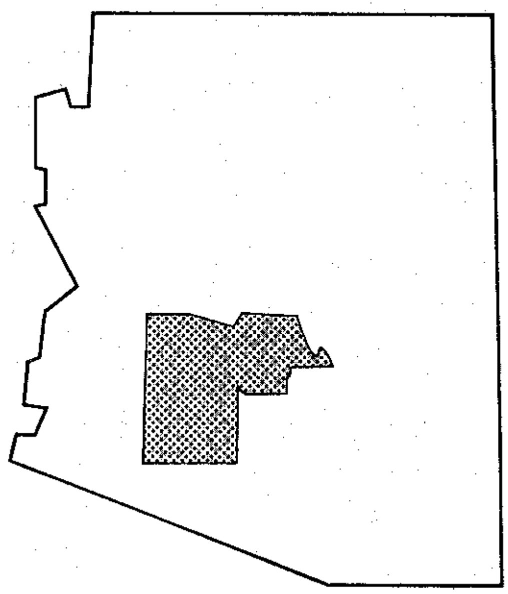
FLOOD INSURANCE STUDY

MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS
VOLUME 1 OF 9



COMMUNITY NAME	COMMUNITY NUMBER
AVONDALE, CITY OF	040038
BUCKEYE, TOWN OF	040039
CAREFREE, TOWN OF	040126
CAVE CREEK, TOWN OF	040129
CHANDLER, CITY OF	040040
EL MIRAGE, TOWN OF	040041
GILA BEND, TOWN OF	040043
GILBERT, TOWN OF	040044
GLENDALE, CITY OF	040045
GOODYEAR, TOWN OF	040046
GUADALUPE, TOWN OF	040111
LITCHFIELD PARK, CITY OF	040128
MARICOPA COUNTY UNINCORPORATED AREAS	040037
MESA, CITY OF	040048
PARADISE VALLEY, TOWN OF	040049
PEORIA, CITY OF	040050
PHOENIX, CITY OF	040051
QUEEN CREEK, TOWN OF	040132
SCOTTSDALE, CITY OF	045012
SURPRISE, TOWN OF	045053
TEMPE, CITY OF	040054
TOLLESON, CITY OF	040055
WICKENBURG, TOWN OF	040056
YOUNGSTOWN, TOWN OF	040057

REVISED: DECEMBER 3, 1993

Federal Emergency Management Agency

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. The Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 10.0

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PUBLISHED SEPARATELY:

Hydrologic and hydraulic analyses for Cave Creek (below Cave Creek Dam) and for East Fork Cave Creek were revised by Cella, Barr, Evans, and Associates, under Contract No. H-4607. This work was completed in October 1980.

Additional hydrologic and hydraulic analyses for portions of the Agua Fria and New Rivers, and Skunk Creek were performed by the COE under contract to the Flood Control District of Maricopa County (FCDMC). Hydrologic and hydraulic analyses for portions of the Salt and Gila Rivers were performed by Harris-Toups Associates in October 1977. The 100-year flood for portions of the above streams, as well as the 500-year flood for the Agua Fria River, was computed by Dames & Moore using data provided by the COE, Los Angeles District. Approximate floodplain boundaries and boundaries for areas subject to sheetflow were delineated by Dames & Moore.

Hydraulic analyses for portions of the following streams were taken from the effective Flood Insurance Studies for the incorporated communities (References 1-20): Agua Fria River, Gila River, Hassayampa River, New River, Salt River, Skunk Creek, Scatter Wash, Aguila Farm Channel, Andora Hills Wash, Atchison, Topeka & Santa Fe Railway Channel, Casandro Wash, South Branch Casandro Wash, Cave Creek, East Fork Cave Creek, Dreamy Draw Wash East, Echo Canyon Wash, Flynn Lane Wash, Flying "E" Wash, Galloway Wash, Granite Reef Wash, Grapevine Wash, Grass Wash, Hospital Wash, Indian Bend Wash, Indian Bend Wash-Low Flow Channel, Little San Domingo Wash, Lower El Mirage Wash, Martinez Wash, Mockingbird Wash, Moon Valley Wash, Myrtle Avenue Wash, Ocotillo Wash, Powder House Wash, Rowe Wash, Tenth Street Wash, Wash B, Willow Springs Wash, Wittmann Drainage, and Weekes Wash.

The hydrologic and hydraulic analyses for portions of the Agua Fria, New, Gila, and Salt Rivers, Skunk Creek, and Scatter Wash included in the restudy were performed by the COE, Los Angeles District, for FEMA, under Interagency Agreement No. EMW-E-0941, Project Order No. 10. This work was completed in March 1986.

Revised hydrologic and hydraulic analyses for Sols Wash, which passes through the Town of Wickenburg and extends to the county boundary between Maricopa and Yavapai Counties, were performed by Cella Barr Associates (CBA), for FEMA, under Contract No. EMW-85-C-1909. This restudy was completed in December 1986.

Revised hydraulic analyses for a portion of Consolidated Canal were performed by Greiner Engineering Sciences, Inc., for the City of Mesa in 1984 (Reference 21).

Revised hydraulic analyses for a portion of the Agua Fria River in El Mirage were performed by Engineering and Surveying of Arizona, Inc., in November 1984 (Reference 22).

Revised hydraulic analyses for flooding along a portion of the Atchison, Topeka & Santa Fe Railway in the City of Chandler were performed in July 1980 (Reference 23).

Revised hydraulic analyses for a portion of East Fork Cave Creek in the City of Phoenix were performed by Erie and Associates, Inc., for the Coral Gables Estates Unit Six Subdivision in November 1985 (Reference 24).

1.3 Coordination

The FCDMC assisted in the selection of the areas that were studied by detailed methods and the selection of preliminary floodway limits.

The Arizona Department of Transportation provided highway maps used for the preparation of base maps covering undeveloped areas studied only by approximate methods.

This study was also coordinated with the Special Studies Section of the Water Resources Division of the U.S. Geological Survey (USGS), Tucson, Arizona (Reference 25).

On May 31, 1977, results of the study were reviewed at the final consultation and coordination meeting, which was attended by residents of the county and representatives of the FCDMC and FEMA.

This study was revised in 1986 to incorporate either new or revised hydrologic and hydraulic analyses for several flooding sources throughout the county. At this time, FEMA decided to include flooding information through the incorporated communities to provide the county with a more usable Flood Insurance Rate Map.

2.0 AREA STUDIED

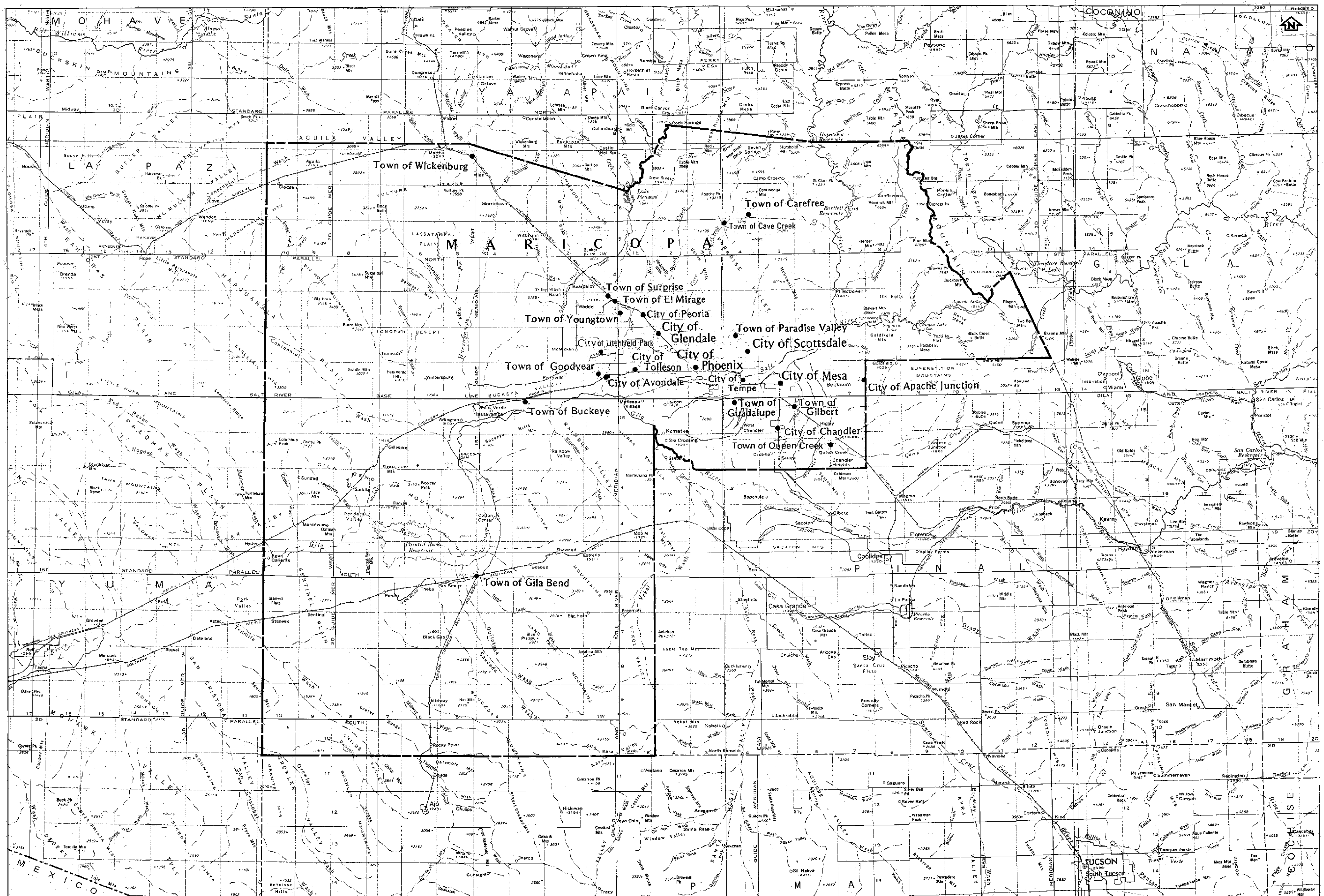
2.1 Scope of Study

This Flood Insurance Study covers the geographic area of Maricopa County, Arizona. The area of study is shown on the Vicinity Map (Figure 1).

The flooding sources studied by detailed methods are shown in Table 1.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

Portions of some flooding sources were studied by approximate methods and are shown in Table 2.



APPROXIMATE SCALE

16 0 16 32 48 MILES

VICINITY MAP

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

FIGURE 1

Table 1. Detailed-Study Sources

Flooding Source	Limits of Study
Agua Fria River	From confluence with Gila River to Waddell Dam
New River	From confluence with Agua Fria River to Rock Springs
Skunk Creek	From confluence of Arizona Canal to River Mile 27.76, in north-central Maricopa County
Scatter Wash	From confluence with Skunk Creek to just above Williams Drive, and between Black Canyon Highway (Interstate Highway 17) and 7th Avenue
Scatter Wash, North Branch	From confluence with Scatter Wash to 1.6 miles upstream
Scatter Wash, South Branch	From confluence with Scatter Wash to 0.8 mile upstream
Salt River	From confluence with Gila River to Granite Reef Dam
Salt River Overflow Area	Along southern overbank between 75th and 39th Avenues
Cave Creek Wash	From confluence with Salt River to Cave Butte Dam, and from 0.7 mile below Carefree Highway to the Tonto National Forest Boundary
East Fork Cave Creek Wash	From confluence with Cave Creek to Beardsley Road
Andora Hills Wash	From confluence with Cave Creek to approximately 2.9 miles upstream
Flying E Wash	From approximately 0.2 mile downstream of U.S. Highways 60 and 70 to 0.5 mile above the highways
Galloway Wash	From confluence with Cave Creek to Pima Road

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Unnamed Tributary to Galloway Wash	From confluence with Galloway Wash to approximately 1 mile upstream
Ocotillo Wash	From confluence with Cave Creek to approximately 5.5 miles upstream
Hassayampa River	From confluence with Gila River to Maricopa-Yavapai County line north of Wickenburg
Sols Wash	From confluence with Hassayampa River to Maricopa-Yavapai County boundary
Casandro Wash	From confluence with Sols Wash to approximately 2.8 miles upstream
South Branch Casandro Wash	From confluence with Casandro Wash to 0.9 mile upstream
Hospital Wash	From confluence with Sols Wash to 0.4 mile upstream
Powder House Wash	From confluence with Hassayampa River to 1.3 miles upstream
Atchison, Topeka & Santa Fe Railway Channel	From confluence with Agua Fria River to 1.5 miles upstream
Atchison, Topeka & Santa Fe Railway Ponding	For ponding along the railroad at Peoria
Echo Canyon Wash	From Arizona Canal to McDonald Drive
Southern Pacific Railroad Shallow Flooding	For shallow flooding at Buckeye, Goodyear, Gilbert, Tempe, and Tolleson
Apache Creek	Flooding on alluvial fan near Apache Junction

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Flynn Lane Wash	From confluence with Arizona Canal upstream to 23rd Place
Granite Reef Wash	From Fillmore Street upstream to Pima Road
Indian Bend Wash	From entire length within Scottsdale corporate limits
Indian Bend Wash - Low Flow Channel	From entire length within Scottsdale corporate limits
Moon Valley Wash	From confluence with Cave Creek to Thunderbird Road
Myrtle Avenue Wash	From confluence with Arizona Canal to Myrtle Avenue
Tenth Street Wash	From confluence with Arizona Canal to Cheryl Drive
Wash B	From Granite Reef Aqueduct to Mountain View Road
Sweat Canyon Wash	From confluence with New River to approximately 4.1 miles upstream
Buchanan Wash	From confluence with Skunk Creek to Central Arizona Project Canal
Martinez Wash	From confluence with Hassayampa River to Maricopa-Yavapai County boundary
Mockingbird Wash	From U.S. Highways 60, 70, and 89 to 0.9 mile upstream
Little San Domingo Wash	From the U.S. Highways 60, 70, and 89 crossing at Morristown to approximately 0.7 mile upstream
Lower El Mirage Wash	From Cactus Road to approximately 0.4 mile upstream
Lower El Mirage Wash Tributary	For shallow flooding, from confluence with Lower El Mirage Wash to 0.7 mile upstream

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Sand Tank and Bender Washes	For combined flows at Gila Bend
Rodeo Wash	For ponding along Southern Pacific Railroad, U.S. Highway 80, and Gillespie Canal at Gila Bend
Rodeo Wash Tributary	For ponding along Southern Pacific Railroad at Gila Bend
Airport Wash	For ponding along U.S. Highway 80 at Gila Bend
Scott Avenue Wash	For ponding along Gillespie Canal, Southern Pacific Railroad, and U.S. Highway 80 at Gila Bend
Centennial Wash	From confluence with Gila River to confluence with Aguila Farm Channel
Cemetery Wash	From confluence with Hassayampa River to approximately 1.8 miles upstream
Trilby Wash	From McMicken Dam to the CAP Canal and from Black Mountain Road in the Circle City area to approximately 1.2 miles north
McMicken Dam Outlet Wash	From confluence with Agua Fria River to 4.5 miles upstream to McMicken Dam Outlet Channel
Wittmann Wash	From CAP Canal to 3.9 miles upstream through the unincorporated community of Wittmann
Wash parallel to the Atchison, Topeka and Santa Fe Railway through Wittmann	From confluence with Wittmann Wash to 0.6 mile upstream along Atchison, Topeka and Santa Fe Railway
Circle City - Wash 1	From Black Mountain Road to 1.2 miles upstream

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Circle City - Wash 2	From confluence with Circle City Wash 1 to 0.7 mile upstream
Circle City - Wash 3	From Black Mountain Road to 1.5 miles upstream
Circle City - Wash 4	From confluence with Circle City Wash 3 to 0.6 mile upstream
Circle City - Wash 5	From confluence with Circle City Wash 6 to 0.4 mile upstream
Circle City - Wash 6	From confluence with Circle City Wash 3 to 0.9 mile upstream
Caterpillar Tank Wash	From confluence with Agua Fria River to CAP Canal
Twin Buttes Wash	From confluence with Agua Fria River to CAP Canal
East Garambullo Wash	From confluence of Garambullo Wash to CAP Canal
West Garambullo Wash	From confluence of Garambullo Wash to CAP Canal
White Peak Wash	From confluence with Twin Buttes Wash to CAP Canal
West Fork of White Peak Wash	From confluence with White Peak Wash to CAP Canal
Jackrabbit Wash	From CAP Canal to Vulture Mine Road
Unnamed Tributary of Jackrabbit Wash	From the mouth to Vulture Mine Road
Star Wash	From confluence with Jackrabbit Wash to 2.1 miles upstream

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Southern Pacific Railroad & Southern Pacific Spur, Ponding	From East Maricopa Floodway to Baseline Road along Southern Pacific Railroad, and from Hunt Highway north to Baseline Road along Southern Pacific Spur
Consolidated Canal, Ponding	From Hunt Highway (Maricopa County Line) to Superstition Freeway (SR 360)
Eastern Canal, Ponding	From Riggs Road north to Superstition Freeway (SR 360)
Cline Creek	From confluence with Skunk Creek to 2.6 miles upstream
Cline Creek-Tributary X-5	From confluence with Cline Creek to 16th Street Alignment
Cline Creek-Tributary C-6	From confluence with Cline Creek to 600 feet west of 20th Street
Cline Creek-Tributary C-8	From confluence with Tributary C-6 to 2,200 feet east of 24th Street
Cline Creek-Tributary X-1 of C-6	From 600 feet west of 20th Street to 1,400 feet east of 24th Street Alignment
Cline Creek-Tributary X-2 of C-6	From confluence with Tributary C-6 to 24th Street Alignment
Cline Creek-Tributary X-3 of C-6	From confluence with Tributary C-6 to 500 feet east of 20th Street
Cline Creek-Tributary X-4A of C-6	From confluence with Tributary C-6 to confluence with Tributary X-4B
Cline Creek-Tributary X-4B of X-4A	From confluence with Tributary X-4A of C-6 to 600 feet west of 14th Street

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Morgan City Wash	From confluence with Agua Fria River to approximately 12 miles upstream at Maricopa County Line
Rodger Creek	From confluence with Skunk Creek to 6.4 miles upstream
Grass Wash	From confluence with Aguila Farm Channel to 5.685 miles upstream
Aguila Farm Channel	From confluence with Centennial Wash to 5.378 miles upsteam
North Branch Centennial Wash	From confluence with Aguila Farm Channel to 2.416 miles upstream
Gila River	From north of Gila Bend to Gillespie Dam and from Gillespie Dam to confluence with Salt River at 115th Avenue
Ocotillo Wash-Tributary 1	From confluence with Ocotillo Wash (OW) to 1.1 miles upstream
Ocotillo Wash-Tributary 1A	From confluence with OW Tributary 1 to 0.69 mile upstream
Ocotillo Wash-Tributary 2	From confluence with Ocotillo Wash to 1.1 miles upstream
Ocotillo Wash-Tributary 3	From confluence with Ocotillo Wash to 1.43 miles upstream
Ocotillo Wash-Tributary 4	From confluence with Ocotillo Wash to 1.25 miles upstream
Willow Springs Wash	From confluence with Cave Creek to approximately 4.6 miles upstream

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Willow Springs Wash-Tributary 1	From confluence with Willow Springs Wash to 3.56 miles upstream
Willow Springs Wash-Tributary 1A	From confluence with Willow Springs Wash-Tributary 1 to 0.97 mile upstream
Willow Springs Wash-Tributary 2	From confluence with Willow Springs Wash to 1.61 miles upstream
Willow Springs Wash-Tributary 2A	From confluence with Willow Springs Wash-Tributary 2 to 1.00 mile upstream
Willow Springs Wash-Tributary 4	From confluence with Willow Springs Wash to 1.09 miles upstream
Willow Springs Wash-Tributary 5	From confluence with Willow Springs Wash to 2.04 miles upstream
Willow Springs Wash-Tributary 5A	From confluence with Willow Springs Wash-Tributary 5 to 0.6 mile upstream
Grapevine Wash	From confluence with Rowe Wash to City of Scottsdale
Cottonwood Creek	From confluence with Cave Creek to City of Scottsdale
Cottonwood Creek-Tributary 1	From confluence with Cottonwood Creek to 0.7 mile upstream
Cottonwood Creek-Tributary 2	From confluence with Cottonwood Creek-Tributary 1 to 0.22 mile upstream
Flemming Spring Wash	From confluence with Willow Springs Wash to 0.76 mile upstream

Table 1. Detailed-Study Sources (Cont'd)

Flooding Source	Limits of Study
Rowe Wash	From confluence with Galloway Wash to 3.98 miles upstream
North Tributary of Galloway Wash	From confluence with Unnamed Tributary to Galloway Wash to 3.26 miles upstream
East Maricopa Floodway, Ponding	From Guadalupe Road northwest to Broadway Road
Southern Pacific Railroad	From Riggs Road northwest to Roosevelt Canal
Wagner Wash	From confluence with Hassayampa River to CAP Canal
Gila Bend Canal, Ponding	From SR 85 north to Gillespie Dam
Basins 1 through 6 - Alluvial Fan Flooding North of the CAP Canal between the McDowell Mountains and Cave Creek	From the Apexes to the CAP Canal

Table 2. Approximate-Study Streams

Cave Buttes Detention Dike
Cave Creek Wash
Cemetery Wash
Cline Creek
Consolidated Canal
Cooper Creek
Cross Cut Canal
Dreamy Draw Detention Dike
Eastern Canal
Echo Canyon Canal
Flying E Wash
Gila Bend Canal
Gila River
Grand Canal
Granite Reef Aqueduct
Harquahala Detention Dike
Hartman Wash
Highline Canal
Iona Wash
Ocotillo Wash
Rowe Wash-Tributary 1
Rowe Wash-Tributary 2

Jackrabbit Wash
Kaiser-Aetna McCormick Ranch Drainage
Kyrene Branch Canal
Little Squaw Creek
Lower El Mirage Wash
Moore Gulch
Padelford Wash
Queen Creek

Roosevelt Canal

Saddle Back Mountain Detention Dike
Salt River
Scatter Wash
Signal Butte Detention Dike
Sols Wash
Southern Pacific Railroad
Spook Hill Detention Dike

Table 2. Approximate-Study Streams (Cont'd)

Sunny Cove Wash	Verde River
Sunset Wash	Verde River Tributaries (Washes 9, 10, and 11)
Sycamore Creek	West Prong Wash
Tempe Canal	Western Canal
Tiger Wash Detention Dike	
Trilby Wash Detention Basin	
Willow Spring Wash	
Willow Spring Wash-Tributary 3	

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Maricopa County.

2.2 Community Description

Maricopa County, encompassing a total area of 9,238 square miles, is located in south-central Arizona. Adjacent counties are Yavapai on the north, Gila on the northeast, Pinal on the east, Pima on the south, Yuma on the west, and La Paz on the northwest. The incorporated communities within the county cover an area in excess of 100 square miles, and an additional 3,330 square miles are Government-owned lands. A large portion of the remaining county land is undeveloped and is considered to be economically unfit for development. The 1980 population of the county was 1.5 million.

The terrain throughout Maricopa County varies in character from numerous rugged mountain ranges to plains and deserts. An abundance of small intermittent streams and washes traverse the major portion of the county.

Residential and agricultural development is concentrated along the major streams, with expansion continuing at a rapid pace.

The climate in Maricopa County is mild, with short winters and long, hot summers.

The Gila River, which is the largest tributary to the lower Colorado River, flows southwesterly through the southern half of the county. The river basin includes the southern half of Arizona and part of southwestern New Mexico and contributes a drainage area of 49,500 square miles at the Gillespie Dam, which is approximately 31 miles downstream from Goodyear.

The Agua Fria River, a tributary to the Gila River, rises in the Prescott National Forest and flows southerly for approximately 130 miles to its confluence with the Gila River. It drains an area of approximately 2,340 square miles. The river is usually dry because flows are regulated by the Carl Pleasant Dam and Lake Pleasant reservoir, approximately 18 miles north of El Mirage, in north-central Maricopa County (Reference 26).

The New River, the major tributary of the Agua Fria River, rises in the Cook Mesa area of the New River Mountains and flows southerly to the Agua Fria River. It is approximately 48 miles long and has a drainage area of approximately 315 square miles (Reference 27).

Skunk Creek flows southwesterly to its confluence with the New River, draining an area of approximately 110 square miles at its mouth.

Scatter Wash flows westerly through northern Phoenix to its confluence with Skunk Creek.

East Branch Scatter Wash is an overflow area from Scatter Wash. Floodwater flows along the southern overbank of Scatter Wash just north of Black Canyon Highway, crosses the highway at the Deer Valley Road interchange, and rejoins Scatter Wash along Rose Garden Lane in Phoenix.

The Salt River originates at the Theodore Roosevelt Lake in Gila County. The river flows westerly through east-central Maricopa County to its confluence with the Gila River. The Salt River has a wide, irregular, sandy streambed with several meandering channels throughout the study area. The river drains an area of 13,700 square miles at its mouth. The Salt River is regulated by four dams: Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain. The total capacity of the four reservoirs is 1.755 million acre-feet. Water from this system is used for irrigation of the Salt River Valley and for the generation of power (Reference 28). Granite Reef Dam, located on the Salt River 3.4 miles below its confluence with the Verde River, diverts water from the river to Arizona and Southern Canals. This water is for municipal use and irrigation.

Cave Creek and its numerous tributaries drain the mountainous areas of east-central Maricopa County. Cave Creek flows southwesterly to its confluence with the Salt River. Its tributaries include East Fork Cave Creek and Andora Hills, Galloway, Rowe, Grapevine, Ocotillo, and Willow Springs Washes. Flows are regulated by Cave Creek Dam, located just north of Phoenix. East Fork Cave Creek flows southwesterly to its confluence with Cave Creek, draining an area of 14.4 square miles at its mouth. Andora Hills Wash flows westerly to its confluence with Cave Creek north of Phoenix. Galloway Wash flows westerly to its confluence with Cave Creek north of Phoenix. Rowe Wash and Grapevine Wash flow southwesterly to their confluences with Galloway Wash north of Phoenix. Ocotillo and Willow Springs Washes flow southwesterly before joining Cave Creek north of Phoenix.

The Hassayampa River flows southerly through northwestern Maricopa County before joining the Gila River 40 miles west of Phoenix. The river, which drains an area in northwestern Maricopa County and southern Yavapai County, originates in the Bradshaw Mountains south of Prescott (Reference 29). The terrain of the drainage basin consists of mountains with heavy forest cover in the northern one-third, rolling hills in the central one-third, and desert valley in the southern one-third. The stream gradient of the Hassayampa River ranges from an average of 20 feet per mile near River Mile 40 to approximately 400 feet per mile near Box Canyon in Yavapai County (Reference 29).

Sols Wash originates in the Date Creek Mountains north of Wickenburg. It flows southeasterly, draining an area of 145 square miles at its confluence with the Hassayampa River. The basin is bounded by low, poorly defined ridges and hills extending to Twin Peaks. On the south and east, pronounced foothills and mountains distinguish the drainage divide. The Sols Wash basin is a mildly sloping desert plain. Tributaries to Sols Wash are Flying E, Hospital, Casandro, and South Branch Casandro Washes. Flying E Wash flows northeasterly, joining Sols Wash in western Wickenburg. Hospital Wash flows southerly to its confluence with Sols Wash within Wickenburg. Casandro Wash flows northeasterly to its confluence with Sols Wash in Wickenburg. South Branch Casandro Wash flows northeasterly to its confluence with Casandro Wash in southwestern Wickenburg.

Powder House Wash flows southwesterly in a well-defined channel, draining 2 square miles of desert highlands before discharging into the Hassayampa River at Wickenburg.

Martinez Wash flows southeasterly, joining the Hassayampa River at the Maricopa-Yavapai County line.

Mockingbird Wash is a tributary of the Hassayampa River approximately 2 miles southeast of Wickenburg. The wash is well defined, with steep sidewalls. Mockingbird Wash flows southwesterly, draining approximately 7 square miles of desert highland. There is some residential development upstream of the U.S. Highways 60, 70, and 89 crossing.

Little San Domingo Wash is a small, well-defined wash near the unincorporated area of Morristown in northern Maricopa County. It flows southwesterly, draining 6.2 square miles of desert highlands at the U.S. Highways 60, 70, and 89 crossing.

Wittmann Drainage flows southerly near the unincorporated community of Wittmann, approximately 25 miles northwest of Phoenix.

Aguila Farm Channel collects floodflows north of the Atchison, Topeka & Sante Fe Railway in northwestern Maricopa County and conveys them westerly across Aguila Farm to Grass Wash.

Grass Wash flows northwesterly through Aguila to its confluence with Centennial Wash in northwestern Maricopa County.

Sand Tank and Bender Washes flow northwesterly through the center of Gila Bend. Sand Tank and Bender Washes approach Gila Bend from the south in two separate channels, but during periods of heavy runoff the washes overflow their banks and the flows are intermixed. The combined flows join the Gila River 3 miles north of Gila Bend.

Rodeo Wash and Rodeo Wash Tributary flow northwesterly through eastern Gila Bend.

Airport Wash flows northwesterly through the northeastern corner of Gila Bend.

Scott Avenue Wash flows northerly through western Gila Bend.

Lower El Mirage Wash and Lower El Mirage Wash Tributary flow easterly to the Agua Fria River near El Mirage.

The Atchison, Topeka & Santa Fe Railway Channel flows easterly to the Agua Fria River through the northern part of the town.

The elevated embankments of the Atchison, Topeka & Santa Fe Railway and the Southern Pacific Railroad impede the movement of floodwaters from the east and northeast, resulting in ponding and shallow flooding along the embankments throughout the county.

Echo Canyon Wash flows southwesterly through Paradise Valley, Scottsdale, and Phoenix to its junction with Arizona Canal.

Apache Creek, near Apache Junction, is on an alluvial fan at the base of the Superstition Mountains in southeastern Maricopa County.

A system of irrigation canals crosses the southern one-half of the county nearly parallel to ground contours. The system consists of the Arizona, Grand, Western, Tempe, Highline, Kyrene Branch, Gila Bend, Southern, Buckeye, Consolidated, Roosevelt, and Eastern Canals, and the Granite Reef Aqueduct.

2.3 Principal Flood Problems

The flooding history of Maricopa County indicates that large portions of the county are subject to destructive floods.

The principal flood hazard results from overflow of the major rivers; the overflow results in the inundation of the wide, flat floodplains, including any residential, commercial, or agricultural developments located within them. Erosion, combined with the development of new channels, adds to the potential hazard from inundation.

Areas adjacent to the floodplains of the major rivers, but not subject to overflow from the rivers, may be flooded due to the failure of earthen dikes and other retarding or diverting structures (Reference 28).

The upland areas of Maricopa County are also subject to flooding. Throughout the county, broad alluvial slopes lie between the steep mountains and major watercourses. These slopes are formed by the intermingling of alluvial fans from several streams and are traversed by many small channels that divide and reconverge at many places.

These channels are usually lined with small amounts of brush. Flooding occurs as a direct result of rainfall on the slopes or is caused by streams that drain from the mountains. Floods originating in the mountains often carry substantial amounts of rock debris, which are deposited on the alluvial slope. The debris may plug old channels and cause new ones to develop. Many of the lower slopes receive runoff only from precipitation that falls directly on the area involved because mountain runoff is completely dissipated on the upper slopes.

Much of the floodflow on the upland areas is unconfined and moves downslope as sheetflow. Generally, the sheetflow is less than 1.0 foot deep because the width of flow prevents water from building up to greater depths, except in depressions and where water ponds behind dikes, canals, and road fills that may divert the flow from its normal path. The concentrated flow may then break through at one spot, causing high velocities and deep flows immediately below the break or overflow area (Reference 30).

The type of sheetflow described above occurs on ground slopes of 1 to 5 percent. Slopes of less than 1 percent are too flat to carry water any significant distance. Ponding and rapid infiltration deplete the floodflows quickly. Slopes of more than 5 percent generally cause defined channels to form. Defined channels of minor tributaries may extend a considerable distance into slopes that are flatter than 5 percent, but will seldom reach slopes of less than 2 percent without distributary channels forming. Water in these channels is generally 2.5 to 3 feet deep (Reference 30).

Floods have plagued the Gila River basin for many years. The flood of February 1891 produced a great flood on the Salt River; the estimated peak floodflow was 300,000 cubic feet per second (cfs) at Arizona Dam (the present site of Granite Reef Dam). The largest flood involving the entire Gila River basin since that time was produced by the storms of January 1916. During that month, two Pacific storms occurring 10 days apart brought warm rain, which melted unusually heavy snowcovers. The resultant flood ravaged the entire basin (Reference 31).

Other large floods occurred in April 1905, February 1920, March 1938, August 1951, December 1965, December 1967, September 1970, and June 1972.

Maricopa County has experienced major flood losses recently. Heavy precipitation in the mountains north and east of Phoenix caused five floods in the Phoenix area from March 1978 to February 1980. The floods occurred in March 1978, December 1978, January 1979, March 1979, and February 1980 (approximately a 50-year event) when the flows in the Salt, Verde, and Agua Fria Rivers exceeded the storage capacity of the reservoirs on the rivers. These floods made almost all river crossings on the Salt River impassable for weeks and cut Maricopa County practically in half. Because of major traffic delays, businesses suffered major income losses. The nuisance of traffic jams also affected the lives of residents in the Phoenix metropolitan area. There were major physical damages to roads and bridges that crossed the Salt and Agua Fria Rivers. The Sky Harbor International Airport runways were flooded, causing partial closure of operations. The other flood damages were to agricultural fields on the flat floodplains, to the sand-and-gravel-mining operations in the riverbed, and commercial establishments in the river floodplains. Emergency assistance costs for local fire, police, and public services increased significantly. The overall flood damage estimate for March 1978 was approximately $33.2 million; for December 1978, $51.8 million; and for February 1980, $63.6 million.

Figures 2, 3, 4, and 5 depict flooding along the Salt River during December 1965. Figure 6 shows flooding on the Agua Fria River near Goodyear during the December 1965 flood.

2.4 Flood Protection Measures

Several flood-control structures exist in Maricopa County. Painted Rock Dam, which is 20 miles northwest of Gila Bend on the Gila River, was completed in 1959. It provides flood protection for approximately 360,000 acres downstream of the dam (Reference 31).

Runoff on the Salt River and its tributary, the Verde River, has been reduced over the years by the construction of several dams: Granite Reef Dam (1908); Roosevelt Dam (1911); Mormon Flat Dam (1925); Horse Mesa Dam (1927); Stewart Mountain Dam (1930) on the Salt River; Bartlett Dam (1939); and Horseshoe Dam (1945) on the Verde River.

Carl Pleasant Dam was constructed at the Frog Tanks gage on the Agua Fria River in 1927. It controls runoff from an area of 1,457 square miles (Reference 32).

Cave Creek Dam, built in 1920, provides protection from a 25-year flood to parts of Phoenix.

The Paradise Valley detention dikes, which are a feature of the Central Arizona Project (CAP), provide flood protection for the northeastern part of Phoenix and Scottsdale in excess of the 100-year flood. The Paradise Valley detention dikes have 14 feet of freeboard to provide protection from the 100-year flood (Reference 14). Also part of the CAP is the Granite Reef Aqueduct, which consists of a concrete-lined channel and a series of levees.

Dreamy Draw detention basin (1973) and Cave Buttes Dam (1980) provide additional flood protection for the City of Phoenix.

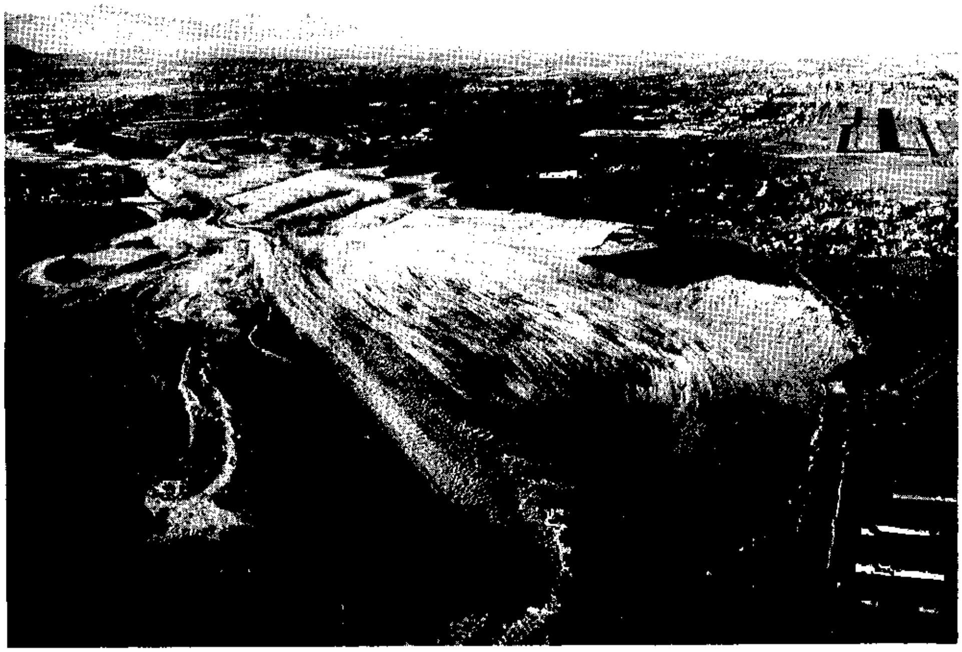


Figure 2. Looking Downstream on the Salt River During the December 1965 Flood (Sky Harbor International Airport runways are in the center.)

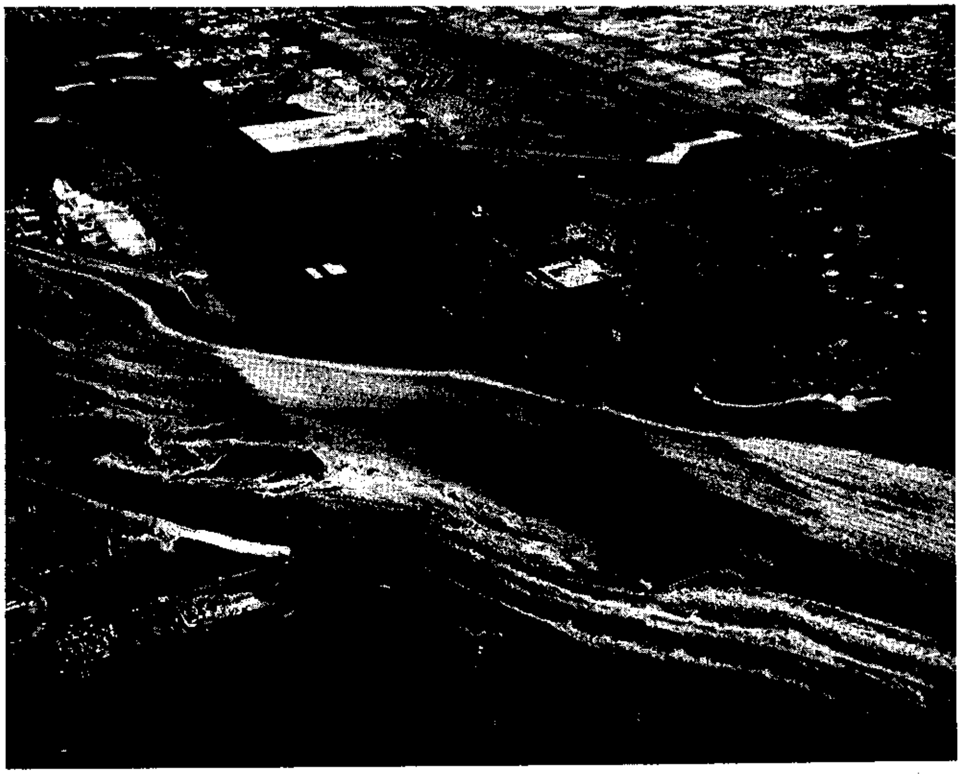


Figure 3. Salt River Flooding in December 1965 (The 40th Street bridge railing is visible at lower right; flow is from right to left.)

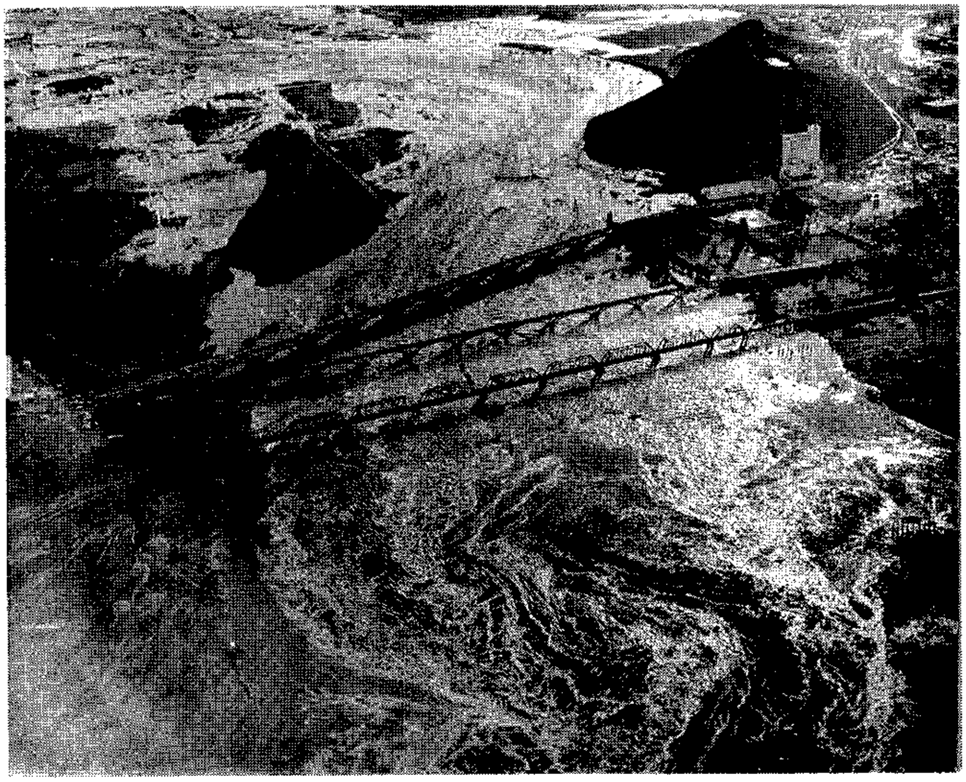


Figure 4. The Salt River Bridges in Tempe, Looking Upstream (The flooded area in the upper center is now developed into athletic fields and parking lots for Arizona State University. Photograph was taken on December 31, 1965.)

Figure 5. The Salt River in Tempe Looking Southwest (The flow is left to right. The buildings in the upper center of the photo are the Arizona State University. Scottsdale Road crosses the photo from the upper left to the lower right. Photograph was taken on December 31, 1965.)

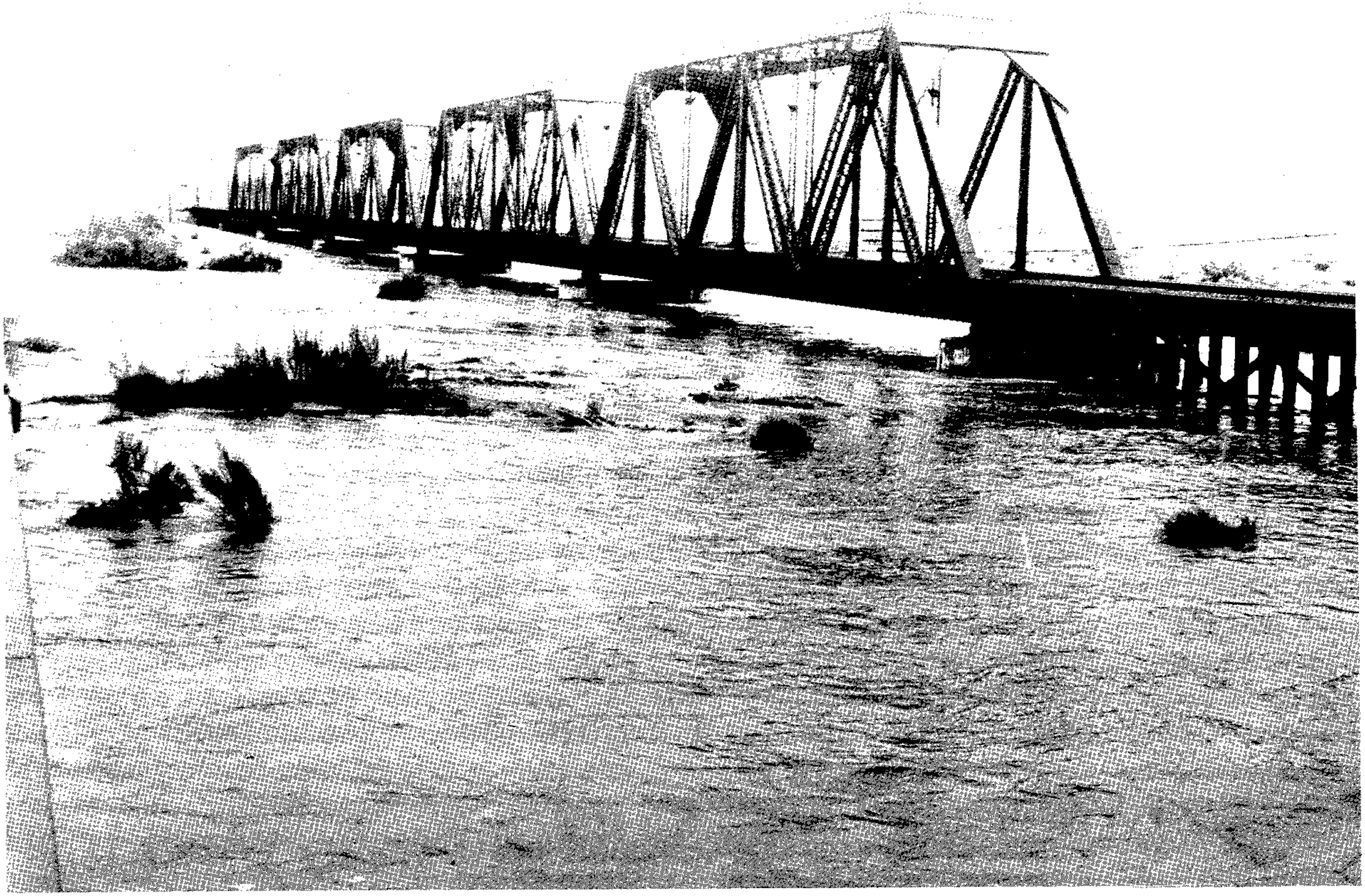


Figure 6. Agua Fria River Flooding at U.S. Highway 80 and Southern Pacific Railroad Bridge near Goodyear, Arizona, on December 22, 1965 (Direction of flow is right to left.)

Trilby Wash detention basin (McMicken Dam) was completed in 1956. The detention basin has a capacity of 19,300 acre-feet (Reference 31). A leveed outlet channel conveys flood releases from the detention basin to the Agua Fria River. The project provides some flood protection to Luke Air Force Base, Phoenix Litchfield Municipal Airport, and the Towns of Goodyear, Litchfield, Avondale, Surprise, and El Mirage.

Spookhill Dam, Signal Butte Dam, Pass Mountain Dam, Powerline Dam, a diversion structure to Powerline Dam, and Rittenhouse Dam control flooding in the southeastern part of the county (References 5 and 8).

Drainage structures in the Interstate Highway 8 embankment south of Gila Bend were designed, according to State criteria, for a 50-year storm. This provides a shielding effect to Gila Bend because floodwaters from lower frequency storms will be detained by the highway, and flows exceeding the capacity of the highway structures will be diverted to the west (Reference 7).

A stormwater detention dike was built approximately 4 miles north of Buckeye under the auspices of FCDMC. This facility was designed and constructed to contain up to the 100-year frequency storm runoff from the drainage areas north of the Roosevelt Canal. This facility provides some flood protection to Buckeye (Reference 13).

The channelization of portions of the Agua Fria, Gila, New, and Salt Rivers, Skunk Creek, and Scatter Wash has significantly reduced their respective floodplain areas.

Adobe Dam was constructed in April 1982 on Skunk Creek across Deer Valley Drive, approximately 1 mile west of Black Canyon Highway. The embankment is a compacted-earthfill structure. The ungated outlet works are designed to release a discharge of 1,890 cfs when the water surface is at the spillway crest (1,377 feet). The dam is designed to reduce the Standard Project Flood peak inflow of 66,000 cfs to an outflow of 1,890 cfs. The 100-year base flood inflow of 39,000 cfs will be reduced to a 1,730-cfs outflow.

In addition, the construction of the New River Dam has reduced the peak flow downstream at the confluence with Skunk Creek from 58,000 cfs to 12,000 cfs.

Levees in the study area provide the community with some degree of protection from flooding. However, it has been ascertained that some of these levees may not provide 100-year flood protection. The criteria used to evaluate 100-year protection are: (1) adequate design, including freeboard; (2) structural stability; and (3) proper operation and maintenance. Levees that do not provide 100-year flood protection are not considered in the hydraulic analyses of the 100-year floodplain.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the county.

Peak discharges for the Hassayampa River were developed from discharge-frequency relationships of historic floods and gage records (Reference 32).

In the absence of observed runoff data, present-condition, discharge-frequency values for Scatter Wash and the New River were used. Present-condition, discharge-frequency values for Scatter Wash and Skunk Creek below Adobe Dam were based on future condition values modified to reflect present conditions (Reference 33). Discharge-frequency values for the Agua Fria River were determined by routing balanced hydrographs, which were developed from Waddell Dam inflow-volume-frequency relationships, through the dam and downstream, and adding local flows as appropriate. Discharge-frequency relationships for the Salt River and Gila Rivers concentration points were determined by routing period-of-record flows through existing reservoirs using the HEC-5 computer model (Reference 34).

Peak discharge-frequency relationships for Cave Creek (below Cave Creek Dam), East Fork Cave Creek, and Echo Canyon Wash were taken from the Flood Insurance Study for the City of Phoenix (Reference 14).

Peak discharge-frequency relationships for Cave Creek (above Cave Creek Dam), Andora Hills Wash, Galloway Wash, Apache Creek, Rowe Wash, Grapevine Wash, Ocotillo Wash, Willow Springs Wash, Skunk Creek (above Carefree Highway), Mockingbird Wash, Little San Domingo Wash, Wittmann Drainage, Aguila Farm Channel, Grass Wash, Sand Tank Wash, Bender Wash, Rodeo Wash and its tributary, Airport Wash, Scott Avenue Wash, and Martinez Wash were developed using the U.S. Soil Conservation Service (SCS) TR-20 program (Reference 35). In addition, the SCS TR-55 computer program (Reference 36) was used to determine flood peaks for Buckeye Canal; Atchison, Topeka & Santa Fe Railway Channel; Southern Pacific Railroad Spur at Chandler; Southern Pacific Railroad at Buckeye, Chandler, Gilbert, Goodyear, Tempe, and Tolleson; and Lower El Mirage Wash and its tributary.

The Town of Wickenburg requested a restudy for Sols Wash based upon studies performed by the SCS and PRC Toups Engineering (PRC) (Reference 37). These studies yielded peak discharges significantly less than what had been assumed in the previous analysis for the effective Flood Insurance Study (Reference 19).

The SCS computer model, TR-20, was selected to be used to estimate the 10-, 50-, 100- and 500-year peak discharges for various concentration points along Sols Wash. The TR-20 model utilizes the method of analysis described in detail in the SCS National Engineering Handbook Section 4, Hydrology, 1972. This method allows for the prediction of surface water runoff, for an individual watershed, using rainfall-duration and intensity data. The TR-20 model provides a convenient means of predicting the results of storm runoff from multiple watersheds. The storm runoff for individual watersheds is computed and an outflow hydrograph simulated. Individual hydrographs may then be routed and combined to obtain the cumulative downstream effects (References 35, 38, 39, 40, 41, 42, 43, and 44).

The precipitation frequencies for the area were obtained from isopluvial maps prepared by the U.S. Weather Bureau. The SCS Type II rainfall distribution was used to model the rainfall, which was adjusted using an areal reduction based upon the total drainage area. Such reduction is necessary to convert from the point areal rainfall amount. Using soils maps of the area, prepared by the SCS, and from site investigation, runoff curve numbers were selected, based upon recent information developed by the SCS. Time of concentrations for steep and incised washes were computed using the Kirpich equation. For gently sloping alluvial plains, many of which occur on the upper northwest portion of the drainage basin, travel velocities were estimated assuming broad sheetflow and utilizing Manning's equation.

Because there is no gaging station on Sols Wash, and thus no accurate record of historic flooding, there is no means to provide calibration of the rainfall-runoff model, and therefore, only comparison with earlier studies can be made.

The discharge estimates obtained from the TR-20 analysis for this study correspond with the results from both the SCS and PRC analyses. The discharge-frequency curve developed by the COE for the 1977 Flood Insurance Study has a steeper slope and results in a much larger 100-year peak discharge than the other studies. The SCS, PRC, and CBA studies each employed the TR-20 model which might explain, in part, the consistency of the results, although the TR-20 is quite sensitive to changes in time of concentration, and each model employed different input parameters.

The calibration of the TR-20 model, by PRC, using streamflow data from the Hassayampa River, lends further credence to each of the study results. Therefore, results from the TR-20 model utilized in this restudy of Sols Wash have been employed in the hydraulic analysis.

Peak discharge-frequency relationships for Casandro, South Branch Casandro, Flying E, Hospital, and Powder House Washes were taken from the Flood Insurance Study for Wickenburg (Reference 19).

Peak discharge-drainage area relationships for flooding sources studied by detailed methods are shown in Table 3.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

For areas of riverine flooding studied by detailed methods, water-surface elevations for floods of the selected recurrence intervals were computed using the COE HEC-2 computer program (Reference 45).

The cross section data for the Agua Fria River were taken from several sources of mapping. A 1981 COE topographic map for the New River (Reference 46) was used for the river section from the confluence with the Gila River to the confluence with the New River. From the New River to Northern Avenue, 1982 City of Glendale mapping was used (Reference 47). From Northern Avenue to Grand Avenue and from Beardsley Road to Jomax Road, 1983 Maricopa County maps were used (Reference 48). The topographic maps for the reach between Grand Avenue and Bell Road (Reference 49) were furnished by American Engineering Company. For the reach between Bell and Beardsley Roads, maps were provided by Cella, Barr, Evans and Associates (Reference 50).

Cross sections for the Gila River were digitized from 1983 topographic maps or taken from as-built data for the Bullard Avenue Bridge.

Table 3. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Cottonwood Creek					
Above confluence with Cave Creek	10.06	5,952	9,253	10,956	14,038
Above confluence with Cottonwood Creek Tributary 1	9.62	5,905	9,202	10,925	14,016
At River Mile 1.85 above Minor Tributary	8.31	5,127	7,963	9,424	12,075
At River Mile 2.71 above Minor Tributary	1.64	746	1,154	1,366	1,747
Cottonwood Creek Tributary 1					
Above confluence with Cottonwood Creek	0.82	764	1,187	1,410	1,804
Above confluence with Cottonwood Creek Tributary 2	0.74	688	1,068	1,269	1,624
Cottonwood Creek Tributary 2					
Above confluence with Cottonwood Creek Tributary 1	0.08	76	119	141	180
North Tributary of Galloway Wash					
At confluence with Unnamed Tributary to Galloway Wash	6.40	5,516	8,143	9,483	11,868
At River Mile 1.89 above Minor Tributary	4.98	3,751	5,632	6,593	8,303
Grapevine Wash					
Above confluence with Rowe Wash	3.80	2,865	4,266	5,004	6,316
Ocotillo Wash Tributary 1					
Above confluence with Ocotillo Wash	0.76	802	1,201	1,397	1,743
Above confluence with Ocotillo Wash Tributary 1A	0.15	126	190	223	283
Ocotillo Wash Tributary 1A					
Above confluence with Ocotillo Wash Tributary 1	0.61	693	1,030	1,206	1,517

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Ocotillo Wash Tributary 2					
Above confluence with Ocotillo Wash	0.19	145	222	260	330
Ocotillo Wash Tributary 3					
Above confluence with Ocotillo Wash	0.21	164	252	296	375
Ocotillo Wash Tributary 4					
Above confluence with Ocotillo Wash	0.06	46	71	83	105
Willow Springs Wash					
Above confluence with Cave Creek	5.0	3,740	5,570	6,240	8,250
0.8 mile above confluence with Cave Creek	3.1	2,920	4,300	4,800	6,220
At River Mile 1.78 Cave Creek	2.76	2,652	4,004	4,682	5,877
Above confluence with Willow Springs Wash Tributary 2	1.64	1,835	2,746	3,193	3,978
Above confluence with Willow Springs Wash Tributary 4	1.41	1,698	2,528	2,932	3,640
At River Mile 3.81 below CP 16	0.88	1,189	1,755	2,027	2,502
At River Mile 4.31 above confluence with Minor Tributary	0.32	420	626	724	897
At River Mile 4.95 above confluence with Minor Tributary	0.16	210	313	362	449
Willow Springs Wash Tributary 1					
Above confluence with Willow Springs Wash	1.65	816	1,226	1,438	1,822
At River Mile 0.98 above confluence with Minor Tributary	1.31	604	908	1,065	1,385
Above confluence with Willow Springs Wash Tributary 1A	0.56	358	537	629	794
At River Mile 2.82	0.25	163	244	286	360
Willow Springs Wash Tributary 1A					
Above confluence with Willow Springs Wash Tributary 1	0.27	192	290	341	431

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
Willow Springs Wash Tributary 2					
Above confluence with Willow Springs Wash	0.72	856	1,275	1,492	1,866
Above confluence with Willow Springs Wash Tributary 2A	0.43	511	762	891	1,114
At River Mile 1.31 above confluence with Minor Tributary	0.22	256	381	446	557
Willow Springs Wash Tributary 2A					
Above confluence with Willow Springs Wash Tributary 2	0.29	345	514	601	752
At River Mile 0.52 above confluence with Minor Tributary	0.19	231	344	403	504
Willow Springs Wash Tributary 4					
Above confluence with Willow Springs Wash	0.23	180	271	318	402
At River Mile 0.52	0.16	124	186	219	277
At River Mile 0.98	0.10	75	113	133	168
Willow Springs Wash Tributary 5					
Above confluence with Willow Springs Wash	0.89	352	536	631	804
Above confluence with Willow Springs Wash Tributary 5A	0.42	236	359	423	539
Willow Springs Wash Tributary 5A					
Above confluence with Willow Springs Wash Tributary 5	0.20	81	123	145	185
Flemming Springs Wash					
Above confluence with Willow Springs Wash	0.32	409	547	610	730

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Northeast Side of Southern Pacific Railroad					
From Maricopa/Pinal County Line to south bank of Queen Creek	23.86	--[1]	--[1]	1,208	--[1]
From north bank of Queen Creek to Ocotillo Road	3.44	--[1]	--[1]	393	--[1]
From Ocotillo Road to Queen Creek Road	10.05	--[1]	--[1]	828	--[1]
From Queen Creek Road to south of Germann Road	16.15	--[1]	--[1]	1,172	--[1]
From south of Germann Road to Germann Road	22.25	--[1]	--[1]	1,358	--[1]
From Germann Road to confluence of East Maricopa Floodway	23.24	--[1]	--[1]	1,085	--[1]
Southwest Side of Southern Pacific Railroad					
From Germann Road to confluence of East Maricopa Floodway	--[2]	--[1]	--[1]	313	--[1]
Caterpillar Tank Wash					
Immediately downstream from CAP Canal	1.03	--[1]	--[1]	489	--[1]
At Beardsley Canal	3.03	--[1]	--[1]	1,375	--[1]
At confluence with Agua Fria River	3.36	--[1]	--[1]	1,315	--[1]
Twin Buttes Wash					
Immediately downstream from CAP Canal	3.03	--[1]	--[1]	2,154	--[1]
Above confluence with Garambullo Wash	3.32	--[1]	--[1]	2,163	--[1]
Above confluence with White Peak Wash	4.65	--[1]	--[1]	2,424	--[1]
At Beardsley Canal	8.04	--[1]	--[1]	2,779	--[1]
At confluence with Agua Fria River	8.77	--[1]	--[1]	2,746	--[1]
Garambullo Wash					
At confluence with Twin Buttes Wash	0.99	--[1]	--[1]	651	--[1]

[1]Not Computed
[1]Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
East Garambullo Wash					
Immediately downstream from CAP Canal	0.15	--[1]	--[1]	93	--[1]
At confluence with Garambullo Wash	0.37	--[1]	--[1]	259	--[1]
West Garambullo Wash					
Immediately downstream from CAP Canal	0.12	--[1]	--[1]	94	--[1]
At confluence with Garambullo Wash	0.62	--[1]	--[1]	483	--[1]
White Peak Wash					
Immediately downstream from CAP Canal	0.38	--[1]	--[1]	97	--[1]
Above confluence with West Fork of White Peak Wash	0.69	--[1]	--[1]	395	--[1]
At confluence with Twin Buttes Wash	1.59	--[1]	--[1]	721	--[1]
West Fork of White Peak Wash					
Immediately downstream from CAP Canal	0.15	--[1]	--[1]	90	--[1]
At confluence with White Peak Wash	0.28	--[1]	--[1]	294	--[1]
Grass Wash					
At U.S. Highways 60/70	70.6	3,340	8,660	11,100	--[1]
At NW. corner of Section 25, T7N, R9W	39.9	2,430	5,950	7,500	--[1]
At SE. corner of Section 25, T7N, R9W	23.9	1,720	3,900	4,870	--[1]
Aguila Farm Channel					
Below Grass Wash	314.4	4,130	14,500	19,300	--[1]
At Eagle Eye Avenue	239.6	3,620	12,700	16,900	--[1]
North Branch Centennial Wash					
At confluence with Centennial Wash	--[2]	--[1]	--[1]	6,960	--[1]

[1]Not Computed
[2]Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Gila Bend Canal					
At Spillway 1	7.31	--[1]	--[1]	2,454	--[1]
At Spillway 2	3.78	--[1]	--[1]	2,187	--[1]
At Spillway 3	50.49	--[1]	--[1]	11,565	--[1]
At Spillway 4	13.74	--[1]	--[1]	5,297	--[1]
At Spillway 5	9.41	--[1]	--[1]	4,885	--[1]
At Spillway 6	11.43	--[1]	--[1]	2,676	--[1]
At Spillway 7	18.22	--[1]	--[1]	2,757	--[1]
At Spillway 8	36.41	--[1]	--[1]	3,330	--[1]
At Spillway 9	10.20	--[1]	--[1]	1,882	--[1]
At Spillway 10	65.15	--[1]	--[1]	4,971	--[1]
At Spillway 11	11.54	--[1]	--[1]	2,609	--[1]
Wagner Wash					
At confluence with Hassayampa River	42.07	--[1]	--[1]	15,717	--[1]
At east quarter corner of Section 13, T3N, R5W	40.21	--[1]	--[1]	15,351	--[1]
1,700 feet below confluence with Bootlegger Wash	37.39	--[1]	--[1]	10,964	--[1]
At Sun Valley Parkway (South Crossing)	28.62	--[1]	--[1]	10,358	--[1]
5,200 feet upstream of Sun Valley Parkway (South Crossing)	24.54	--[1]	--[1]	8,079	--[1]
3,700 feet downstream of Sun Valley Parkway (North Crossing)	22.72	--[1]	--[1]	7,225	--[1]
Upstream of Sun Valley Parkway (North Crossing)	15.99	--[1]	--[1]	3,446	--[1]
3,200 feet north of Sun Valley Parkway (North Crossing)	15.07	--[1]	--[1]	2,894	--[1]
1,700 feet downstream of CAP Canal	13.14	--[1]	--[1]	1,723	--[1]
Downstream of CAP Canal	11.89	--[1]	--[1]	873	--[1]

[1]Not Computed

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Cline Creek					
At confluence with Skunk Creek	13.72	--[1]	--[1]	16,700	--[1]
At confluence with Tributary C-6 and C-8	10.59	--[1]	--[1]	13,300	--[1]
Tributary C-6 and C-8					
At confluence with Cline Creek	4.85	--[1]	--[1]	4,320	--[1]
Tributary C-6					
At confluence with Tributary C-8	3.29	--[1]	--[1]	2,210	--[1]
At confluence with Tributary X-4A	1.87	--[1]	--[1]	1,920	--[1]
At confluence with Tributary X-3	1.59	--[1]	--[1]	1,430	--[1]
At confluence with Tributary X-2	1.03	--[1]	--[1]	943	--[1]
Tributary X-4A					
At confluence with Tributary C-6	0.28	--[1]	--[1]	399	--[1]
At confluence with Tributary X-4B	0.16	--[1]	--[1]	254	--[1]
Tributary X-4B					
At confluence with Tributary X-4A	0.09	--[1]	--[1]	139	--[1]
Tributary X-3					
At confluence with Tributary C-6	0.56	--[1]	--[1]	518	--[1]
Tributary X-2					
At confluence with Tributary C-6	0.43	--[1]	--[1]	390	--[1]
Tributary X-1					
600 feet west of 20th Street	0.60	--[1]	--[1]	708	--[1]
Tributary X-5					
At confluence with Cline Creek	0.38	--[1]	--[1]	301	--[1]
Tributary C-8					
At confluence with Tributary C-6	1.42	--[1]	--[1]	2,280	--[1]

[1]Not Computed

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Morgan City Wash					
At confluence with Agua Fria River	22.97	--[1]	--[1]	14,400	--[1]
At confluence with Tributary M-12	21.16	--[1]	--[1]	14,200	--[1]
At confluence with Tributary M-10	18.90	--[1]	--[1]	13,900	--[1]
At confluence with Tributary M-8	15.64	--[1]	--[1]	12,300	--[1]
At confluence with Tributary M-7	13.25	--[1]	--[1]	12,000	--[1]
At confluence with Tributary M-4	8.12	--[1]	--[1]	8,130	--[1]
At confluence with Tributary M-3	5.45	--[1]	--[1]	4,820	--[1]
Rodger Creek					
At confluence with Skunk Creek	--[2]	--[1]	--[1]	6,170	--[1]
At 18th Street	--[2]	--[1]	--[1]	5,450	--[1]
Upstream of 28th Street	--[2]	--[1]	--[1]	2,870	--[1]
Jackrabbit Wash					
Below Star Wash	319.2	--[1]	--[1]	33,200	--[1]
Above Star Wash	152.4	--[1]	--[1]	19,300	--[1]
Below Unnamed Tributary	148.7	--[1]	--[1]	19,800	--[1]
Above Unnamed Tributary	140.3	--[1]	--[1]	19,700	--[1]
At Wickenburg Road	140.3	--[1]	--[1]	20,000	--[1]
At Vulture Mine Road	138.1	--[1]	--[1]	21,100	--[1]
Star Wash					
Mouth	166.8	--[1]	--[1]	17,300	--[1]
Below Powerline Wash	160.6	--[1]	--[1]	17,600	--[1]
Above Powerline Wash	125.7	--[1]	--[1]	14,000	--[1]
Unnamed Tributary of Jackrabbit Wash					
Mouth	8.4	--[1]	--[1]	2,900	--[1]
At Wickenburg Road	8.4	--[1]	--[1]	3,000	--[1]
At Vulture Mine Road	3.7	--[1]	--[1]	3,000	--[1]

[1]Not Computed
[2]Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Eastern Canal (Watershed 1)					
At Brown Road	--[5]	--[6]	--[6]	823	--[6]
At Main Street	--[5]	--[6]	--[6]	1,468	--[6]
At Southern Avenue	--[5]	--[6]	--[6]	1,963	--[6]
At Freeway	--[5]	--[6]	--[6]	2,129	--[6]
Consolidated Canal (Watershed 2)					
At Tempe Cross Cut	--[5]	--[6]	--[6]	441	--[6]
At Main Street	--[5]	--[6]	--[6]	1,122	--[6]
At Southern Avenue	--[5]	--[6]	--[6]	1,884	--[6]
At Freeway[1]	--[5]	--[6]	--[6]	2,456	--[6]
Consolidated Canal (Watershed 3)[2]					
At Lindsay Road	--[5]	--[6]	--[6]	660	--[6]
Southern Pacific Railroad (Watershed 4)					
At Main Street	--[5]	--[6]	--[6]	506	--[6]
At Southern Avenue	--[5]	--[6]	--[6]	1,293	--[6]
At Southern Avenue[4]	--[5]	--[6]	--[6]	1,195	--[6]
At Freeway[3]	--[5]	--[6]	--[6]	1,209	--[6]

[1]Includes Overflow From Watershed 1
[2]Includes Overflow From Watershed 1 and 4
[3]Includes Overflow From Watershed 1, 4 and 3
[4]After Diversion of 237-Acre-Feet, Total Storage in Kingsborough, Emerald and Sherwood Parks Detention Basins
[5]Not Available
[6]Not Computed

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
East Maricopa Floodway					
At Guadalupe Road	--[1]	--[2]	--[2]	4,900	--[2]
At Baseline Road	--[1]	--[2]	--[2]	4,800	--[2]
At Southern Road	--[1]	--[2]	--[2]	3,500	--[2]
At Broadway Avenue	--[1]	--[2]	--[2]	3,500	--[2]

[1]Not Available
[2]Not Computed

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Wittmann Wash at AT&SFRR					
At confluence with Wittmann Wash South Split	0.28	55	128	172	--[1]
McMicken Dam Outlet Wash					
At confluence with Aqua Fria River	322.99	2,917[2]	5,085[2]	6,522[2]	--[1]
4,200 feet south of Deer Valley Drive	320.56	2,876	4,916	6,273	--[1]
1,700 feet north of Deer Valley Drive	318.13	2,835	4,747	6,023	--[1]
McMicken Dam Outlet Channel					
confluence with McMicken Dam Outlet Wash	304.92	2,613	4,279	5,087	--1
Centennial Wash					
At confluence with the Gila River	1,870	N/A	N/A	67,300	N/A
At Southern Pacific Railroad Near Arlington	1,825	N/A	N/A	67,300	N/A
Near Baseline Road	1,398	N/A	N/A	58,100	N/A
At Gin Road	1,110	N/A	N/A	52,200	N/A
At Eagle Eye Road	1,031	N/A	N/A	52,200	N/A
At Maricopa/La Paz County Boundary	451.5	4,880	16,400	21,700	--[1]
At S.W. corner of Section 4, T7N, R9W	41.1	1,900	5,410	6,960	--[1]
Cemetery Wash					
At confluence with Hassayampa River	8.8	N/A	N/A	6,492	N/A
Waterman Wash					
At confluence with the Gila River	422	N/A	N/A	33,600	N/A
About 9,000 feet upstream of Rainbow Valley Road	337	N/A	N/A	27,300	N/A
At confluence with the West Prong of Waterman Wash	246	N/A	N/A	22,850	N/A

[1]Not Computed
[2]Due to Storage Behind McMicken Dam and CAP Canal

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Gila River					
Below confluence with Agua Fria River (At Bullard Avenue)	41,902	95,000	200,000	250,000	360,000
Below confluence with Waterman Wash	--[2]	88,000	195,000	245,000	350,000
Below confluence with Hassayampa River	--[2]	82,000	190,000	240,000	340,000
At Gillespie Dam	--[2]	78,000	186,000	235,000	335,000
At Gila Bend Indian Reservation	--[2]	--[1]	--[1]	230,000	--[1]
Agua Fria River					
At confluence with Gila River	--[2]	22,000	68,000	94,000	183,000
Above downstream end of COE levee (0.7 mile below Lower Buckeye Road)	--[2]	22,000	69,000	95,000	184,000
Above MCFCD levees at Indian School Road	--[2]	23,000	69,000	95,000	184,000
Above confluence with New River	--[2]	18,005	66,010	90,015	177,000
Above Olive Avenue	--[2]	10,970	69,700	98,780	179,900
Above Bell Road	--[2]	23,000	87,000	115,000	182,000
Above Jomax Road	--[2]	51,360	101,220	127,440	182,000
Below Waddell Dam	--[2]	60,000	110,000	135,000	182,000
New River					
Near Rock Springs	--[2]	--[1]	--[1]	34,500	--[1]
At New River Road	--[2]	--[1]	--[1]	32,000	--[1]
At Interstate 17	--[2]	--[1]	--[1]	33,400	--[1]
Above confluence with Sweat Canyon Wash	--[2]	--[1]	--[1]	33,000	--[1]
At Carefree Highway	--[2]	--[1]	--[1]	35,800	--[1]
Upstream of New River Dam	--[2]	--[1]	--[1]	49,300	--[1]
At Outflow of New River Dam	0	1,700	2,200	2,350	--[1]
Above Beardsley Road	10.3	2,400	6,500	9,800	--[1]
Above confluence with Skunk Creek	17.3	2,700	8,000	12,000	--[1]
Below confluence with Skunk Creek	--[2]	13,500	31,000	41,000	75,000
Sweat Canyon Wash					
Above confluence with New River	--[2]	--[1]	--[1]	19,800	--[1]

[1]Not Computed
[2]Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Powder House Wash					
At Jack Burden Road	1.9	300	1,300	1,900	4,400
Martinez Wash					
At Mouth	103.0	9,220	27,400	32,000	45,000
Mockingbird Wash					
At U.S. Highways 60, 70, and 89	6.9	2,750	4,040	5,060	7,400
Little San Domingo Wash					
At U.S. Highways 60, 70, and 89	6.2	1,690	2,620	3,090	4,250
Wittmann Drainage					
At Atchison, Topeka & Santa Fe Railway	8.6	1,760	2,770	3,060	4,350
Lower El Mirage Wash					
At Cactus Road	1.9	90	200	250	--[1]
Lower El Mirage Wash Tributary					
At Mouth	1.3	53	110	150	--[1]

[1] Not Computed

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Basin 1A					
At Apex	1.46	348	2,148	4,083	14,981
Basin 1B					
At Apex	1.79	234	1,787	3,661	15,663
Basin 2A					
At Apex	0.80	169	1,063	2,036	7,572
Basin 2B					
At Apex	7.87	1,243	5,782	9,949	29,836
Basin 3					
At Apex	0.46	86	482	887	3,021
Basin 4A					
At Apex	0.63	222	848	1,360	3,544
Basin 4B					
At Apex	0.78	153	706	1,210	3,620
Basin 4C					
At Apex	1.78	452	2,108	3,629	10,918
Basin 4D					
At Apex	9.70	901	4,062	6,912	20,276
Basin 5					
At Apex	3.09[1]	358	1,659	2,849	8,535

[1]Includes portion of Basin 4D from which runoff can be diverted into Basin 5

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Basin 6A					
At Apex	3.32	322	1,831	3,382	11,709
Basin 6B					
At Apex	0.43	100	358	562	1,400
Basin 6C					
At Apex	1.49	182	854	1,475	4,451

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Circle City - Wash 4 along RR					
Upstream of confluence with Wash 4	--[1]	28	54	179	--[2]
Circle City - Wash 4					
At confluence with Wash 3	0.16	51[3]	85[3]	125[3]	--[2]
Downstream of Grand Avenue (U.S. Highway 89)	0.14	41[3]	65[3]	78[3]	--[2]
Upstream of railroad	0.14	45	94	132	--[2]
Circle City - Wash 5					
At confluence with Wash 6	0.05	30[3]	85[3]	85[3]	--[2]
Upstream of Grand Avenue	0.05	30[3]	93[3]	101[3]	--[2]
Upstream of railroad	0.05	33	176[4]	309[4]	--[2]
200 feet upstream of railroad	0.05	33	65	89	--[2]
Circle City - Wash 6					
At confluence with Wash 3	0.72	117[3]	196[3]	199[3]	--[2]
At confluence with Wash 5	0.67	87[3]	111[3]	114[3]	--[2]
Upstream of railroad	0.62	167	361	479	--[2]
Circle City - Wash 7					
At Black Mountain Road	0.57	109	192	215	--[2]
Trilby Wash at Circle City					
At Black Mountain Road	16.10	1,297[3]	2,280[3]	2,780[3]	--[2]
Upstream of AT&SFRR	16.10	1,380	2,428	2,970	--[2]
Trilby Wash-CAP to Black Mountain Road					
At Carefree Highway	--[1]	--[1]	--[1]	2,995	--[1]
Upstream of White Wing Road	--[1]	--[1]	--[1]	3,322	--[1]

[1]Not Computed, Overflow From Wash 5
[2]Not Computed
[3]Decrease Due to Storage Behind AT&SFRR
[4]Increase Due to Overflow from Wash 6

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
At Patton Road	--[1]	--[1]	--[1]	3,756	--[1]
Upstream of Jomax Road	--[1]	--[1]	--[1]	3,805	--[1]
Upstream of CAP	--[1]	--[1]	--[1]	3,851	--[1]
Trilby Wash-CAP to McMicken Dam					
At McMicken Dam	113.00	4,773	8,999	11,688	--[1]
At 195th Avenue (Extended)	112.40[2]	4,730	8,920	11,625	--[1]
650 feet upstream of 203rd Avenue (Extended)	111.77[2]	4,690	8,845	11,560	--[1]
500 feet downstream of Deer Valley Road (Extended)	103.94[2]	4,646	8,769	11,499	--[1]
150 feet downstream of Deer Valley Road (Extended)	67.16	3,065	5,750	7,430	--[1]
200 feet upstream of Deer Valley Road (Extended)	27.84	1,488	2,728	3,362	--[1]
1,000 feet upstream of Deer Valley Road (Extended)	--[1]	1,525[3]	2,775[3]	3,420[3]	--[1]
1,050 feet downstream of Pinnacle Peak Road (Extended)	--[1]	1,560[3]	2,825[3]	3,480[3]	--[1]
400 feet upstream of Pinnacle Peak Road (Extended)	--[1]	1,595[3]	2,875[3]	3,540[3]	--[1]
1,350 feet downstream of Happy Valley Road (Extended)	--[1]	1,665[3]	2,975[3]	3,660[3]	--[1]
200 feet downstream of Happy Valley Road (Extended)	--[1]	1,700[3]	3,025[3]	3,720[3]	--[1]
1,350 feet downstream of CAP Canal	--[1]	1,735[3]	3,075[3]	3,780[3]	--[1]

[1]Not Computed
[2]Computed by Specific Discharge Transfer Equation
[3]Decrease Due to Storage Behind CAP Canal and Storage in Overbanks

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Galloway Wash (Middle Branch)					
Upstream of confluence with Lower Branch	3.3	N/A	N/A	1,719	N/A
At Pima Road	2.8	N/A	N/A	1,574	N/A
Galloway Wash (Lower Branch)					
Upstream of confluence with Middle Branch	1.8	N/A	N/A	752	N/A
At 800 feet downstream of Pima Road	1.4	N/A	N/A	654	N/A
At Pima Road	1.2	N/A	N/A	430[1]	N/A
Rowe Wash					
Above confluence with Galloway Wash	5.5	4,170	6,190	6,940	9,200
2.5 miles above confluence with Galloway Wash	4.8	4,030	5,940	6,650	8,800
At confluence of Grapevine Wash	4.63	3,033	4,531	5,307	6,687
Above confluence with Grapevine Wash	0.74	1,225	1,782	2,048	2,512
Above confluence with Rowe Wash Tributary 1	0.49	790	1,158	1,334	1,639
At River Mile 4.05	0.12	217	305	352	433
Unnamed Tributary to Galloway Wash					
At confluence with Galloway Wash	--[2]	4,090	6,420	7,290	10,000
Ocotillo Wash					
Above confluence with Cave Creek	3.8	3,200	4,820	5,420	7,200
Near intersection of Rockaway Hills Drive and Fleming Springs Road	2.8	2,800	4,140	4,630	6,200

[1]Interpolated Values
[2]Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Cave Creek Wash					
At confluence with Salt River	25.0	N/A	N/A	2,257	N/A
At 35th Avenue	22.6	N/A	N/A	2,226	N/A
At Interstate 10 Freeway downstream of Durango Exit	21.0	N/A	N/A	2,217	N/A
At Interstate 10 Freeway upstream of Durango Exit	21.0	N/A	N/A	2,523	N/A
At Jackson Street	16.1	N/A	N/A	1,890	N/A
At Van Buren Street	15.3	N/A	N/A	1,865	N/A
At McDowell Road	12.9	N/A	N/A	1,691	N/A
At Encanto Street	9.3	N/A	N/A	1,375	N/A
At Thomas Road	7.9	N/A	N/A	1,210	N/A
At Indian School Road	7.2	N/A	N/A	1,237	N/A
At the confluence with the Arizona Canal Diversion Channel	34.7[1]	10,300[2]	16,100[2]	18,500[2]	N/A
Below Moon Valley Wash	33.1[1]	10,100[2]	15,300[2]	17,500[2]	N/A
Above Moon Valley Wash	26.5[1]	8,900[2]	13,400[2]	15,400[2]	N/A
Below 19th Avenue	25.5[1]	8,900[2]	13,400[2]	15,400[2]	N/A
Below the East Fork Cave Creek	23.5[1]	8,400[2]	12,700[2]	14,600[2]	N/A
Above the East Fork Cave Creek	8.6[1]	3,300[2]	4,900[2]	5,700[2]	N/A
Below Deer Valley Drive	5.0[1]	3,000[2]	4,500[2]	5,200[2]	N/A
Below the Central Arizona Project Canal	4.0[1]	2,700[2]	4,000[2]	4,600[2]	N/A
Above the Central Arizona Project Canal	2.5[1]	1,700[2]	2,500[2]	2,900[2]	N/A
Below Carefree Highway	126.9[3]	20,600	32,975	36,860	52,000
Above Carefree Highway	121.5[3]	20,130	32,180	35,900	51,000
At confluence with Andora Hills Wash	115.1[3]	19,640	31,430	35,000	50,000
Above confluence with Willow Springs Wash	80.3[3]	13,210	21,480	23,600	33,000

[1]Contributing Drainage Area Below Cave Creek Dam Only
[2]Regulated by Cave Creek Dam and Cave Buttes Dam
[3]Decrease Due to Storage in Overbanks upstream

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
At Morning Star Road	75.86	16,890	24,831	28,338	34,901
At River Mile 35.77 above Minor Tributary	75.13	16,888	24,817	28,319	34,868
At River Mile 36.78 above Minor Tributary	73.94	16,870	24,778	28,271	34,802
At River Mile 37.37 above Minor Tributary	71.70	16,966	24,890	28,381	34,909
Above confluence with Cottonwood Creek	70.78	7,105	9,819	10,979	13,168
At River Mile 38.79 concentration point for Upper Basin	60.21	16,613	24,246	27,603	33,871
East Fork Cave Creek					
Near Coral Gables & 7th Avenue	14.1	5,500	8,200	9,400	N/A
Near Paradise Lane & Central Avenue	13.4	5,300	7,900	9,100	N/A
Below 7th Street	12.4	2,200	5,900	8,400	17,000
Above 7th Street	10.0	1,900	5,300	7,500	15,200
At Bell Road	3.4	1,100	2,900	4,200	8,200
Below Cave Creek Road	3.0	1,000	2,800	3,900	7,900
At Utopia Road	1.8	800	2,100	3,000	5,800
At Beardsley Road	1.0	600	1,500	2,100	4,300

Cross sections for the Salt River between Central Avenue and 115th Avenue were based on digitized data from topographic mapping. From Central Avenue to Country Club Road in Mesa, cross sections were also taken from topographic mapping (References 51 and 52).

For study purposes, Skunk Creek was divided into two sections. Lower Skunk Creek lies between Adobe Dam outlet channel and the Bell Road Bridge. Upper Skunk Creek is from the Central Arizona Project channel to Adobe Dam. Cross sections for both reaches were generated using 1974 Maricopa County topographic maps at a scale of 1:2,400, with a contour interval of 2 feet. These maps were supplemented by additional mapping from the City of Phoenix and the COE at scales of 1:1,200 and 1:2,400, respectively, both with a contour interval of 2 feet.

Cross sections for the Hassayampa River (below Carefree Highway) were field surveyed.

Cross section data for the following were developed from topographic maps (Reference 53): Skunk Creek above Carefree Highway; Cave Creek above Cave Creek Dam; Andora Hills, Galloway, Rowe, Grapevine, Ocotillo, Willow Springs, Powder House, Mockingbird, and Little San Domingo Washes; Wittmann Drainage; Aguila Farm Channel; Grass, Sand Tank, and Bender Washes; Rodeo Wash and its tributary; Airport, and Scott Avenue Washes; Lower El Mirage Wash and its tributary; Atchison, Topeka & Santa Fe Railway Channel at El Mirage; the Atchison, Topeka & Santa Fe Railway at Peoria; and the Southern Pacific Railroad and its spurs.

Cross section data for East Branch Scatter Wash and Echo Canyon Washes were developed from topographic maps provided by the City of Phoenix (Reference 54).

Cross section data for Cave Creek below Arizona Canal and for East Fork Cave Creek were developed from aerial photographs flown in March 1980 (Reference 55). Cross section data for Cave Creek between Arizona Canal and Cave Creek Dam were developed from aerial photographs flown in March 1978 (Reference 56).

Cross section data for the Sols Wash backwater analyses were obtained from topographic maps, at a scale of 1:200, with a contour interval of 2 feet, prepared specifically for this project by Cooper Aerial Survey in March 1986 (Reference 57). Culvert and bridge data were obtained from the topographic maps and were field checked to verify structural geometry.

Cross section data for Casandro, South Branch Casandro, Flying E, and Hospital Washes were taken from a COE Flood Plain Information report for Wickenburg (Reference 58) and from topographic maps (Reference 59).

Cross section data for Martinez Wash were digitized from topographic maps (Reference 26).

Cross sections were located at close intervals above and below bridges in order to compute the significant backwater effects of these structures. All bridges and culverts were investigated to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Hydraulic roughness coefficients (Manning's "n") were selected on the basis of field inspection and engineering judgment. Table 4 gives the range of Manning's "n" values for each flooding source studied by detailed methods.

Starting water-surface elevations for all riverine flooding sources, except as noted below, were developed using the slope-area method.

The Agua Fria River starting water-surface elevations were determined assuming normal depth. The Manning's "n" values used ranged from 0.03 to 0.035 for the channel and from 0.04 to 0.045 for the overbanks.

The starting water-surface elevations for the Gila River were computed by normal-depth methods. The "n" value used for the Gila River was 0.045 for both the channel and overbanks.

The starting water-surface elevations for the New River were developed through the use of 1985 topographic mapping in the area of its confluence with Skunk Creek. Manning's "n" values were based on field observations and engineering judgment. These "n" values ranged in the channel from 0.03 to 0.035.

In the overbank areas, "n" values ranged from 0.03 to 0.06. A significant feature of the New River floodplain is the channelization in the vicinity of its confluence with Skunk Creek. This channelization has occurred from approximately 1,500 feet downstream of the Thunderbird Road Bridge upstream to the Greenway Road. In addition, in the left overbank area above Union Hill Drive, a new wastewater treatment plant with improved channel banks is reflected in the hydraulic model.

For the upper reaches of Skunk Creek, the starting water-surface elevations were computed from the reservoir spillway elevation of 1,377 feet. For the lower reach, normal-depth and New River backwater computations were used. Mannings "n" values were 0.035 for the channel and 0.045 for the overbanks on the lower reach. For the upper reach, the "n" values ranged from 0.035 to 0.04 in the channel and from 0.035 to 0.05 in the overbank.

Table 4. Range of Hydraulic Roughness Coefficients (Manning's "n")

Flooding Source	Channel	Overbanks
Agua Fria River	0.022 - 0.059	0.032 - 0.070
Gila River	0.03 - 0.120	0.035 - 1.0
Hassayampa River	0.030 - 0.05	0.03 - 1.0
New River	0.030 - 0.035	0.030 - 0.060
Salt River	0.030 - 0.035	0.040 - 0.050
Skunk Creek	0.035	0.045 - 0.050
Sweat Canyon Wash	0.035	0.055
Scatter Wash, North Branch	0.020 - 0.050	0.070 - 0.150
Scatter Wash, South Branch	0.035	0.045
Aguila Farm Channel	0.030	0.04 - 0.05
Airport Wash	0.025	0.035
Andora Hills Wash	0.020 - 0.045	0.020 - 0.052
Atchison, Topeka & Santa Fe Railway Channel	0.032 - 0.037	0.032 - 0.047
Atchison, Topeka & Santa Fe Railway Ponding	0.035 - 0.040	0.035 - 0.040
Bender and Sand Tank Washes	0.025	0.035
Casandro Wash	0.030 - 0.060	0.040 - 0.060
South Branch Casandro Wash	0.030 - 0.060	0.040 - 0.060
Circle City Area Washes	0.03 - 0.08	0.03 - 0.08
Echo Canyon Wash	0.018 - 0.025	0.012 - 0.035
Flying "E" Wash	0.030 - 0.060	0.040 - 0.060
Galloway Wash	0.032 - 0.045	0.016 - 0.045
Grapevine Wash	0.020 - 0.046	0.020 - 0.052
Grass Wash	0.025 - 0.04	0.025 - 0.045
Hospital Wash	0.030 - 0.060	0.040 - 0.060
Little San Domingo Wash	0.030	0.040
Lower El Mirage Wash	0.044	0.044
Lower El Mirage Wash Tributary	0.044	0.044
Martinez Wash	0.025 - 0.060	0.060 - 0.100
McMicken Dam Outlet Wash	0.02 - 0.05	0.035 - 0.08
Mockingbird Wash	0.030 - 0.037	0.035 - 0.042
Ocotillo Wash	0.020 - 0.045	0.020 - 0.052
Powder House Wash	0.030 - 0.060	0.040 - 0.060

Table 4. Range of Hydraulic Roughness Coefficients (Manning's "n") (Cont'd)

Flooding Source	Channel	Overbanks
Rodeo Wash	0.025	0.035
Rodeo Wash Tributary	0.025	0.035
Rowe Wash	0.020 - 0.045	0.020 - 0.052
Sols Wash	0.035 - 0.065	0.025 - 0.1
Scott Avenue Wash	0.025	0.035
Trilby Wash	0.04 - 0.10	0.05 - 0.10
Willow Springs Wash	0.020 - 0.045	0.020 - 0.080
Wittmann Area Washes	0.015 - 0.06	0.015 - 0.09
Centennial Wash	0.030 - 0.070	0.030 - 0.20
Cemetery Wash	0.035 - 0.10	0.040 - 0.10
Waterman Wash	0.025 - 0.065	0.028 - 0.070
Caterpillar Tank Wash	0.024 - 0.055	0.036 - 0.060
Twin Buttes Wash	0.024 - 0.055	0.036 - 0.060
White Peak Wash	0.024 - 0.055	0.036 - 0.060
West Fork White Peak Wash	0.024 - 0.055	0.036 - 0.060
East Garambullo Wash	0.024 - 0.055	0.036 - 0.060
West Garambullo Wash	0.024 - 0.055	0.036 - 0.060
Cave Creek Wash	0.015 - 0.065	0.035 - 0.065
East Fork Cave Creek Wash	0.015 - 0.035	0.035 - 0.045
Jackrabbit Wash	0.030 - 0.035	0.035 - 0.04
Star Wash	0.030 - 0.035	0.035 - 0.04
Unnamed Tributary of Jackrabbit Wash	0.030 - 0.035	0.035 - 0.04
Southern Pacific Railroad & Southern Pacific Spur, Ponding	0.025 - 0.075	0.025 - 0.075
Consolidated Canal, Ponding	0.025 - 0.075	0.025 - 0.075
Eastern Canal, Ponding	0.032 - 0.075	0.032 - 0.075
Cline Creek and Tributaries	0.045 - 0.075	0.045 - 0.080
Morgan City Wash	0.035 - 0.100	0.055 - 0.100
Rodger Creek	0.045 - 0.080	0.055 - 0.080
Centennial Wash	0.040	0.040
North Branch Centennial Wash	0.040	0.040
Cottonwood Creek	0.030 - 0.060	0.050 - 0.080
Cottonwood Creek Tributary 1	0.045 - 0.050	0.060 - 0.070
Cottonwood Creek Tributary 2	0.050	0.060 - 0.070
Galloway Wash-North Tributary	0.025 - 0.041	0.045

Table 4. Range of Hydraulic Roughness Coefficients (Manning's "n") (Cont'd)

Flooding Source	Channel	Overbanks
Ocotillo Wash Tributary 1	0.035 - 0.040	0.045
Ocotillo Wash Tributary 1A	0.032 - 0.035	0.040 - 0.045
Ocotillo Wash Tributary 2	0.035 - 0.045	0.040 - 0.050
Ocotillo Wash Tributary 3	0.045 - 0.055	0.055
Ocotillo Wash Tributary 4	0.025 - 0.045	0.045 - 0.050
Rowe Wash Tributary 1	0.045	0.045 - 0.055
Rowe Wash Tributary 2	0.045	0.050 - 0.055
Willow Springs Wash Tributary 1	0.030 - 0.040	0.035 - 0.055
Willow Springs Wash Tributary 1A	0.028 - 0.050	0.040 - 0.060
Willow Springs Wash Tributary 2	0.030 - 0.055	0.045 - 0.060
Willow Springs Wash Tributary 2A	0.040 - 0.050	0.050 - 0.055
Willow Springs Wash Tributary 3	0.060	0.080
Willow Springs Wash Tributary 4	0.040 - 0.050	0.050
Willow Springs Wash Tributary 5	0.035 - 0.050	0.045 - 0.060
Willow Springs Wash Tributary 5A	0.040	0.045 - 0.050
Flemming Springs Wash	0.038 - 0.060	0.055 - 0.060
Southern Pacific Railroad	0.014 - 0.050	0.014 - 0.100
Wagner Wash	0.040 - 0.105	0.065 - 0.100
Gila Bend Canal	0.045	0.050

Salt River photos for the 1978 and 1980 flooding events were extensively used in establishing channel parameters for bank station identification, "n" values, and floodflow conveyance patterns. Information from the current airport channelization project was also transferred to the maps. The Salt River model also includes the proposed south dike on the Salt River, which represents an extension of the airport channelization project. This dike is located between Hohokam Expressway (48th Street) and Priest Road on the southern bank of the Salt River.

Water-surface elevations computed in the HEC-2 hydraulic model were calibrated with the known floodplains of the 1978 and 1980 flooding events. This technique involved the adjustment at conveyance boundaries and "n" values. The calibrated "n" values ranged from 0.03 to 0.035 for the channel and from 0.04 to 0.05 for the overbanks.

The starting water-surface elevation for Scatter Wash was taken from Skunk Creek. Manning's "n" values were determined through field investigations and engineering judgment. Scatter Wash is a relatively flat floodplain for the majority of its reach, with a substantial amount of development in some overbank areas. Manning's "n" values for the channel ranged between 0.02 at Deer Valley underpass to 0.05 for heavy brush areas.

In the upper Scatter Wash drainage basin, it was determined that floodflows would proceed along the many braided streamlines, until they reach Interstate Highway 17 (I-17). At I-17, the flows will begin to concentrate in the area north of Williams Road. The 100-year flows at this point will separate into a north and south branch of Scatter Wash. The Scatter Wash, North Branch, passes under I-17 through two culverts, and over I-17 via sheetflow action. Scatter Wash, South Branch, continues to flow southerly along the eastern side of I-17, until it eventually ponds and passes under I-17 at Deer Valley Road. Both branches of Scatter Wash join in the vicinity of Rose Garden Lane and 33rd Avenue. At this location, the flows proceed downstream to their confluence with Skunk Creek.

During periods of heavy runoff, flows from Sand Tank and Bender Washes near Gila Bend are intermixed. Highway and railroad bridges traverse both washes. These structures cannot pass a 100-year flood, resulting in extensive ponding at each obstruction during floods of low frequency.

Apache Creek is located on an alluvial fan near Apache Junction at the base of the Superstition Mountains. A vast network of intermingling channels exists on the fan. Flooding on alluvial fans is often erratic and unpredictable, and flow may occur on separate parts of an alluvial fan during sequent flood events. Flooding in this area was analyzed using alluvial fan methodology developed by FEMA.

Much of the flooding in the county is caused by sheetflow that originates from alluvial fans. Flows are intercepted by canal levees, railroad embankments, and elevated roads, causing water to pond behind the embankments. Depths of ponding depend on the elevation of the embankments. When the intercepted runoff exceeds ponding storage capacity, the flow will overtop the embankment, thus eroding the levee. Areas immediately downslope of the breakout will be affected by high water. However, flows will fan out to again become shallow sheetflow that is less than 1 foot in depth. Therefore, many areas in the county have been designated Zone B. (See Section 5.)

Approximate hydraulic analyses for Bulldog, Apache, and Goldfield Washes and the downstream reach of Weekes Wash were carried out using approximate flow velocities and normal-depth calculations. These analyses revealed that the channels have very little capacity relative to the 100-year flood, and in some cases, the channels are nonexistent. Furthermore, the overbank flow is not confined to a well-defined floodplain, causing shallow flooding. The average depth of flooding for the overbank areas was determined to be less than 1 foot.

Areas of ponding on the upstream side of U.S. Highway 60/89 were also studied. Water-surface elevations for these areas were based on the elevation of the highway grade with shallow flows over the highway of less than 1 foot. This results in average shallow flooding depths behind the highway between 1 and 3 feet.

Cross sections were taken perpendicular to the canals and railroad embankments using topographic maps (Reference 60). The top of the embankments were assumed to be the maximum ponding elevation upslope of the embankment. Flood hazard areas were then determined by projecting this elevation upslope to intersect the natural ground.

The canal levees and railroad embankments do not permanently retain stormflows, but divert them along the embankments. Most of the canal levees consist of unconsolidated material. These levees are subject to failure when runoff volumes exceed storage capacity. Potential flood hazard areas on the downslope side of the canals were analyzed for levees exceeding 2 feet in height. This analysis determined the distance required for flow through a break in a levee to spread and be reduced to an average depth of 1 foot, using Manning's equation. This analysis assumed the following:

1. A canal breach could occur at any point.

2. A broad, cresting horizontal weir equation with a head of 3 feet could be used to determine the length of a breach, resulting in a weir from 50 to 100 feet long.

3. Floodwaters would spread at a 45 degree angle from the breach in the levee.

4. The peak discharge at a potential levee break was the maximum canal capacity or the concentration of peak flows from runoff in the watershed, whichever was greater.

Due to the nature of flooding along the New River, Skunk Creek below Carefree Highway, Lower El Mirage Wash, Scatter Wash below Black Canyon Highway, and East Branch Scatter Wash, no 500-year flood profiles were developed. The floodplains of these streams are wide; therefore, flow could increase substantially without significantly raising the water-surface elevation or increasing the velocity of flow. Moreover, most of the area contiguous to the floodplains is subject to sheetflow during a 100-year flood.

In addition, 50-year flood profiles for the Agua Fria and New Rivers, Skunk Creek below Carefree Highway, Cave Creek below Cave Creek Dam, East Fork Cave Creek, and Echo Canyon, Scatter, and East Branch Scatter Washes were not computed.

Flood profiles are not applicable for areas of shallow flooding and ponding; therefore, flood profiles are not presented for any of the canals or other areas of shallow flooding, including Sand Tank and Bender Washes, Rodeo Wash and its tributary, Lower El Mirage Wash Tributary, and Airport and Scott Avenue Washes.

For flooding sources studied by approximate methods, 100-year flood elevations were computed using Manning's equation, COE Flood Plain Information reports (References 27, 29, 58, and 61), USGS Flood-Prone Area Maps (Reference 62), USGS slope maps (Reference 63), high-resolution Skylab photographs (References 64 and 65), and USGS topographic maps (Reference 66).

The study was limited to the uses of fixed-bed modeling for the hydraulic analyses. However, with the occurrence of a large flood, substantial changes in the riverbed are expected to occur, particularly where the bottom slope is very non-uniform and/or where other structures, such as bridges, cause local increases in the velocity. Resultant changes in the water-surface elevations can be expected.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks and descriptions used in this study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at scales of 1:1,200, 1:2,400, 1:4,800, and 1:6,000, with contour intervals of 2 and 4 feet (References 53, 54, 59, and 60).

The 100- and 500-year floodplain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Approximate flood boundaries were delineated using USGS topographic maps and Flood-Prone Areas Maps (References 62 and 66), and high-resolution Skylab photographs (References 64 and 65).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 5).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The floodways for Little San Domingo, Mockingbird, and Powder House Washes are shown coincident with the 100-year floodplain boundaries because of high, hazardous velocities in their respective floodplains. No floodway was computed for Wash B downstream of Granite Reef Aqueduct. Also, no floodway was computed for Cave Creek below Arizona Canal. No floodway was computed for Wittmann Drainage due to the split flow below Center Street. Floodways for Grass Wash below the U.S. Highway 60 bridge and for Aguila Farm Channel were not computed due to excessive overbank losses.

Floodways are not applicable for areas of shallow flooding; therefore, floodways were not computed for any of the canals, railroad embankments, or for Sand Tank and Bender Washes, Rodeo Wash and its tributary, Airport and Scott Avenue Washes, Lower El Mirage Wash Tributary, and Apache Creek.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 7.

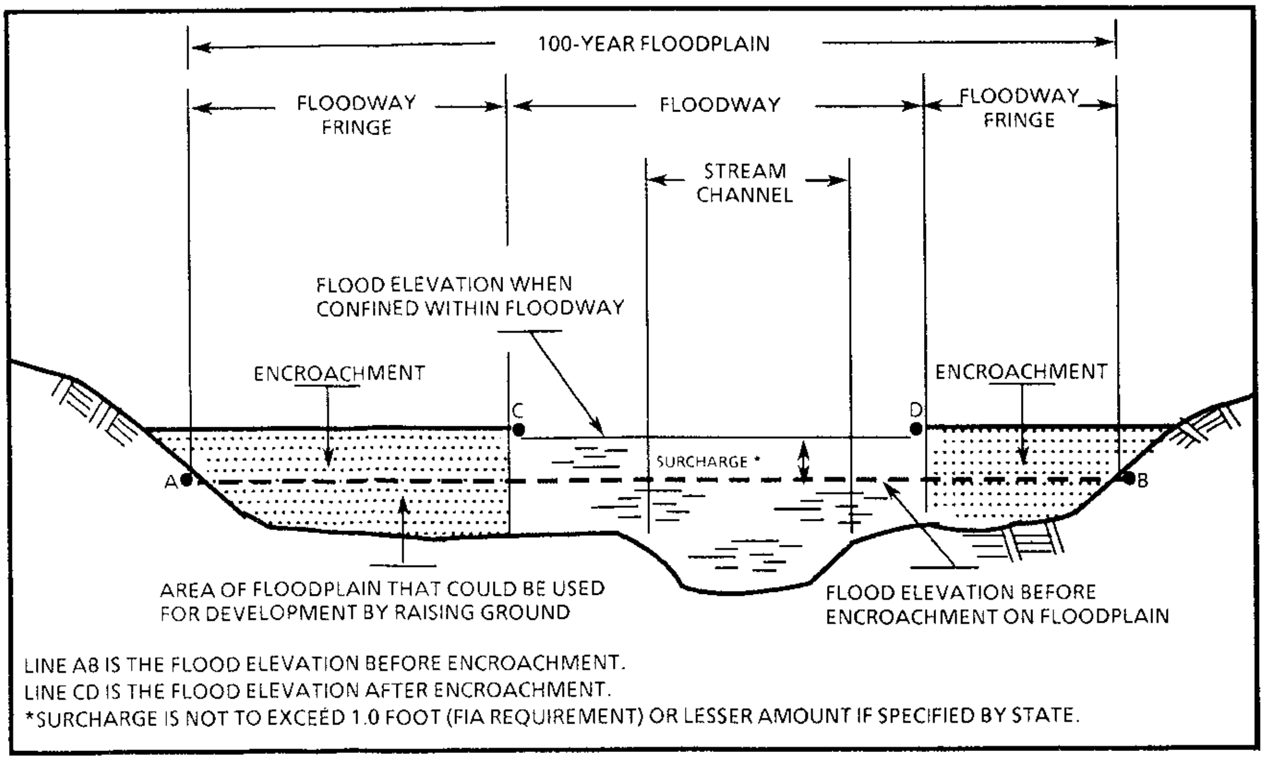


Figure 7. Floodway Schematic