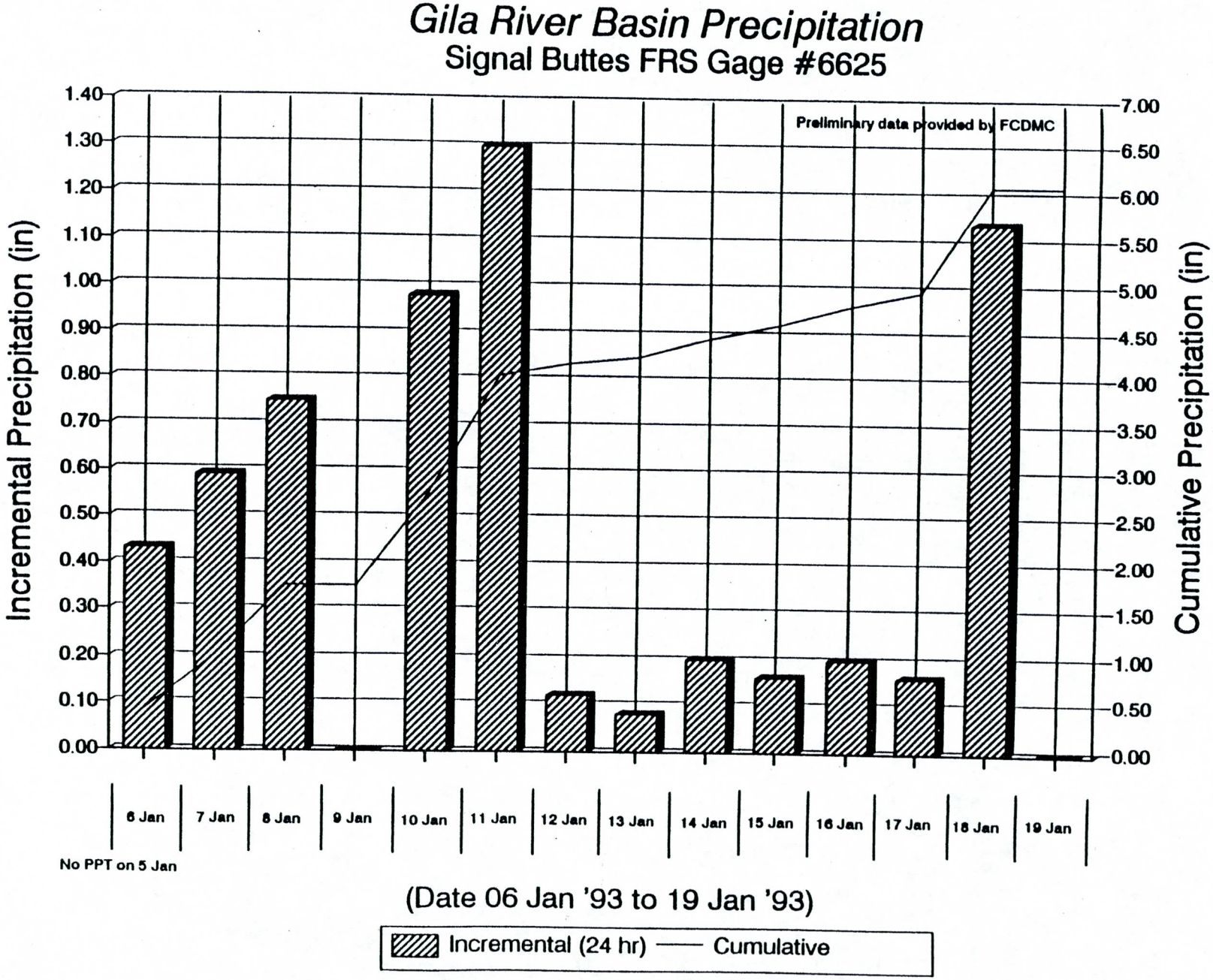

Gila River Basin Precipitation
Signal Buttes FRS Gage #6625
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 13

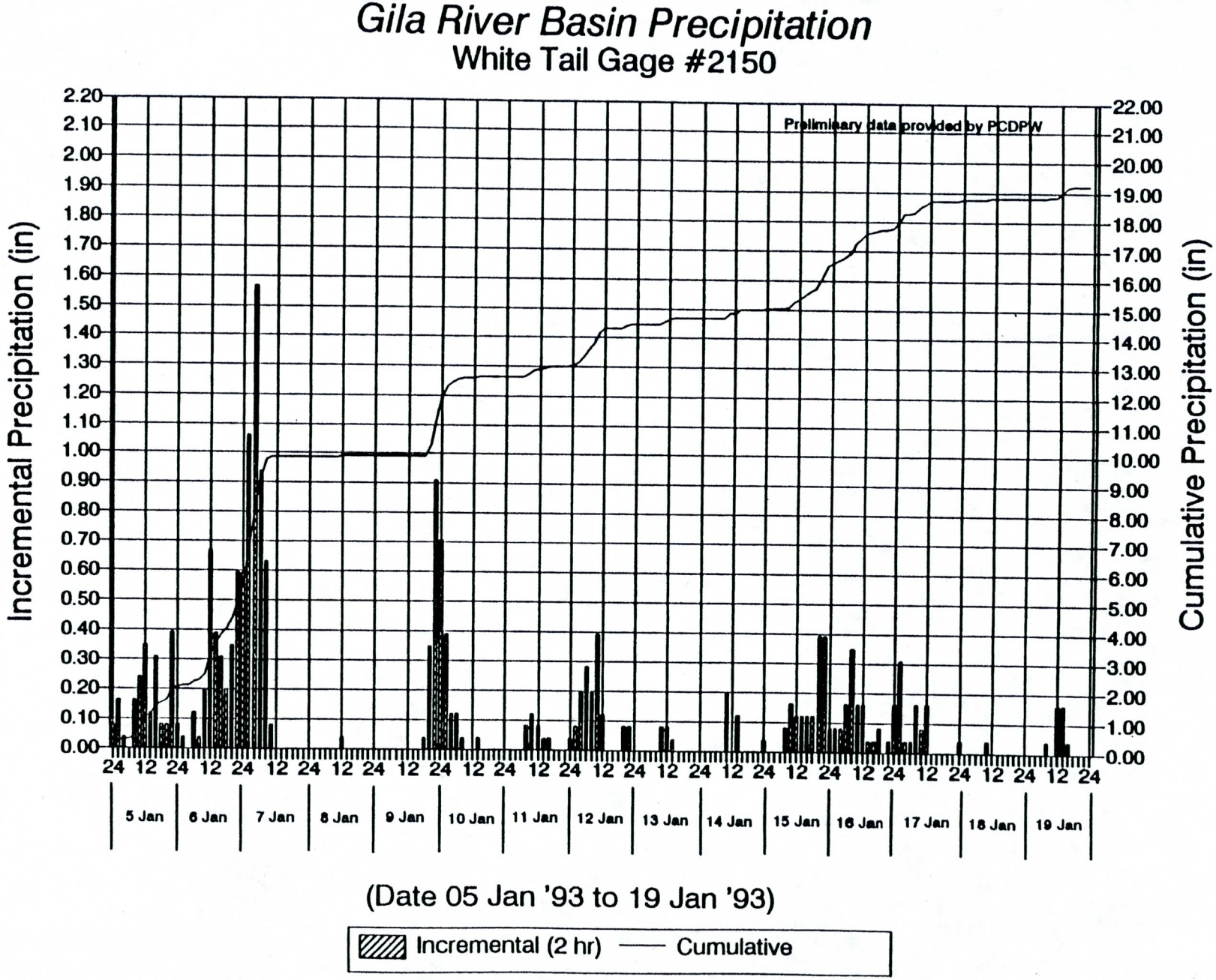

Gila River Basin Precipitation
White Tail Gage #2150
Preliminary data provided by PCDPW
Incremental Precipitation (in)
Cumulative Precipitation (in)
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
22.00
21.00
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24
5 Jan
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
(Date 05 Jan '93 to 19 Jan '93)
Incremental (2 hr)
Cumulative

FIGURE 14

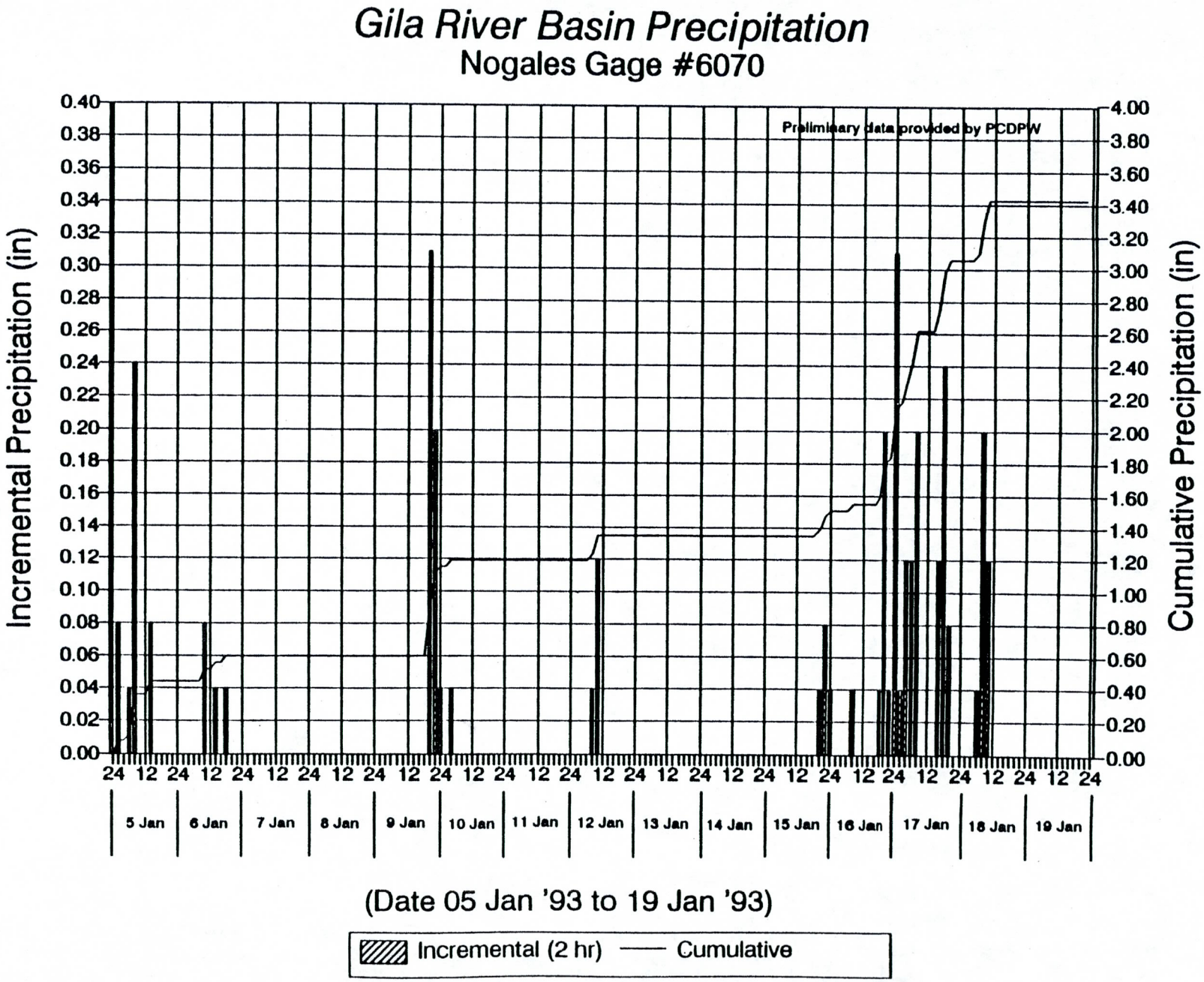

Gila River Basin Precipitation
Nogales Gage #6070
Preliminary data provided by PCDPW
Incremental Precipitation (in)
Cumulative Precipitation (in)
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24
5 Jan
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
(Date 05 Jan '93 to 19 Jan '93)
Incremental (2 hr)
Cumulative

FIGURE 15

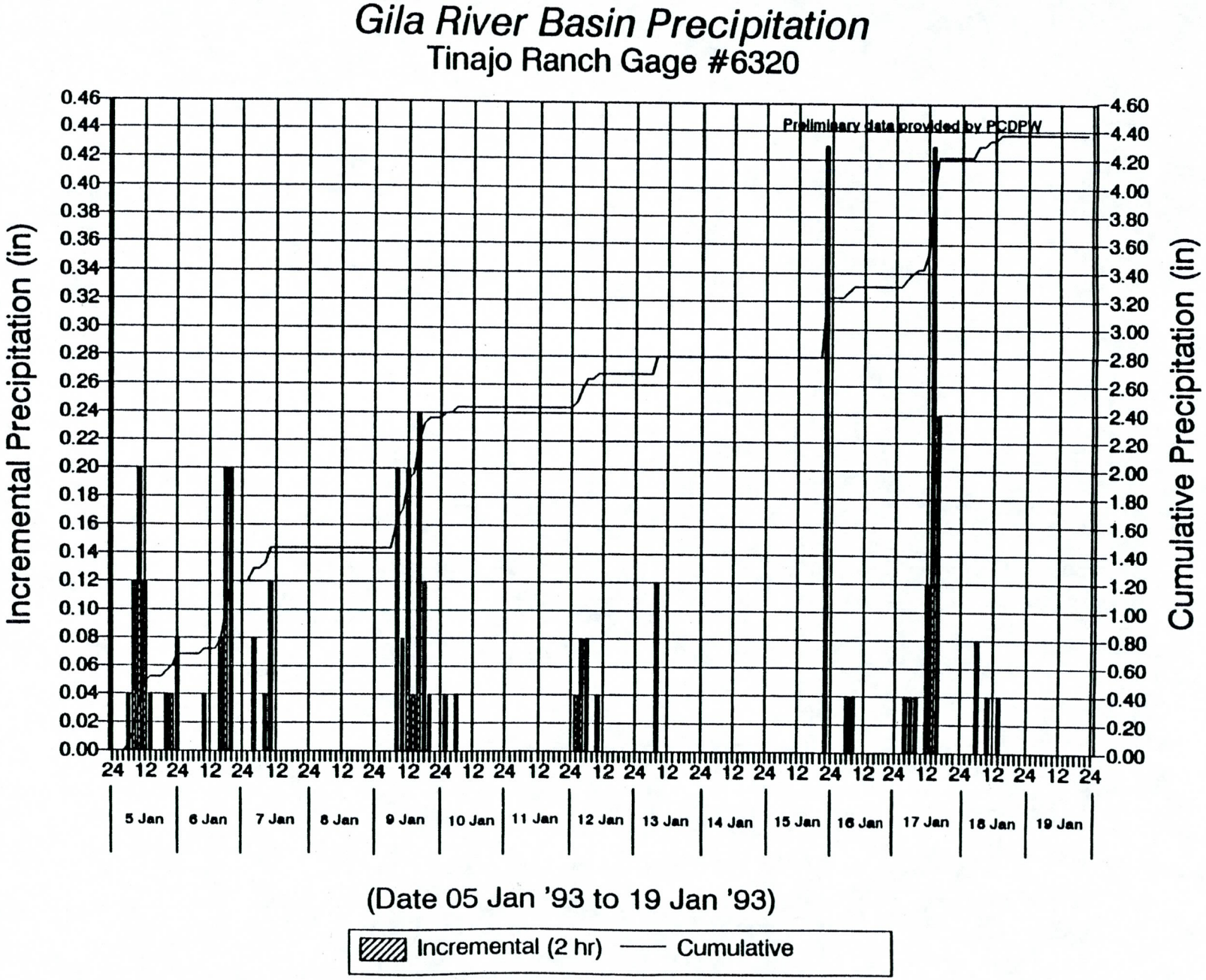

Gila River Basin Precipitation
Tinajo Ranch Gage #6320
Preliminary data provided by PCDPW
Incremental Precipitation (in)
Cumulative Precipitation (in)
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24
5 Jan
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
(Date 05 Jan '93 to 19 Jan '93)
Incremental (2 hr)
Cumulative

FIGURE 16

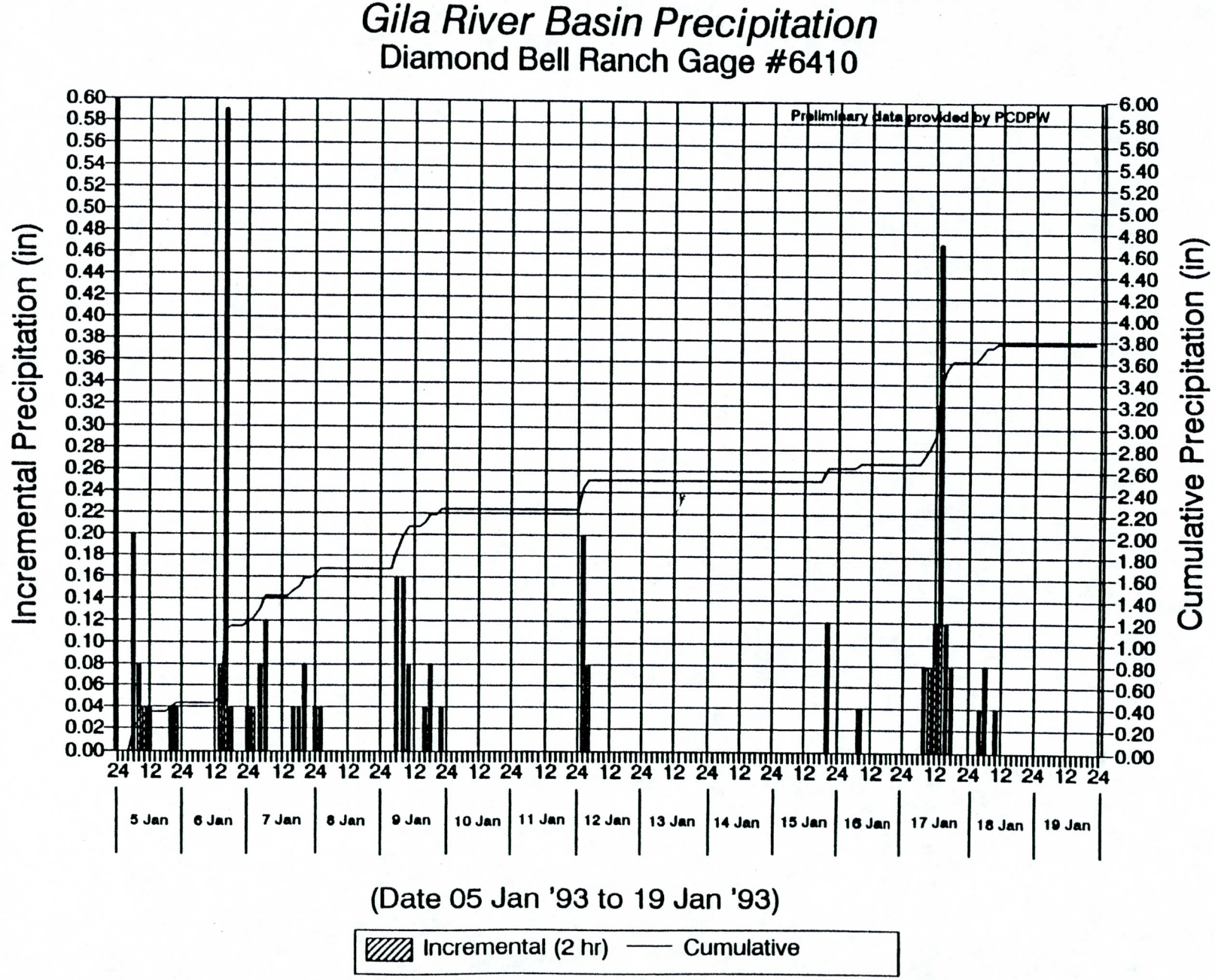

Gila River Basin Precipitation
Diamond Bell Ranch Gage #6410
Preliminary data provided by PCDPW
Incremental Precipitation (in)
Cumulative Precipitation (in)
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24 12 24
5 Jan
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
(Date 05 Jan '93 to 19 Jan '93)
Incremental (2 hr)
Cumulative

FIGURE 17

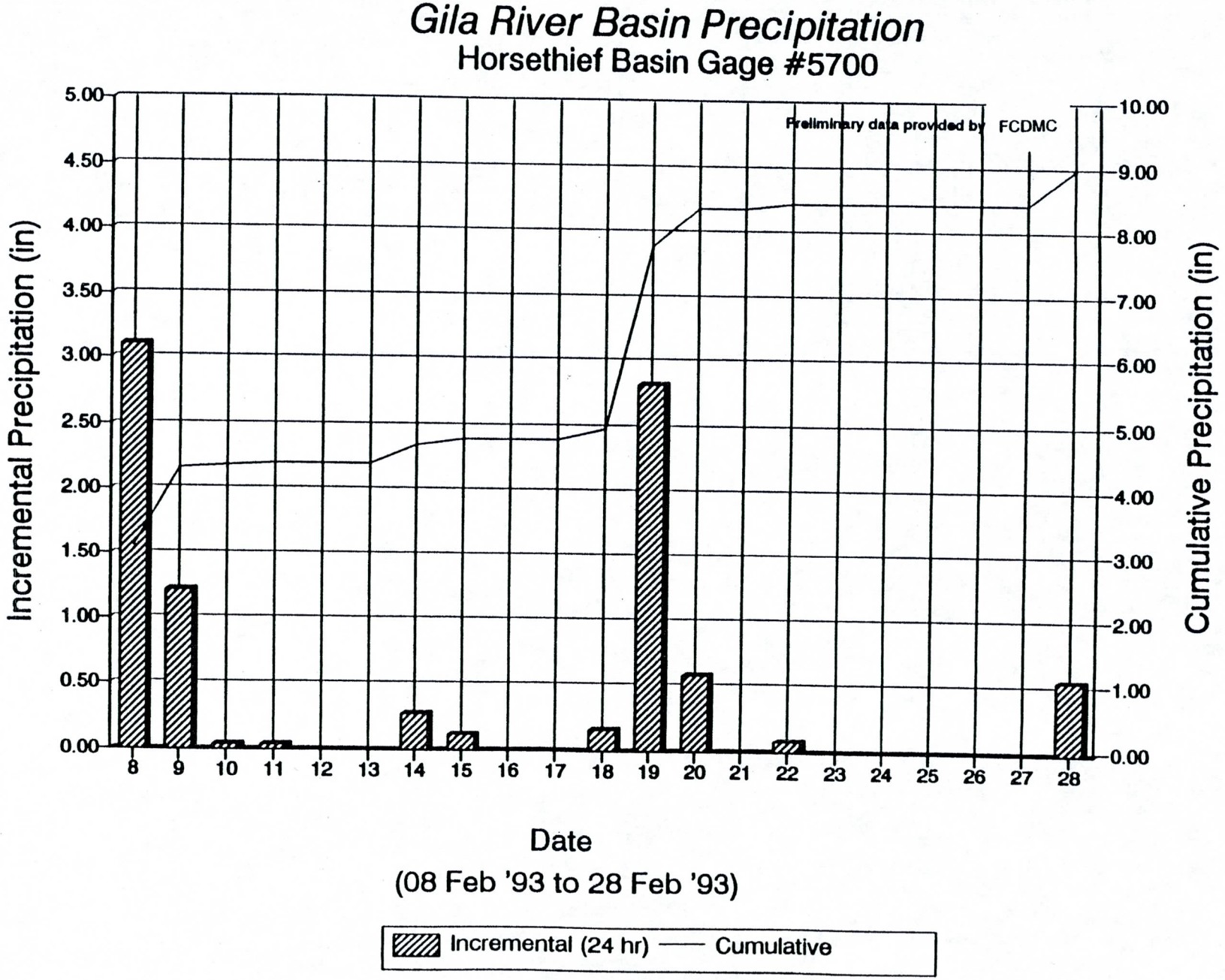

Gila River Basin Precipitation
Horsethief Basin Gage #5700
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Date
(08 Feb '93 to 28 Feb '93)
Incremental (24 hr)
Cumulative

FIGURE 18

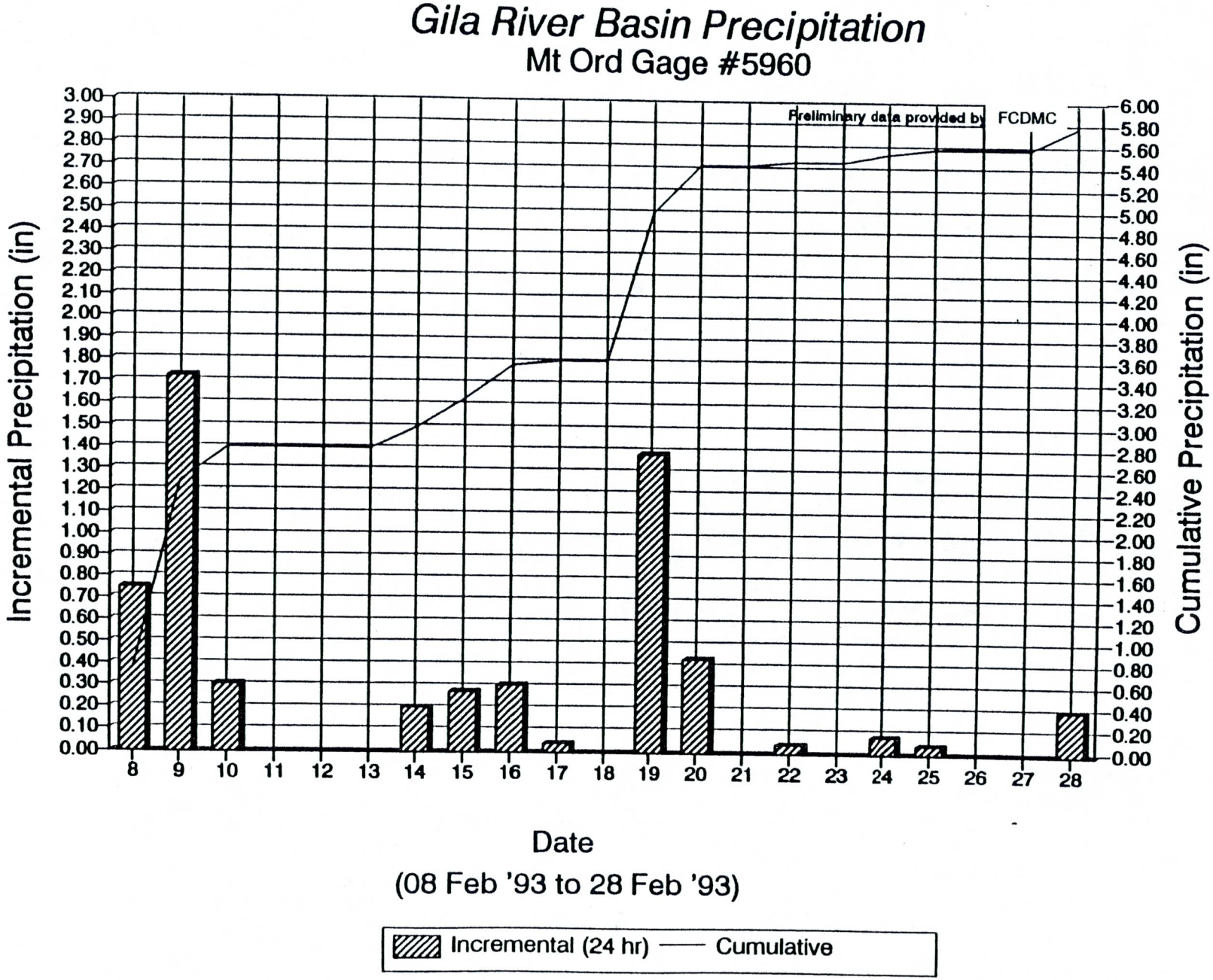

Gila River Basin Precipitation
Mt Ord Gage #5960
Preliminary data provided by FCDMC
Incremental Precipitation (in)
Cumulative Precipitation (in)
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Date
(08 Feb '93 to 28 Feb '93)
Incremental (24 hr)
Cumulative

FIGURE 19

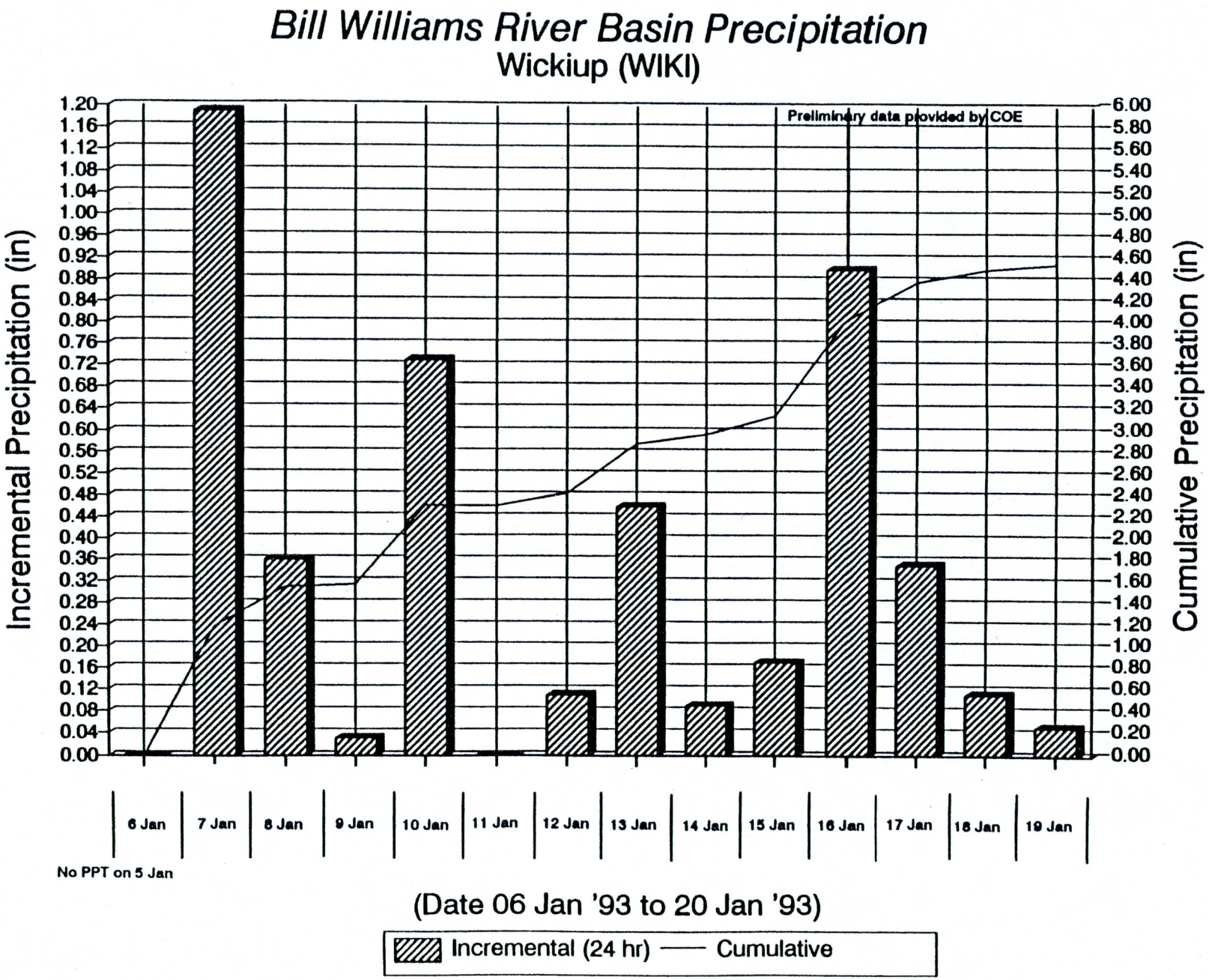

Bill Williams River Basin Precipitation
Wickiup (WIKI)
Preliminary data provided by COE
Incremental Precipitation (in)
Cumulative Precipitation (in)
1.20
1.16
1.12
1.08
1.04
1.00
0.96
0.92
0.88
0.84
0.80
0.76
0.72
0.68
0.64
0.60
0.56
0.52
0.48
0.44
0.40
0.36
0.32
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 20 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 20

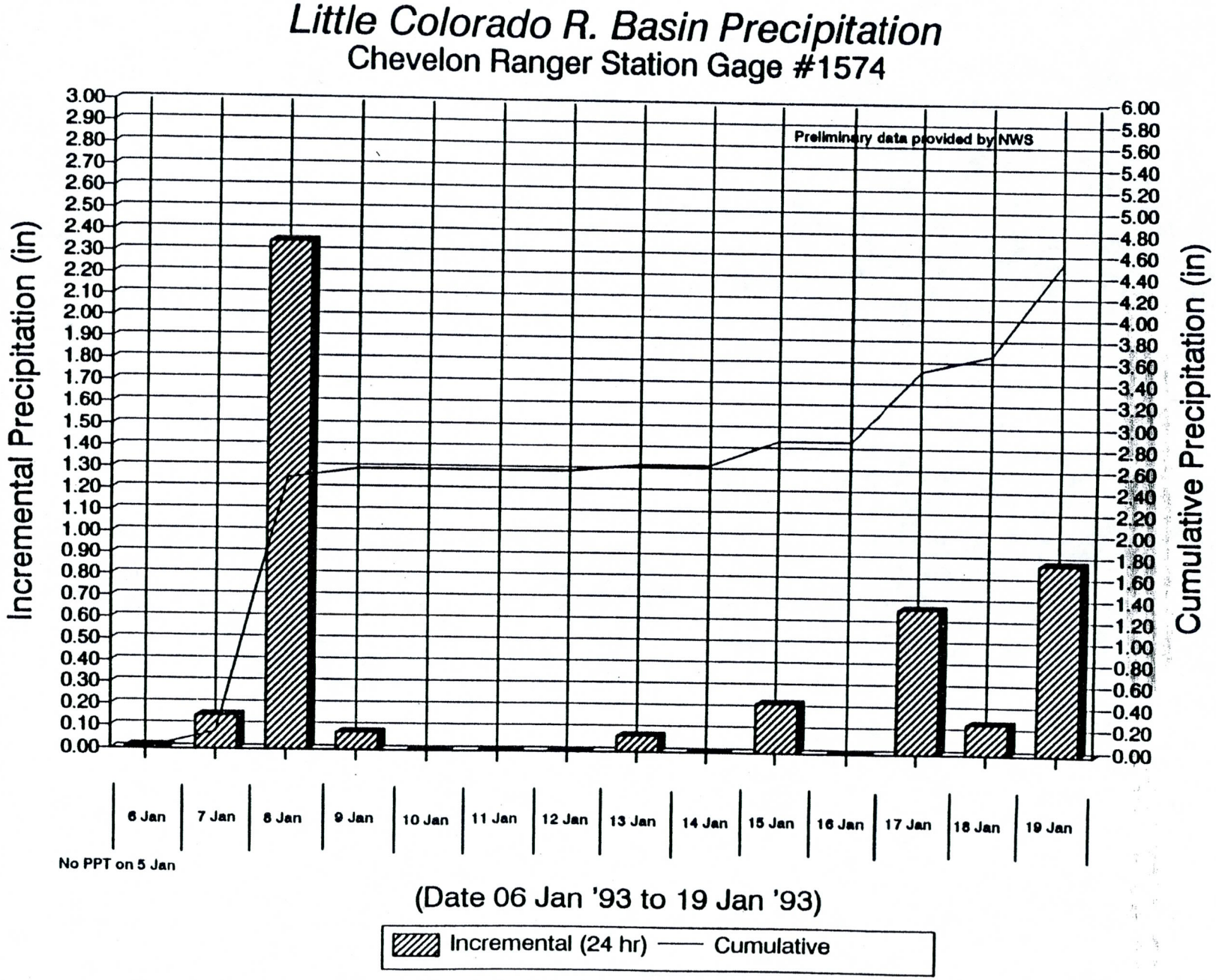

Little Colorado R. Basin Precipitation
Chevelon Ranger Station Gage #1574
Preliminary data provided by NWS
Incremental Precipitation (in)
Cumulative Precipitation (in)
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 21

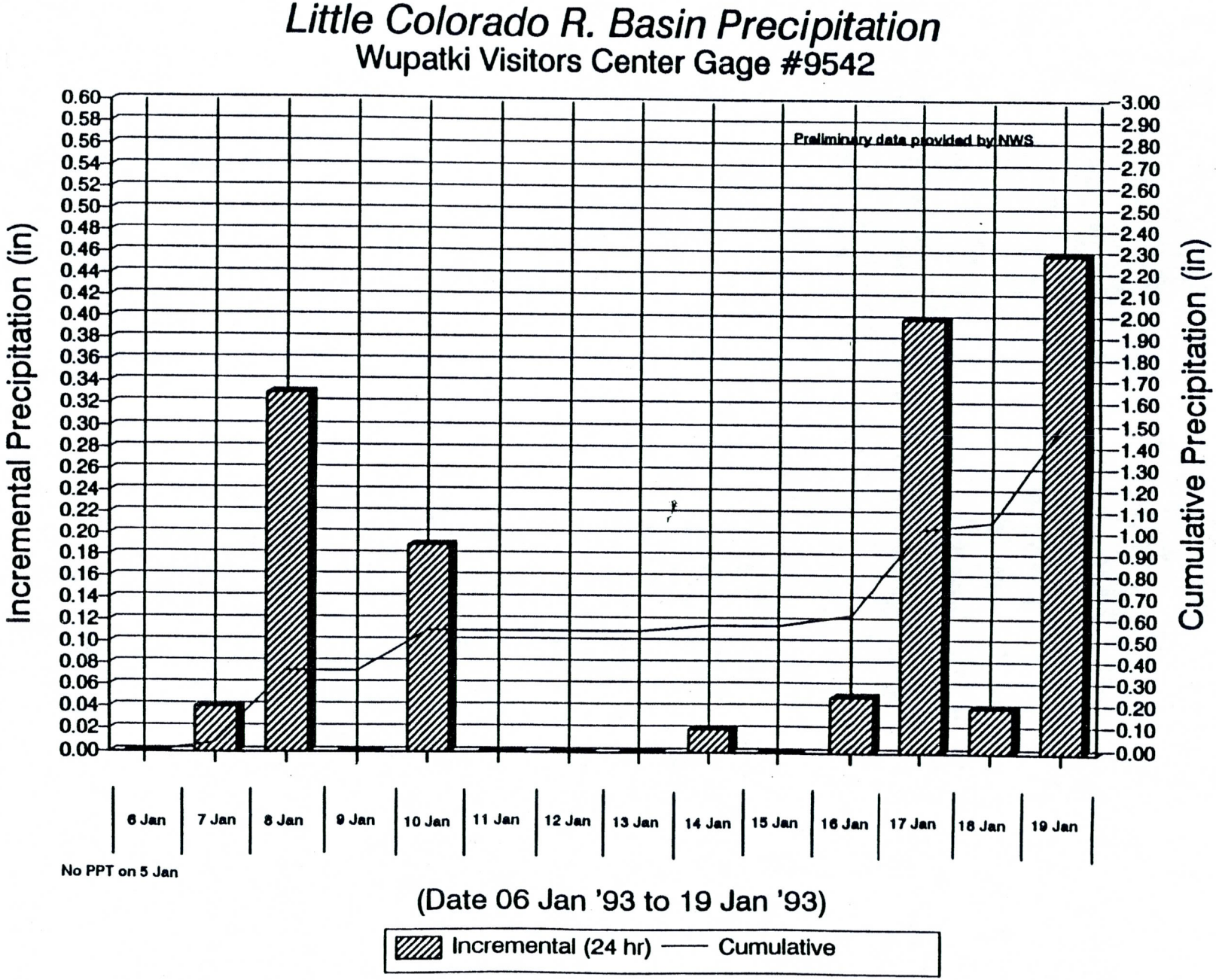

Little Colorado R. Basin Precipitation
Wupatki Visitors Center Gage #9542
Preliminary data provided by NWS
Incremental Precipitation (in)
Cumulative Precipitation (in)
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
3.00
2.90
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6 Jan
7 Jan
8 Jan
9 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
No PPT on 5 Jan
(Date 06 Jan '93 to 19 Jan '93)
Incremental (24 hr)
Cumulative

FIGURE 22

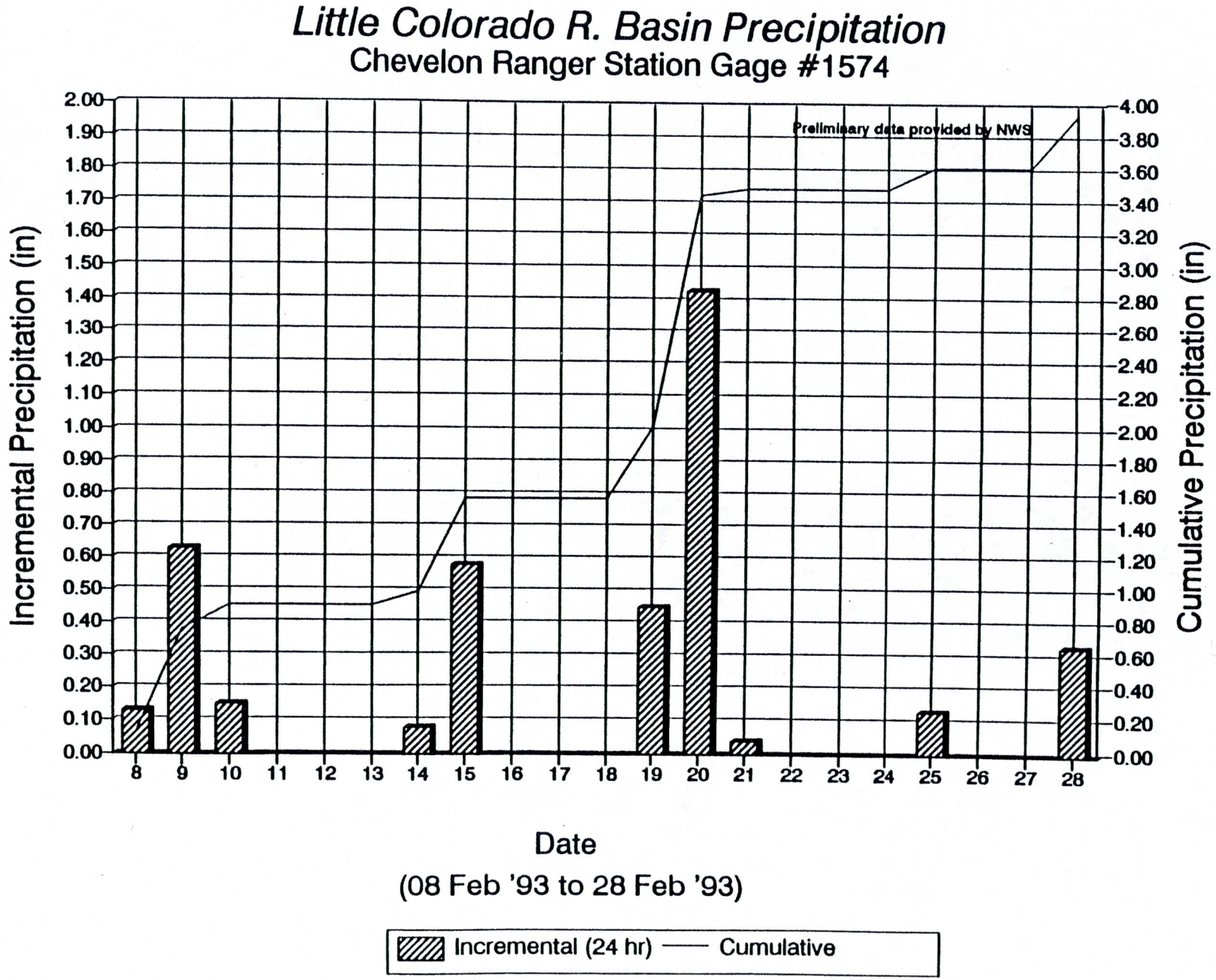

Little Colorado R. Basin Precipitation
Chevelon Ranger Station Gage #1574
Preliminary data provided by NWS
Incremental Precipitation (in)
Cumulative Precipitation (in)
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Date
(08 Feb '93 to 28 Feb '93)
Incremental (24 hr)
Cumulative

FIGURE 23

4. STREAMFLOW

4.01 GENERAL

Streamflow in the Gila River and Bill Williams River drainage areas was extremely heavy during the months of January and February of 1993. Runoff in the Little Colorado River basin was considerably less during these same periods as reported at the available stream gages. However, high water marks at the Winslow bridge across the Little Colorado River suggest a major flow occurred at this location.

Preliminary data reported by the United States Geological Survey (USGS) indicates that 26 discharges in the Gila River and tributaries, and in the Bill Williams River and tributaries, exceeded the previous recorded peak discharge during the months of January and February 1993, while another 14 discharges were nearly equivalent to the previously recorded peak.

Due to the duration of the storm and runoff periods, reservoirs throughout the Gila River drainage filled and spilled during this period. Notable among these was Coolidge Dam (drainage area = 12,886 sq. mi.) on the Gila River which spilled at a record rate, and Painted Rock Dam (drainage area = 50,800 sq. mi.) on the Gila River which spilled for the first time in its history. In addition reservoirs on the Salt River and Verde River exceeded storage capacities and spilled or released record volumes of water to the downstream drainage. New Waddell Dam on the Agua Fria River also experienced large inflows; due to restrictions on the rate of filling, operators of the project were required to release water which also minimally contributed to the spill from Painted Rock Dam.

Painted Rock Dam and Alamo Dam operations during the 1993 floods are discussed in detail in Chapter 4. Streamflow gaging stations are shown on Figure 24. Hydrographs showing daily inflow and outflow for the Salt River Project, Coolidge Dam, and New Waddell Dam are shown on figures 25 to 33. A summary of preliminary peak flows for January - February 1993 is presented in APPENDIX B.

Data acquisition was limited to calculated reservoir inflows and estimated releases provided by operators of the respective projects - Salt River Project (SRP), Bureau of Reclamation (BUREC), and the Corps of Engineers (COE) - estimated streamflow provided by Pima County Flood Control District (PCFCD) and the Flood Control District of Maricopa County (FCDMC), and GOES or DCP stream gage estimates provided by the USGS.

Streamflow Gaging Stations
State of Arizona

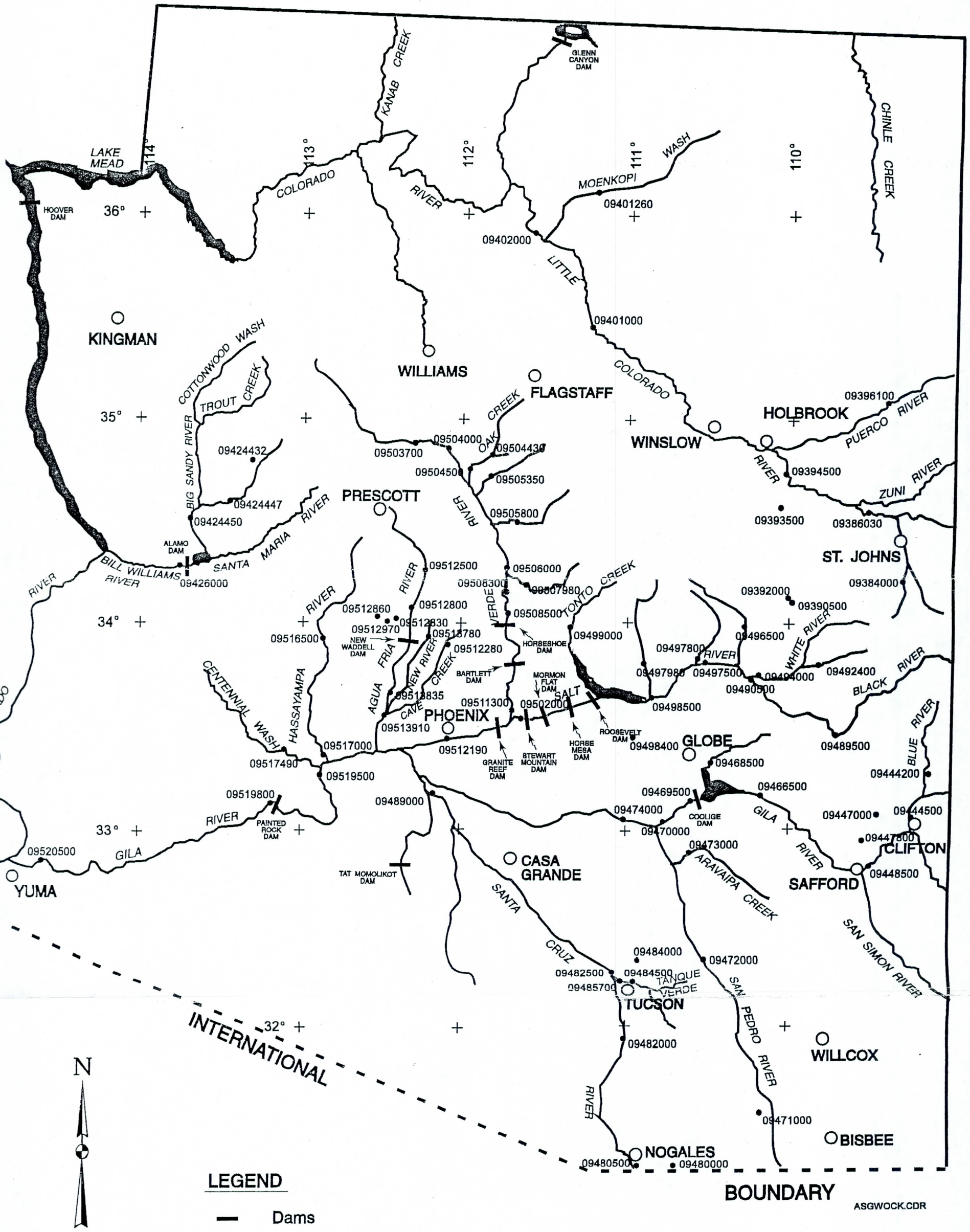


Figure 24

4.02 GILA RIVER AND TRIBUTARIES.

4.02.1 Unregulated Tributaries.

a. Santa Cruz River Basin - Peak discharges of record occurred in the following streams:

- Sabino Creek near Tucson (40% greater than Labor Day 1970 flood)
- Tanque Verde at Tucson (40% greater than December 1978 flood)
- Rillito Creek at Dodge Blvd. (the peak flow in October 1983 was probably greater, but the location is different; this gage has only been active since 1988)

Discharges approaching the record occurred in the following streams:

- Santa Cruz River at Continental (2nd highest peak of record next to October 1983 event)
- Santa Cruz River at Cortaro (2nd highest peak of record next to October 1983 event)

b. Salt River Basin - Peak discharges of record occurred in the following streams:

- Salt River near Chrysotile (marginally greater than January 1916)
- Pinal Creek at Inspiration Dam (nearly twice as great as previous maximum - record began in 1980)
- Salt River near Roosevelt Dam (nearly 40% greater than January 1916)
- Tonto Creek above Gun Creek (marginally greater than February 1980)

Discharges approaching the record occurred in the following streams:

- Black River below Pumping Plant (85% of October 1972 event)
- Black River near Fort Apache (75% of January 1916 event)
- White River near Fort Apache (86% of December 1978 event)

c. Verde River Basin - Peak discharges of record occurred in the following streams:

- Verde River near Paulden (February flood exceeded February 1980 event by nearly 30%)
- Verde River near Clarkdale (February flood 25% greater than February 1920 event)
- Oak Creek at Sedona (February flood approximately 3 times the next highest flood - record began in 1983)
- Oak Creek near Cornville (February peak nearly 50% greater than February 1980 event)
- Verde River near Camp Verde (February peak exceeded the March 1938 flood)

Discharges approaching the record occurred in the following streams:

- Wet Bottom Creek near Childs (February peak slightly less than February 1980)
- Verde River below Tangle Creek (largest flood since estimated Feb. 1891 event; on the 8th of January as well as the 20th of February, the USGS gage reported a peak flow which exceeded any other flow within the systematic record)

d. Agua Fria River Basin - Peak discharges of record occurred in the following streams:

- Cave Creek below Cottonwood Wash (record at this gage began in 1991)
- Boulder Creek near Rock Springs (record at this gage began in 1984)
- Humbug Creek near Castle Hot Springs (record at this gage began in 1984)

Discharges approaching the record occurred in the following streams:

- Agua Fria River near Mayer (83% of the February 1980 event)
- Agua Fria River near Rock Springs (95% of the November 1919 flood)
- Agua Fria River at New Waddell Dam
- New River near Rock Springs (95% of the Labor Day 1970 flood)

e. Gila River - Discharges approaching the record occurred in the following streams:

- Eagle Creek above Pumping Plant (75% of October 1983 event)
- Gila River at Head of Safford Valley (considerably smaller than the October 1983 flood, but a significant flood event)
- Gila River at Calva (considerably smaller than the October 1983 flood, but a significant flood event)

4.02.1 Regulated Streams.

Peak discharges of record occurred in the following streams:

- Salt River at 24th Street (record is only from 1990 - larger flows have occurred as recently as February 1980, although the 1993 estimate appears low)
- Verde River nr Scottsdale (probably exceeded only by the February 1891 flood event, despite the presence of Horseshoe and Bartlett dams upstream, which were completed in 1945 - certainly greater than any other flood within the systematic record)
- Gila River below Coolidge Dam (largest spill since completion of the dam in 1928)
- Gila River at Estrella Parkway (new gage site due to breach of Gillespie Dam during the January flood - peak (140,000 ft^3/s or higher), approximately equal to the peak of February 1980, which is the largest flood since completion of major upstream storage facilities)
- Gila River below Painted Rock Dam (only spill since completion of the dam in 1960)
- Gila River at Dome (largest flood since completion of major upstream storage facilities)

4.03 BILL WILLIAMS RIVER AND TRIBUTARIES.

Peak discharges of record occurred in the following streams:

- Francis Creek nr Bagdad (record for this gage began in 1990)
- Burro Creek at Old US 93 Bridge (February peak 11% greater than the previous record, while the January peak was 92% of the previous peak - record for this gage began in 1980)

- Big Sandy River nr Wikieup (the January peak exceeded the previous maximum - February 1980 - by 9%, while the February peak was 70% greater than the previous maximum)
- Bill Williams River at Alamo Dam (largest flow since 1927, and largest since completion of the dam in 1968)
- Bill Williams River bl Alamo Dam (largest release since completion of the dam in 1968)

4.04 LITTLE COLORADO RIVER AND TRIBUTARIES.

As shown in Table 2 (Appendix B), most stream gages in the Little Colorado River Basin recorded peaks well below their historic maximums. For the tabulated gages, the Show Low Creak near Lakeside gage indicated a flow of 73% of the historic maximum recorded in 1978. However, high water marks are recorded for major floods, and at the Winslow bridge, across the Little Colorado River, the water level was 1.6 to 2.0 feet higher than the 1978 flood peak. A preliminary estimate by the USGS indicates a peak flow of 70,000 ft^3/s at the Winslow bridge, which is inconsistent with the peak flows recorded at upstream and downstream gages. The Arizona Department of Water Resources investigated and surmised that a combination of rare conditions combined to generate a large flood in a small part of the Little Colorado River Basin.

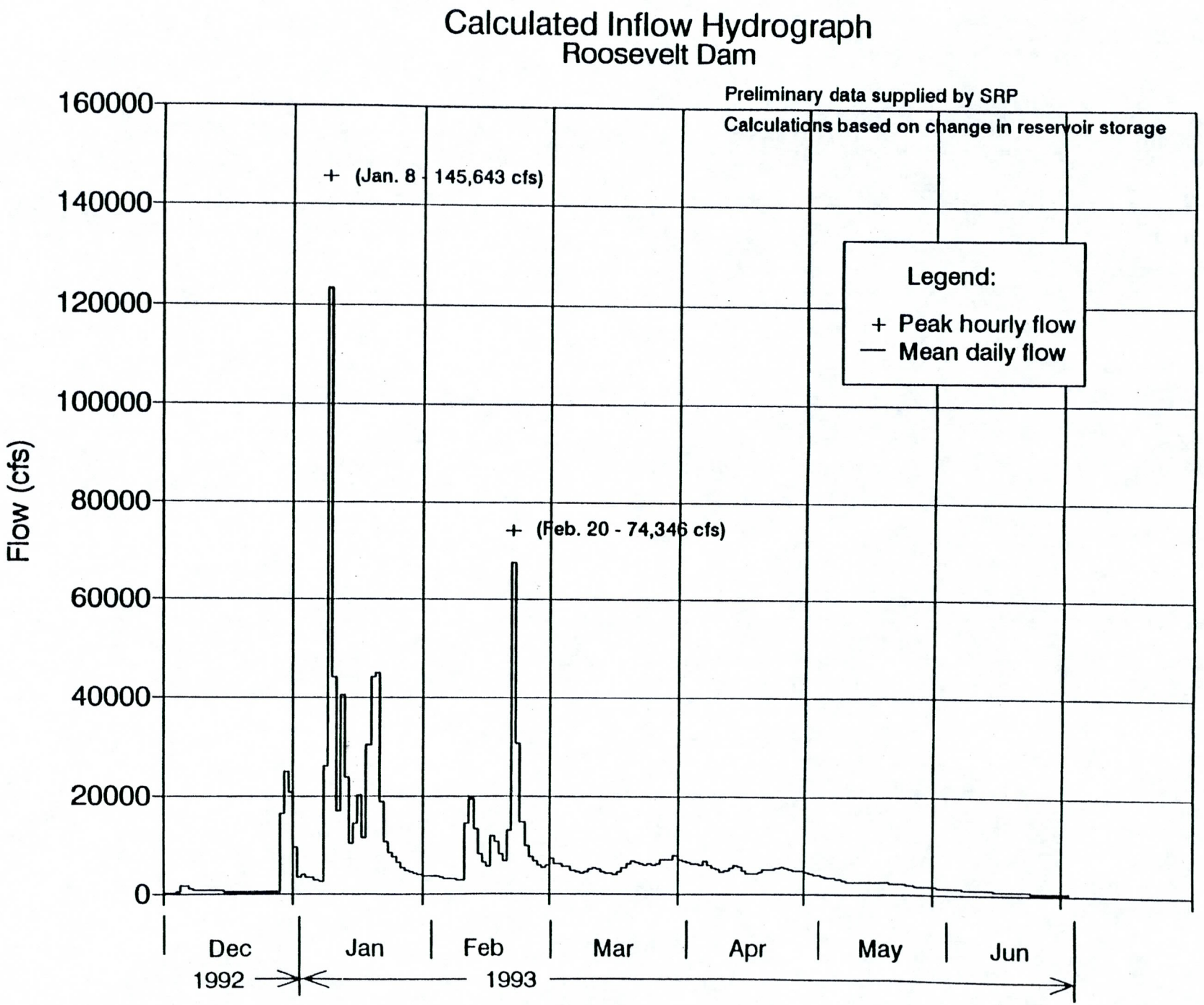

Calculated Inflow Hydrograph
Roosevelt Dam
Preliminary data supplied by SRP
Calculations based on change in reservoir storage
+ (Jan. 8 - 145,643 cfs)
+ (Feb. 20 - 74,346 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Flow (cfs)
160000
140000
120000
100000
80000
60000
40000
20000
0
Dec
Jan
Feb
Mar
Apr
May
Jun
1992
1993

Figure 25

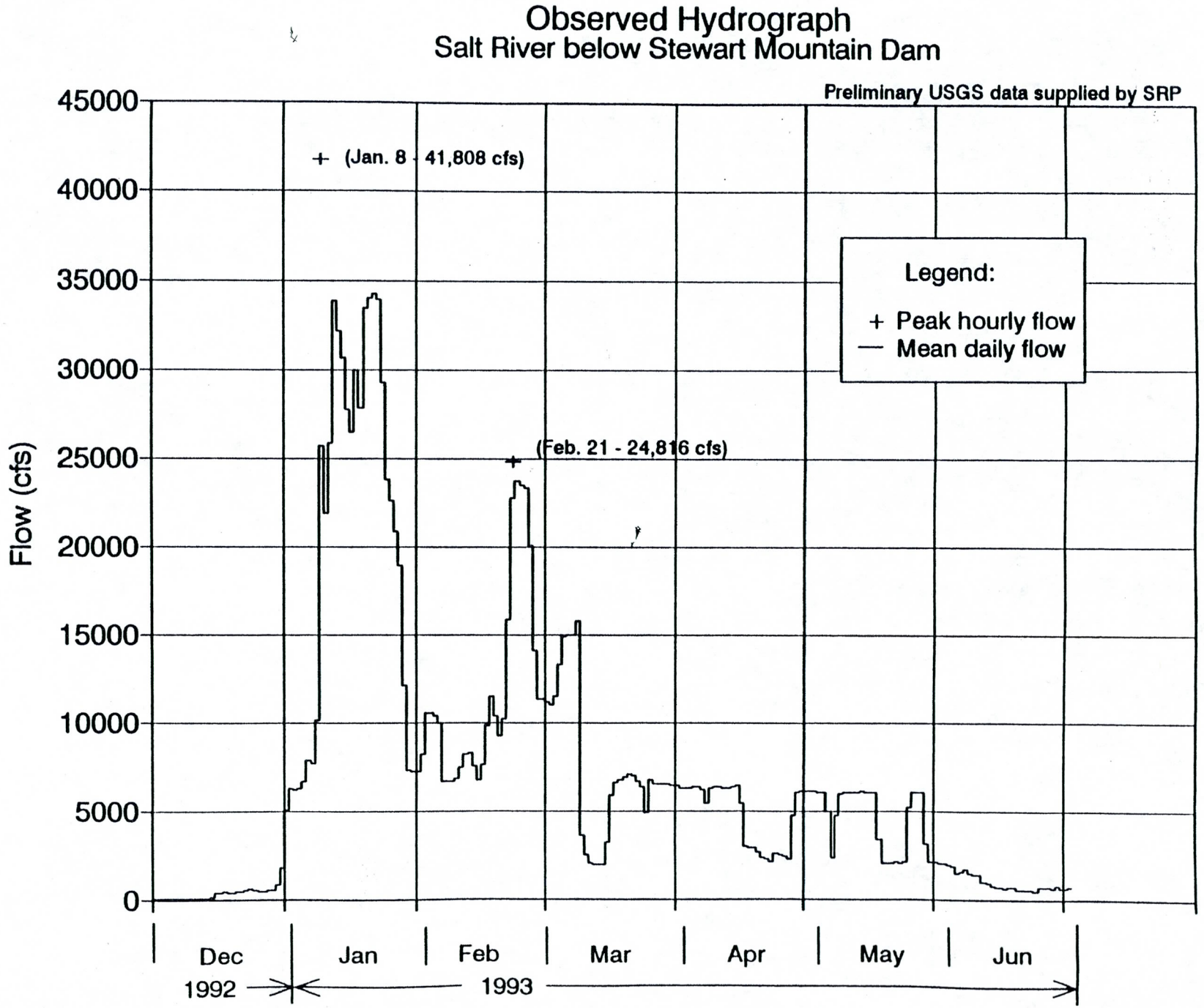

Observed Hydrograph
Salt River below Stewart Mountain Dam
Preliminary USGS data supplied by SRP
+ (Jan. 8 - 41,808 cfs)
(Feb. 21 - 24,816 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Flow (cfs)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Dec
Jan
Feb
Mar
Apr
May
Jun
1992
1993

Figure 26

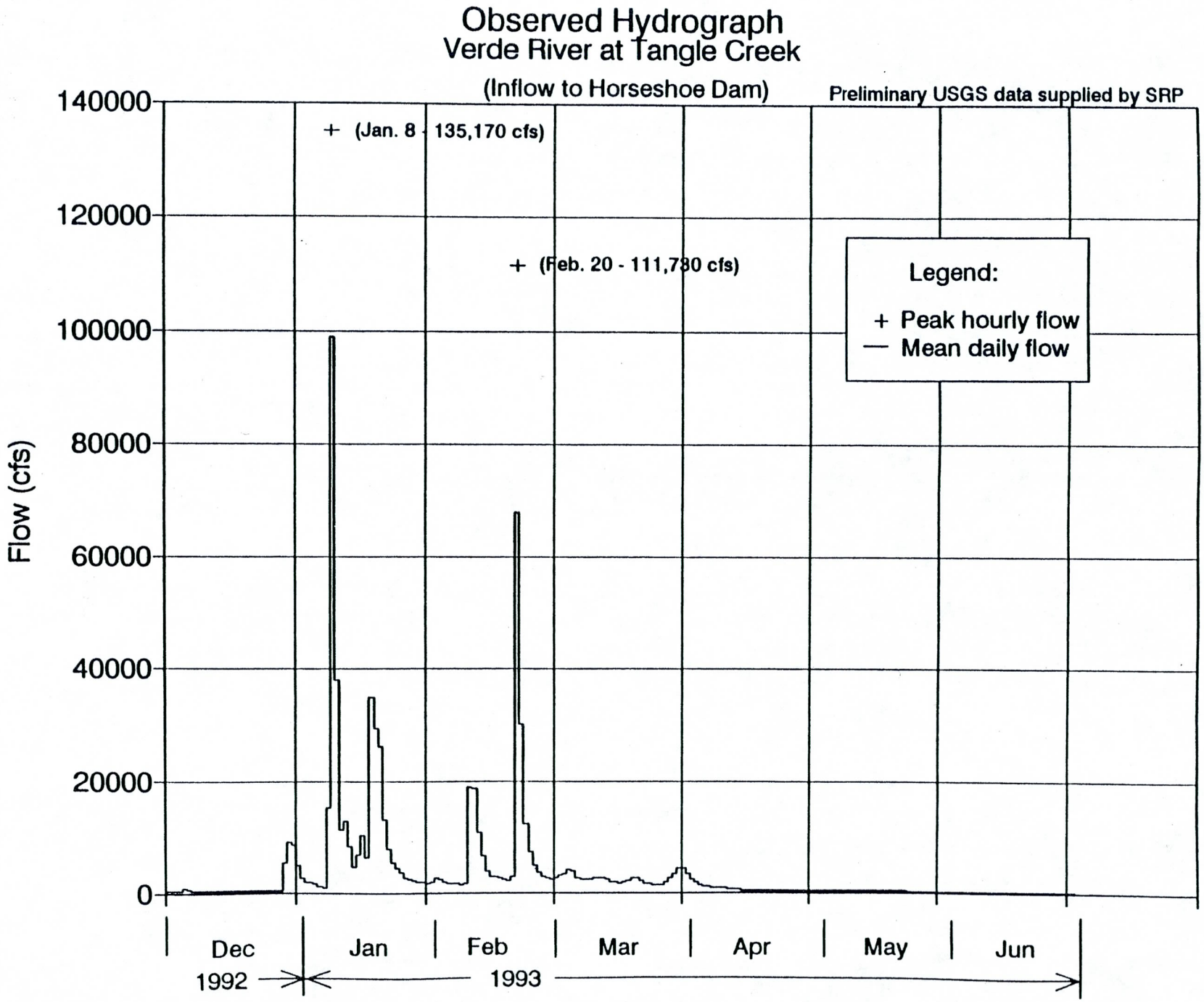

Observed Hydrograph
Verde River at Tangle Creek
(Inflow to Horseshoe Dam)
Preliminary USGS data supplied by SRP
+ (Jan. 8 - 135,170 cfs)
+ (Feb. 20 - 111,780 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Flow (cfs)
140000
120000
100000
80000
60000
40000
20000
0
Dec
Jan
Feb
Mar
Apr
May
Jun
1992
1993

Figure 27

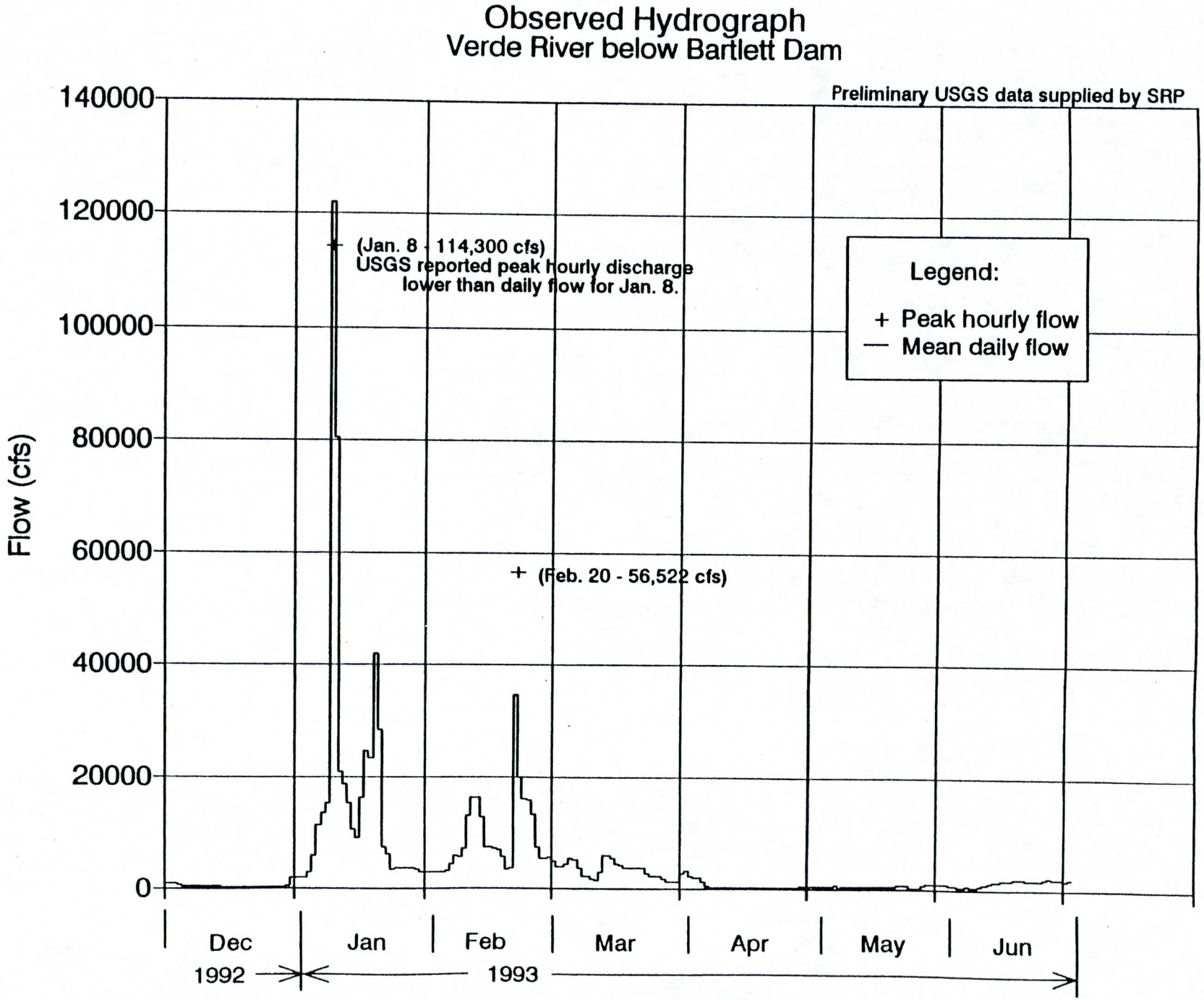

Observed Hydrograph
Verde River below Bartlett Dam
Preliminary USGS data supplied by SRP
140000
120000
100000
80000
60000
40000
20000
0
Flow (cfs)
(Jan. 8 - 114,300 cfs)
USGS reported peak hourly discharge
lower than daily flow for Jan. 8.
(Feb. 20 - 56,522 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Dec
Jan
Feb
Mar
Apr
May
Jun
1992
1993

Figure 28

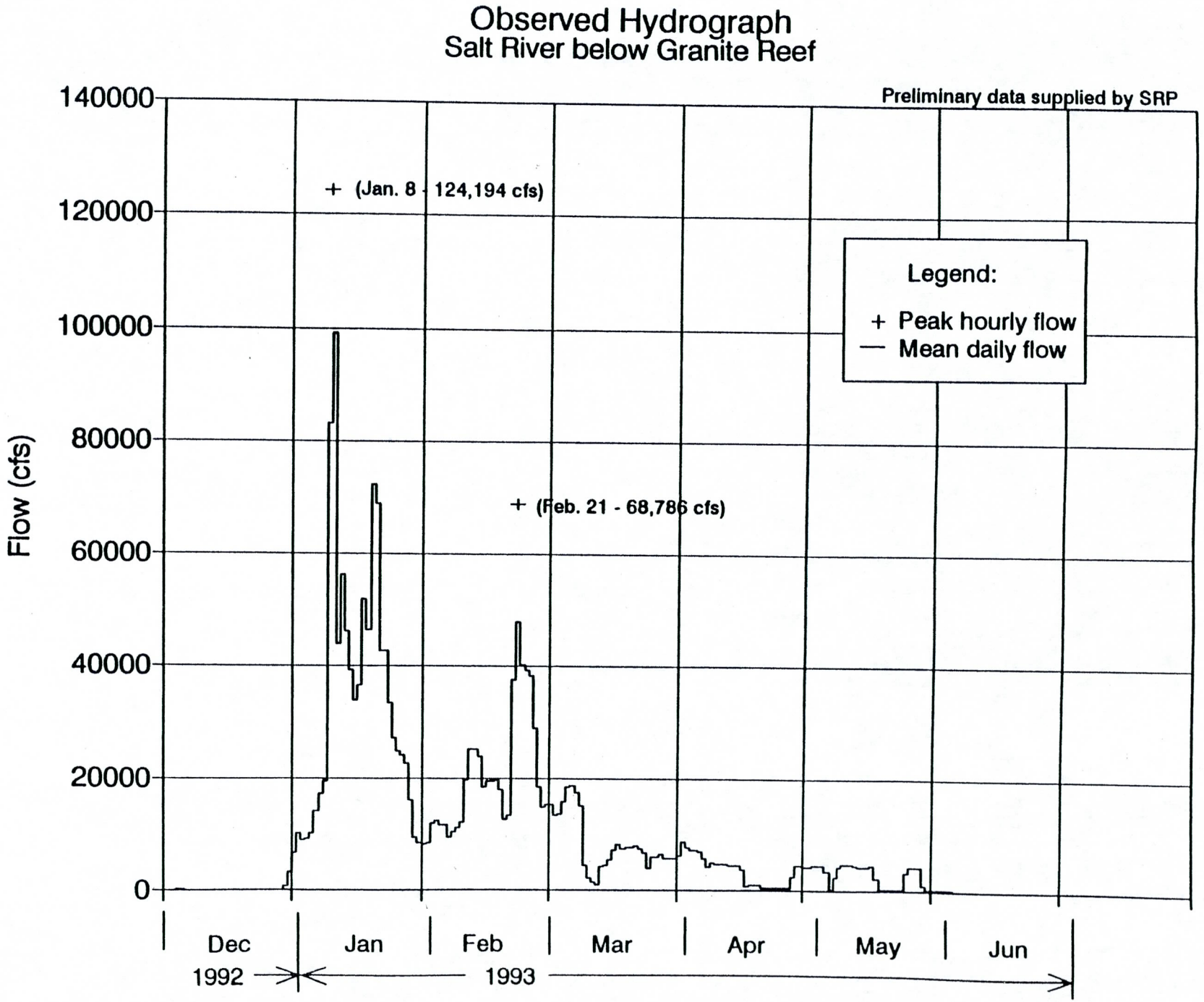

Observed Hydrograph
Salt River below Granite Reef
Preliminary data supplied by SRP
+ (Jan. 8 - 124,194 cfs)
+ (Feb. 21 - 68,786 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Flow (cfs)
140000
120000
100000
80000
60000
40000
20000
0
Dec
Jan
Feb
Mar
Apr
May
Jun
1992
1993

Figure 29

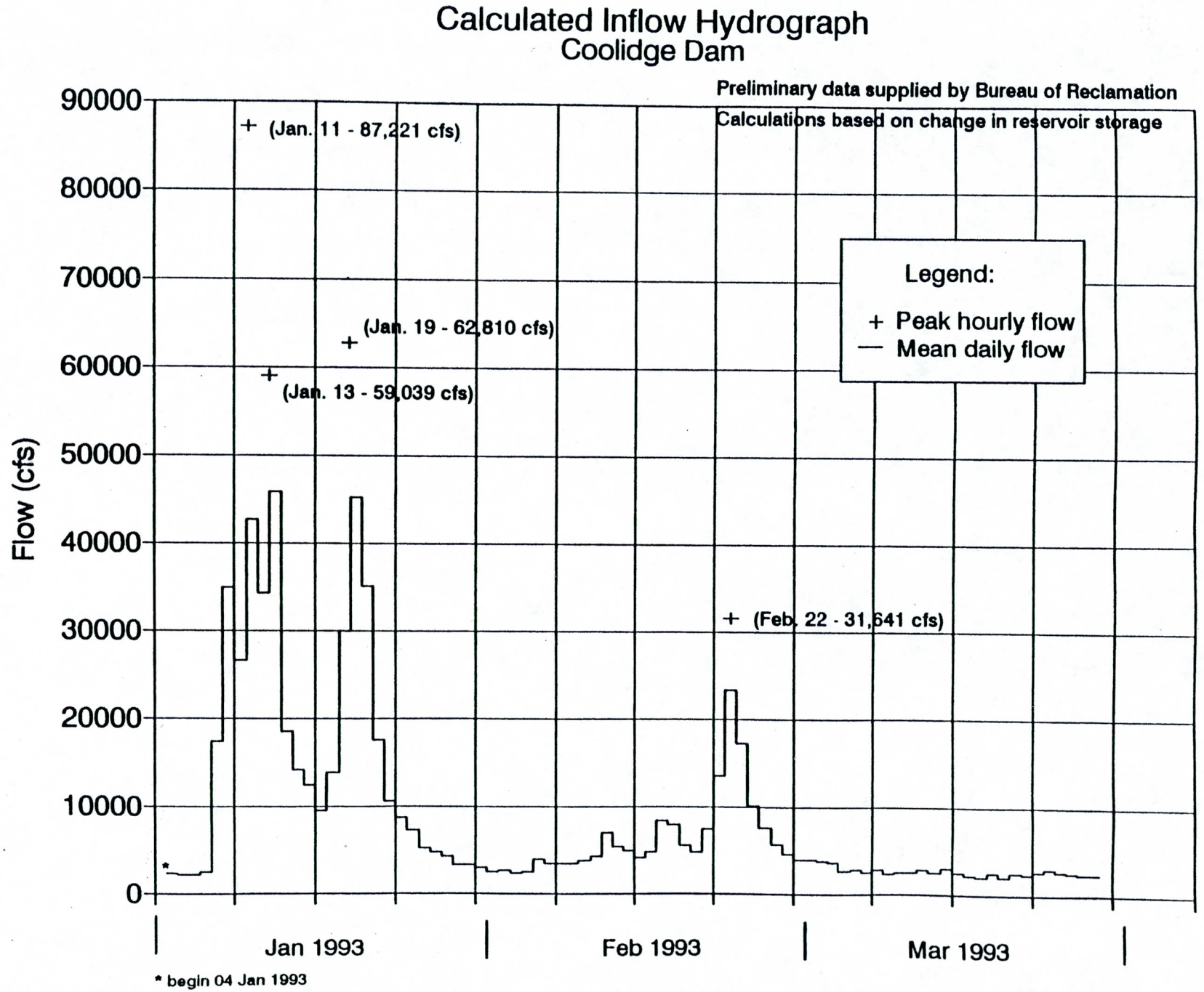

Calculated Inflow Hydrograph
Coolidge Dam
Preliminary data supplied by Bureau of Reclamation
Calculations based on change in reservoir storage
+ (Jan. 11 - 87,221 cfs)
+ (Jan. 19 - 62,810 cfs)
+ (Jan. 13 - 59,039 cfs)
+ (Feb. 22 - 31,641 cfs)
Legend:
+ Peak hourly flow
— Mean daily flow
Flow (cfs)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Jan 1993
Feb 1993
Mar 1993
* begin 04 Jan 1993

Figure 30

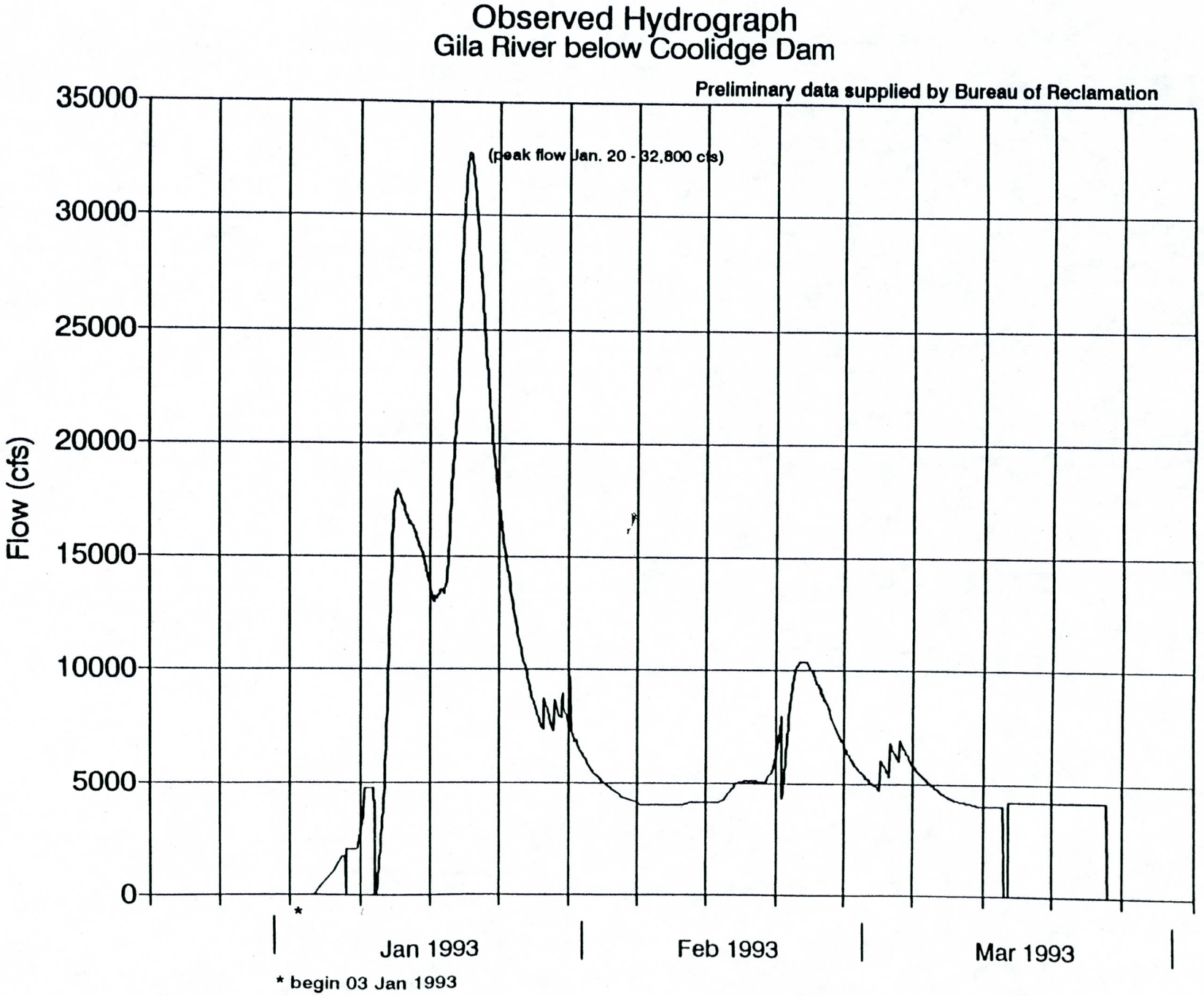

Observed Hydrograph
Gila River below Coolidge Dam
Preliminary data supplied by Bureau of Reclamation
(peak flow Jan. 20 - 32,800 cfs)
Flow (cfs)
35000
30000
25000
20000
15000
10000
5000
0
*
Jan 1993
Feb 1993
Mar 1993
* begin 03 Jan 1993

Figure 31

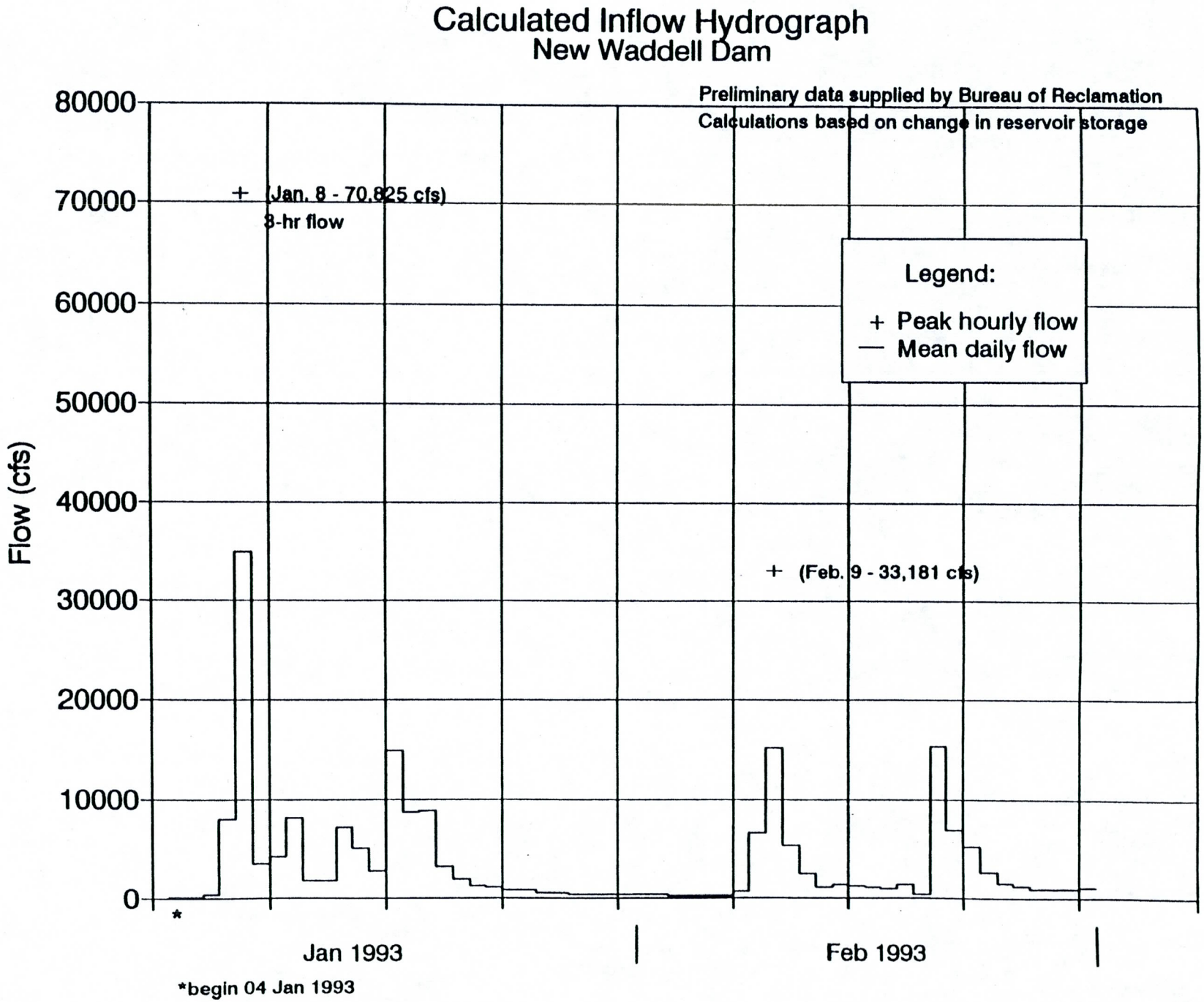

Calculated Inflow Hydrograph
New Waddell Dam
Preliminary data supplied by Bureau of Reclamation
Calculations based on change in reservoir storage
80000
70000
60000
50000
40000
30000
20000
10000
0
Flow (cfs)
+ (Jan. 8 - 70,825 cfs)
8-hr flow
Legend:
+ Peak hourly flow
— Mean daily flow
+ (Feb. 9 - 33,181 cfs)
*
Jan 1993
Feb 1993
*begin 04 Jan 1993

Figure 32

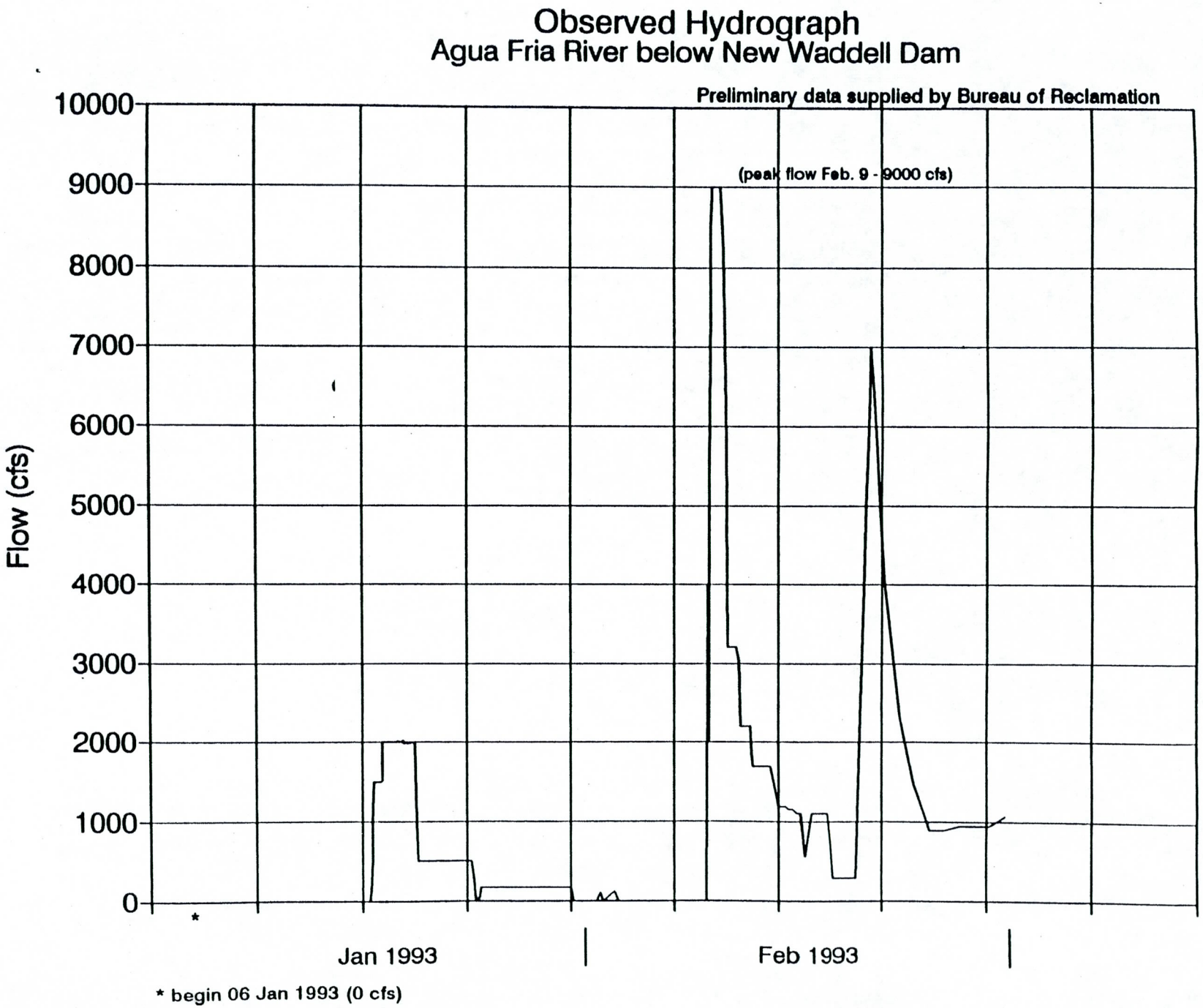

Observed Hydrograph
Agua Fria River below New Waddell Dam
Preliminary data supplied by Bureau of Reclamation
(peak flow Feb. 9 - 9000 cfs)
Flow (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan 1993
Feb 1993
* begin 06 Jan 1993 (0 cfs)

Figure 33

5. RESERVOIR OPERATION

5.01 PAINTED ROCK DAM

5.01.1 Project Background.

Painted Rock Dam was built by the Corps of Engineers for its congressionally authorized purpose of flood control. Completed in January 1960, Painted Rock Dam is located on the Gila River, approximately 126 miles from its confluence with the Colorado River (see Figure 1). The drainage area above Painted Rock Dam is 50,800 sq mi. The reservoir has a total storage of 2,476,339 ac-ft at spillway crest (based on 1985 survey). Figure 34 shows the project's pertinent data, and Figure 35 is a diagram showing the reservoir's storage allocation. The approved flood control plan for Painted Rock Dam calls for a maximum reservoir release of 22,500 ft^3/s, as stated in the Painted Rock Dam water control manual dated June 1962; however, the downstream channel has a limited capacity, lower than the maximum flood control releases, as explained in sections 5.01.2 and 5.01.4.

There are numerous reservoirs in the Gila Basin above Painted Rock Dam. However, only eight influence the regulation of major floods at the dam (see Figure 1, and Table 3 on page 63). These reservoirs have a combined usable storage space below spillway crests of approximately 3.25 million ac-ft, and intercept runoff from an area of 26,742 sq. mi, or approximately 53 percent of the total drainage area above Painted Rock Dam. These projects and their operations in 1993 are briefly discussed in section 5.01.6.

5.01.2 Downstream Development.

Below Painted Rock Dam, the Gila River flows approximately 126 miles to the Colorado River at Yuma. South of the River, Interstate Highway 8 runs the entire distance from Gila Bend to Yuma. There are nine bridges across the Gila River that connect the communities downstream of the dam (see Table 4, p. 64), and only six of these nine crossings were designed to handle as much as 10,000 ft^3/s. With only an estimated 5,000 to 7,000 residences scattered throughout the area, there is no major urban development that exists along the Lower Gila River between the dam and the City of Yuma. For 65 miles downstream of the dam, the terrain is sparsely inhabited, with widely scattered pockets of agriculture. The next 45 miles consists of the Wellton-Mohawk Irrigation and Drainage District which is an intensive agricultural area consisting of about 65,000 acres of land. Existing improvements include irrigation canals, pump stations, transmission lines, and flood control structures. In addition to the nine bridge crossings shown on Table 4, there are other bridges that are affected in the overflow area created when releases are in excess of current channel capacities.

Where the Gila River joins the Colorado River east of Yuma, there is a large irrigated agriculture area owned in part by the North Gila Valley Irrigation District, and in part by the Yuma Irrigation District. To the east and south of Yuma, The Yuma Mesa Irrigation District extends to the US - Mexico International Border. The combined flows from the Colorado River and the Gila River continue to Mexico where water is used primarily for irrigated agriculture on the upper delta and Mexicali Valley.

5.01.3 Agency Cooperation.

a. The Corps of Engineers (COE) - The COE is responsible for the operation and maintenance of Painted Rock Dam.

b. U.S. Bureau of Reclamation (USBR) - The USBR constructed the levees in Yuma County along the lower Gila River and the Lower Colorado River system. During the period of the significant storms of 1993 as discussed in this report, the USBR was managing a safety modification for Coolidge Dam for the Bureau of Indian Affairs, the reconstruction of Roosevelt Dam for Salt River Project, and the construction of New Waddell Dam for the Central Arizona Water Conservation District.

c. Bureau of Indian Affairs (BIA) - The BIA owns and operates Coolidge Dam located on the Gila River upstream of Painted Rock Dam.

d. Wellton-Mohawk Irrigation and Drainage District (WMIDD) - Created by Act of the Arizona State Legislature on July 23, 1951, the WMIDD is a political subdivision of the State of Arizona, and is responsible for the irrigation and power within its jurisdiction. The District consisting of 65,000 acres of irrigable farmlands extends 45 miles along the Gila River, from the Gila Gravity Canal Siphon under the Gila River, 15 miles east of Yuma, to Texas Hill. The irrigation system was constructed by USBR and turned over to the WMIDD for operation and maintenance.

e. Salt River Project (SRP) - SRP operates the Salt River system consisting of Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain Dams; and the Verde River system consisting of Horseshoe and Bartlett Dams.

f. US International Boundary and Water Commission (IBWC) - The IBWC is interested in the operation of Painted Rock Dam because of the Commission's responsibilities relating to the United States' 1944 Water Treaty with Mexico.

g. Central Arizona Water Conservation District (CAWCD) - Operates New Waddell Dam located on the Agua Fria River upstream of Painted Rock Dam .

5.01.4 Constraints at Painted Rock Dam.

The currently approved water control plan for Painted Rock Dam calls for a maximum flood control release of 22,500 ft^3/s, as discussed in section 5.01.1. However, releases in excess of 10,000 ft^3/s could produce devastating social and economic impacts to the downstream areas, especially to the Wellton-Mohawk's intensive improvements. Table 4 lists the major bridge crossings that connect communities downstream of the dam. Releases in excess of 15,000 ft^3/s would result in closure of some or all these river crossings and isolation of the north and south sides of the river. According to the local sheriff department's estimate, approximately 3,500 area residents would be isolated on the north bank when all bridges are closed. Travel to schools, work and hospitals would be impossible, except for 120 mile long alternate route.

5.01.5 Painted Rock Dam Operation During the Floods of 1993.

Virtually empty before January 4, 1993, Painted Rock Reservoir received high inflows resulting from a series of storms that lasted through late February. As the water surface elevation was on an increasing trend, releases were gradually increased in the first weeks of January, reaching 12,500 ft^3/s near the end of month. The COE kept releases below the maximum scheduled flood control release of 22,500 ft^3/s in order to minimize damages downstream. On 1 February the release rates were reduced to 10,000 ft^3/s because roads and bridges were starting to get washed away or inundated. A week later, on 8 February, release rates had to be increased back up to 12,500 ft^3/s due to significant rainfall in the watershed. This rate (12,500 ft^3/s) was maintained until 21 February when the WSE exceeded the spillway crest elevation of 661 feet. As the spillway discharges increased, the outlet gates were lowered accordingly so as to maintain a total discharge (spillway and outlet gates) of 12,500 ft^3/s, thus minimizing downstream impacts. However, the WSE continued to increase, resulting in higher spillway flows, that eventually exceeded 12,500 ft^3/s on 23 February. At this time, all of the outlet gates were completely closed. In the succeeding days, as the water surface elevation continued to rise, the spillway discharges continued to increase. These increases continued and finally exceeded the operational maximum flood control release of 22,500 ft^3/s. A peak outflow of about 25,600 ft^3/s occurred on 27 February. The peak WSE was 667 feet. On 1 March, as the spillway discharges dropped below 25,000 ft^3/s, the outlet gates were opened accordingly so as to maintain 24,000 ft^3/s, until the WSE dropped below the spillway crest elevation of 661 feet, on 16 March.

On 17 March, at the requests of downstream interests, the outlet discharge was gradually reduced to 20,000 ft^3/s. This reduction allowed the re-opening of US Highway 95, a major roadway corridor, and Sentinel Road. It also allowed the repairs of other bridges and roadways, such as the one near Dateland. On 9 April, at the requests of local officials, release rates were further decreased to 15,000 ft^3/s, in order to allow the re-opening of other transportation corridors, draining of additional fields for farming, and to help the USBR maintain their levees along the lower Gila River. On 29 April, the release rates were decreased to 10,000 ft^3/s to help the WMIDD and the USBR in their flood fighting efforts, and to speed the reconstruction of US Highway 95 bridge, which eventually collapsed due to sustained high flows.

On 21 May, the COE inspected and found the outlet works to be in good condition with no emergency repairs required. In order to facilitate this inspection, the releases were gradually decreased to zero. After the inspection, the gates were set back to maintain a release of 10,000 ft^3/s.

On 27 May, at the request of local officials, including the Governor of Arizona, Painted Rock releases were reduced to 5,000 ft^3/s, as the inflow was projected to drop to near zero. This reduction negated further flood fighting efforts, and enabled the political jurisdictions, and the farmers to begin their recovery measures. It also enabled the USBR to assess damages, begin repairs of their facilities, and coordinate water resources from the Gila and Colorado Rivers. On 7 July, releases were gradually reduced to 2,200 ft^3/s over a 7 day period. This reduction was made in order to facilitate the repair and reconstruction of the USBR's Main Outlet Drain Extension (MODE) - a reach of the channel which carries saline groundwater flows from the WMIDD directly to the Gulf of California without flowing to the Colorado River and adversely affecting the salinity levels of water going to Mexico.

The floods of 1993 also resulted in historic maximums recorded at Painted Rock Dam, including: 1) maximum water surface elevation of 667 feet (6 feet above spillway crest), maximum storage of 2,808,960 (113 percent of flood control capacity), and, 3) maximum outflow of 25,600 ft^3/s (spillway) (see Table 5). Figure 36 shows the inflow and outflow hydrographs for Painted Rock Dam during the 1993 floods, as well as the water surface elevation and storage for the same time period. Table 6 summarizes the COE's operation of Painted Rock Dam during January and February 1993 floods.

The 1993 flood event at Painted Rock Dam which began on 4 January had a maximum inflow on 8 January, estimated at 204,000 ft^3/s. This would make the peak inflow the second largest annual maximum event since the dam was completed in 1960 (219,000 ft^3/s occurred on 17 February, 1980). In addition, the maximum 10-day inflow volume (7-16 January) of 1,320,000 ac-ft was only exceeded by the historic event of February 1891, while the maximum 30-, 60-, and 90-day inflow volumes of 2,670,000 ac-ft, 3,900,000 ac-ft, and 4,390,000 ac-ft, respectively, exceeded previous maxima since streamflow record began in 1888. Consequently, the pre-1993 inflow-duration-frequency relationship shown in figure 37 must be updated to reflect the 1993 events in the period of record.

5.01.6 Operation of Other Projects above Painted Rock Dam.

While the significant inflow continued to inundate the Painted Rock Reservoir during the months of January and February, little could be done at the upstream structures in order to prevent Painted Rock Dam from spilling.

On the Verde system, storage was 9 percent above the planned storage. Roosevelt Dam, which had been undergoing rehabilitation, had only one of its 2 spillways in operation. The other spillway was blocked by a construction coffer dam. On 1 March, SRP reported that March 1 storage for Roosevelt Dam was 25 percent above the planned storage.

On the Gila River, Coolidge Dam received significant inflows and started spilling on 11 January. Operated by the Bureau of Indian Affairs for agriculture, Coolidge Dam was undergoing safety modifications during this period of significant storms. The spillway discharge peaked on 20 January at 32,800 ft^3/s. Peak WSE was 2,521.68 feet, more than 10 feet above the spillway crest elevation. Previous maximum spill from Coolidge Dam occurred in 1983 at 5,000 ft^3/s. USBR who was managing the safety modification of the dam stated that a reservoir restriction of WSE 2,496.4 feet exists during the period of construction. Coolidge Dam spills which eventually entered Painted Rock Reservoir continued until the 2nd week of March.

On the Agua Fria River, heavy runoff from the January storms added 224,000 ac-ft to the Lake Pleasant Reservoir. On 9 February, the USBR started releasing from the New Waddell Dam which forms the Lake Pleasant reservoir. These releases were gradually increased up to 9,000 ft^3/s. New Waddell Dam, which replaces the old upstream Waddell Dam, was on its first year of filling, and the rapid rise in WSE substantially exceeded the USBR's criteria for filling the newly constructed dam; therefore, water had to be released rather than stored, hence the storage space behind New Waddell Dam was not fully utilized.

Table 3. Pertinent Data for Existing Dams [1]

Upstream of Painted Rock

Dam	Reservoir	River	D.A. (sq mi)	Storage[2] (ac-ft)	Purpose	Agency
1. Coolidge	San Carlos	Gila	12,886	884,594	Irrigation and Power	BIA
2. New Waddell	Lake Pleasant	Agua Fria	1,460	902,502	Irrigation	CAWCD
3. Roosevelt	Roosevelt Lake	Salt	5,830	1,075,507	Irrigation and Power[3]	SRP
4. Horse Mesa	Apache Lake	Salt	5,940	188,106	Irrigation and Power	SRP
5. Mormon Flat	Canyon Lake	Salt	6,100	19,886	Irrigation and Power	SRP
6. Stewart Mt.	Saguaro Lake	Salt	6,211	44,084	Irrigation and Power	SRP
7. Horseshoe	Horseshoe	Verde	5,991	68,777	Irrigation	SRP
8. Bartlett	Bartlett	Verde	6,185	72,073	Irrigation	SRP

[1] There are other dams located upstream; however, only the projects shown above influence the operation of Painted Rock Dam.

[2] Up to spillway crest elevation.

[3] Being modified for flood control.

Table 4.

Major Gila River Crossings

Downstream of Painted Rock Dam

Name	Location from Dam (miles)	Pre-flood Design Capacity (ft^3/s)
1. Sentinel	35	5,000
2. Dateland (Ave 264)	49	10,000
3. Ave 51E	66	7,000
4. Ave 45E	83	10,000
5. Ave 38E	98	10,000
6. Ave 30E	120	10,000
7. Ave 20E	104	10,000
8. US Highway 95	115	10,000
9. Ave 7E	125	7,000

Table 5.

Maximum Inflow, Outflow,

WSE and Storage

at Painted Rock Dam

During Jan - Feb 1993 Floods

	Maximum Value	Date
Inflow (ft^3/s)	186,000	10 Jan 1993
Outflow (ft^3/s)	25,600[1]	26 Feb 1993
WSE (ft)	667.00[2]	26 Feb 1993
Storage (ac-ft)	2,808,960	26 Feb 1993

[1] Spillway Flow.

[2] 6 ft above spillway crest.

Table 6.

Summary of COE's

Painted Rock Dam Operation

During Jan - Feb 1993 Floods

Date	Discharge (ft^3/s)	Remarks
28 Jan - 31 Jan	12,500	To utilize max. d/s channel capacity.
1 Feb - 7 Feb	10,000	Prevent/minimize d/s damages.
8 Feb - 20 Feb	12,500	Additional rainfall caused more inflow into the dam.
21 Feb - 26 Feb	12,500	Spillway discharge begun. Maintained total outflow (from spillway and outlet gates) to 12,500 ft^3/s.
27 Feb - 28 Feb	up to 26,000	Spillway flow. Max. reached 25,600 ft^3/s.
1 Mar - 16 Mar	24,000	Total discharge (outlet and spillway) maintained at 24,000 ft^3/s.
17 Mar - 8 Apr	20,000	Spillway flow ended. Gate discharge maintained at 20,000 ft^3/s for repairs and re-opening of roads.
29 Apr - 26 May	10,000	Help USBR and WMIDD in flood fights.
21 May	0	Inspection of outlet works and tunnel. Outflow was back to 10,000 ft^3/s at the end of the day.
27 May - 6 Jul	5,000	Inflow into the reservoir ended.
7 July	2,200	Reconstruction of USBR's Main Outlet Drain Extension (MODE).
15 November	0	Painted Rock Reservoir empty.

Painted Rock Dam and Reservoir
Maricopa County, Arizona
PERTINENT DATA
APRIL 1993

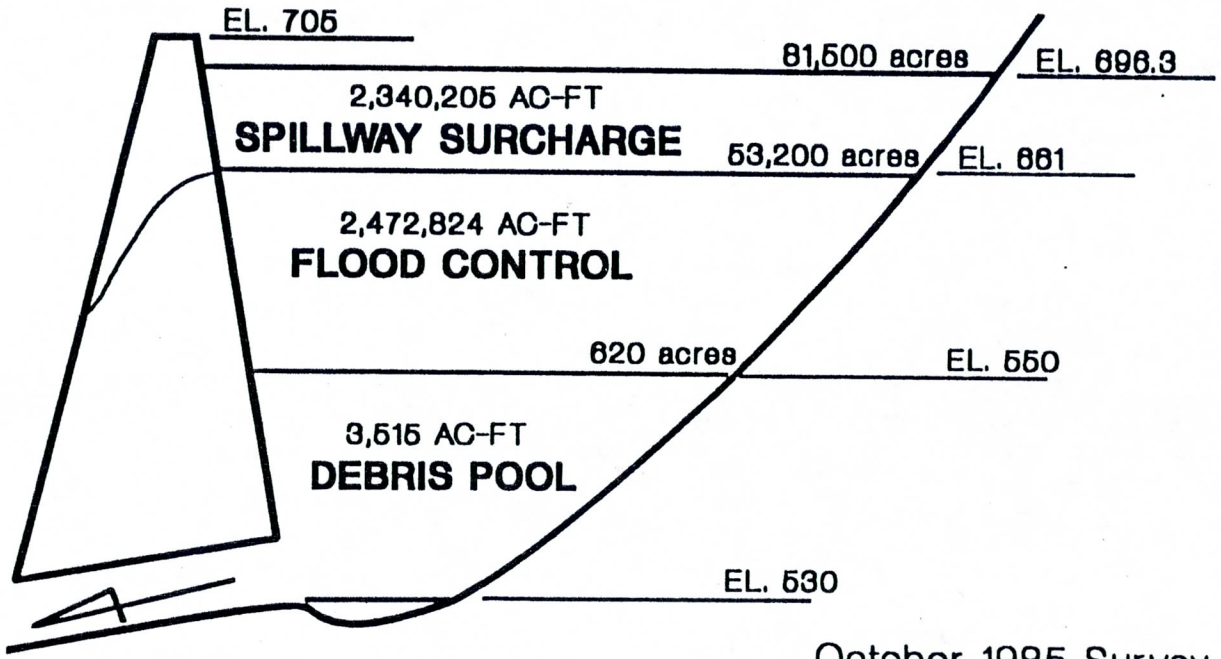
Stream System		Gila River
Drainage Area	sq. mi.	50,800
Reservoir:		
Elevation		
Streambed	ft., msl	524
Debris Pool	ft., msl	550
Flood Control Pool (Spillway Crest)	ft., msl	661
Spillway Design Surcharge level	ft., msl	696.3
Top of Dam	ft., msl	705
Area*		
Debris Pool	acres	620
Flood Control Pool (Spillway Crest)	acres	53,200
Spillway Design Surcharge Level	acres	81,500
Top of Dam	acres	89,600
Capacity*		
Debris Pool	ac-ft	3,515 (0.00**)
Flood Control Pool (spillway crest)	ac-ft	2,476,339 (.91**)
Spillway Design Surcharge Level	ac-ft	4,816,544 (1.79**)
Top of Dam	ac-ft	5,561,470 (2.05**)
Allowance for Sediment (50-yr)	ac-ft	200,000 (0.07**)
Dam: - Type		Earthfill
Height Above Original Streambed	ft	181
Top of Length (excluding saddle dike and spillway)	ft	4,780
Top Width	ft	20
Freeboard	ft	8.7
Spillway: - Type		Ungated, Broad-crested
Crest Length	ft	610
Design Surcharge	ft	35.3
Design Discharge	cfs	401,700
Outlets:		
Gates - type		Tainter
Number and Size		3 - 10'W X 18'H
Gate and Sill Elevation	ft., msl	530
Conduits		
Number and Size - Inside Diameter	ft	1 - 25
Length	ft	925
Maximum Capacity at Spillway Crest	cfs	30,480
Regulated Capacity at Spillway Crest	cfs	23,000
Reservoir Design Flood:		
Duration (Inflow)	days	18
Total Volume	ac-ft	2,800,000 (1.03**)
Inflow Peak	cfs	300,000
Spillway Design Flood		
Duration (Inflow)	days	18
Total Volume	ac-ft	7,680,000 (2.83**)
Inflow Peak	cfs	620,000
Historic Maximums		
Maximum Release	cfs	26,000
Date		2/27/93
Maximum Water Surface Elevation	ft., msl	667.00
Date		2/27/93

* Based on October 1985 survey

**Inches of runoff

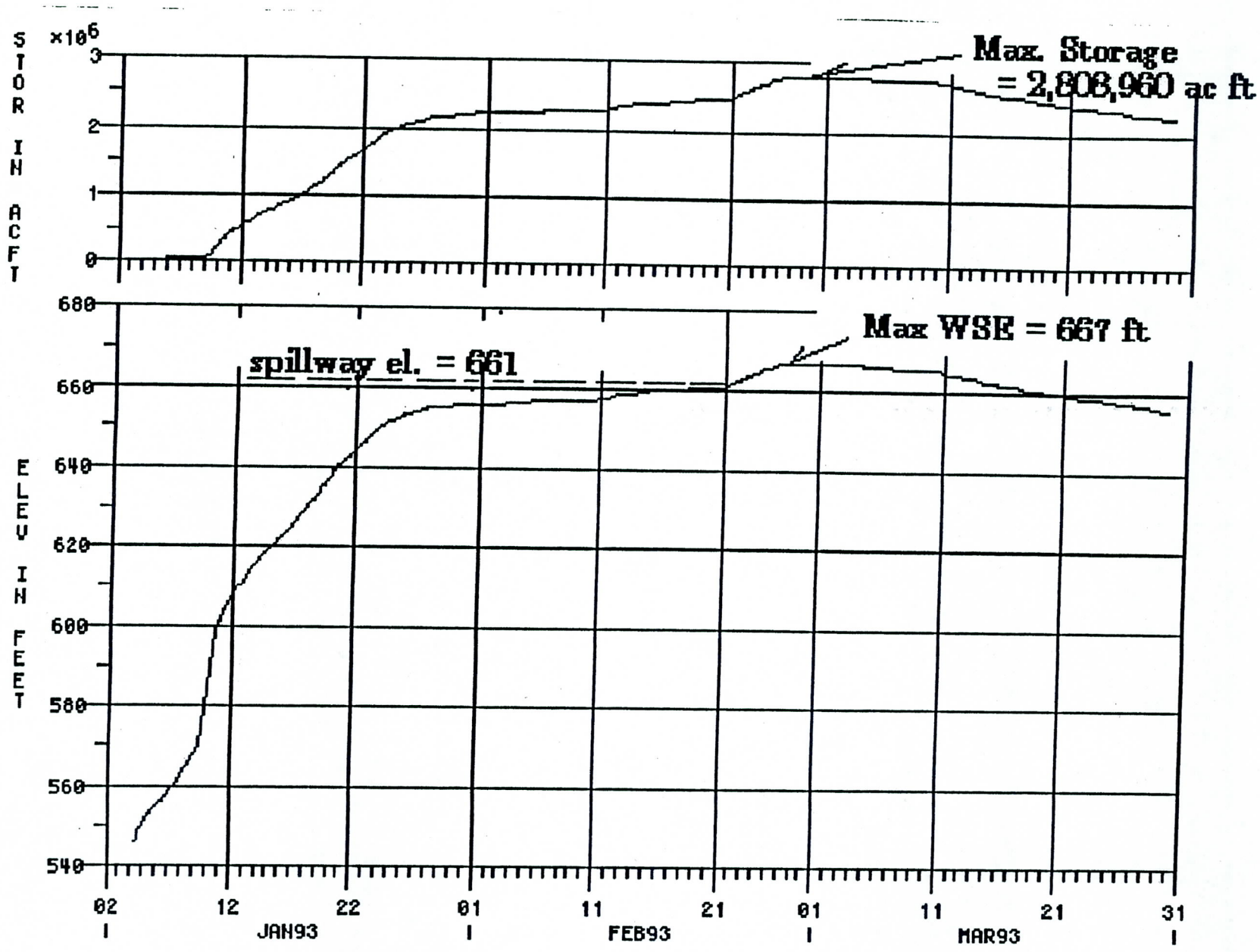
Figure 34

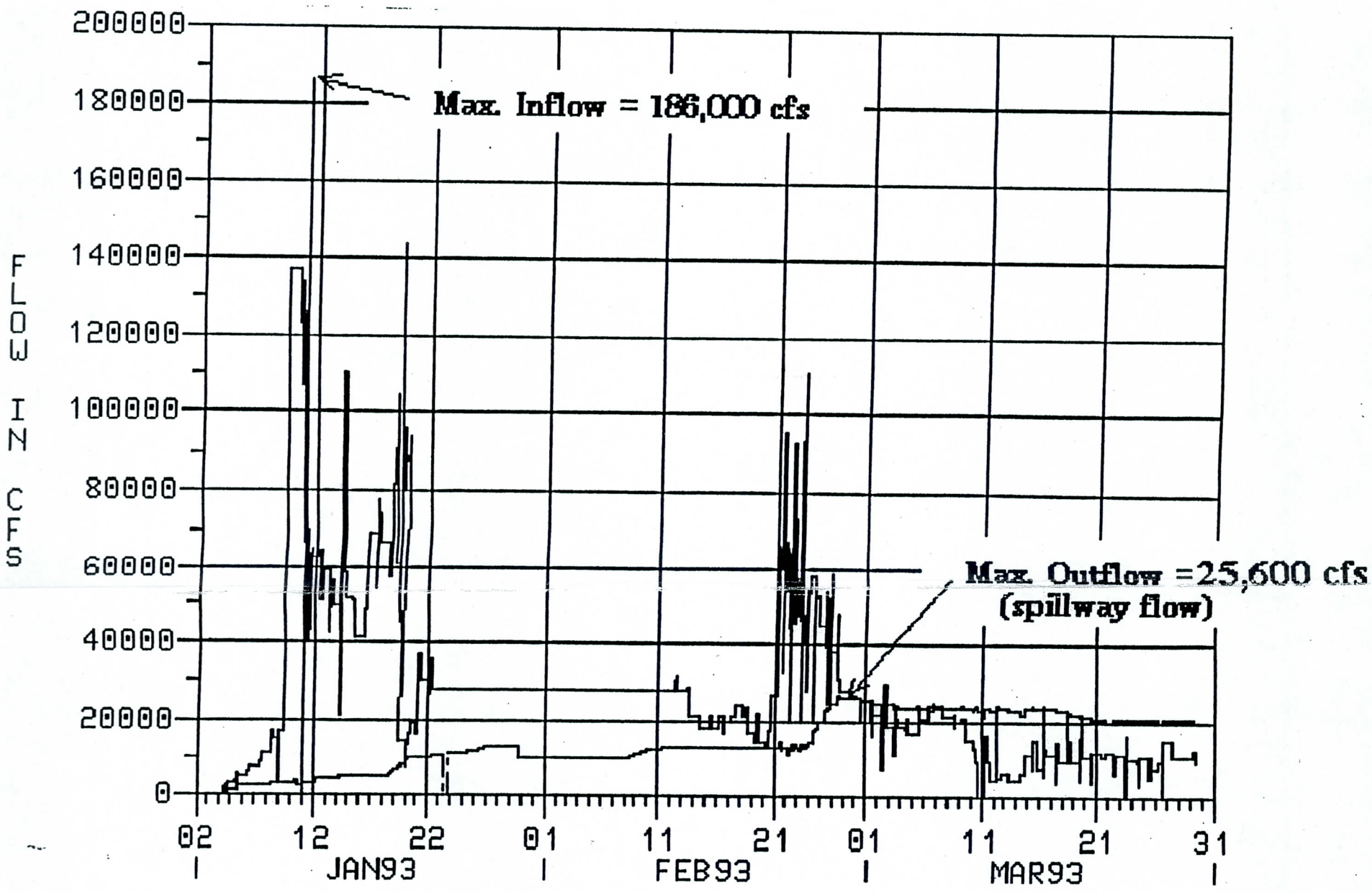
PAINTED ROCK RESERVOIR
GILA RIVER BASIN, ARIZONA
REVISED: April 1993



October 1985 Survey

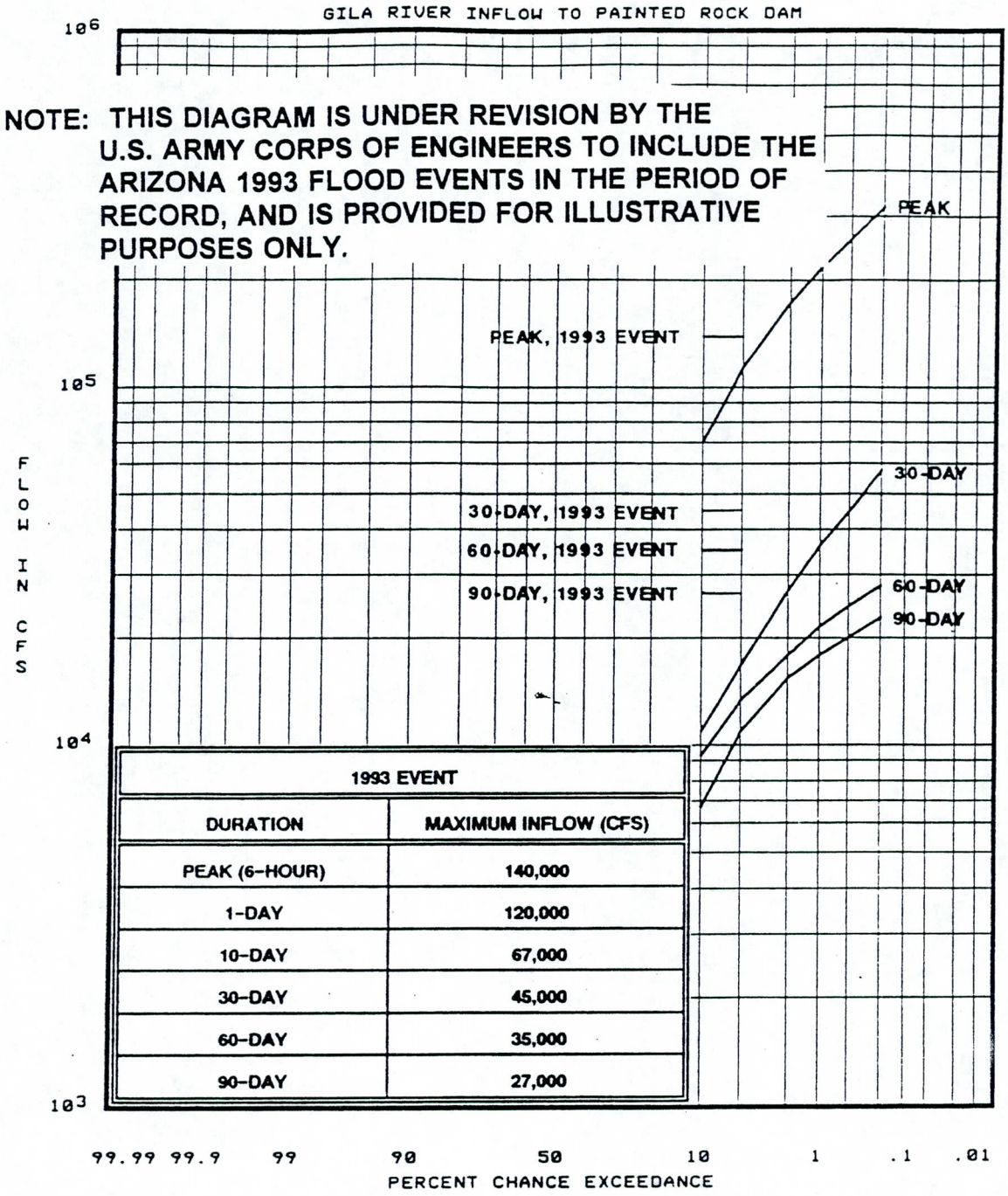
Figure 35





Flood Routing at Painted Rock Dam
01 January 1993 - 29 March 1993

Figure 36



1993 EVENT	
DURATION	MAXIMUM INFLOW (CFS)
PEAK (6-HOUR)	140,000
1-DAY	120,000
10-DAY	67,000
30-DAY	45,000
60-DAY	35,000
90-DAY	27,000

NOTE: CURVES DEVELOPED FROM AUG 1888 - FEB 1980 STREAMFLOW RECORDS, SEE CAWCS HYDROLOGY REPORT, MAY 1982.
FROM REPORT:
PEAK CURVE: PLATE 15
30-DAY CURVE: TABLES 4, & 3-4; PLATE 3-6
60-, AND 90-DAY CURVES: TABLES 4, 3-1, 3-2, 3-3, & 3-6; PLATE 3-6.

GILA RIVER AT PAINTED ROCK DAM
MARICOPA COUNTY, AZ

INFLOW-DURATION-FREQUENCY
(PRE-1993) CURVES

GILA RIVER INFLOW TO
PAINTED ROCK DAM, AZ

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Figure 37

5.02 ALAMO DAM.

5.02.1 Project Background.

Alamo Dam was built by the Corps of Engineers to provide flood protection for the valley of the lower Colorado River. Completed in June of 1968, Alamo Dam is located on the Bill Williams River, approximately 39 miles from its confluence with the Colorado River in Lake Havasu. The generally mountainous drainage area above Alamo Dam is approximately 4,770 sq. mi. and is shown on Figure 1. The reservoir behind the dam has a total storage of 995,300 ac-ft (1985 survey, and 1993 reservoir capacity calculation). Completed in January 1968, Alamo Dam also provides storage for water conservation and recreation. Figure 38 shows the project's pertinent data[1], and Figure 39 shows the reservoir's storage allocation diagram[2].

The maximum authorized flood control release from Alamo Dam is 7,000 ft^3/s, as specified in the Alamo Dam General Design Memorandum, dated April 1964; however, the outlet works are physically capable of a maximum release of 7,600 ft^3/s. The downstream channel is adequate to handle such flows without significant damage. There are no major structures on the Bill Williams River that have a regulatory effect on the flood flows at Alamo Dam.

Subsequent to initial authorization, Alamo Dam became subject to the stipulations of the Fish and Wildlife Coordination Act of 1958 (P.L. 85-624), Federal Water Project Recreation Act - Uniform Policies (P.L. 89-72), the National Environmental Policy Act of 1969 (P.L. 91-190), the Clean Water Act of 1977 (P.L. 95-217), and the Endangered Species Act of 1973 (P.L. 93-205). Alamo Dam is therefore operated to conform with objectives and specific provisions of the authorizing legislation, as well as in a manner consistent with these subsequent applicable Congressional acts.

5.02.2 Downstream Development.

Below Alamo Dam, the Bill Williams River flows approximately 39 miles west into the Colorado River. Developments protected by Alamo Dam are situated primarily along the lower Colorado River; little development is protected along the Bill Williams River. Properties of significant values are situated in the lowlands of the Colorado River between Parker Dam and the Mexican border, a distance of about 200 miles. Areas susceptible to damage contain residential, business, and industrial properties, and various facilities such as irrigation, and flood control works, highways and public utilities. Alamo Dam also provides flood protection to the communities and agricultural areas of Sonora and Mexicali Valleys in Mexico.

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[1]Pertinent data sheet shown on Figure 18 is from the Alamo Dam water control manual dated 1973, revised in 1983, and does not reflect the latest information about the project in all categories.

[2] Storage allocation diagram shown on Fig 19 was updated in 1993 and is based on 1985 bathymetric survey plus interpolation of historic data. Elevations shown are based on the 1993 storage-elevation information.

5.02.3 Agency Cooperation.

a. The Corps of Engineers (COE) - The COE is responsible for the operation and maintenance of Alamo Dam.

b. US Bureau of Reclamation (USBR) - The USBR operates Parker Dam and controls the elevation of Lake Havasu located at the confluence of the Bill Williams and Colorado Rivers. The USBR is also responsible for the operation of the lower Colorado River system and for flood protective works on the lower Colorado River.

c. US International Boundary and Water Commission (IBWC) - The IBWC is interested in the operation of Painted Rock Dam because of the Commission's responsibilities relating to the United States' 1944 Water Treaty with Mexico.

d. Arizona State Parks - The Arizona State Parks is recreational licensee for Alamo Reservoir.

e. Arizona Game and Fish Department -The Arizona Game and Fish Department is a licensee for all fish and wildlife areas at Alamo Dam.

5.02.4 Constraints at Alamo Dam.

a. Operational Constraints: There are 2 identical sets of gates, called the emergency gates and the service gates, placed in tandem at Alamo Dam. Each set consists of three 5.5 feet-wide by 8.5 feet-high slide gates. The service gates are used for discharge regulation. The emergency gates are open most of the time except when the service gates malfunction or require maintenance. There is also a butterfly valve for discharging low flows of 25 ft^3/s or less. Constraints associated with the operation of the gates include the following:

(1) Maximum Gate Setting. Operational constraints for the outlet gates restrict the maximum gate setting to 80 percent of the 8.5-ft vertical dimension of the gates, which is 6.8 feet. Because of this restriction, the minimum elevation within the pool at which the maximum release of 7,000 ft^3/s can be made is 1,148.4 feet.

(2) Minimum Gate Setting. Pursuant to an inspection and subsequent rehabilitation of the outlet gates in 1990, criteria have been established which prohibit the gates from being set at less than 0.5 feet of opening. The result is that with one gate open at 0.5 feet and the reservoir water surface at elevation 1070 feet (top of authorized recreation pool), the minimum service gate release is approximately 147 ft^3/s. A low flow butterfly valve is capable of making releases ranging from 75 to 95 ft^3/s between reservoir elevations of 1070 and 1125 feet. Because of these constraints, releases between 95 and 147 ft^3/s cannot be made.

b. Environmental Constraints:

(1) Bald Eagles. Pairs of Bald Eagles, an endangered species, have been observed nesting within the Alamo Lake area since the early 1980's. As a result of informal

consultation with the U.S Fish and Wildlife Service (USFWS) and AG&FD, from December to April of each year Alamo lake has to be maintained 1) at a minimum elevation of 1,100 feet in order to provide sufficient lake surface foraging area for the nesting eagles, and 2) below 1,124 feet, the approximate elevation of one of the eagle nests.

(2) Cottonwood Trees within Bill Williams River National Wildlife Refuge. Approximately 200 species of birds have been observed nesting within the stands of cottonwood trees located within the Lake Havasu National Wildlife Refuge at the mouth of the Bill Williams River. In the past, many trees have died due to high ground water inundating their root zones. To prevent this, the USFWS asked the COE to make larger releases for shorter durations, instead of lesser flows for longer durations, as a means of drawing down Alamo Reservoir. The critical period of preventing inundation is during the budding season from April through June.

(3) Bass Spawning and Growth. The Arizona Game and Fish Department maintains a bass fishery in Alamo Lake. The AG&FD criteria for sustaining the fishery are: 1) a maximum lake level fluctuations of 2 inches per day during 15 Mar - 31 May, and 2) a maximum weekly fluctuation of 9.5 inches during 16 May - 30 Sep of each year.

c. Water Supply: Water supply releases within the water conservation pool are coordinated with the operations of the USBR's Hoover, Davis, and Parker Dams on the lower Colorado River. Releases from the water conservation pool are normally limited to 2,000 ft^3/s.

5.02.5 Alamo Dam Operation During the Floods of 1993.

During the last months of 1992, the lake level at Alamo Reservoir was maintained steadily within the water conservation pool (just below WSE 1,100 feet) with releases limited to about 10 ft^3/s. The dam was being operated in this manner to be in compliance with Section 7 of the Endangered Species Act, and to satisfy downstream water rights. During the 2nd week of January 1993, a series of storm events caused high inflows that raised the reservoir water level significantly, up to elevations above 1,143 feet beginning on 12 January. On the same day, high water conservation discharges were initiated by gradually increasing the releases to 1,500 ft^3/s, and then to 2,000 ft^3/s on the following day. These release rates were maintained for about a month. In the second week of February, another storm event in the basin brought more inflows into the reservoir causing the water surface elevation to go even higher. On 12 February, with the water surface elevation at approximately 1,175 feet, discharges were increased up to 5,000 ft^3/s.

During the last week of February, Painted Rock Dam, another COE dam located on the Gila River Basin, started spilling with flows in excess of 20,000 ft^3/s. Painted Rock Dam discharges into the Gila River approximately 126 miles upstream of its confluence with the Colorado River. A flow in the magnitude of about 23,000 ft^3/s at the Southerly International Boundary of the Colorado River (SIB) causes serious flooding in Mexico. The Mexican officials understood that high flows would be reaching Mexico as a result of uncontrolled discharges from Painted Rock Dam; however, they were not willing to accept additional flows resulting from releases at other Colorado River dams. In order to prevent further damages, the Mexican Government, through the International Boundary and Water Commission (IBWC), requested a reduction of flows from

Alamo Dam. The COE concurred with the request and lower releases from Alamo Dam (ranging from 1,200 to 1,500 ft^3/s) were started on 26 February.

As Painted Rock spill reached its peak and began to recede, higher Alamo releases were possible without causing additional flooding in Mexico. Higher releases were initiated from Alamo Dam starting on 9 March , reaching 5,000 ft^3/s by 11 March. During this time period, Parker Dam, located downstream of Alamo Dam was releasing at a rate equal to the consumptive use rate downstream from Parker Dam; therefore, Alamo releases did not cause an increase in the deliveries of water to Mexico. On 11 March, the USBR informed the COE that with warmer weather, consumptive use was high enough to allow the COE to go as high as the maximum scheduled release of 7,000 ft^3/s from Alamo Dam. On 15 March, with a water surface elevation of 1,173.22, releases from Alamo Dam were increased to 7,000 ft^3/s.

The Alamo gate regulation schedule calls for a reduction in releases once water surface elevation reaches 1,160 feet, which occurred on 21 March. However, the COE kept releasing 7,000 ft^3/s in order to better meet the project purposes of the dam, namely flood control, recreation and water supply. In addition, such an increase in releases minimized the duration of inundation of riparian habitation (Cottonwood stands) in the Havasu Wildlife Refuge located downstream of the dam (see Section 1-4.b.3).

On 29 March, the water surface elevation dropped below 1,140 feet, and discharges were gradually reduced. April through July water conservation releases of 200 to 300 ft^3/s permitted the recovery of inundated cottonwood trees located in the Lake Havasu Refuge area; at the same time, during the middle of March to the end of May, the dam was also operated to insure that the water level behind Alamo Dam would not change by more than 2 inches per day in order to enhance bass spawning in the lake area (Section 1-4.b.4).

The 1993 flood season resulted in a record historic maximum release of 7,000 ft^3/s. The previous maximum release was 4,730 ft^3/s in February 1969. A peak water surface elevation of 1,182.40 feet and peak storage of approximately 499,500 ac-ft (a little less than 50 percent of capacity) were recorded on 21 February. The peak inflow of 122,800 ft^3/s occurred on 8 January (see Table 7). Figure 40 shows inflow and outflow hydrographs from 1 January to 15 April, as well as the water surface elevation and the corresponding storage for the same time period. Table 8 summarizes the COE's operation of Alamo Dam.

Table 7.

Maximum Inflow, Outflow,

WSE and Storage

at Alamo Dam

During Jan - Feb 1993 Floods

	Maximum Value	Date
Inflow (ft^3/s)	122,800	8 January
Outflow (ft^3/s)	7,000	17 - 29 March
WSE (ft)	1182.40	21 February
Storage (ac-ft)	499,500	21 February

Table 8. Summary of COE's

Alamo Dam Operation

During Jan - Mar 1993 Floods

Date	Discharge (ft^3/s)	Remarks
12 Jan - 11 Feb	1,500 - 2,000	High water conservation releases.
12 Feb - 25 Feb	5,000	Flood control releases.
26 Feb - 10 Mar	1,200 - 1,500	Releases coordinated with Colorado River system in order to prevent additional flow to Mexico.
11 Mar - 14 Mar	5,000	Flood control releases.
15 Mar - 28 Mar	7,000	Higher flood control releases. Lasted until 29 March.
29 March	200 - 300	To enhance cottonwood trees downstream. Drop in lake level was limited to 2 in. per day during the middle of March through May to enhance bass spawning in the reservoir.

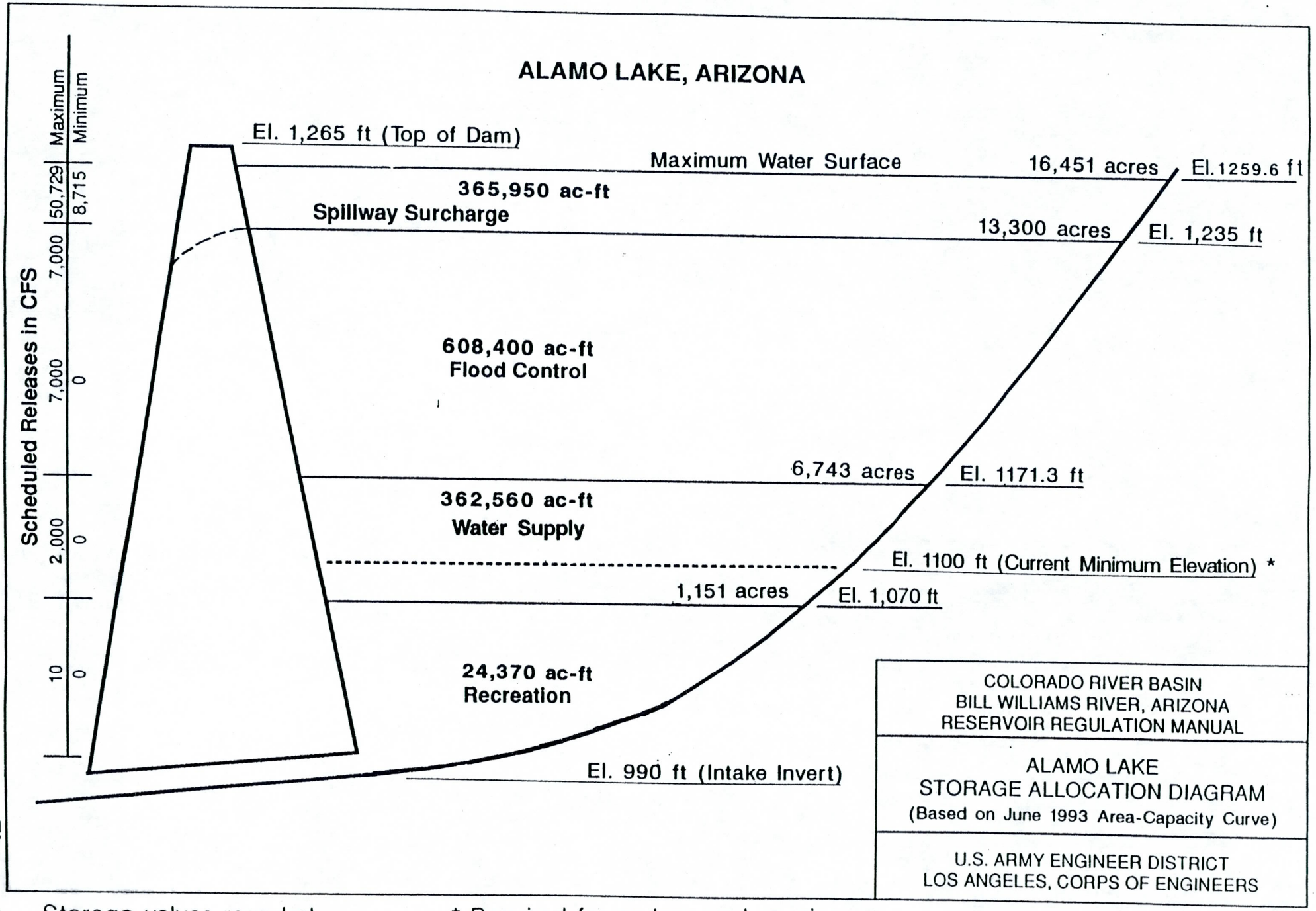
ALAMO DAM AND RESERVOIR
MOHAVE COUNTY AND LA PAZ COUNTY, ARIZONA

PERTINENT DATA
MAY 1983

Stream System	Bill Williams River
Drainage area, sq. miles	4,770
Reservoir:	
Elevation	
Recreation water supply pool, ft., m.s.l.	1,046
Water supply pool, ft., m.s.l.	1,174
Flood control pool (spillway crest), ft., m.s.l.	1,235
Spillway design surcharge level, ft., m.s.l.	1,259.6
Top of dam, ft., m.s.l.	1,265
Area	
Recreation water supply pool, acres	547.8
Water supply pool, acres	7,044.5
Spillway crest, acres	13,307
Spillway design surcharge level, acres	16,452
Top of dam, acres	17,040
Capacity, gross	
Recreation water supply pool, acre-feet	9,762.4 (0.04*)
Water supply pool, acre-feet	437,303 (1.72*)
Spillway crest, acre-feet	1,046,314 (4.11*)
Spillway design surcharge level, acre-feet	1,412,474 (5.55*)
Top of dam, acre-feet	1,503,064 (5.91*)
Allowance for sediment (100-year), acre-feet	200,000 (0.79*)
Dam: - Type	Rolled Earth
Height above original streambed, ft.	283
Top length, ft.	975
Top width, ft.	30
Freeboard, ft.	5.4
Spillway: - type	Ungated, broad-crested
Crest length, ft.	110
Design surcharge, ft.	1,259.6
Design Discharge, c.f.s.	41,500
Outlets:	
Tunnel -	
Length (including gate chamber and transition sections), ft.	1,290
Intake invert elevation, ft., m.s.l.	990
Outlet invert elevation, ft., m.s.l.	980
Discharge at spillway crest, c.f.s.	8,700
Gates - type	Slide, tandem
Number and size -	
Service (downstream)	3 - 5.5'W x 8.5'H
Emergency (upstream)	3 - 5.5'W x 8.5'H
Low-flow bypass around gate No. 3 -	
Pipe size, I.D., in.	18
Control valve - type	Butterfly
Maximum discharge capacity, c.f.s.	25
Water-surface elevation to initiate operation, ft., m.s.l.	1,002.3
Standard project flood:	
Duration (inflow), days	7
Total volume, acre-feet	613,000 (2.41*)
Inflow peak, c.f.s.	389,000
Probable maximum flood:	
Duration (inflow), days	3
Total volume, acre-feet	1,390,000 (5.46*)
inflow peak, c.f.s.	859,000
Historic Maximums:	
Maximum release on record, c.f.s.	4,730
Date	2-27-69
Maximum water surface elevation, ft., m.s.l.	1207.4
Date	2-23-80

*inches of runoff

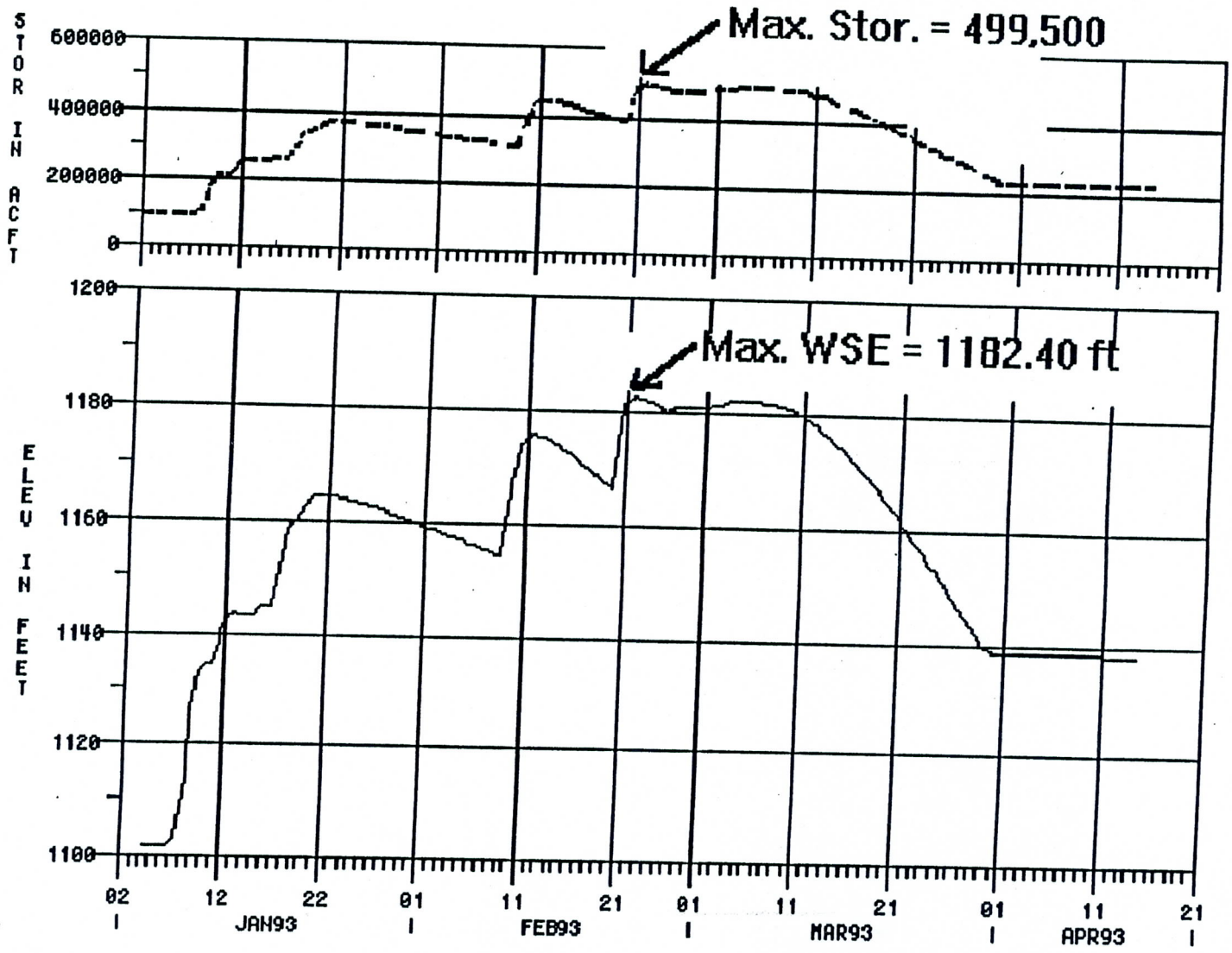
Figure 38

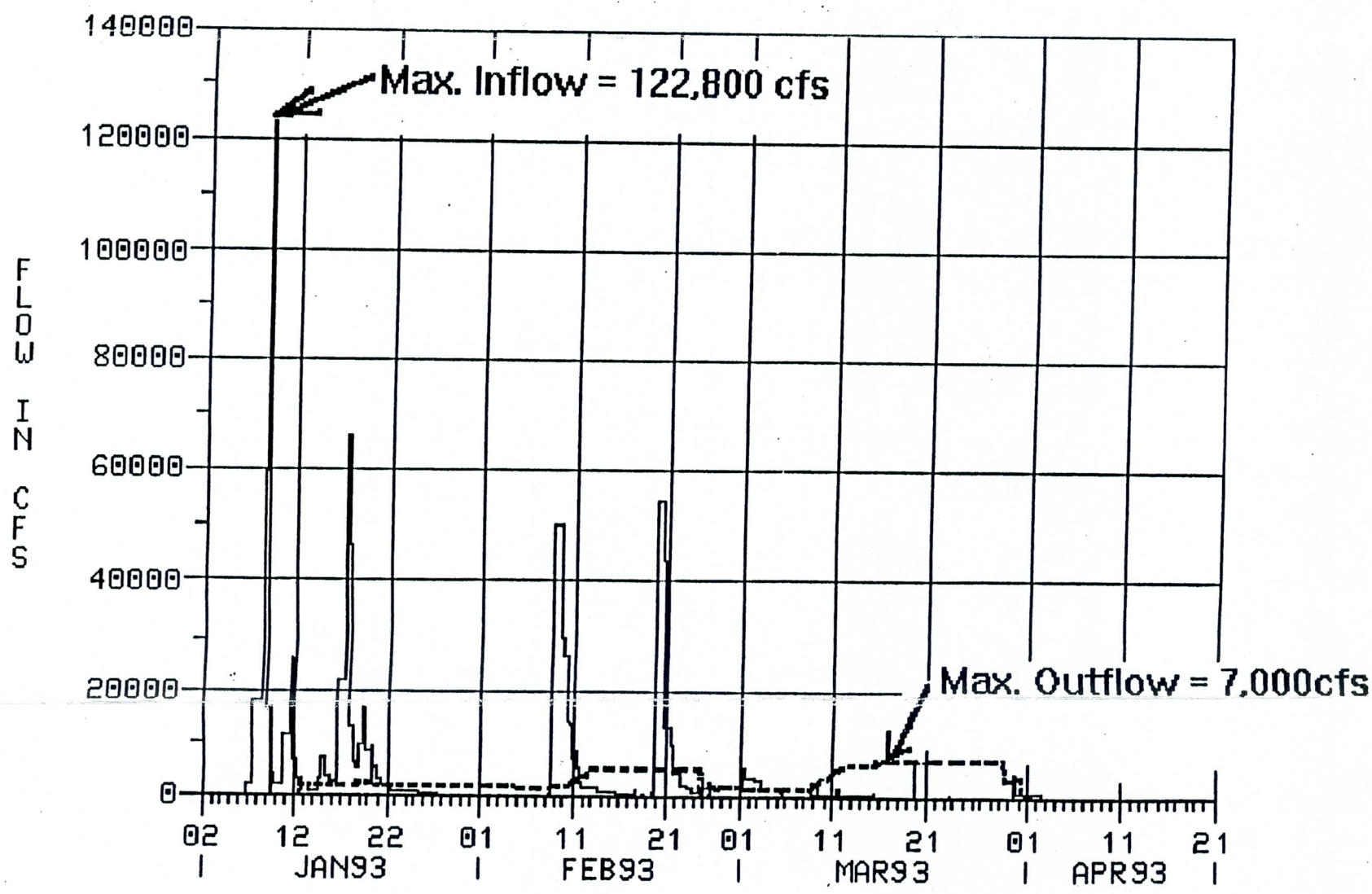


Storage values rounded.

* Required for endangered species.

Figure 39





Flood Routing at Alamo Dam
01 January 1993 - 15 April 1993

Figure 40

6. FLOOD DAMAGE

6.01 DATA SOURCES

Sources of data for damage estimates includes information from Federal and State agencies, information supplied by County officials, interviews with personnel involved with the Floods of 1993, site visits to affected areas, and 1993 flood damage reports published by a variety of sources. A listing of participating agencies is provide in Chapter 1.03, Acknowledgements. Damage estimates and impacted areas do not represent a complete tabulation, but only available information. Actual damages in Arizona are likely higher than the data indicates. The data is intended to show the relative magnitude of economic flood impacts. A qualification statement is provided in Chapter 1.02.2.

6.02 DAMAGE ESTIMATES

6.02.1 Federal, State and Local Assistance

The Federal Emergency Management Agency (FEMA) provides assistance and reimbursement for public and private damages. Reimbursement is provided for the following categories:

PUBLIC ASSISTANCE:
Debris Removal
Emergency Protection
Road Damages
Water System Facilities
Public Buildings and Equipment
Other

PRIVATE ASSISTANCE:
Housing Assistance
Individual & Family Grant Program
Disaster Unemployment Assistance
Crisis Counseling

FEMA provides 75% of the funding granted for eligible costs of political subdivisions and qualifying private nonprofit applicants. The Arizona Division of Emergency Management is responsible for overall administration of the disaster assistance including the 15% state share of grants to political subdivisions. Political subdivisions provide 10% of the eligible costs for repairing damages, and bear the full cost of repairs not eligible.

The U.S. Small Business Administration (SBA) provides loan assistance for individuals and businesses.

The Federal Highway Administration (FHWA) provides funds for repair of roads and bridges which are part of the Federal Aid System.

Table 9 was prepared using data from FEMA, FHWA, SBA, and Arizona Division of Emergency Management. Other Federal emergency response assistance and costs are shown in Table 11.

TABLE 9

FEDERAL DAMAGE ASSISTANCE FOR THE JANUARY - FEBRUARY 1993 ARIZONA FLOODS

JURISDICTION	SHARE	U.S. SMALL BUSINESS ADMINIST. LOANS APPROVED				FEDERAL HIGHWAY ADMIN. ASST.	FEMA ARIZONA MANAGED ASSIST.	FEDERAL EMERGENCY MANAGEMENT AGENCY			ESTIMATED DAMAGES $ TOTAL
		# OF HOMES	$ OF HOMES	# OF BUSINESS	$ OF BUSINESS			HAZARD MITIG.	HOUSING ASSISTANCE	PUBLIC DAMAGES	
ARIZONA STATE AGENCIES	Federal State					$75,000				$4,652,394 $1,512,490	$6,239,884
APACHE	Federal State/Local					$94,300 $5,700				$54,849 $9,232	$158,381
COCHISE	Federal State/Local	4	$44,600	2	$43,500	$15,000 $0	$18,192	$181,895	$40,083	$139,094 $43,904	$344,373
COCONINO	Federal State/Local	26	$514,200	5	$89,400	$2,224,260 $29,046	$136,406	$99,152	$137,895	$631,642 $202,936	$3,936,739
GILA	Federal State/Local	64	$3,350,600	10	$993,200	$7,777,610 $351,890	$297,688	$2,179,998	$203,712	$1,305,082 $420,808	$14,348,700
GRAHAM	Federal State/Local	1	$17,600	0	$0	$951,653 $47,791	$4,480		$8,856	$3,768,551 $1,223,754	$5,974,894
GREENLEE	Federal State/Local	0	$0	2	$15,900	$289,000 $0	$13,177		$5,536	$569,636 $182,887	$1,076,136
MARICOPA	Federal State/Local	21	$166,500	6	$1,301,200	$9,012,783 $416,437	$86,547	$34,892,200	$55,871	$13,881,104 $4,553,021	$29,057,026
NAVAJO	Federal State/Local	23	$465,800	5	$377,500	$739,822 $14,478	$52,972		$187,653	$1,650,617 $531,384	$4,005,748
PIMA	Federal State/Local	21	$324,200	8	$418,600	$5,947,896 $249,187	$33,243		$66,319	$2,477,747 $802,433	$10,070,438
PINAL	Federal State/Local	1	$3,200	2	$35,700	$11,501,676 $418,836	$54,593	$910,000	$61,156	$4,890,891 $1,584,990	$18,132,206
SANTA CRUZ	Federal State/Local					$611,956 $31,415	$11,734		$12,796	$577,022 $183,588	$1,397,096
YAVAPAI	Federal State/Local	45	$1,047,500	12	$1,259,100	$1,866,825 $0	$462,982	$283,600	$322,346	$2,500,111 $810,859	$8,269,723
YUMA	Federal State/Local	8	$24,300	1	$33,000	$21,593,616 $948,143	$27,478	$549,200	$70,078	$44,477,005 $14,690,711	$80,916,188
ARIZONA INDIAN TRIBES	Federal Local									$3,707,250 $1,235,750	$4,943,000
TOTAL		214	$5,958,500	53	$4,567,100	$65,214,320	$1,199,492	$39,096,045	$1,172,301	$113,271,742	$195,364,955

NOTES:

1. OF THE $39,096,045 HAZARD MITIGATION NEEDS IDENTIFIED, FEMA HAS DISBURSED $3,981,500. THIS AMOUNT IS INCLUDED IN THE TOTAL OF $130,150,635 ABOVE.
2. PUBLIC DAMAGES SHOWN DO NOT REFLECT DAMAGES INELIGIBLE FOR FEMA ASSISTANCE OR DAMAGES NOT REPORTED.
3. PUBLIC DAMAGES INCLUDE ESTIMATES OF CLAIMS IN PROGRESS AND EXPECTED FOR FEMA APPROVAL IN MARICOPA, PINAL, AND YUMA COUNTIES.

6.02.2 Private Damage Categories

Categories of private damages estimated are as follows:

Agricultural Damage includes direct crop losses, values of land eroded away, costs of restoration of land back to productive use, and loss of income for a period of one year from lands in process of restoration.

Residential Damage reflects direct structural and content damage or loss, including public assistance provided.

Commercial Damage reflects structure and content (inventory) damage, and lost income due to business closure for flood repairs.

Industrial Damage estimates are for repair of flood damages to industrial facilities such as mining operations, railroads, utilities companies (electric, water, sewer, natural gas), emergency response costs, and lost income and service during repairs. Irrigation Districts are not included.

Private damages in Table 10 include SBA loans and FEMA private assistance shown in Table 9, and estimates by local officials integrally involved with the floods of 1993.

TABLE 10
ESTIMATED PRIVATE DAMAGES
JAN - FEB 1993 FLOODS

COUNTY	AGRICULTURAL	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	EST. TOTAL
APACHE	-	$25,000	$25,000	-	$50,000
COCHISE	$200,000	$125,000	$75,000	$100,000	$500,000
COCONINO	$500,000	$900,000	$1,500,000	$100,000	$3,000,000
GILA	-	$4,000,000	$1,000,000	$24,000,000	$29,000,000
GRAHAM	$750,000	$50,000	-	$200,000	$1,000,000
GREENLEE	-	$20,000	-	$54,400,000	$54,420,000
MARICOPA	$3,500,000	$400,000	$1,800,000	$5,000,000	$10,700,000
NAVAJO	-	$780,000	$400,000	-	$1,180,000
PIMA	$400,000	$570,000	$518,000	$250,000	$1,738,000
PINAL	$500,000	-	$40,000	_	$540,000
SANTA CRUZ	-	-	$100,000	-	$100,000
YAVAPAI	$100,000	$2,230,000	$1,460,000	$500,000	$4,290,000
YUMA	$67,000,000	$125,000	$1,000,000	$1,500,000	$69,625,000
TOTAL	$72,950,000	$9,225,000	$7,918,000	$86,050,000	$176,143,000 $176,143,000

NOTE: RESIDENTIAL AND COMMERCIAL ESTIMATES INCLUDE DOLLAR AMOUNTS SHOWN IN TABLE 9. ALL FIGURES ABOVE INCLUDE ESTIMATED DAMAGES UNREPORTED OR INELIGIBLE FOR FEDERAL ASSISTANCE/REIMBURSEMENT.

AGRICULTURAL DAMAGE IN YUMA COUNTY INCLUDES AN ESTIMATED $47 MILLION FOR PROTECTIVE LEVEE RESTORATION NOT INCLUDED IN FEMA CLAIMS.

6.03 SELECTED DAMAGE DESCRIPTIONS AND FLOOD IMPACTS

6.03.1 Apache County

Flood impacts in Apache County were relatively minor compared with the damages experienced throughout Arizona. Several county roads were damaged. Damage as reported to the Federal Highway Administration and to the Federal Emergency Management Agency was $158,381, including emergency response costs and coordination with the Navajo Nation, which comprises a large portion of the county.

Public and private damages from the 1993 floods are estimated to exceed $200,000.

Flooding occurred on Vernon Creek. The Little Colorado River reservoir at Greer Dam was damaged by sedimentation, resulting in overflow of the spillway.

County officials reported that Lyman Lake had been drained completely, prior to the flood, for repair work. The repair work had just been completed shortly before the storm events occurred. As a result, flows in the Little Colorado River were captured by the empty reservoir. The lake is normally kept full for recreational and irrigation purposes. People were very concerned about the rapid, unscheduled filling of the reservoir, because of a previous dam failure in 1915 that destroyed the entire town of St. Johns. As a result of much higher than average snowpack in November and December 1992, water flowed over the spillway at Lyman Dam until the end of May 1993. The incidental flood control provided at Lyman Lake reduced the total volume of downstream flow during the floods. The lake is a major recreational area in the county, and tourism to the lake accounts for a large part of the economy of the county.

6.03.2 Cochise County

Flood impacts in Cochise County were relatively minor compared with the damages experienced throughout Arizona. Several county roads were damaged. Damage reported to the Federal Highway Administration, the Federal Emergency Management Agency, and other Federal assistance, was $344,373.

Agricultural damages are estimated to be approximately $200,000 throughout the County, and other private damages are estimated to exceed $150,000. The County applied for approximately $182,000 for flood hazard mitigation needs.

Total public and private damages from the 1993 floods are estimated to exceed $700,000.

6.03.2.1 Affected Communities

Rucker Creek, near the town of Elfrida, caused flooding of several homes, closure of State Route 191, and affected businesses in the town. Inundation of agricultural lands east of Elfrida resulted in crop damages and isolation of several people.

The City of Willcox, Arizona, reported damages totalling approximately $21,000 to FEMA. North of Willcox, agricultural lands were inundated by Ash Creek. No crops were in season at the time of the flood events. Previous Soil Conservation Service estimates indicate that if the same event occurred before harvest, agricultural damages would amount to about $1,000,000.

Other FEMA reported damages are as follows: City of Benson - $35,287, City of Bisbee - $17,891, City of Tombstone -$13,265, Cochise County - $95,300.

6.03.3 Coconino County

Coconino County experienced considerable damages in a few problem areas. Damage to residences was limited to structures built prior to the County's enactment of floodplain ordinances. Damage reported to the Federal Highway Administration, the Federal Emergency Management Agency, and other Federal assistance, was $4,120,000.

Federal and State private assistance was in excess of $875,000. The County applied for about $100,000 for flood hazard mitigation needs. Private damages are estimated to exceed $1,500,000.

Public and private damages from the 1993 floods are estimated to exceed $5,500,000.

6.03.3.1 City of Sedona

The City of Sedona reported FEMA damages of $32,433. Damages occurred along Oak Creek which runs through the city. At least 75 structures were damaged in the Oak Creek area, and 170 people were evacuated. The peak flow was approximately 30,000 ft^3/s in Oak Creek.

Sycamore Cove area experienced damage of approximately $1,500,000 to a mobile home park and facilities. Approximately 3 feet of water damaged or destroyed 25 mobile homes. Debris removal and security was estimated to cost an additional $50,000.

The Trails End area experienced damage to 12 homes valued at an average of $275,000. Residential damages were estimated at approximately $200,000 total for the area. Outside facilities and the neighborhood access road were also damaged.

In the Newcastle Island area, an apartment building suffered minor damage to 4 units, and eight homes had between 1-1/2 and 4-1/2 feet of water in them. A retaining wall was overtopped and broke in two locations, requiring repairs 20 feet and 40 feet long.

At Tlaquepaque, where an upscale resort and over 50 retail stores are located, water was within one foot of the Highway 179 bridge, which was closed for about an hour while an inspection for structural integrity was made. Approximately 1-1/2 feet of water damaged outdoor facilities at the Los Abrigados Resort. Apartments 100 feet upstream of the bridge were flooded by about 2 feet of water.

At Copper Cliffs, 3 homes were severely damaged by about three feet of water, and 5 homes sustained minor interior and exterior damage. Outside facilities were also damaged, and some residents could not occupy their homes for about 6 weeks.

The Oak Creek mobile home park had water flowing through, but only minor damages to the mobile homes.

Three homes were damaged in the Doodlebug Island area from one to two feet of water. Bridge abutments were exposed by erosion.

6.03.3.2 Oak Creek Canyon

Rainbow Trailer Park, north of Sedona, had damage to 14 mobile homes. Low water dip crossings were damaged, some damage occurred at Rancho Shangri La, Indian Gardens, Junipine, Forest Houses, and Garlands. People were stranded east of Oak Creek in some areas.

Damages to Highway 89A was most severe between mileposts 383 and 388. Damage at Slide Rock State Park was estimated at $260,000. Water lines were also out.

The Sterling Springs Fish Hatchery lost an access road , and feeder lines into the hatchery were damaged. One-third of the trout crop was lost. The hatchery manager anticipated that river conditions would be unsuitable for release of fingerlings, which would impact tourist revenue in the area due to reduction of fishing.

6.03.3.3 Flagstaff and Vicinity

The City of Flagstaff reported FEMA damages of $201,421. Most of the damage was due to February flood events. Numerous road repairs were made after the January floods and then damaged again during February.

At Lake Continental, in the Fairview area, townhomes were inundated by up to four feet, people were cut off from State Route 66, fire hydrants were out of service, and power outages were widespread. City officials said that constructed levees could have prevented the flooding. Access at the Continental Country Club was cut off for several days, and there was a sewage spill at the Fairfield Country Club.

In south Flagstaff, homes were flooded with three to four feet of water. Flooding occurred from the Rio de Flag river, which has an estimated capacity for a 10 year event.

Switzer Canyon Road was covered with water. Other affected areas include Clay Avenue Wash and Enterprise Road.

6.03.3.4 Countywide and other Communities

At the wastewater treatment plant in Kachina Village, 19,500,000 gallons of water per day was contaminated when it flowed through the plant which only has capacity for 6,000,000

gallons per day. Floodwaters slightly exceeded the 100 year level, washing out a road and flooding three homes with 2 feet of water.

The City of Williams had FEMA damages of $103,238. The floods also impacted families in Pinedale, the Bird Springs area, Mormon Lake, and Fort Valley. The Redlands dam breached and residents and tourists were evacuated from Havasupai Canyon.

Severe road damages occurred in the Lake Mary area, resulting in 200 mile detours for residents and isolation for up to two days. Lake Mary Road was inundated until after March 10, 1993.

6.03.4 Gila County

Gila County experienced numerous damages from the floods of 1993. Damages reported to FEMA, FHWA, and other Federal assistance, was $14,348,700.

Private damages are estimated to exceed $29,000,000. No agricultural or industrial damages were reported within Gila County. The County identified $2,179,998 in flood hazard mitigation needs.

Public and private damages from the 1993 floods are estimated to exceed $38,500,000.

6.03.4.1 Affected areas

Pinal Creek through the City of Globe experienced high flows and overbank flooding in low lying areas. Several residences were flooded by water approximately 1 foot deep. Numerous dip crossings were flooded, resulting in access problems. At the Globe sewer plant, erosion along the bank threatened to cut into the sewer plant, but only a portion of the adjacent road was washed away. Further downstream, near the Wilbanks bridge, bank erosion resulted in roadway repairs of $40,000.

Campaign Creek upstream of Pinto Creek flows through a residential subdivision. 42 homes within the floodplain were affected during the 1993 floods when sand levees could not withstand the floodwaters.

Tonto Creek experienced approximately a 40 year flood event. At Gisela, 95 residences and mobile homes were threatened. No estimate is available as to the number of people affected. Further downstream, several residences experienced flooding, erosion, and access problems in the area of Roosevelt Gardens East, and at Punkin Center where a Corps floodfight cost $59,065.

Coolidge dam on the Gila River filled to capacity, and spillway flow was estimated at a record 32,800 ft^3/s. The previous high flow downstream of Coolidge dam had been 5,000 ft^3/s. A section of the Town of Winkleman known as the "Flats" was inundated with water at depths of up to 8 feet. All of the families were evacuated safely, but over ninety dwellings were totalled. A FEMA reimbursed buy-out/relocation plan in the area is estimated to cost $852,000.

Winkleman water treatment facilities downstream were threatened, but reinforcements to an existing dike prevented damage during the 1993 floods.

Downstream of Winkleman, the ASARCO mine tailings dump was eroded by high floodflows in four separate locations. The mine was closed for approximately one week. Total flood damages reported by ASARCO were $24 million. This area is just downstream of the confluence of the Gila and San Pedro rivers. The confluence area was widened by the floods, going from an approximately 300 foot wide low flow channel to a 2300 foot wide floodplain, and the confluence itself moved nearly 2000 feet downstream of its previous location.

In the Town of Hayden, further downstream on the Gila River, FEMA damages were $14,605.

In the town of Pine, flooding from Pine Creek affected several homes.

Flooding in Christopher Creek threatened approximately 55 structures located near the banks.

In Star Valley, Houston Creek flooded. Although 50 residences are within the 100 year floodplain, no estimate was available for the number of people affected by the 1993 floods.

In Whispering Pines Subdivision, located approximately eight miles north of Payson along the East Verde River, there are approximately 70 homes within the floodplain. During the 1993 floods this area experienced minor flooding, erosion, and access problems. No estimate was made of the number of affected people.

In the community of Young, reconstruction of a crossing across Mexican Wash cost $40,000.

6.03.5 Graham County

Graham County damages consisted primarily of public damages. FEMA, FHWA, and other Federal assistance, was $5,974,894.

Private damages are estimated to exceed $1,000,000, primarily agricultural damages. Residential and industrial losses were not as severe.

Public and private damages from the 1993 floods are estimated to exceed $6,950,000.

6.03.5.1 Affected areas

Klondike - Aravaipa Canyon: Approximately 7 or 8 ranches were isolated for up to one week due to flows estimated at 10,000 ft^3/s. Power was out for 1 week.

Bonita - N. Sulphur Springs Valley: The Bonita School was closed for several days. Road erosion was the main problem in the area.

Ash Creek: Primarily road and utilities damages. Power outages of up to 1 week.

Oak Creek: No flow data was available.

Solomon School: Access to the school was interrupted resulting in an extra 30 mile round trip through May 1993.

Gila River: The County reported 3 separate flood peaks of up to 90,000 ft^3/s. Six bridge crossings were affected. Damage to Solomon bridge resulted in round trip detours of 100 miles.

Graham County Rural Electric reported that they had a large number of repairs due the floods. No dollar amounts were available.

The Gila County Irrigation District reported that canals and irrigation systems were damaged, at an estimated total of $3,445,573.

The City of Safford experienced FEMA damages of $461,387, primarily due to damage to the water supply system.

6.03.6 Greenlee County

Greenlee County is a mining oriented area, and private industrial damages were significant. Public damage assistance in Greenlee County by FEMA, FHWA, and SBA, totalled $1,076,136.

Industrial flood damages at the Phelps Dodge mine were estimated at $50 million, due to the excessive amount of water entrapped behind a containment dam. Overall private damages are estimated to exceed $54,400,000.

Public and private damages from the 1993 floods are estimated to exceed $55,500,000.

Town of Duncan: A protective dike was breached by flows in the Gila River of 14,000 ft^3/s. The breach was approximately 400' long and cost to repair was $70,000. Minor inundation occurred due to this breach. Five businesses and six residences experienced inundation up to 2 feet deep.

Due to flow in the Gila River, the groundwater table in Duncan rose, causing sewer system failures and backup. The sewer lift station was damaged due to high flows. Some areas of town had standing water due to the rise. Vehicles parked on road shoulders/dirt areas sunk in the mud. Some structural distress due to settlement resulted in warped and damaged flooring in some homes.

Franklin Irrigation District: Two irrigation diversion structures were destroyed, and the cost to repair estimated at $175,000. As of May 20, 1993, repairs were not complete. Impacts to farmers resulted from extended reduced water supplies. Some farms incurred additional costs for emergency pumping of needed water.

South Pacific Eastern Arizona Railroad: Experienced damages totalling $3 million. Tracks and roadbed were washed out in five locations. The railroad is obligated by contract to move

copper concentrate from the Morenci mine, and in order to fulfill this obligation, a fleet of trucks was hired and operated 24 hours a day for 4 weeks.

Phelps Dodge Mining, Morenci AZ.: A diversion structure on Eagle Creek was destroyed by flows of 30,000 ft^3/s (est). Cost to repair $ 1.2 million. Down time at the mine occurred (i.e. lost salaries, decrease in production). Additional costs incurred include extra de-watering of the mine over normal levels. Mine tailings in Chase Creek cause contamination of water by leaching copper sulfate. Water is prevented from flowing downstream by a special dam which contains the contaminated water, which must be removed, treated, transported, and disposed of properly. Estimated cost of de-watering was $90 million. The estimated portion of this cost attributed to the storm events is $50 million due to the existing average annual cost of dewatering.

El Paso Gas Company: Experienced failure of two 8" high pressure gas mains, resulting in loss of service to 300 customers from Sheldon south to the Gila River.

Upper Eagle Creek: Approximately 25 families were isolated for up to two weeks. Road repairs were not completed as of July 1993.

Blue River: Approximately 25 families were isolated for up to two weeks. The road servicing this area was the most severely damaged of all County facilities. Repairs were not complete as of July 1993.

Clifton: Four peak flows on Chase Creek caused damage to a sewage outfall resulting in raw sewage from approximately 35 homes discharged into the creek. ADEQ assessed a $ 5000 fine.

Approximately 12 ranches in other areas were isolated for up to two weeks.

County Maintenance reported that roads were damaged from increased truck traffic hauling materials and supplies during the flood emergency, and afterward. The cost of the increased maintenance and repair was not estimated.

The County Tax Assessor conducted aerial surveys to determine the amount of agricultural land lost during the floods. Additionally, the tax rate basis has been lowered from $ 400 to $150 per acre.

6.03.7 Maricopa County

Maricopa County is the most heavily populated county in Arizona, with the Greater Phoenix Metropolitan area comprising about 2.3 million people. Agriculture is a significant part of the economy throughout the county, and Phoenix is a major center of tourism in the State.

Public damages reported through FEMA, FHWA, and SBA amounted to $29 million. The Flood Control District of Maricopa County identified nearly $34 million in flood hazard mitigation needs.

Private damages are estimated to exceed $10 million, of which agricultural damage comprises $3,500,000 and industrial damage is about $5,000,000.

Public and private damages from the 1993 floods are estimated to exceed $38,000,000.

6.03.8.1 Affected Areas

At Granite Reef Dam on the Salt River, outflow began on December 28, 1992 at 4000 ft^3/s. Flow continued at this rate until January 7, 1993, when it rapidly rose to an estimated 124,000 ft^3/s on January 8. High flows of over 100,000 ft^3/s in the Salt river continued for almost three days. From January 10 to January 18, flows subsided to around 50,000 ft^3/s, then on January 18 rose rapidly to about 80,000 ft^3/s. By January 31 Salt River flows had subsided to 15,000 ft^3/s. On February 8, 1993, Salt River flows again rose rapidly to 25,000 ft^3/s, subsided, and then rapidly rose to almost 69,000 ft^3/s on February 21, 1993.

As a result of these pulsed flows, severe effects were experienced downstream through Phoenix, and, combined with record Gila River flows, extended through Painted Rock Dam and the City of Yuma on the Arizona border 240 river miles downstream.

Downstream of Granite Reef dam, floodwaters from the Salt River eroded a section of the Tri-City landfill. An estimated 90,000 cubic yards of municipal solid waste, weighing around 800 tons, sloughed into the Salt River and carried downstream. On January 18, 1993, the Governor of Arizona requested a Presidential Declaration of Emergency. The Salt River Pima-Maricopa Indian Community constructed a temporary containment dike at a cost of over $2.4 million. River cleanup efforts in downstream communities after floodwaters subsided were estimated at approximately $4 million. The "Great Salt River Cleanup", a cooperative effort facilitated by the Governor's office among a number of groups, including the Indian Community, State of Arizona, City of Tempe, City of Phoenix, Maricopa County Flood Control, and local citizen's groups, was conducted on May 22, 1993. 21,000 volunteers, 100 convicts, 550 Forest Service personnel, and 760 City of Tempe workers cleaned up 990 tons of debris, which included additional debris from other areas. Additional river cleanup efforts continued throughout 1993.

Of greatest concern was the Holly Acres community located at the confluence of the Salt and Gila Rivers. Holly Acres is protected by a Flood Control District levee rated at 115,000 ft^3/s. On January 8, water rose within 18 inches of the top of the levee. Local authorities reinforced the levee with 96,000 cubic yards of material and 15,000 sandbags. Over 200 families were evacuated on January 8, but allowed to return on January 9 with appropriate precautions.

An area west of Holly Acres received flood damage between 105th Avenue and the Agua Fria River.

High Salt River flows forced the evacuation of six families in the Hawaiian Mobile Home Park, west of Country Club Road in Mesa.

As a result of roads and bridges washing out, several families in the New River area were stranded. Some families stayed at the New River Community Center until they could return home. All 16 families received support from the Arizona Search and Rescue organization.

The rising Hassayampa River forced 15 families five miles south of Wickenburg to relocate. Several trailers were washed away, and the trailer park suffered damages. Additionally, a Nature Conservancy property was impacted upstream.

Arlington School and six farm houses located in the Arlington area received flood damage from water up to two feet deep. Damage was not extensive, but considerable cleanup effort was needed to reopen the school. Four homes, two mobile homes, and three farms were damaged in the area of 227th Avenue by water two feet deep.
Rainbow Rd.

Several farms, feedlots, and dairies in western Maricopa County were damaged by high water, including reported loss and drowning of livestock.

The El Paso Natural Gas Company pipeline failed at the Gila River Crossing. Two separate explosions were reported. No injuries were reported.

The 91st Avenue wastewater treatment plant was endangered by high water levels, which caused backwater in the outflow from the plant. The plant continued to function throughout the event, but had water levels risen higher, several million dollars of damage would have resulted to the plant, and wastewater from about 1 million people could have entered the Salt River untreated.

The Verde Water Treatment Plant, located just downstream from the confluence of the Salt and Verde rivers, received considerable damage from high water and was shut down for several months for repairs estimated to cost $1 million.

The Del Rio landfill at 16th Street was nearly breached, but was successfully shored up. A storm drain outfall, exposed by erosion, potentially could have flooded the landfill. Extensive dike protection was performed and no damage reported.

The San Lucy Village sewage disposal pond, north of Gila Bend, was breached causing raw sewage to enter the Gila River and Painted Rock reservoir backwater.

Business establishments receiving damage include the many sand and gravel mining operations located in or near the river. One company estimated their losses at $1.4 million and a temporary loss of 75 jobs during the floods.

Repair of the Salt River embankment protection for Sky Harbor Airport was estimated to cost $4.2 million.

Hail and one tornado damaged eighteen homes in East Phoenix.

Construction formwork and an uncompleted span for the new $6.6 million Mill Avenue bridge collapsed into the Salt River during the first high flows. Several unbridged crossings, Gilbert Road bridge, and the 35th Avenue bridge, were closed within the metropolitan area.

Bridges over the Gila River on Highway 85 and Old US 80 were subject to closures due to flooding and due to the damaged El Paso natural gas pipeline. Interstate 10 bridge was closed for several hours to remove tanks floating down the river. Flood flows in the Gila River nearly necessitated closure of the Interstate 10 bridge on a few occasions.

Numerous road and streets were closed due to flooding throughout the county. The Department of Transportation placed over 1,000 barricades and closed 64 roads.

Gillespie Dam, an irrigation diversion structure upstream of Painted Rock Dam, failed when an estimated 100 foot midsection was washed away on January 9. The breach widened to more than 230 feet as high flows continued. The dam supplied water to more than 50,000 acres of farmland in the Gila Bend area. Agricultural impacts as a result of forced pumping or hauling of water in are extensive. Some areas may be out of production permanently as a result of unavailability of irrigation water.

Painted Rock Dam, a flood control structure in Maricopa County, built by the Corps of Engineers, captured a total volume of floodwater of 5,286,284 acre feet. The maximum inflow to the dam of 204,000 ft^3/s was attenuated down to 25,600 ft^3/s maximum, preventing $100 million in damages downstream.

6.03.8 Navajo County

Navajo County experienced flood damages and problems as a result of flow in the Little Colorado River and tributary streams. A large portion of the county is comprised of land within the Navajo Nation. FEMA, FHWA, and SBA damages and assistance totalled $4,005,748 for the 1993 flood events.

Private damages in Navajo County are estimated to exceed $1,180,000, primarily residential and commercial damages and losses. 78 homes were destroyed or damaged, one business suffered major damage, and two businesses received lesser damage. Tourism dropped rapidly in the county, resulting in lost revenue to area hotels and other businesses.

Public and private damages from the 1993 floods are estimated to exceed $4,100,000.

6.03.8.1 Affected Areas

In Winslow, a 345 foot long section of levee breached and flooded Ames Acres, Bushman Acres, and Winslow Plaza subdivisions. 284 homes and 900 people were evacuated for up to 3 days. 50 homes were flooded up to 4 feet deep. One business and one farm received damages. At McHood Park the recreational lake silted up. The Corps of Engineers repaired the breach during the flood at a cost of $350,050. The County continued reinforcing the breach, and working on 24 hour shifts.

Clear Creek Reservoir south of Winslow experienced a large amount of sedimentation, losing about 70% of the reservoir capacity. Recreational use is expected to diminish, and fish and wildlife habitat was destroyed. The cost to remove the sediment was estimated at $750,000.

In the Bird Springs/Leupp area, on the Navajo Reservation, the National Guard evacuated 110 people by air. The road to Leupp was closed, greatly limiting access to the area. About 20 homes were flooded, livestock was lost, and water and power service interrupted. Navajo County provided emergency response and supplied 1500 sandbags.

Navajo County assessed conditions on the Navajo and Hopi Reservations and responded to extremely muddy road conditions and stranded homeowners by providing coal and wood.

In the Snowflake/Taylor area, Silver Creek overflowed its banks by a width of 65 to 100 feet. The elementary school received damage, 4 families were evacuated, 3 homes were flooded, numerous road crossings were underwater, and Shumway bridge was overtopped. Many homes were sandbagged. At Snowflake, repairs to a flood control dike were made, and a parking lot sustained $20,000 damage. These extreme February flows were not experienced during the January flood.

At Pinetop/Lakeside, there were over a dozen road closures and washouts. Flows up to two feet deep in Sky High Retreat subdivision cut off access to 45 homes. Two homes received minor damage.

In Show Low, heavy flows on Show Low Lake Creek threatened closure of State Route 60 bridge, the only access from Show Low to Globe. Flood waters came within 6" of the top of the bridge. The City of Show Low reported significant damage to sewer lines and a septic pump station. One home received major damage, and one home received minor damage.

The high amount of runoff from Show Low and Pinetop necessitated water releases from Schoens Dam, a new flood control structure, to ensure a safe level of capacity to prevent catastrophic flooding in the event that Lone Pine Dam failed. Lone Pine Dam was damaged, the estimated cost of repairs was $30,000. At Lone Pine Dam, spillway flow was estimated at 6000 ft^3/s.

In Holbrook, flooding on Leroux Wash nearly inundated a wastewater lift station for the City of Holbrook. A radio station was off the air for two weeks.

A landslide on State Route 260 resulted in closure for two days, causing major detours to get to Phoenix and Payson. Routes 277 and 377 were closed due to washouts for 3 days.

The Atchison, Topeka & Santa Fe Railroad was impacted by the flood and experienced economic damages.

Numerous roads were washed out in Sitgreaves National Forest.

The Joseph City Powerplant, on the Little Colorado River, incurred expenses for protecting power lines as a result of the river changing course.

Navajo County officials stressed that flows in the Little Colorado had been attenuated by Lyman Lake Dam, upstream in Apache County. The normally full reservoir had been drained and repairs to the dam had just been completed prior to the flood events. The reservoir rapidly filled to capacity, and reduced peak flows through Holbrook, Winslow, and the Navajo Nation. If the lake had been full, floodflows in the Little Colorado would have been greater and caused more damage than was experienced.

6.03.9 Pima County

Pima County is the second most populated county in Arizona, with a population of approximately 735,000, including the City of Tucson with a population of 432,000. Although flood damages were widespread, actions taken by the Pima County Flood Control District in recent years resulted in damages significantly less than would have occurred without the flood control projects, structural standards, and floodplain management practices which were in place prior to the Floods of 1993. No lives were lost, and no residential or commercial structures were destroyed. Several bridge abutments and approaches were damaged, but there was no direct structural damage to any bridges. Existing bank stabilization projects suffered little damage.

Damages in Pima County consisted primarily of public damages, reported through FEMA, FHWA, and SBA in the amount of approximately $10 million. Pima County estimated an additional $13.9 million for long term improvements.

Private damages are estimated to exceed $1.5 million, primarily losses to private residents, commercial establishments, utilities, and mining operations.

Public and private damages from the 1993 floods are estimated to exceed $12,000,000. This is in sharp contrast to previous damages of $105,000,000 in Pima County from the 1983 floods.

6.03.9.1 Affected Areas

Erosion along portions of the Santa Cruz River and Rillito Creek resulted in significant damage or loss to public infrastructure and private property. Overbank flooding caused damage along the Agua Caliente Wash, Sabino Creek, Lower Finger Rock Wash, Tanque Verde Creek, Rincon Creek, and Rillito Creek; and along the Santa Cruz River upstream and downstream of the Tucson metropolitan area.

Santa Cruz River: Along the Santa Cruz River, bank erosion occurred along the natural channel banks in the upper reach, eroding agricultural land and damaging the Elephant Head and Sahuarita Road bridge crossings. Overbank flow occurred to the east and west in several locations from Green Valley to upstream of Martinez Hill, inundating primarily vacant land and pecan orchards. A major breakout occurred upstream of Pima Mine Road, and the east overbank flow returned to the main channel via the Lee Moore Wash a few miles downstream. From I-19 to Cortaro Road, little damage occurred in the urban area where flow was contained within soil cement banks, and the Rillito Creek tributary contribution was relatively large. Large sand and gravel pits within the river between Ina and Cortaro roads may have contributed

to the shifting of the channel to the east. Bank erosion caused extensive damage to the west approach at the Ina Road bridge and at Cortaro Road.

Along the Lower Santa Cruz River, from Cortaro Road to the County line, some bank stabilization was damaged downstream of Cortaro Road. Downstream of the Continental Ranch area, the east approach to the Avra Valley Road bridge was inundated. Further downstream, overbank flow inundated agricultural and vacant lands. In the Honea Heights subdivision, floodwaters were in yards, but no residences were damaged. The Sanders Road bridge south approach was inundated. Breakouts to the west and east within the Town of Marana inundated agricultural and vacant land. Erosion threatened the south approach of Trico-Marana Road. Massive flow breakouts caused inundation and sedimentation of the Trico Road approach. Large quantities of sediment and debris were deposited under the Trico Road bridge, and sediment deposition covered the north and south approach roads for one-half mile in each direction. The Trico Road bridge was closed until early May 1993.

Rillito Creek: Rillito Creek flowed bank full from Cortaro Road to the Santa Cruz River on January 7th and 8th, with significant tributary flows contributed by Agua Caliente Wash, Sabino Creek, and Tanque Verde Creek. Overbank flows occurred in the vicinity of Dodge Boulevard, impacting the bend area upstream of Country Club Road. Downstream of Shannon Road, flows broke out to the north and into the Pegler Wash.

A Corps of Engineers bank stabilization project under construction along the Rillito Creek performed well in areas already completed, however those areas not yet protected experienced erosion along the banks. As a result of the floods, the Corps provided emergency floodfight assistance, accelerated the construction of soil cement bank stabilization, and made revisions to the design for portions os the project.

Agua Caliente Wash: On January 7th and 8th, flows broke out of the limited channel and inundated several properties and deposited large amounts of sediment over a large area. Approximately 2500 residents were affected between the Tanque Verde Creek and Agua Caliente Wash. In the vicinity of Tanque Verde Road, Amity House, a drug and alcohol rehabilitation facility, experienced major damages and serious disruptions of operations from the flooding. All of the residents there had to relocate to another facility. Damage was approximately $180,000.

Transportation infrastructure was heavily damaged, considerable erosion was experienced, a breakouts occurred in several areas. Based upon the number of residents affected, the Agua Caliente Wash area was the residential area most heavily affected by the 1993 floods.

Tanque Verde Creek: Overbank flows occurred to the north, downstream of Monument Wash, at Fortyniners Country Club Estates, the Lakes at Castle Rock subdivision, and along Woodland Road, breakouts to the south occurred downstream of Tanque Verde Loop Road. Several accessory structures and yards were flooded, however little damage was reported inside residences. Substantial erosion occurred along the north bank downstream of the Wentworth Wash confluence, and along the south bank at Tucson Country Club Estates. Although no residences were damaged at Tucson Country Club Estates, several were threatened, accessory

structures were lost, and a sewer line was damaged. Access was a problem for a few days due to damage to the Tanque Verde Loop Road and Wentworth road crossings.

Rincon Creek: Overbank flows occurred to the south from upstream of Camino Loma Alta to the Old Spanish Trail crossing. Access within the Rincon Valley was limited as both roadway crossings were damaged. Access across several private roads was also lost. Overbank flooding and sediment deposition damaged at least one residence located at the intersection of Old Spanish Trail and Avenida de la Potranca.

Finger Rock Wash: Snowmelt combined with rain induced runoff resulted in large flows in watercourses draining the south face of the Santa Catalina Mountains. Flooding and sediment deposition at the downstream end of Finger Rock Wash were especially severe as no defined channel exists to convey flows to the Rillito Creek.

Downstream of Alvernon Way just north of River Road, flows spread out in an alluvial fan, inundating several residences along Sutton Lane and depositing sediment over broad areas. Damages in the area include traffic delays, sediment removal and debris cleanup, inundation and damages to private residences, road repairs, and emergency response costs.

Sabino Creek: Private property was eroded, one residence experienced one foot of inundation. Upstream of the Tanque Verde Creek confluence, bank full flows caused the failure of the north bank soil cement protection.

Canado del Oro Wash: Compared to other major watercourses, flow was much less and resulted in little damage. Some access problems were reported.

FEMA damages for The Township of Marana amounted to $30,288. Several pecan orchards were damaged from flows in the Santa Cruz River. Agricultural areas north of Green Valley were also inundated by overbank flows.

FEMA damages for the City of Tucson amounted to approximately $640,000.

6.03.10 Pinal County

In Pinal County, extensive damage occurred to public roadways, bridges, dikes, culverts, levees, river crossings, private facilities, utilities, homes, and irrigation canals. Large areas of the County suffered damage from the 1993 floods. Shifting channels, erosion, and sedimentation also contributed to the problems.

Damages reported through FEMA, SBA, and FHWA in Pinal County amounted to approximately $18,000,000. Much of the damage was to public infrastructure, primarily bridges and roads which are part of the Federal Aid system. The County identified approximately $910,000 in hazard mitigation needs.

Private damages from the 1993 floods in Pinal County consist primarily of agricultural damages and damage to the railroad, estimated at a total of $3,540,000.

Total public and private damages from the 1993 floods in Pinal County are estimated to exceed $21,500,000.

6.03.10.1 Affected Areas

Flood problems in Pinal County are typically caused by flows in the San Pedro, Gila, and Santa Cruz Rivers. During the floods of 1993, communities situated along these three rivers and their tributaries experienced problems.

San Pedro River: At the City of Mammoth, the 1993 flood discharge was approximately 19,000 ft^3/s, which represents a 7 year flood. FEMA damages were approximately $32,000, including emergency services, debris removal, and siltation damage to a sewer line. Erosion damage occurred to the Highway 77 bridge approaches, resulting in short closures. The El Paso natural gas pipeline was destroyed, and Magma mining and ASARCO mining experienced problems. Portions of the town near the San Pedro had water 1.5 to 2 feet deep in residences and businesses along Main Street. Erosion threatened a local access road, and the sewage treatment plant for the town had inundation and siltation damage to the overflow lagoon, and erosion of the protective bank for the sewage pond almost occurred.

Flooding of Aravaipa Creek, a tributary of the San Pedro, caused extensive damages in Aravaipa Canyon, including catfish ponds, residences, erosion of property, damages to orchards, and downed telephone lines.

In Dudleyville, an estimated 17 homes were affected by some degree of flooding, and some local access problems were experienced.

Gila River: Just upstream of the Town of Kearny, approximately 2 miles of Highway 177, adjacent to the Gila River, was inundated, resulting in closure of the Highway for about one week. This affected people who could not get to work in the nearby Town of Hayden, and caused disruption of emergency medical and police services and school buses. Severe erosion of the banks of the Gila River destroyed a 1500 foot long section of the Copper Basin Railroad which runs between the Gila River and Highway 177. The railroad, which primarily serves for mine hauling operations, was out of service for 30 days. Estimated repair costs and lost income for the railroad was $3,000,000. The erosion area came to within 50 feet of Highway 177, but emergency riprap protection prevented the destruction of this vital roadway.

Further downstream, within the Town of Kearny, a protective dike was breached by approximately 77,000 ft^3/s floodflows in the Gila River. A recently constructed airport runway was about 50% destroyed, a park and park lake were completely filled in with sediment, and the wastewater treatment plant was partially damaged from erosion to its protective dike. The access road to the wastewater treatment plant was destroyed, and raw sewage spilled into the river. Several homes and businesses may also have been flooded. Total FEMA damages for the Town of Kearny amounted to approximately $1,635,000.

In the towns of Kelvin and Riverside, further downstream on the Gila, high water caused the access road to be impassable for 6 weeks. Up to 300 residents may have been affected. An emergency bypass access road was constructed, and emergency riprap was placed along the

access road to prevent erosion. There were water and electric utility outages, and 3 water wells were lost.

Near the Town of Florence, erosion problems threatened the Highway 79 bridge over the Gila River, and the Attaway bridge approaches were destroyed by erosion. Price Road and a portion of the railroad northeast of town were washed out.

Santa Cruz River: The Town of Eloy lies within the Santa Cruz Flats, an area affected by flooding from the Santa Cruz River to the south and the McClellan Wash to the east. Damages and impacts in the from the 1993 floods are not specifically known, however FEMA claims did amount to approximately $98,000.

The City of Casa Grande, further downstream along the Flats, had FEMA claims of approximately $21,000.

Queen Creek: The Town of Queen Valley is located approximately one-half mile downstream of Whitlow Ranch Dam which controls releases in Queen Creek. Apparently there were no homes flooded in the 1993 flood, but water came very close to entering some residences which are located very close to the earth channel. There was some minor erosion, particularly at the roadway crossings, but no erosion damage to residences. The eroded areas were repaired.

Other Damage: Damages were also reported by the Stanfield Flood Control District, the San Carlos Irrigation and Drainage District, the Greene Reservoir Flood Control District, the Maricopa Flood Control District, the Midway Flood Control District, and the Maricopa-Stanfield Irrigation and Drainage District.

6.03.11 Santa Cruz County

Damages in Santa Cruz County occurred primarily from flows and erosion in the Santa Cruz River, Nogales Wash, Peck Canyon Creek, Western Wash, and other minor tributaries. Public damages reported through FEMA, FHWA, and SBA amount to approximately $1,400,000.

Very little private damages were available. It is known that damages to the Tubac Country Club, in the Town of Tubac along the Santa Cruz River, were over $100,000.

Total public and private damages in Santa Cruz County are estimated to exceed $1,500,000.

The City of Nogales had FEMA claims of $29,409, and the City of Patagonia had FEMA claims of $47517.

6.03.12 Yavapai County

Yavapai County was hard hit in widespread areas from the flood of 1993. Estimates placed flows in the Verde River at the 100 year level, affecting several communities. Communities along West Clear Creek and Wet Beaver Creek, both tributaries to the Verde, also experienced damages and problems.

Public damages reported through FEMA, FHWA, and SBA amount to over $8,200,000, including federal private assistance, in Yavapai County. Much of the damage was to public infrastructure such as bridges, roads, public utilities and other facilities.

Private damages in Yavapai County were significant relative to the public damages reported. Private flood damage in Yavapai County is estimated to exceed $4,200,000, including the amounts shown in Table 9.

Total public and private damages in Yavapai County from the 1993 floods are estimated to exceed $10,000,000.

6.03.12.1 Affected Areas

Approximately 270 families were evacuated from the communities of Camp Verde, Cottonwood, Clarkdale, Page Springs, and Cornville. During peak flows, the county's main fiber optics cable for long distance calling was out of service for 24 hours, resulting in lack of communication except within individual communities and disruption of emergency response activities.

In Clarkdale, the upstream Verde River damage center, 4 homes were rendered uninhabitable, and 2 other homes suffered minor damages. These homes were located along Rincon Road, and were inundated by water to depths of two and three feet. Eight cars and one motorcycle were flooded. The Clarkdale wastewater treatment plant, located along the Verde River, narrowly escaped erosion damage of the lagoons as a result of emergency riprap placement. Operators of the plant stated that if the lagoons had been lost, the result would have been spillage of raw sewage into the Verde River until a temporary mobile treatment unit could have been rented.

At the Town of Cottonwood, a low water crossing was destroyed. Further downstream, there was scouring and overtopping of the Cottonwood Irrigation Ditch, and the Verde Irrigation Ditch. The irrigation system was damaged and approximately eight miles along the ditch were without service until after March 11. Utility outages, including the natural gas pipeline, were sporadic until the damaged areas could be repaired. Several other City facilities, such as parks, sustained damages.

In Bridgeport, along Bates Lane, a mobile home park was inundated with 7 to 9 feet of water. Nine mobile homes were totally destroyed, and ten had substantial damage. A few residents returned after 2 weeks in a hotel, but most had not returned by mid-March. Ten homes along Bates Lane were also damaged by about 3 to 4 feet of inundation. A County report indicated that a total of 29 residences were damaged, and a State report said that looting had occurred in the Bridgeport area.

In the Town of Camp Verde, one cluster of 30 homes and two smaller clusters of homes all sustained about four to five feet of inundation. In the Verde Lakes Estates area on West Clear Creek, 16 residential structures were damaged. On Sparkling Lane, eight to ten mobile homes and 2 residences were flooded. There was three to four feet of water in the area for about 3 days. A water well and tank in the area were damaged. During the flooding, some residents

were stranded and had to be evacuated by helicopter. One half mile of pavement was lost. In some cases, the previous uses of the land was indeterminable, because everything had been washed away. In the Wagon Wheel trailer park, 6 mobile homes were damaged.

On the south side of West Clear Creek, twenty older single family residences in the Citrus way vicinity were damaged. The low-water crossings to the north side of the Creek were severely damaged.

On the south side of Wet Beaver Creek, southwest of Lake Montezuma Road, 17 homes were damaged and 51 homes (100 people) had to be evacuated. The estimated flow in Wet Beaver Creek was 19,900 ft^3/s. Numerous homes are located along the banks, and two emergency bank stabilization projects had to be done during the flood events. One home was undermined by bank erosion and collapsed into the Creek. Ten homes on Rimrock Drive experienced exterior damage and minor interior damage. Two homes on Beaver Vista Road sustained major damage, and one home on Sycamore Lane was damaged. Flood waters washed out .4 miles of roadway.

Residents in the Lake Montezuma area reported that several homes were damaged on Beaver Vista Road northeast of Lake Montezuma Road. There may have been some instances of minor damage, but brief inspections did not detect any major damages. The construction of homes as per floodplain management regulations as enforced by the County was deemed responsible for the relative lack of damage.

On Aztec Road, on the north side of Wet Beaver Creek, there were 5 residences and about 40 mobile homes, but these sustained little damage. However, there was between 20 and 60 feet of lateral bank erosion along .3 miles of the Creek. Significant quantities of sediment, up to 6 feet deep, were deposited in some areas of Wet Beaver Creek.

There is only one bridge providing access to the Lake Montezuma area, which contains 2200 homes, and some commercial structures including a golf course and country club. Prior to the 1993 floods, which were estimated to be a 25 year event, the bridge was considered stable up to a 100 year event. Subsequent evaluation indicated that the channel shifting upstream of the bridge has placed this structure in jeopardy of failing from a 40 year event. During the January floods, water was at the low chord of the bridge. The bays of the bridge obstructed with large trees and debris which were removed by County maintenance personnel at a cost of $25,000.

In Black Canyon City, on the Agua Fria River, a mobile home park received damage. Damages were estimated to be $50,000. Several families had to be evacuated, and water contamination was a problem. An RV park near the confluence of the Agua Fria and Black Canyon Creek sustained extensive erosion damage and up to 4 feet of inundation. Upstream of the confluence, a large amount of sediment was deposited for approximately one mile.

In Page Springs, a few homes experienced carpet damage.

Flood damages also occurred on Lynx Creek in the Dewey area, and on Clipper Wash in the Prescott Country Club.

Camp Verde, Prescott, and Crown King had no electricity for one day.

6.03.13 Yuma County

Yuma County in southwestern Arizona was particularly hard hit from the Floods of 1993. The Lower Gila River runs through the County in areas of extensive agricultural development. Prior to the 1993 floods, the maximum release from Painted Rock Dam, upstream in Maricopa County, had been no more than an estimated 5000 ft^3/s. Although Painted Rock Dam reduced the peak inflow of 186,000 ft^3/s down to 26,000 ft^3/s during the 1993 floods, preventing an estimated $100 million in additional downstream damages, the impacts of the 1993 flood events were severe and long lasting. As of July 1994, all of the repairs had not yet been completed.

Public damages reported through FEMA, FHWA, and the SBA amount to in excess of $80 million, comprised mostly of damage to public infrastructure and facilities including bridges, irrigation canals, and protective levees.

Private damages are estimated to exceed $50 million, primarily from lost crops, destroyed or damaged farmland, and private agricultural and industrial facilities and equipment. Damages resulting from reduced yields in future years on damaged farmland was not estimated.

Public and private damages in Yuma County from the flood events of 1993 is estimated to exceed $130 million.

The City of Yuma and City of Wellton experienced flood damages and problems. The Yuma Irrigation District, Yuma Mesa Irrigation District, the North Gila Valley Irrigation District all experienced some degree of flood damage.

Yuma County Emergency Services reported that California SR 24 and SR 34 were used by employees of Yuma Proving Grounds, area farmers, and Interstate 8 traffic due to the closure of Arizona State Route 95. Imperial County, CA. reported a dramatic increase in maintenance costs on SR24 and SR34 as a result of the rerouted traffic. Arizona Route 95 re-opened on July 12, 1993.

The Yuma County Public Health Department estimated that the cost of mosquito spraying for disease vector reduction would total $330,000. The spraying is necessary due to the flood events creating marsh-like conditions and prime breeding grounds for mosquito reproduction.

Other impacts include costs incurred by the Dateland and Mohawk School Districts, costs associated with the landfill on the north shore of the Gila River being inaccessible, AZ. Natl. Guard expenditures, public utilities (APS, El Paso Gas, Bell telephone, US West), Cocopah Indians, Quechan Indians (CA) (Desalinization Plant Closed), and Southern Pacific Railroad.

Wellton-Mohawk Irrigation & Drainage District (WMIDD) - Reported that their jurisdiction encompassed 62,775 acres of irrigable land, of which an estimated 12,500 acres were inundated during the flood events, and 2,800 acres were eroded and washed away, which would leave a total of approximately 48,000 acres currently usable. It was estimated that it will take two years

to bring the total of productive land back up to 60,000 acres, and that the 12,500 acres which were inundated during the flood would only be productive at reduced yields for several years.

Additional impacts occurred to approximately 6,000 acres of irrigable land due to the rising groundwater table (0 to 4 ft. depth) which increases soil salinity in the root zone. The result is a reduction in yields or altered cropping patterns for some period of time. Approximately 16,000 additional irrigable acres were affected to some lesser degree (0 to 6 ft. depth) for a reduction in yields that will be proportional to the increased salinity level on those acres.

The WMIDD stated that, on average, the cost to restore inundated lands back to a reduced productive status, was $1200 to $1500 per acre. This figure includes the average cost of restoration work and the average estimated value of crop loss for a period of one year.

Floodfight/Emergency Costs : Total approximately $6.2 million.

Levee damages: The WMIDD has 105 miles of levees along 60 river miles. The levees are typically uncompacted fill and were intended to provide protection for flows up to 10,000 ft^3/s. Approximately 65 miles of these levees were damaged to varying degrees. The WMIDD stated that throughout the 60 mile reach of river, channel scouring generally occurred, so that in their estimation, reconstruction of the 10,000 ft^3/s configuration will actually result in an approximate 15,000 ft^3/s level of protection. This estimate is based on water surface elevation primarily and may not take into account structural/velocity considerations.

Irrigation System: The WMIDD operates and maintains approximately 280 miles of irrigation canals and laterals which supply water to 640 acre parcels. 7 miles of minor laterals were destroyed during the 1993 flood events. Supply disruptions occurred, no estimate was given as to the length or extent of temporary disruptions. However, approximately 2500 acres were without water until after August 1, 1993. In some areas experiencing supply disruptions, planting cannot occur due to the required length of growing season for the crops.

Irrigation Water Drainage System: The WMIDD Drainage System Main Conveyance Channel (MCC) normally empties into the Bureau of Reclamation's Main Outlet Drain (MOD) which empties into the BOR's Main Outlet Drain Extension (MODE). During the flood events of 1993, 3 major breaks in the MCC occurred where it crosses the Gila River. The upstream capacity of the MCC is 140 ft^3/s, the downstream capacity of the MCC is 280 ft^3/s. Irrigation drainage water was being discharged to the Gila River directly at the three breaks pending completion of repairs. Damage to the MCC include silting of the channel which decreases capacity, and washouts/breaks. The WMIDD also reported that damages occurred to the MOD and MODE.

Power System: The WMIDD purchases power from a variety of sources and maintains and operates a distribution system which transmits the power to end users. Damages include downed transmission lines and 1 substation had to be rebuilt. No major disruptions of power were reported, but WMIDD stated that all of the redundancy in the system had been utilized. If the flood events had lasted longer or if the peak flow had been higher, sustained power disruptions would have been likely.

6.03.14 Indian Reservations

Little information is available on the extent and types of damages experienced on the many Indian Reservations in Arizona. The Bureau of Indian Affairs reported damages to federal facilities of approximately $15,000,000. Information available from the Federal Emergency Management Agency indicates that damages on Indian lands were widespread throughout Arizona. Of nearly $6,100,000 of damages claimed, almost $5,000,000 was found to be eligible for FEMA reimbursement to ten tribes, as follows:

	AMOUNT CLAIMED
Havasupai	$ 626,214
Tonto Apache	$ 13,780
San Carlos Apache	$ 762,474
Salt River Pima-Maricopa	$2,532,532
Hopi	$ 126,576
Pasqua Yaqui	$ 29,836
Tohono O'Odham	$ 662,256
Gila River Indian Community	$1,218,324
Ak-Chin	$ 121,556
Yavapai Apache	$ 1,336
ESTIMATED TOTAL:	$6,094,884

6.04 FEDERAL EXPENDITURES AND COSTS

The Federal Government experienced physical damage to several major projects and facilities, resulting in construction contracts for repair of these facilities. Additional costs were incurred by Federal agencies during and after the flood events for emergency response personnel, equipment, flood monitoring and reporting. Post-flood response and personnel costs are also estimated.

Table 11 provides an estimate of the total Federal cost as a result of the floods of 1993 in Arizona. Public and private assistance provided is included. The figures below are not intended to be all inclusive, but are provided to show the relative magnitude of federal flood involvement.

TABLE 11. Estimated Federal Expenditures, ARIZONA FLOODS OF 1993

FEDERAL AGENCY	PHYSICAL DAMAGES	FLOOD RESPONSE	POST-FLOOD RESPONSE	ESTIMATED EXPENDITURES
FEMA Public Private Haz. Mit.	 $85,500,000 $ 2,372,000	$ 1,500,000	$ 1,000,000 $ 4,000,000	$ 94,372,000
Federal Highways	$65,200,000	$ 100,000	$ 100,000	$ 65,400,000
Bureau of Indian Affairs	$15,000,000	$ 100,000	$ 100,000	$ 15,200,000
Bureau of Reclamation	$ 20,000,000	$ 2,200,000	$ 500,000	$ 22,700,000
Corps of Engineers	$ 2,564,000	$ 2,070,000	$ 500,000	$ 5,134,000
Red Cross	-	$ 1,325,000	$ 100,000	$ 1,425,000
Soil Conservation Service	$ 5,200,000	$ 1,000,000	$ 500,000	$ 6,700,000
Small Business Administration Home Loans Business Lns.	 $ 6,000,000 $ 4,600,000	$ 250,000	$ 50,000	$ 10,900,000
U.S. Geological Survey	$ 834,000	$ 100,000	$ 261,000	$ 1,195,000
TOTALS:	$207,270,000	$ 8,645,000	$ 7,111,000	$223,026,000

6.05 CORPS FLOOD FIGHT ACTIVITIES

The U.S. Army Corps of Engineers conducted flood fight activities at the following locations in the State of Arizona:

Painted Rock Dam Emergency Repair	$ 161,332
Winslow, AZ.	$ 350,950
Punkin Center, AZ.	$ 59,065
Rillito River, Tucson, AZ.	$ 135,887
Wellton, AZ.	$ 850,037
Safford, Az.	$ 13,299
TOTAL FLOODFIGHT:	$ 1,570,570
PERSONNEL COSTS :	$ 500,000
TOTAL COE FLOOD RESPONSE:	$ 2,070,571

6.06 CORPS POST FLOOD ACTIVITIES

The U.S. Army Corps of Engineers conducted several post flood activities. After the emergency repair of the spillway at Painted Rock Dam, complete repairs were initiated. The total cost of final repairs to the spillway was $2,564,000.

Other post flood activities include production of this statewide Post Flood Damage Report, numerous site visits to affected local communities, and initiation of three flood control studies. A brief description of these three studies is as follows:

Gila River Gillespie Dam to Yuma, AZ.: The purpose of this study is to evaluate alternatives and solutions to flood problems upstream and downstream of Painted Rock Dam.

Arizona Flood Control Study, AZ.: The purpose of this study is to evaluate statewide flood warning systems and recommend improvements.

Flood Control Studies for Arizona Communities, AZ.: This study will evaluate the large volume of requests for assistance received from local communities for small scale, localized flood control projects under the U.S. Army Corps of Engineers Continuing Authorities Program.

As a result of the floods of 1993, a large number of requests for 404 permits were received related to reconstruction and repair of damaged bridge crossings, dikes, levees, and a variety of other in-channel work. The Corps of Engineers increased staffing to process the large volume of 404 requests.

6.07 EFFECTS OF PROJECTS

6.07.1 Estimated Damages Prevented by Existing Corps Projects

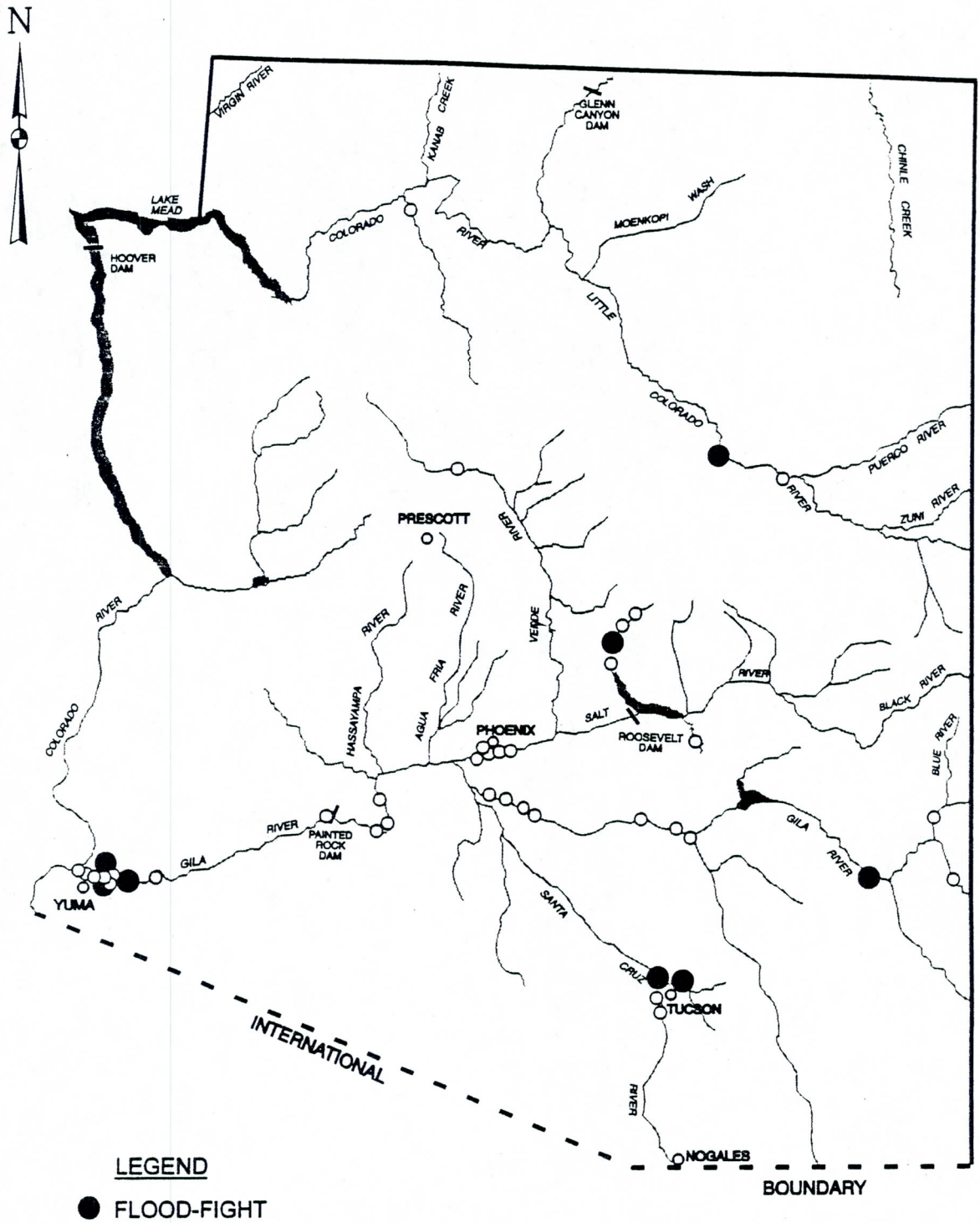
Painted Rock Dam, located on the Lower Gila River, prevented an estimated $100 million in flood damages downstream. The peak inflow to the reservoir of over 200,000 ft^3/s was reduced to 26,000 ft^3/s maximum outflow.

Alamo Dam, located on the Bill Williams River, prevented an estimated $13 million in flood damages.

Other Corps of Engineers built projects statewide, operated by others, prevented significant damages of an unspecified amount, qualitatively estimated at several million dollars. These projects include the Holbrook levee, the Matthews Canyon Dam, Pine Canyon Dam, Tat Momolikot Dam, Tucson Diversion Channel, Whitlow Ranch Dam, the Winslow Diversion levee, Adobe Dam, Cave Buttes Dam, Dreamy Draw Detention Basin, the New River Dam, Indian Bend Wash, Arizona Canal Diversion Channel, and others.

6.07.2 Estimated Damages Prevented by Other Projects

The U.S. Soil Conservation Service estimated that their projects prevented over $21,500,000 in flood damages statewide. Estimates from other agencies are not available.

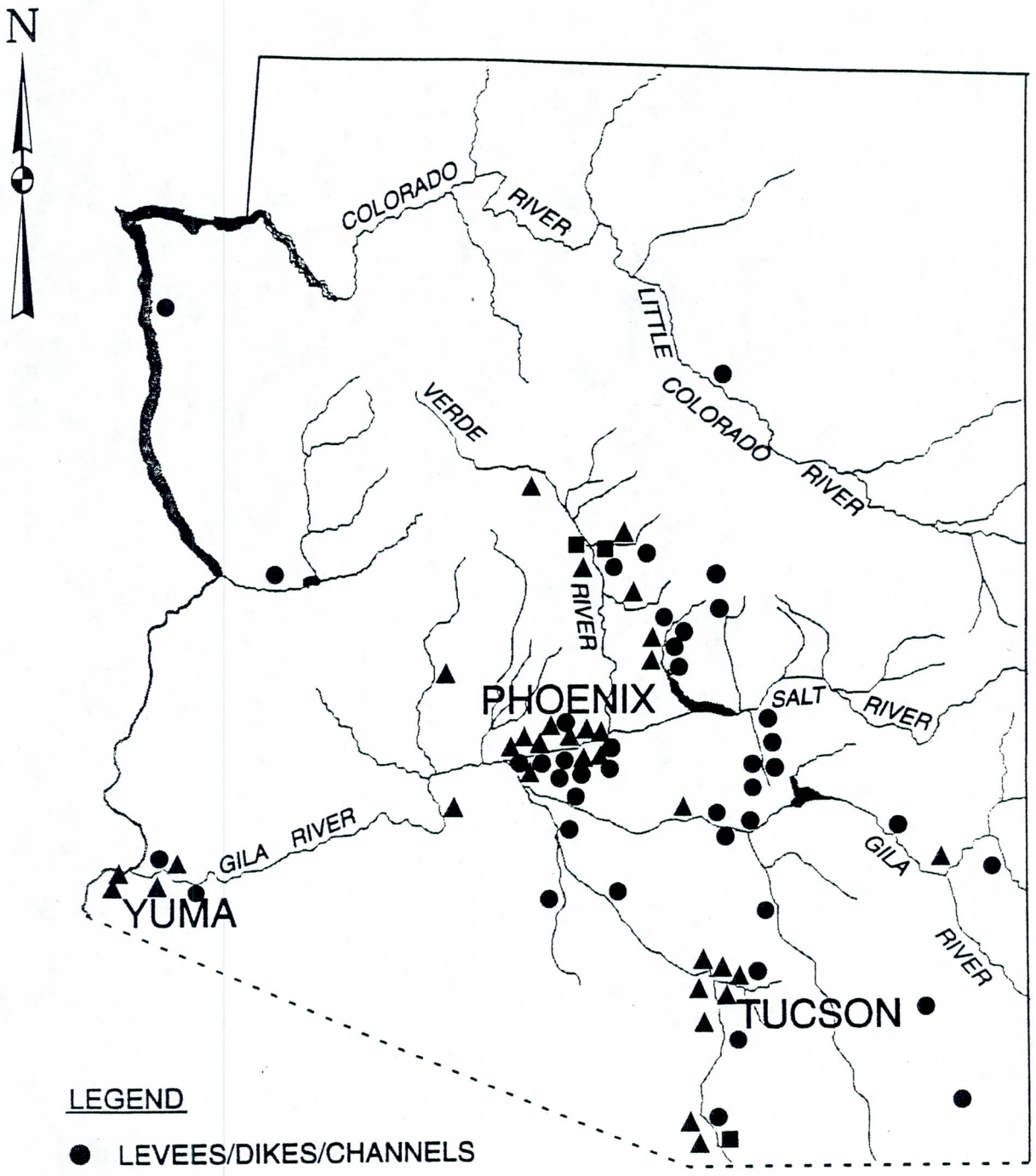


FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

FLOOD RESPONSE CORPS OF ENGINEERS

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

ARS9.CDR



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

REQUESTS FOR STUDIES BY CORPS OF ENGINEERS

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

ARS8.CDR

APPENDIX A

PRECIPITATION DATA

(PRELIMINARY)

Table 1. Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Little Colorado R.							
NWS (1574)	Chevelon	8	4.58	3.95	34:32 N	110:55 W	7006
NWS (9542)	Wupatki Visitors Center	9	1.53	n/a	35:31 N	111:32 W	4908
SCS 09S01S	Baldy Snotel	1	7.00	5.00	33:59 N	109:31 W	9125
SCS 09R11S	Buck Springs Snotel	2	9.60	7.10	34:07 N	109:51 W	7400
SCS (4089)	Holbrook	3	2.73	0.48	34:54 N	110:10 W	5080
SCS 11R10S	Promontory Snotel	4	21.40	10.50	34:22 N	111:01 W	7930
SCS (8162)	Springerville	5	1.24	0.58	34:08 N	109:17 W	7060
SCS (8792)	Tuba City	6	4.25	1.75	36:08 N	111:15 W	4980
SCS (9410)	Window Rock 4 SW	7	3.48	1.75	35:37 N	109:07 W	6900
Bill Williams R./& NW Arizona							
COE - ALMO	Alamo	22	3.42	3.19	34:14 N	113:35 W	1290
COE - SAND	Big Sandy River	21	5.05	4.41	34:28 N	113:37 W	1400
COE - BURO	Burro Creek	20	3.98	4.48	34:32 N	113:27 W	2700
COE - CAMP	Campwood	19	9.35	10.83	34:48 N	112:53 W	5800
COE - LOKU	Lookout Wash	17	3.40	3.83	35:12 N	113:14 W	5000
COE - WIKI	Wikieup	18	4.55	5.32	34:45 N	113:38 W	3500
NWS (0586)	Bagdad	n/s	n/a	n/a	34:34 N	113:10 W	3710
SCS (0672)	Beaver Dam	16	3.17	2.79	36:54 N	113:56 W	1875
SCS (1001)	Bright Angel	15	10.99	6.66	36:12 N	112:04 W	8400
SCS (1920)	Colorado City	10	5.32	3.25	37:00 N	112:59 W	5010

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Bill Williams R./& NW Arizona							
SCS	Fredonia	n/s	5.85	2.97	n/a	n/a	n/a
SCS (3596)	Grand Canyon	11	3.93	2.85	36:03 N	112:09 W	6785
SCS (4645)	Kingman 2	12	9.43	9.13	35:12 N	114:01 W	3539
SCS (6180)	Page	13	1.38	1.25	36:56 N	111:27 W	4270
SCS (9359)	Williams	14	6.63	8.10	35:15 N	112:11 W	6750
Gila R.							
ASLC	Cottonwood (Bridgeport)	n/s	4.20	3.27	n/a	n/a	3250
ASLC	Sierra Vista	n/s	3.97	0.96	n/a	n/a	4680
FCDMC #4820	ACDC @ 43rd Ave	n/s	4.76	1.89	33:35 N	112:09 W	1225
FCDMC #5520	ACDC @ 67th Ave	n/s	4.37	2.56	33:37 N	112:12 W	1220
FCDMC #5535	Adobe Dam	106	5.86	2.52	33:41 N	112:09 W	1413
FCDMC #5400	Agua Fria @ Buckeye	98	4.96	1.93	33:26 N	112:20 W	940
FCDMC #4500	Alvord Park	n/s	4.29	1.85	33:22 N	112:08 W	1070
FCDMC #6670	Apache FRS	n/s	5.55	1.61	33:26 N	111:33 W	1989
FCDMC #5775	Arizona Hunt Club	114	5.63	5.20	34:23 N	112:08 W	3805
FCDMC #5900	Asher Hills	118	6.46	2.36	33:43 N	111:41 W	1680
FCDMC #6960	Bender Wash	133	1.65	1.81	32:55 N	112:32 W	1243
FCDMC #5305	Box Canyon	93	5.23	3.86	34:03 N	112:42 W	2245
FCDMC #6810	Buckeye FRS #3	n/s	3.74	1.46	33:27 N	112:33 W	1200
FCDMC #5200	Buckeye FRS#1	87	3.58	2.68	33:28 N	112:45 W	1097
FCDMC #5205	Buckeye FRS#2	88	3.23	2.17	33:26 N	112:36 W	1150

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila R.							
FCDMC #6520	Carriage Lane Park	n/s	2.91	0.94	33:22 N	111:53 W	1200
FCDMC #5490	Castle Hot Springs	104	6.73	4.29	33:56 N	112:32 W	2683
FCDMC #4900	Cave Buttes Dam	n/s	3.94	2.01	33:43 N	112:03 W	1649
FCDMC #4830	Cave Creek @ Cactus	75	4.72	1.97	33:36 N	112:07 W	1280
FCDMC #5120	Centennial Levee	82	1.89	1.46	33:31 N	113:18 W	1298
FCDMC #5100	Centennial Railroad	80	3.98	1.81	33:19 N	112:53 W	850
FCDMC #5180	Centennial Wash	85	5.43	3.66	33:57 N	113:00 W	2417
FCDMC #5460	Chrysler Prvg Grounds	102	5.51	3.74	33:37 N	112:30 W	1720
FCDMC #5475	Circle City	103	5.43	4.25	33:49 N	112:35 W	1890
FCDMC #4770	City of Glendale	n/s	4.49	1.69	33:33 N	112:12 W	1148
FCDMC #5685	Columbia Hill	n/s	12.08	5.24	34:01 N	112:21 W	2393
FCDMC #5640	Cooks Mesa	108	14.21	5.28	34:04 N	111:57 W	4565
FCDMC #5715	Crown King	n/s	8.89	8.15	34:13 N	112:21 W	6783
FCDMC #5550	Deer Valley Airport	n/s	5.67	2.40	33:41 N	112:05 W	1445
FCDMC #5805	Dewey	116	5.47	4.09	34:30 N	112:09 W	4775
FCDMC #4800	Dreamy Draw	74	5.16	2.09	33:34 N	112:02 W	1407
FCDMC #4700	Durango Complex	72	5.75	1.77	33:25 N	112:07 W	1050
FCDMC #5510	Dysart @ Bell Rd	105	5.20	3.19	33:38 N	112:20 W	1190
FCDMC #6580	EMF @ Queen Creek Rd	n/s	2.66	1.54	33:16 N	111:44 W	1317
FCDMC #6595	EMF @ Arizona Ave	122	2.87	1.42	33:11 N	111:52 W	1214
FCDMC #6565	EMF @ Broadway	n/s	4.09	2.09	33:24 N	111:43 W	1349

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila R.							
FCDMC #6890	Estrella Park	129	3.58	1.77	33:19N	112:19W	1425
FCDMC #6840	Estrella Park	n/s	5.08	1.97	33:23 N	112:22 W	950
FCDMC #4540	Fitch Park	n/s	4.41	1.73	33:26 N	111:50 W	1245
FCDMC #6730	Florence Junction	126	5.27	2.13	33:18 N	111:24 W	1840
FCDMC #5930	Fraesfield Mtn	119	8.23	3.43	33:46 N	111:49 W	2661
FCDMC #5670	Garfias Mtn	110	10.66	5.24	33:58 N	112:26 W	2645
FCDMC #5050	Gila Bend Mountain	79	3.46	2.40	33:22 N	113:18 W	1560
FCDMC #5170	Gladden	84	2.64	4.41	33:54 N	113:18 W	2198
FCDMC #4840	Greenway @ 32nd Ave	n/s	4.76	2.32	33:38 N	112:08 W	1300
FCDMC #6500	Guadalupe FRS	n/s	3.42	1.81	33:22 N	111:58 W	1250
FCDMC #5350	Hassy Bridge	96	7.24	6.81	34:19 N	112:34 W	3785
FCDMC #5760	Horner Mtn Ranch	n/s	6.02	3.31	34:32 N	111:57 W	4407
FCDMC #5745	Horseshoe Ranch	113	7.98	4.76	34:14 N	112:00 W	3805
FCDMC #5700	Horsethief Basin	111	12.59	9.06	34:06 N	112:21 W	6702
FCDMC #4940	Humbolt Mtn	76	7.91	3.94	33:59 N	111:48 W	5198
FCDMC #5790	I-17 @ 169	115	6.45	4.84	34:31 N	112:00 W	4750
FCDMC #4620	IBW @ Interceptor	n/s	3.54	2.01	33:32 N	111:54 W	1071
FCDMC #4640	IBW @ Sweetwater	n/s	5.23	2.24	33:36 N	112:00 W	1400
FCDMC #4610	IBW @ Indian Bend Rd	70	4.84	2.01	33:32 N	111:55 W	1071
FCDMC #4600	IBW @ McKellips Rd	n/s	4.41	2.05	33:27 N	111:55 W	1187
FCDMC #5215	Jackrabbit Wash	89	4.96	5.31	33:44 N	112:55 W	1798

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila River							
FCDMC #6745	Kings Ranch	127	7.20	2.60	33:23 N	111:26 W	2145
FCDMC #4530	Kleinman Park	68	4.09	1.93	33:24 N	111:51 W	1120
FCDMC #5650	Lake Pleasant	109	6.30	3.23	33:51 N	112:17 W	1600
FCDMC #4660	Lost Dog Wash	71	4.80	2.20	33:36 N	111:48 W	1700
FCDMC #6715	Magma FRS	n/s	1.74	1.61	33:07 N	111:24 W	1610
FCDMC #4760	Maryvale Muni Golf	73	5.47	1.85	33:28 N	112:10 W	1200
FCDMC #5915	McDowell Mtn Park	n/s	8.23	3.35	33:43 N	111:45 W	2040
FCDMC #5445	McMicken Dam	n/s	4.17	2.95	33:41 N	112:25 W	1361
FCDMC #5435	McMicken Floodway	100	4.25	2.52	33:41 N	112:25 W	1337
FCDMC #6540	Mesa Tower	n/s	3.34	1.77	33:23 N	111:50 W	1215
FCDMC #5335	Minnehaha	95	8.66	6.89	34:10 N	112:22 W	5602
FCDMC #4780	Missouri @ 16th	n/s	5.39	2.05	33:31 N	112:03 W	1155
FCDMC #5220	Morristown	n/s	4.63	4.33	33:51 N	112:37 W	1978
FCDMC #4550	Mountain View Park	69	4.56	2.01	33:26 N	111:46 W	1280
FCDMC #5000	Mt Oatman	78	2.24	1.69	33:03 N	113:08 W	1720
FCDMC #5960	Mt Ord	121	10.78	5.79	33:53 N	111:24 W	7139
FCDMC #5380	Mt Union	n/s	16.06	8.54	34:25 N	112:25 W	7495
FCDMC #5505	New River @ Glendale	n/s	3.46	1.89	33:32 N	112:17 W	1050
FCDMC #5610	New River Dam	n/s	4.13	3.39	33:44 N	112:14 W	1498
FCDMC #5595	New River @ Bell Rd	n/s	4.41	1.14	33:38 N	112:14 W	1200
FCDMC #5320	O'Brian	94	7.44	5.59	34:04 N	112:34 W	2798

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila R.							
FCDMC #4740	Papago Park	n/s	3.46	1.85	33:28 N	111:58 W	1200
FCDMC #4790	Paradise Valley CC	n/s	3.04	2.01	33:32 N	112:00 W	1494
FCDMC #4650	Paradise Valley Park	n/s	5.16	2.13	33:39 N	112:00 W	1494
FCDMC #5450	Patton Rd	101	4.21	2.91	33:44 N	112:34 W	2683
FCDMC #4730	Perry Park	n/s	5.67	1.85	33:29 N	112:01 W	1160
FCDMC #4710	Phoenix Municipal	n/s	5.19	1.50	33:27 N	112:05 W	1080
FCDMC #6530	Pima Wash	n/s	3.11	1.22	33:22 N	111:59 W	1338
FCDMC #6680	Powerline FRS	n/s	5.19	1.85	33:21 N	111:33 W	1580
FCDMC #5820	Prescott Valley	117	3.69	3.07	34:41 N	112:15 W	5228
FCDMC #6610	Queen Creek Rd	123	3.50	1.69	33:16 N	111:38 W	1409
FCDMC #6700	Rittenhouse FRS	125	4.72	1.57	33:17 N	111:30 W	1580
FCDMC #4510	Roeser @ 2nd St	67	4.33	1.69	33:24 N	112:04 W	1079
FCDMC #5110	Saddleback FRS	81	2.79	2.17	33:28 N	113:04 W	1177
FCDMC #6940	Sand Tanks Wash	132	1.45	1.42	32:48 N	112:38 W	1108
FCDMC #6920	Sauceda Wash	131	1.38	2.20	32:52 N	112:45 W	726
FCDMC #4950	Seven Springs	77	12.24	5.55	34:03 N	111:51 W	4595
FCDMC #6625	Signal Buttes FRS	124	6.10	1.97	33:27 N	111:35 W	1650
FCDMC #5565	Skunk Creek @ I-17	n/s	6.34	2.24	33:44 N	112:07 W	1475
FCDMC #5190	Smith Peak	86	7.24	4.88	34:04 N	113:21 W	5131
FCDMC #5275	Sols Wash	91	4.61	3.98	34:07 N	112:57 W	2771
FCDMC #6550	South Mountain West	n/s	2.40	1.65	33:19 N	112:09 W	1500

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila R.							
FCDMC #6510	South Mountain Park	n/s	3.82	1.97	33:21 N	112:03 W	2135
FCDMC #4560	Spookhill FRS	n/s	5.63	1.97	33:28 N	111:41 W	1595
FCDMC #5245	Sunnycove FRS	90	3.90	4.37	33:57 N	112:44 W	2200
FCDMC #5230	Sunset FRS	n/s	3.58	1.81	33:58 N	112:45 W	2100
FCDMC #5730	Sunset Point	112	10.39	6.69	34:11 N	112:08 W	3378
FCDMC #5625	Sunup Ranch	n/s	7.48	3.23	33:54 N	112:08 W	2141
FCDMC #4720	Thomas @ 16th St	n/s	4.49	1.65	33:29 N	112:02 W	1120
FCDMC #4750	Thomas @ 48th St	n/s	4.80	1.97	33:29 N	111:59 W	1200
FCDMC #5945	Thompson Peak	120	6.06	2.68	33:39 N	111:49 W	3993
FCDMC #6655	Thunder Mtn	n/s	4.57	1.93	33:30 N	111:38 W	2552
FCDMC #4630	Thunderbird Academy	n/s	4.41	1.93	33:37 N	111:55 W	1448
FCDMC #5340	Towers Mtn	n/s	7.21	7.20	34:14 N	112:22 W	7528
FCDMC #5580	Upper Skunk Creek	107	7.59	3.94	33:54 N	112:04 W	2109
FCDMC #5130	Upper Tiger Wash	83	6.22	3.78	33:49 N	113:10 W	2198
FCDMC #6900	Upper Waterman Wash	130	2.32	1.30	33:05 N	112:25 W	1600
FCDMC #6640	Usery Mtn Park	n/s	6.69	2.05	33:28 N	111:36 W	1799
FCDMC #6980	Vekol Wash	134	2.08	1.26	32:51 N	112:15 W	1720
FCDMC #6685	Vineyard FRS	n/s	4.88	1.34	33:21 N	111:33 W	1582
FCDMC #5260	Vulture Mine	n/s	3.27	4.25	33:57 N	112:46 W	2311
FCDMC #6880	Waterman Wash	128	3.32	1.81	33:13 N	112:19 W	1263
FCDMC #5415	White Tank 3	n/s	5.83	1.97	33:32 N	112:28 W	1190

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila R.							
FCDMC #6820	White Tanks 4	n/s	4.45	1.97	33:27 N	112:30 W	1044
FCDMC #5430	White Tanks E. Peak	99	9.64	6.54	33:34 N	112:33 W	4031
FCDMC #5365	Wilhoit	97	6.69	5.04	34:27 N	112:37 W	5043
FCDMC #5455	Wittmann	n/s	5.04	3.03	33:46 N	112:31 W	1653
FCMDC #5290	Yarnell Hill	92	11.57	5.98	34:13 N	112:45 W	5128
NWS	Alpine	n/s	4.26	n/a	n/a	n/a	n/a
NWS	Alpine 8SE	n/s	6.26	n/a	n/a	n/a	n/a
NWS	Beaver Creek	n/s	5.52	n/a	n/a	n/a	n/a
NWS (0958)	Bowie	62	4.04	n/a	32:20 N	109:29 W	3770
NWS	Campbell Ave (Tucson)	n/s	5.91	n/a	n/a	n/a	n/a
NWS	Flagstaff	n/s	7.07	n/a	n/a	n/a	n/a
NWS (3027)	Florence	64	4.79	n/a	33:02 N	111:23 W	1505
NWS	Green Valley	n/s	3.46	n/a	n/a	n/a	n/a
NWS (4590)	Kearney	63	10.96	n/a	33:03 N	110:54 W	1850
NWS (6513)	Picacho 8SE	65	5.40	n/a	32:39 N	111:25 W	1830
NWS (8865)	Tumacacori	66	7.26	n/a	31:34 N	111:03 W	3267
NWS (9166)	Walnut Grove	n/s	8.62	n/a	34:18 N	112:33 W	3764
NWS (9425)	Winkelman 12SE	61	6.55	n/a	32:52 N	110:36 W	2590
PCFCD #2080	Alamo Tank	n/s	8.19	4.00	32:17 N	110:38 W	4100
PCFCD #3310	Alamo Wash	n/s	4.69	2.20	32:15 N	110:52 W	2440

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
PCFCD #6330 Gila R.	Anamax	n/s	1.11	0.04	31:52 N	111:03 W	3445
PCFCD #6110	Avra Valley Air Park	148	3.78	1.64	32:24 N	110:13 W	2021
PCFCD #2050	Bellota Ranch Rd	140	3.34	4.29	32:18 N	110:36 W	4300
PCFCD #6420	Brawley/Three Points	154	3.39	1.32	32:33 N	111:20 W	2551
PCFCD #1070	Cargodera Canyon	137	5.36	2.79	32:26 N	110:52 W	3195
PCFCD #1200	CDO at Ina	138	5.67	1.68	32:20 N	110:02 W	2245
PCFCD #1050	Cherry Spring	136	5.09	3.61	32:30 N	110:50 W	4080
PCFCD #4280	Cienega/I-10	143	2.60	1.28	31:59 N	110:34 W	3570
PCFCD #6290	Corona	149	3.55	1.32	31:58 N	110:47 W	3147
PCFCD #6020	Cortaro Rd	n/s	4.44	1.64	32:21 N	110:05 W	2145
PCFCD #4310	Davidson Canyon	n/s	2.14	1.68	31:59 N	110:38 W	3480
PCFCD #6410	Diamond Bell Ranch	153	3.74	1.68	31:59 N	111:50 W	3250
PCFCD #1040	Dodge Tank	n/s	6.28	3.27	32:30 N	110:51 W	3240
PCFCD #6350	Elephant Head Butte	152	3.19	1.80	31:43 N	110:58 W	3475
PCFCD #1010	Golder Ranch	n/s	5.50	3.15	32:32 N	110:52 W	3310
PCFCD #1100	Golder Road Bridge	n/s	4.96	1.20	32:26 N	110:53 W	2960
PCFCD #2030	Italian Trap	n/s	6.86	3.20	32:16 N	110:33 W	4000
PCFCD #6310	Keystone Peak	150	3.42	1.32	31:52 N	110:12 W	6206
PCFCD #4100	Manning Camp	n/s	0.95	3.51	32:12 N	110:33 W	7930
PCFCD #1090	Mount Lemmon	n/s	8.83	2.71	32:26 N	110:47 W	9000

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
PCFCD #2060	Mule Deer Tank	n/s	0.32	0.04	32:14 N	110:36 W	4610
PCFCD #1020	Oracle Ranger Sta	135	6.93	2.84	32:35 N	110:47 W	4520
Gila R.							
PCFCD #1030	Oracle Ridge	n/s	6.68	2.99	32:31 N	110:45 W	6560
PCFCD #2020	Park Tank	139	8.03	3.43	32:15 N	110:32 W	5100
PCFCD #1060	Pig Springs	n/s	7.80	3.47	32:31 N	110:47 W	4815
PCFCD #1080	Rancho Solano	n/s	6.08	2.31	32:33 N	110:51 W	3380
PCFCD #3050	Rillito/Dodge	n/s	3.29	1.40	32:16 N	110:54 W	2375
PCFCD #4110	Rincon Creek	n/s	n/a	1.72	32:07 N	110:37 W	3137
PCFCD #2160	Sabino Dam	n/s	7.03	2.76	32:18 N	110:48 W	2160
PCFCD #6060	SCR/Conoa	146	1.69	1.20	31:44 N	110:02 W	3008
PCFCD #6050	SCR/Continental	145	2.87	1.04	31:51 N	110:58 W	2856
PCFCD #6070	SCR/Nogales	147	3.38	1.48	31:20 N	110:51 W	3825
PCFCD #6040	SCR/Valencia	144	3.19	1.12	32:08 N	110:59 W	2400
PCFCD #2090	Tanque Verde Ranch	n/s	6.35	2.96	32:14 N	110:40 W	2720
PCFCD #2110	Tanque Verde Bridge	n/s	5.40	2.44	32:15 N	110:49 W	2510
PCFCD #6320	Tinajo Ranch	151	4.31	1.92	31:50 N	111:09 W	4165
PCFCD #2120	TV/Sabino Bridge	141	6.19	2.32	32:15 N	110:50 W	2475
PCFCD #4250	Vail	n/s	0.51	0.00	32:02 N	110:40 W	3210
PCFCD #6430	Valhala	n/s	3.04	1.32	32:06 N	111:08 W	2585
PCFCD #2170	Vantana/Sunrise	n/s	6.08	2.20	32:18 N	110:50 W	2720

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
PCFCD #2150	White Tail	142	19.17	6.06	32:25 N	110:44 W	8400
SCS	Alpine	n/s	5.07	2.31	n/a	n/a	n/a
SCS Gila R.	Ash Fork 5 N	n/s	5.95	4.42	n/a	n/a	n/a
SCS 11R07	Baker Butte Snotel	43	16.10	10.10	34:27 N	111:23 W	7700
SCS (0670)	Beaver Creek R.S.	44	6.71	2.90	34:40 N	111:43 W	3820
SCS (1849)	Beaverhead R.S., NM	n/s	2.80	1.60	n/a	n/a	n/a
SCS (0775)	Bisbee	155	5.50	2.74	31:28 N	109:56 W	5600
SCS (1314)	Casa Grande Ruins	56	4.19	1.38	33:00 N	111:32 W	1419
SCS	Clifton	54	n/a	1.38	33:03 N	109:17 W	3480
SCS 12R06	Copper Basin Divide	45	10.00	7.56	34:30 N	112:33 W	6720
SCS 09S07S	Coronado Trail Snotel	36	7.60	4.30	33:48 N	109:09 W	8400
SCS (2664)	Douglas FAA AP	156	3.11	0.73	31:28 N	109:36 W	4098
SCS (3010)	Flagstaff WSO AP	46	9.55	9.99	35:08 N	111:40 W	7006
SCS	Fort Bayard, NM	n/s	4.73	2.02	n/a	n/a	n/a
SCS 11P02 NWS (3160)	Fort Valley	60	6.60	6.00	35:16 N	111:44 W	7347
SCS 08S01S	Frisco Divide Snotel, NM	n/s	4.20	3.30	33:44 N	108:56 W	8000
SCS 11P13S	Fry Snotel	47	13.00	8.30	35:04 N	111:51 W	7200
SCS 09S11S	Hannagan Meadows Snotel	37	10.90	7.80	33:39 N	109:18 W	9020
SCS 11R05	Happy Jack Ranger Sta	48	12.10	5.40	34:45 N	111:24 W	7630

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
SCS 10R04S	Heber Snotel	38	13.40	9.30	34:19 N	110:45 W	7640
SCS 07S04S	Lookout Mountain Snotel, NM	n/s	3.50	2.90	33:22 N	107:50 W	8500
SCS	Luna Ranger Sta, NM	n/s	3.96	2.16	n/a	n/a	n/a
SCS 09S02S	Maverick Fork Snotel	39	9.70	5.70	33:55 N	109:27 W	9200
SCS 11R03S Gila R.	Mormon Mountain Snotel	49	13.00	11.50	34:56 N	111:31 W	7500
SCS	Mt Lemon	n/s	9.72	2.68	n/a	n/a	n/a
SCS (5924)	Nogales 6N	57	4.44	0.50	31:25 N	110:57 W	3560
SCS (6323)	Payson	50	10.06	5.64	34:14 N	111:20 W	4913
SCS (6653)	Pleasant Valley R.S.	40	9.32	5.16	34:06 N	110:56 W	5050
SCS (6796)	Prescott	51	5.69	5.73	34:34 N	112:26 W	5205
SCS	Reserve R.S., NM	n/s	2.53	2.72	n/a	n/a	n/a
SCS (7390)	Safford Exp Farm	55	3.23	1.23	32:49 N	109:41 W	2954
SCS (7880)	Sierra Vista	58	3.71	1.13	31:33 N	110:18 W	4600
SCS 08T01S	Signal Peak Snotel	n/s	10.80	7.00	32:55 N	108:08 W	8360
SCS	Silver City, NM	n/s	5.62	2.69	n/a	n/a	n/a
SCS 08S08S	Silver Ck Divide Snotel	n/s	9.40	8.10	33:22 N	108:43 W	9000
SCS 11R08S	Sugar Loaf Snotel	52	9.80	n/a	34:37 N	111:31 W	6120
SCS (8650)	Tonto Ck Fish Hatch #2	n/s	19.89	7.18	34:23 N	111:06 W	6390
SCS (8820)	Tucson WSO AP	59	4.81	1.21	32:08 N	110:56 W	2584
SCS 12P02S	White Horse Lake Snotel	53	12.80	10.40	35:08 N	112:09 W	7180

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
SCS 09S18S	Wildcat Snotel	42	10.50	6.00	33:45 N	109:30 W	7850
SCS 10S01S	Workman Creek Snotel	41	22.10	12.30	33:49 N	110:55 W	6900
SRP - AGUM	Agua Fria - Mayer	n/s	6.66	3.82	n/a	n/a	n/a
SRP - AGUR	Agua Fria - Rock Springs	n/s	5.31	3.85	n/a	n/a	n/a
SRP - ASHF	Ashfork	27	4.64	3.89	35:17 N	112:42 W	5800
SRP - BARM Gila R.	Bar-M Ranch	32	10.08	6.27	34:52 N	111:36 W	6380
SRP - BLKP	Black R. - Point of Pines	n/s	5.88	3.40	n/a	n/a	n/a
SRP - BLRR	Blue Ridge Res. nr Verde	n/s	4.42	2.78	n/a	n/a	n/a
SRP - BUSP	Buck Spring	n/s	n/a	5.10	34:06 N	110:56 W	7400
SRP - CARZ	Carrizo Ck - Show Low	n/s	6.71	4.23	n/a	n/a	n/a
SRP - CAVE	Cave Ck - Cottonwood	n/s	4.88	3.98	n/a	n/a	n/a
SRP - CHER	Cherry Creek - Globe	n/s	14.11	7.29	n/a	n/a	n/a
SRP - CHEV	Chevelon Canyon	n/s	3.56	1.17	n/a	n/a	n/a
SRP - CHLD (CHIL)	Childs	35	8.85	4.48	34:21 N	111:42 W	2720
SRP - CIBQ	Cibecue Ck - Chrysotile	n/s	9.05	5.29	n/a	n/a	n/a
SRP - COLC	Colcord Mt	28	3.81	5.64	34:18 N	110:58 W	6165
SRP - CROK	Crook Trail	24	9.25	4.91	34:30 N	111:34 W	5900
SRP - DBEV	Dry Beaver Ck - Rimrock	n/s	5.67	n/a	n/a	n/a	n/a
SRP - EVED	E. Verde R. - Childs	n/s	9.01	1.68	n/a	n/a	n/a
SRP - EVRD	E. Verde R. diversion nr Pine	n/s	13.57	5.70	n/a	n/a	n/a

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
SRP - EGLM	Eagle Ck - Morenci	n/s	2.74	n/a	n/a	n/a	n/a
SRP - FISH	Fish Creek	29	7.62	4.08	33:32 N	111:16 W	2450
SRP - FLGW	Flagstaff	n/s	4.77	n/a	n/a	n/a	n/a
SRP - FORD	Forestdale Ck diversion nr Show Low	n/s	5.53	4.38	n/a	n/a	n/a
SRP - GSLA	Gisela	23	8.01	1.54	34:06 N	111:16 W	3000
SRP - GLOB (GLBE)	Globe	34	8.99	4.50	33:21 N	110:46 W	3800
SRP - HJRS Gila R.	Happy Jack Ranger Sta	25	9.97	4.43	34:40 N	111:24 W	7500
SRP - JCAB	JD Cabin at Whitehorse Lake	30	6.36	6.63	35:08 N	112:03 W	6720
SRP - NFTH	N. Fk Thomas Ck nr Alpine	n/s	4.25	4.83	n/a	n/a	n/a
SRP - OAKS	Oak Creek - Sedona	n/s	7.87	4.30	n/a	n/a	n/a
SRP - PVRS	Pleasant Valley Ranger Station	26	7.09	4.38	34:17 N	110:50 W	5200
SRP - SLTC	Salt River - Chrysotile	n/s	7.33	4.17	n/a	n/a	n/a
SRP - SLTR	Salt R. - Roosevelt	n/s	5.58	3.74	n/a	n/a	n/a
SRP - SLTS	Salt R. blw Stewart Mt Dam	n/s	5.75	n/a	n/a	n/a	n/a
SRP - SUNF	Sunflower	31	15.13	6.62	33:52 N	111:28 W	3440
SRP - SYCM	Sycamore Creek	n/s	6.09	3.08	n/a	n/a	n/a
SRP - TONT	Tonto Ck - Roosevelt	n/s	n/a	5.04	n/a	n/a	n/a
SRP - TNFH (TOFH)	Tonto Fish Hatchery	33	13.98	5.77	34:23 N	111:06 W	6390
SRP - VEDC	Verde R. - Clarkdale	n/s	4.65	2.70	n/a	n/a	n/a

Table 1 (continued). Total Precipitation, 5-19 January and 8-28 February, 1993

BASIN/ AGENCY[1]	LOCATION	MAP ID#[2]	5-19 Jan '93 ppt total[3]	8-28 Feb '93 ppt total[3]	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
SRP - VEDT	Verde R. - abv Horseshoe	n/s	5.20	4.64	n/a	n/a	n/a
SRP - VEDE	Verde R. - blw E. Verde	n/s	11.21	4.04	n/a	n/a	n/a
SRP - VEDP	Verde River - Paulden	n/s	5.21	3.14	n/a	n/a	n/a
SRP - WBEV	Wet Beaver Ck - Rimrock	n/s	2.11	1.46	n/a	n/a	n/a
SRP - WITF	White R. - Fort Apache	n/s	5.75	3.78	n/a	n/a	n/a
Sulphur Springs Valley / SE AZ							
ASLC	Galeyville (nr Portal)	n/s	4.81	2.20	n/a	n/a	n/a
ASLC	Portal	n/s	6.15	1.54	n/a	n/a	5000
SCS (9334)	Willcox	157	6.11	1.38	32:18 N	109:51 W	4175

(1) Listed agency provided data, numbers in parentheses are National Weather Service Station Index Numbers for cooperatively operated gages.
Agencies providing data:
ASLC - Arizona State Laboratory of Climatology
COE - Corps of Engineers
FCDMC - Flood Control District of Maricopa County
NWS - National Weather Service
PCFCD - Pima County Flood Control District
SCS - Soil Conservation Service.

(2) MAP ID#: ID# used to plot gages on Selected Precipitation Gaging Stations map

(3) Total precipitation in inches. All SCS and FCDMC #5380 (Mt Union) precipitation is total for month. SRP Ashfork (ASHF) total 5 Jan - 20 Jan. Most or all of the precipitation in January and February occurred within the storm periods listed.

n/a: not readily available at the time report was prepared
n/s: not shown on Selected Precipitation Gaging Stations map

Note: All data are provisional.

APPENDIX B

STREAMFLOW / DISCHARGE DATA

(PRELIMINARY)

Table 2. Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[2] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Little Colorado										
09384000	ab Lyman Lake	706	33 (9th)	63(21st)	16,000(25Jul40)	1940	<2	34:19 N	109:22 W	6010
09386030	ab Zion Reservoir	1,007	17(19th)	8.7(15th)	582(4Aug83)	1976	n/a	34:35 N	109:24 W	5560
09390500	Show Low Ck nr Lakeside	68.6	4370(8th)	3400(19)	5550(18Dec78)	1954	20	34:11 N	109:59 W	6610
09392000	Show Low Ck bl Jaques Dam	73	1840(8th)	1560(20)	3080(28Dec84)	1943	n/a	34:12 N	110:00 W	6530
09393500	Silver Creek nr Snowflake	925	5390(8th)	4290 20th	25,000(5Dec19)	1920	5	34:40 N	110:03 W	5204
09394500	at Woodruff	8,072	8960(8th)	5250(20th)	25,000(5Dec19)	1916	11	34:47 N	110:03 W	5130
09396100	Puerco R. nr Chambers	2,156	2920(4th)	n/a	17,800(30Sep71)	1971	n/a	35:11 N	109:27 W	5705
09401000	at Grand Falls	21,068	16,600(12th)	12,300(23rd)	120,000(19Sep23)	1923	4	35:26 N	111:12 W	4439
09401260	Moenkopi W. at Moenkopi	1,629	8.0(8th)	3110(20th)	10,100(30Sep83)	1974	<2	36:06 N	111:12 W	4610
09402000	nr Cameron	26,459	16,340(13th)	14,000(23rd)	120,000(20Sep23)	1923	23	35:56 N	111:34 W	3979
Bill Williams										
09424432	Francis Ck nr Bagdad	134	4500(8th)	n/a	3090(1Mar91)	1990	n/a	34:46 N	113:16 W	3260
09424447	Burro Ck at Old US 93 Bridge	611	43,600(8th)	55,300(8th)	47,400(14Feb80)	1980	n/a	34:33 N	113:27 W	1880
09424450	Big Sandy R. nr Wikieup	2,742	41,500(8th)	68,700(9th)	38,500(20Feb80)	1966	65	34:28 N	113:37 W	1400
COE	Alamo Dam inflow:*	4,770	2630(19th)	5110(17th)	estimated 200,000(1891)	Dam completed 1968	n/a	n/a	n/a	n/a
09426000	bl Alamo Dam	4,633	2880(20th)	5300(14th)	4950(26Jan69) max since dam const.	1891	n/a	34:14 N	113:36 W	967
Gila										
09444200	Blue R. nr Clifton	506	11,300(8th)	n/a	30,000(20Oct72)	1966	7	33:17 N	109:12 W	4160

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
* calculated inflow based on change in reservoir storage
n/a not readily available at the time this report was prepared

Table 2 (continued). Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[2] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila										
09444500	San Francisco R. at Clifton	2,766	42,900(18th)	15,800(20th)	90,900(2Oct83)	1891	20	33:03 N	109:18 W	3436
09447000	Eagle Ck ab Pumping Plant	622	28,800(8th)	9800(21st)	36,400(2Oct83)	1916	55	33:04 N	109:27 W	3495
09447800	Bonita Ck nr Morenci	302	19,500(18th)	1690(16th)	19,400(2Oct83)	1981	n/a	32:57 N	109:32 W	3500
09448500	at Head of Safford Valley	7,896	86,200(19th)	500(21st)	132,000(2Oct83)	1914	40	32:52 N	109:31 W	3060
09466500	at Calva	11,470	109,000(20th)	36,800(21st)	150,000(3Oct83)	1916	60	33:11 N	110:13 W	2517
09468500	San Carlos R. nr Peridot	1,026	54,800(7th)	11,900(20th)	40,600(14Mar41)	1916	30	33:18 N	110:27 W	2579
Bureau of Rec	Coolidge Dam inflow:* outflow:	12,886	87,200(11th) 32,800(20th)	31,600(22nd) 10,300(23rd)	n/a	Dam completed 1928	n/a	33:11 N	110:33 W	2383
09469500	bl Coolidge Dam	12,886	29,300(21st)	10,000(22-24)	150,000(28Nov05) 4960(7Oct83)	1906	20	33:10 N	110:32 W	2309
09470000	at Winkelman	13,268	37,200(20th)	12,600 (24th)	55,000(9Aug44)	1942	3	33:00 N	110:46 W	1922
09471000	San Pedro R. at Charleston	1,234	11,500(19th)	84 (22nd)	98,000(28Sep26)	1916	5	31:38 N	110:10 W	3954
09472000	San Pedro R. nr Redington	2,927	19,100(19th)	498 (20th)	90,000(28Sep26)	1926	3	32:23 N	110:27 W	2940
09473000	Aravaipa Ck nr Mammoth	537	13,000 (11th)	669 (20th)	70,800(2Oct83)	1919	9	32:51 N	110:37 W	2350
09474000	at Kelvin	18,011	74,900(19th)	12,800(24th)	190,000(28Nov05) 100,000(2Oct83)	1891	n/a	33:06 N	110:59 W	1745
09480000	Santa Cruz R. nr Lochiel	82.2	7320(18th)	n/a	12,000 (9Oct77,15Aug84)	1949	35	31:21 N	110:35 W	4620
09480500	Santa Cruz R. nr Nogales	533	8800(18th)	n/a	31,000(9Oct77)	1930	10	31:21 N	110:51 W	3703
09482000	Santa Cruz R. at Continental	1,662	32,400(19th)	n/a	45,000(2Oct83)	1940	100	31:51 N	110:59 W	2832
09482500	Santa Cruz at Tucson	2,222	37,400(19th)	n/a	52,700(2Oct83)	1915	30	32:13 N	110:59 W	2318

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
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n/a not readily available at the time this report was prepared

Table 2 (continued). Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[2] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
Gila										
PCFCD	Santa Cruz at Valencia Rd	n/a	22,000(18th)	M	n/a	n/a	n/a	n/a	n/a	n/a
09484000	Sabino Ck nr Tucson	35.5	12,900(8th)	n/a	7730(6Sept70)	1932	100	32:19 N	110:49 W	2720
09484500	Tanque Verde at Tucson	219	24,500(8th)	3020(19th)	12,700(18Dec78)	1940	n/a	32:16 N	110:50 W	2470
09485700	Rillito Ck at Dodge Blvd	871	24,100(8th)	1900(20th)	10,600(24Jul90)	1988	100	32:16 N	110:55 W	2380
PCFCD 09486500	Santa Cruz R. at Cortaro	3,503	40,000	M	65,000(2Oct83)	1940	>100	32:21 N	111:06 W	2133
PCFCD	Santa Cruz R. at Trico-Marana Bridge	n/a	38,000	M	n/a	n/a	n/a	n/a	n/a	n/a
09488650	Vekol W. nr Stanfield	150	n/a	n/a	2610(17Jul1990)	1990	n/a	32:51 N	112:15 W	1724
09489000	Santa Cruz R. nr Laveen	8,581	11,000(21st)	n/a	33,000(4Oct83)	1940	n/a	33:14 N	112:10 W	1021
09489500	Black R. bl Pumping Plant	560	8940(8th)	3080(20th)	17,900(19Oct72)	1954	n/a	33:29 N	109:46 W	5725
09490500	Black R. nr Ft. Apache	1,232	54,700(8th)	12,800(20th)	50,000(19Jan16)	1915	15	33:43 N	110:13 W	4345
09492400	E. Fork White R. nr Ft. Apache	38.8	563(8th)	190(20th)	2700(1Oct83)	1958	10	33:49 N	109:49 W	6050
09494000	White R. nr Ft. Apache	632	12,600(8th)	4840(20th)	14,600(18Dec78)	1958	35	33:44 N	110:10 W	4366
09496500	Carrizo Ck. nr Show Low	439	19,300(8th)	10,400(20th)	23,000(30Dec65)	1951	18	33:59 N	110:17 W	4750
09497500	Salt R. nr Chrysotile	2,849	76,600(8th)	33,900(20th)	74,000(19Jan16)	1916	40	33:48 N	110:30 W	3355
09497800	Cibecue Ck nr Chrysotile	295	10,600(8th)	7880(20th)	22,200(2Sep77)	1959	10	33:51 N	110:33 W	3200
09497980	Cherry Ck nr Globe	200	10,100th)	4130(19th)	15,700(17Jan79)	1966	7	33:50 N	110:51 W	3200
09498400	Pinal Ck at Inspiration Dam	195	5700(12th)	3300(20th)	2920(9Jul81)	1980	n/a	33:34 N	110:54 W	2800
09498500	Salt R. nr Roosevelt	4,306	143,000(8th)	60,200(20th)	100,000(19Jan16)	1916	50	33:37 N	110:55 W	2177
Gila										

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
[a] calculated inflow based on change in reservoir storage
n/a not readily available at the time this report was prepared

Table 2 (continued). Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[2] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
09499000	Tonto Ck ab Gun Ck	675	72,500 (8th)	29,200(20th)	61,400(15Feb80)	1941	25	33:59 N	111:18 W	2523
SRP	Roosevelt Dam inflow:[a]	5,830	146,000(8th)	74,300(20th)	n/a	Dam completed 1911	n/a	n/a	n/a	n/a
SRP	Stewart Mountain Dam outflow:	6,211	41,800(8th)	24,800(21st)	n/a	Dam completed 1930	n/a	33:33 N	111:35 W	n/a
09502000	Salt R. bl Stewart Mt Dam	6,232	34,500(8th)	23,700(21st)	64,000(16Feb80)	1935	n/a	33:33 N	111:35 W	1370
09503700	Verde R. nr Paulden	2,507	9060(8th)	23,200(20th)	15,700(20Feb80)	1963	50	34:54 N	112:20 W	4117
09504000	Verde R. nr Clarkdale	3,503	26,300(8th)	53,200(20th)	50,600(21Feb20)	1916	85	34:51 N	112:04 W	3500
09504430	Oak Ck at Sedona	233	15,700 (8th)	23,200(19th)	9460(30Nov82)	1983	n/a	34:52 N	111:46 W	4169
09504500	Oak Ck nr Comville	355	18,500(8th)	26,000(20th)	26,400(19Feb80)	1938	80	34:46 N	111:53 W	3470
09505350	Dry Beaver Ck nr Rimrock	142	11,600(8th)	9870(20th)	26,600(5Sep70)	1961	6	34:44 N	111:47 W	3694
09505800	W. Clear Ck nr Camp Verde	241	24,800(8th)	6900(20th)	22,400(18Dec78)	1965	8	34:32 N	111:42 W	3630
09506000	Verde R. nr Camp Verde	5,009	87,500 (8th)	119,000(20th)	97,000(3Mar38)	1934	65	34:27 N	111:47 W	2874
09507980	E. Verde R. nr Childs	331	20,100(8th)	7650(20th)	23,500(5Sep70)	1961	14	34:17 N	111:39 W	2500
09508300	Wet Bottom Ck nr Childs	36.4	7380(8th)	1560(9th)	6830(19Feb80)	1968	10	34:10 N	111:42 W	2320
09508500	Verde R. bl Tangle Ck	5,858	145,000(8th)	124,000(20th)	150,000(24Feb1891)	1891	50	34:04 N	111:43 W	2029
SRP	Verde R. at Tangle Ck	5,858	135,000(8th)	112,000(20th)	150,000(24Feb1891)	1891	n/a	34:04 N	111:43 W	2029
SRP	Verde R. bl Bartlett Dam	6,161	114,000(8th)	56,500(20th)	n/a	Dam completed 1939	n/a	33:49 N	111:40 W	1572
09511300	Verde R. nr Scottsdale	6,615	81,000(8th)	23,900(21st)	98,000(16Feb80)	1961	n/a	33:34 N	111:40 W	1360
Gila										
FCDMC #5523	ACDC @ 67th Ave	n/a	480(8th)	M	n/a	n/a	n/a	n/a	n/a	n/a

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
[a] calculated inflow based on change in reservoir storage
n/a not readily available at the time this report was prepared

Table 2 (continued). Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[3] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
FCDMC #5103	Centennial Wash at SPRR	n/a	270(11th)	M	n/a	n/a	n/a	n/a	n/a	n/a
FCDMC #6113	Indian Bend Wash at Indian Bend Rd	n/a	3900(11th)	M	n/a	n/a	n/a	n/a	n/a	n/a
FCDMC #6099	Indian Bend Wash at McKellips	n/a	3100(11th)	M	n/a	n/a	n/a	n/a	n/a	n/a
FCDMC #6139	Indian Bend Wash at Sweetwater Ave	n/a	370(18th)	M	n/a	n/a	n/a	n/a	n/a	n/a
09512190	Salt R. at 24th St	13,391	112,000(8th)	M	3800(28Mar91)	1990	n/a	33:25 N	112:02 W	1100
FCDMC #6333	Cave Ck at Cactus	n/a	1370(10th)	M	n/a	n/a	3	n/a	n/a	n/a
FCDMC #6413	Cave Ck at Cave Creek	n/a	5800(8th) gage destroyed by floodwater	M	n/a	n/a	n/a	n/a	n/a	n/a
09512280	Cave Ck bl Cottonwood Wash	82.7	9200(8th)	4390(9th)	3900(1Mar91)	1981	n/a	33:53 N	111:57 W	2280
09512500	Agua Fria R. nr Mayer	585	27,400(8th)	17,800(20th)	33,100(19Feb80)	1940	65	34:19 N	112:04 W	3434
09512800	Agua Fria R. nr Rock Springs	1,111	52,500(8th)	30,400(20th)	85,000(27Nov19)	1920	26	34:01 N	112:10 W	1800
FCDMC #5403	Agua Fria R. at Buckeye Rd	n/a	2600(11th)	M	n/a	n/a	n/a	n/a	n/a	n/a
Bureau of Rec	New Waddell Dam inflow:[a] outflow:	1,433	70,800(8th) 2000(18th)	33,200(9th) 9000(9th)	n/a	Dam completed 1927	n/a	33:51 N	112:16 W	1431
09512830	Boulder Ck nr Rock Springs	37.8	10,000(8th)	1620(20th)	3230(1Mar91)	1984	n/a	33:60 N	112:13 W	1890
09512860	Humbug Ck nr Castle Hot Springs	59.9	9120(8th)	1060(20th)	3220(1Mar91)	1984	n/a	33:58 N	112:18 W	1790
Gila										
09513780	New R. nr Rock Springs	68.3	12,600(8th)	4230(9th)	18,600(5Sep70)	1962	22	33:58 N	112:06 W	2310
09513835	New R. at Bell Rd	185	2760(8th)	1830(10th)	14,600(19Dec67)	1963	n/a	33:38 N	112:14 W	1206

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
[a] calculated inflow based on change in reservoir storage
n/a not readily available at the time this report was prepared

Table 2 (continued). Peak Discharges, January-February, 1993

River Basin/ Station #[1]	Stream	Drainage Area (mi^2)	Jan 93 Peak Flow (ft^3/s)	Feb 93 Peak Flow (ft^3/s)	POR[2] Peak Flow (ft^3/s)	Record Began (yr)	Return Per.[3] Jan-Feb 93 Pk (yrs)	Latitude (deg:min)	Longitude (deg:min)	Elevation (ft)
FCDMC #5568 09513860	Skunk Ck nr Phoenix at I-17	64.9	4980(11th)	M	11,500(1Aug64)	1959	7	33:44 N	112:07 W	2180
09513910	New R. nr Glendale	324	5450(11th)	1850(10th)	38,000(Aug43)	1943	3	33:32 N	112:17 W	1135
FCDMC #5353	Hassayampa R. at Wagner Rd	n/a	13,800(8th)	M	n/a	n/a	n/a	n/a	n/a	n/a
09516500	Hassayampa R. nr Morristown	796	26,300(8th)	15,200(20th)	47,500(5Sep70)	1939	15	33:53 N	112:40 W	1831
09517000	Hassayampa R. nr Arlington	1,471	11,400(8th)	5580(9th)	39,000(5Sep70)	1961	8	33:21 N	112:44 W	832
09517490	Centennial W. at SPRR Bridge	1,817	9210(11th)	240(9th)	14,500(23Jul61) drainage area = 1870 mi^2	1981	n/a	33:19 N	112:53 W	841
09519500	bl Gillespie Dam	49,650	154,000(9th); (162,000 cfs @Estrella)	60,000 (21st)	250,000(Feb1891) 178,000(16Feb80) - max since u/s storage	1891	n/a	33:14 N	112:46 W	753
COE	Painted Rock Dam inflow:* outflow:	50,800	186,000(10th) 12,500(29th)	6-hr peak inf 73,300(21st) 25,600(26th)	220,000(Feb1980) 4500(Jun1983)	dam completed 1959	n/a	n/a	n/a	n/a
09520500	nr Dome	57,850	M	13,400(28th) actual peak 27,700(3Mar)	200,000(22Jan16) 14,000(22Apr41) 4820(18Sep63)	1904	n/a	32:46 N	114:25 W	148

(1) Station number and source of data is the US Geological Survey (USGS) unless designated as one of the following:
Bureau of Rec - US Bureau of Reclamation
COE - Corps of Engineers
FCDMC - Flood Control District of Maricopa County
PCFCD - Pima County Flood Control District, or,
SRP - Salt River Project.

USGS station number may also be listed if cooperative gage.

(2) POR = Period-of-Record.

(3) Frequency analyses of annual maximum events performed by USGS, values are approximate.

Note: All data are provisional.

- indicates no apparent flow above base discharge
M indicates flow data is unavailable
* calculated inflow based on change in reservoir storage
n/a not readily available at the time this report was prepared

APPENDIX C

SALT and GILA OVERFLOW MAPPING

Granite Reef Dam to Painted Rock Dam

R 6 W | R 5 W | R 4 W | R 3 W | R 2 W | R 1 W | R 1 E | R 2 E | R 3 E | R 4 E | R 5 E | R 6 E | R 7 E

T 3 N | T 2 N | T 1 N | T 1 S | T 2 S | T 3 S | T 4 S

Tonopah - Salome Hwy.
I-10
Sun Valley Pkwy
Yuma Rd.(1200-S)
Lower Buckeye Rd. (2800-S)
Southern Ave.(8000-S)
Baseline Rd.(7600-S)
Johnson Rd. (307th Ave.)
Bronco Rd. (299th Ave.)
Palo Verde Rd. (291st Ave.)
Wigan Ave. (283rd Ave.)
Jomar Rd. (275th Ave.)
Gravelly Rd. (267th Ave.)
Rose Rd. (259th Ave.)
Miller Rd. (251st Ave.)
Apache Rd. (243rd Ave.)
Watson Rd. (235th Ave.)
Rainbow Rd. (227th Ave.)
Dean Rd. (219th Ave.)
Arnold Rd. (211th Ave.)
Jackrabbit Trail
Perryville Rd. (187th Ave.)
Citrus Rd. (179th Ave.)
Cotton Ln. (173rd Ave.)
Sarival Ave. (163rd Ave.)
Bullard Ave. (155th Ave.)
Litchfield Rd. (139th Ave.)
Dysart Rd. (131st Ave.)
El Mirage Rd. (123rd Ave.)
115th Ave.
107th Ave.
99th Ave.
91st Ave.
83rd Ave.
75th Ave.
67th Ave.
59th Ave.
51st Ave.
43rd Ave.
35th Ave.
27th Ave.
19th Ave.
7th Ave.
Central Ave.
7th St.
16th St.
24th St.
32nd St.
40th St.
48th St.
56th St.
Scottsdale Rd.
Hayden Rd.
Pima Rd.
Agency Rd.
Indian School Rd.(4100-N)
Thomas Rd.(2900-N)
McDowell Rd.(1600-N)
McKellips Rd. (300-N)
Van Buren St. (300-N)
Buckeye Rd. (1200-S)
Broadway Rd. (4400-S)
Southern Ave. (6000-S)
Baseline Rd.(7600-S)
Dobbins Rd.(9200-S)
Elliot Rd. (10800-S)
Narramore Rd. (12400-S)
Arlington Canal Rd.
Cactus Rose Rd.
Desert Rose Rd.
Collente Rd.
Old U.S. 80
U.S. 80
M.C. 85
S.R. 85
Tuthill Rd. (195th Ave.)
Narramore Rd.(12400-S)
Arlington Rd.(13200-S)
Roy Rd.(14000-S)
Indian Springs Rd.
Hohokam Expy.
Country Club Dr.
Alma School Rd.
Dobson Rd. (88th St.)
Price Rd. (88th St.)
McClintock (89th St.)
Rural Rd. (90th St.)
Kyrene Rd. (48th St.)
Hardy Dr. (64th St.)
Mill Ave. (56th St.)
Hayden Rd. (64th St.)
Priest Dr. (56th St.)
Hardy Rd. (48th St.)
Van Buren (40th St.)
Greenfield Rd. (24th St.)
Higley Rd. (32nd St.)
Gilbert Rd. (40th St.)
Power Rd. (68th St.)
Ellsworth Rd. (60th St.)
Recker Rd. (68th St.)
GRANITE REEF DAM
Bush Hwy.
S.R. 87
SALT RIVER
GILA RIVER
GILLESPIE DAM

PLATE 1
PLATE 2
PLATE 3
PLATE 4
PLATE 5
PLATE 6
PLATE 7
PLATE 8
PLATE 9
PLATE 10
PLATE 11
PLATE 12
PLATE 13
PLATE 14

0' 25,000' 50,000' 75,000'

SCALE : 1" = 25,000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA-SALT RIVER
INDEX SHEET
JANUARY 9, 1993

PLATE 1 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

MATCH TO PLATE 3

Beeline Hwy

Arizona Canal

Granite Reef Dam

C.A.P.

Salt River

Flow

Southern Canal

Recker Rd

Bush Hwy

Salt River

Higley Rd

Thomas Rd

Gilbert Rd

Lindsay Rd

Val Vista Dr.

Greenfield Rd

McDowell Rd

0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

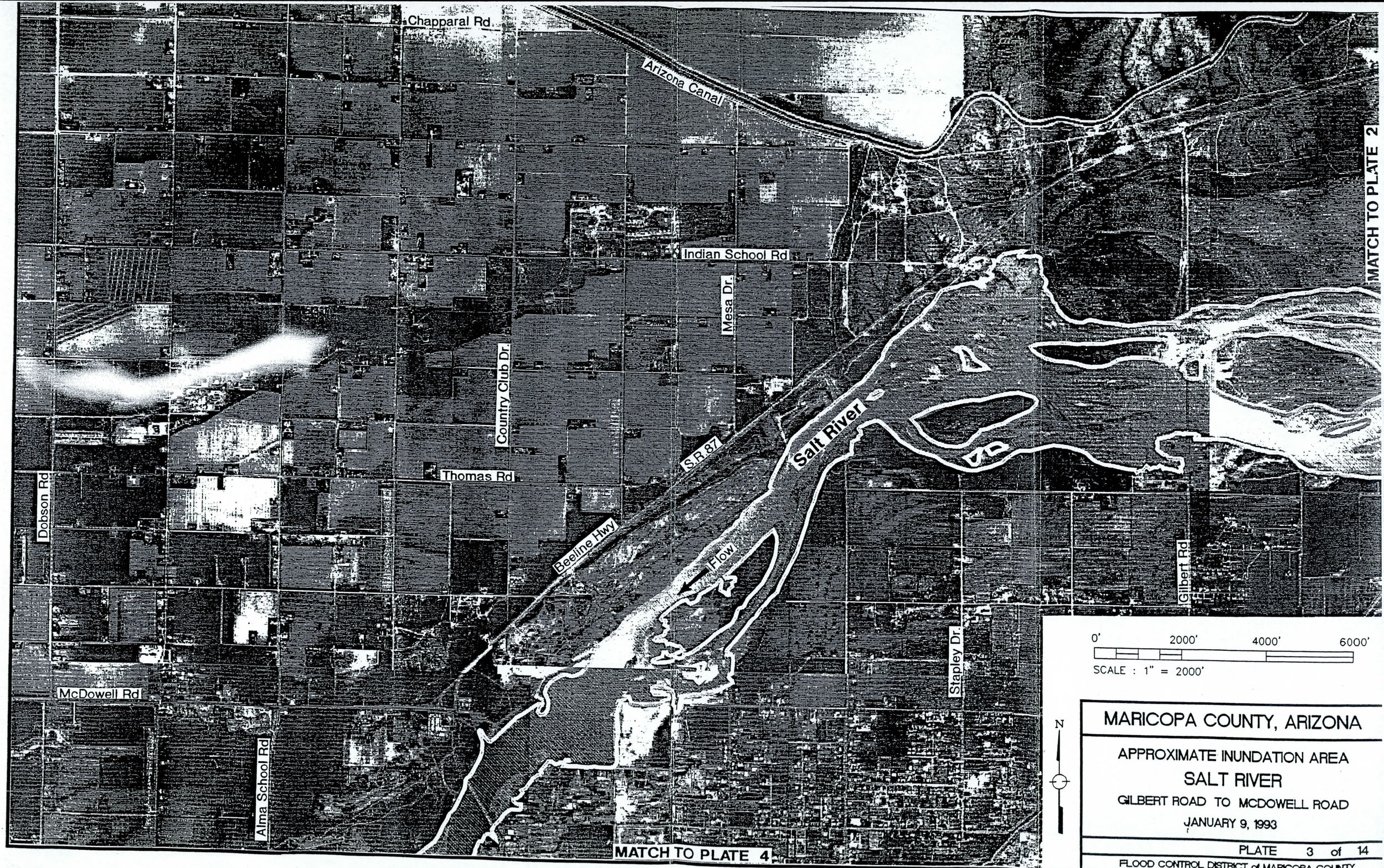
SALT RIVER

GRANITE REEF DAM TO GILBERT ROAD

JANUARY 9, 1993

PLATE 2 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
SALT RIVER
GILBERT ROAD TO MCDOWELL ROAD

JANUARY 9, 1993

PLATE 3 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

MATCH TO PLATE 3

McDowell Rd

McKellips Rd

Pima Rd

Salt River

Flow

Consolidated Canal

Crosscut Canal

Brown Rd

Tempe Canal

Stapley Dr.

Consolidated Canal

Gilbert Rd

MATCH TO PLATE 5

University Rd

Price Rd

Dobson Rd

Alma School Rd

S.R. 87-93
Country Club Dr.

Mesa Dr.

0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

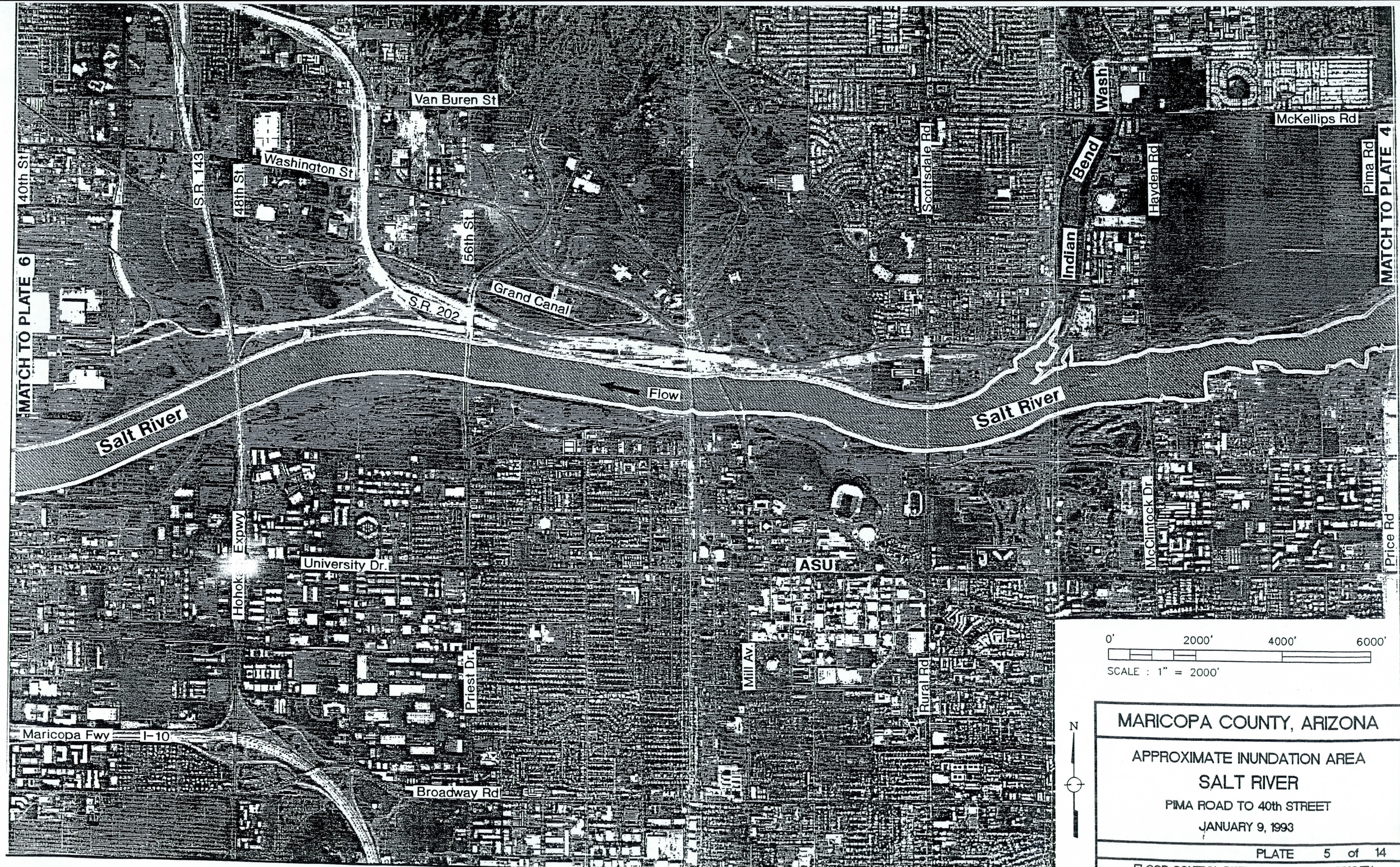
SALT RIVER

MCDOWELL ROAD TO PIMA ROAD

JANUARY 9, 1993

PLATE 4 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



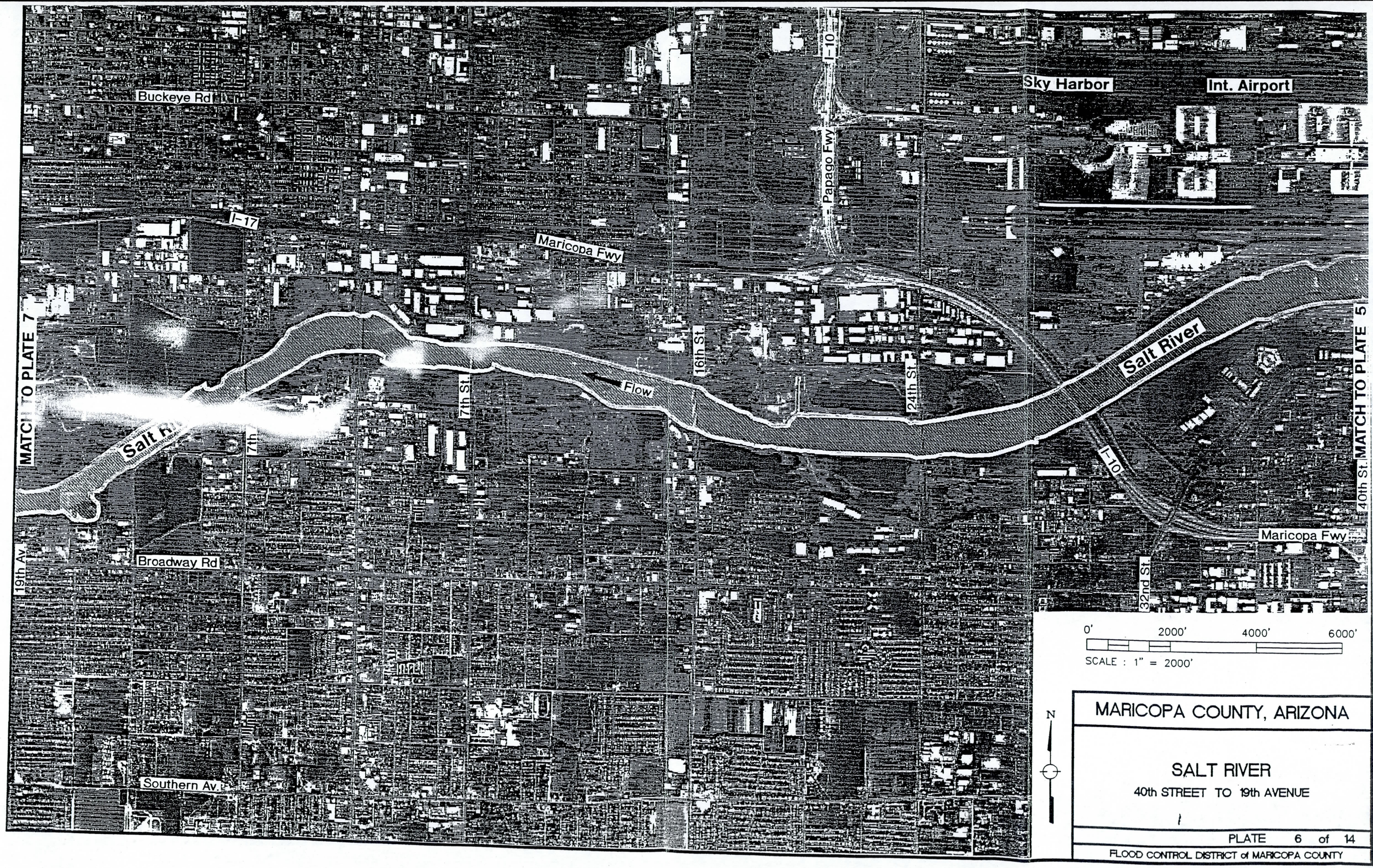
MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
SALT RIVER
PIMA ROAD TO 40th STREET

JANUARY 9, 1993

PLATE 5 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

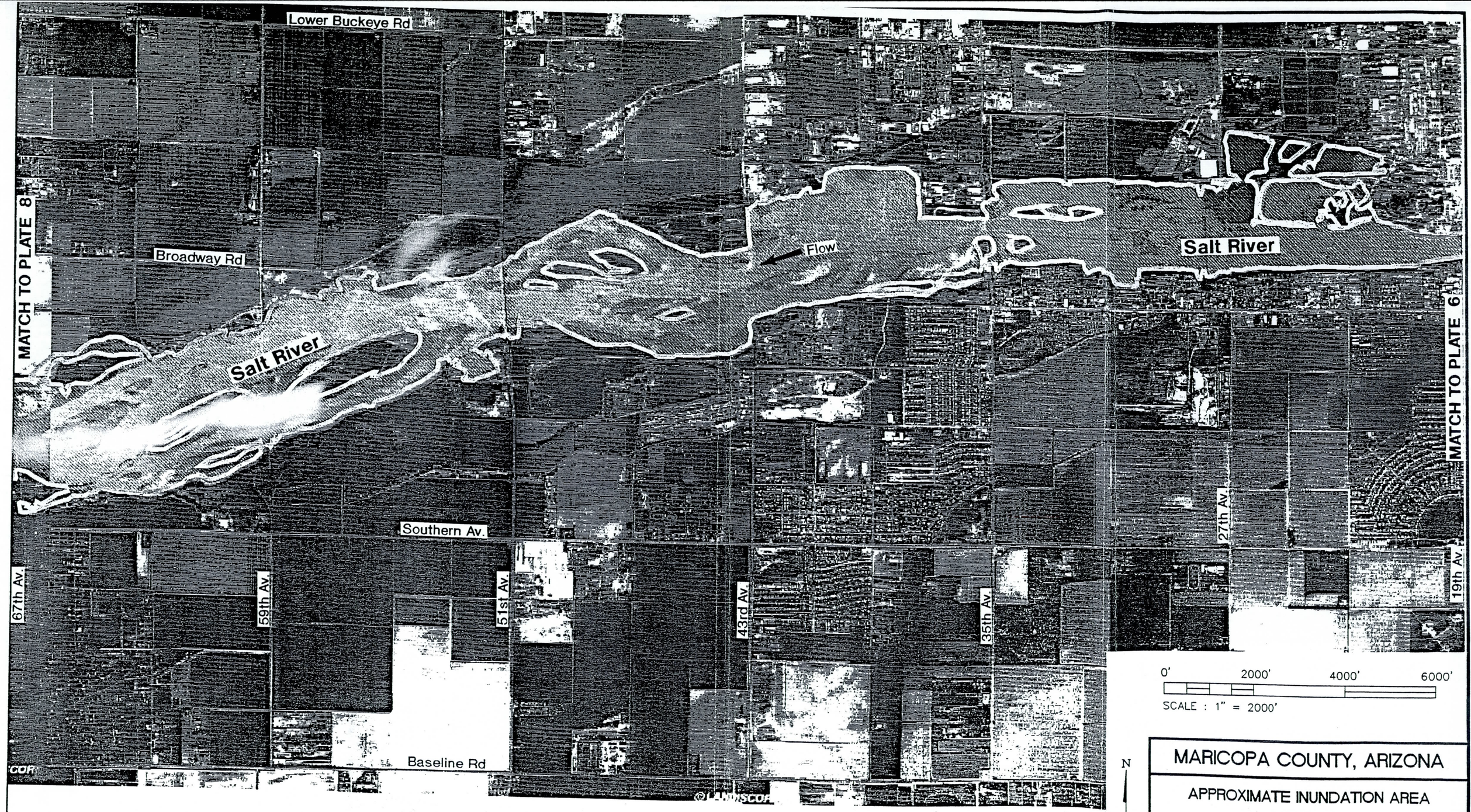
MARICOPA COUNTY, ARIZONA

SALT RIVER

40th STREET TO 19th AVENUE

PLATE 6 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

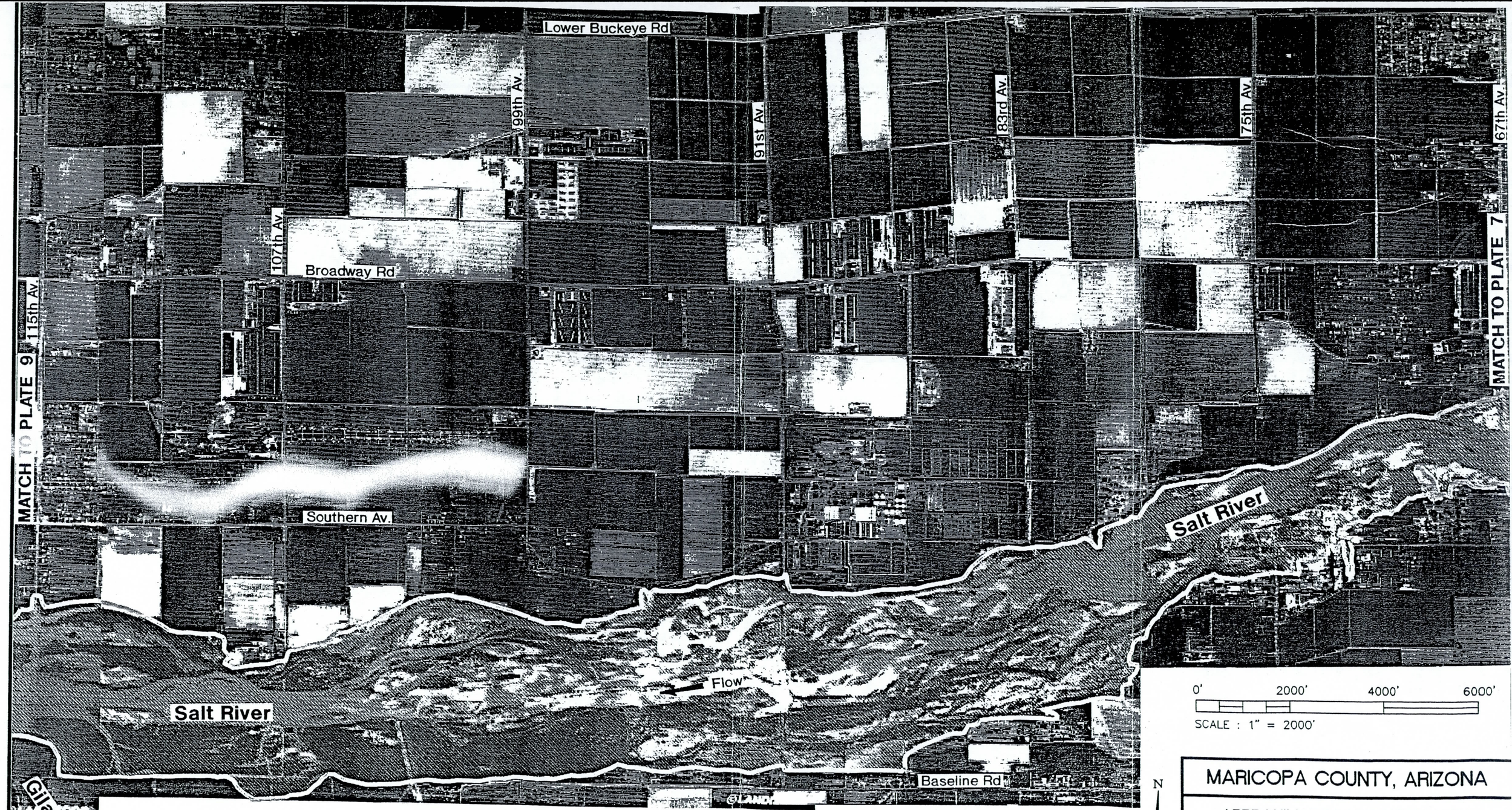


MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
SALT RIVER
19th AVENUE TO 67th AVENUE
JANUARY 9, 1993

PLATE 7 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

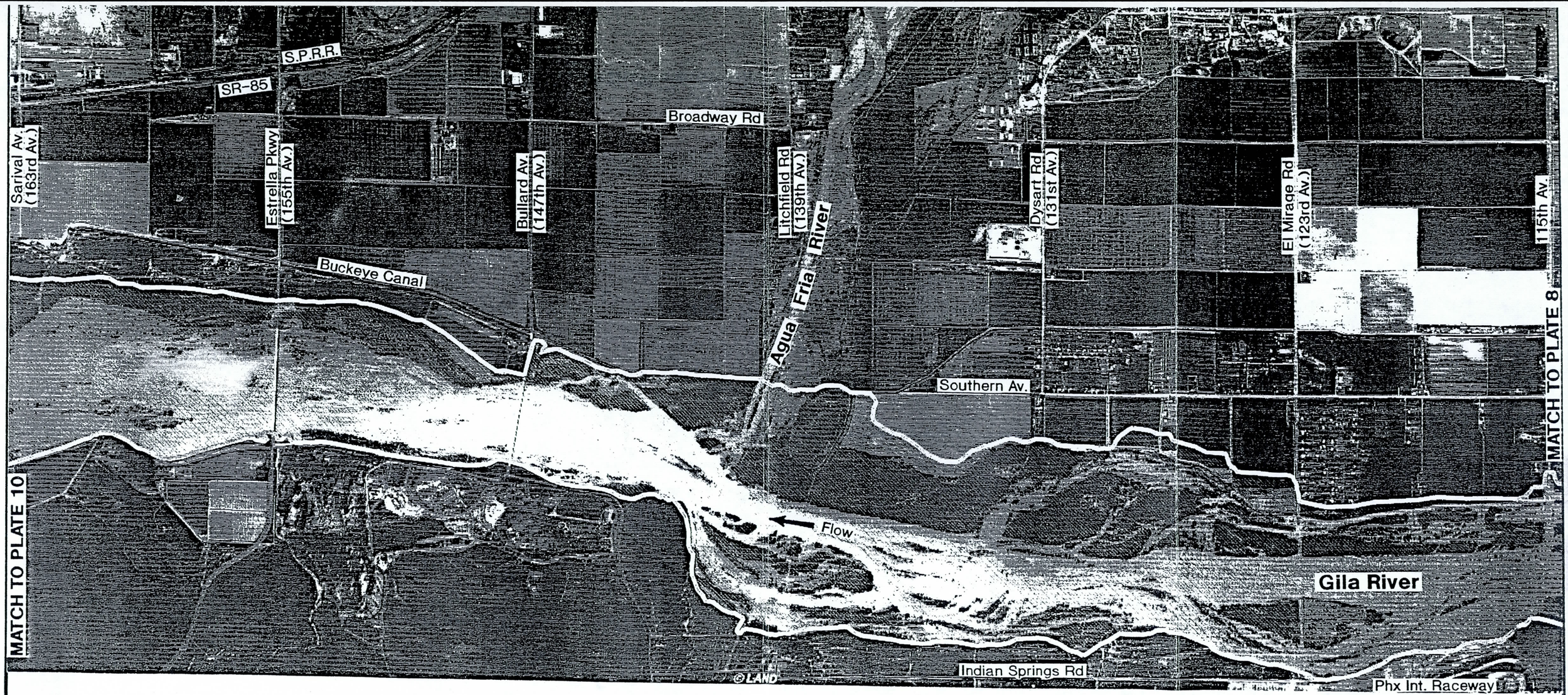
GILA RIVER

67th AVENUE TO 115th AVENUE

JANUARY 9, 1993

PLATE 8 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

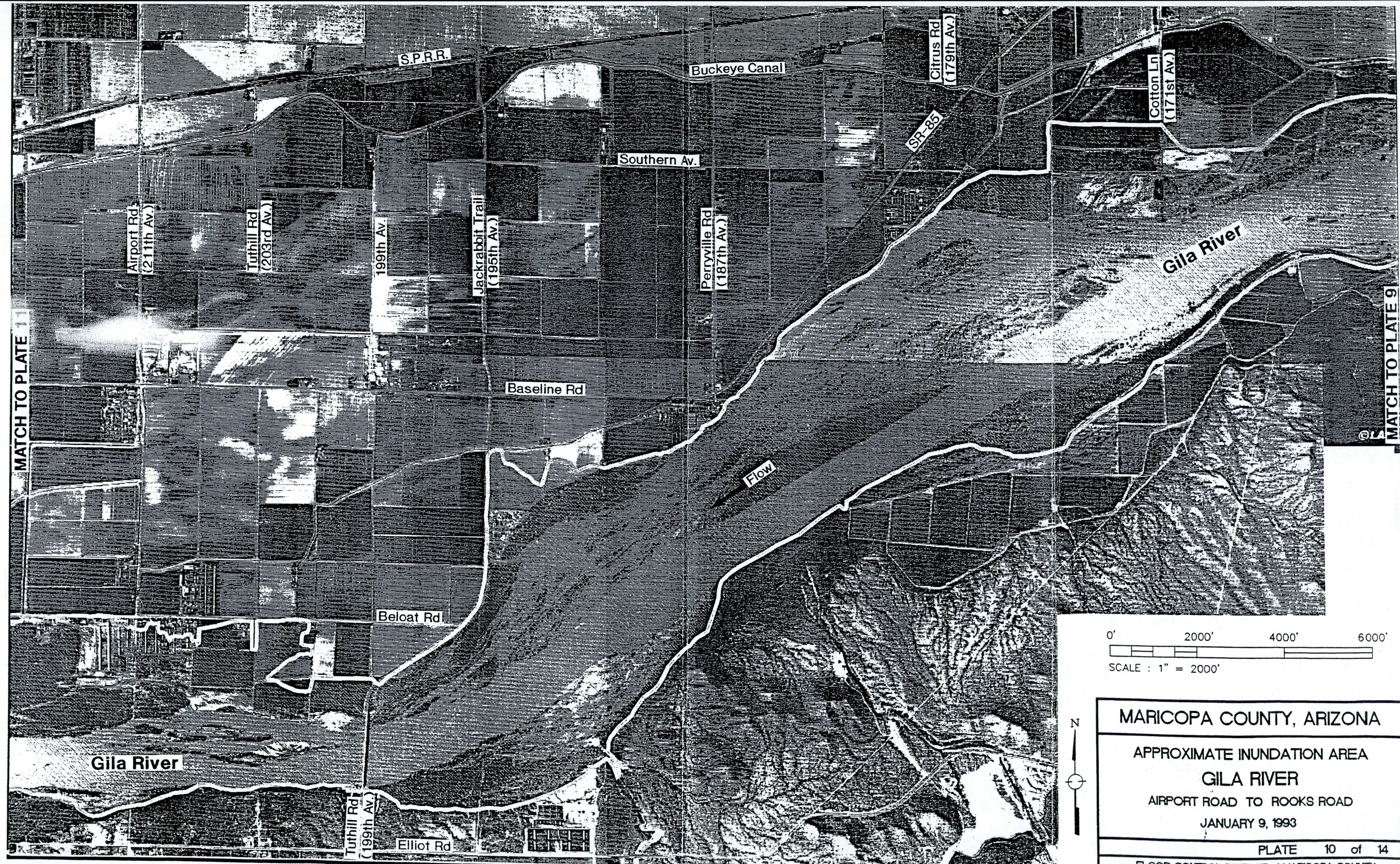
GILA RIVER

SARIVAL AVENUE TO AIRPORT ROAD

JANUARY 9, 1993

PLATE 9 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

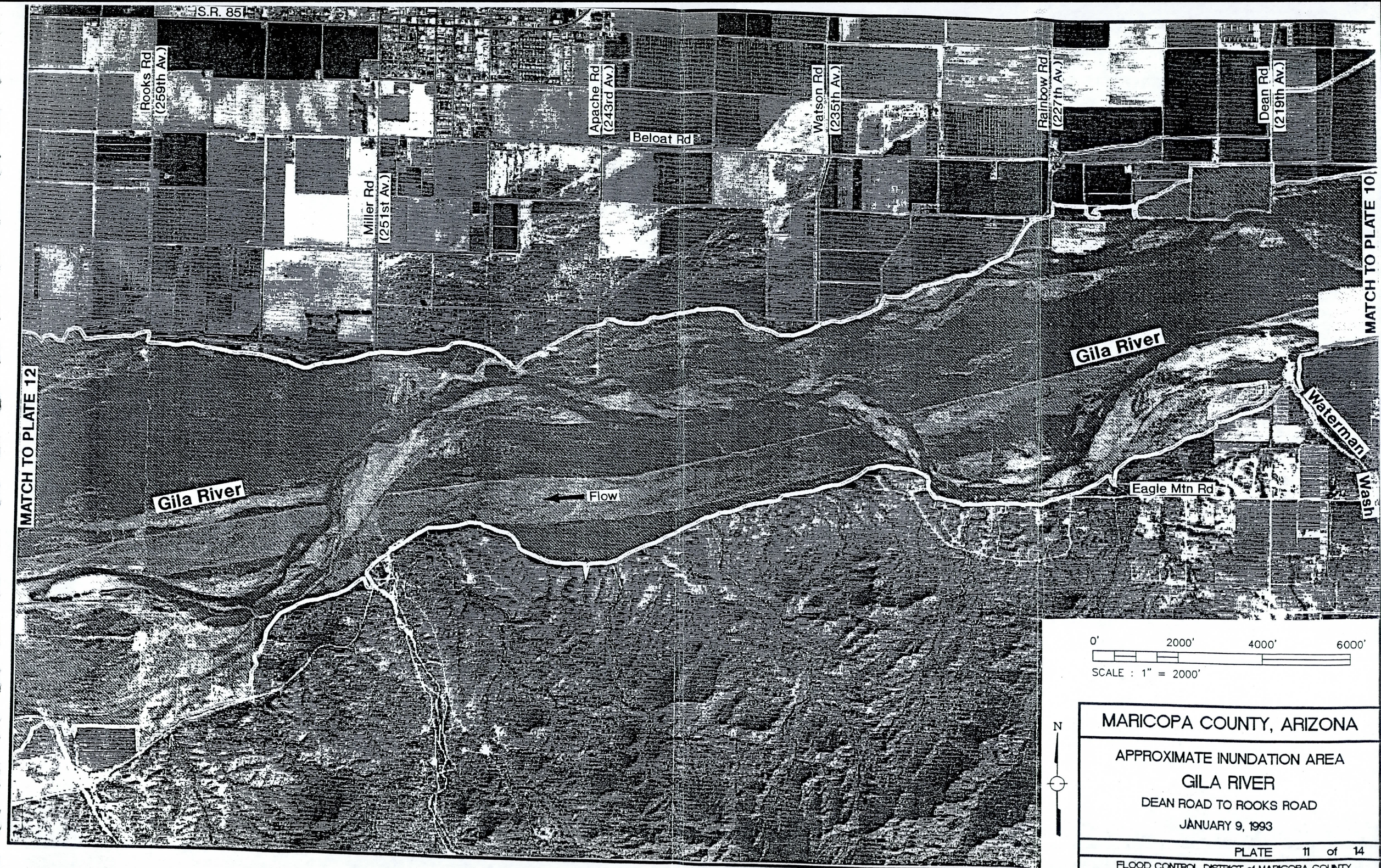


MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA RIVER
AIRPORT ROAD TO ROOKS ROAD
JANUARY 9, 1993

PLATE 10 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

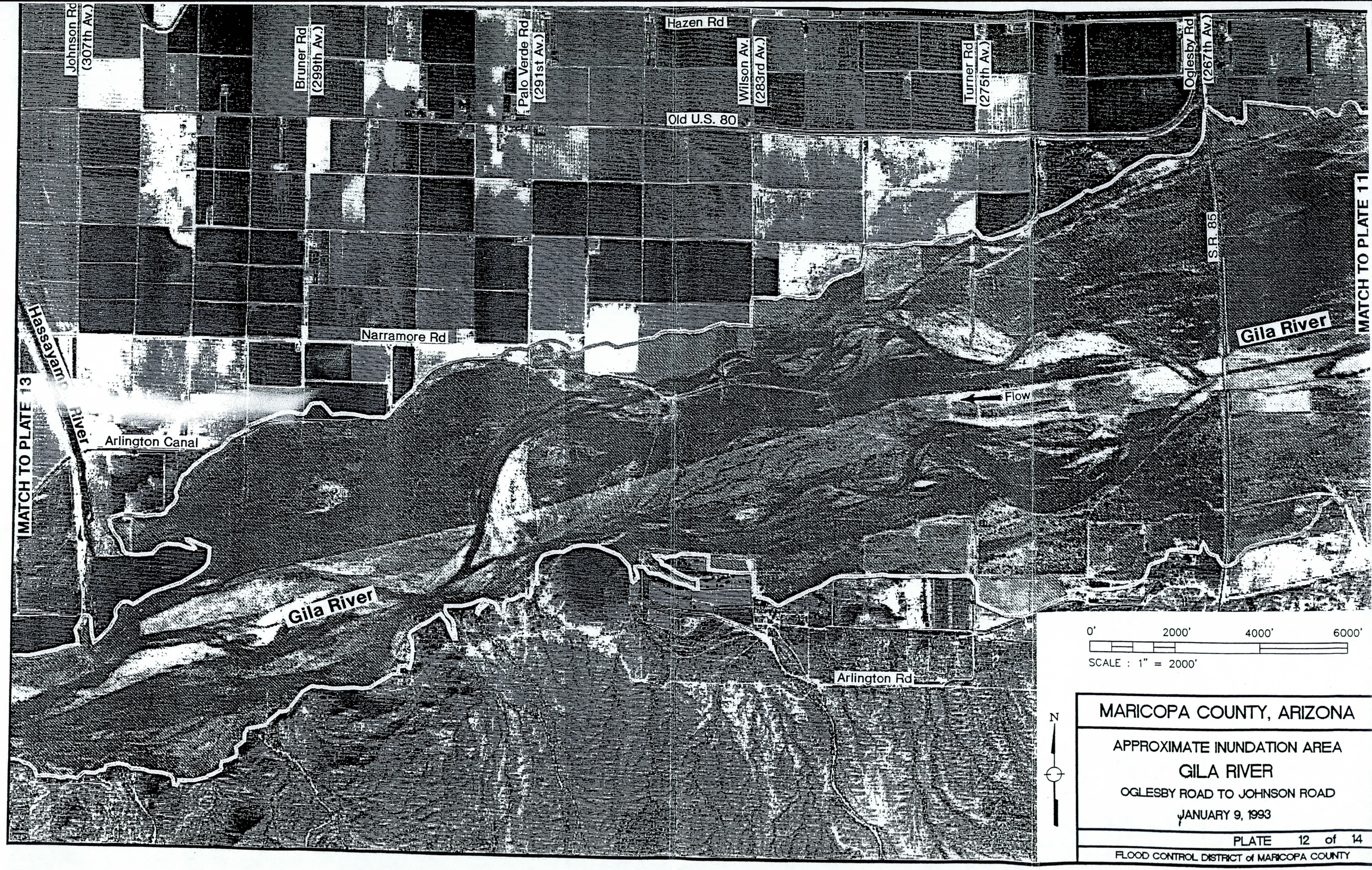


MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA RIVER
DEAN ROAD TO ROOKS ROAD
JANUARY 9, 1993

PLATE 11 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

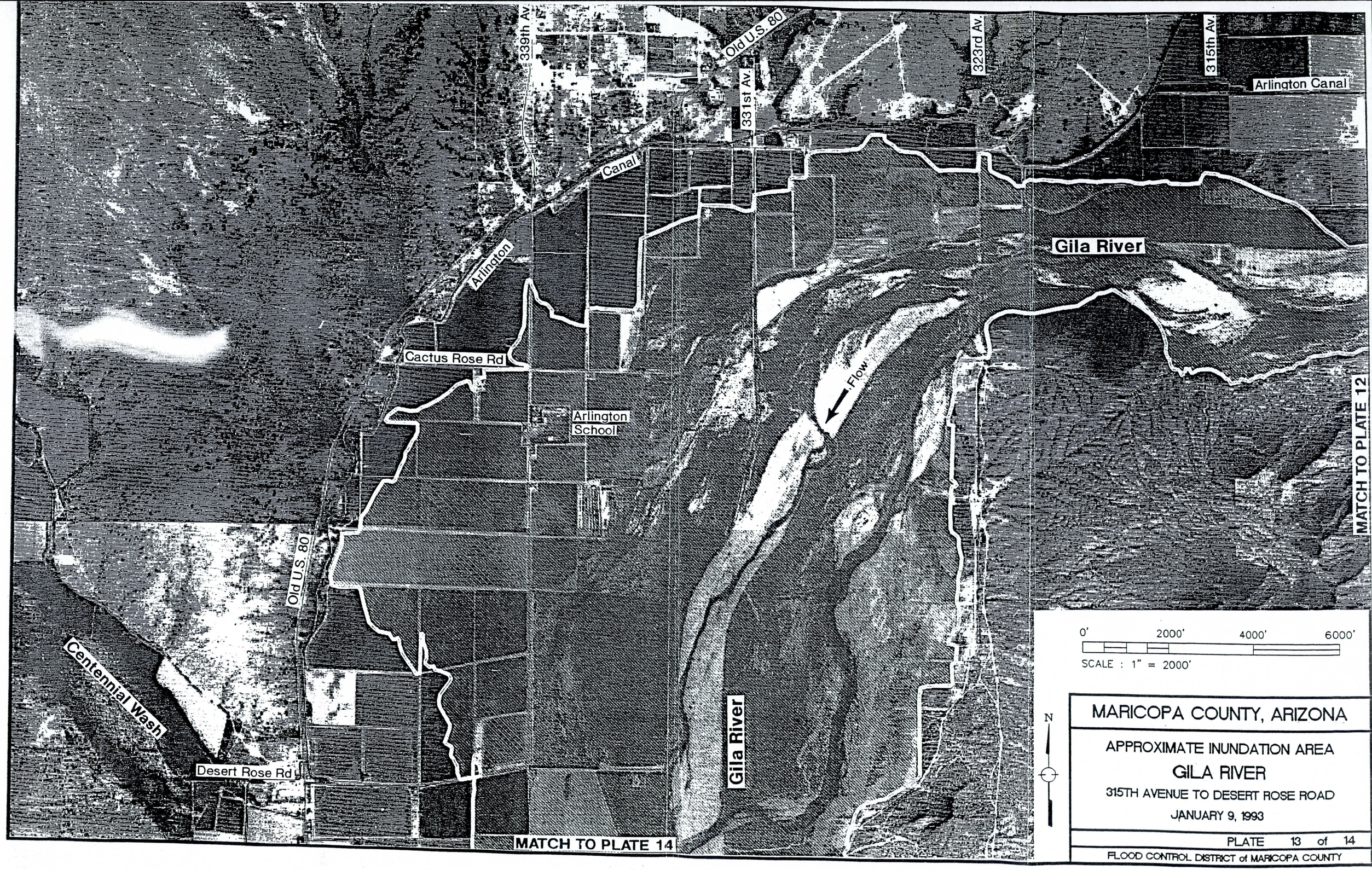
GILA RIVER

OGLESBY ROAD TO JOHNSON ROAD

JANUARY 9, 1993

PLATE 12 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA RIVER
315TH AVENUE TO DESERT ROSE ROAD
JANUARY 9, 1993

PLATE 13 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

MATCH TO PLATE 13

Centennial Wash

339th Av.

Gila River

Aqua Caliente Rd

Old US 80

Flow

Gillespie Dam

Enterprise Canal

Gila River

Gila Bend Canal

Old U.S. 80

0' 2000' 4000' 6000'

SCALE : 1" = 2000'

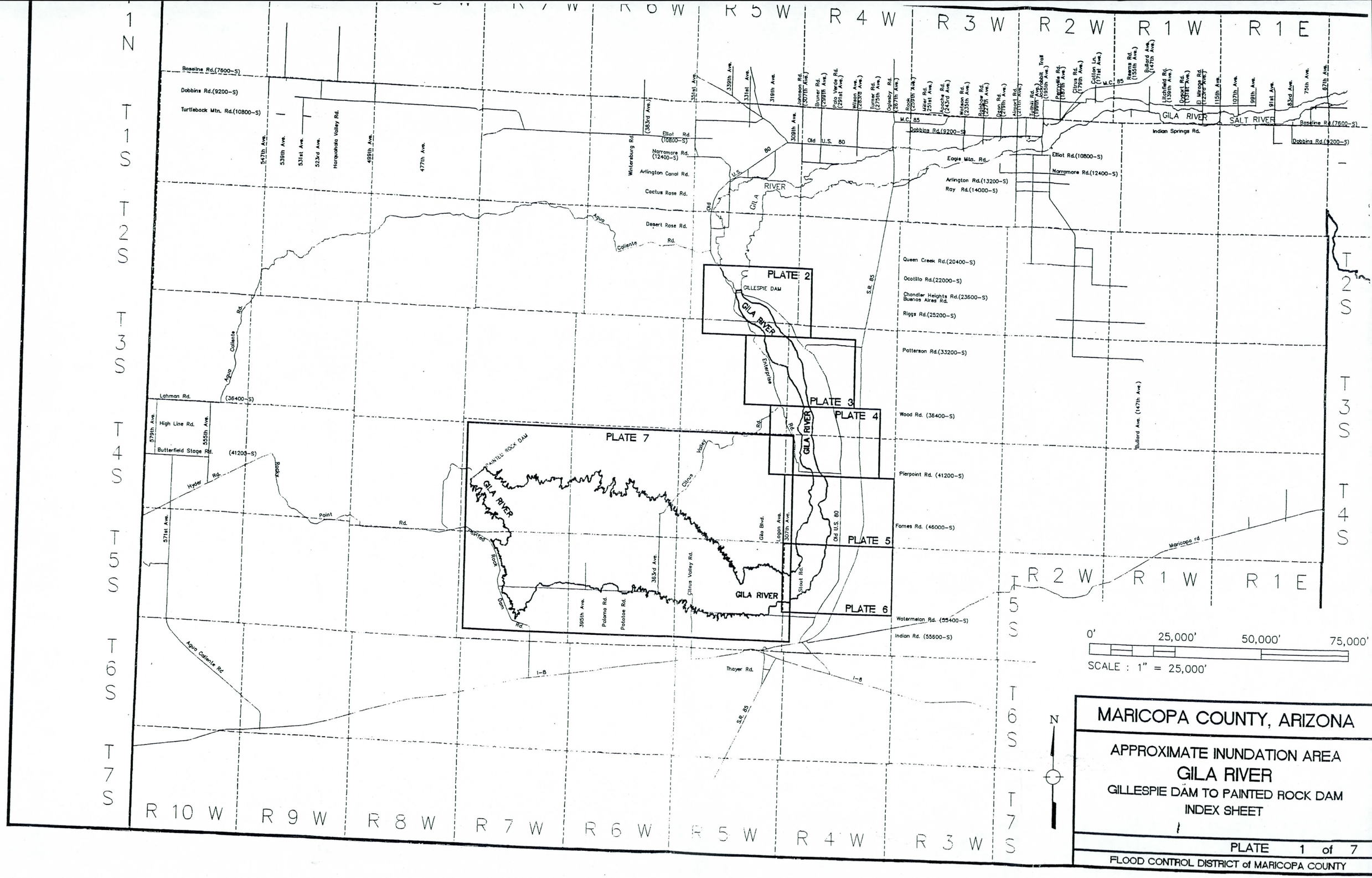
N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
SALT RIVER
DESERT ROSE ROAD TO GILLESPIE DAM
JANUARY 9, 1993

PLATE 14 of 14

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

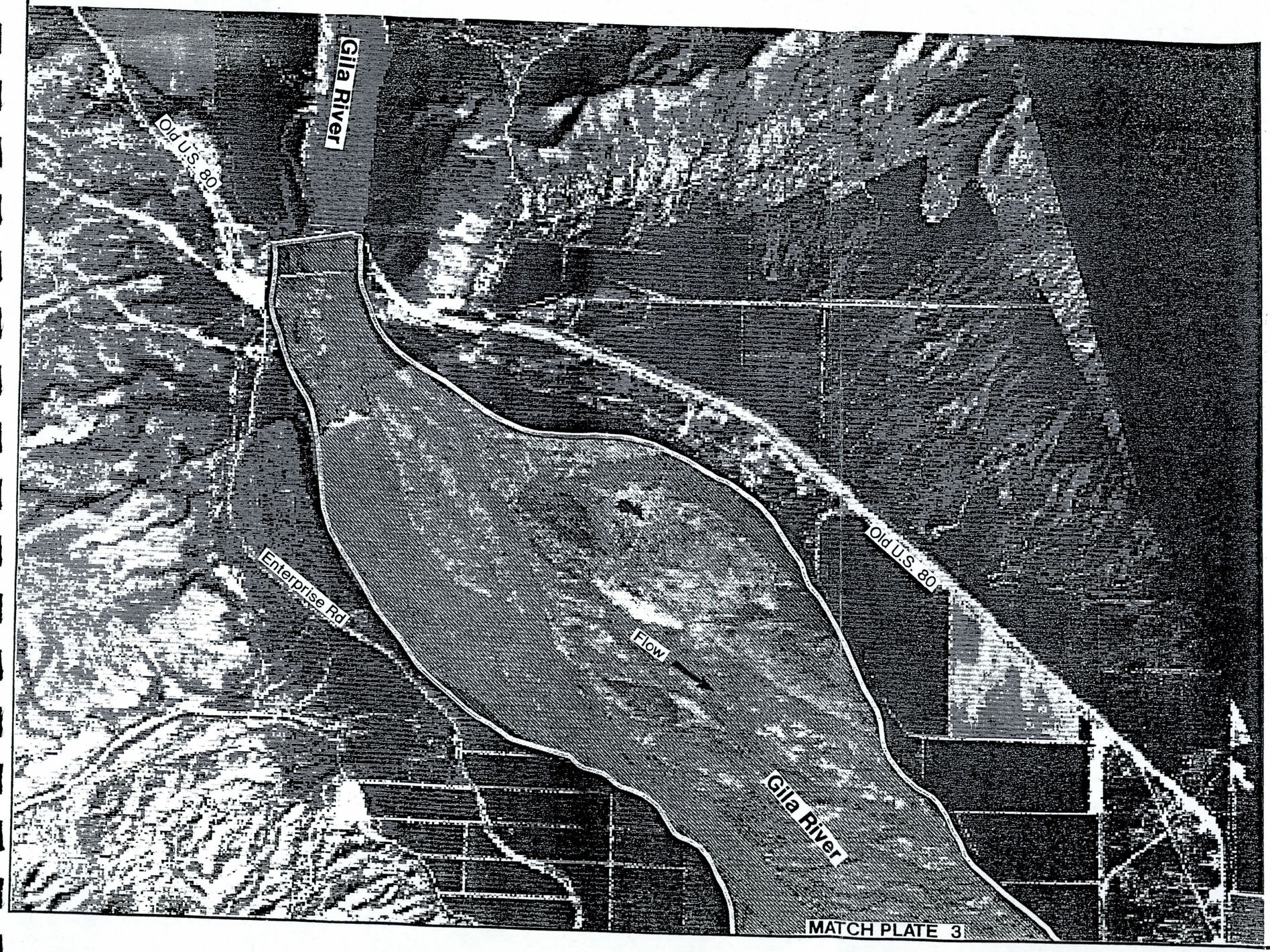


MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA RIVER
GILLESPIE DAM TO PAINTED ROCK DAM
INDEX SHEET

PLATE 1 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

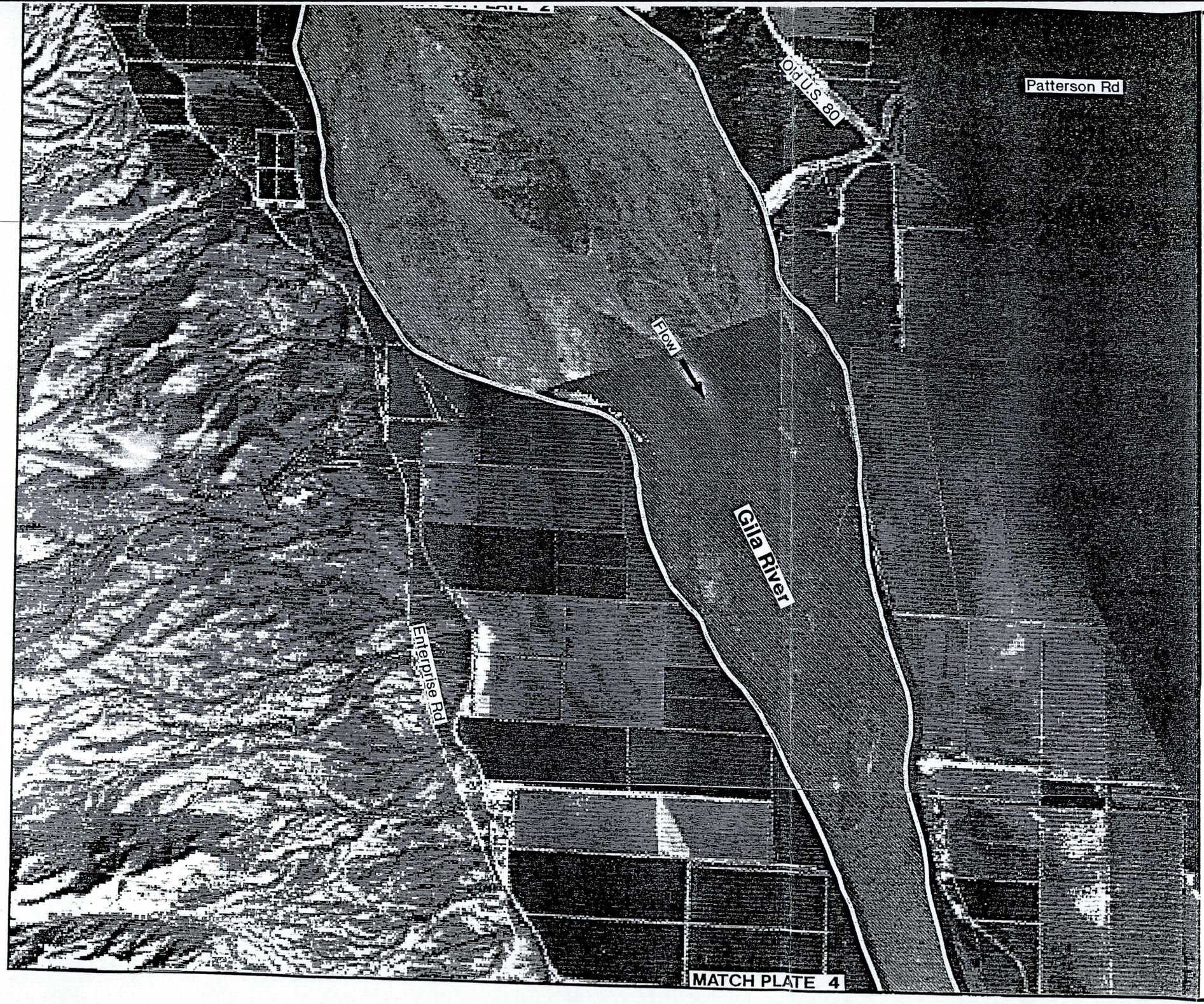
N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA
GILA RIVER
GILLESPIE DAM TO PATTERSON RD

PLATE 2 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

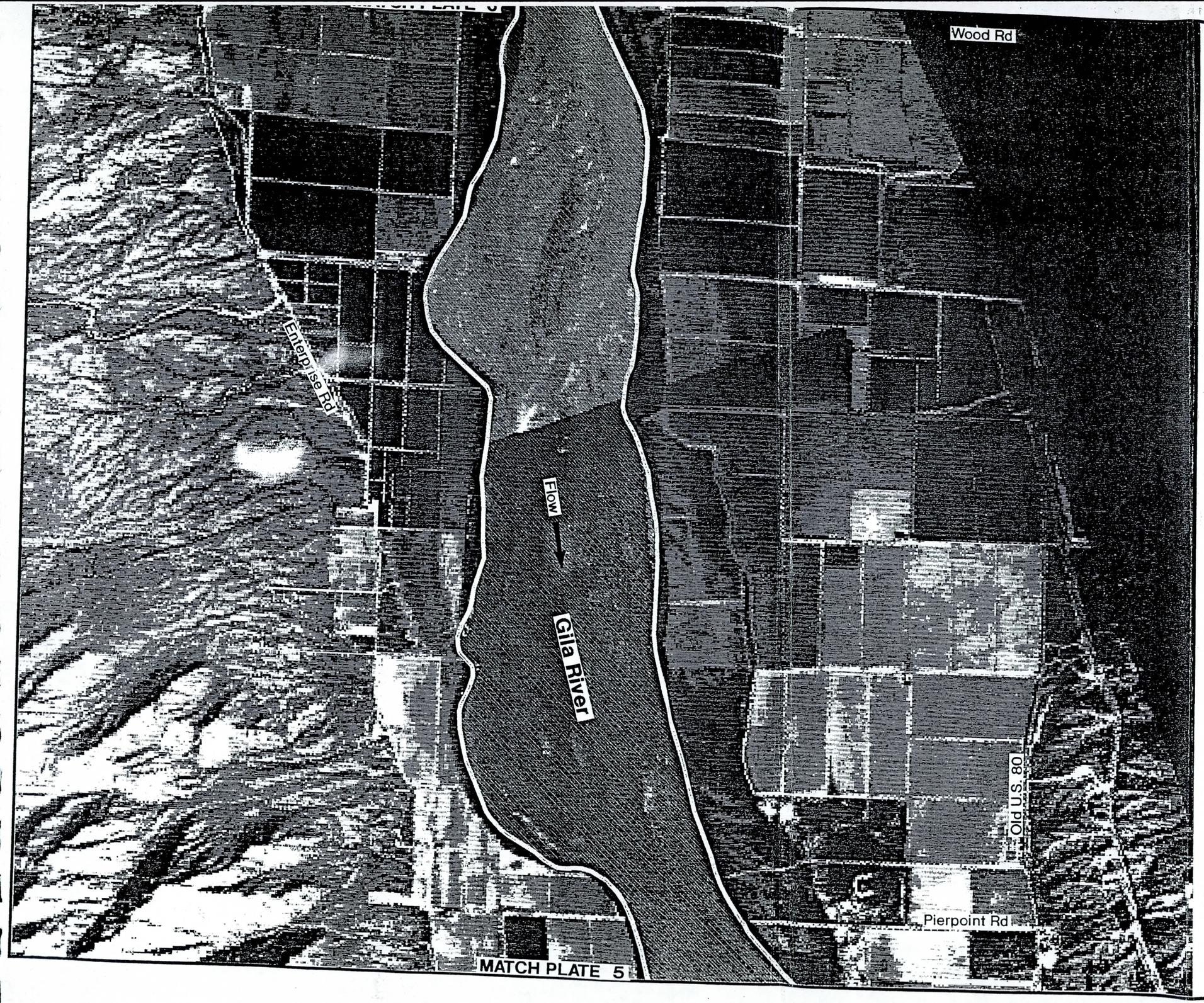
APPROXIMATE INUNDATION AREA

GILA RIVER

PATTERSON RD TO WOOD RD

PLATE 3 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

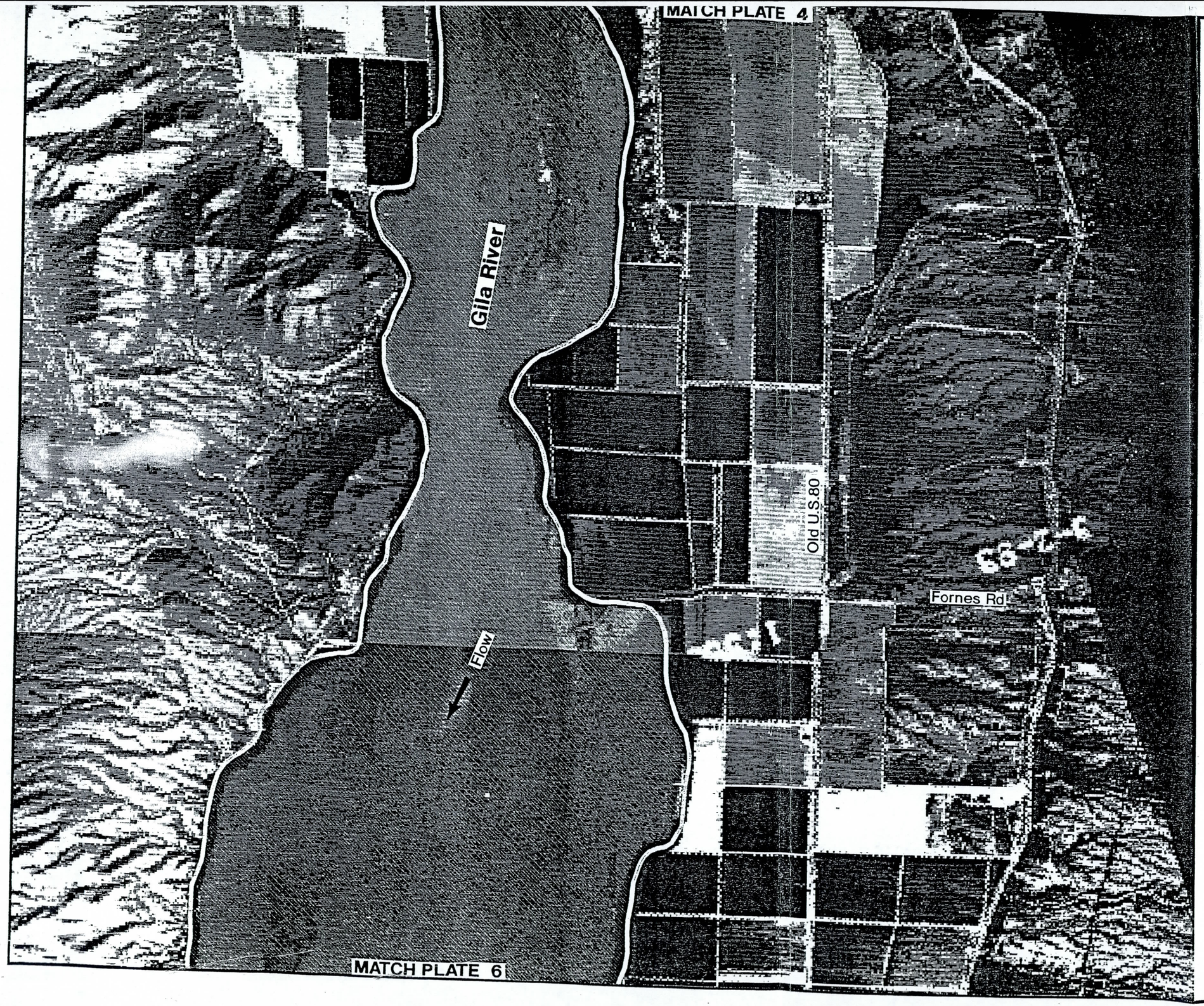
APPROXIMATE INUNDATION AREA

GILA RIVER

WOOD RD TO PIERPOINT RD

PLATE 4 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

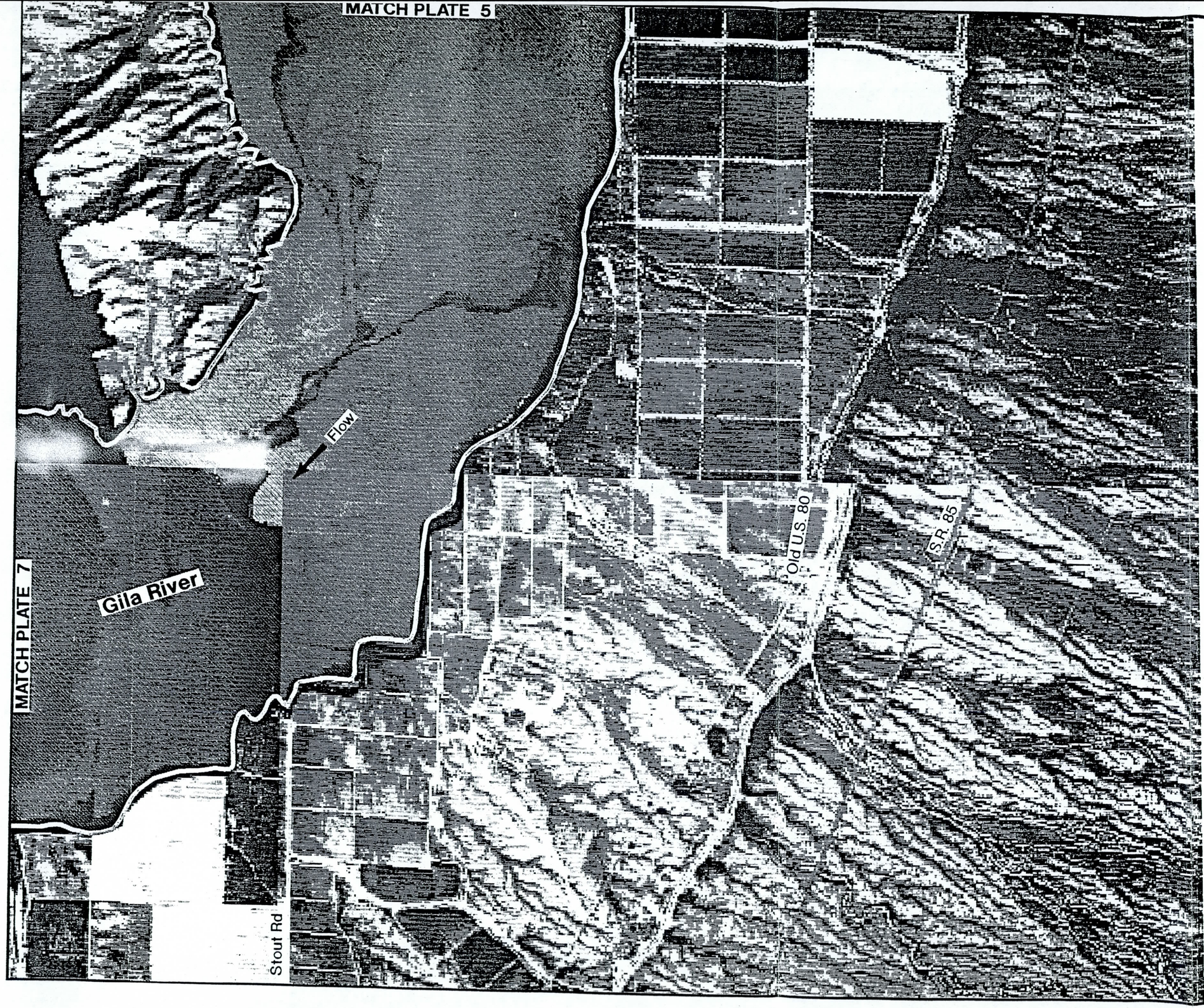
APPROXIMATE INUNDATION AREA

GILA RIVER

PIERPOINT RD TO 2 MILES SOUTH OF FORNES RD

PLATE 5 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY



0' 2000' 4000' 6000'

SCALE : 1" = 2000'

N

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

GILA RIVER

OLD U.S. 80 TO LOGAN AV.

PLATE 6 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

MARICOPA COUNTY, ARIZONA

APPROXIMATE INUNDATION AREA

GILA RIVER

LOGAN AV. TO PAINTED ROCK DAM

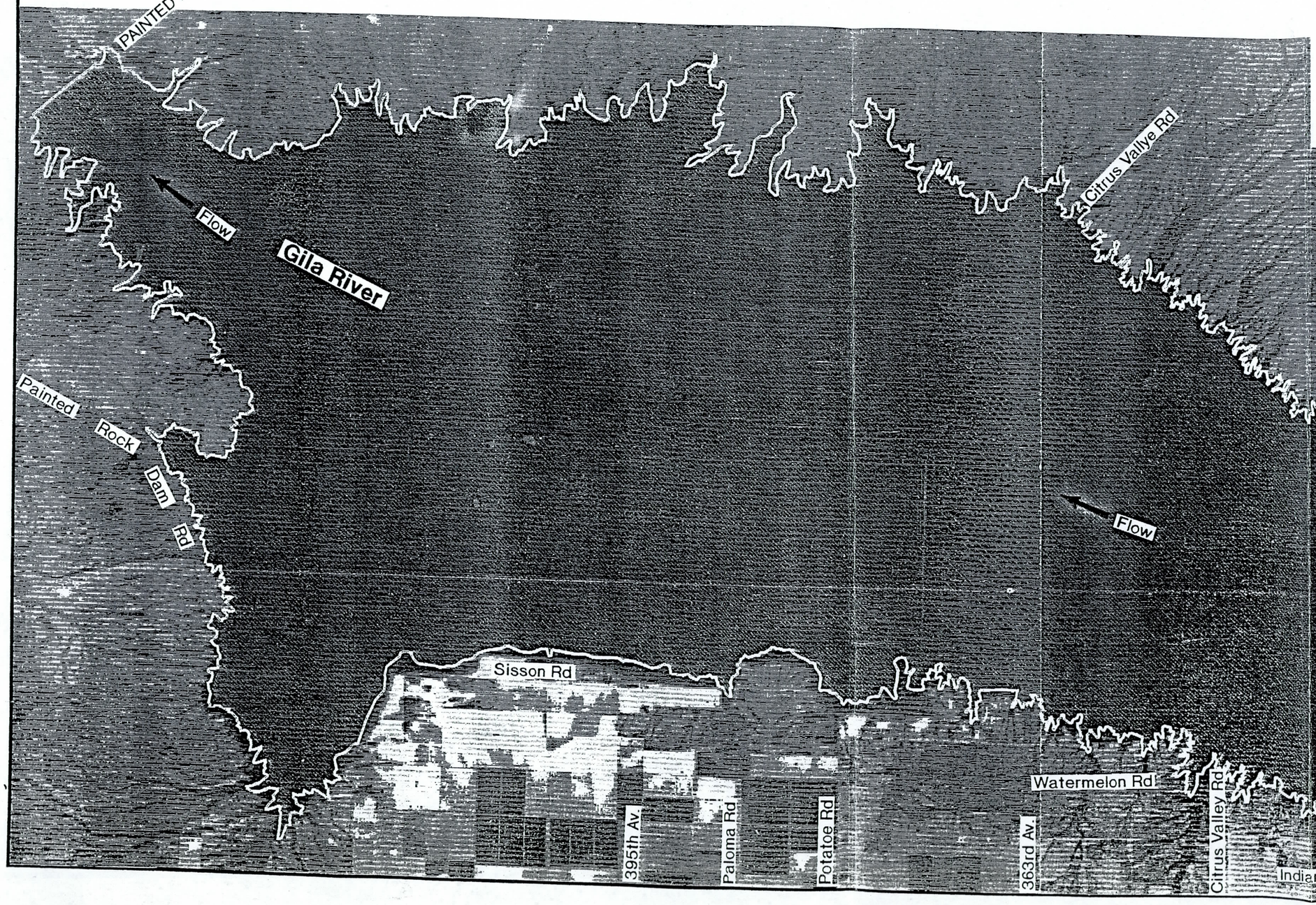
PLATE 7 of 7

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

N

0' 6,000' 12,000' 18,000'

SCALE : 1" = 6,000'

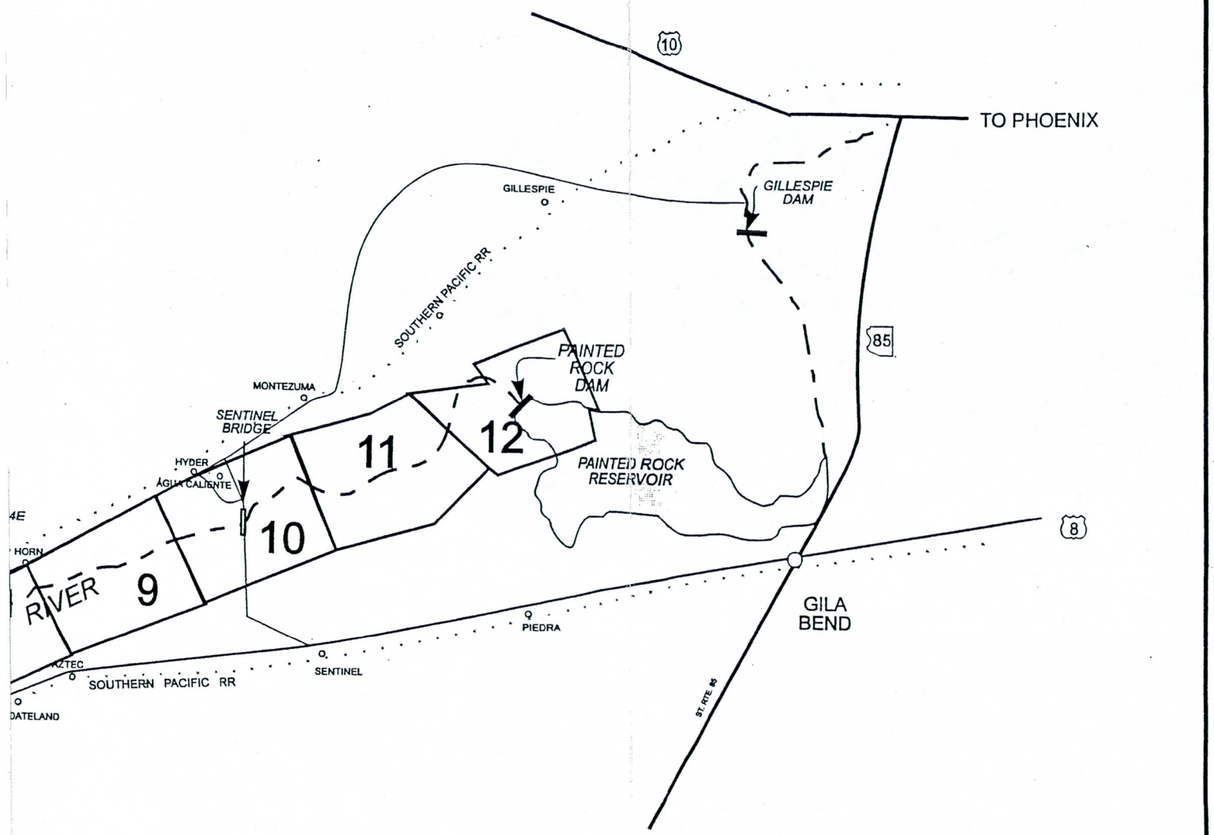


APPENDIX D

LOWER GILA AERIAL PHOTOGRAPHY

March 3 thru 9, 1993

CORPS OF ENGINEERS



GEND

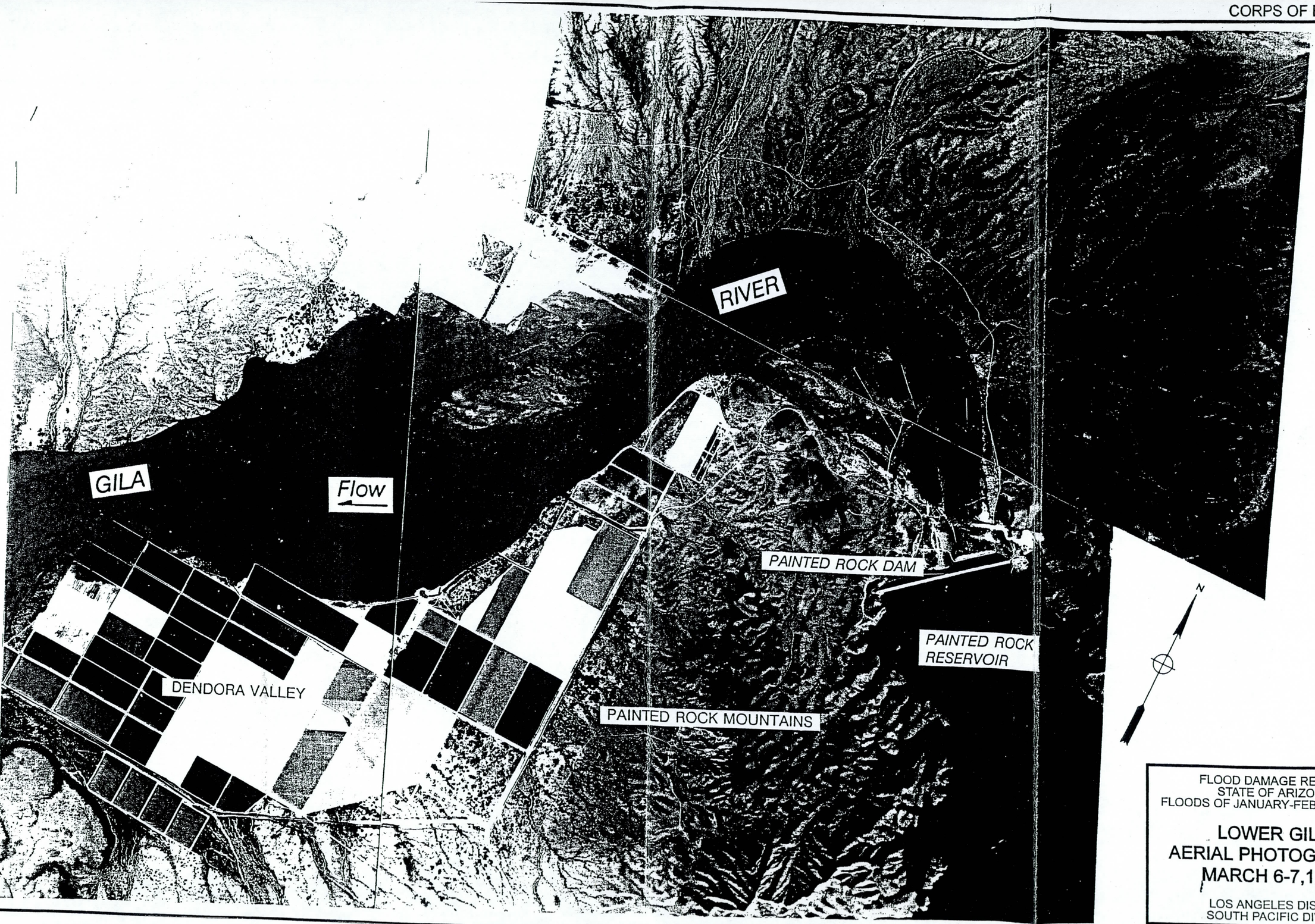
5	AREA APPROXIMATELY COVERED BY PLATE

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993 INDEX MAP

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

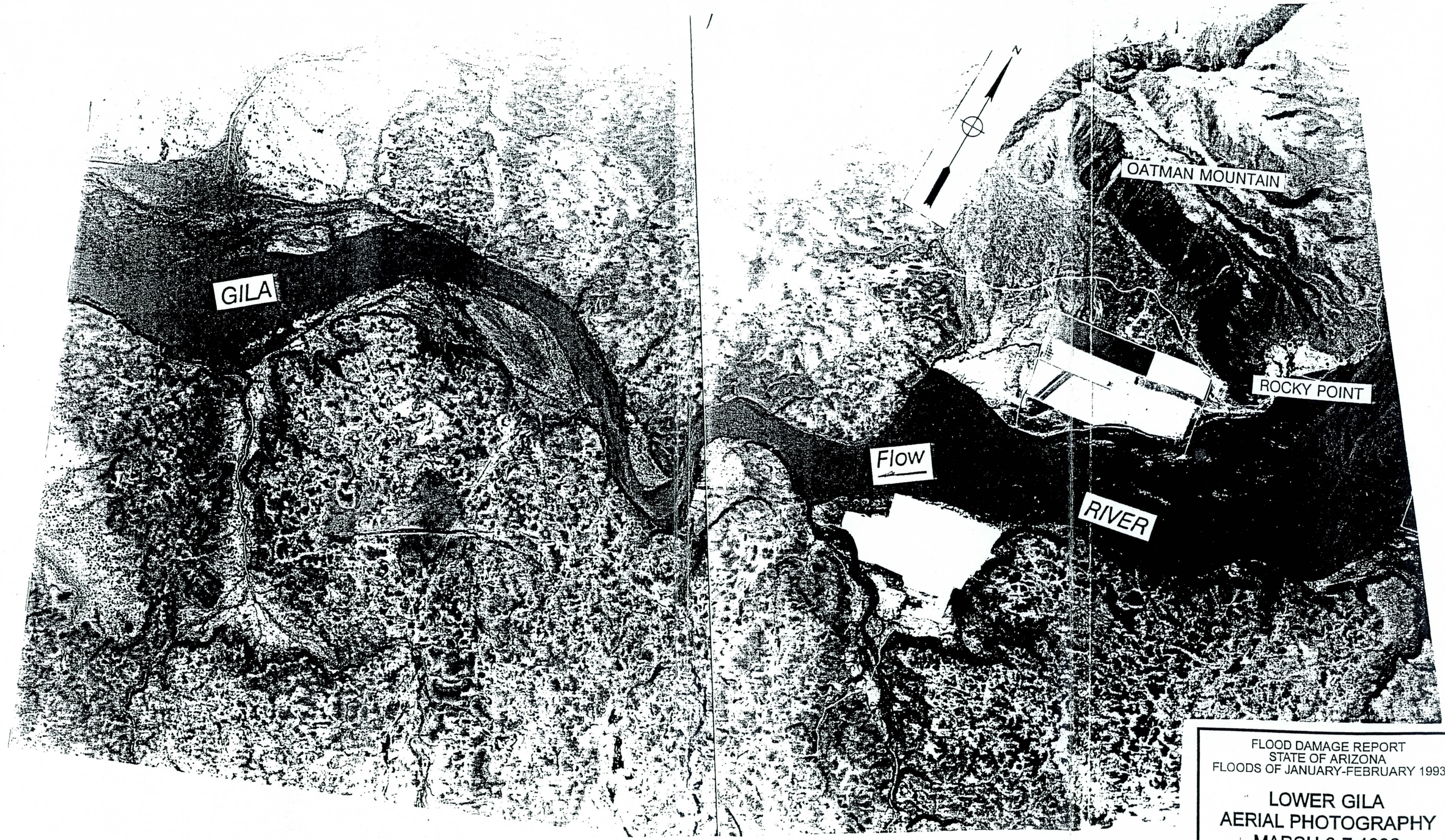
AR59 CDR



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

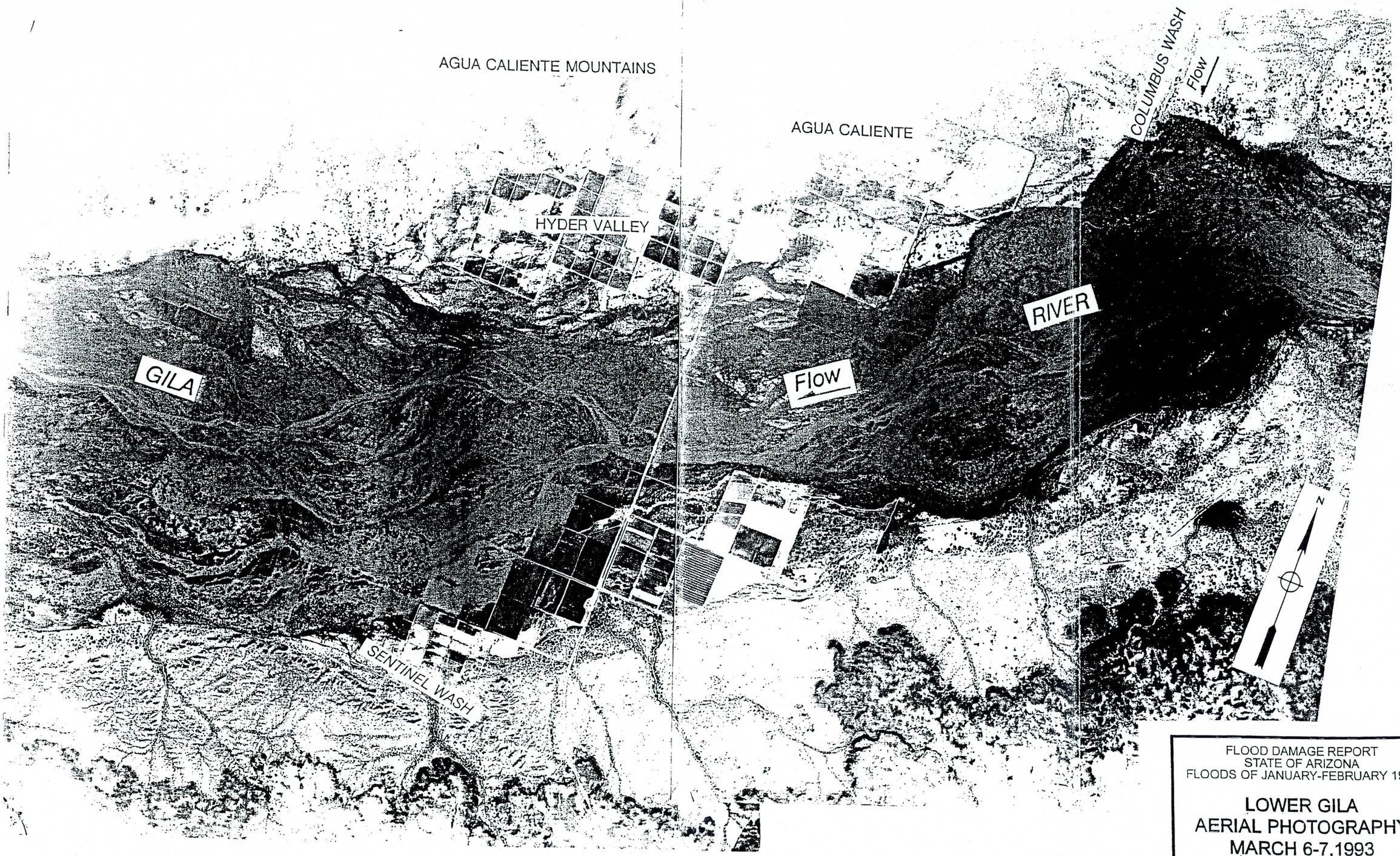
LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

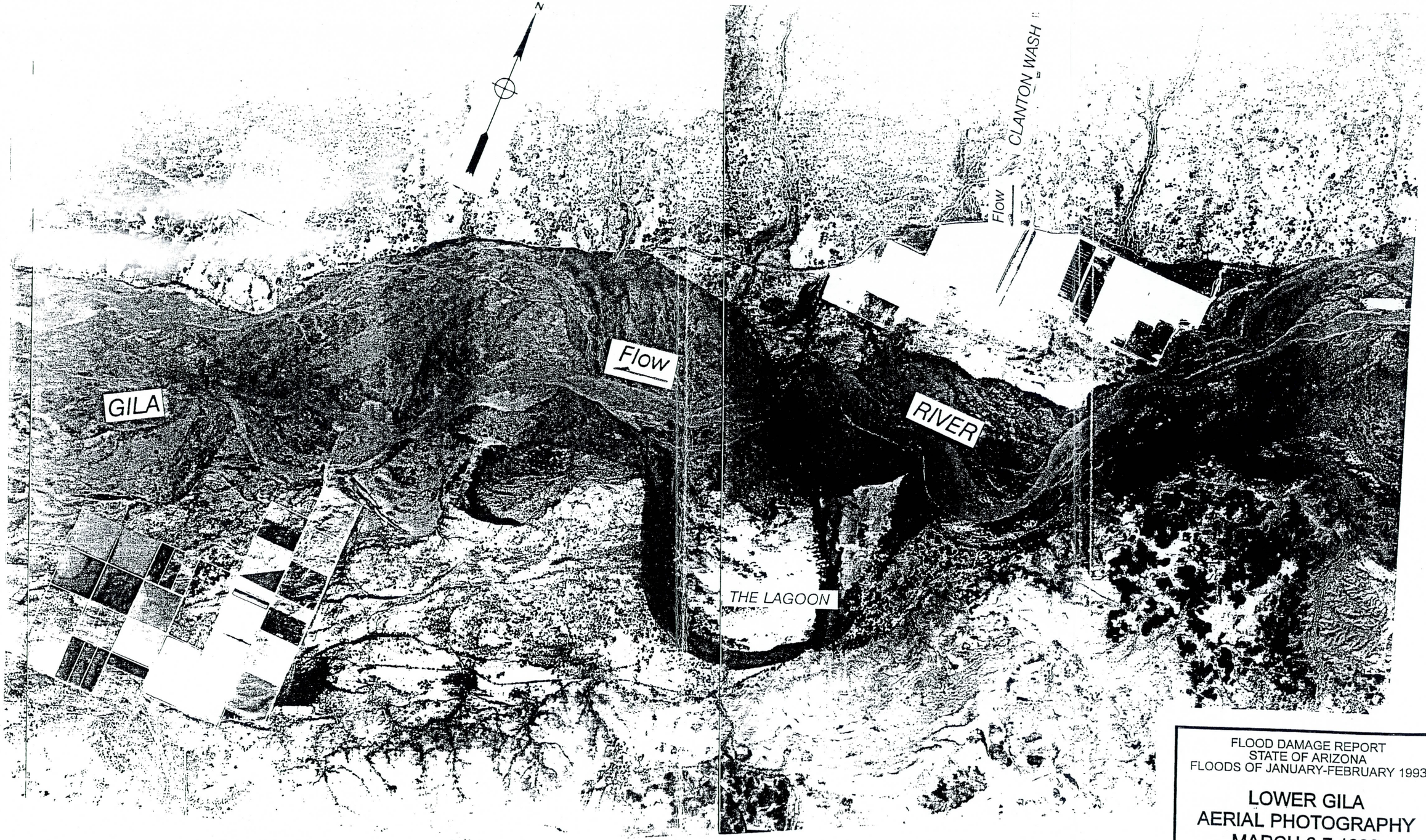
LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

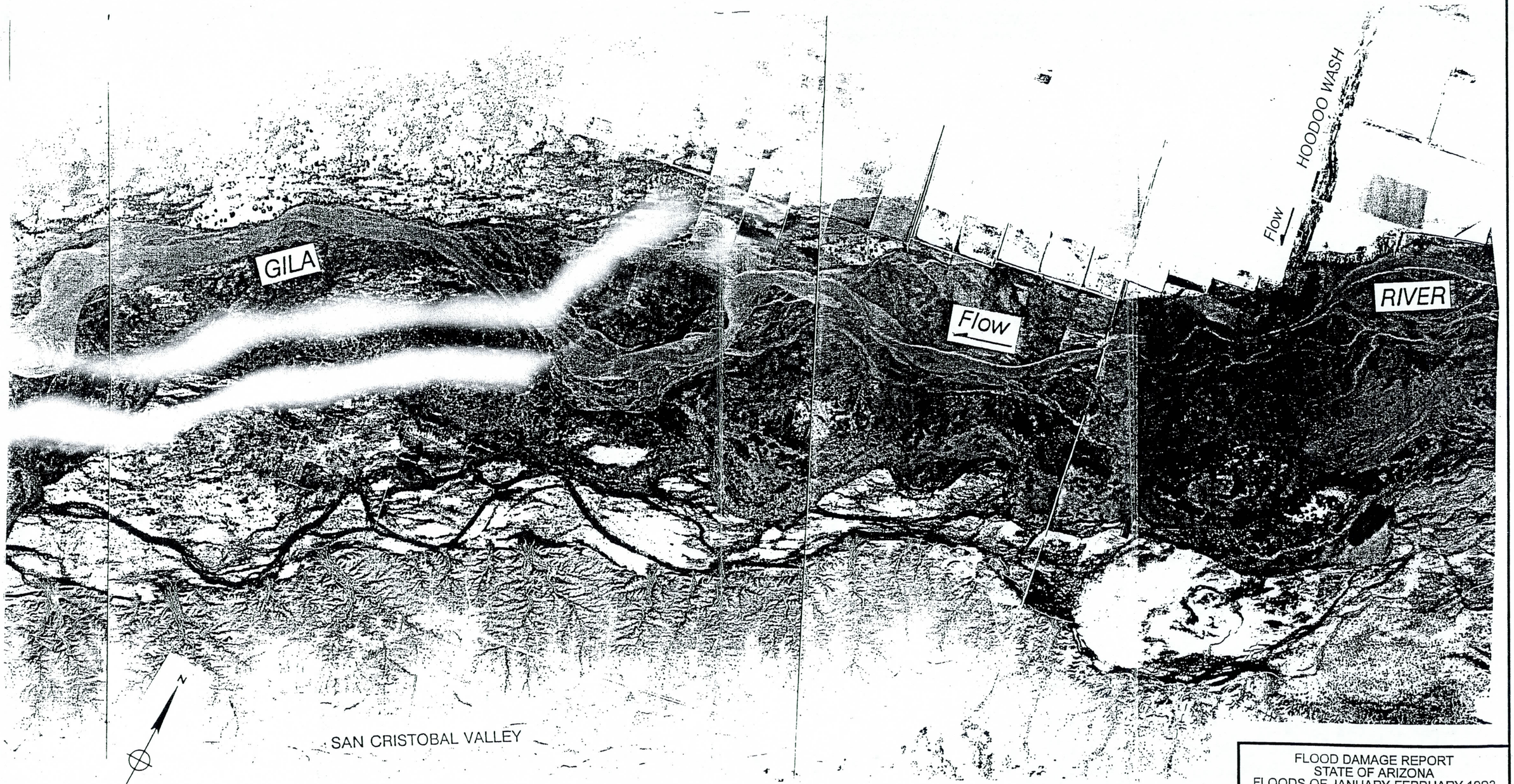


FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 4 OF 12



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

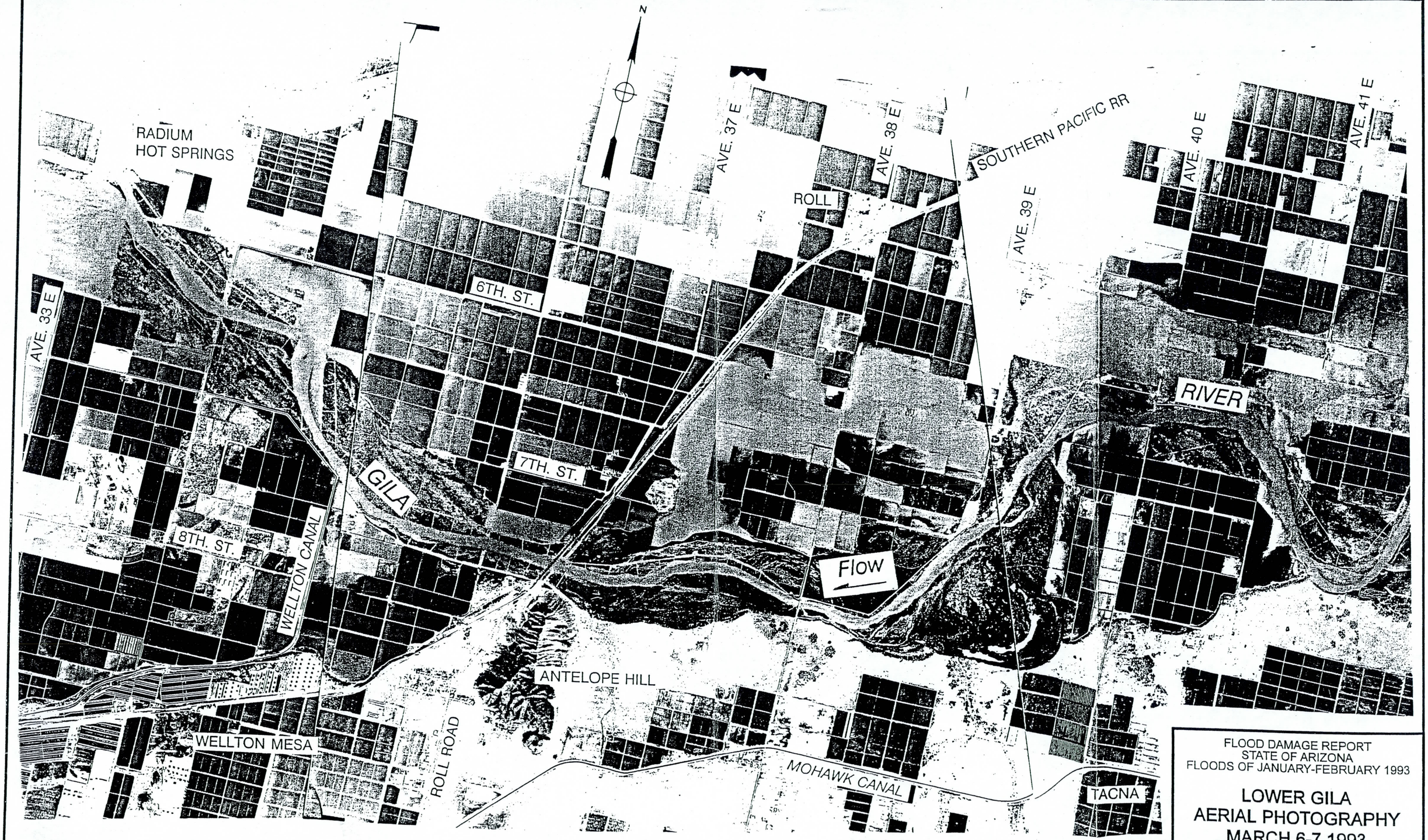
LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 7 OF 12



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 8 OF 12

CORPS OF ENGINEERS

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 9 OF 12

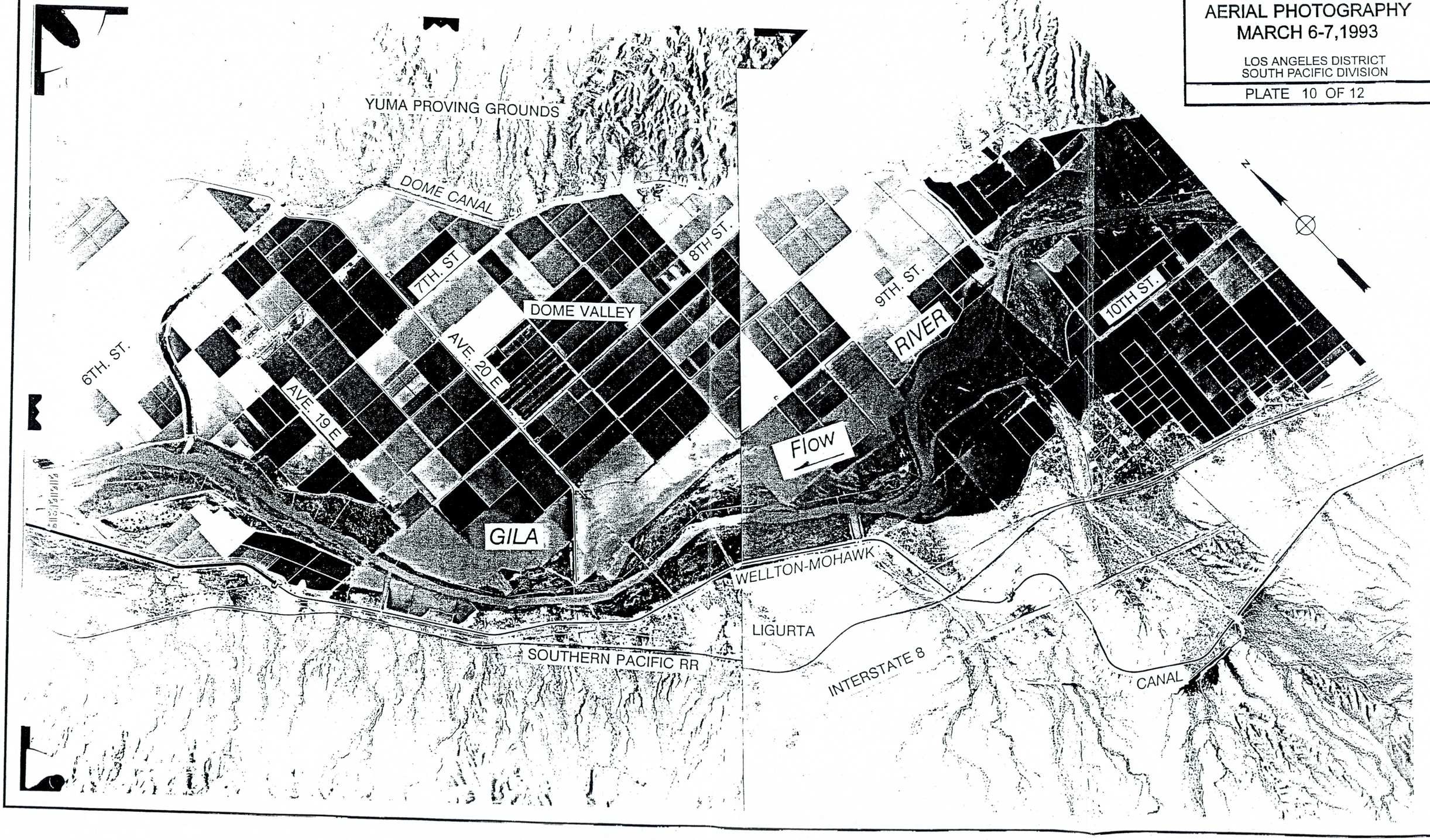
CORPS OF ENGINEERS

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 10 OF 12



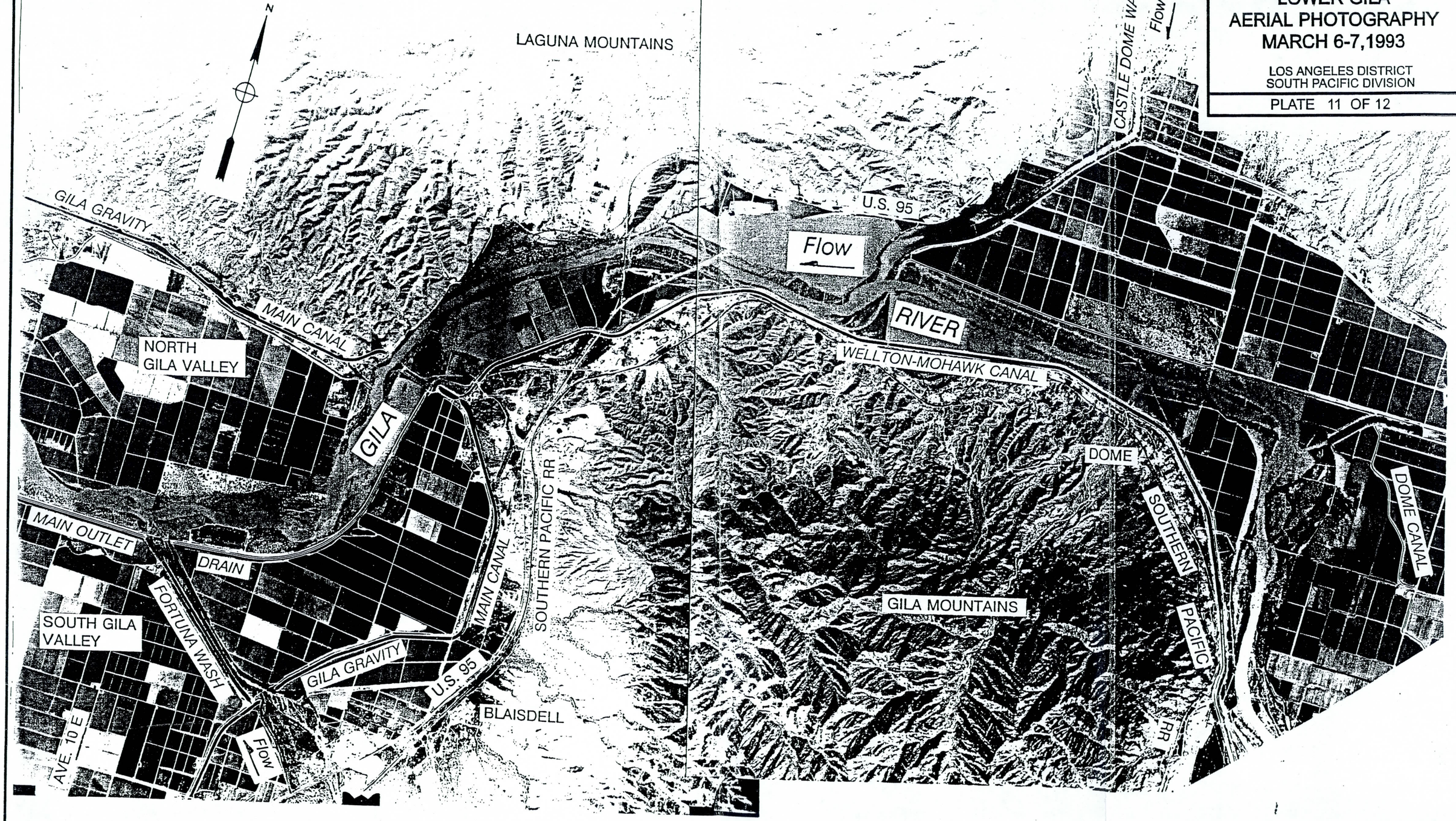
CORPS OF ENGINEERS

FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA
AERIAL PHOTOGRAPHY
MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION

PLATE 11 OF 12



FLOOD DAMAGE REPORT
STATE OF ARIZONA
FLOODS OF JANUARY-FEBRUARY 1993

LOWER GILA AERIAL PHOTOGRAPHY MARCH 6-7,1993

LOS ANGELES DISTRICT
SOUTH PACIFIC DIVISION