

COMPREHENSIVE FLOODPLAIN MANAGEMENT PLAN AND PROGRAM REPORT



PREPARED BY THE
FLOOD CONTROL DISTRICT
OF
MARICOPA COUNTY, ARIZONA

2009

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Cover:

The cover design is a re-creation of the cover from the Comprehensive Flood Control Program Report of 1963.

Pictured:

The Salt River at Maricopa Freeway, December 31, 1965. A traffic regulating sign falls into the water after the freeway was undermined.

Flood Control District of Maricopa County

2009 Comprehensive Floodplain Management Plan and Program

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Plan Content and Structure

The contents of the *2009 Comprehensive Floodplain Management Plan and Program* (Plan) include:

Chapter 1 introduces the Plan's purpose, scope and role in the flood mitigation process. It includes a discussion of the planning process as well as a summary of previous comprehensive plans.

Chapter 2, in recognition of the District's 50th anniversary, explores the key milestones in the District's history.

Chapter 3 describes the goals, philosophy, and initiatives that guide the actions proposed in the Plan. This chapter contains an analysis of the District's current activities and possible future direction. Five new strategic initiatives to address challenges facing the District are recommended.

Chapter 4 summarizes the costs and impacts of flooding and erosion hazards in Maricopa County.

Chapter 5 discusses the District's four strategic programs and the possible activities the District can undertake to mitigate flood hazards.

Chapter 6 details the physical environment of the county including size and topography, soils, climate, hydrology, geology, geomorphology, vegetation, riparian habitat, and landscape character.

Chapter 7 provides a county-wide overview of socioeconomic factors, which when combined with the county's physical characteristics, are used to prioritize future District activity. Socioeconomic factors include population, land ownership, land use and future development.

Chapter 8 presents a watershed-by-watershed description of the vulnerability to flooding and recommends both county-wide and watershed-specific flood control or floodplain management actions.

Chapter 9 is a five-year flood hazard mitigation action plan for Maricopa County based on the information presented in chapters 3 and 8. The chapter concludes with a discussion of implementation and funding of Plan activities.

Appendix A is a glossary of terms and acronyms used in the plan.

Appendix B is a summary of the federal, state and local regulations that affect the District.

Appendix C is the Organizational Chart for the Flood Control District.

Appendix D documents the public and stakeholder involvement activities associated with development of the Plan.

Appendix E includes the Floodplain Regulations for Maricopa County.

Appendix F is a complete list of major flooding events in Maricopa County since the late 1800s.

Appendix G is a white paper that details the Context Sensitive Flood Hazard Mitigation Process.

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Executive Summary

In response to a series of devastating floods and rapid urbanization in high hazard areas, Arizona lawmakers enacted legislation for the creation of regional flood control districts. The Flood Control District of Maricopa County (District) was officially organized on August 3, 1959. Over the past 50 years, the District has constructed more than 140 structures, delineated 4,100 miles of floodplains, and identified flood mitigation solutions for over half of the 9,226 square miles of the county. Since 1963, when the first flood control report was published, the District's comprehensive plans and reports have served as the roadmap for flood mitigation efforts in the county.

The *2009 Comprehensive Floodplain Management Plan and Program* (Plan) establishes a framework for how flood hazards should continue to be managed in Maricopa County in order to reduce the risks to people and property.

The primary objectives of this Plan are to:

- Identify areas for future studies and projects

Executive Summary Outline:

Strategic Analysis

Needs Assessment by
Watershed

Action Plan

Future of Flood Control

- Guide policy-making and program development
- Provide public information and education
- Fulfill a requirement under the Community Rating System of the National Flood Insurance Program for the development of a floodplain management plan
- Comply with ARS §48-3616 which requires the publication of a flood control report and program

The 2009 Comprehensive Plan includes a strategic analysis of the District's future direction; an assessment of the county's risk and vulnerability to flooding; and an action plan that summarizes future District activities.

Strategic Analysis

The strategic analysis is based on more than 75 interviews with the District's Board of Directors and staff, as well as input from other stakeholders including cities, governmental agencies, non-profit organizations and the public. The analysis identifies key issues and challenges affecting the District's implementation of its mission, and includes recommendations to address any gaps in the District's ability to meet those challenges.

The strategic analysis concludes that the District's four existing flood control programs—outreach, identification, regulation and remediation—are working well. The 2009 Plan recommends five strategic initiatives to address challenges facing the District and other emerging issues. The five strategic initiatives are: 1) Strengthen Role as Regional Leader; 2) Streamline Multi-Objective Watershed Approach to Flood Mitigation; 3) Increase Collaboration and Partnerships; 4) Preserve and Restore the Natural Resources and Functions of Floodplains and Riparian Areas; and 5) Continued Commitment to Process Improvement. The intent is that the recommended strategic initiatives will be further explored by District staff and used to develop policies, programs, and other tools needed to continue protecting Maricopa County residents from flooding over the next 50 years.

Needs Assessment by Watershed

The needs assessment provides an overview of flooding problems and general public risk and vulnerability to flooding. This section discusses the flooding characteristics of each watershed including types of flooding, delineated floodplains, and run-off potential. A discussion of development patterns, road crossing hazards, repetitive loss areas, and other issues describe the general risk and public vulnerability to flooding.

In Maricopa County, there are approximately 27,800 residential structures in the floodplain. Since 2005, 1,510 permits were issued for construction or modifications to floodplain property in unincorporated county. Over 1,800 miles of watercourses still require delineation, and six dams have identified safety deficiencies.

Action Plan

The public's vulnerability to flooding is reduced by the completion of delineations, area drainage master plans and structural projects. The 2009 Plan recommends a five-year flood hazard management action plan and program for Maricopa County. Recommended actions are categorized by the District's strategic programs—outreach, identification, regulation and remediation.

- Outreach: The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes.
- Identification: The District will complete 530 miles of delineations, and identify flooding problems and solutions for 2,800 square miles of the county.
- Regulation: The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the 12 communities for which the District performs floodplain management duties. The District will also work with other jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.
- Remediation: The five-year Capital Improvement Program recommends the construction or rehabilitation of 57 projects to mitigate flooding. Non-structural measures to remediate flooding include purchasing homes located in the 100-year floodplain through the Floodprone Properties Assistance Program. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Future of Flood Control

The District's future role is continually developing and adapting to changing flooding conditions, new development and community expectations. During the next 20 years, the District will make significant progress toward completing construction on the infrastructure that is needed to protect the developed areas. As flood control structure construction lessens, the District's focus will shift from building flood control works to administering programs that keep people out of flood-prone areas. Continued maintenance and rehabilitation of the existing flood control infrastructure will ensure each structure performs as designed. Into the future, the District will continue its dedication to protecting the residents of Maricopa County from flooding through flood hazard identification, regulation, remediation, and outreach services.



Western Avenue and Litchfield Road, Goodyear, August 30, 1951

1. Introduction

In response to a series of devastating floods and rapid urbanization in high hazard areas, Arizona lawmakers enacted legislation for the creation of regional flood control districts. The Flood Control District of Maricopa County (District) was organized under Arizona Revised Statutes (ARS) §45-2351 to §45-2371, in August 1959. This statute was repealed in 1985 and replaced by ARS §48-3601 to §48-3628.

ARS §48-3616 states that a "...report shall be prepared at least every five years beginning in 1985 and shall indicate the past efforts of the district in eliminating or minimizing flood control problems and state the planned future work of the district to eliminate or minimize flood control problems." The District administers the National Flood Insurance Program's (NFIP) Community Rating System for unincorporated Maricopa County, and is therefore tasked with completing a floodplain management plan. The floodplain management plan must review and recommend a program of activities to address the county's vulnerability to flooding and educate residents about loss reduction measures and the beneficial functions of floodplains.

Introduction Outline

Purpose and Need

Geographic Scope

Role of Comprehensive Plan in
Flood Mitigation Process

Planning Process

Previous Comprehensive Plans

The *2009 Comprehensive Floodplain Management Plan and Program* (Plan) establishes a framework for how flood hazards should be managed in Maricopa County in order to reduce the risks to people and property. It examines the District's past and future activities for providing flood control and floodplain management—from education and identification of flood hazards to regulation and implementation of non-structural and structural flood mitigation solutions.

Purpose and Need

The purpose of this Plan is to define the future direction for flood hazard mitigation in Maricopa County and to propose near-term actions consistent with that direction. The 2009 Plan recommends new initiatives and regional projects to reduce the risk of flooding and erosion, while, when possible, enhancing the natural and built environment.

The District developed the latest Comprehensive Plan in 2005. The 2009 update is necessary to reflect completed District studies and projects, as well as changes in watershed conditions, population, and community expectations. Regular updates also ensure that the District's Plan is useful in guiding future development and is compatible with the comprehensive planning documents of the county, cities and other agencies.

There are three primary audiences for this Plan: 1) District staff, management and elected officials; 2) cities, towns, and other county and government agencies; and 3) the general public. The Plan is designed to present adequate background data to help District leadership, in partnership with cities and other agencies, prioritize areas for future studies and projects. The Plan is also intended to provide the public with enough information to fully participate in developing effective solutions to flooding.

The primary objectives of this Plan are to:

- Fulfill a requirement under the Community Rating System–National Flood Insurance Program for the development of a floodplain management plan
- Comply with ARS §48-3616 which requires the publication of a flood control report and program
- Identify areas for future studies and projects
- Guide policy-making and program development
- Provide public information and education

Geographic Scope

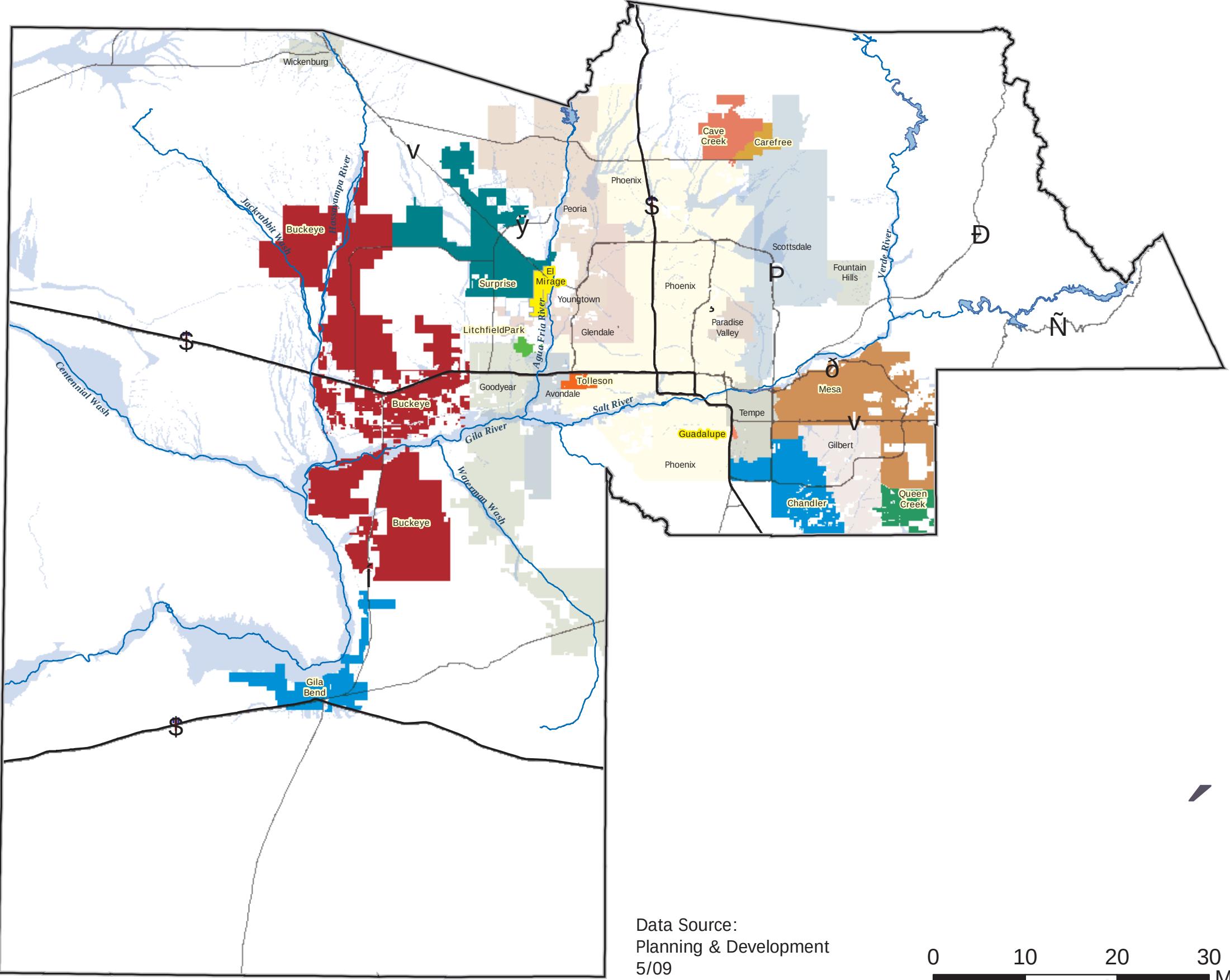
The geographic scope of the 2009 Plan includes all unincorporated and incorporated areas of Maricopa County. The District has regulatory authority for floodplain management in unincorporated Maricopa County as well as in incorporated areas, unless the jurisdiction assumes the responsibility. Municipalities may declare by resolution that they will assume the powers and duties of floodplain management, including the adoption of floodplain management regulations, for the areas within their jurisdiction. The District provides floodplain management services for 12 municipalities (see Map 1-1 Incorporated Municipalities within Maricopa County). For purposes of the Community Rating System administered under the NFIP, only the areas in unincorporated county are considered in the insurance credits awarded for this Plan.

Incorporated Municipalities within Maricopa County

MAP 1-1

Legend

- Cities & Towns with FCDMC managed floodplains
- Buckeye
 - Carefree
 - Cave Creek
 - Chandler
 - El Mirage
 - Gila Bend
 - Guadalupe
 - Litchfield Park
 - Mesa
 - Queen Creek
 - Surprise
 - Tolleson
- Interstates & State Routes
- Floodplains



Data Source:
Planning & Development
5/09



Role of Comprehensive Plan in Flood Mitigation Process

The Comprehensive Plan is the first step in the overall flood mitigation process. It defines how flood control activities should be carried out and provides information on general problems and needs. The Comprehensive Plan is guided and supported by other District plans, policies and documents. The goals of this Plan are drawn from the District's Managing for Results strategic plan. The initiatives and actions outlined in the Plan are implemented by tools such as Financial Plans and Budgets, Area Drainage Master Studies and Plans, the Capital Improvement Program, and adopted regulations and policy documents.

The Managing for Results plan sets the strategic direction for the District and the goals for how flood control is implemented in Maricopa County. The goals outlined in the District's Managing for Results plan guide the development of this Plan and are discussed in Chapter 3. The Financial Plan and Budgets define how available financial resources support the District's mission and strategic goals. This Plan is part of the allocation process of fiscal resources to accomplish the District's mission.

Area Drainage Master Studies and Plans, as well as Watercourse Master Plans, provide more detailed information on watersheds and watercourses and are important for determining flood management solutions for specific areas. The Capital Improvement Program prioritizes and sets a financial schedule for completion of these solutions. Adopted regulations and policies provide flood management guidance beyond or in place of structural solutions.

Planning Process

The 2009 Plan was developed using an iterative planning process that included goal setting, hazard and problem assessment, review of possible activities, and development of recommendations.

The overall development of the Plan was managed by District staff. The Plan team included professional engineers, certified floodplain managers and certified planners. The team had experience in flood control and floodplain management, planning, environmental sciences, geographic information systems and landscape architecture.

Input from the public, staff and stakeholders were incorporated throughout all stages of Plan development. Over 75 interviews were conducted with District staff and elected officials to identify opportunities and challenges facing the District. A survey was sent to more than 90% of floodplain residents in unincorporated Maricopa County. Public "open house" meetings were held during the data collection phase and at the end of the planning process to obtain input on the draft plan. The draft plan was submitted to government agencies, non-profit organizations and all jurisdictions within Maricopa County for review. See Appendix D for documentation of the public outreach activities associated with the Plan.

Previous Comprehensive Plans

The District completed its first Flood Control Report in 1963. The 1963 report served as a blueprint for District activities for the following 25 years. There have been additional reports prepared over the years. The 1963, 1991, 2002 and 2005 Comprehensive Flood Control Program reports were approved by the Flood Control District Board of Directors. This Plan, and the 1997, 2002 and 2005 plans, provides an update on the activities completed since the 1963 report.

Comprehensive Flood Control Program Report of 1963

The 1963 Report was the culmination of several general area studies that identified flooding problems in Maricopa County. The basic purpose of this report was to summarize all pertinent information on Maricopa County flood control problems and to make recommendations for their solutions. The report divided Maricopa County into 35 watersheds that generally conformed to major drainage areas. Flooding problems were defined and structural solutions were proposed for each as needed. This report was the guiding force behind most of the Flood Control District's programs for over 25 years.

Comprehensive Flood Control Program, Status Report Interim Update, 1963-1989

The *Comprehensive Flood Control Program, Status Report Interim Update, 1963-1989*, was completed in 1989. This report gave an update on the status of all the projects recommended for implementation in the 1963 Comprehensive Plan. It also reprioritized all of the 1963 projects that had not yet been built. A draft Comprehensive Flood Control Program Report was also developed in 1989. This draft report added more detail to each of the projects described in the Status Report, reported on projects by other agencies, and explained the Area Drainage Master Study Program. This draft culminated in the publication of the *Comprehensive Flood Control Program Report of 1991*.

Comprehensive Flood Control Program Report of 1991

The 1991 Comprehensive Report summarized what had been accomplished since the 1963 Report and what was still needed based on more current information. Approximately 15 of the 40 projects identified in 1963 were in construction or had been completed at the time of the 1991 Report. Five of these 40 projects were incorporated into other projects or eliminated. The 1991 report also listed projects that were being constructed in cooperation with the Arizona Department of Transportation (ADOT), various municipalities and the Soil Conservation Service, an agency within the United States Department of Agriculture. By 1991, the District was operating and maintaining 29 flood control facilities. The 1991 Report documented the District's non-structural flood control programs such as Floodplain Management, Drainage Administration and Flood Warning. This report pointed out the need for additional planning in many areas of the county and explained the Area Drainage Master Study program.

1997 Comprehensive Flood Control Program Report

A draft Comprehensive Flood Control Report/Plan was developed in 1997. This report updated projects completed since 1991 and took a more comprehensive look at non-structural program activities such as floodplain and drainage administration. The District's governing body did not officially adopt this report.

Comprehensive Plan 2002–Flood Control Program Report

The *Comprehensive Plan 2002–Flood Control Program Report* was an update to the

1997 plan. For the 2002 plan, District staff expanded on the report requirements of the statutes to include aspects of the Growing Smarter Plus legislation (2000) and requirements of the Community Rating System–NFIP. Adding these elements made the Plan more compatible with other comprehensive planning documents for guiding future development.

Comprehensive Plan 2005 – Flood Control Program Report

The most recent Comprehensive Plan was adopted by the Board of Directors in 2005. For this report, District staff continued to include aspects of the Growing Smarter Plus legislation and Community Rating System–NFIP requirements. The plan looked at all of the District’s activities for providing flood control and floodplain management—from structural to non-structural solutions, education and regulation.



Luke Air Force Base, 1951

2. Fifty Years of Flood Control

The Flood Control District of Maricopa County (District) celebrated its golden anniversary on August 3, 2009. Over the past 50 years, the District has constructed 140 flood control structures, delineated more than 4,100 miles of floodplains, and identified flood mitigation solutions for nearly half of the 9,226 square miles of the county¹. To commemorate the 50th Anniversary of the District, this chapter provides an overview of key milestones and events in the District's history.

Flooding in Maricopa County

Water is a scarce resource in the Southwest. As a result, people settled along the rivers in order to survive. The Hohokam Indians, the first permanent inhabitants of the area, diverted water from the Salt and Gila rivers through an extensive canal system to water their crops. The formation of the Arizona

Fifty Years of Flood Control Outline

Flooding in Maricopa County
District Formation
Trends and Milestones
Timeline

¹ See Maps 2-1, 2-2, 2-3 and 2-4, Total and Delineated Stream Lengths by Watershed, Completed Capital Projects through Fiscal Year 2010 (East of I-17), Completed Capital Projects through Fiscal Year 2010 (West of I-17), and Status of Master Plans and Studies.

2. Fifty Years of Flood Control

Territory in 1863 was the beginning of more intense development, which was furthered by the construction of additional irrigation canals.

The rivers were a double-edge sword for the Hohokam and the early residents of the Arizona Territory. On one hand, the rivers provided fertile agricultural soil and a source of water; on the other, they delivered devastating floods that inundated agricultural lands, demolished housing and wreaked emotional havoc on early settlers.

Two major floods between the years 1890-1891 highlighted this hazard.

- On February 22, 1890, 15 feet of water overtopped the Walnut Grove Dam just north of Wickenburg. A construction camp downstream of the dam was washed away when the dam collapsed, killing 50 people.
- One year later, in 1891, the maximum flood of record for Maricopa County occurred on the Verde, Salt and Gila rivers. The Salt River had an estimated 300,000 cubic feet per second water flow, expanding to several miles wide in the Phoenix area. Homes along the Salt River were demolished and the railroad bridge between Tempe and Phoenix was destroyed, leaving Phoenix without a rail connection for three months.

Periodic and severe flooding continued. In 1923 the Cave Creek Dam was built, which provided protection for parts of the central Phoenix area. The 1936 passage of the Federal Flood Control Act allowed the federal government to partner with states and municipalities for flood control, but only if the benefits outweighed the costs. The federal government constructed several major flood control works to protect the metropolitan area. Large areas of the county, however, were still at risk, especially in developing urban areas and more flood control works were needed. Arizona was also turned down for a key flood control project along the Salt River because of “federal bureaucracy and property title issues².”

District Formation

Frustrated with the long timeframe associated with constructing federal projects and fearing future flooding events, in October 1957 the City of Phoenix, the Salt River Project and Maricopa County formed the Flood Protection Improvement Committee (FPIC). The FPIC was tasked with preparing a flood control general plan for the greater Phoenix area. The FPIC met with the Army Corps of Engineers to discuss the Corps plan of channelizing the Salt and Gila rivers and decided to expand the plan to other areas and rivers within the greater Phoenix area. The FPIC also met with the Los Angeles County Flood Control District, which would serve as the model for the formation of the Flood Control District of Maricopa County.

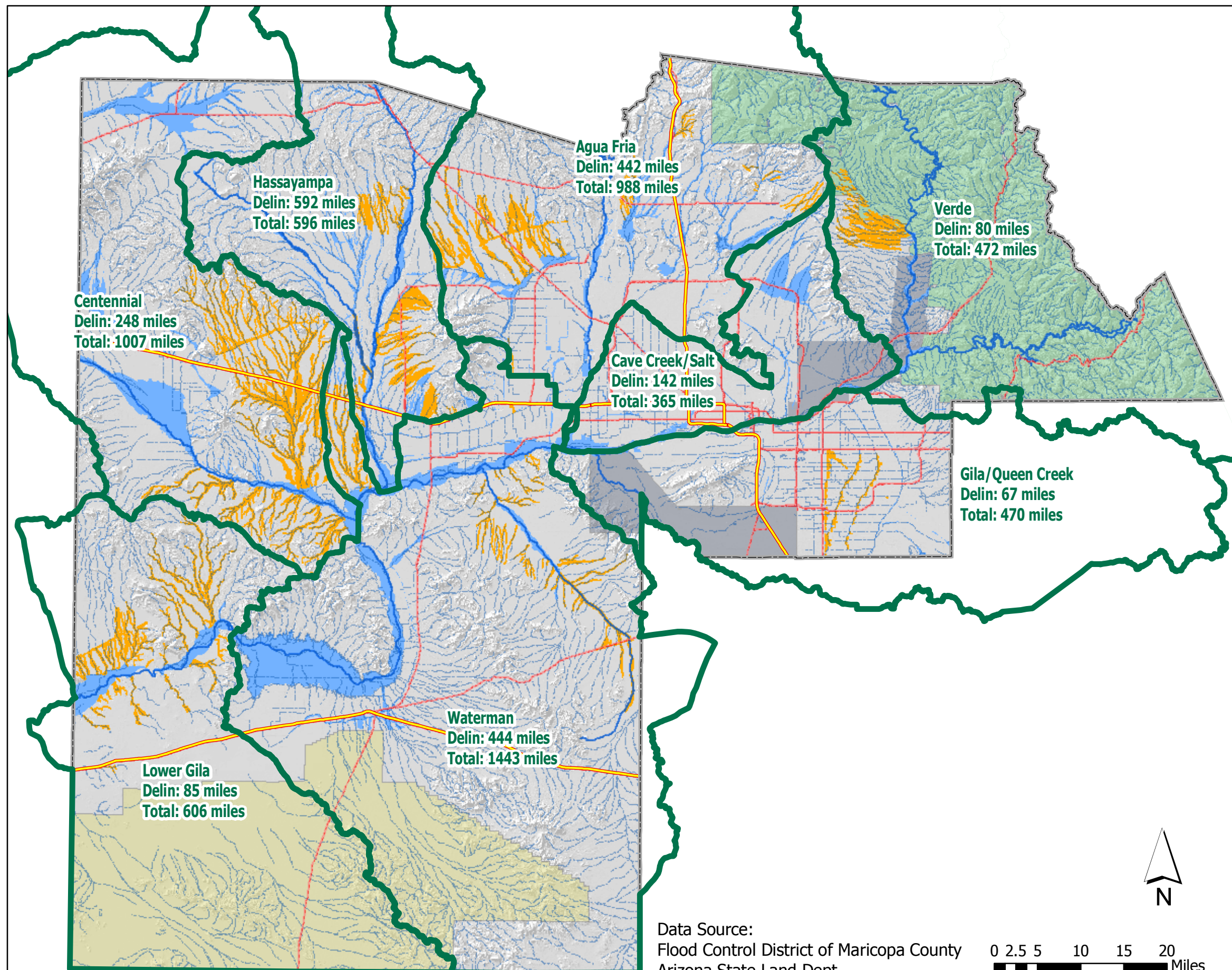
The resulting FPIC plan in 1958 detailed the process for the formation of the District and, in the interim, the Maricopa County Flood Control Agency. The Maricopa County Flood Control Agency began drafting legislation to allow the creation of flood control districts. On March 23, 1959 Arizona Governor Paul Fannin signed Senate Bill 204, which allowed the creation of flood control districts in the state. On August 3, 1959, the Maricopa County Board of Supervisors held a meeting and unanimously approved the resolution creating the Flood Control District of Maricopa County. Before any construction work could begin, the newly formed Flood Control District needed to survey the flood control problems in Maricopa County and prepare a report with the recommendations, called the Comprehensive Flood Control Program Report³.

² Murray, Vincent Smith, 2006. A History of Flooding and Flood Control in Maricopa County.

³ Murray, Vincent Smith, 2006. A History of Flooding and Flood Control in Maricopa County.

Total & Delineated Stream Lengths by Watershed

Map 2-1



Legend

- Watershed Boundaries
- FEMA Floodplains
- Pending Floodplains
- 100K USGS National Hydrography
- Areas not to be Delineated**
 - Forest
 - Indian Community
 - Military

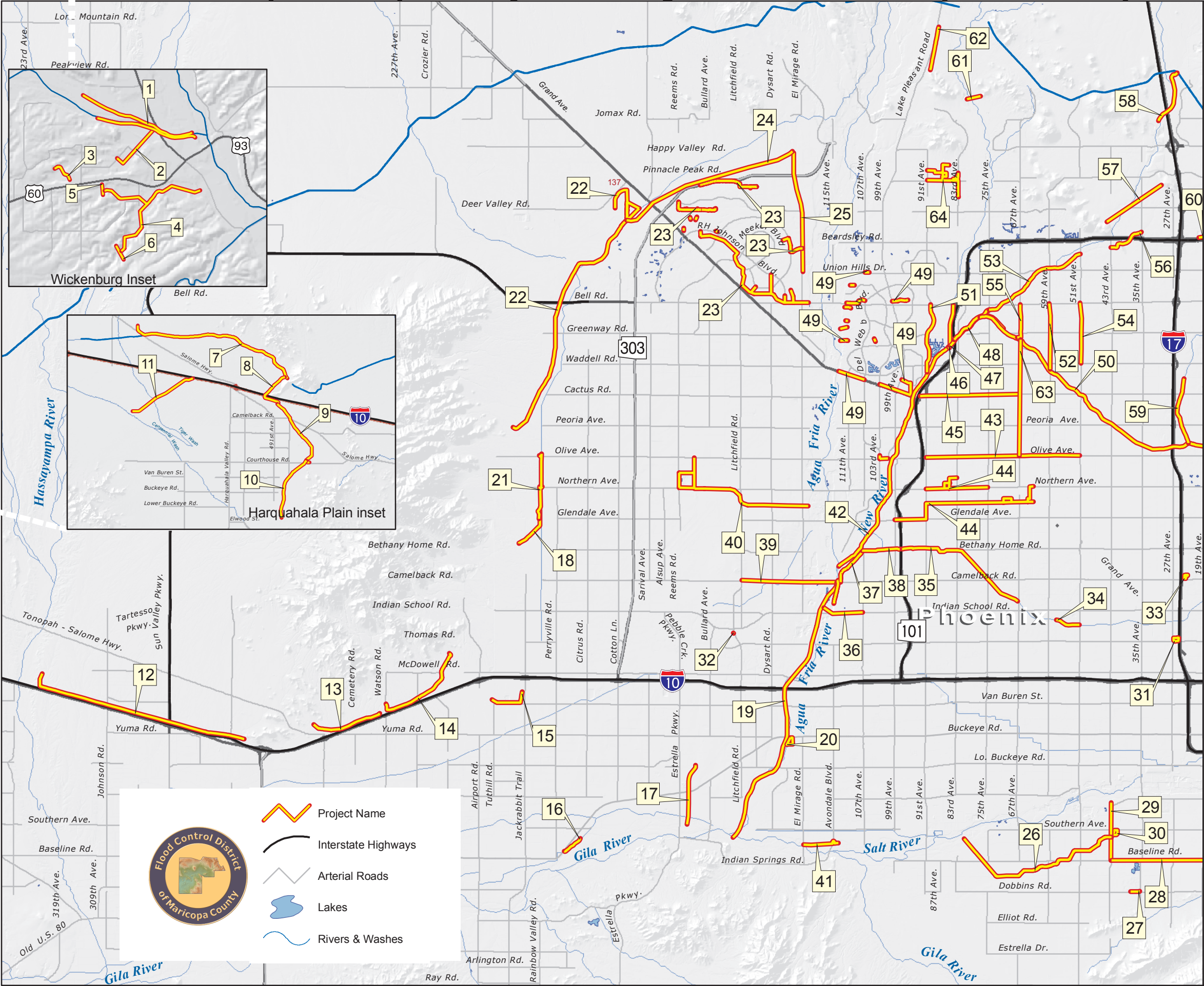
Data Source:
Flood Control District of Maricopa County
Arizona State Land Dept.

0 2.5 5 10 15 20 Miles



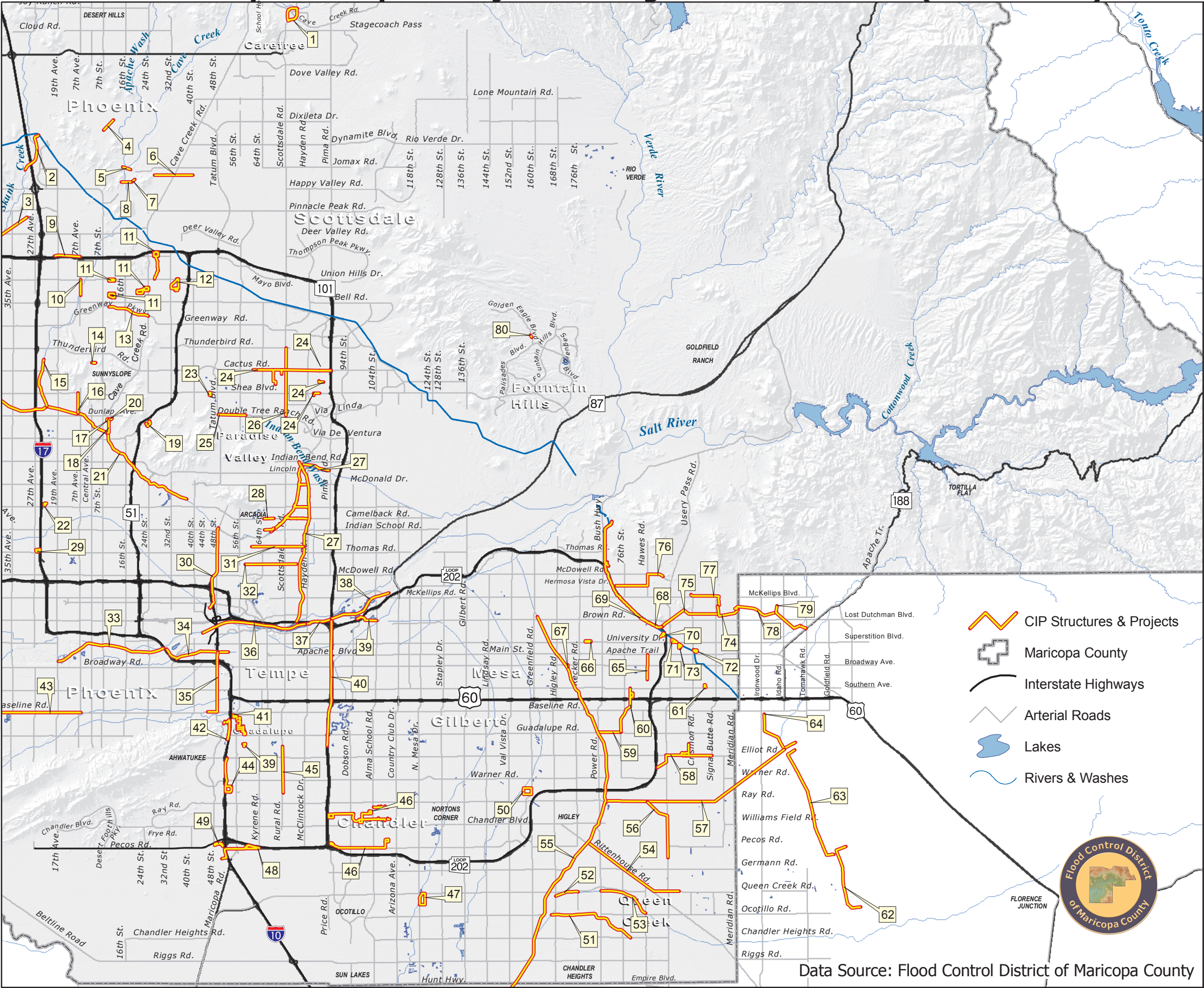
Completed Capital Projects through Fiscal Year 2010 (West of I-17)

Map 2-2



Label	Project Name
1	Wickenburg Downtown Flooding Hazard Mitigation Project
2	Casandro Wash Outlet
3	Casandro Wash Dam
4	Sunset/Sunnycove Pipeline
5	Sunset Dam
6	Sunnycove Dam
7	Harquahala Floodway
8	Harquahala FRS
9	Saddleback FRS
10	Saddleback Diversion Channel
11	Centennial Levee
12	Buckeye FRS No. 1
13	Buckeye FRS No. 2
14	Buckeye FRS No. 3
15	White Tanks FRS No. 4
16	Perryville Bank Stabilization
17	Bullard Wash (Phase I)
18	White Tanks FRS No. 3
19	Agua Fria Channelization
20	Avondale Landfill Excavation
21	White Tanks FRS No. 3 North Inlet Channel (NIC) Project
22	McMicken Dam
23	Sun City West Drains
24	McMicken Dam Outlet Channel
25	El Mirage Drain
26	Laveen Area Conveyance Channel
27	35th Avenue and Dobbins Road Basin and Storm Drain
28	Baseline Rd Storm Drain
29	43rd Ave Storm Drain
30	43th Ave and Southern Ave Detention Basin
31	26th Avenue and Verde Lane Basin
32	Roosevelt Irrigation District Canal Overchute
33	24th Avenue and Camelback Rd Basin
34	Maryvale Stadium West Inlet Channel
35	Bethany Home Outfall Channel (Phases IIA IIB & IIC)
36	Indian School Road Drain (107th Ave to Agua Fria River)
37	Camelback Ranch Levee
38	Bethany Home Outfall Channel (Phase I)
39	Colter Channel
40	Dysart Drain
41	Holly Acres Bank Stabilization
42	New River Channelization
43	Olive Ave. Storm Drain (51st Ave to 91st Ave)
44	Northern & Orangewood Storm Drain
45	Cactus Rd Storm Drain (67th Ave to SR101L)
46	83rd Ave Grade Control Structure
47	Skunk Creek/ACDC Low Flow Channel
48	Skunk Creek Sports Complex Bank Protection
49	Sun City Drains
50	Arizona Canal Diversion Channel
51	91st Ave & Bell Rd Drainage
52	59th Ave Storm Drain (Bell Rd to ACDC)
53	Skunk Creek Channel Improvements (75th Ave to 51st Ave)
54	51st Ave Storm Drain (Bell Rd. to Thunderbird Rd.)
55	67th Ave Storm Drain (Bell Rd to ACDC)
56	Scatter Wash Channel (43rd Ave. to 35th Ave.)
57	Adobe Dam
58	Skunk Creek Channel and Levee
59	Cave Creek Channelization
60	Beardsley Rd. Drainage System (7th Ave to 23rd Ave)
61	New River Dam
62	New River Dam Dike No. 1
63	67th Ave Storm Drain (Olive Ave. to ACDC)
64	83rd Avenue and Pinnacle Peak Road Drainage Improvements Project

Completed Capital Projects through Fiscal Year 2010 (East of I-17)



Label	Project Name
1	Carefree Town Center Drainage
2	Skunk Creek Channel and Levee
3	Adobe Dam
4	Cave Buttes Dike No. 3
5	Cave Creek Dam
6	Cave Buttes Dike No. 2
7	Cave Buttes Dike No. 1
8	Cave Buttes Dam
9	Bearsley Rd. Drainage System (7th Ave to 23rd Ave)
10	7th Ave Storm Drain (Union Hills Dr to Cave Creek Wash)
11	Upper East Fork Cave Creek Drainage
12	Paradise Valley Detention Basin No. 4
13	Greenway Parkway Channel (9th St to Cave Creek Rd)
14	City of Phoenix Dam No. 7
15	Cave Creek Channelization
16	9th Avenue Storm Drain (Peoria Avenue to ACDC)
17	10th St Wash Basin No.2
18	10th St Wash Improvements (Alice Ave to ACDC)
19	Dreamy Draw Dam
20	10th St Wash Basin No. 1
21	Arizona Canal Diversion Channel
22	24th Avenue and Camelback Rd Basin
23	Tatum Wash Detention Basin
24	Cactus Rd Flood Control System
25	Doubletree Ranch Road System
26	Scottsdale Rd Drainage (Thunderbird Rd to Doubletree Ranch Rd)
27	Indian Bend Wash
28	Camelback Side Drain Extension
29	26th Avenue and Verde Lane Basin
30	Old Cross Cut Canal
31	Osborn Rd. Storm Drain
32	Oak St Drain (58th St to Indian Bend Wash)
33	Salt River Low Flow Ch. (19th Ave to I-10)(Phx Rio Salado)
34	48th St Drain
35	48th St Storm Drain
36	Salt River Channel (SR-143 to McClintock Dr)
37	Salt River Channel (McClintock Dr to Price Rd)
38	Salt River Channel (Price Rd to McKellips Rd)
39	Alma School Drain
40	Price Road Drain
41	Guadalupe Drainage Improvement Project
42	Guadalupe FRS
43	Baseline Rd Storm Drain
44	ADOT Pit and Diversion Channel
45	Gila Drain Storm Drain
46	Central Chandler Area Drainage System
47	Queen Creek Road Basin
48	S.E. Valley Regional Drainage System
49	S.E. Phoenix Regional Drainage System
50	Gilbert Crossroads Park Basin
51	Sonoqui Wash Channelization (Higley Rd to Chandler Heights Rd)
52	Queen Creek Channel (Recker to Higley)
53	Queen Creek Channel (Hawes Rd to Power Rd)
54	Rittenhouse Road Channel
55	East Maricopa Floodway
56	Ellsworth Rd Channel at Phoenix-Mesa Gateway Airport
57	Powerline Floodway
58	Elliot Road Basin and Channel
59	Guadalupe Box and Channel
60	Sossaman Channel and Basin
61	Central Arizona Project Detention Basin No. 5
62	Rittenhouse FRS
63	Vineyard FRS
64	Powerline FRS
65	Hawes Rd. Channel (Emilia Ave to Main St)
66	University Drive Basin
67	Broadway Rd Collector Channel (Broadway Rd to EMF)
68	Spook Hill FRS and Floodway
69	Spook Hill FRS Rehabilitation
70	Central Arizona Project Detention Basin No. 1
71	Central Arizona Project Detention Basin No. 2
72	Central Arizona Project Detention Basin No. 4
73	Central Arizona Project Detention Basin No. 3
74	Signal Butte FRS
75	Signal Butte Floodway
76	Hermosa Vista/Hawes Road Project
77	Pass Mountain Diversion Channel
78	Bulldog Floodway
79	Apache Junction FRS and Floodway
80	Golden Eagle Park Dam

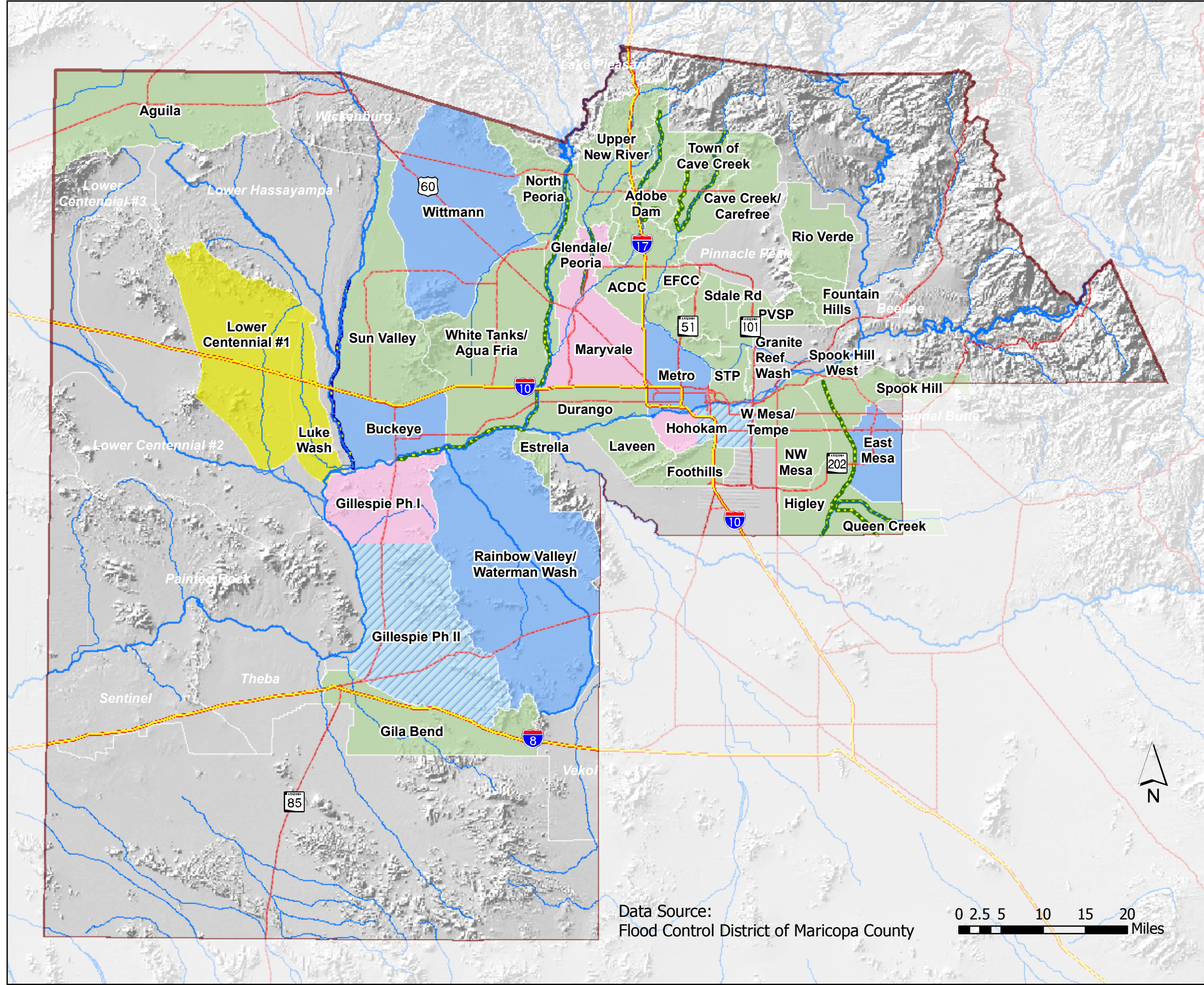
Data Source: Flood Control District of Maricopa County



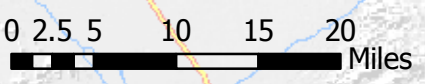
Status of Master Plans & Studies

Map 2-4

- ### Legend
- Interstate
 - State Roads
 - Rivers
 - Mapping
 - Delineation Only
 - ADMP Status
 - Ongoing
 - New Start
 - Complete
 - Future
 - WCMP Status
 - Complete
 - Current Project



Data Source:
Flood Control District of Maricopa County



Revised: 9 January 2009

The District published the Comprehensive Report it was tasked with preparing in 1963. The 1963 Report was the culmination of several general area studies that identified flooding problems in Maricopa County. The report divided Maricopa County into 35 watersheds that generally conformed to major drainage areas. Flooding problems were defined and potential structural solutions, such as dams, channels or levees, were proposed. This report was the guiding force behind most of the District's programs for over 25 years.

Trends and Milestones

1960s-1970s: Federal Partner

During the 1960s and 1970s many of the Flood Control District projects involved being the local sponsor for federal projects, most of which were dams or flood retarding structures (FRS). It was during these years that projects such as Buckeye FRS Nos. 1, 2 and 3 were constructed in the West Valley with the U.S. Soil Conservation Service (now the Natural Resources Conservation Service). The District was the local sponsor for the Powerline, Rittenhouse and Vineyard flood retarding structures, three structures located in the East Valley which together capture storm water for a 159-square mile area. The U.S. Soil Conservation Service was the federal sponsor for these projects.

Starting in this period and through the next several decades, the Phoenix metropolitan region became one of the fastest-growing urban areas in the country. County population increased 46 percent and 56 percent in the 1960s and 1970s, respectively. This more than doubled the 1960 population of 663,510 to 1,509,052 by 1980. Post-World War II development spurred the expansion of the metropolitan area outward in each direction, toward Glendale, North Phoenix, Scottsdale, Tempe, and Mesa. This growth created a greater demand on District projects to protect new residents from flooding hazards.

1980s: District Takes Lead

During the 1980s the District continued acting as the local sponsor for several federal projects, including the Indian Bend Wash. Many of the federal projects, however, were coming to an end. During this decade, the District assumed more of a leadership role in flood control projects, overseeing the construction and completion of several storm drains and the channelization of the Agua Fria River. Excluding the Agua Fria channelization, many of these projects were relatively small, localized flood control projects. The inception of various types of planning studies such as the Area Drainage Master Study (ADMS) and the Area Drainage Master Plan (ADMP) occurred during the 1980s and has continued ever since.

As in the previous decades, migration to the Sunbelt led to a large increase in population. Between 1980 and 1990, Maricopa County's population increased from 1,509,052 to 2,122,101, a 41 percent increase. This population increase caused continued urban expansion, especially in periphery areas, which created demand for flood protection in a larger portion of the County. In response, the District continued to delineate floodplains and build additional flood protection structures in these areas.

1990s Multi-use, Intergovernmental Agreements and Cost Share

The 1990s were a time of change for the Flood Control District. Structural projects were supplemented by non-structural approaches to hazard mitigation. Incorporating multi-use

elements into projects became an area of concern for not just District staff, but also residents of Maricopa County. During these years, projects such as the channelization of New River incorporated “softer” elements such as parks and trails. Another change that occurred during the 1990s was the transition from federal sponsorship of projects to the District partnering with local municipalities to cost-share the design and construction of flood control projects. While these District-municipal cost-share agreements had occasionally occurred since the formation of the District, during the 1990s these agreements became standard for most projects. Additionally, during this decade the District expanded the planning studies concept to include Watercourse Master Plans (WCMP).

The population expansion seen in the 1980s continued into the new decade, necessitating additional floodplain delineations and flood protection structures. Most notably, the population surpassed three million people in this period and increased by 45 percent, to 3,072,149 from 1990 to 2000.

Flood Control Today and Tomorrow: Regional Leadership

In the last 50 years, the work of the District has protected the central urban region, identified hazards in outlying areas and enhanced the community. According to the Morrison Institute of Public Policy at Arizona State University, the District’s efforts have “enabled the Valley of the Sun to grow and thrive.”⁴

Today, the District continues to provide regional leadership to solve flooding problems that are too large for one property owner or one community to manage. The District is also responding to increasing public demand for flood protection that enhances the natural and built environment; provides year-round opportunities for multiple uses; and protects and restores the natural resources of floodplains.

The District is continually adapting to changing flooding conditions, new development and community expectations. In the next 20 years, the District will make significant progress toward completing construction on most of the infrastructure that is needed to protect the developed areas. The District’s focus will then shift from constructing flood control works to programs that keep people out of floodprone areas, and maintenance and rehabilitation of the existing infrastructure. In the meantime, the District will continue to do what it does best—protect the residents of Maricopa County from flooding through providing flood hazard identification, regulation, remediation, and outreach services.

Timeline

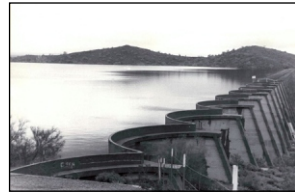
Over the last 50 years, there have been numerous milestones for the Flood Control District. The following timeline highlights the more significant events.

4 Morrison Institute of Public Policy, Arizona State University. Forum 411, December 2008, Edition 1, Issue 3.



1891

The Salt River at Mill Avenue during the 1891 flood, the largest flood on record in Maricopa County.



1923

Following severe floods that inundated central Phoenix, including the State Capitol Building, Cave Creek Dam was constructed



1959

Gov. Paul Fannin signs legislation authorizing the establishment of flood control districts by Arizona counties in March 1959.



1963

The first Comprehensive Flood Control Program Report is adopted by the County Board of Supervisors.

1967

Powerline Flood Retarding Structure (FRS) was completed. Vineyard FRS was operational the following year.

1968

The United States Congress passed the National Flood Insurance Act.

1969

Construction on Rittenhouse FRS was completed.



1970

Maricopa County officially began participation in the National Flood Insurance Program.

1974

Maricopa County adopts the first floodplain regulations for the unincorporated areas of the county. Dreamy Draw Dam was completed.

1975

Buckeye FRS 1, 2 and 3; Guadalupe FRS and Old Cross Cut Canal are completed.

1979

Spook Hill FRS was completed.



1980

The District launches the ALERT System.



1980

Cave Buttes Dam was completed.



1982

Construction is finished on Harquahala FRS and Floodway Channel.

1984

Adobe Dam and Signal Butte Floodway Channel are operational.

1985

First Area Drainage Master Plan conducted.

1985

New River Dam and Indian Bend Wash in Scottsdale are completed.

1988

Apache Junction FRS was completed.

1989

East Maricopa Floodway Channel was completed.



1990

FEMA initiates the NFIP-Community Rating System (CRS).

1991

Maricopa County joins the CRS program and receives a Class 9 rating.



1994

Arizona Canal Diversion Channel (ACDC) was completed.

2002

Maricopa County improves to a Class 5 rating in the CRS program, allowing residents in unincorporated Maricopa County to receive a 25 percent reduction in flood insurance premium rates.



2003

Floodprone Property Assistance Program approved by Board of Directors.



2009

District celebrates 50 years of protecting Maricopa County residents from flooding.



The "Labor Day Storm of 1970" killed 23 people in the Phoenix area and caused \$5.8 million in damages.

3. The Next Fifty Years: An Analysis of the District's Future Direction

The business of flood control has changed significantly since the Flood Control District of Maricopa County's (District) inception in 1959. The District's comprehensive plans and reports have served as the roadmap for the evolution of flood mitigation in the county. Dating back to the *Comprehensive Flood Control Program Report of 1963*, these plans guided the District's programs and activities. The *2009 Comprehensive Floodplain Management Plan and Program* (Plan) synthesizes the District's continued efforts to develop sustainable, cost-effective solutions to flooding in Maricopa County.

The key component of the 2009 Plan is the strategic analysis of the District's current activities and possible future directions as presented in this chapter. The purpose of this chapter is to identify actions necessary to maintain the District's capability to provide mandated public services. All of the subsequent information provided in this Plan - including the risk analysis by watershed and recommendations for future flood control activities - is framed by the analysis in this chapter. The strategic analysis is based on over 75 interviews with the District's Board

The Next Fifty Years Outline

- Mission, Vision, and Philosophy
- Flood Hazard Mitigation Goals
- Flood Hazard Mitigation Programs
- Emerging Issues
- Assessment of Organizational Strengths and Challenges
- Recommended Actions
- Summary

of Directors and staff, as well as input from other stakeholders including cities, governmental agencies, non-profit organizations and the public.

This chapter reviews the District's mission, vision, philosophy and goals and summarizes the programs that the District employs to realize its mission. The analysis concludes with a summary of the key challenges facing the District and recommendations to address any gaps in the District's ability to meet those challenges. The intent is that the recommended strategic initiatives will be further explored by District staff and used to develop policies, programs, and other tools needed to continue protecting Maricopa County residents from flooding over the next 50 years.

Mission, Vision, and Philosophy

Formed in 1959 after decades of catastrophic flooding, the District is governed by federal mandates and state statutes¹. The District is tasked by Arizona Revised Statutes to oversee the development and implementation of comprehensive flood control measures in Maricopa County. Flood control solves drainage problems that follow major storm events and are regional in nature, impacting large geographic areas.

The District operates under the umbrella of the Maricopa County Public Works Department. The **mission** of the Public Works Department *is to provide facility and security services, flood control, solid waste management, and transportation infrastructure and related services to the people within Maricopa County so they can live, work, conduct business, and travel in a safe and clean environment.*

The **vision** of the District is that *the people of Maricopa County and future generations will have the maximum amount of protection from the effects of flooding through fiscally responsible flood control actions and multiple-use facilities that complement or enhance the beauty of our desert environment.*

The **mission** or **purpose** of the District is to provide flood hazard identification, regulation, remediation, and education to the people in Maricopa County so that they can reduce their risks of injury, death, and property damage due to flooding while enjoying the natural and beneficial values served by floodplains.

The District's **philosophy** for the planning and implementation of flood control solutions is detailed in several policies and guidance documents, including the Floodplain Regulations for Maricopa County, (FCDMC 2006)²; Drainage Policy and Standards Manual, (FCDMC 2007); Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects, (FCDMC 1992); and various comprehensive and strategic plans.

The District's philosophy can be condensed to several salient points:

- A well-planned flood control system that preserves as much of the natural waterways as possible, can a) protect life and property, b) reduce the cost of capital improvement infrastructure, c) enhance quality of life and property value and d) preserve the unique Sonoran Desert environment.
- Planning of flood control facilities should be based upon incorporating natural waterways, artificial channels, storm drains, and other drainage works into the

¹ A summary of the regulatory framework in which the District operates is found in Appendix B.

² See Appendix E for the complete text of the Floodplain Regulations for Maricopa County.

development of a desirable and aesthetic community, rather than attempting to superimpose flood control works on existing developments.

- Constructed facilities should be combined, where feasible, with open space, parks, and trails to create focal points for the community and increased recreational opportunities.

In implementing flood control solutions, the District **pledges** *to be responsive to our clients in an efficient, effective, and fiscally responsible manner. We will show personal integrity and professionalism in all our actions, and display continuous improvement, innovative thinking, and technical expertise. We will be stewards of the environment and the public's trust, and we will be concerned about the effects of our actions on not only the current, but also future generations.*

Flood Hazard Mitigation Goals

The District sets general goals for how flood hazards should be mitigated through the Managing for Results strategic planning process. These goals are adopted annually by the Maricopa County Board of Supervisors, which serves as the District's Board of Directors. The following goals will be achieved through implementation of the strategic initiatives described in this chapter and the activities outlined in the five-year action plan summarized in Chapter 9.

- By June 30, 2014, the District will meet the increasing demands for public works services by constructing 85% of flood structure projects planned to be completed on time.
- By June 30, 2015, the District will enhance public safety for Maricopa County residents and visitors by providing structural and non-structural solutions to flooding such that 80% of residents will have a reduced risk of loss of life or property due to storm water flooding.
- By June 30, 2013, the District will enhance public safety for Maricopa County residents and visitors by completing 90% of all critical maintenance tasks that directly impact the immediate safety of Maricopa County residents and visitors within an average of 14 days, and 100% of those tasks within an average of 90 days to sustain maintenance of our flood control infrastructure to federal, state, and local safety and operational standards.

The following flood hazard management goals were established in previous strategic or comprehensive planning efforts and still serve as guiding principles for District activities:

- The District will maintain and seek to improve the CRS rating for unincorporated Maricopa County through use of the best available flood hazard mitigation practices, principles and information. The District will also help other jurisdictions in Maricopa County improve their CRS rating, and encourage participation by communities that are not currently part of the CRS program.
- The District, recognizing the impacts of major public works projects on the community, will incorporate appropriate strategies to mitigate these impacts to the extent allowed by enabling statutes, and, where feasible, design and construct facilities to complement the surrounding environment, provide opportunities for recreation, enhance wildlife habitat and minimize impacts to cultural resources. Detailed goal and objective statements regarding the integration of flood control projects into the natural and built environment can be found in Appendix G.

Flood Hazard Mitigation Programs

The District provides flood control services to the public under four different program areas—outreach, identification, regulation and remediation. These programs are the link between the District's mission and the flood control solutions that are implemented to protect public safety in Maricopa County.

Flood Control District Strategic Programs³

Flood Hazard Outreach Program

The Flood Hazard Outreach Program provides information collection and dissemination of flood hazard information, technical data, and flood safety guidance to public agencies and the public so that they are aware of and can respond to flood hazards.

Flood Hazard Identification Program

The Flood Hazard Identification Program provides flood and erosion hazard information and documentation to the public so that they can be knowledgeable about the dangers of erosion and flooding, the areas in which they occur, and the future remediation measures. This program includes development of drainage master plans, watercourse master plans, floodplain delineations and strategic and comprehensive plans and the management of storm water quality.

Flood Hazard Regulation Program

The Flood Hazard Regulation Program provides floodplain and drainage compliance guidance, direction and enforcement for the public so that they can use their property safely and in compliance with applicable state and federal laws. This program includes floodplain management and sand and gravel mining administration.

Flood Hazard Remediation Program

The Flood Hazard Remediation Program provides flood protection using structural and non-structural⁴ mitigation of flood hazards for the public so that they can live with minimal risk of loss of life or property damage due to flooding. This program includes design, construction, and operation and maintenance of flood control infrastructure.

Each District program is comprised of a variety of "tools." Tools can be regulations, construction of flood control projects, development of plans or education programs. Reducing the risk of flooding is a complex undertaking. In most cases, a combination of programs and tools is needed to reduce risks and protect the natural resources and functions of floodplains.

Emerging Issues

Based on interviews with staff, input from stakeholders and other research, the key external factors and issues affecting the District's implementation of its mission in the near and long-term are:

³ A description of the District's four strategic programs can be found in Chapter 5.

⁴ Non-structural flood control is a term used to distinguish techniques that modify susceptibility to flooding (such as watershed management, land use planning, regulation, and flood warning) from the traditional structural methods (such as dams, levees, and channels) used to control flooding. Non-structural flood control activities span all four of the District's programs and include education programs, identification of floodplains, regulation, and floodprone property acquisition.

- The public may underestimate the risk of flooding during prolonged droughts, or they may not realize that existing flood control structures are protecting their neighborhood from flooding.
- Population growth and expansion of urban boundaries, especially into high hazard areas.
- Economic climate due to the recent downturn may reduce funding. The District is challenged with balancing the level of acceptable public safety risk versus the cost of the flood control solution.
- Increased demand for recreation and open space as the metro area develops. Residents have approved increases in taxes to support the acquisition of open space. For example, 83 percent of Phoenix voters authorized the continuation of a modest sales tax for a 30-year period to purchase thousands of acres of state trust land and to fund improvements to parks.
- Increased demand for restoration and protection of wildlife habitats and riparian areas.
- Public interest in “sustainable flood mitigation solutions” that balance community, economic and environmental concerns.
- Environmental issues unique to Maricopa County such as water quality and quantity, loss of riparian or native habitats, subsidence and earth fissures.

Assessment of Organizational Strengths and Challenges

The following presents an assessment of the District’s capacity to address the emerging issues (identified above) and continue to protect Maricopa County from flooding. The list of strengths and challenges is based on public input and over 75 interviews with staff, elected officials and a facilitated session with District management.

Flood Hazard Outreach Program

The Flood Hazard Outreach Program provides the public with information regarding risk mitigation from flooding events to reduce loss of life and property from storm water runoff.

Strengths

- Utilization of innovative techniques to educate the public regarding flood hazards, such as public service messages and partnerships with local media.
- Highly regarded flood warning and forecasting program.
- Pro-active public meetings to obtain citizen input when developing solutions to flooding.

Challenges

- Limited public understanding of the extent of the flooding risk in Maricopa County. The public has a false sense of security due to the arid climate, the large number of new residents who may not have experienced a large flood event in Arizona and the network of existing flood control infrastructure that protects portions of the metropolitan area.

3. The Next Fifty Years: An Analysis of the District's Future Direction

- Communicating the floodplain delineation process and impacts to property owners.
- Building and sustaining consensus with diverse stakeholders over the course of a multi-year project or study.

Flood Hazard Identification Program

The Flood Hazard Identification Program provides information in the form of technical, engineering and planning analysis of current conditions and identifies opportunities for mitigation of flooding impacts.

Strengths

- Commitment to completing delineations and planning studies ahead of development. The pro-active planning and delineation process helps minimize public exposure to flood prone areas.
- Area Drainage Master Studies/Plans and Watercourse Master Plans provide a comprehensive process for identifying flooding problems and developing solutions that incorporate multi-use opportunities.
- District staff are recognized experts in unique flooding hazards, such as alluvial fans.

Challenges

- The District needs to increase coordination with the planning departments of cities and the county to implement recommendations from ADMP/WCMPs, such as land use guidelines, rules of development, and design guidelines.
- Completing delineations and studies ahead of development.
- Developing a consistent prioritization methodology for identifying Area Drainage Master Plans/Studies. The formalized prioritization process for the Capital Improvement Program works well and could serve as a model (see Chapter 5, Capital Improvement Program).

Flood Hazard Regulation Program

The Flood Hazard Regulation Program provides floodplain management and enforcement for the public so that they can use their property safely and in compliance with applicable state and federal laws.

Strengths

- Established floodplain regulations that set regulatory standards higher than the minimum NFIP standards including prohibiting buildings within the floodway and elevating the lowest residential floor at least one foot above the base flood elevation.
- Technical expertise of staff.
- Streamlined process of drainage/floodplain review with Maricopa County Planning and Development.

Challenges

- Limited ability to regulate erosion hazard zones in unincorporated county.
- Limited ability to regulate cumulative impacts of encroachment in floodplains and river systems.

Flood Hazard Remediation Program

The Flood Hazard Remediation Program is centered upon the implementation of flood mitigation measures and includes land acquisition, design, construction, operation, maintenance and management of flood control infrastructure.

Strengths

- The construction of nearly 140 regional flood control facilities that protect the core urban center, as well as surrounding areas.
- Formalized process for including projects in the Capital Improvement Program.
- Comprehensive operations and maintenance program staffed by experienced people.
- Nationally recognized dam safety program.
- Construction of structures that complement the surrounding environment and incorporate multi-use opportunities.
- Development of a “small projects” program to provide financial assistance to communities to solve local flooding problems.
- Floodprone Property Assistance Program to voluntarily acquire properties in the 100-year floodplain and floodway.

Challenges

- Aging flood control infrastructure and the associated expense of repairing the facilities.
- Ensuring continued effective utilization of public-private partnerships and other funding sources to implement projects.
- Compliance with new levee standards established by the Federal Emergency Management Agency.
- Establishing satisfactory cost share relationships with project partners given current economic conditions.
- Uncertain capability and authorization to restore degraded floodplains or riverine systems.

Recommended Actions

This analysis concludes that the current programs—outreach, identification, regulation and remediation—are working well and should continue to be core functions. Five recommended strategic initiatives are summarized below. The purpose of these initiatives is three-fold: 1) Address the District’s challenges; 2) Capitalize on its strengths; and 3) Respond to emerging issues in order to reduce the flooding risk to people and property. An action plan and a near-term implementation schedule for the key elements of the initiatives can be found in Chapter 9.

Strategic Initiative #1: Strengthen Role as Regional Leader in Flood Control and Floodplain Management

The purpose of this initiative is to strengthen the District's regional leadership role through forging partnerships with cities and towns to best utilize the District's flood control expertise, resources and programs. This initiative is an affirmation of the District's focus on service to client cities and the public and includes continued outreach to build awareness of District capacity and programs. District services or programs with broad applicability and benefit include flood warning, landscape inventory and analysis, educational materials, design manuals, sample ordinances or rules of development, assistance with Community Rating System activities and other technical expertise or advice.

As a result of this initiative, the District can also provide regional guidance through original research or development of pilot projects to identify best management practices for emerging issues such as stormwater quality, control of invasive species (in areas where the vegetation impacts flood conveyance) and bioengineered flood control techniques.

Strategic Initiative #2: Streamline the Multi-Objective Watershed Approach to Flood Mitigation

The District's current process for developing Area Drainage Master Studies/Plans identifies the nature of the flooding problem on a watershed scale and then recommends the best means to sustainably mitigate the flooding while taking into account opportunities for recreation, wildlife, quality of life enhancement and economic development.

This initiative focuses on streamlining the District's existing planning studies to standardize processes and create cost efficiencies. Areas for increased efficiencies or improvements to the planning process, include:

- Developing a risk assessment and prioritization model for locating flood control structures
- Integrating the identification of non-structural solutions as part of the alternatives development process

Strategic Initiative #3: Increase Collaboration and Partnering to Expand Flood Mitigation Efforts

The purpose of this initiative is to ensure the continued protection of the most lives and property through the efficient use of funding.

Possible activities under this initiative include:

- Leveraging public/private partnerships
- Balancing partner cost share ability with need for infrastructure, including exploring solutions for events less than the 100-year flood
- Creating unifying visions at the onset of project planning and design to define project parameters

Strategic Initiative #4: Preserve and Restore the Natural Resources and Functions of Floodplains and Riparian Areas

This initiative seeks to restore or sustain the natural resource functions of floodplains to improve conveyance and protect Maricopa County's unique natural environment. This initiative recommends two actions:

- Creation of an exploratory committee that is tasked with:
 - Defining the natural and beneficial functions of floodplains and riverine systems in Maricopa County
 - Investigating tools for preserving floodplains for conveyance and other beneficial uses
 - Determining the District's role in river management and restoration efforts
 - Developing a sensitive-lands management plan for District property
- Development of a habitat mitigation banking program to assist with regulatory compliance related to construction of flood control projects

Strategic Initiative #5: Continued Commitment to Process Improvement

This initiative seeks to strengthen internal processes to continually improve the District's services to the public, partner agencies and other customers. The focus of this initiative is on supporting a culture of continuous improvement and analysis which can respond to changing conditions and issues.

Possible activities under this initiative include:

- Developing a methodology for a county-wide vulnerability assessment given a large storm event.
- Continued focus on utilizing and developing new technology
- Developing meaningful metrics to evaluate existing programs and future initiatives
- Increasing community participation in establishing priorities
- Investigating legislation to close regulatory gaps that threaten public safety

Summary

The District has provided flood control services to Maricopa County for 50 years, including developing a network of flood control structures which protect the county's core urban area. The District's comprehensive plans and reports have served as the roadmap for the flood mitigation efforts in the county. The key component of the 2009 Comprehensive Plan is the strategic analysis of the District's current activities. The strategic analysis is based on over 75 interviews with the District's Board of Directors and staff, as well as input from other stakeholders including cities, governmental agencies, and the public. The strategic analysis concludes that the District's four existing flood control programs—outreach, identification, regulation and remediation—are working well. The 2009 Plan recommends five strategic initiatives to address challenges facing the District and other emerging issues. The five strategic initiatives are: 1) Strengthen Role as Regional Leader; 2) Streamline Multi-Objective Water-

3. The Next Fifty Years: An Analysis of the District's Future Direction

shed Approach to Flood Mitigation; 3) Increase Collaboration and Partnerships; 4) Preserve and Restore the Natural Resources and Functions of Floodplains and Riparian Areas; and 5) Continued Commitment to Process Improvement. An action plan for implementing the key components of the initiatives is included in Chapter 9.



Apache Junction, August 2006

“It has been said that weather in the Sonoran Desert is a story of monotonous, cloudless days, interrupted by catastrophic exceptions.

—Mrell Ingram, *A Natural History of the Sonoran Desert*

4. Flooding in Maricopa County

Maricopa County has thousands of miles of rivers and washes and related floodplains. Floodplains are the areas adjoining the channel of a watercourse that may be covered by water during a flood. Floodplains are crucial for maintaining natural flood and erosion control. The county’s mountainous desert topography, compacted soil, and countless watercourses prevent rainfall runoff from quickly soaking into the ground. In their natural state, floodplains contain and store this runoff until it dissipates.

Flooding in Maricopa County occurs when natural waterways such as creeks, rivers and washes cannot contain the flow of a rainfall event. Development which increases impervious surfaces can worsen the impacts of flooding. Buildings, homes, and paved streets and parking lots disrupt the natural flow of water and prevent absorption into the ground, creating inadequate drainage in large portions of the county.

In the last 50 years, flood events have claimed 45 lives and inflicted more than \$1.5 billion in dam-

Flooding in Maricopa County Outline

Storms in the Desert

Types of Flooding

Functions of Natural Floodplains

Floodplains and Development

Historic Flood Events:
1891–Present

Vulnerability to Future
Flood Events

Reptitive Loss Areas

Erosion and Other Flood-Related
Hazards

Summary

ages¹. This chapter provides background on flooding in Maricopa County including types of storm events and flooding, natural floodplain processes, and the cost and impacts of historical flood events. The chapter concludes with a general assessment of the county's vulnerability to flooding.

Storms in the Desert

Flooding in Maricopa County is typically caused by one of three types of storm conditions: winter storms, tropical storms, or monsoons.

1. Winter storms offer the greatest potential for damage. Since these storms occur over several days and often combine with snow runoff from the high country, they saturate soils and overwhelm the natural and built drainage capacity, resulting in significant flood damage in developed areas. These storms usually cover a large geographic area, such as the January 2008 flood that caused damage in parts of Cave Creek, Carefree and north Scottsdale.
2. Tropical storms are derived from hurricanes in the Pacific. Tropical storms or hurricanes drop high amounts of rainfall in a short duration, usually 12 to 36 hours. These storms cause the most damaging floods in watersheds from 50 to 500 square miles in size. In 1997, record rainfall from Tropical Storm Nora caused two earthen dams to break in Aguila, causing widespread flooding and the evacuation of approximately 40 people from the town.
3. "Monsoons" occur during the mid- to late-summer. The word monsoon comes from the Arabic word "mausim" which means "season" or "wind-shift." As summer approaches, winds shift from a westerly to southerly direction, allowing moisture to stream into Arizona from the Gulf of California or the Gulf of Mexico. Summer heating warms the desert and city surfaces, allowing large cumulonimbus clouds to form in the humid air. These storms are typically short, intense and localized. Monsoon storms not only bring almost one-third to one-half of the annual rainfall in Maricopa County, they can also cause flash floods, lightning, strong winds, dust storms and hail. The storms have caused significant property damage and several fatalities.

Types of Flooding

The type of flooding caused by a storm event depends on the physical conditions, such as slope or soil type, of the floodplain and surrounding land. Development and other man-made features or modifications to the landscape can also alter the dynamics of flooding. Most flooding events in Maricopa County fall into one of three major categories: riverine, alluvial fan, and shallow flooding.

1. Riverine Flooding: Flooding that occurs along a defined channel is called riverine flooding. When a river or wash receives too much water, the excess flows over its banks and inundates the adjacent floodplain.

Flash flooding can occur in a riverine environment. A flash flood is a rapidly moving flood through low-lying areas such as washes and canyons. Flash flooding can also occur in urban areas where impervious surfaces, gutters and storm sewers accelerate runoff. Flash floods occur after intense storms that

¹ Maricopa County Multi-Hazard Mitigation Plan, FEMA Approved November 2004

drop large amounts of rainfall in a short period of time. When this happens, the ground cannot absorb the water fast enough so it accumulates in channels and flows downhill. Flash floods are often preceded by a debris flow that contains rocks, brush, logs and anything else it picks up along the way. Flash floods are the leading cause of flood-related deaths in the United States because they happen quickly and often without warning².

2. Alluvial Fan Flooding: An alluvial fan is a geomorphologic feature characterized by a cone or fan-shaped deposit of boulders, gravel and fine sediments that have been eroded from mountain slopes, transported by flood flows and then deposited in the valley floors. Alluvial fan flooding typically occurs in parts of the Valley with slopes between 2-16 percent.

Alluvial fans pose a significant public safety hazard. The area within a fan is subject to flash flooding, high velocity flows, debris flows, erosion, sediment movement and deposition. The public safety risk is intensified since the areas where alluvial fan flooding occurs are attractive for development due to proximity to mountains and scenic value.

3. Shallow flooding, as defined by the National Flood Insurance Program, occurs in flat areas "where a lack of channels means water cannot drain away easily."² Shallow flood problems include sheet flow and ponding.

Sheet flow is a condition where stormwater runoff forms a sheet of water to a uniform depth. Sheet flooding is often found in areas where there are no clearly defined channels with slopes less than two percent.

Ponding typically occurs in low spots on the upstream side of roadways, railroads and other embankments. The stormwater remains in the depressions until the water evaporates or seeps into the soil.

Functions of Natural Floodplains

The benefits and functions of natural, undisturbed floodplains can be described in terms of hydraulic, biological, and social resources and functions. The physical characteristics of floodplains provide flood and erosion control, water quality maintenance and groundwater recharge. The biological resources within a floodplain provide wildlife and fish habitat, erosion control, and water quality maintenance. The social values provided by the floodplains include public opportunities for outdoor recreation, scientific study and education, and enjoyment of scenery and open space. Table 4-1 summarizes a few of the key natural resources and benefits of floodplains.

Hydraulic Functions

Floodwater conveyance and storage are among the most important hydraulic functions performed by floodplains in Maricopa County. Water inundates floodplains from flows that exceed the capacity of river and wash channels, through surface runoff and direct precipitation. Flows that exceed the capacity of a natural channel are temporarily stored within the floodplain, re-enter the watercourse slowly as either surface or subsurface flows, and then are conveyed downstream in the watershed. The capacity

² National Flood Insurance Program (NFIP) Floodplain Management Requirements: A Study Guide and Desk Reference for Local Officials FEMA 480 February, 2005

of natural floodplains for floodwater storage and conveyance provides the functions of minimizing the magnitude of flooding and the potential for flood-related damage.

Biological Functions

The natural vegetation of floodplains performs the important functions of erosion control, bank stabilization, sedimentation storage, and water filtering. The roots of plants hold soil together, which decreases soil erosion and stabilizes the banks. Vegetation improves water quality by trapping and storing sediments, and by absorbing other pollutants through the water and soil.

Maricopa County's floodplains support riparian habitat, which is one of the most productive and contains the most diverse composition of plant and animal species in the county. Healthy floodplains and riparian areas contribute to the overall ecosystem integrity of an entire watershed area. Desert river and wash floodplains are among the most important biotic communities within Maricopa County. Natural floodplains provide wildlife forage, breeding, and movement corridors. These floodplain corridors also link other natural open spaces in Maricopa County such as the mountain preserves. The functions and values of riparian areas are discussed in greater detail in Chapter 6.

Social and Economic Values

In addition to the physical and biological functions, floodplains provide a variety of values that enhance the livability of communities in Maricopa County including scenic, recreation and economic benefits.

Floodplains in Maricopa County provide citizens opportunities to experience and enjoy natural settings within the urbanized metro area. The scenic values and recreation opportunities inherent in natural floodplains and washes create ideal locations for outdoor activities, such as hiking, biking, birding, and nature based education.

Floodplains and associated open space provide an economic value to the community. The environment has several types of value, including infrastructure benefits, property enhancement value, and production value. Each value should be recognized when making policy and planning decisions.

1. **Infrastructure Value:** Floodplains can provide infrastructure-like benefits to the community. For example, floodplains reduce peak flows through storage of flood waters. This is similar to the function provided by constructed flood control basins. The District recognizes this value in that it may be less expensive to purchase flood prone lands rather than providing flood control infrastructure for that land.
2. **Property Enhancement:** Riparian areas, natural floodplains and "greenbelts" increase property values and enhance the local economy. New developments generally charge a "lot premium" for lands adjacent to open space. River restoration projects and greenbelts create recreation and ecotourism opportunities that draw visitors and dollars to the community.
3. **Production Value:** Production value is the worth of the economic output of the land when it produces something. Production value of floodplains includes vegetation for grazing, sand and gravel mining output and crop yield on agricultural land. Agriculture, which provides open space near the urban periphery,

is important to the local economy, can provide a buffer between land uses, and is an important land use which is commonly found within floodplains.

Table 4-1 Beneficial Functions of Natural Floodplains

Hydraulic Functions	Biological Functions	Societal Values
Provide natural flood and sediment storage and conveyance	Support high rate of plant growth	Provide an area for active and passive recreation
Reduce erosive energy	Maintain biodiversity	Offer open space, scenic views and aesthetic relief
Reduce peak flows	Maintain integrity of ecosystems	Provide an area for scientific study and outdoor education
Maintain water quality	Provide habitat for fish and wildlife, including rare and endangered species	Contain significant archaeological resources
Filter nutrients and impurities from runoff	Serve as a travel corridor for wildlife	Increase value for property adjacent to riparian floodplains and open space
Recharge groundwater	Moderate temperature fluctuations	Are a source of natural and agricultural products

The Floodplain Regulations for Maricopa County in Appendix E define the rules for usage, development restrictions and permitting requirements necessary to protect the environmental and flood control qualities of floodplains. The regulations define the natural and beneficial functions of floodplains as: natural flood and sediment storage and conveyance, water quality maintenance, groundwater recharge, biological productivity, fish and wildlife habitat, harvest of natural and agricultural products, recreation opportunities, and areas for scientific study and outdoor education.

Floodplains and Development

Flooding is a natural process of river systems. All rivers overtop their banks at some time, inundating the river's floodplain. A flood event is only considered hazardous when the floodwaters threaten human life or property generally due to development in the floodplain. Land within floodplains is attractive to agricultural and urban development for many reasons, including natural beauty, density of vegetation, recreational purposes and access to fertile soil.

Proper floodplain management and flood control activities mitigate the risk of development in the floodplain. The District seeks to balance the beneficial functions and resources of natural floodplains with the need to protect life, property and infrastructure. This is accomplished by a proactive multi-objective planning and design process that considers flooding, community and ecosystem concerns. Constructed flood control facilities can replicate the "natural" functions of floodplains if designed and built in a sustainable, sensitive manner. For example, linear

greenbelts, such as Indian Bend Wash, the Laveen Area Conveyance Channel or the Bethany Home Outfall Channel, provide recreational opportunities, wildlife habitat and flood water storage and conveyance.

Historic Flood Events

In 1891, the maximum flood of record for Maricopa County occurred on the Verde, Salt and Gila rivers. The Salt River had an estimated flow of 300,000 cubic feet per second water flow, expanding to nearly three miles wide in the Phoenix area. Homes along the Salt River were demolished and the railroad bridge between Tempe and Phoenix was destroyed, leaving Phoenix without a rail connection for three months.

This pattern was repeated throughout the early development of the Phoenix area. Devastating floods wreaked economic and emotional havoc on early settlers. A series of floods in the mid-20th century led to the creation of the District in 1959.

In the past 50 years, major flooding in Maricopa County has led to the loss of 45 lives and an estimated \$1.5 billion in property damage. Many of the fatalities were the result of motorists trying to cross flooded roadways. When a major flood is so severe that effective response is beyond the capabilities of the local governments, FEMA may declare a federal disaster. When a federal disaster declaration is made, federal funding and assistance is available to aid in the response and recovery effort. Since 1966, Maricopa County has been declared a flood disaster area 17 times³.

Appendix F provides a summary of major floods since 1889, most of which fit into the three general categories of winter storms, tropical storms and summer monsoons.

Vulnerability to Future Flood Events

Maricopa County's susceptibility to future flood events can be categorized in three areas of risk to public safety: 1) Risk associated with flooded wash crossings; 2) Risk to critical infrastructure located in floodplains; and 3) Risk of flood damage to residences and other property.

1. Flooded wash and stream crossings are the most immediate area of vulnerability. The county has an extensive network of improved and unimproved roads and highways. In numerous locations, wash and river flood drainage and dam spillway discharges impact low water crossings, temporarily closing access, disrupting traffic flow, stranding motorists in vehicles, and isolating residents either in or out of their homes and businesses. Every year in the United States dozens of drownings occur because of vehicles trapped in rapidly rising flash floodwaters.
2. In many areas of the county, especially in more rural areas, construction of culverts and bridges to alleviate the impact of flooded crossings is not cost effective, and may cause adverse impacts on flood flows, increasing flood damages. The most effective flood mitigation tool to reduce the impact of flooded road crossings is to use flood warning strategies and deploy transportation departments, police and other first responders in the placement of road barricades to prevent vehicles from becoming trapped.
3. Critical infrastructure and facilities such as canals, water and wastewater treatment plants, police and fire stations, power generation facilities, hospitals, and

³ Maricopa County Multi-Hazard Mitigation Plan 2009 Update, preliminary draft.

bridges is the second area of vulnerability to flooding. These facilities maintain vital public services and are essential to the community, especially during a disaster and its aftermath. Within unincorporated Maricopa County, 111 critical facilities are located in the 100-year floodplain as identified by the Maricopa County Department of Emergency Management in the Multi Jurisdictional Multi Hazard Mitigation Plan (preliminary 2009). Flood hazard preparedness, response, and mitigation strategies are used to protect facilities and provide flood warning to facility operators.

4. The third area of flood hazard vulnerability is to individual homes, businesses, agriculture, and other development in the floodplain. Unincorporated Maricopa County has more than 6,200 individual improved parcels located in identified flood hazard and erosion prone areas⁴. Many more structures are located in floodplains within incorporated communities. The flood exposure of these developments ranges from shallow ponding along canals, levees, and road or railroad embankments, to sheet flow in alluvial fans along mountain ranges, to major flood flows along riverine systems such as the Agua Fria and Salt/Gila rivers. Floodwaters cause damage to buildings from the combination of floodwater inundation (depth), hydrostatic pressure (weight of saturated soils against foundations), hydrodynamic forces (effects of water flowing against and around buildings), and scour and erosion (damage to foundations, building pads, and utilities). In many types of floodplains the impacts of these flood forces is aggravated by the sediment and particle loads carried by floodwaters.

Mitigation of flood damages to new and existing development is accomplished through flood control structures such as dams, levees, detention and retention basins, and stormwater management practices. Floodplain management regulations protect new and substantially improved buildings from flooding by elevating building pads and structures above predicted flood levels, and limiting activities in high hazard floodways (channels of washes and rivers and adjoining areas) to open space uses that protect the beneficial floodplain functions. Existing floodprone buildings can be structurally retrofitted or reinforced to protect against flooding, and emergency measures such as sandbagging can also be used to minimize the impact of flooding. Buildings substantially damaged by flooding or other disasters must be elevated or floodproofed to resist future flood damages. Existing property owners anywhere in Maricopa County can obtain flood insurance coverage on buildings through the National Flood Insurance Program (NFIP). The rate policyholders pay for insurance varies by flood zone, building location, and elevation. Table 4-3 lists and evaluates NFIP insurance policy statistics for all Maricopa County communities. Table 4-2 lists flood insurance claims in unincorporated Maricopa County.

⁴ The majority of homes constructed in the floodplain after 1974 are in compliance with the Floodplain Regulations for Maricopa County for events up to the 100-year flood. Building in compliance with the Floodplain Regulations reduces the overall vulnerability to flooding, but does not completely eliminate the flooding hazard. Examples of areas of vulnerability include erosion of building pads, occurrence of floods greater than the 100-year flood, or flood damage can be aggravated by blocked channels, bridges and culverts. The vulnerability discussion presented herein is general and does not differentiate between non-compliant structures and buildings in compliance with existing regulations.

4. Flooding in Maricopa County

Table 4-2: Flood Insurance Claims for Unincorporated Maricopa County Only

Calendar Year	Amount of Total Claims Paid Out ⁽¹⁾	Total # of Claims Paid ⁽¹⁾	Average Claim Paid Out	Inflation Adjustment Factor ⁽²⁾	Inflation Adjusted Total Claims	Inflation Adjusted Average Claim
1978	\$453,742	56	\$8,103	3.34969	\$1,519,895	\$27,141
1979	\$23,683	1	\$23,683	3.00826	\$71,245	\$71,245
1980	\$821,601	87	\$9,444	2.65049	\$2,177,645	\$25,030
1981	\$5,653	1	\$5,653	2.40264	\$13,582	\$13,582
1982	\$11,798	2	\$5,899	2.26321	\$26,701	\$13,351
1983	\$109,508	23	\$4,761	2.19277	\$240,126	\$10,440
1984	\$74,974	6	\$12,496	2.10202	\$157,597	\$26,266
1985	\$0	0	\$0	2.02974	\$0	\$0
1986	\$2,360	1	\$2,360	1.99270	\$4,703	\$4,703
1987	\$1,401	2	\$701	1.92254	\$2,693	\$1,347
1988	\$23,783	4	\$5,946	1.84615	\$43,907	\$10,977
1989	\$0	0	\$0	1.76129	\$0	\$0
1990	\$34,827	5	\$6,965	1.67100	\$58,196	\$11,639
1991	\$0	0	\$0	1.60352	\$0	\$0
1992	\$62,759	8	\$7,845	1.55666	\$97,694	\$12,212
1993	\$100,540	18	\$5,586	1.51142	\$151,958	\$8,442
1994	\$0	0	\$0	1.47368	\$0	\$0
1995	\$30,514	2	\$15,257	1.43307	\$43,729	\$21,865
1996	\$0	0	\$0	1.39197	\$0	\$0
1997	\$9,986	1	\$9,986	1.36075	\$13,588	\$13,588
1998	\$0	0	\$0	1.33988	\$0	\$0
1999	\$3,888	1	\$3,888	1.31092	\$5,097	\$5,097
2000	\$14,430	1	\$14,430	1.26829	\$18,301	\$18,301
2001	\$0	0	\$0	1.23390	\$0	\$0
2002	\$33,447	6	\$5,575	1.21401	\$40,605	\$6,768
2003	\$2,272	1	\$2,272	1.18696	\$2,697	\$2,697
2004	\$3,723	1	\$3,723	1.15617	\$4,304	\$4,304
2005	\$59,829	4	\$14,957	1.11828	\$66,906	\$16,727
2006	\$5,134	2	\$2,567	1.08333	\$5,562	\$2,781
2007	\$329,539	12	\$27,462	1.05355	\$347,186	\$28,932
TOTALS	\$2,219,391	245			\$5,113,917	
Average Number of Claims Paid Per Year					8.2	
Average Actual Dollar Amount for a Claim					\$9,059	
Average Inflation Adjusted Dollar Amount for a Claim					\$20,873	

(1) Based upon NFIP claims data only. Uninsured, under insured, not covered, and didn't have a policy losses are not included.

Some example losses not covered are contents, accessory structures, landscaping, pools, fences, and public facilities.

(2) <http://www.minneapolisfed.org/research/data/us/calc/>, adjusted to 2009.

Table 4-3: Policy Statistics for Maricopa County Communities

Community Name	Number of Policies In Force	Insurance In Force Whole \$	Written Premium In Force	Average Coverage (Insurance In Force)	Average Premium
1 Avondale	48	\$12,143,400	\$27,004	\$252,988	\$563
2 Buckeye	40	\$8,131,500	\$21,974	\$203,288	\$549
3 Carefree	16	\$5,105,900	\$7,549	\$319,119	\$472
4 Cave Creek	98	\$25,736,600	\$51,384	\$262,618	\$524
5 Chandler	134	\$20,492,700	\$69,782	\$152,931	\$521
6 El Mirage	13	\$4,000,000	\$4,256	\$307,692	\$327
7 Fountain Hills	31	\$8,081,000	\$23,223	\$260,677	\$749
8 Gila Bend	13	\$1,750,900	\$6,338	\$134,685	\$488
9 Gilbert	265	\$85,712,300	\$198,286	\$323,443	\$748
10 Glendale	139	\$37,073,600	\$87,033	\$266,717	\$626
11 Goodyear	83	\$22,091,400	\$40,222	\$266,161	\$485
12 Guadalupe	2	\$113,200	\$1,032	\$56,600	\$516
13 Litchfield Park	7	\$2,210,000	\$2,722	\$315,714	\$389
14 Maricopa County	2,274	\$505,030,400	\$1,088,241	\$222,089	\$479
15 Mesa	316	\$78,331,200	\$214,786	\$247,884	\$680
16 Paradise Valley	96	\$33,947,400	\$56,891	\$353,619	\$593
17 Peoria	229	\$65,027,800	\$124,215	\$283,964	\$542
18 Phoenix	5,231	\$1,093,805,300	\$3,315,353	\$209,101	\$634
19 Queen Creek	32	\$8,667,800	\$13,690	\$270,869	\$428
20 Scottsdale	8,358	\$2,076,399,900	\$3,405,044	\$248,433	\$407
21 Surprise	124	\$36,589,900	\$57,899	\$295,080	\$467
22 Tempe	189	\$44,822,800	\$146,409	\$237,158	\$775
23 Tolleson	53	\$12,403,000	\$50,254	\$234,019	\$948
24 Wickenburg	81	\$14,539,700	\$63,479	\$179,502	\$784
25 Youngtown	5	\$846,400	\$2,183	\$169,280	\$437
Maricopa County Total	17,877	\$4,203,054,100	\$9,079,249		
Maricopa County Average				\$235,110	\$508
State Of Arizona Total	36,109	\$7,723,710,200	\$19,820,044		
State Of Arizona Average				\$213,900	\$549

NOTE: Maricopa County represents 50% of the policies in force; 54% of the insurance in force; and 46% of the premiums collected in the State of Arizona.

Policy Statistics for Maricopa County communities as of 01/31/2009

Source: FEMA web site, <http://bsa.nfipstat.com/reports/1011.htm>

Repetitive Loss Areas

Repetitive loss areas are properties within the county that have been repeatedly damaged by floods. FEMA requires communities to identify repetitive loss areas. Unincorporated Maricopa County currently has six federally recognized repetitive loss areas that include over 100 properties. Two of the six repetitive loss areas are shown on Map 4-1, Holly Acres Repetitive Loss Area, and Map 4-2 Wickenburg Repetitive Loss Area.

Holly Acres is located along the Salt, Gila and Agua Fria rivers. The U.S. Army Corps of Engineers, in conjunction with the City of Phoenix and the District, have initiated the Tres Rios project to mitigate flooding in Holly Acres. Tres Rios consists of north bank levee improvements from 105th Avenue to the Agua Fria River, channelization, creation of habitat areas composed of open water marshes and overbank wetlands, and a pump station to provide water for the habitat areas. The property on the north side of the Salt and Gila rivers, including the Holly Acres subdivision, will be protected from river flooding by the north bank levee component of the project. Construction has been completed on the first half of the 4.5-mile levee, which runs along the Salt River from 83rd Avenue to the Agua Fria. Monies were allocated in 2009 to complete the levees. The District will operate and maintain the north bank levee.

Erosion and Other Flood-Related Hazards

Flood mitigation activities need to focus on more than the impact of floodwaters. Erosion and other related hazards, such as lateral migration of watercourses and aggradation and degradation of streambeds, also pose a significant public safety hazard.

Erosion

Erosion is a two-step process involving “detachment” and “mobilization.” Detachment is the breaking away of particles at the surface of the soil. The rate of detachment depends upon the type of soil, the steepness and length of slope, amount and type of land cover, and external forces such as duration and amount of runoff. High velocity flows can cause “detachment” and subsequent erosion of channel banks. Structures within these erosion areas may be damaged or destroyed unless some type of bank stabilization is installed.

Mobilization or transportation results in the actual loss of soil material. The product of this transportation is sediment, a major contributor to water quality problems. Sediment, deposited by floodwaters within homes and businesses, will normally contribute as much to total damages as from the high water itself.

Detachment and mobilization can cause problems with culverts, disrupting traffic movement and putting persons at risk if roads become flooded. Over half of the soils in the county are susceptible to detachment and/or transportation of soil particles under the right conditions.

Lateral Migration

Lateral migration is the change in the position of a channel by erosion of one bank and simultaneous deposition on the opposite bank. Lateral migration of the channel can threaten areas outside of the floodplain. For example, a home on a high bank, above flood levels, can be undermined by the flood’s erosive flows. The District delineates

Holly Acres

Repetitive Loss Area

Map 4-1

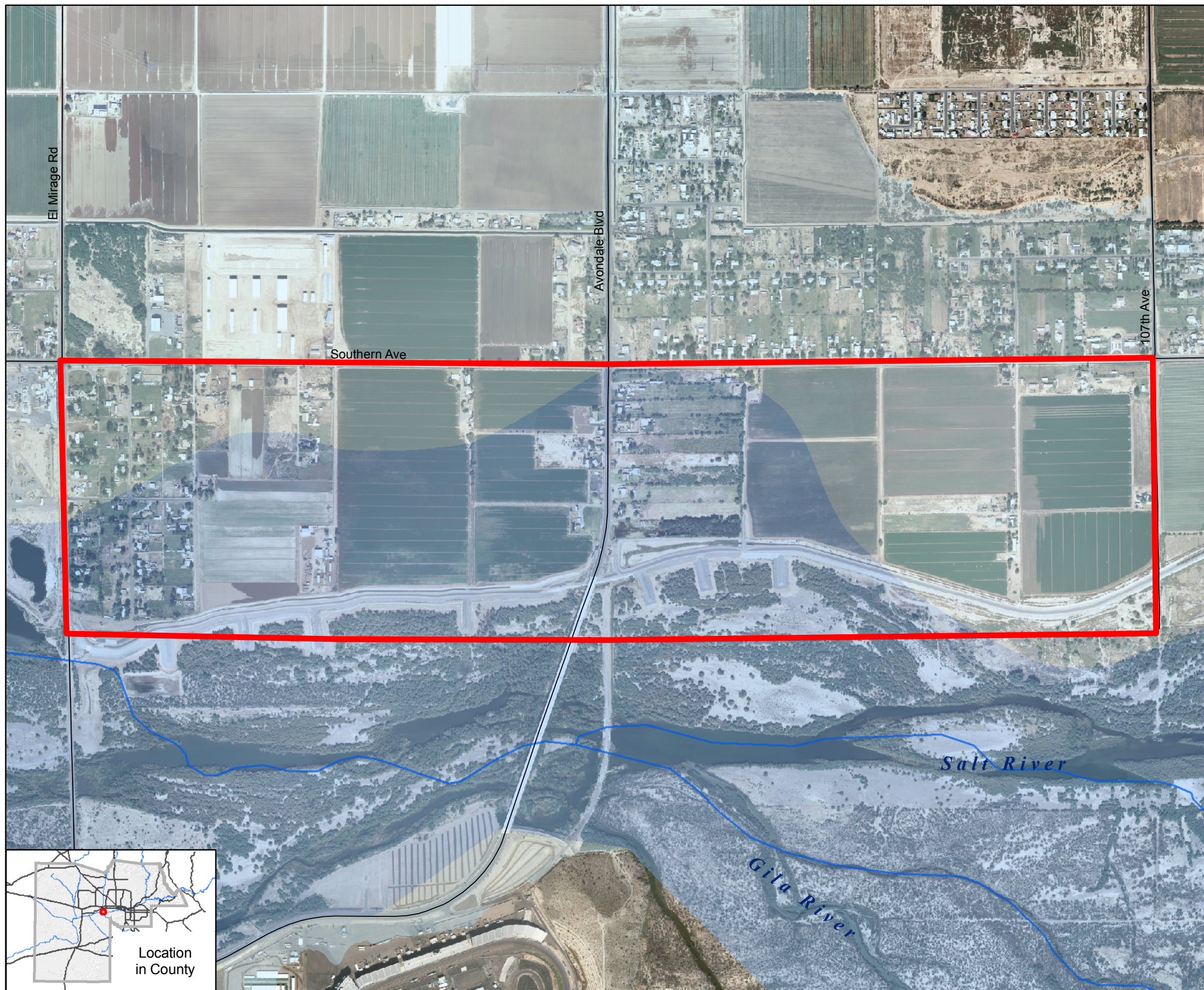
Legend

-  Repetitive Loss Area
-  FEMA Floodplains



0 1,000 2,000 Feet

May 2009





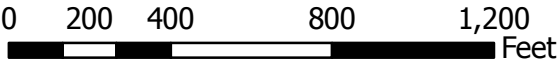
Wickenburg

Repetitive Loss Area

Map 4-2

Legend

-  Repetitive Loss Area
-  FEMA Floodplains



erosion hazard zones as an advisory tool. The District regulates erosion hazard zones that are identified within the limits of the 100-year floodplain.

Aggradation and Degradation

Aggradation is the progressive buildup or raising of the channel bed due to sediment deposition. Permanent or continuous aggradation is an indicator that a change in the stream's discharge and sediment characteristics is taking place. Degradation is the lowering of the channel bed due to erosive processes. Degradation can lower the water table and lead to bank erosion and long-term instability of the river channel.

Aggradation and degradation occur naturally within a river system. Accelerated aggradation and degradation processes can be related to many sources, including dams, sand and gravel mining and encroachment into the floodplain. Aggradation and degradation pose threats to flood control and drainage systems and can lead to failure of valuable infrastructure, such as bridges and roads.

Summary

Flooding in Maricopa County is typically caused by one of three types of storm conditions: winter storms, tropical storms, or monsoons. The type and impact of flooding caused by a storm event depends on the physical conditions of the floodplain and development in the watershed. Most flooding events in Maricopa County fall into one of three major categories: riverine, alluvial fan, and shallow flooding. Other flood-related hazards, such as lateral migration of watercourses, and aggradation and degradation of streambeds, can also pose a significant public safety hazard.

In the last 50 years, flood events have claimed 45 lives and inflicted more than \$1.5 billion in damages. Maricopa County's susceptibility to future flood events can be categorized in three areas of risk to public safety: 1) Risk associated with flooded wash crossings, 2) Risk to critical infrastructure located in floodplains; and 3) Risk of flood damage to residences and other property.

Flooding is a natural process of river systems. All rivers overtop their banks at some time, inundating the river's floodplain. A flood event is only considered hazardous when the floodwaters threaten human life or property generally due to development in the floodplain. Land within floodplains is attractive to agricultural and urban development for many reasons, including natural beauty, density of vegetation, recreational purposes and access to fertile soil.

Proper floodplain management and flood control activities mitigate the risk of development in the floodplain. The District seeks to balance the beneficial functions and resources of natural floodplains with the need to protect life, property and infrastructure. This is accomplished by a proactive multi-objective planning and design process that considers flooding, community and ecosystem concerns.



Agua Fria River and McDowell Road, Avondale, February 22, 1980

5. Flood Control Programs and Activities

The District is a municipal corporation, and political taxing subdivision of the State of Arizona. The Maricopa County Board of Supervisors serves as the District's Board of Directors, with the advice of a Flood Control Advisory Board comprised of citizens appointed by the Board of Directors, a representative from the City of Phoenix and a representative from the Salt River Project.

The District is housed within the Maricopa County Public Works Department, under the oversight of the Public Works Director. The District is managed by a Chief Engineer and General Manager who supervises five divisions and the executive branch. The five divisions are sub-divided into various branches along functional lines. An organizational chart is found in Appendix C.

This chapter explains the District's four core programs and the associated activities that the District can undertake to solve flooding problems. These four programs are the basis for the recommended flood mitigation actions described in Chapter 8 and summarized in Chapter 9. The chapter concludes with a discussion of the District's "context sensitive" approach to flood control.

Flood Control Programs and Activities Outline

Core Programs

- Flood Hazard Outreach
- Flood Hazard Identification
- Flood Hazard Regulation
- Flood Hazard Remediation

Context Sensitive Framework for Solving Flooding Problems

Summary

Core Programs

The District's divisions and branches work together to support the District's four core programs – outreach, identification, regulation and remediation.

Flood Hazard Outreach

Flood Hazard Outreach provides collection and dissemination of flood hazard information, technical data, and flood safety guidance to government agencies and the public so that they are aware of and can respond to flood hazards. This program includes: public outreach, project public involvement, flood hazard preparedness, flood warning and hydrometeorology information. It is managed and staffed by the Public Information Office with input from the Planning and Project Management, Flood Management and Services, and Engineering divisions. Flood hazard preparedness and warning are managed by the Flood Warning Data Collection Branch of the Engineering Division.

Public Involvement and Education

A dedicated public outreach program was initiated as a District function in 1985. Up to this time, the District had no specific process for educating the public or receiving public comment concerning flood control projects or activities. As part of this effort, a Public Involvement Coordinator was hired to coordinate public involvement and information activities.

Prior to the use of in-house public information staff, public information responsibilities were often performed by project managers and engineers. Transferring these responsibilities to a public relations professional improved the consistency and effectiveness of the public involvement program, allowing project managers to focus on overseeing the technical work of a project.

Currently, the District's in-house public information staff includes a public information manager, public information officer, graphic design coordinator, media specialist and Web developer. The group has three responsibilities:

Public Education—Educating the public about flooding and related hazards, and about the District and its mission, via the District's Web site, public service announcements, home shows and expos, and school presentations.

Public Involvement—Encouraging the public to contribute input about a project or activity through public meetings and surveys, and assimilating that input into the District's decision-making process; and

Public Information—Informing the public about pending District flood control projects, studies and activities through public meetings and mailers.

In the past, the public was not involved as they are today in the District's flood control studies or projects. Shifts in social values, information technology, heightened neighborhood activism and increased expectations of tax-supported services have made the District projects more visible to the public. The District's proactive public education, involvement and information activities are a critical element in its mission to provide flood hazard protection to the citizens of Maricopa County.

Flood Warning

The flooding of the late 1970s and early 1980s made it clear that local authorities, including the District, lacked sufficient hydrometeorologic data to make decisions concerning evacuations and flood fighting efforts. Information was not available for watershed conditions, status of structures, and the quantity of storm runoff being conveyed to the natural streams and rivers. Maricopa County is just over 9,200 square miles, yet it is affected by runoff from a drainage area greater than 50,000 square miles. In addition, the catastrophic failure of both the Grand Teton Dam in Wyoming and the Big Thompson flood in Colorado in 1976 brought a heightened awareness of the increased need for hydrologic data especially in light of the 22 dams and flood retarding structures the District operates and maintains.

The Board of Directors, realizing the importance of real-time hydrometeorologic data, authorized District staff to initiate a flood hazard information/mitigation system that could provide early warning of flooding. The early warning system was developed according to a National Weather Service protocol called Automated Local Evaluation in Real Time (ALERT). Today, this warning system allows time for cities and the county to initiate appropriate responses to save lives and reduce damages within endangered areas.

Flood Hazard Identification

Flood Hazard Identification provides flood and erosion hazard information and documentation to the public so that they are knowledgeable about the dangers of erosion and flooding, the areas in which they occur, and the future remediation measures. This program includes: development of area drainage master plans, watercourse master plans, floodplain delineations, landscape aesthetics/recreation multi-use, integration of projects into the natural environment, and strategic and comprehensive plans. It is managed and staffed by the Floodplain Management and Planning branches of the Planning and Project Management Division.

Delineations

The District, recognizing the importance of proactive floodplain management and the potential for problems resulting from continuing new development within the county, initiated a floodplain delineation program in 1986. This service was established to add detail to the remainder of the original Flood Prone Area Maps developed by FEMA and to delineate those watercourses yet to be studied. Recently, the District has been studying about 200 linear miles of floodplains per year with approximately 4,100 linear miles completed as of 2008.

The Floodplain Delineation Branch identifies floodplains using both detailed and approximate methods. Detailed delineations are done in areas that are already developed or will soon be developed. Approximate delineations are done in order to get ahead of potential development, and are suitable in areas that currently have little development. This effort allows for sound floodplain management so that future devel-

opment will not impede, divert or retard the conveyance of floodwaters to the detriment of others as well as reducing the flood damage potential to the development.

Planning

The District's planning program emphasizes a regional, uniform, and coordinated approach to watershed management. This approach works to minimize the public cost of protecting citizens from flooding resulting from private and public development's cumulative effects on drainage characteristics.

The first step toward an independent planning function began with the initiation of Area Drainage Master Studies (ADMS) in 1983. This was intended to regulate development and establish plans and drainage criteria for implementation by the development community. In 1989, planning was first identified as a separate and distinct District program. In support of the District's mission, the primary goal of the Planning Program is to reduce flood risks for the people of Maricopa County. The objective of this goal is to plan and facilitate implementation of flood control projects in the shortest time possible coupled with the lowest total cost, while balancing both social and environmental considerations. A second important goal of the Planning Program is to identify potential flood control and stormwater management problems prior to the onset of new development. The objective of this goal, through sound planning, is to avoid or minimize the future need for publicly funded structural flood control projects.

The Planning Branch prepares comprehensive studies and analyses; identifies locations and property at risk from potential flooding; and identifies regional flood control facilities that will be required in growth areas. Following an analysis of existing and future flooding problems, alternative solutions are developed to determine the most cost effective and publicly acceptable projects. Recommended projects are then prioritized for inclusion in the District's Capital Improvement Program. Non-structural alternatives are also evaluated and recommended.

The District's planning activities are integrated with the regulatory and floodplain delineation activities. Information developed by the Planning Branch is utilized for completing floodplain delineations and regulating new developments. Conversely, the Planning Branch utilizes information developed in the regulatory and floodplain delineation activities.

Activities in the Planning Program include: Area Drainage Master Studies (ADMS) and Master Plans (ADMP); Watercourse Master Plans (WCMP); site specific plans; project pre-design studies; and the coordination of interagency cooperative projects and agreements.

1. Area Drainage Master Studies

Area Drainage Master Studies (ADMS) were originally conceived in 1983 to provide technical information to define and quantify flood hazards. Authority for these studies is found in the Floodplain and Drainage Regulations for Maricopa County. The enormity of the ADMS program required that the county be divided into smaller study areas. The ADMS study areas were identified by first establishing the watershed boundaries, and then subdividing these to arrive at study areas that could reasonably be completed. There are 48 ADMS areas established from the watershed boundaries, ranging in size from 15 to 580

square miles. The areas with known flooding and with existing and expected development or population growth are given priority.

The purpose of the ADMS is to identify existing flood-prone areas as well as projections of future conditions. The information obtained is then used to identify areas, which require flood mitigation, and to guide future development. To identify flood hazards a series of tools such as computer rainfall-runoff models, topographic mapping, soils data developed by the National Resource Conservation Service, and land use data developed by the Maricopa Association of Governments are used.

2. Area Drainage Master Plans

Area Drainage Master Plans (ADMP) recommend strategies to mitigate the flood hazards identified in the preceding ADMS. The major components of the ADMP include public involvement, biological and archeological assessments, landscape character assessment, inventory of known hazardous waste sites, engineering analysis and cost estimates for alternative flood protection facilities, evaluation of multi-use potential, and detailed engineering analyses of the recommended project features. The District's objective is to integrate these components to develop a solution that is cost effective, provides a high level of flood protection, and avoids impacting natural and cultural resources to the maximum extent practicable.

In recent years the planning program has been accelerated to get ahead of development. A goal of the District is to complete ADMPs for the entire developable portion of the county by 2015 subject to available funds. The various studies completed and underway are listed in Chapter 8 by watershed.

3. Watercourse Master Plans

ARS §48-3609.01 authorizes the District to perform Watercourse Master Plans (WCMP). These plans are similar to the ADMS/ADMP program but focused on watercourses not watersheds. The primary goal of the WCMP is to provide information and develop solutions that protect existing and future residents from possible damages associated with floods up to and including the 100-year event. In addition, minimization of future expenditures of public funds for flood control and emergency management is of paramount importance.

The intent of the WCMP is to bring together the public, the business community, property owners, and concerned agencies for the purpose of identifying flood hazards and mitigation solutions. These plans incorporate identified unique characteristics that should be preserved, and plan for ongoing uses—both commercial and recreational, which are often neglected in traditional floodplain management. Often, disregarding these issues can result in construction of expensive structural solutions to solve flooding problems.

WCMPs develop and identify alternative plans for the provision of flood control. Traditional structural flood control alternatives are compared to non-structural flood control alternatives. Selected solutions are based upon the river system hydrology, hydraulics, lateral migration potentials, and sediment trends. An important objective of the District is to provide opportunities for multiple uses including recreation, groundwater recharge, riparian habitat preservation or restoration, and other related enhancements. These goals would be imple-

mented by others providing they are consistent with the District's flood control mission. The non-structural flood control alternatives of floodplain delineation, building restriction ordinances, and floodplain acquisition programs supplement traditional structural floodplain management. The District's objective is to partner with the sand and gravel industry and other property owners to develop plans and implementation strategies that are mutually beneficial.

Flood Hazard Regulation

Flood Hazard Regulation offers direction and enforcement to the public so that they can avoid causing adverse impacts to floodplains, and use their property safely and in compliance with applicable state and federal laws. This program includes: floodplain management, stormwater quality, and sand and gravel mining administration. It is managed and staffed by the Floodplain Management and Services Division with technical support from the Engineering Division. The Water Quality Branch of the Engineering Division manages and monitors storm water quality.

Floodplain Management

The Floodplain Management and Services Division is responsible for the regulation of development in the identified floodplain through enforcement of the Floodplain Regulations for Maricopa County (see Appendix E). When regulating floodplains, the District first identifies flood-prone areas through floodplain delineations and then limits or restricts land use within those areas. These activities, in addition to others, earn flood insurance premium reduction credits for county residents through the NFIP-Community Rating System program. The regulations also provide guidance for the development of flood prone properties.

Through the administration and enforcement of the Floodplain Regulations for Maricopa County, proposed development is managed to ensure it is free from flood damage during the one percent annual chance flood, and does not cause damage to other properties by avoiding the most hazardous areas of the floodplain. Reduction of the risk to life and property is also achieved through compliance inspections in conjunction with approved permits.

Congress passed the National Flood Insurance Act in 1968, which created the National Flood Insurance Program (NFIP). The 1968 Act required the publishing of flood insurance studies within five years for every community with a special flood hazard. These studies identify the special flood hazard areas and establish flood risk zones within the community. The U.S. Army Corps of Engineers (USACE) began a massive nationwide surveying and mapping effort of major watercourses and other selected areas. During the first years of the NFIP operation, it became evident that the time required to complete the detailed flood insurance studies would delay implementation in many communities. The Housing and Urban Development Act of 1969 expanded participation by authorizing an Emergency Program under which insurance coverage could be provided during the period prior to the completion of a community's flood insurance study.

Maricopa County entered into the NFIP Emergency Program, which offered a limited amount of flood insurance coverage, in 1970. Flood Prone Area Maps, generated by the United States Geological Survey (USGS), were used for floodplain management during this time. The USACE delineated portions of major watercourses such as the

Salt, Gila, Agua Fria and New rivers, and Skunk and Cave creeks after the District entered into the Emergency Program.

The 1973 Flood Disaster Protection Act made comprehensive revisions to the NFIP Regulations and required all participating communities to adopt and enforce floodplain regulations in return for the availability of flood insurance through the NFIP. The Act also required flood insurance for federally backed financial assistance on buildings located in identified flood hazard areas. The purpose was to supplement structural flood control projects with cost-effective, non-structural regulation of floodplain uses and development. In 1973, the State of Arizona passed legislation that empowered cities, towns and counties to adopt floodplain regulations for the management of watercourses within their jurisdictions.

In 1974, the first approved floodplain regulations for the unincorporated areas of Maricopa County were adopted by the Board of Supervisors and the county began reviewing land development and issuing floodplain use permits based on the preliminary floodplain delineations. The District acted as technical support in charge of reviewing the plans.

In 1984, the state flood control statutes were revised, specifically charging each county's flood control district with floodplain management responsibility. The flood control districts were mandated to identify and delineate floodplains and adopt and enforce floodplain regulations throughout the county unless municipalities specifically resolved to perform their own floodplain management. Maricopa County adopted the revisions, which resulted in the responsibilities of floodplain management being transferred from the county to the District.

In 1991, the county volunteered to participate in the CRS program. This is a program in which the county agrees to be rated by the federal government on its effectiveness in performing floodplain management. Citizens, within rated communities, may be eligible for flood insurance premium reductions based on the community's rating. Several local communities receive discount ratings based partly on District activities performed on a regional or inter-jurisdictional basis. In addition to regulating Floodplain Use Permits in unincorporated Maricopa County, the District also performs floodplain management activities for 12 incorporated communities in the county.

The CRS recognizes 10 classes and credits are awarded for 18 activities. The first class has the most credit points and receives the largest premium discounts. In 1991, the District rated a five percent (5%) discount on flood insurance rates within the unincorporated county. In 1993, this improved to a 15 percent (15%) discount rating. In 1994, Maricopa County was rated second highest in the nation. In 2001, the District achieved Class 5 status, which qualifies floodplain residents in unincorporated county for up to a 25% premium discount. Maricopa County is rated in the top one percent in the nation in the CRS program. Maricopa County is a Category C community (10 or more repetitive losses).

Sand and Gravel Operations in the Floodplain

The District has regulated sand and gravel mining within watercourses since February 25, 1974, when the county's first floodplain regulations were established. Like all other floodplain activities, sand and gravel mining regulations are based on federal and state requirements for floodplain management. ARS 48-3613 states "...a person shall not construct any structure which will divert, retard or obstruct the flow of water in any

5. Flood Control Programs and Activities

watercourse without securing written authorization from the board of the District in which the watercourse is located... This paragraph does not exempt those sand and gravel operations which will divert, retard or obstruct the flow of waters in a watercourse from complying with and acquiring authorization from the board....”

The Floodplain Regulations for Maricopa County define development standards and permit requirements for sand and gravel excavation within flood and erosion hazard zones (Article VIII, Sections 800.19, 801, 802, and 810.3). The stated purpose of these regulations is to have applicants “...show that excavations will not have cumulative adverse impact nor be of such depth, width, length, or location as to present a hazard to life or property or to the watercourse in which they located and they will comply with any applicable Watercourse Master Plan adopted by the Board of Directors.”

There are a total of 115 sand and gravel operations that have been permitted within the District’s jurisdiction since 1974. There have been 83 Floodplain Use Permits issued for sand and gravel operations since 1983. The current rate of permitting is about six per year, with 57 currently active. A detailed review of the Floodplain Use Permit database for Sand and Gravel Activities revealed 189 records of permit applications, not all of which were approved.

Erosion Hazard Areas

The District is not authorized by statute to regulate development in erosion hazard zones outside of an identified floodplain. Cities and towns, however, can choose to regulate erosion hazard zone development within their jurisdictions.

Flood Hazard Remediation

Flood Hazard Remediation provides flood protection using structural and non-structural mitigation of flood hazards so that the public can live with minimal risk of loss of life or property damage due to flooding. This program includes: design, construction, operation, maintenance, land acquisition, management of flood control infrastructure, and environmental activities. It is managed and staffed by the Planning and Project Management (PPM) and the Operations and Maintenance (O & M) divisions.

Structural flood control is the use of artificial barriers or construction of infrastructure to contain or re-direct floodwater. Structural flood control measures include dams, levees, channelization, basins and storm drains. Floodproofing of buildings, such as raising foundations, blocking low-level entrances and windows, and strengthening existing walls and foundations, is also considered a structural measure.

Non-structural flood remediation is “a term devised to distinguish techniques that modify susceptibility to flooding (such as watershed management, land use planning, regulation, and flood warning) from the traditional structural methods (such as dams, levees, and channels) used to control flooding.”¹ Other forms of non-structural flood control include floodprone property acquisition, insurance programs, environmental

1 Interagency Floodplain Management Review Committee (1994)

enhancement, and education and outreach efforts. Non-structural flood control activities span all four of the District's programs.

Capital Improvement Program

The District primarily accomplishes structural flood hazard mitigation measures through its five-year Capital Improvement Program (CIP) – the revolving five-year funding plan for capital projects. Under this program, the District has participated in the construction of over 100 flood control structures. Guided by strategic goals and objectives, the CIP drives design and construction of new infrastructure in concert with the District's planning activities, while it simultaneously addresses modification and replacement of existing infrastructure.

The CIP accounts for approximately 65% of the total Flood Control District annual budget and includes all District costs associated with the implementation of projects or elements of projects that have been proposed by District programs or external agencies' programs.

The District maintains the five-year CIP as mandated by state statutes under the direction established by the following Board of Directors policy resolutions:

- FCD 88-08 and 88-08A, General Funding Policy
- FCD 93-03, Landscaping and Aesthetics Policy
- FCD 2006R003, Floodprone Properties Assistance Program
- FCD 2009R003, Small Project Assistance Program

Prior to their inclusion in the CIP, all capital projects are evaluated under the CIP Prioritization Procedure (regional projects), Small Project Assistance Program (local projects) or Floodprone Property Assistance Program (floodprone property buyout).

- **Prioritization Procedure**

The District's Prioritization Procedure, initially implemented for the Fiscal Year 1995 budget cycle, serves as the primary annual mechanism for evaluating new proposed projects for possible inclusion in the CIP.

The Prioritization Procedure promotes a balanced approach to the evaluation of proposed projects. The District attempts to identify and support flood control and regional drainage projects that not only provide long-term protection to individuals and property from flash floods and seasonal flooding, but that also promote community development, protect natural habitats, and maintain watercourse flow paths. The procedure favors projects that involve cost-sharing partnerships, allowing the District to best leverage limited financial resources.

All newly proposed projects are evaluated according to predetermined and weighted criteria by a Project Evaluation Committee comprised of senior representatives of the District's Engineering, Operations & Maintenance, Planning & Project Management, Floodplain Management & Services and Real Estate divisions. The committee develops its recommendations using a system that allocates points to individual projects based on specific criteria. In developing the prioritization criteria, which have been approved by the FCAB, the District seeks the input of its client agencies through Prioritization Procedure workshops attended by potential project partners. The last workshop was held in 2008. Project Evaluation Committee recommenda-

tions are forwarded sequentially to the Chief Engineer and General Manager, the FCAB Budget Subcommittee and the FCAB for approval.

The CIP Prioritization Procedure also governs maintenance and safety related modifications to existing structures operated and maintained by the District. These modification projects may be recommended by the Chief Engineer and General Manager independent of the committee-based evaluation process.

The expenditure of CIP funding toward a project recommended under the CIP Prioritization Procedure will not occur until the District's Board of Directors has adopted a formal resolution authorizing the project to move forward. Following resolution adoption, for multilateral projects, District staff work with partnering municipalities to develop project Intergovernmental Agreements (IGAs) that generally must be in place before cost-shared project activity begins.

- **Small Project Assistance Program**

The CIP Prioritization Procedure is intended to address projects that provide regional solutions to regional flood hazards. The District has recently recognized that, particularly in urban areas, localized flooding hazards exist in areas where major structural solutions would be impractical. The Small Project Assistance Program provides a mechanism for the District to commit funding, on a limited basis, to advancing localized solutions in these situations. This program, approved in May 2009, will fund a first round of local drainage construction projects in Fiscal Year 2010/2011.

The program terms restrict per-project District funding to \$250,000 or 75% of project construction costs, whichever is less. Submitting municipalities are solely responsible for project design, rights-of-way acquisition, utility relocations, construction management and operations and maintenance, and are responsible for construction costs in excess of the District's contribution limit.

Projects submitted under this program are evaluated each October, under an entirely objective method, based mainly on the frequency and severity of property flooding mitigated by the proposed project, and on project implementation readiness.

Dam Safety

The District operates and maintains 22 flood control dams and flood retarding structures (FRS), which provide highly beneficial flood protection for significant portions of Maricopa County. Most of these dams are the main flood control features of federal flood control projects of which the District was the local sponsor. The District's Dam Safety Program is made up of three major components, which go beyond normal operation and maintenance activities. These major components are: Recurrent Dam Safety Activities, Structures Assessments and Repairs, and Dam Rehabilitation.

- **Recurrent Dam Safety Activities**

Recurrent Dam Safety Activities primarily include: dam safety inspections, outlet pipe inspections, field surveys, land subsidence monitoring, earth fissure monitoring and development and updating of Emergency Action Plans. Dam safety inspections are performed on an annual basis by District staff. Inspections of outlet pipes by video camera are performed every five years. Field surveys of the dams are required to monitor physical changes to the dams due primarily to embankment and foundation settlement and land subsidence.

Most dam surveys are performed under professional consultant service contracts. Land subsidence occurring at and in the vicinity of dams is monitored through use of an engineering tool developed from satellite imagery known as Interferograms which can detect small-scale vertical ground movements over very large areas. Monitoring for the development of new earth fissures is performed through instrumentation installed at identified earth fissure risk zones at dams. Emergency Action Plans are required for all dams and are updated periodically.

- **Structures Assessments and Repairs**

The Structures Assessments and Repairs component of the Dam Safety Program consists of important dam safety activities which; assess and evaluate the physical condition of the District's 22 dams and related features; assure continued compliance with current regulations; and implement short term and interim measures for the safe operation and proper functioning of the dams required beyond normal O&M requirements. In addition this element of the program includes "one time" management activities for District dams such as detailed land boundary surveys when needed. Site-specific dam safety issues and potential dam safety issues are investigated and repaired or corrected as needed. More extensive interim dam safety repairs are performed as required under Capital Improvement Program (CIP) design and construction contracts.

- **Dam Rehabilitation**

As of the end of Fiscal Year 2008/09, six District dams were identified for overall rehabilitation or replacement due to issues of: dam safety, urbanization and flood protection. The Dam Rehabilitation component of the Dam Safety Program is anticipated to have a total cost of \$220 million over a 20-year period. The District intends to seek federal funding assistance for all six dams to be rehabilitated or replaced under existing federal programs that provide a 65% federal, 35% local cost share split. The District is currently working on all of these dam rehabilitation/replacements projects which are in various stages of planning, design and construction.

Operation and Maintenance

In addition to the dams and flood retarding structures, the District oversees many miles of infrastructure and improved channels. This infrastructure must be managed to its optimum potential in order to eliminate or greatly reduce the amount of floodwater damage for which it is designed. The Operations and Maintenance Division (O & M) is responsible for ensuring that each flood control structure functions as designed and that all dams comply with the licensing standards set by the Arizona Department of Water Resources (ADWR) as outlined in Arizona Revised Statutes.

It is the goal of the O & M Division to protect the lives and property of the citizens of Maricopa County by reducing the risks associated with storm water runoff by maintaining all flood control facilities to the highest functional standards. Maintenance activities for District structures include mitigating the effects of erosion and sedimentation; vegetation and vector control; maintenance of channels, floodways and outflow devices; and storm damage repair. O & M staff must also maintain excess property obtained

from severances and/or buy-out programs and respond to citizen complaints regarding trash removal, insects, odors, dust, gates and other nuisances.

The O&M Division provides both emergency response and storm monitoring services during a flood emergency or storm event. When an emergency exists, crews are dispatched to monitor the functions of the structures and operate outflow devices to control the release of storm water. Maintenance crews also transport and operate heavy equipment used to protect the public during emergencies and to perform temporary repairs to structures.

The significant objectives adopted by the O&M Division include the following:

- Conduct annual inspections of each structure.
- Perform quarterly dam operational inspections to guarantee the proper operation of outlets and spillways.
- Maintain structure features to design standards. Keep floodways free and clear of silt, debris and obstructive vegetation. Maintain protective linings of banks and dikes for the long-term functional life of the structure.
- Monitor all significant impoundments.
- Participate in the District's Dam Safety Program.
- Develop comprehensive weed abatement and rodent and vector treatment service that correspond with the District's maintenance activity.

Non-Structural Approaches to Flood Mitigation

The federal Interagency Floodplain Management Review Committee prepared a report in 1994 which evaluated the performance of existing floodplain management practices and offered guidelines for improved efficiency and effectiveness. Inspired by the Midwest Flood of 1993, which caused between \$12 billion and \$16 billion dollars in damages, the report contains several non-structural approaches to reduce the vulnerability to damages resulting from severe floods. These methods are less costly than most structural approaches and can potentially achieve other objectives, such as preserve agricultural and natural resources, and increase recreational opportunities, and protect wildlife habitats. Non-structural flood control activities span all four of the District's programs and include delineations of floodplains, regulation and prohibition of development within floodways and education and outreach.

Funded under the Capital Improvement Program budget, the Floodprone Property Assistance Program provides a non-structural tool to mitigate flood hazards where structural solutions are impractical. Homeowners living in residences within delineated floodplains are eligible to apply for assistance under this program. Assistance takes the form of voluntary buyout, with the District purchasing the property at appraised market value. The District typically demolishes structures on the purchased property.

Context Sensitive Framework for Solving Flooding Problems

As stated in the District's vision and mission, the District is committed to implementing flood hazard mitigation activities that protect people and property from flooding threats and provide secondary natural and societal benefits². These ancillary benefits can include increased

² See Chapter 3 for a discussion of the District's mission, vision and philosophy.

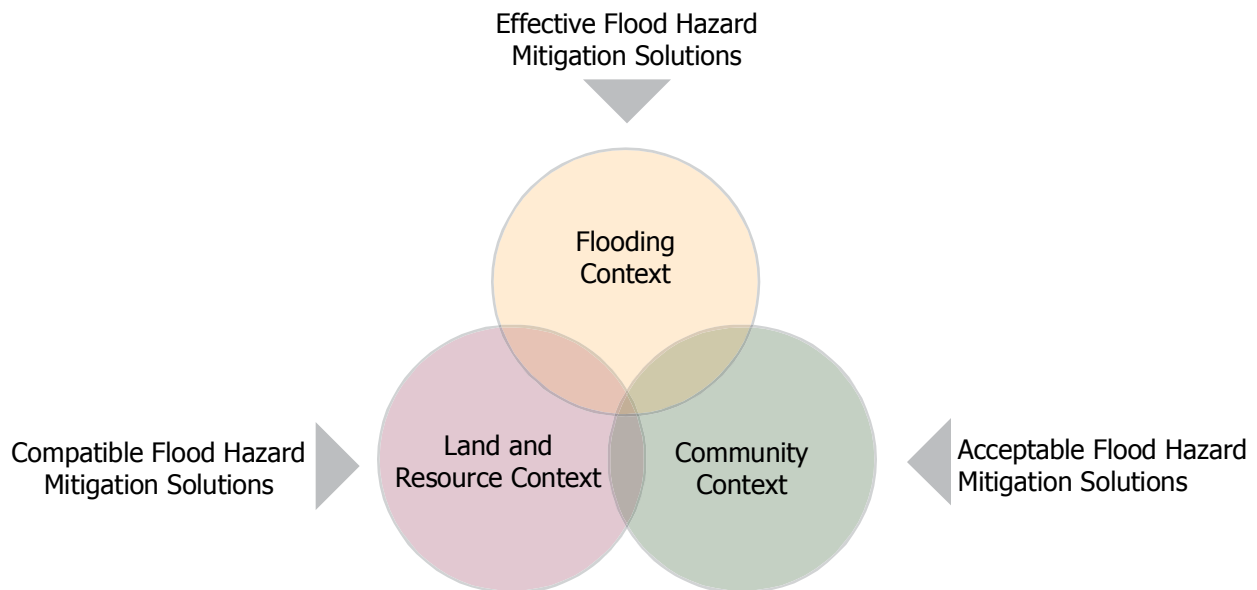
protection of natural habitat, new recreational facilities and open space, and aesthetically pleasing designs that enhance community character. To achieve the above stated secondary benefits, the District employs a Context Sensitive Flood Hazard Mitigation planning and design approach.

“Context sensitive” refers to the ability of various District flood hazard mitigation activities, structural and non-structural, to complement the characteristics of the landscape settings in which they are placed. This ability is influenced by the visual characteristics, scale and magnitude of each structure. Flood control activities that preserve or mimic the surrounding landscape setting are more likely to be considered context sensitive and a valued component of the community.

The process of formulating context sensitive solutions involves balancing community, aesthetic, historic, and environmental values with public safety. Context sensitive solutions are reached through a collaborative, interdisciplinary approach involving planning team members, stakeholders and concerned citizens.

The context sensitive approach involves defining the Flooding, Land and Resource and Community contexts. The Flood Hazard Context is defined through an assessment of flooding types, degree of risk and vulnerability. The Community Context is defined through public and stakeholder input. The Land and Resource Context is defined by an assessment of the visual, recreation, open space, biological and cultural resources. “Context sensitive solutions” are those solutions that fall within the “sweet spot” between the three contexts: Flooding, Land and Resource, and Community (see Figure 5-1).

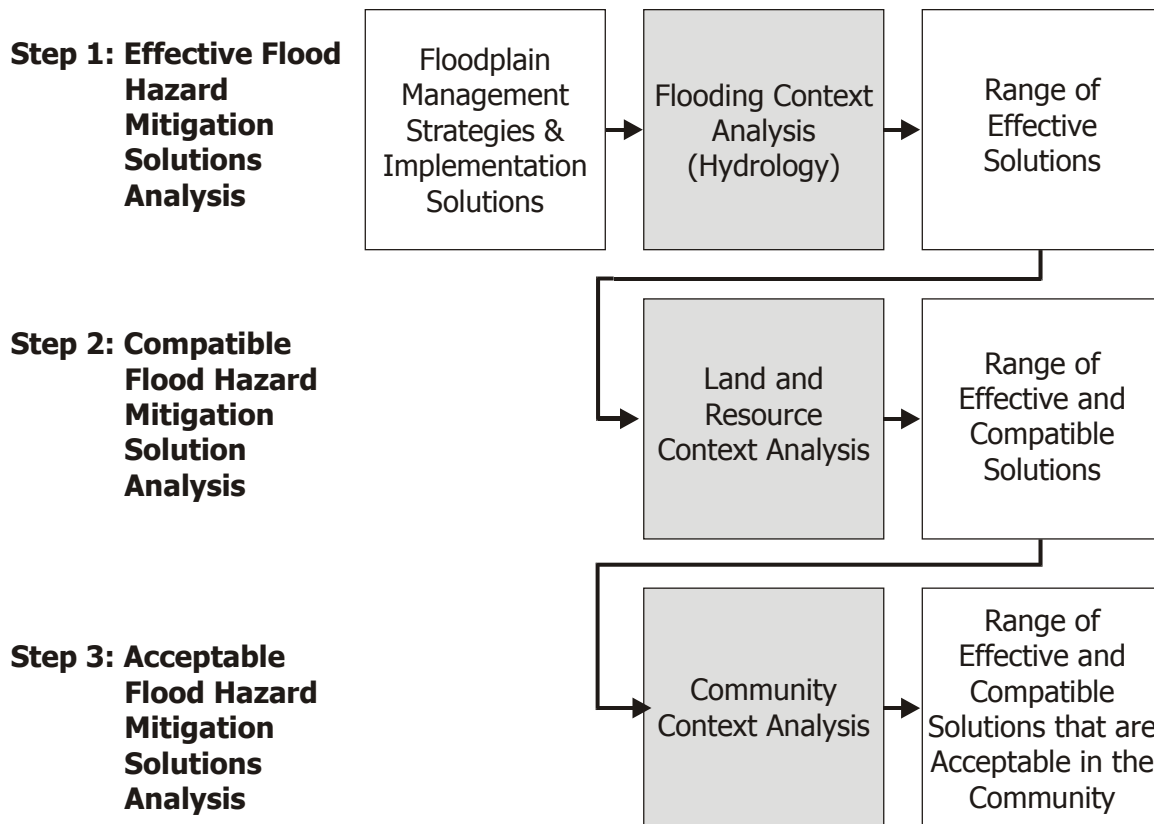
Figure 5-1: Context Sensitive Flood Hazard Mitigation Model



The context sensitive flood mitigation process (see Figure 5-2) starts with an analysis of the Flooding Context that narrows a list of all possible flood mitigation solutions to the most effective solutions based on flooding types and degree of risk. The second step involves an analysis of the Land and Resource Context, in which the range of effective solutions is refined to those solutions that are compatible with the surrounding environment. The third step involves the analysis of the Community Context that further refines the range of effective and compatible

solutions to those that are acceptable to the community. The ideal Context Sensitive Flood Hazard Mitigation solutions are those that are effective in providing public safety, compatible with landscape resources and acceptable to the citizens of Maricopa County. These ideal solutions are within the interface of the three contexts.

Figure 5-2: Context Sensitive Flood Hazard Mitigation Process



The District's Board approved Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects (Policy), dated December 16, 1992, is one tool the District utilizes to implement context sensitive flood control projects. The Policy provides general guidance and direction for the integration of landscape aesthetic features and recreation multi-use opportunities in the planning, design, construction and operation of flood control facilities by the District.

The Policy:

- Promotes the preservation of Sonoran Desert natural landscapes and protection of local community character;
- Authorizes expenditure of District funds for inclusion of landscaping and aesthetic features, and acquisition of right-of-way to provide for such features; and
- Promotes full integration of aesthetic features, and multi-use opportunities in all phases of planning and design of District flood control facilities.
- Requires use of Aesthetic Advisory Committees, comprised of public interest groups, stakeholders and landscape aesthetics professionals, to provide project review and oversight.

- Requires the development of landscape themes for District structures that will help preserve natural landscape character and/or complement and enhance local community character.

Summary

The District is a municipal corporation, and political taxing subdivision of the State of Arizona. The District is managed by a Chief Engineer and General Manager who supervises five divisions and the various branches. The District's four core programs—outreach, identification, regulation and remediation—respond to the functions that are mandated by state and federal laws. As stated in the District's vision and mission, the District is committed to implementing flood hazard mitigation activities that protect people and property from flooding threats and provide secondary natural and societal benefits³. These secondary benefits can include increased protection of natural habitat, new recreational facilities and open space, and aesthetically pleasing designs that enhance community character. To achieve the above stated secondary benefits, the District employs a Context Sensitive Flood Hazard Mitigation planning and design approach. "Context sensitive" refers to the ability of various District flood hazard mitigation activities, structural and non-structural, to complement the characteristics of the landscape settings in which they are placed. The ideal Context Sensitive Flood Hazard Mitigation solutions are those that are effective in providing public safety, compatible with landscape resources and acceptable to the citizens of Maricopa County.

³ See Chapter 3 for a discussion of the District's mission, vision and philosophy.



Gila River near Estrella Mountain Regional Park

6. Natural Environment

Maricopa County and the surrounding region have unique physical and biological characteristics. Five major rivers drain from mountain ranges that surround the northern and eastern part of Maricopa County. The Verde, Salt, Agua Fria and Hassayampa rivers flow into the Gila River. These rivers, especially the Gila, Salt, and Verde, made settlement in Phoenix and Maricopa County possible. This chapter will describe the physical and biological characteristics of Maricopa County. In particular, the natural environment characteristics that define or affect flooding and development in flood hazards areas will be emphasized.

Physical Characteristics

Size and Topography

Maricopa County is located in south central Arizona. The county has a land area of 9,226 square miles, of which 1,441 square miles are incorporated (15.6 percent) and 7,785 square miles are unincorporated (84.4 percent). It is the fifth largest of Arizona's 15 counties, and the 14th largest county in the United

Natural Environment Outline

Physical Characteristics

Biological Characteristics

Fauna

Settlement of Maricopa County:
Floodplain Development and the
Environment

Summary

States. Maricopa County is larger than five states and the District of Columbia. The county measures 132 miles from east to west and 103 miles from north to south. Twenty-four cities and towns are located within Maricopa County.

The land surface elevation ranges between 436 and 7,657 feet above sea level. The tallest feature in the county is Brown's Peak, which is located in the eastern part of the county. The lowest point is in the southwest part of the county.

Climate

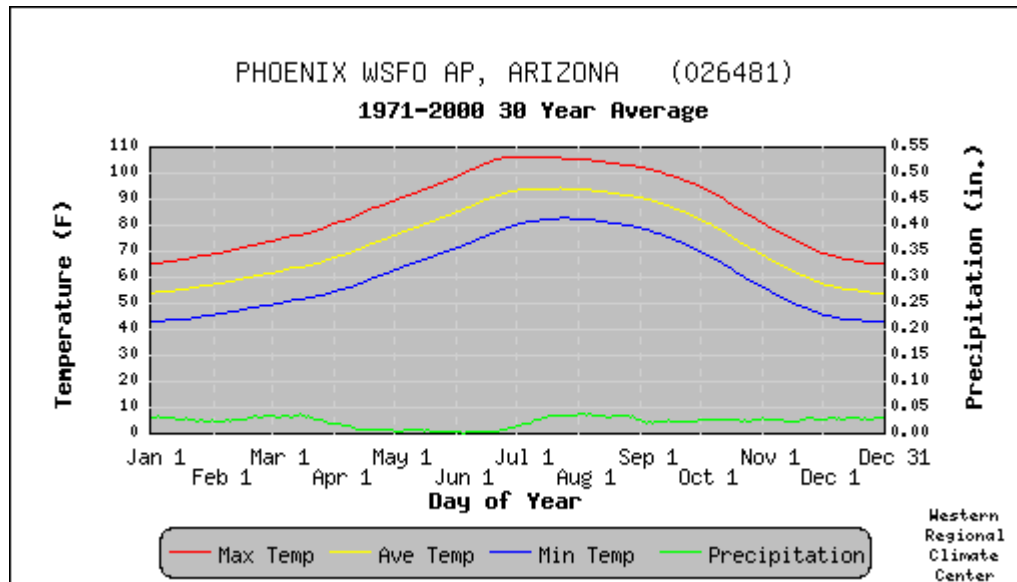
Maricopa County lies within a dry, subtropical desert climate zone. Average annual rainfall ranges from five inches in the lower elevations to over 16 inches in the higher elevations. Temperatures are high in the summer and moderate in the winter. Records kept at Phoenix Sky Harbor Airport indicate that, on the average over 80 days per year, the maximum temperature exceeds 100 degrees. Figure 6-1 shows the 30-year temperature average for each month, showing high summer temperatures contrasted by relatively low winter temperatures. Approximately 95% of Maricopa County is in the Sonoran Desert. Although the Sonoran Desert is lush compared to other deserts, the average evaporation losses exceed the precipitation, which defines the area as a desert.

Precipitation

There are two separate precipitation seasons. The winter storms occur from November to March when the region is subjected to occasional frontal storms from the Pacific Ocean. The highest winter precipitation occurs when the mid-latitude storm track is to the south. Southern-originating storms tend to enter Arizona directly from the west or southwest after picking up considerable moisture from the Pacific Ocean.

The second rainfall season, also known as monsoon season, occurs in July, August and most of September. Characteristics of this season include widespread storm activity associated with moist air moving into Maricopa County from the south and southeast. These storms are extremely variable in intensity and location, and some of the heaviest amounts of precipitation in a short period occur during these months.

Figure 6-1: 30-Year Temperature Average for Phoenix, Arizona
 Source: Western Regional Climate Center



Geology

Maricopa County lies within the Basin and Range province of the Southwest, which includes the southern third of Arizona. The Maricopa County portion of the Basin and Range province is located within the Sonoran Desert and is characterized by wide valleys and mountain ranges. The mountain systems surrounding the valleys are generally comprised of metamorphic and igneous rocks. In the northern and western portions, volcanics are more dominant, while basalts are more common in the west.

The majority of the populated areas of Maricopa County are located along the quaternary alluvial deposits of the river basins. The basins of the Salt and Gila rivers consist of recent alluvium (Holocene to late Pleistocene), while the Hassayampa River basin consists of older sedimentary materials (middle Pleistocene to late Pliocene). This fine-grained alluvial material produces the wide, flat open spaces that typify the desert.

Water table depth, location of aquifers, and subsidence issues due to groundwater mining can affect or contribute to flooding in some areas. The Arizona Department of Water Resources (ADWR) is responsible for regulation of groundwater issues.

Soils

Maricopa County has nearly 60 different soil types, each of which have been surveyed and mapped. These soil types show the geographic distribution of dynamic and inherent soil qualities, some of which contribute to erosion and sedimentation. These potential hazards are of particular importance. In order to understand the extent of Maricopa County's soil related risk, a brief discussion about soil taxonomy follows.

Hydrologic Soil Groups

A Hydrologic Soil Group is a group of soils that have similar runoff potential under similar storm and vegetative cover conditions. These groupings are used in calculations that estimate runoff from rainfall. These physical properties of soil influence runoff potential, or the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties include depth to a seasonally high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The influence of ground cover is treated independently.

The soils in Maricopa County are placed into four Hydrologic Soil Groups; A, B, C, and D and an unclassified group as defined by the Natural Resources Conservation Service (NRCS). The soils are categorized by infiltration and transmission rate. The infiltration rate is the rate that water enters the soil at the surface. The infiltration rate is controlled by surface conditions. Transmission rate is the rate at which water moves in the soil. It is controlled by the physical properties of the soil. The unclassified grouping consists primarily of rock outcropping and soils with inadequate information available to be classified in one of the other four groups.

Hydrologic Soil Groups A and B have low and moderate runoff potential. Soils in these two groups range from sands and/or gravels to sandy loams and clay loams. Most of the county can be characterized as Hydrologic Soil Groups A or B (See Map 6-1, Hydrologic Soils Groups).

Hydrologic Soil Groups C and D have a high runoff potential. These soils are primarily silt and clays or have an impervious under layer, such as bedrock that impedes the downward movement of water. Approximately 35 percent of Maricopa County, excluding the Tonto National Forest and the Barry M. Goldwater Gunnery Range, fall into Hydrologic Group C or D. These groups are in the mountains and low hills of the county.

Hydrology

Rivers

Six major watercourses flow through Maricopa County: Centennial Wash, and the Agua Fria, Gila, Hassayampa, Salt, and Verde rivers. These rivers drain an area of approximately 57,000 square miles, including areas of New Mexico and Mexico. The Agua Fria, the Hassayampa, and the Verde rivers flow from north to south. The Salt River flows east to southwest and bisects Maricopa County. The Gila, which flows from the southeast, joins the Salt River near the center of the county and continues in a southwesterly direction toward the county line.

Approximately 11,000 miles of rivers, streams, and washes flow through Maricopa County. Few rivers have perennial flow, and some of the perennial flow is treated wastewater, agricultural tail water, or other urban runoff. The majority of washes are ephemeral or intermittent and only have flow during storms. Some ephemeral washes may remain dry for several years before a storm will result in sufficient runoff to create flows.

Stream density is defined as the length of all channels in the watershed or geographic area divided by the area. A high stream density is associated with higher flood peaks and high sediment production. The average stream density for the six watersheds

Hydrologic Soils Groups

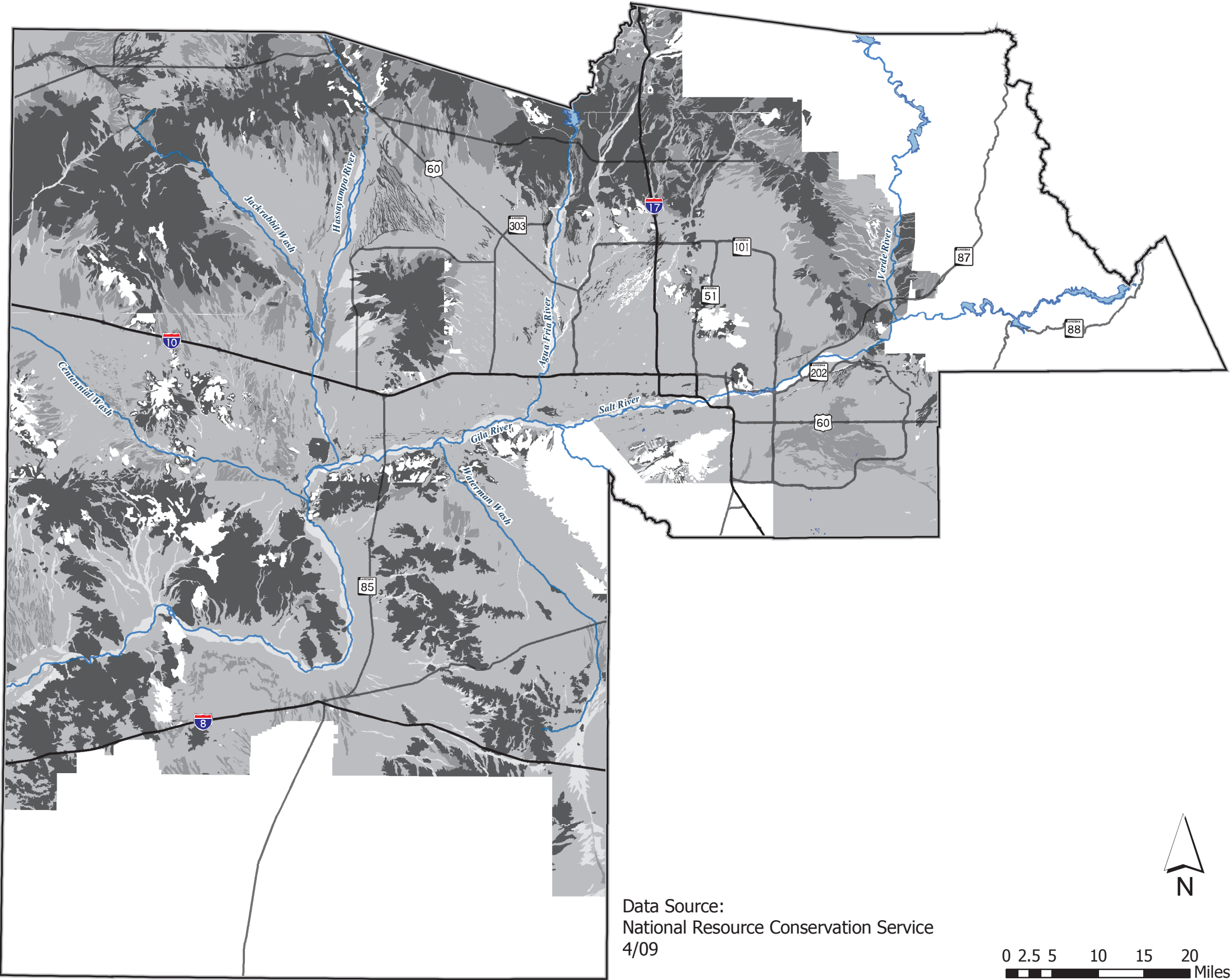
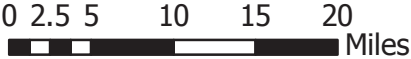
Map 6-1

Legend

- Rivers and Washes
- Interstates and State Routes
- Group
 - A - low runoff potential
 - B - moderately low runoff potential
 - C - moderately high runoff potential
 - D - high runoff potential
 - No data available
- Lakes



Data Source:
National Resource Conservation Service
4/09



within Maricopa County is 1.2 miles/square mile. Stream densities for nine watersheds in the State of Arizona are depicted in Table 6-1.

Table 6-1: Stream Density for Nine Watersheds in Arizona¹

Watershed	Miles/Sq. Mile
Bill Williams	1.18
Upper Agua Fria*	1.23
Santa Cruz	1.27
Middle Gila*	1.33
Lower Colorado River	1.35
Verde	1.35
Salt River*	1.47
San Pedro	1.59
Upper Gila	1.76

* Portions of the watershed are within Maricopa County

Storm Events and Frequency

Rainfall records have been kept for the Phoenix area on a consistent basis for over 100 years. At Sky Harbor Airport the 24-hour duration rainfall that would occur in a 100-year event would be 3.30 inches; a 50-year event would generate 2.93 inches. These values vary throughout Maricopa County.

The District currently has over 310 precipitation measuring gages located in Maricopa County and surrounding counties, with the first of these gages being installed in 1981. This system is still being expanded as information is needed in other locations. Data from these gages is available from the District Web site located at www.fcd.maricopa.gov.

Summary data from these gages has been studied to determine how frequently rainfall, with the potential to cause damage, has occurred in Maricopa County. Rainfall events of 10-year frequency (10 percent) or greater were tabulated for each of the precipitation gages for this six-year period.

In a six-year period, the 10 percent chance rainfall was equaled or exceeded somewhere in Maricopa County 138 times. This does not mean that damageable floods occurred 138 times during this period. It does mean that the potential existed 138 times, or an average of 23 times per year, for floodwater damages to take place if the right conditions should prevail. These "right conditions" become more and more prevalent as people continue to move to Maricopa County.

Geomorphology

Geomorphology is the study of landforms and the processes that shape them. In the desert, both natural and artificial processes can shape landforms, as well as create relatively sudden (in geologic time) changes. Whether unexpected or predictable, these geologic changes can affect the drainage patterns of an area. Because the majority of the urbanized population

¹ Source: NEMO Watershed Based Plans, University of Arizona <http://www.snrn.arizona.edu/nemo>

live in the valleys and along the floodplains of the major washes and their tributaries where the results of processes such as sedimentation and erosion culminate, they are more likely to become susceptible to flooding. As the county continues to grow, pressure to develop hillsides could potentially lead to more complicated flooding problems.

Desert landforms, such as arroyos and alluvial fans, are an example of erosion forces and depositional processes that are characteristic of the desert. In the Sonoran Desert water plays a large role in these erosion processes. Arroyos and alluvial fans can both influence and be influenced by floodwaters.

Arroyos

An arroyo (wash) is a term applied in the arid and semi-arid southwestern United States to a small flat-floored channel or gully usually with steep or vertical banks that form under certain conditions. As arroyos develop, sediment generated upstream is conveyed and deposited downstream. Urban development along arroyos can result in the release of relatively clean water to the system that increases flood velocities and the rate of erosion. Other land uses, such as agricultural activity and mining, can also complicate erosion and flooding problems.

Alluvial Fans

Alluvial fans occur at the base of mountain ranges where the sediment has eroded from the mountainside to form a gently sloping fan-shaped deposit. These fans are formed when floodwaters transport sediment from upper watersheds via stream channels onto the valley floors below. As the floodwaters near the valleys, the velocity decreases, and the sediment begins to be deposited. Alluvial fans can contribute to flooding problems because of their unpredictable nature. It is common for alluvium to backfill a channel in these areas causing the channel to shift its course (avulsion). In addition, alluvial fan flows frequently shift their position horizontally, a phenomenon known as lateral migration. The nature of this type of shift on an alluvial fan is very unpredictable and, as such, it is very difficult to forecast the course of flooding along an alluvial fan.

In a report entitled "Alluvial Fans: Hazards and Management" the 1999 Federal Emergency Management Agency lists the following as hazards that may occur on alluvial fans: high velocity flows; erosion/scour; deposition of sediment and debris; debris flows/impact forces; mudflows; inundation; and flash flooding.

Lateral Migration

Streams have a natural tendency to shift, or migrate, as the channel evolves. In the Southwest, this migration may occur either vertically or horizontally. Lateral migration or bank erosion occurs when the main channel shifts its course, either for natural or human induced reasons. Vertical channel migration is usually associated with aggradation or deposition, both of which affect the stability of the stream. Alterations in the

channel, whether horizontal or vertical, can cause severe changes in the capacity of the channel to carry floodwaters and can affect peak flows and velocities.

Biological Characteristics

Vegetation Communities

The vegetative communities of Maricopa County can be divided into six communities. These communities are Arizona Upland Subdivision of Sonoran Desertscrub, Lower Colorado Valley Subdivision of Sonoran Desertscrub, Interior Chaparral, Semidesert Grasslands, Great Basin Conifer Woodland and Petran Montane Conifer Forest (See Map 6-2, Vegetative Communities). Most (95%) of the county is within the Sonoran Desert, which includes the Lower Colorado Valley Sonoran Desertscrub community (57%) or the Arizona Upland Sonoran Desertscrub community (38%). The remaining vegetation communities comprise less than five percent of the total habitat. For the purposes of this discussion, only the two dominant communities will be described.

Arizona Upland Subdivision

The Arizona Upland Subdivision of the Sonoran Desert occurs primarily on the slopes and hills of the mountain ranges in the county. Due to the bimodal pattern of rainfall and subtropical climate, the Arizona Upland Subdivision community houses the most lush and diverse desert vegetation with more than 100 native plant species. This community is often very architecturally complex. According to Lowe and Brown 1973, it contains the most structurally diverse vegetation in the United States². Some of the plants that contribute to the diversity are: large cactus species, such as saguaro, organ pipe, and senita; tall trees, such as foothill palo verde, mesquite, and ironwood; large shrubs, such as jojoba, creosote, and ocotillo; medium cacti, such as barrel and cholla; small shrubs, such as brittlebush, triangle-leaf bursage, and many herbaceous perennials and annual wildflowers.

Lower Colorado River Valley Subdivision

The Lower Colorado River Valley Subdivision, which occurs primarily on the flat desert valleys, is the largest and most arid biotic community in the Sonoran Desert. Reflecting the competition for water between plants, plant growth is open and simple³. Some of the Arizona Upland species, such as saguaro, are completely absent in this community; while other species, such as smoketree (*Dalea spinosa*) are endemic to this community.⁴ Plants commonly found in this community are creosote bush, bursage, salt bush, foothill palo verde, ocotillo and brittlebrush.

Riparian Habitat

“Riparian” is defined as vegetation, habitats, or ecosystems that are associated with bodies of water or are dependent on the existence of perennial, intermittent, or ephemeral surface or subsurface drainage. In other words, vegetation growing along rivers, streams, or washes are riparian areas. Riparian habitat is adapted to flooding. Floods help remove vegetation

2 Lowe, C.H. and D.E. Brown 1973. “The Natural Vegetation of Arizona”. Arizona Resources Information System. 53pp.

3 David E. Brown 1994. “Biotic Communities Southwestern United States and Northwestern Mexico” University of Utah Press; 342 pp.

4 Arizona Riparian Council No. 2 2004

and debris, redistribute sediments, and create bare moist germination beds necessary for cottonwood and willow seed germination.

The type of riparian vegetation varies primarily depending upon both groundwater and surface water. Some species, such as cottonwoods and willows, require a significant amount of water so they grow in areas with frequent flows, shallow groundwater, or near other consistent water sources. Other riparian species, such as ironwood and mesquite, also grow in the upland communities; however, the plant density and size are typically greater along streams and washes. Pre-settlement of Arizona, mesquite bosques (i.e., forests) commonly grew in the floodplain and on floodplain terraces.

Even though riparian areas account for less than 0.5% of the land area in Arizona, they provide many values and functions, which are discussed below.

Functions and Values

Riparian areas are one of the most productive ecosystems in the world. One estimate of their relative productivity is that if riparian areas were managed for natural values, they may be capable of producing 100 times more biomass than adjacent desert areas⁵.

Riparian areas also provide diverse growing conditions, with varying types of soils and various degrees of moisture and sunlight. Due to this diversity of physical conditions, many types of plants can grow there. Along a five mile reach of the Hassayampa River, more than 300 plant species have been identified⁶. Due to the increased density and diversity of plants, as well as the diversity of topographical features, such as channel banks, riparian habitat provides food, breeding cover, and shelter for many wildlife species. Approximately 60 to 75% of wildlife species in Arizona depend on riparian areas to sustain their population⁷. Riparian corridors also function as a wildlife corridor or linkage to other habitat types. Maintaining wildlife linkages minimizes habitat fragmentation, which is important to maintain biological diversity.

Riparian habitat also serves several natural flood control functions. Vegetation along watercourses acts as natural erosion control. Tree roots and vegetation help to stabilize soil and the channel banks, and decrease erosion impacts near streams. Vegetation growing on the banks also helps decrease the probability that a stream will erode or that the channel will widen. Vegetation can also trap and stabilize sediment from floodwaters, and can store and slowly release floodwaters. In addition, riparian vegetation improves the water quality by trapping sediment and biodegradation. Another important function of riparian vegetation is that the vegetation in the floodplain tends to decrease the flow velocities, thereby attenuating the flows and alleviating some potential downstream flooding.

Invasive Plant Species

Invasive species are defined as "...a nonnative plant, animal or other organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human health⁸." When introduced into new habitats, invasive species can quickly displace native species where

⁵ Lowe and Brown 1973

⁶ Arizona Riparian Council No 2 2004

⁷ Arizona Riparian Council No. 1 2004

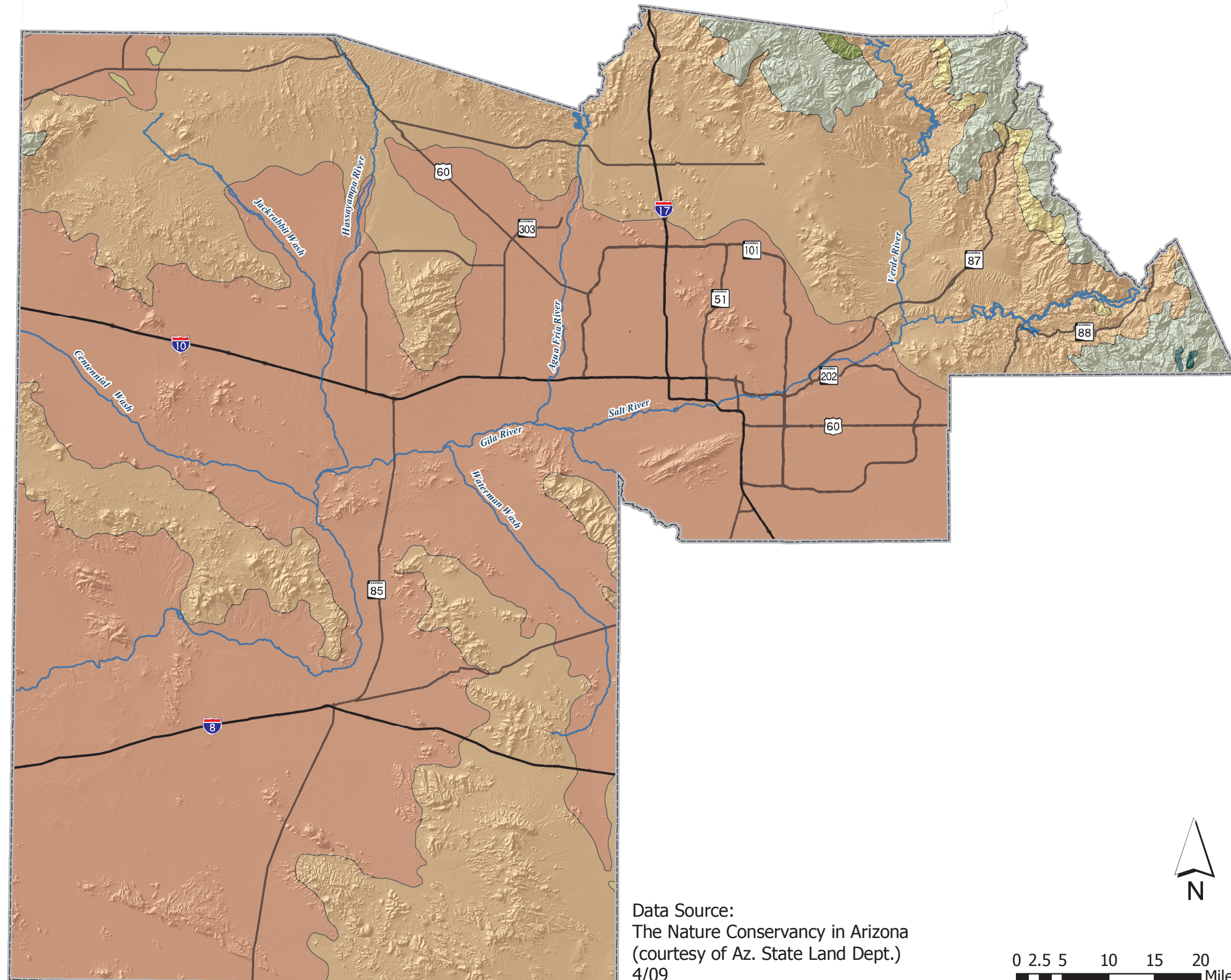
⁸ Arizona Invasive Species Management Plan 2008

Vegetative Communities

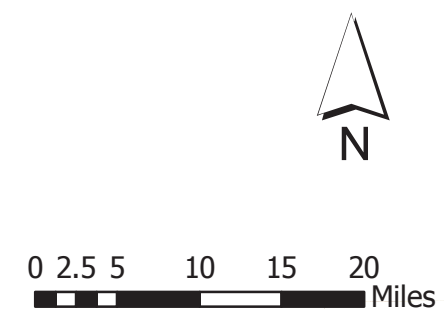
Map 6-2

Legend

-  Rivers and Washes
-  Interstates and State Routes
- Biotic Communities of the Southwest
- Descriptions
-  L. Colorado-Sonoran Desert Shrub
-  Az. Upland Sonoran Desert Shrub
-  Semidesert Grassland
-  Interior Chaparral
-  Great Basin Conifer Woodland
-  Petran Montane Conifer Forest



Data Source:
The Nature Conservancy in Arizona
(courtesy of Az. State Land Dept.)
4/09



the invasive species' natural enemies are not present to control their growth. According to the Sonoran Institute⁹, "invasive species are the second most significant threat to biological diversity after direct habitat loss." Invasive species can increase the fire potential, alter nutrient cycles, and change the character of the biotic community. By 1998, invasive species "... were implicated in the decline of 42 percent..." of the listed species under the Endangered Species Act¹⁰. The annual economic impact of invasive species has not been estimated for the State of Arizona; however, Pimental et al¹¹ estimated that the annual costs of invasive species is more than \$100 billion in the United States.

Salt Cedar/Tamarisk

Salt cedar is an invasive tree that grows in riparian areas, ephemeral streams, and their associated floodplains. The highly invasive salt cedar has become established on over a million acres of lowland riparian habitats, floodplains, wetlands, and lake shores in the western United States.

Salt cedar readily colonizes and thrives in disturbed river systems. Spring floods and shallow, plentiful ground water helped sustain the native riparian vegetation, such as cottonwood and mesquite bosques. Changing the natural hydrologic regime in western rivers and streams by constructing dams, pumping excessive ground water, and constructing structural flood control projects resulted in highly disturbed river systems and, consequently, a niche for salt cedar.

The potential for salt cedar to occupy the floodplain and its effects need to be considered when conducting floodplain studies. Salt cedar's dense growth can reduce the conveyance capacity of the stream by occupying space that could be used for flowing water. The dense stems of salt cedar also reduce the flow velocity. Lower conveyance capacity and slower velocities can increase the width of the floodplain, especially floodplains that have shallow channels and water depths. In addition, slower velocities increases sediment deposition; an increase in sediment deposition can also reduce the conveyance capacity and, therefore, increase the floodplain.

Salt cedar has some ecological effects as well. Not only is salt cedar fire adapted, its dense growth habit increases the potential for wildfires. Although some wildlife, including the federally endangered southwestern willow flycatcher, have adapted to using salt cedar, salt cedar generally provides low quality habitat compared to native riparian habitat. Salt cedar tends to form dense monocultures that preclude other species from growing and, therefore, reduces the biodiversity of plants and consequently wildlife.

Fauna

The fauna in the Sonoran Desert, especially in the Arizona Upland subdivision, is diverse. Over 300 species of birds inhabit Maricopa County. The structural diversity of the Arizona Upland plant community supports moderate densities of some large mammals, such as mule deer and javelina. Desert bighorn sheep reside in the more arid regions in the mountains. Numerous reptiles, such as the Gila monster, whiptail lizards, and the Sonoran mountain kingsnake also inhabit the Sonoran Desert.

⁹ Sonoran Institute 2009. www.sonoraninstitute.org

¹⁰ Center for Wildlife Law 1999

¹¹ Pimental, David, Rodolfo Zuniga, and Doug Morrison 2004. "Update on the environmental and economic costs associated with alien-invasive species in the United States". Ecological Economics.

Wildlife in Arizona have a significant economic impact. In 2001, hunting, fishing, and watchable wildlife activities contributed \$2.8 billion to Arizona's economy. Riparian habitat and floodplains are very important for up to 75% of all wildlife in Arizona. The diverse plant life in the riparian habitat provides food, shelter, and breeding habitat. Rivers and washes are natural wildlife corridors that support wildlife movement from one resource area to another. The way flooding hazards are mitigated and floodplains are managed in Maricopa County can significantly affect the local wildlife populations and diversity; therefore, floodplain management actions must consider potential effects on wildlife and their habitat.

Special Status Species

Special status species in Arizona are species that are listed species under the Endangered Species Act (ESA), sensitive species designated by federal agencies, or wildlife species of concern as designated by the Arizona Game and Fish Department (AGFD). As of April 2009, there are 126 special status species in Maricopa County (Table 6-2). Of these, 12 are listed as threatened or endangered under the ESA.

Table 6-2: Special Status Species in Maricopa County by Taxon

Taxon	Number
Amphibian	5
Bird	29
Fish	11
Invertebrates	3
Mammals	19
Plants	39
Reptiles	20

Floodplain managers and those conducting projects must determine if their actions affect any of the listed special status species, especially the threatened or endangered species.

Wildlife Corridors

Wildlife corridors are linkages that maintain connectivity between habitat elements or types. Habitat loss, alteration, and fragmentation are the most significant threats to Arizona's wildlife populations. As connectivity between key habitat types is lost, animals are deprived of necessary resources, and migration and breeding patterns are disrupted reducing gene flow, preventing animals from recolonizing areas they once occupied. If habitat fragmentation continues unchecked, remnant populations of pronghorn antelope, bighorn sheep, desert tortoise, badger, and other species may be lost. Therefore, preserving key wildlife linkages is very important to maintaining biodiversity.

The Arizona Department of Transportation (ADOT), AGFD, and several other groups formed the Arizona Wildlife Linkages Workgroup. The workgroup developed the Arizona Wildlife Linkages Assessment, which identifies key wildlife linkages. One of their

goals is for wildlife connectivity to be considered in regional planning and projects early in the process. By integrating wildlife linkages into flood control projects, the linkage areas have a greater potential to be maintained or conserved.

Landscape Character

A wide variety of landscape settings, each with its own individual nature, characterizes Maricopa County. These settings include a variety of natural, pastoral, suburban, urban and industrial attributes. The natural and traditional pastoral landscapes of the wide valley regions offer unobstructed large-scale panoramas of the Sonoran Desert. The uplands and rolling foothills (Bajadas) that surround the valley areas offer a variety of visually interesting and striking topographic and vegetative forms that create a feature landscape composition. The surrounding steep and craggy mountain ranges that rise dramatically from the floor of the valleys serve as primary landscape focal points that capture the viewer's attention. The desert rivers, streams, and washes that transect the wide valley floors, together with the riparian vegetation, form small scale linear canopied landscapes that provide welcome visual contrast and relief. The suburban, urban and industrial landscapes offer a variety of historic, traditional and contemporary architectural forms and open spaces that define the cultural and historical context of the communities and places of the county.

Landscape character can be systematically classified and mapped at different scales. Landscape Character Types and Subtypes were identified and delineated at a macro-scale for Arizona by the United States Forest Service. The District has refined and expanded upon the Forest Service methodology to identify landscape character for Maricopa County. The character types and subtypes represent regional and sub-regional areas of land having similar distinguishing characteristics of landform, vegetation, water features and rock formations. Two of the character types are represented in Maricopa County. They include: 1) the Sonoran Desert Character Type (89% of the county land area) and 2) the Tonto Character Type (11%). The character types and subtypes provide a frame of reference for further refinement and identification of existing landscape character at an appropriate scale for regional and project level planning of flood control facilities. This information is then used to guide the development of flood hazard mitigation solutions that complement the surrounding environment and community. The Context Sensitive Flood Hazard Mitigation process is summarized in Chapter 5.

Settlement of Maricopa County: Floodplain Development and the Environment

People developed in floodplains for many reasons. Over 100 years ago, metropolitan Phoenix was a large agricultural community. Many floodplains, especially along the Gila River, were converted to agriculture fields because of the proximity of the water, and the relatively fertile soil and flat land that is characteristic of floodplains. When converting desert to agricultural land, farmers typically modified the natural drainage characteristics by grading the land and filling in the washes. Therefore, the natural drainage patterns on agriculture land would become indistinguishable. As the population grew, agricultural land was relatively easy to change into residential development. Because the flooding hazards on agricultural lands were often indistinct, people built houses in flood hazard areas.

Similarly, people often do not recognize the flood hazards present in undeveloped or natural desert areas. The flood risk associated with sheet flow, alluvial fans or ephemeral washes are not evident to the average person. These areas—especially along washes or on alluvial fans—have dense vegetation and are aesthetically pleasing which invites development. Consequently, people build in flood hazard areas because they simply do not know there is a hazard or understand the degree of the hazard. This illustrates the importance of delineating flood hazards before development occurs.

Balancing Development and Environmental Concerns

Development in sensitive areas, such as floodplains, can negatively impact the natural environment and ecosystem. Regulations and policies help balance development with environmental protection. There are several environmental regulations that must be addressed or complied with when conducting floodplain management and other activities within the floodplain. Before 1970, there were few regulations that protected the environment. Development and other land uses occurred without addressing environmental issues. Today, there are several regulations that protect the environment directly or indirectly. See Appendices B and E for a summary of the regulations that govern development in the floodplain.

Summary

With a land area of 9,226 square miles, Maricopa County is the fifth largest in area in Arizona, and larger than five states. The characteristics of the natural environment presented in this chapter demonstrate the complexity of the vast area under the District's jurisdiction. Maricopa County lies within a dry, subtropical desert climate zone. Average annual rainfall ranges from five inches in the lower elevations to over 16 inches in the higher elevations. There are two separate precipitation seasons: winter storms and summer monsoons. Rainfall records have been kept for the Phoenix area on a consistent basis for over 100 years. At Sky Harbor Airport the 24-hour duration rainfall that would occur in a 100-year event would be 3.30 inches; a 50-year event would generate 2.93 inches. These values vary throughout Maricopa County. The way flooding hazards are mitigated in Maricopa County can significantly impact the natural environment. The District considers these impacts while undertaking floodplain management and flood control activities.



Black Canyon Freeway (I-17) and Grant Street, June 22, 1972

7. Developed Environment

Rapid population growth and urbanization has characterized development in Maricopa County over the past several decades. The Maricopa Association of Governments (MAG) projects that the year 2000 population of 3,681,025 will increase to 6,135,000 by 2030. Maricopa County is part of the "Sun Corridor" megapolitan area¹. The Sun Corridor is part of a larger metropolitan area consisting of the metropolitan areas of Prescott, Phoenix, Casa Grande, Tucson, Nogales and Sierra Vista. These interconnected metropolitan areas are expected to rapidly increase in population.

Maricopa County has experienced tremendous population growth in recent decades. Each year development reaches further out from the urban center, replacing agricultural and other undeveloped lands. Recent growth has occurred in the urban fringe areas. Like the other Sun Corridor urban areas, new development generally consists of low-density residential development followed by commercial development. This low-density development results in a steadily expanding urban area.

¹ Morrison Institute for Public Policy. "Megapolitan: Arizona's Sun Corridor." Arizona State University, May 2008. <http://www.asu.edu/copp/morrison/megapolitan.htm/>

Developed Environment Outline

- Population
- Land Ownership
- Existing Land Use
- Future Development
- Summary

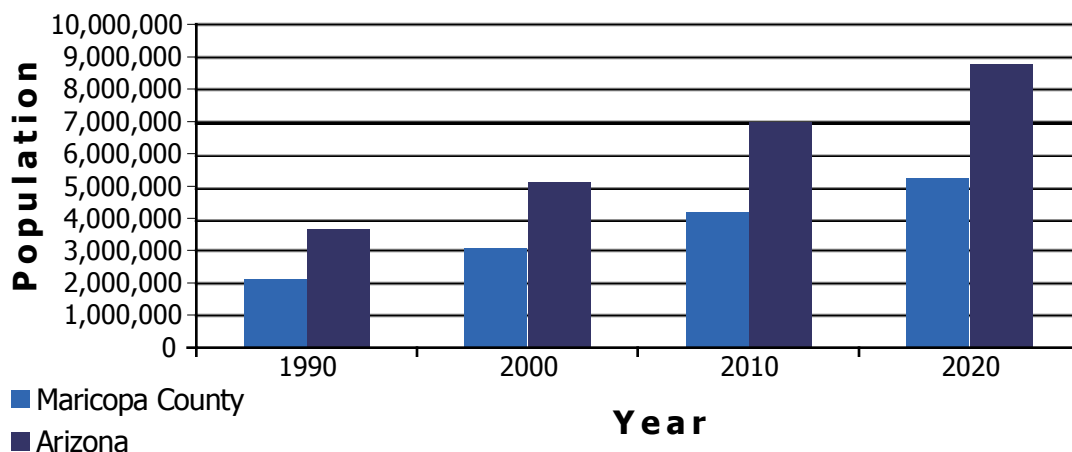
Since the District protects both the existing urban areas from flooding as well as developing areas, the District must prioritize flood control projects and programs in both contexts. This section discusses the regional development context and analyzes county-wide social and economic issues to provide a framework for District priorities. Socioeconomic characteristics are explored at a watershed-level in Chapter 8.

Population

The southwestern United States experienced rapid population growth in the recent decades. The 1990 Arizona population of just over 3.5 million is expected to double to seven million in 2010, followed by an increase to almost nine million by 2020 (see Figure 7-1). This growth is the result of a continuing trend of the migration toward Sunbelt cities such as Phoenix.

The majority of Arizona's population growth will occur in Maricopa County. The Maricopa Association of Governments (MAG) projects population growth for each municipal long-range planning area. Municipalities within the county are growing at varying rates, but all are projected to increase in population in the coming decades (see Table 7-1). MAG projects Phoenix to add the most population; similarly, many of the suburbs will grow rapidly. The 2005 population of Phoenix, at 1,510,177, is expected to increase to almost two million by 2020. Buckeye, Gilbert, Goodyear, and Surprise are all projected to add 100,000 residents by 2020.

Figure 7-1: Maricopa County and Arizona Population



This future population growth results in an expansion of urban areas, which in turn generates demand for additional flood hazard mitigation. The population projections are subject to economic and development conditions, local development policies, and updated data. Negative economic conditions in 2008 and 2009 such as rising unemployment, increasing commercial vacancies, property foreclosures, reduced building permit activity, and the fall of housing prices should be considered. Future planning decisions should take into consideration revised figures in the 2010 census and other socioeconomic indicators².

² Adapted from "Notes and Caveats for 2007 Projections" in the MAG Socioeconomic Projections Document available at <http://www.mag.maricopa.gov>. See this document for detailed methodology and caveats

Table 7-1: Total Resident Population by Municipal Planning Area, July 1, 2005 and Projections July 1, 2010 to July 1, 2020

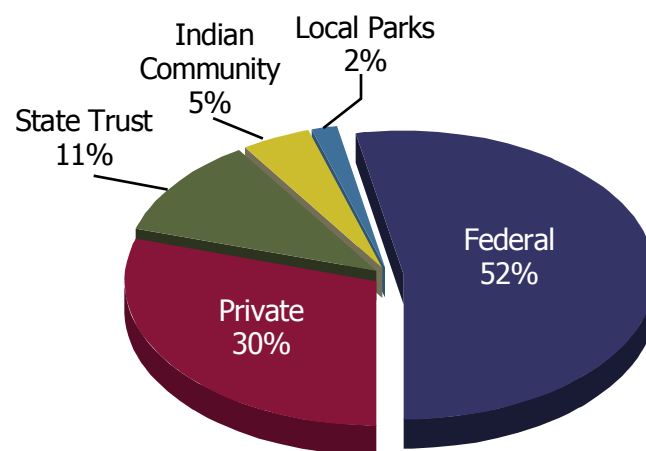
Municipal Planning Area	2005	2010	2020	Increase, 2005 to 2020	Percent Increase, 2005 to 2020
Avondale	70,160	83,856	105,989	35,829	51%
Buckeye	32,735	74,906	218,591	185,856	568%
Carefree	3,654	4,418	5,816	2,162	59%
Cave Creek	4,845	5,781	7,815	2,970	61%
Chandler	236,073	265,107	282,991	46,918	20%
County Areas	80,661	87,434	107,441	26,780	33%
El Mirage	31,935	34,819	38,620	6,685	21%
Fountain Hills	24,347	27,166	33,331	8,984	37%
Fort McDowell	824	839	1,037	213	26%
Gila Bend	2,118	2,575	3,950	1,832	86%
Gila River	2,742	2,790	2,941	199	7%
Gilbert	178,708	218,009	285,819	107,111	60%
Glendale	257,891	279,807	315,055	57,164	22%
Goodyear	47,520	71,354	174,521	127,001	267%
Guadalupe	5,555	5,790	5,982	427	8%
Litchfield Park	6,787	8,587	10,305	3,518	52%
Mesa	486,296	518,944	565,693	79,397	16%
Paradise Valley	14,136	14,790	15,224	1,088	8%
Peoria	141,441	172,793	236,154	94,713	67%
Phoenix	1,510,177	1,695,549	1,990,450	480,273	32%
Queen Creek	19,879	34,506	55,529	35,650	179%
Salt River	6,822	7,087	7,308	486	7%
Scottsdale	234,515	249,341	269,266	34,751	15%
Surprise	93,356	146,890	268,359	175,003	187%
Tempe	165,740	177,771	191,881	26,141	16%
Tolleson	6,491	7,748	9,646	3,155	49%
Wickenburg	9,606	11,022	13,311	3,705	39%
Youngtown	6,011	6,820	7,275	1,264	21%
County Total	3,681,025	4,216,499	5,230,300	1,549,275	42%

Source: Socioeconomic Projections of Population, Housing, and Employment by Municipal Planning Area and Regional Analysis Zone, May 2007. Maricopa Association of Governments; Flood Control District of Maricopa County.

Land Ownership

Nearly two-thirds of the land in Maricopa County is publicly owned or under some form of federal control. Figure 7-2 shows land ownership as a percentage of all land in Maricopa County and is supplemented with Map 7-1, Land Ownership. The largest areas of public land are the Tonto National Forest, in the northeastern part of the county, and various areas in the western portion of the county which are managed by the U.S. Bureau of Land Management (BLM). In Maricopa County, the BLM controls twice as much land as the Forest Service. As with Forest Service lands, BLM lands largely are used for cattle grazing leases, though they are managed under the doctrine of “multiple use” or that the land may be used differently in the future. Some BLM land is administered as wilderness areas managed for wildlife habitat and limited recreation.

Figure 7-2: Land Ownership in Maricopa County



Source: Arizona State Land Department; FCD GIS Database

The State of Arizona controls a considerable amount of land in the county in the form of State Trust Land. Like the BLM, state trust land is used primarily for grazing but it may eventually be developed. Statewide, ranchers hold grazing leases on 93 percent of the state trust lands. Trust lands limit development in the near-term, but in the long-term, lands are subject to sale, lease and development. Trust lands are sold when the lands can produce the greatest amount of revenue. Other public lands include federal, state, county/municipal parks, preserves and open spaces which generally are not subject to future development.

Five Native American communities control about five percent of land in Maricopa County. Three of them border urbanized areas, including the Gila River Indian Community to the south and the Salt River Pima-Maricopa and Fort McDowell Mohave-Apache communities in the northeast. Modest amounts of development have occurred on the three Indian Communities, with the exception of the Salt River-Pima Maricopa Indian Community (SRPMIC). Located between Scottsdale and Mesa, commercial development is expected to occur along the Loop 101, designated a business corridor by the SRPMIC.

Privately owned land is generally concentrated in the urbanized area, and in urban fringe areas. Agricultural lands and state land along transportation corridors, as in the past, should continue to develop and expand the urban area.

Land Ownership

MAP 7-1

Legend

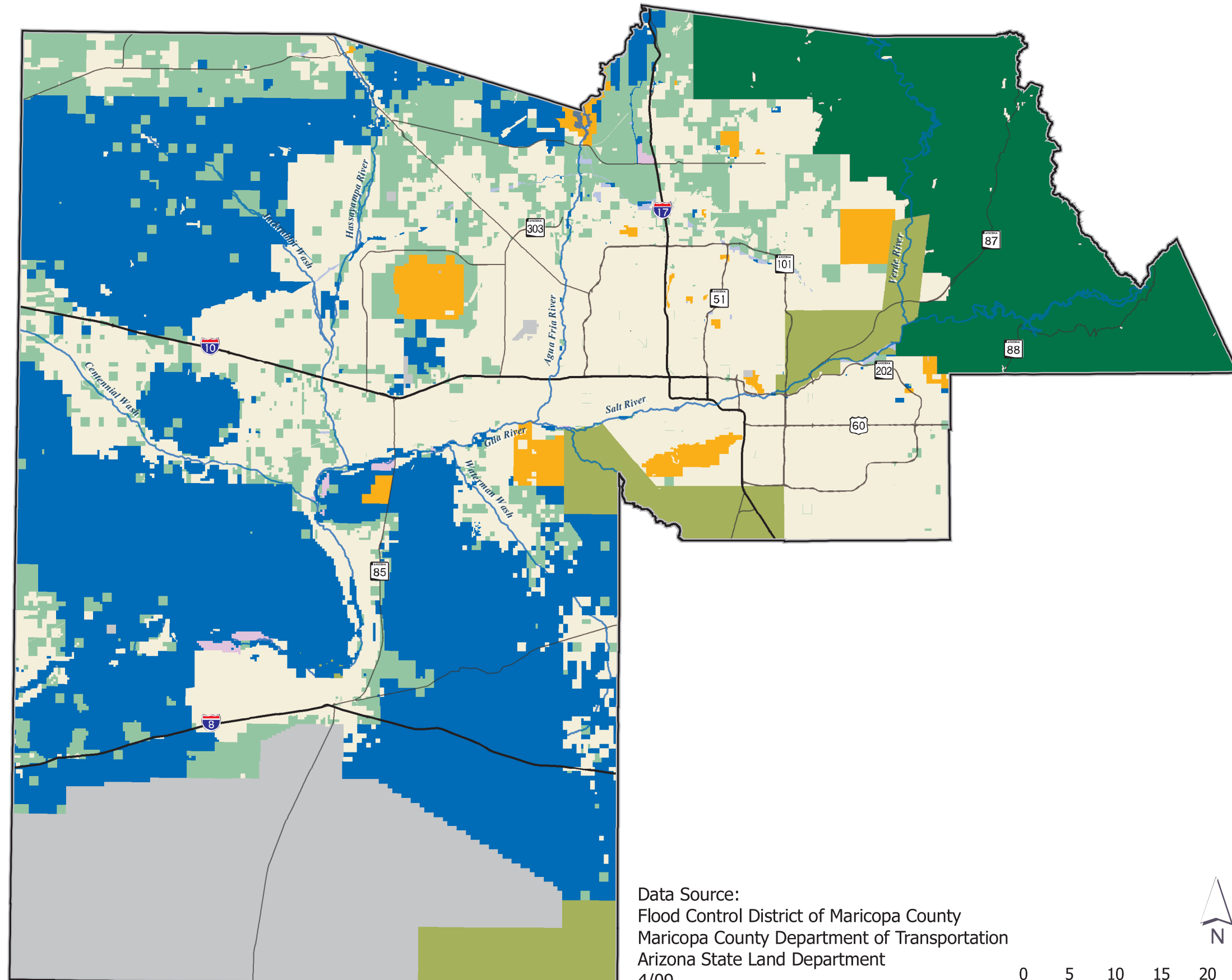
- Private 30%
- Bureau of Land Management 29%
- State Trust 11%
- Military 12%
- National Forest 11%
- Indian Community 5%
- Local or County Parks 2%
- Other <1%
- Wildlife Preserve <1%



Data Source:
Flood Control District of Maricopa County
Maricopa County Department of Transportation
Arizona State Land Department
4/09



0 5 10 15 20
Miles



Despite much of the land in the county being publicly held or undevelopable, the remaining amount of land available for development would allow the population of the Phoenix metropolitan area to expand by at least several million people in the coming decades.

Existing Land Use

The availability of water enables urban growth and influences land use in arid regions. In the Phoenix area, development of irrigation systems for agriculture in the late 19th and early 20th centuries initiated rural settlement and development of the Salt River Valley. The Salt River Project provided water and power infrastructure, beginning in the 1900s. This enabled large numbers of residents to move to the area, increasing demand for commercial and industrial uses. Today, extensive urban and suburban residential development has replaced agriculture. The Phoenix area has experienced exceptionally high urban growth and has been able to accommodate this growth due to the availability of developable land and inexpensive, imported water.

Agricultural land in Maricopa County is being converted to mostly residential development. Maricopa County now uses only 12% of its land base for agricultural purposes. Approximately 6,000 acres of agricultural land—an area the size of the Town of Paradise Valley—permanently goes out of production each year. Today, about half of the Phoenix urbanized area is on land previously used for farming. Flooding in populated, residential areas poses a greater public safety risk than flooding on agriculture land.

Future Development

Anticipating future development areas to determine flood hazard issues requires an analysis of trends and land ownership. Understanding the direction of the county's population growth is essential to adequately coordinate flood protection with development. To this end, the District analyzes future development, combining aspects of recent residential completions, land ownership, population projections and economic conditions.

Development in the county has primarily been suburban residential, made possible by expanding transportation infrastructure (see Map 7-2 Historic Urban Growth Patterns and Map 7-3 Residential Completions). Commercial development and employment generally follows. Future development will be heavily concentrated in the west and north sections of the metropolitan area, while the southeast valley continues to develop toward Pinal County, through Queen Creek to Florence. Projected expansion of urban areas is illustrated in Map 7-4 Future Urban Growth Patterns. As shown, future urban growth is projected to expand on developable land, generally along existing and planned transportation corridors. Major growth areas are identified below.

General future growth areas:

- West along I-10 through Buckeye
- Northwest along future State Route 303 Loop and US Highway 60 near Surprise and Peoria toward Wickenburg
- North along Interstate 17
- Southeast toward Queen Creek and Florence, in Pinal County

These future growth areas are forecasted to develop due to expanding transportation infrastructure and the availability of developable land. The west valley, along I-10, is likely to

develop due to the large expanse of private agricultural and vacant land and expanding freeway system. As seen in Map 7-1, Land Ownership, much of this land is accessible to I-10, recently completed SR 101L, as well as planned future freeways such as SR 303L and SR 202L, both of which connect to I-10 in the west valley. As with the case in the west valley, the development in the northwest valley is facilitated by the expanding freeway system and the availability of private and state trust lands. The southeast valley is expected to continue to grow rapidly toward Florence, facilitated by SR 202L and the planned SR 802 near the Phoenix-Mesa Gateway Airport. Each of these areas contains state land, which is eventually sold and subject to development.

With control of 9.3 million acres of land, the ASLD exerts significant influence over future development in Maricopa County. Managed to generate revenue for trust beneficiaries, ASLD leases or sells land (along with the natural products: forage, timber, minerals, etc.) to the highest and best bidder. The mandate to maximize revenue implies that the state, more than any other entity, has the ability to drive the future pattern of development and open space in Maricopa County. As the State Land Department administers its mission, state lands will convert to private ownership for commercial and residential development. Approximately 3,000 to 5,000 acres of state trust lands are sold per year, primarily for commercial and residential development.

Summary

Rapid population growth and urbanization has characterized development in Maricopa County over the past several decades. The Maricopa Association of Governments (MAG) projects that the year 2000 population of 3,681,025 will increase to 6,135,000 by 2030. The increase in population has placed Maricopa County residents in areas susceptible to flooding and/or erosion and sediment damages. Population will continue to expand in both existing urbanized areas and more remote unincorporated areas. The District faces challenges in providing flood control solutions for a growing population in urbanized and rural areas.

Historic Urban Growth Patterns

Map 7-2

Legend

- Interstates & State Routes
- Rivers & Washes
- Historic Urban Edge
- Year
 - 1955
 - 1975
 - 1995
 - 2005



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County
Maricopa County Department of Transportation
04/09

0 5 10 15 20 Miles



Residential Completions

Map 7-3

Legend

Residential Completions

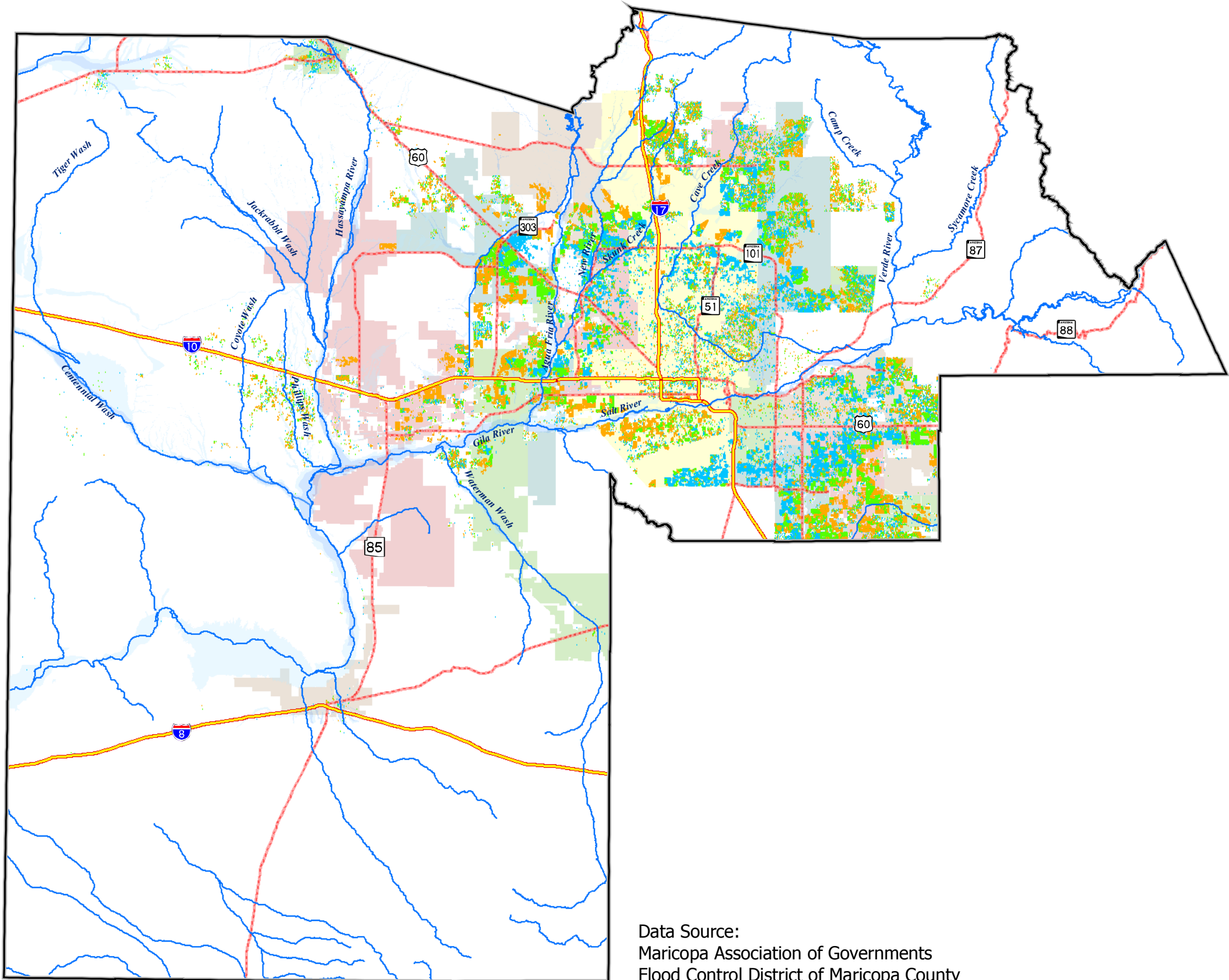
- 2005 to 2009
- 2000 to 2005
- 1990 to 2000

- Rivers & Washes
- Interstate Highways
- State Roads

- FEMA Floodplains
- 100-year Floodplains
 - Floodways



0 2.5 5 10 15 20 Miles



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

Future Urban Growth Patterns

Map 7 - 4

Legend

Interstates & State Routes

Rivers & Washes

Projected Urban Growth

Year

2010

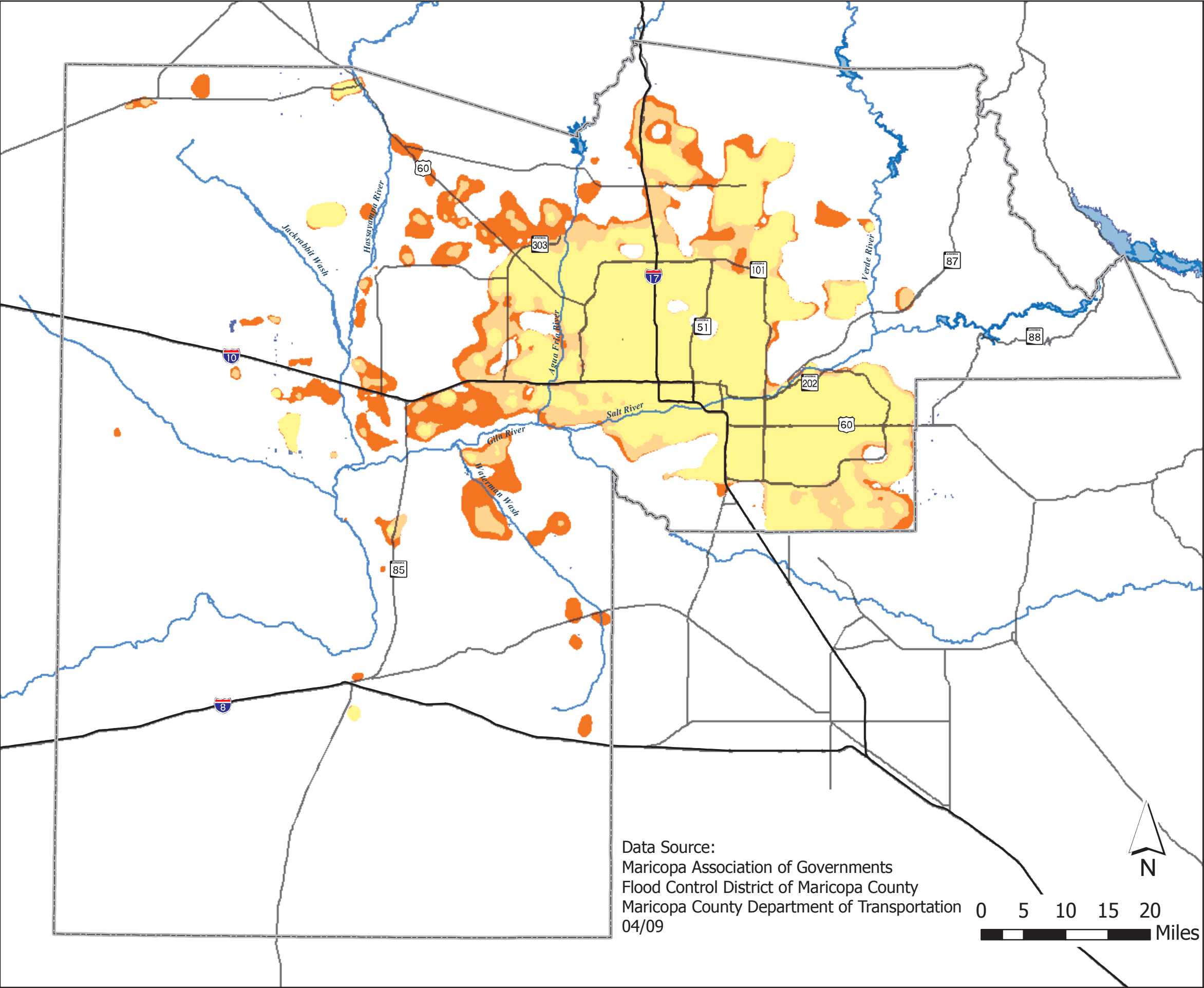
2020

2030



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County
Maricopa County Department of Transportation
04/09

0 5 10 15 20 Miles





Agua Fria River and Bell Road, Surprise, February 22, 1980

8. Risk Analysis by Watershed

Maricopa County is drained by the Gila River and five principal tributaries: Centennial Wash, and the Salt, Verde, Agua Fria and Hassayampa rivers. The county's natural drainage system is further divided into eight watersheds—Agua Fria, Cave Creek/Salt, Centennial, Gila/Queen Creek, Hassayampa, Lower Gila, Verde, and Waterman¹. Each watershed has unique topographic, hydrologic, and socioeconomic characteristics. The particular attributes of a watershed determine the flooding risk and influence the activities the District can employ to mitigate the risk.

This chapter provides a watershed by watershed description of vulnerability to flooding and recommends both county-wide and watershed-specific flood control or floodplain management actions². These recommendations are part of the five-year flood hazard mitigation action plan for Maricopa

Risk Analysis by Watershed Outline

Agua Fria
Cave Creek/Salt
Centennial
Gila/Queen Creek
Hassayampa
Lower Gila
Verde
Waterman
Summary

¹ A watershed is the area of land where all of the water that drains off it runs off to the same location. The eight watersheds reviewed in this chapter are based on water resource sub-regions identified by the United States Geological Service. The District modified the watershed boundaries to reflect changes in flow patterns due to construction of flood control facilities and other factors.

² A county-wide overview of flooding risk and vulnerability is presented in Chapter 3.

County. Elements of the plan are presented throughout this chapter. The action plan, including implementation and funding, is summarized in Chapter 9. The plan draws on the possible flood mitigation activities that the District could undertake which are discussed in Chapter 5.

The individual watershed needs assessment has four components:

- **Watershed Description**

Each description consists of two parts 1) Physical characteristics of the watershed including topography, geology, and hydrology; and 2) Socio-economic information, including population and development trends. This information is important to consider when prioritizing flood hazard mitigation activities.

- **Needs Assessment**

The needs assessment provides an overview of flooding problems and general public vulnerability to flooding. This section discusses the flooding characteristics of each watershed including types of flooding, delineated floodplains, and run-off potential. A discussion of development patterns, road crossing hazards, repetitive loss areas, and other issues describe the risk and public vulnerability to flooding.

- **Completed District Activities**

A list of completed studies, plans and capital improvement projects since the 2005 Comprehensive Plan update is provided for each watershed.

- **Action Plan**

A recommended five-year program of work is presented for each watershed including delineations, planning studies and structural projects. The program of work is based on the needs assessment, proposed District activities, and the five-year delineations, planning and CIP budgets. The action plan is categorized by District strategic program—outreach, identification, regulation and remediation.

Agua Fria

The Agua Fria watershed is located in northcentral Maricopa County. The watershed contains 2,329 square miles, of which approximately half lies outside the county. The Arizona Canal Diversion Channel (ACDC), completed in 1993, marks the southern boundary of the watershed. The ACDC runs parallel to the Arizona Canal from approximately 40th Street and Camelback Road to Skunk Creek. Several dams and flood retarding structures also provide protection in the Agua Fria watershed including White Tanks Flood Retarding Structure No. 3, and Adobe, Cave Buttes, Cave Creek, Dreamy Draw, McMicken, New River and New Waddell dams.

Physical Characteristics

The central and southern portions of the Agua Fria watershed are generally flat. The northern part and southwest corner contain several mountain ranges with slopes 10% and greater. The watershed retains a significant amount of its natural vegetation in the north and western areas.

There are several major rivers and washes, including Cave Creek, Skunk Creek, New River and the Agua Fria River. The Agua Fria River is an ephemeral river downstream of Lake Pleasant and New Waddell Dam. It is the primary channel for conveying flows

during flood events from the New River down to the Gila River³. During flood events, the river channel south of the crossing of the Central Arizona Project (CAP) siphon has a tendency to migrate from side to side and erode its banks. The river channel is carved into hard rock north of the CAP to Lake Pleasant⁴.

Valuable wildlife habitat exists along the Agua Fria River just below Lake Pleasant, as well as at the confluence with the Gila River. The Sonoran Preserve in northern Phoenix encompasses more than 5,000 acres of pristine desert land. The land in the preserve is unique, characterized by a lushness and diversity of plant and animal life.

Socioeconomic Characteristics

All or parts of the municipal boundaries of Avondale, Buckeye, Carefree, Cave Creek, El Mirage, Glendale, Goodyear, Litchfield Park, Paradise Valley, Peoria, Phoenix, Scottsdale, Surprise and Youngtown fall within this watershed. Approximately 50% of the watershed within Maricopa County is unincorporated county.

The Agua Fria watershed had a population of 991,186 in 2005. By 2020, the population is expected to increase to 1,523,060 persons. The majority of the watershed will consist of low to medium density suburban development (see Map 8-1, Delineated Floodplains & 2020 Population Projections, Agua Fria Watershed).

Industrial uses in the Agua Fria watershed include several city wastewater treatment plants and landfills and sand and gravel mines and processing plants. The sand and gravel mining is located predominately along the Agua Fria River. Critical facilities, including Luke Air Force Base and Glendale Municipal Airport, are located primarily in the western portion of the watershed.

Several regional transportation corridors intersect the area—Interstate-17, State Route 74, and State Routes Loop 101 and Loop 303. The Central Arizona Project Canal crosses roughly east-west through the watershed.

Approximately 285 square miles of the watershed are already developed. An additional 454 square miles are potentially developable, meaning that the land is either privately held or is owned by the Arizona State Land Department (ASLD). The majority of the existing development is concentrated in the southern portions of the watershed (see Map 8-2, Developable Areas, Agua Fria Watershed).

Open space and parks account for nearly 21 percent of the watershed. Open space areas of significance are White Tank Mountain Regional Park, the Tonto National Forest and Lake Pleasant Regional Park. Jurisdictions along the Agua Fria River have partnered with a non-profit organization and the District to develop the West Valley Recreation Corridor. The vision of the West Valley Recreation Corridor is to utilize the Agua Fria and New rivers for recreation and as a means to link neighborhoods, communities and commerce.

3 Agua Fria Watercourse Master Plan Addendum, Channelization Alternative, Volume I Summary Report. (2005). David Evans and Associates.

4 Agua Fria Watercourse Master Plan Addendum, Channelization Alternative, Volume I Summary Report. (2005). David Evans and Associates.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Agua Fria watershed is the third most populated of the eight watersheds. There are currently 7,583 parcels with residential structures in the identified 100-year floodplain. Since 2005, 552 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

Approximately half of the Agua Fria watershed is unincorporated. Single-lot development is the predominant residential type in unincorporated areas, especially Witmann, New River and Desert Hills. Single-lot development does not benefit from the large-scale drainage features constructed in master planned communities.

Numerous rivers and washes crisscross the northern portion of the watershed. This area is subject to flash flooding due to its steep topography, creating a dangerous situation for motorists crossing washes during flood events. In 2005, heavy rains from widespread thunderstorms caused flash flood waters to over-flow washes from New River east to the Seven Springs area and Camp Creek. Two fatalities occurred during this storm: A pickup truck driver drowned while attempting to drive across a flooded road, and a seven-year-old girl being evacuated from a home along Camp Creek slipped from the grasp of the adult she was with and was swept away by a flooded wash.

Flooding Risk Summary

- There are 442 miles of delineated floodplains in the Agua Fria watershed. The District estimates that an additional 834 miles of floodplains still require delineation.
- Nearly one-third of the soils have a high runoff potential (see Table 8-1). See Chapter 6 for a complete discussion of hydrologic soil type.
- Two dams—McMicken and White Tanks FRS No.3—have dam safety deficiencies as identified by the Arizona Department of Water Resources.
- General flooding and erosion issues in this watershed include:
 - Overtopping of the CAP canal.
 - Sheet and split flows across the valley plains.
 - Alluvial fans near the White Tanks, Hieroglyphics and other mountainous areas.
 - Flash flooding, especially in the northeastern portion of the watershed.
 - Flooding and erosion along the major watercourses including the Agua Fria River. During flood events, the channel of the Agua Fria River has a tendency to migrate from side to side and erode its banks. Sand and gravel mining combined with the lateral erosion potential of the river pose

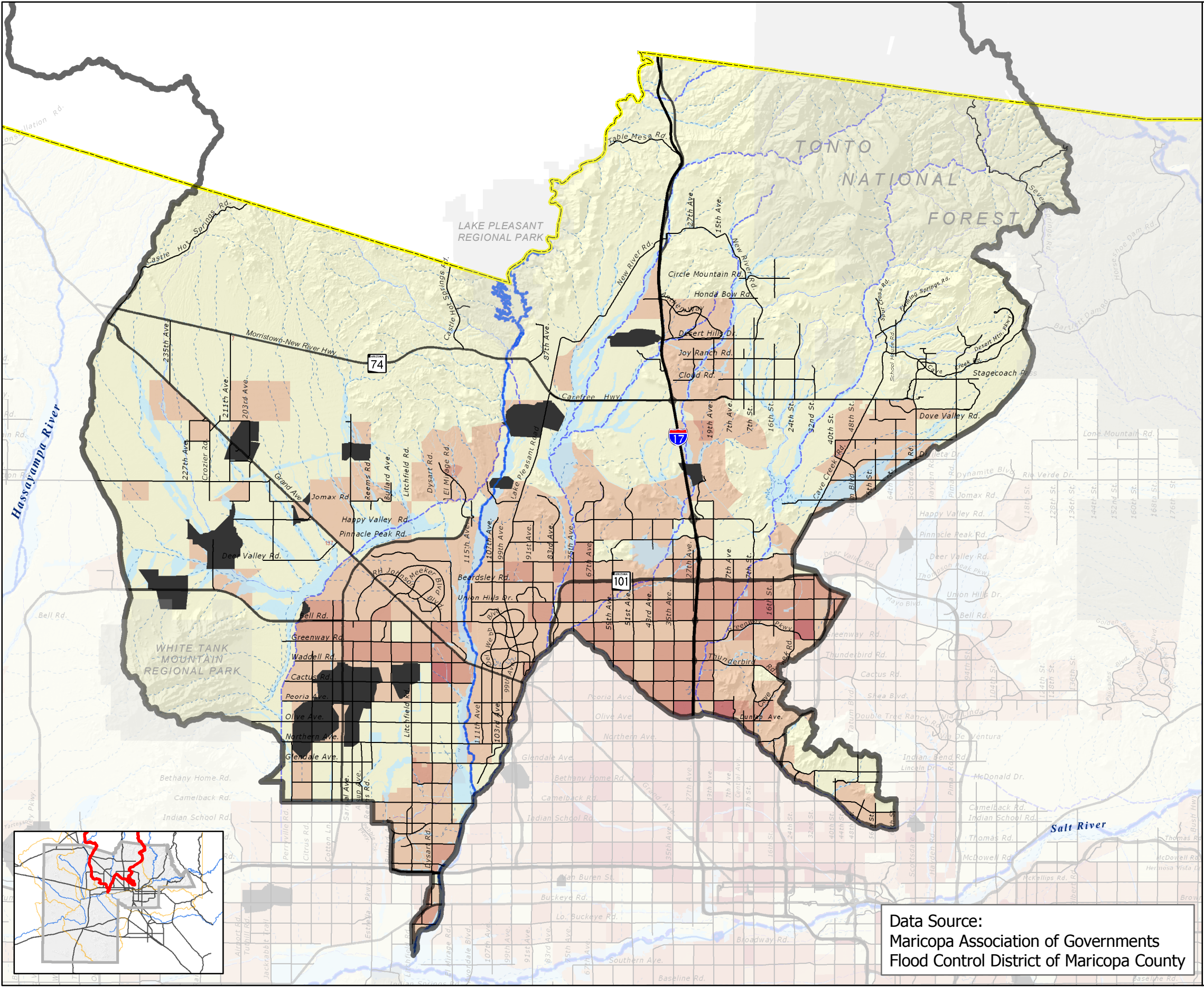
Delineated Floodplains & 2020 Population Projections

Agua Fria Watershed

Map 8-1

Legend

-  Agua Fria Watershed
-  FEMA Floodplains
- Estimated 2020 Population**
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



0 2.5 5 10 Miles

May 2009

Developable Areas

Agua Fria Watershed

Map 8 - 2

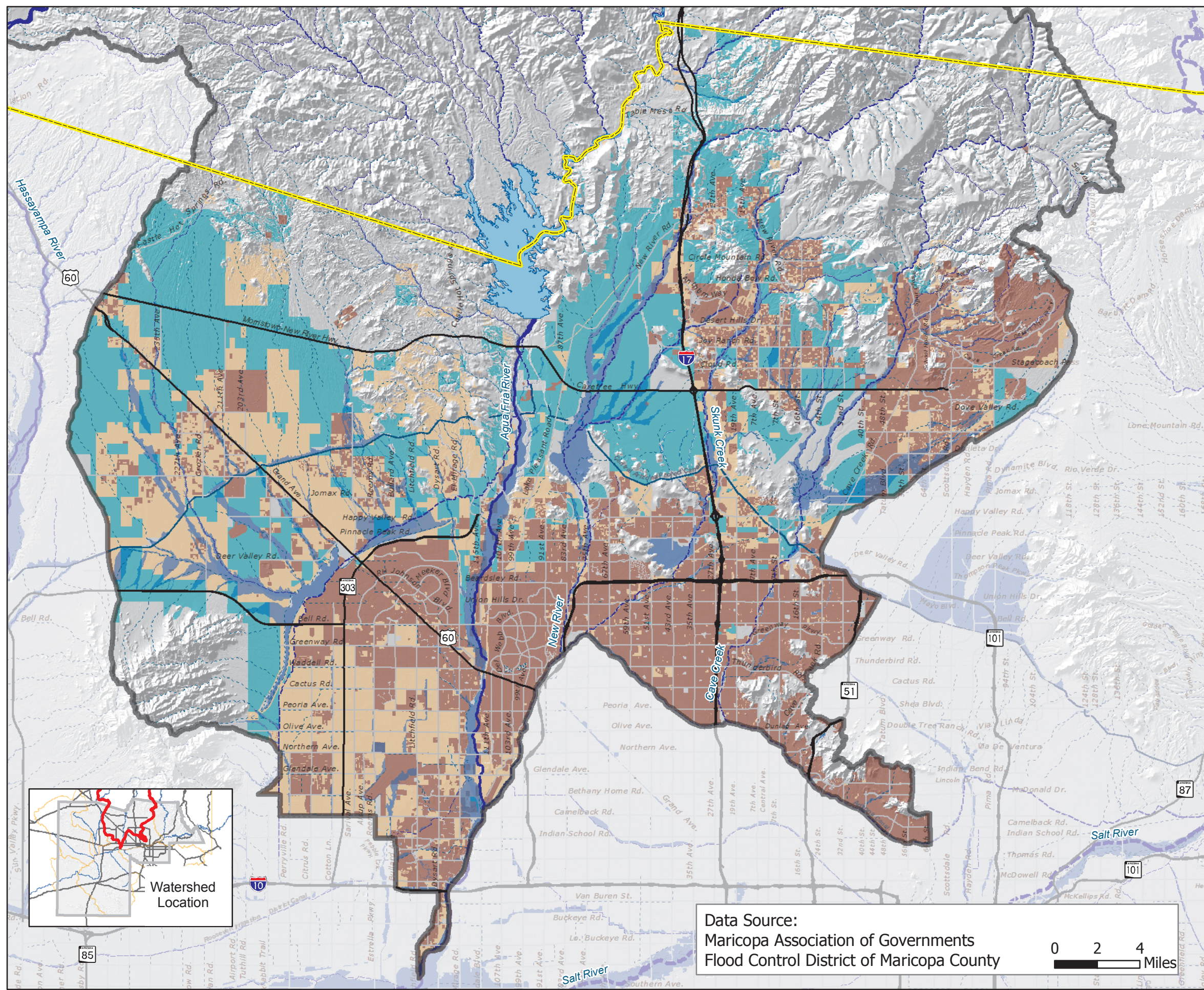
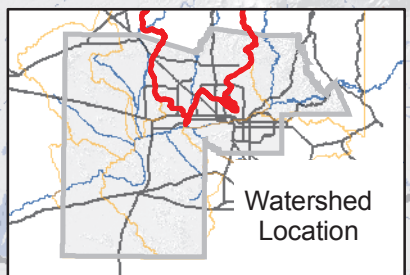
Legend

- Agua Fria Watershed - 2329 sq. mi.
- Developable Private Land - 212 sq. mi.
- Developable State Trust Land - 233 sq. mi.
- Existing Development (2007) - 285 sq. mi
- Freeways & State Routes
- Arterial Roads
- 100 Year Floodplains
- Maricopa County boundary



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

0 2 4 Miles



a serious threat to ongoing development and public infrastructure between Indian School Road and the crossing of the CAP siphon.

- Flooding problems associated with an urbanized watershed, such as changes in the timing of flows along tributaries to major watercourses, and the acceleration of flood flows through construction of storm sewers and increase in impervious surfaces.

Table 8-1: Hydrologic Soil Type of Agua Fria Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	2.0%
B	Moderately low runoff potential	49.8%
C	Moderately high runoff potential	16.2%
D	High runoff potential	32.0%

Completed District Activities

In addition to the 442 miles of delineated floodplains, the District has identified flood control solutions for a significant portion of this watershed and constructed an extensive network of flood control structures that protect the core urban area. The following list includes 1) area drainage master plans, area drainage master studies, watercourse master plans completed since 1985 (Table 8-2); and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District (Table 8-3).

Table 8-2 Completed Studies and Plans in Agua Fria Watershed

Name	Boundaries	Study Area (Sq Mi)	Completed
ACDC ADMS	Cave Buttes Dam and CAP canal (N); ACDC and Phoenix Mountains (S)	36	1995
Adobe Dam/Desert Hills ADMP	Tonto National Forest (N), Adobe Dam (S), 40th St./7th St. alignments (E)	100	2005
Agua Fria WCMP	Gila River to New Waddell Dam		2002
Agua Fria WCMP Channelization Ad- dendum	Indian School Road to CAP siphon		2005
Apache Wash Drain- age/Storm Drain Master Plan	Scatter Wash Basin and Cave Creek Wash with outfall to Cave Buttes Res- ervoir	29	1990
Carefree DMP	Town of Carefree	20	2002
Cave Creek DMP	Carefree Highway (S), 24th St. (W), Tonto National Forest (N), Carefree town limits (E)	50	2008
Glendale/Peoria ADMS/ADMP	ACDC and New River (S), New River Dam, 51st Ave. and Ludden Moun- tains (N/E), Agua Fria River (W)	80	1987, 1993, 2001, 2007
Loop 303/White Tanks ADMP	McMicken Dam (N), Gila River (S), White Tanks Mountain (E), Agua Fria River	220	2005
Middle New River WCMP	Confluence of Skunk Creek to New River Dam		2000
North Peoria ADMP			2002
Skunk Creek WCMP	CAP Canal (S) to 2,000 feet upstream of New River Road (N)		2001
Upper Cave Creek/ Apache Wash WCMP	County line (N) to Cave Buttes Dam (S)		2001
Upper New River ADMP	Tonto National Forest (E), Lower New River (S), Lower Agua Fria (W) and Upper Agua Fria (N)	97	2008
White Tanks/Agua Fria ADMS/ADMP	McMicken Dam (N), Gila River (S), White Tanks Mountain (E), Agua Fria River	215	1994

Table 8-3: Completed Capital Improvement Projects in Agua Fria Watershed

Project	Location	Completed
10th St Wash Basin No. 1	12th St. and Peoria Ave.	1996
10th St Wash Basin No.2	11th St. and Alice Ave.	1997
10th St Wash Improvements (Alice Ave to ACDC)	10th St., Alice Ave to ACDC at Griswold Rd. alignment	2008
67th Ave Storm Drain (Bell to ACDC)	67th Ave., Bell Rd. to ACDC	1990
67th Ave Storm Drain (Olive Ave. to ACDC)	67th Ave., Olive Ave. to ACDC	2009
7th Ave Storm Drain (Union Hills Dr to Cave Creek Wash)	7th Ave., Union Hills Dr. to Cave Creek Wash	1995
83rd Ave Grade Control Structure	Area bounded by Calley Lejos (N), Willisams Rd. (S), 91st Ave. (W), 83rd Ave. (E)	2008
83rd Avenue and Pinnacle Peak Road Drainage Improvements Project	83rd Ave. and Skunk Creek	2003
91st Ave & Bell Rd Drainage	91st Ave., Bell Rd. to Greenway Rd.; Greenway Rd., 91st Ave. to New River	1991
9th Avenue Storm Drain (Peoria Avenue to Arizona Canal Diversion Channel)	9th Ave., Peoria Ave. to ACDC	2008
Adobe Dam	Skunk Creek at Deer Valley Rd. alignment and 39th Ave. alignment	1982
Agua Fria Channelization	Agua Fria River, Camelback Rd. to 1/4 mi. south of Lower Buckeye Rd.	1988
Arizona Canal Diversion Channel	Arizona Canal, 37th Street to New River	1994
Beardsley Rd. Drainage System (7th Ave to 23rd Ave)	Beardsley Rd., 7th Ave. to 23rd Ave.	1995
Bethany Home Outfall Channel (Phase I)	Bethany Home Rd., SR-101L to New River	2000
Carefree Town Center Drainage	Area bounded by Sundance Tr./Tom Darl. Dr. (NW), Bloody Bas. Rd. / Tranquil Tr. (SE)	2002
Cave Buttes Dam	16th St. alignment and Happy Valley Rd. alignment	1980

8. Risk Analysis by Watershed

Project	Location	Completed
Cave Buttes Dike No. 1	18th St. alignment and Happy Valley Rd. alignment	1980
Cave Buttes Dike No. 2	32nd St. alignment , 1/2 mi. north of Happy Valley Rd. alignment	1980
Cave Buttes Dike No. 3	9th St. alignment and Dixileta Dr. alignment	1980
Cave Creek Channelization	Deer Valley Rd. to Arizona Canal	1991
Cave Creek Dam	16th St. alignment and Jomax Rd. alignment	1923
City of Phoenix Dam No. 7	Phoenix North Mountain Preserve, approximately 2nd St. and Aster Dr.	2009
Colter Channel	Between Camelback Rd. and Missouri Ave., Litchfield Rd. to Agua Fria River	1995
Dreamy Draw Dam	SR-51 and Northern Ave.	1973
Dysart Drain	Between Olive Ave. and Glendale Ave., Reems Rd. to Agua Fria River	1996
El Mirage Drain	El Mirage Rd., from Deer Valley Rd. to a point 1 1/4 mi. south, to Agua Fria River	1990
Greenway Parkway Channel (9th St to Cave Creek Rd)	Greenway Parkway, 9th St. to Cave Creek Rd.	2002
McMicken Dam	Area bounded by Grand Ave. (N), Peoria Ave. (S), 165th Ave. (E), 199th Ave. (W)	1956
McMicken Dam Outlet Channel	Extends 5.5 mi. northeast of northeast end of McMicken Dam	1956
New River Channelization	New River, Bethany Home Rd. to Olive Ave.	1996
New River Dam	Alignment of 79th Ave. and approximately Pinnacle Vista Rd.	1985
New River Dam Dike No. 1	Lake Pleasant Rd. and Dixileta Dr. Alignment	1985
Paradise Valley Detention Basin No. 4	Paradise Valley Community College (Component of Upper E. Fork Cave Creek)	1991
Roosevelt Irrigation District Canal Overchute	Litchfield Rd. and RID Canal	1998
Scatter Wash Channel (43rd Ave. to 35th Ave.)	Scatter Wash, 43rd Ave. to 35th Ave.	1995
Skunk Creek Channel and Levee	Skunk Creek, approximately Jomax Rd. alignment to Central Arizona Project	1983

Project	Location	Completed
Skunk Creek Channel Improvements (75th Ave to 51st Ave)	Skunk Creek, 75th Ave. to 51st Ave.	2000
Skunk Creek Sports Complex Bank Protection	Skunk Creek, New River to 75th Ave.	1999
Skunk Creek/ACDC Low Flow Channel	Skunk Creek, New River to 75th Ave.; ACDC, 73rd Ave. to Skunk Creek	2007
Sun City Drains	Sun City, T4N/R1W	1990
Sun City West Drains	Sun City West, T3N/R1E	1990
Upper East Fork Cave Creek Drainage	Area bounded by SR-101L (N), Bell Rd. (S), 9th St. (W), 32nd St. (E); 4 basins & PVCC	1996
White Tanks FRS No. 3	Jackrabbit Tr. alignment and Glendale Ave. alignment	1954
White Tanks FRS No. 3 North Inlet Channel (NIC) Project	Beardsley Canal, Olive Ave. to White Tanks FRS No. 3	2008

Recommendations

Based on the results of the above needs assessment, and compilation of recommendations from Area Drainage Master Plans and other studies, the following five-year program of work is proposed to mitigate flooding in the Agua Fria Watershed. The proposed activities are categorized by District program⁵. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes. Flood warning systems should be installed at wash crossings that frequently flood. The District will also develop Flood Response Plans for specific high hazard areas to allow for efficient and timely emergency response to flooding events.

Identification

The District will complete 60 miles of additional delineations, and identify flooding problems and solutions for 142 square miles in the Agua Fria watershed.

⁵ Chapter 5 describes the possible activities under four core programs that the District can undertake to mitigate flooding.

Table 8-4: Five-year Delineation Program in Agua Fria Watershed

Delineation Name	Study Area (linear miles)	Timeframe
Wittmann	40	FY 2010-2013
Upper Wittmann	20	FY 2012-2013

Table 8-5: Five-Year Planning Program in Agua Fria Watershed

Study Name	Study Area (Square Miles)	Timeframe
Glendale Peoria ADMP	83	FY 2010-2012
Lake Pleasant ADMP	59	FY 2013-2015

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the six communities within the watershed for which the District performs floodplain management duties. The District will also work with other jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

The five-year Capital Improvement Program recommends the construction of flood control infrastructure to mitigate flooding in the Agua Fria Watershed (see Map 8-3, Capital Improvement Projects, FY 2010-2014). Non-structural measures to remediate flooding in this watershed include purchasing homes located in the 100-year floodplain through the Floodprone Properties Assistance Program. Operation and maintenance of existing structures will be ongoing to preserve the integrity of facilities.

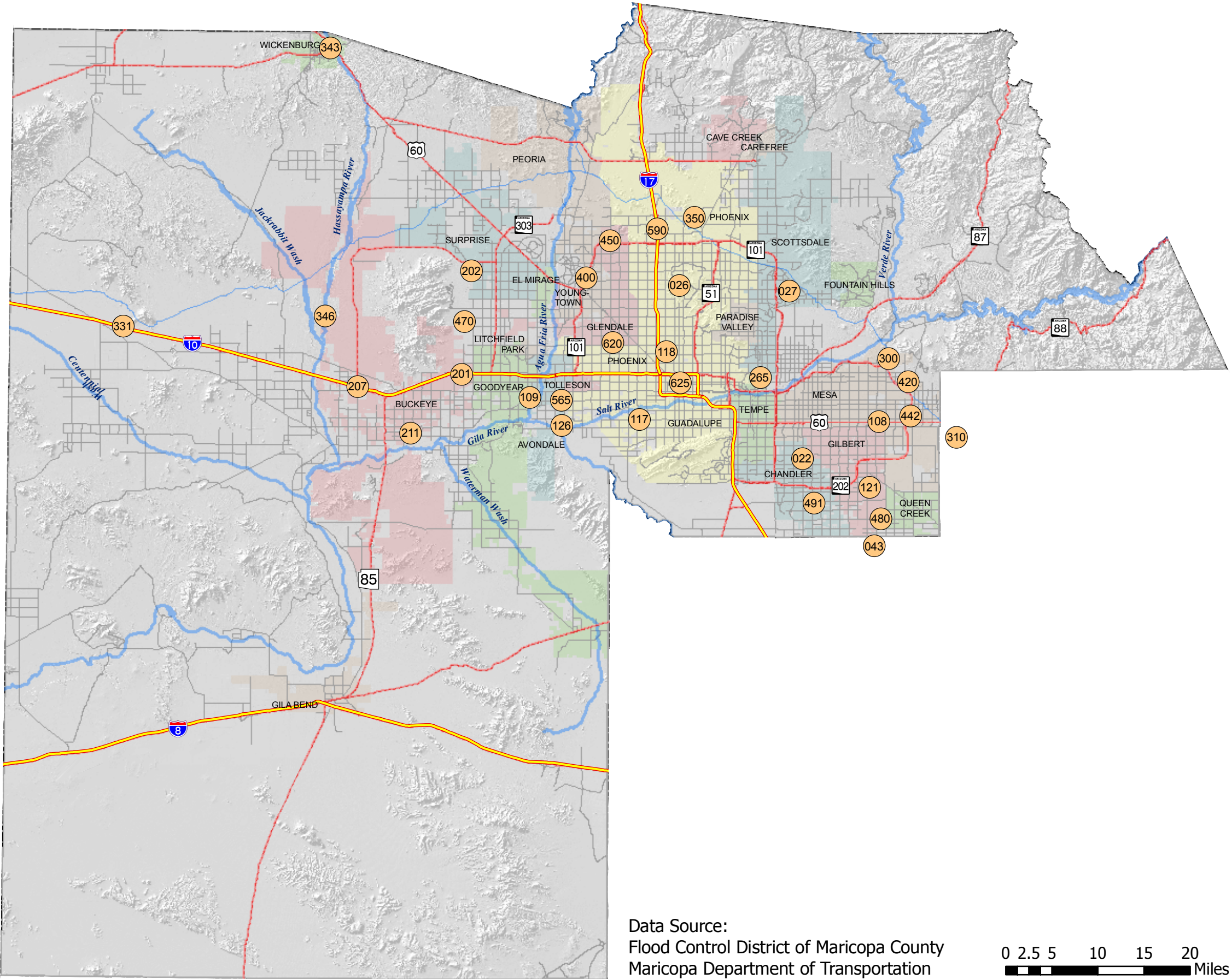
Table 8-6: Five-Year Capital Improvement Program in Agua Fria Watershed

Project	CIP Map Code	Benefitted Area	Timeframe
Arizona Canal Diversion Channel Improvements	118		FY 2010-2012
Cave Buttes Dam Modifications	350	100	FY 2010-2013
Loop 303 Drainage Improvements	470	78	FY 2010-2014
McMicken Dam	202	19	FY 2010-2014
New River (Grand Ave. to Skunk Creek, including Paradise Shores)	400	1.5	FY 2010
Northern Ave. Storm Drain (47th Ave. to 63rd Ave.)	450	3.5	FY 2010-2011

Capital Improvement Projects FY 2010 - 2014

Map 8-3

- 022 City of Chandler
- 026 City of Phoenix
- 027 City of Scottsdale
- 043 Town of Queen Creek
- 108 Sossaman Road Channel
- 109 Agua Fria River
- 117 South Phoenix Drainage Improvements
- 118 Arizona Canal Diversion Channel
- 121 East Maricopa Floodway
- 126 Salt / Gila River
- 201 White Tanks FRS No.4
- 202 McMicken Dam
- 207 Buckeye FRS No.1
- 211 Buckeye / Sun Valley ADMS
- 265 Granite Reef Wash
- 300 Spook Hill FRS
- 310 Powerline Dam
- 331 Saddleback FRS
- 343 Wickenburg ADMS
- 346 Hassayampa WCMP
- 350 Cave Buttes Dam
- 400 Skunk Creek and New River
- 420 Spook Hill ADMP
- 442 East Mesa ADMP
- 450 Glendale / Peoria ADMP
- 470 White Tanks / Agua Fria ADMP
- 480 Queen Creek ADMS
- 491 Higley ADMP
- 565 Durango ADMP
- 590 Scatter Wash
- 620 Maryvale ADMP
- 625 Metro ADMP



Data Source:
Flood Control District of Maricopa County
Maricopa Department of Transportation

0 2.5 5 10 15 20
Miles



Project	CIP Map Code	Benefitted Area	Timeframe
Pinnacle Peak Rd./67th Ave. Drainage Improvements	450	1	FY 2010-2014
Pinnacle Peak Rd. Channel (89th Ave. to Agua Fria River)	450	4.4	FY 2010-2014
Reems Rd. Channel and Basin	470	9.4	FY 2010
Rose Garden Lane Channel	450	8	FY 2010-2012
Scatter Wash Channel and Basin	590	0.7	FY 2010
Waddell Rd. Drainage Improvements	470	2.3	FY 2011-2014
White Tanks FRS No. 3 Modifications	470	13.7	FY 2010-2011

Cave Creek/Salt

At 506 square miles, the Cave Creek/Salt Watershed is the smallest of the watersheds. The Salt/Gila River marks the southern boundary of the watershed. The Arizona Canal Diversion Channel marks the northern boundary from 40th Street to the confluence with Skunk Creek.

Physical Characteristics

Major hydrologic features include the Salt River, Indian Bend Wash, Arizona Canal, and the Crosscut Canal. The McDowell, Phoenix, and Papago mountains limit development in this area. A diversity of physical features such as varied topography, soil erosion, and geology are present throughout the watershed. Large alluvial fans, especially in the north Scottsdale area, contribute to the large floodplain in that area. The first major area within the 100-year floodplain covers large land areas near Loop 101 through Scottsdale, Hayden and Pima roads in north Scottsdale. This area is bounded by the McDowell Mountains to the east. Second, the 100-year floodplain covers existing urban areas generally south of I-10 between Interstate 17 and 19th Avenue. Third, rapidly urbanizing areas in the western portion south of I-10 are also within the Salt River 100-year floodplain. Lastly, existing canals in Glendale, Phoenix and Scottsdale form the 100-year floodplain, which presents a potential flooding problem in existing urban areas.

Socioeconomic Characteristics

All or parts of the municipal boundaries of Avondale, Fountain Hills, Glendale, Good-year, Mesa, Paradise Valley, Peoria, Phoenix, Scottsdale, Tempe and Tolleson fall within this watershed. Approximately 18% of the watershed is unincorporated county.

While the Cave Creek/Salt Watershed includes central and downtown Phoenix and the first urban areas in Maricopa County, it also includes the rapidly urbanizing areas of the West Valley and North Scottsdale. Within this watershed, the 2005 population of 1,552,269 is projected to increase to 1,937,775 by 2020. Geographically, this popula-

tion will locate in areas such as privately owned farmland near the western portion of I-10 and in presently undeveloped private and state trust land in the northern sections of the watershed (see Map 8-4 Delineated Floodplains & 2020 Population Projections, Cave Creek/Salt Watershed). Outside these areas, Indian Communities, forest, and park areas will experience very little development.

There are several areas within the watershed that are characterized as significant growth areas, defined as a 10,000% projected increase in population between 2005 and 2020 (see Map 8-5, Developable Areas Cave Creek/Salt Watershed). The majority of the significant growth areas are master planned developments or special development areas. For example, the Western Area Specific Plan in Glendale, centered on the Arizona Cardinals and Phoenix Coyotes stadiums, is located within the Agua Fria watershed. The Western Area Plan is bounded on the east and west by 83rd and 115th Avenues. The current land use is primarily agricultural. Glendale forecasts that development in this sector, focused at the Glendale Avenue/SR Loop 101 interchange, will accommodate two-thirds of the added population and jobs, and nearly half of the city's commercial development, to 2025.

Critical facilities in the Cave Creek/Salt Watershed include Sky Harbor International Airport, and the freeway system including I-10, I-17, and State Routes 101L and 202L. Development in the north and southwestern sections of this watershed will force the expansion of the transportation infrastructure. The future Loop 202 (South Mountain Freeway) will be expanded near 55th Avenue to intersect I-10. As with past freeway expansions, areas along this freeway corridor will develop rapidly.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

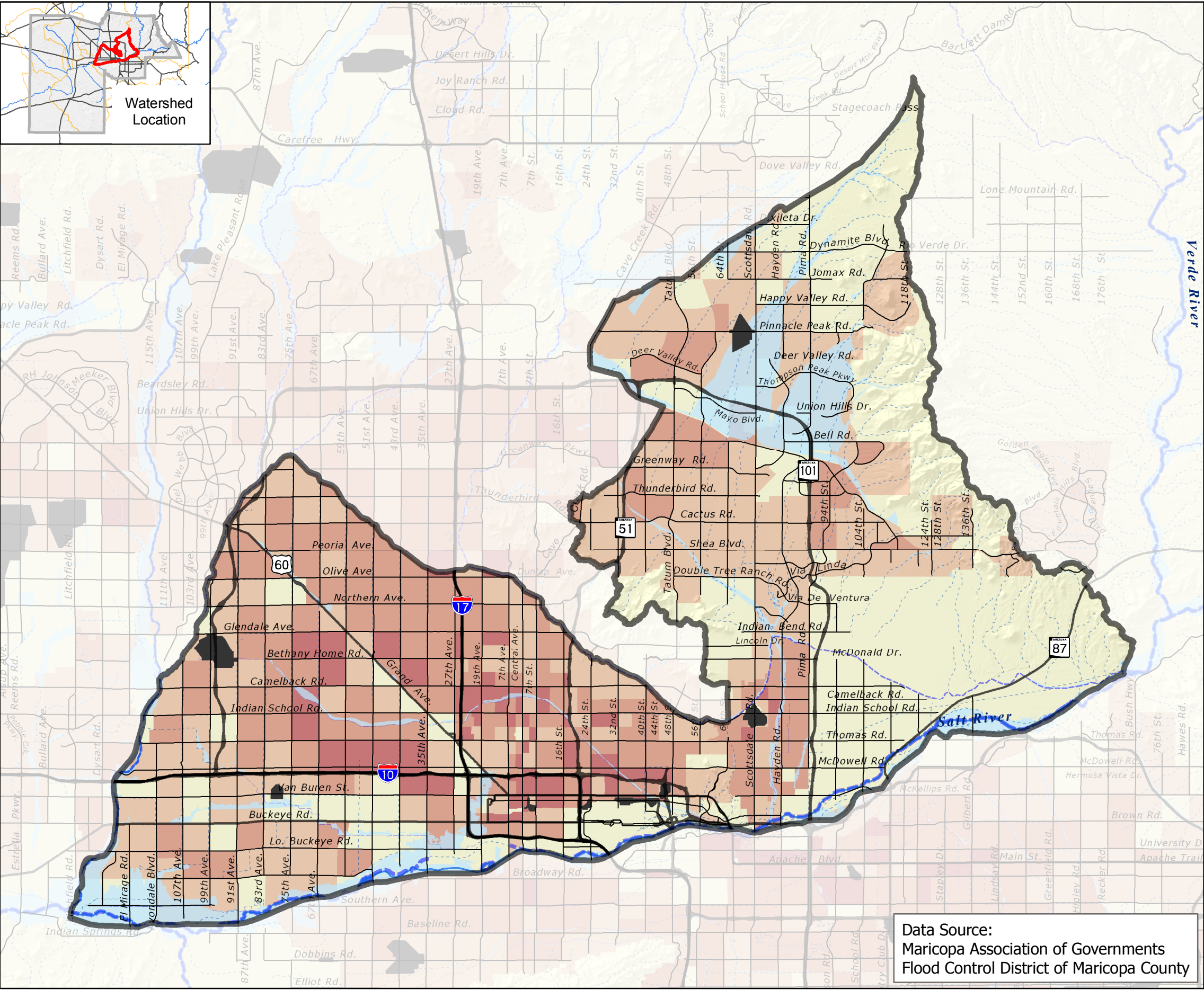
The Cave Creek/Salt Watershed is the most populated of the eight watersheds. This area experiences flooding problems associated with an urbanized watershed, such as changes in the timing of flows along tributaries to major watercourses, and the acceleration of flood flows through construction of storm sewers and increase in impervious surfaces.

There are currently 14,016 residential structures in the identified 100-year floodplain. Since 2005, 115 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

The repetitive loss community of Holly Acres is located in the southwestern corner of the Cave Creek/Salt watershed. The property owners in this area receive information from the District regarding repetitive loss and the NFIP (see Map 4-1).

Flooding Risk Summary

- There are 142 linear miles of delineated floodplains in the watershed; an estimated 440 miles remain to be delineated.



Delineated Floodplains & 2020 Population Projections

Cave Creek / Salt River Watershed

Map 8-4

Legend

-  Cave Creek/Salt Watershed
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas

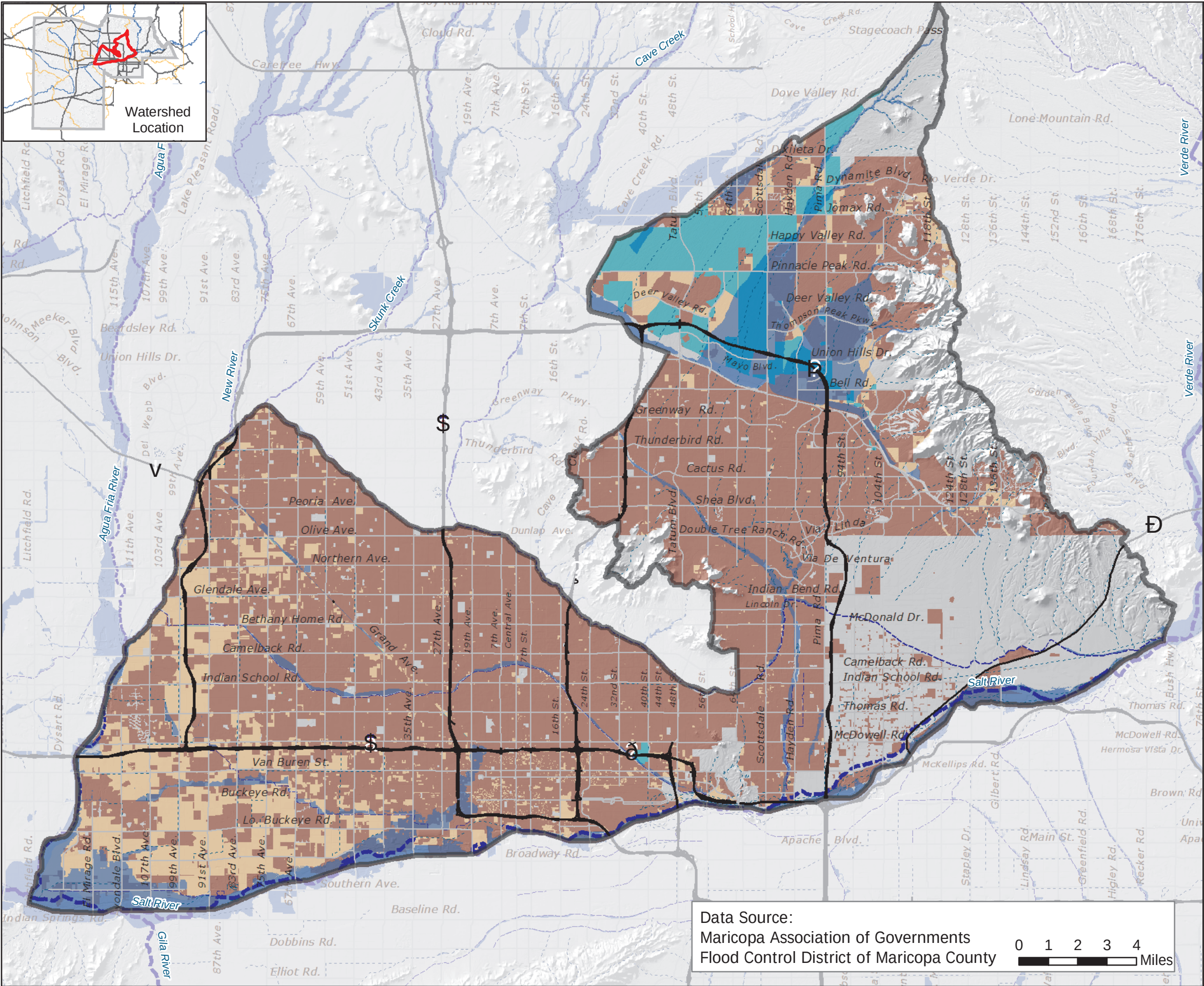


0 2.5 5 Miles

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



Watershed Location



Developable Areas

Cave Creek/Salt Watershed

Map 8-5

Legend

- Cave Creek/Salt Watershed-506 sq. mi.
- Developable Private Land-67 sq. mi.
- Developable State Trust Land-23 sq. mi.
- Existing Development (2007) - 296 sq. mi.
- Freeways & State Routes
- Arterial Roads
- 100 Year Floodplains

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



- Approximately three-quarters of the soils in the watershed have a moderately low runoff potential (see Table 8-7).
- There are no dams with identified deficiencies.
- General flooding and erosion issues in this watershed include:
 - Ponding behind canals, especially along the Grand Canal in central Phoenix
 - Shallow flooding for large sections of the urban area
 - Alluvial fan flooding in north Scottsdale
 - The downtown area is subject to substantial flood flows, as evidenced by the August 2005 and July 2008 floods that caused considerable disruption to the downtown areas. These flooding problems are largely due to the lack of open, undeveloped land that can absorb water.
 - Substantial stormwater accumulation occurs along the north side of Sky Harbor Airport. This area is characterized by a wide, shallow floodplain that extends westward toward I-10. Once the capacity of the storm drain system is exceeded, runoff accumulates and results in a flood hazard for low-lying properties.

Table 8-7: Hydrologic Soil Type of Cave Creek/Salt Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	5.1%
B	Moderately low runoff potential	75.1%
C	Moderately high runoff potential	8.8%
D	High runoff potential	11.2%

Completed District Activities

In addition to the 142 miles of delineated floodplains, the District has identified flood control solutions for a significant portion of this watershed and constructed an extensive network of flood control structures that ring the core urban area. The following list includes 1) area drainage master plans, area drainage master studies, and watercourse master plans completed since 1985; and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District.

Table 8-8: Completed Studies and Plans in Cave Creek/Salt Watershed

Name	Boundaries	Study Area (Sq Mi)	Completed
Granite Reef Wash ADMP	Arizona Canal (N), Salt River (S), SR101L (E), Indian Bend Wash (W)	6	2002
Scottsdale Road	71st Street Channel from Mountain View Rd. to Cactus Rd. and along Scottsdale Rd. from Mountain View Rd. to Thunderbird Rd.	9	2002
Maryvale ADMS	ACDC and Skunk Creek (N), Black Canyon Highway (E), Papago Freeway (S), and Agua Fria River, New River and Agua Fria Freeway (W).	100	1997
Durango ADMP	I-10 (N), Salt River (S), Agua Fria River (W), I-17 (E)	53	2002
Metro Phoenix ADMS/ADMP	ACDC (N), I-17 (W), Salt River (S) and Papago Buttes (E)	90	2008

Table 8-9: Completed Capital Improvement Program in Cave Creek/Salt Watershed

Project	Location	Completed
24th Avenue and Camelback Rd Basin	24th Ave. and Camelback Rd.	2008
26th Avenue and Verde Lane Basin	Verde Ln. alignment; 26th Dr. to I-17 Frontage Rd.	2007
67th Ave Storm Drain (Olive Ave. to ACDC)	67th Ave., Bell Rd. to ACDC	1990
Agua Fria Channelization	Agua Fria River, Camelback Rd. to 1/4 mi. south of Lower Buckeye Rd.	1988
Arizona Canal Diversion Channel	Arizona Canal, 37th Street to New River	1994
Avondale Landfill Excavation	Dysart Rd. and Buckeye Rd.	1986
Bethany Home Outfall Channel (Phase I)	Bethany Home Rd., SR-101L to New River	2000
Bethany Home Outfall Channel (Phase IIA)	Bethany Home Rd., SR-101L to 83rd Ave.; Grand Canal, Bethany Home Rd. to 67th Ave.	2008

Project	Location	Completed
Cactus Rd Flood Control System	Cactus Rd., Scottsdale Rd. to 64th St.; 68th St., Cactus Rd. to Mescal Park	1991
Cactus Rd Storm Drain (67th Ave to SR101L)	Cactus Rd., 67th Ave. to Agua Fria Freeway (SR-101L)	1998
Camelback Ranch Levee	Agua Fria River and Camelback Rd.	1999
Camelback Side Drain Extension	Camelback Rd., 64th St. to 68th St; Lafayette Blvd., 64th St. to 68th St.	1986
Cave Buttes Dike No. 2	32nd St. alignment , 1/2 mi. north of Happy Valley Rd. alignment	1980
Doubletree Ranch Road System	Doubletree Ranch Rd., Tatum Blvd to Indian Bend Wash at 58th St. alignment	2004
Holly Acres Bank Stabilization	Gila River North Bank, El Mirage Rd. to 113th Ave.	1984
Indian Bend Wash	Between Hayden Rd. and Scottsdale Rd., Indian Bend Rd. to Salt River at SR-202L	1985
Indian School Road Drain (107th Ave to Agua Fria River)	Indian School Rd., 107th Ave. to Agua Fria River	1989
Maryvale Stadium West Inlet Channel	Grand Canal, between Indian School Rd. and Osborn Rd., 57th Ave. to 51st Ave.	2001
New River Channelization	New River, Bethany Home Rd. to Olive Ave.	1996
Northern & Orangewood Storm Drain	Between Butler Dr. and Glendale Ave., 63rd Ave. to Agua Fria River	2001
Oak St. Drain (58th St to Indian Bend Wash)	Oak Street, 58th St. to Indian Bend Wash	2000
Old Cross Cut Canal	48th St., Arizona Canal to McDowell Rd.	1991
Olive Ave. Storm Drain (51st Ave to 91st Ave)	Olive Ave., 51st Ave. to 91st Ave.	1995
Osborn Rd. Storm Drain	Between Osborn Rd. and Thomas Rd., 60th St. to Ind. Bend Wash at 76th St. and Earll Dr.	2001

Project	Location	Completed
Salt River Channel (McClintock Dr to Price Rd)	North bank of Salt River, McClintock Dr. to Price Rd.	1998
Salt River Channel (Price Rd to McKellips Rd)	Salt River, Price Rd. to McKellips Rd.	1998
Salt River Channel (SR-143 to McClintock Dr)	Salt River, SR-143 to McClintock Dr.	1991
Salt River Low Flow Ch. (19th Ave to I-10)(Phx Rio Salado)	Salt River, 19th Ave. to I-10 at approximately 30th St. alignment	2002
Scottsdale Rd Drainage (Thunderbird Rd to Doubletree Ranch Rd)	Approximately Scottsdale Rd., Thunderbird Rd. to Doubletree Ranch Rd.	2008
Tatum Wash Detention Basin	45th St. and Shea Blvd.	1998

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Cave Creek Watershed. The recommended activities are categorized by District program⁶. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes. Flood warning systems should be installed at wash crossings that frequently flood.

Identification

The District will complete 40 miles of additional alluvial fan delineations in Phoenix and Scottsdale by fiscal year 2011. The methods used to delineate the alluvial floodplains will be those that are more accurate for the watershed than those currently being applied. Solutions for flooding problems will be finalized in FY 2010 for 50 square miles of Phoenix area as part of the Metro ADMP.

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the communities for which the District performs floodplain management duties. The District will also work with jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

⁶ Chapter 5 describes the possible activities under four core programs that the District can undertake to mitigate flooding.

The five-year Capital Improvement Program recommends the construction of flood control infrastructure to mitigate flooding in the Cave Creek/Salt Watershed (see Map 8-3, Capital Improvement Projects FY 2010-2014). Non-structural measures to remediate flooding in this watershed include the Floodprone Properties Assistance Program, to purchase or floodproof homes located in the 100-year floodplain, and in ponding areas. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Table 8-10: Five-Year Capital Improvement Program in Cave Creek/Salt Watershed

Project	CIP Map Code	Benefitted Area (Sq. Miles)	Timeframe
Tres Rios	126	49	FY 2010-2014
Granite Reef Wash Drainage Improvements	265	2.1	FY 2012-2014
67th Ave. Storm Drain	450		FY 2010
75th Ave. Storm Drain	565	6.4	FY 2010
DRCC (107th Ave. to Agua Fria)	565	2.3	FY 2010-2014
DRCC (75th Ave. to 107th Ave.)	565	2.3	FY 2010-2014
Bethany Home Outfall Channel	620	24.5	FY 2010
Camelback Road Storm Drain (59th Ave. to 75th Ave.)	620	1.4	FY 2010-2013
Bethany Home Rd. Storm Drain (79th Ave. to 59th Ave.)	620	3.7	FY 2010-2013
Downtown Phoenix Drainage System	625	0.6	FY 2010-2014

Actions to Reduce Repetitive Losses

The U.S. Army Corps of Engineers, in conjunction with the City of Phoenix and the District, have initiated the Tres Rios project to mitigate flooding in the repetitive loss community of Holly Acres. Tres Rios consists of north bank levee improvements from 105th Avenue to the Agua Fria River, channelization, creation of habitat areas composed of open water marshes and overbank wetlands, and a pump station to provide water for the habitat areas. The property on the north side of the Salt and Gila rivers, including the Holly Acres subdivision, will be protected from river flooding by the north bank levee component of the project. Construction has been completed on the first half of the 4.5-mile levee, which runs along the Salt River from 83rd Avenue to the Agua Fria. Monies have been allocated in 2009 to complete the levees. The District will operate and maintain the north bank levee.

Centennial

The Centennial Watershed covers an area of 1,924 square miles in northwestern Maricopa County and portions of La Paz and Yavapai counties. The Harquahala and Saddleback flood retarding structures provide protection for portions of the watershed.

Physical Characteristics

The Centennial Watershed consists of flat valleys juxtaposed against Saddle Mountain and the Gila Bend and Harquahala mountain ranges. Major hydrologic features include Centennial Wash, Grass Wash and the Gila River. The wide floodplains in the Aguila area are characteristic of natural, unregulated rivers and washes. The Signal Mountain Wilderness Area is located in the southeastern portion of the watershed. The majority of the watershed retains its native Sonoran Desert vegetation.

Socioeconomic Characteristics

Nearly 100% of the watershed is unincorporated county, including the community of Aguila. The Town of Buckeye is the only incorporated area within the Centennial watershed, with less than 1% of the total land area.

The 2005 population of 4,587 is expected to triple to 13,790 in 2020. In this watershed, the population centers expand near existing agricultural areas along I-10 and US 60 (see Map 8-6, Delineated Floodplains & 2020 Population Projections, Centennial Watershed).

The Bureau of Land Management is the major land owner, with over 53% of the watershed area under its control. The remaining land is either privately held (28%) or owned by the Arizona State Land Department (19%). In the northern section near US 60, private land exists along the highways and is surrounded by state trust land. In the southwestern section, I-10 is surrounded by both private, predominately agriculture lands and state trust lands.

Critical facilities include the existing transportation infrastructure consisting of I-10, US 60, and other highways; the Palo Verde Nuclear Generating Station, located south of I-10 on Wintersburg Road, and the Central Arizona Project Canal.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Centennial Watershed is one of the least populated of the eight watersheds. There are currently 160 parcels with residential structures in the identified 100-year floodplain. Since 2005, 140 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

Delineated Floodplains & 2020 Population Projections

Centennial Watershed

Map 8-6

Legend

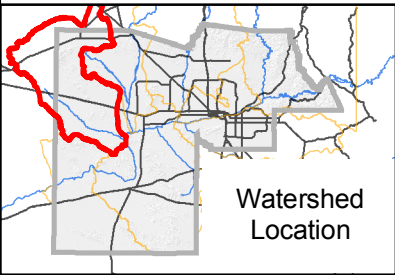
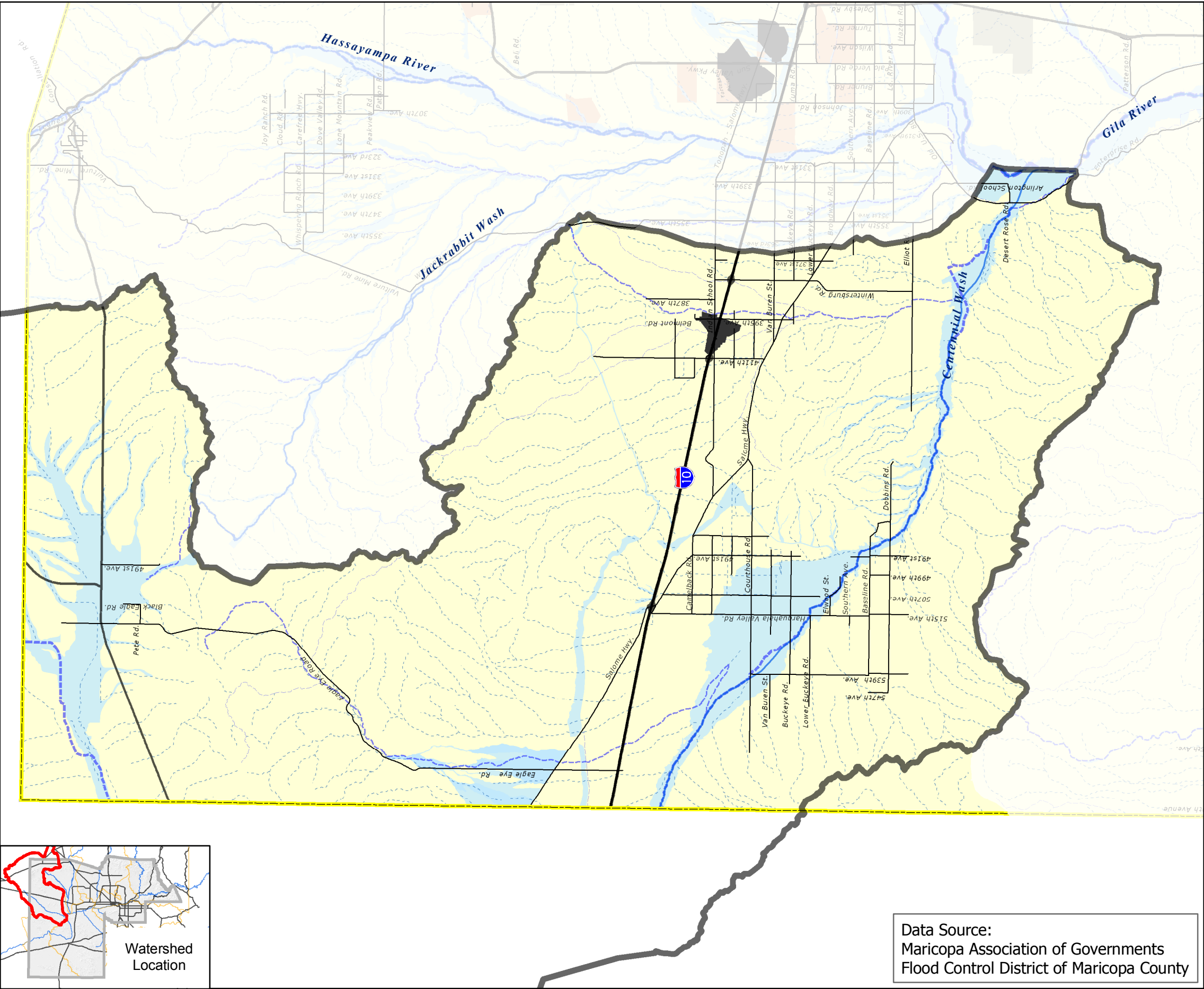
-  Centennial Watershed
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas



0 2.5 5 10 Miles

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

May 2009



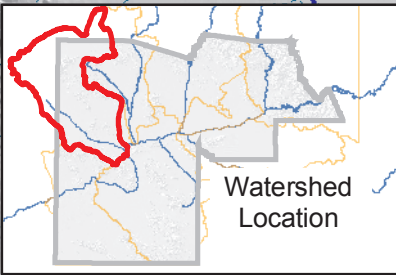
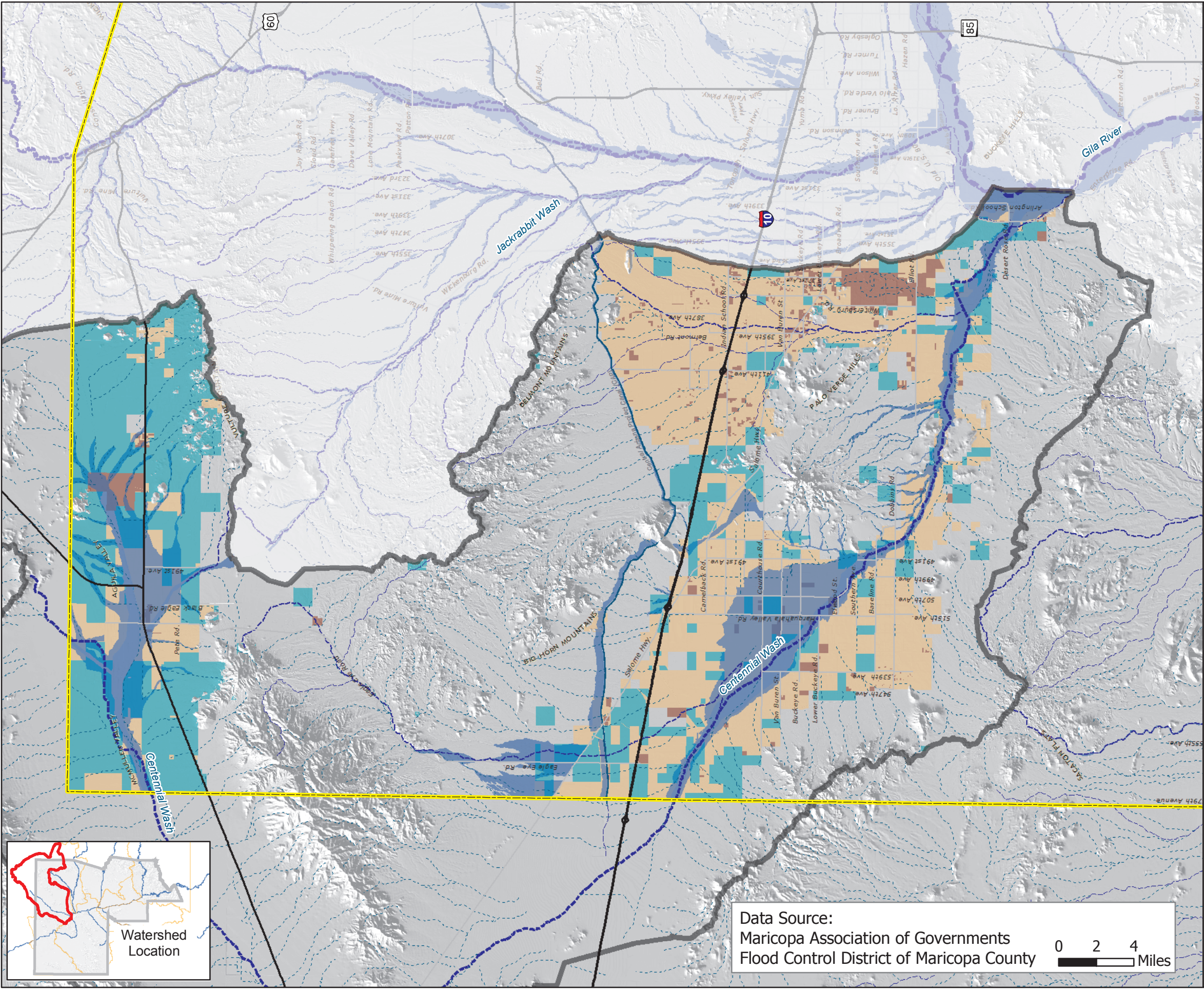
Developable Areas

Centennial Watershed

Map 8-7

Legend

- Centennial Watershed 1924 sq. mi.
- Developable State Trust Land-212 sq. mi.
- Developable Private Land-287 sq. mi.
- Existing Development (2007)-25 sq. mi
- Freeways & State Routes
- Arterial Roads
- 100 Year Floodplains
- Maricopa County boundary



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

0 2 4 Miles

Residential and agricultural development in the Centennial watershed tends to occur in floodprone areas (see Map 8-7, Developable Areas, Centennial Watershed). The populated areas of the watershed have been subject to repeated flooding. Numerous homes were flooded and streets washed out in the Town of Aguila during the August 1997 and October 2000 storms.

Flooding Risk Summary

- There are 248 linear miles of delineated floodplains in the watershed; an estimated 1,116 miles remain to be delineated.
- Over one-third of the soils in the watershed have a moderately low runoff potential (see Table 8-11).
- There are no dams with identified deficiencies.
- General flooding and erosion issues in this watershed include:
 - Riverine flooding along the Centennial Wash and the Gila River
 - Wide shallow washes with hard to define floodways and floodplains
 - Sheet flow across flat valleys and agricultural land

Table 8-11: Hydrologic Soil Type of Centennial Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	4.4%
B	Moderately low runoff potential	46.0%
C	Moderately high runoff potential	14.4%
D	High runoff potential	35.1%

Completed District Activities

There are no regional flood control structures in the Centennial Watershed. The District has delineated 248 miles of floodplains and completed an Area Drainage Master Plan for 80 square miles in the Aguila area in 2004.

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Centennial Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes.

Identification

8. Risk Analysis by Watershed

The District will complete 130 miles of additional delineations, and identify flooding problems and solutions for 682 square miles.

Table 8-12: Five-Year Delineation Program in Centennial Watershed

Delineation Name	Study Area (linear miles)	Timeframe
Tiger Wash Alluvial Fans	20	FY 2013-2014
Aguila (Upper Centennial)	50	FY 2013-2014
Lower Centennial Wash	60	FY 2014-2015

Table 8-13: Five-Year Planning Program in Centennial Watershed

Study Name	Study Area (square miles)	Timeframe
Palo Verde ADMP	251	FY 2013
Tiger Wash ADMP	200	FY 2014-2015
Upper Centennial ADMP	231	FY 2012-2015

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the Town of Buckeye.

Remediation

There are no structural flood control measures planned for the Centennial watershed in the next five years. Non-structural measures to remediate flooding in this watershed include the Floodprone Properties Assistance Program.

Gila/Queen Creek

The Gila/Queen Creek watershed is located in southeastern Maricopa County. The watershed contains 1,307 square miles, of which a portion lies outside the county. The Salt/Gila River serves as the northern boundary of the watershed. Several dams and flood retarding structures protect large areas of the watershed from flooding including the East Maricopa Floodway, and the Spook Hill, Guadalupe, Powerline, Rittenhouse and Vineyard flood retarding structures.

Physical Characteristics

In Maricopa County, the Gila/Queen Creek watershed is a flat valley interrupted by the steep slopes of South Mountain. The Salt River, Sonoqui Wash and Queen Creek are the main hydrologic features in the watershed. The remaining floodplains are primarily ponding associated with canals and other features. The majority of the area's natural waterways were obliterated by a long history of farming.

Socioeconomic Characteristics

All or parts of the municipal boundaries of Apache Junction, Avondale, Chandler, Gilbert, Goodyear, Guadalupe, Mesa, Phoenix, Queen Creek and Tempe fall within this watershed. The Gila River Indian Community is located in the southwestern portion of the watershed. Approximately one-third of the area is unincorporated county.

The Gila/Queen Creek watershed had a population of 1,312,104 in 2005. By 2020, the population is expected to grow to 1,741,025 persons. Over 70% of the developable land is already developed. The remaining developable areas are located in the southeastern and northwestern corners of the watershed (see Map 8-8, Delineated Floodplains & 2020 Population Projections, Gila/Queen Creek Watershed).

An area of significant growth in the watershed (defined as a 10,000% increase in population) is surrounding the Phoenix-Mesa Gateway Airport in southeast Mesa (see Map 8-9, Developable Areas, Gila/Queen Creek Watershed). This 32-square-mile area from Power Road to Meridian Drive and from approximately Guadalupe Road to Germann Road is intended to become "the economic engine for southeast Mesa and the surrounding region⁷." The vision for the master planned community is to balance residential, commercial, and industrial uses in one sustainable, live-work community. By 2030, Mesa estimates that the area will support more than 132,000 jobs, with much of the workforce living nearby in one of the more than 46,000 housing units. The proposed flood control and drainage system for the area is based on the recommendations of the East Mesa Area Drainage Master Plan.

Several regional transportation corridors intersect the area—Interstate-10, State Route 60, and State Routes Loop 101 and Loop 303. The future Loop 202 South Mountain Transportation Corridor will be a significant feature in this watershed.

The watershed is primarily under private ownership (67%) or part of the Gila River Indian Community (24%). The South Mountain Regional Park is the only open space of major significance. The park is nearly six percent of the total land area for this watershed.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Gila/Queen Creek watershed is the second most populated of the eight watersheds. There are currently 4,567 structures in the identified 100-year floodplain. Since 2005, 124 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

The Gila/Queen Creek watershed benefits from the presence of large flood retarding structures in the eastern portion of the watershed, as well as from the construction

⁷ Mesa Gateway Strategic Development Plan Summary Document, Adopted on December 8, 2008

of other major flood control works including the East Maricopa Floodway (EMF). The EMF is a compacted earth, concrete and riprap channel that provides 100-year flood protection for the Mesa Gateway-Chandler area.

In the 1990s, several area drainage master plans were completed in this area. Since then many of the recommended drainage features identified in the ADMPs, such as the Elliot Road Detention Basin/Outfall Channel and Ellsworth Road Channel, have been constructed. In the early 2000s, the region experienced widespread residential and commercial development. More development is proposed, requiring the update of several of the studies.

Flooding Risk Summary

- There are 67 linear miles of delineated floodplains in the watershed; an estimated 691 miles remain to be delineated.
- Approximately three-quarters of the soils in the watershed have a moderately low runoff potential (see Table 8-14).
- One dam—Powerline Flood Retarding Structure—has identified deficiencies.
- General flooding and erosion issues in this watershed include:
 - Shallow flooding for large sections of the urban area.
 - Alluvial fan flooding in and around South Mountain Park.
 - Flooding and ponding due to the inadequate capacity of storm drains and channels in the urban areas.
 - Flooding problems associated with an urbanized watershed, such as changes in the timing of flows along tributaries to major watercourses, and the acceleration of flood flows through construction of storm sewers and increase in impervious surfaces.

Table 8-14: Hydrologic Soil Type of Gila/Queen Creek Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	5.9%
B	Moderately low runoff potential	78.3%
C	Moderately high runoff potential	12.4%
D	High runoff potential	3.5%

Completed District Activities

In addition to the 67 miles of delineated floodplains, the District has identified flood control solutions for a significant portion of this watershed and constructed an extensive network of flood control structures that ring the core urban area. The following list includes 1) area drainage master plans, area drainage master studies, and watercourse master plans completed since 1985; and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District.

Delineated Floodplains & 2020 Population Projections

Gila / Queen Creek Watershed

Map 8-8

Legend

 Gila/Queen Creek Watershed

 FEMA Floodplains

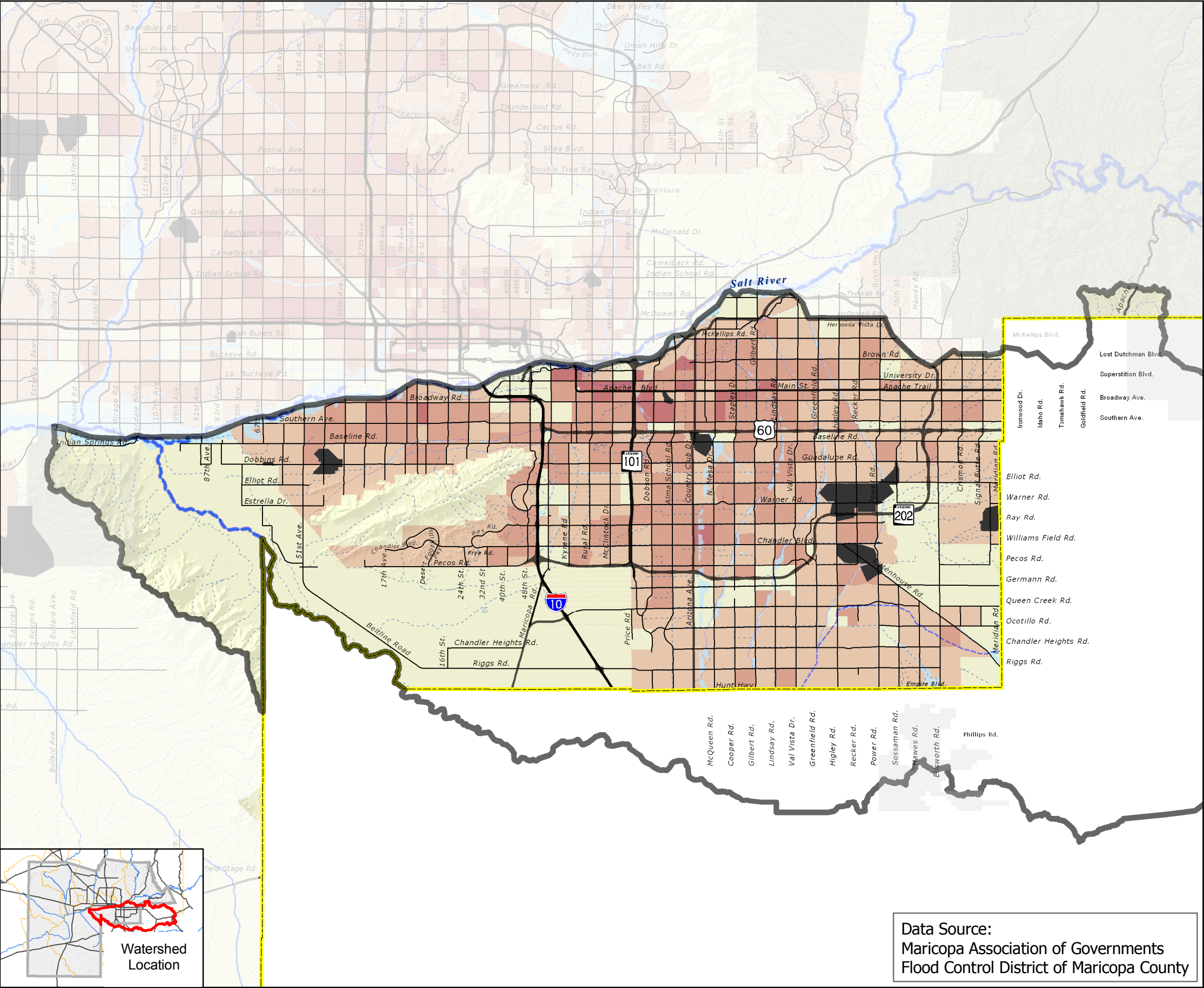
Estimated 2020 Population

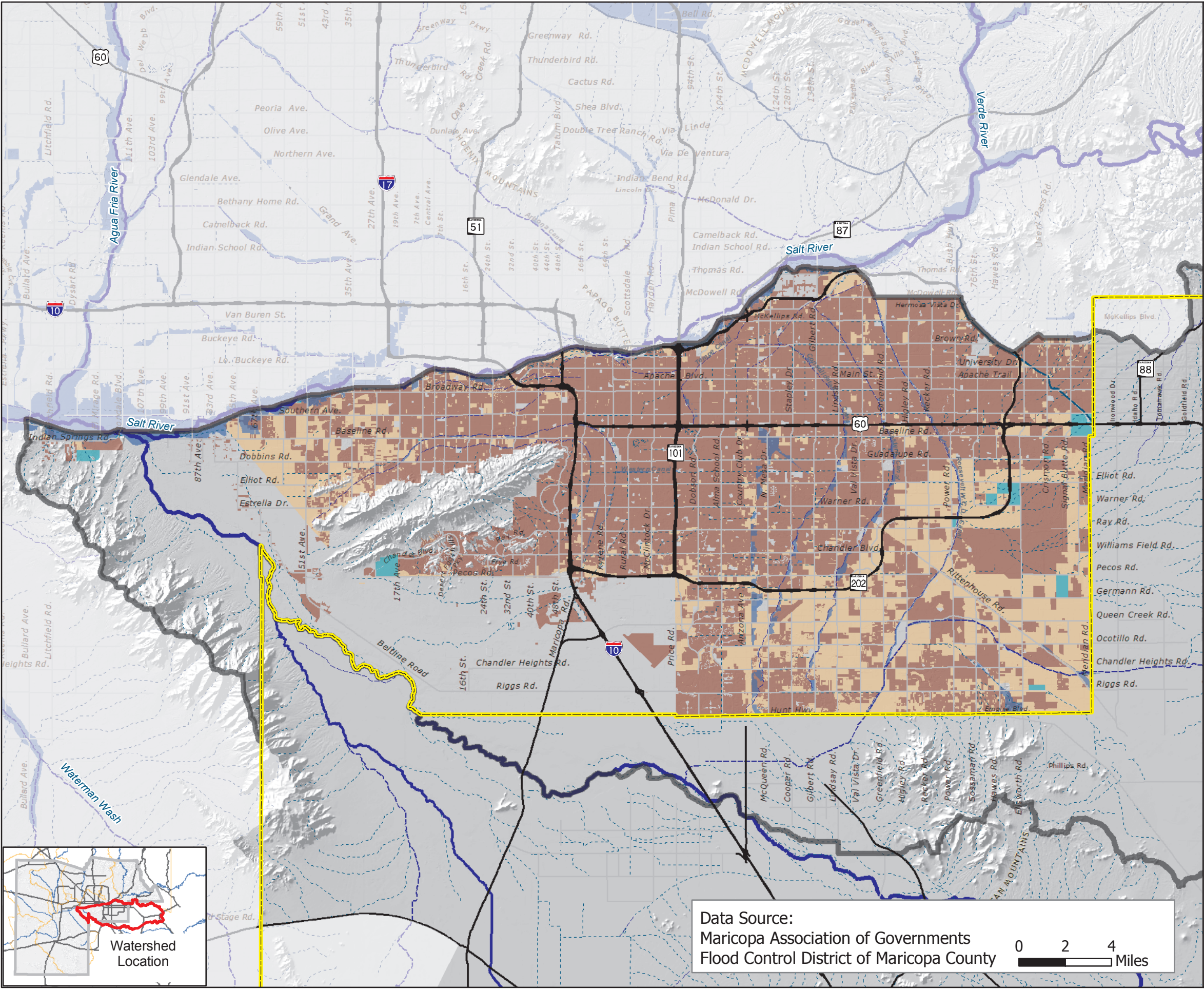
-  Low Density
-  Medium Density
-  High Density
-  Very High Density
-  Significant Growth Areas



0 2.5 5 10 Miles

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County





Developable Areas

Gila/Queen Creek Watershed

Map 8-9

Legend

Gila/Queen Creek Watershed 1307 sq. mi.



Developable Private Land- 122 sq. mi.



Developable State Trust Land- 4.22 sq. mi.



Existing Development (2007)-301 sq. mi



Freeways & State Routes

Arterial Roads

100 Year Floodplains



Maricopa County boundary



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

0 2 4 Miles

Table 8-15: Completed Studies and Plans in Gila/Queen Creek Watershed

Name	Boundaries	Study Area (Sq Mi)	Completed
East Maricopa County ADMS	Buckhorn-Mesa FRS (N), Northern Diversion and Powerline Floodway (S/SE), and the East Maricopa Floodway (EMF) (W)	68	1987
East Mesa ADMP	Meridian Rd. (E), the EMF (W), Rittenhouse Channel and Queen Creek Rd. (S), Central Arizona Project (NE)	121	1998
EMF Capacity Mitigation Study	Parallel to the Roosevelt Water Conservation District (RWCD) irrigation canal from Princess Basin to Hunt Highway, west to the Gila River.	27	2000
Higley ADMP	RWCD Main Canal and the EMF (E), Salt River Project Eastern Canal (from the Salt River to Pecos Rd.) and Arizona Ave. (from Pecos Rd. to the county line) (W)	73	2000
Queen Creek ADMS	Goldmine and San Tan mountains (S), CAP (E), EMF (W)	70	1991
Queen Creek/Sonoqui Wash Hydraulic Master Plan	16 miles of Queen Creek between the EMF and CAP aqueduct and 10 mi. of Sonoqui Wash (6 miles from the Queen Creek confluence to the Maricopa County line).	95	2000
South Phoenix/Laveen ADMS/ADMP	Salt River (N), 7th Ave (E), South Mountain Park (S) and the Gila River Indian Community (W)	16	2001

Table 8-16: Completed Capital Improvement Program in Gila/Queen Creek Watershed

Project	Location	Completed
35th Avenue and Dobbins Road Basin and Storm Drain	35th Ave. and Dobbins Rd.	2002
43rd Ave Storm Drain	43rd Ave. and Southern Ave.	2005
43rd Ave and Southern Ave Detention Basin	43rd Ave., Broadway Rd. to Baseline Rd.	2000
48th St Drain	San Francisco Canal, 48th St. to University Dr.	1981
ADOT Pit and Diversion Channel	I-10, Elliot Rd. to 1/4 mi. south of Warner Rd.; I-10 and 1/4 mi. south of Warner Rd.	1987
Alma School Drain	McClellan Rd. alignment, Tempe Canal at Alma School Rd. to the Salt River	1969
Apache Junction FRS and Floodway	Lost Dutchman Blvd. and Idaho Rd.	1988
Baseline Rd Storm Drain	Baseline Rd., 7th Ave. to 43rd Ave.	2002
Broadway Rd Collector Channel (Broadway Rd to EMF)	Approximately 1/2 mi. east of Higley Rd., Broadway Rd south for 1/3 mi. to EMF	1998
Bulldog Floodway	Apache Junction FRS to Signal Butte FRS	1988
Central Arizona Project Detention Basin No. 1	Approximately Sossaman Rd. alignment and approximately McClellan Rd. alignment	2001
Central Arizona Project Detention Basin No. 2	93rd St. and University Dr.	2001
Central Arizona Project Detention Basin No. 3	Approximately 96th St. and University Dr.	2001
Central Arizona Project Detention Basin No. 4	Crismon Rd. and Apache Tr.	2001
Central Arizona Project Detention Basin No. 5	Northeast corner of Cheshire St. and Southern Ave.	2001
Central Chandler Area Drainage System	Area bounded by Ray Rd. (N), Pecos Rd. (S), SR-101L (W), Arizona Ave. (E)	2005
East Maricopa Floodway	Between Val Vista Dr. and Sossaman Rd., Thomas Rd. to GRIC to the Gila River	1989
Elliot Road Basin and Channel	Approx. Elliot Rd., approx. Signal Butte Rd. to SR-202L; Crismon Rd. 0.5 mi. north	2007

Project	Location	Completed
Ellsworth Rd Channel at Phoenix-Mesa Gateway Airport	North and East boundaries of Phoenix-Mesa Gateway Airport	2008
Gila Drain Storm Drain	Rural Rd., 1/2 mi. south of Guadalupe Rd. to 1/2 mi. south of Warner Rd. (Hanger Park)	1988
Gilbert Crossroads Park Basin	Greenfield Rd. and Ray Rd.	1992
Guadalupe Box and Channel	Guadalupe Rd., Sossaman Rd. to the EMF at Power Rd.	1989
Guadalupe Drainage Improvement Project	Town of Guadalupe (Various Basins)	2003
Guadalupe FRS	West side of I-10, between Guadalupe Rd. and Baseline Rd.	1975
Hawes Rd. Channel (Emilita Ave to Main St)	Hawes Rd., Apache Tr. (Main St.) To Emelita Ave. (1/2 mi. north of Southern Ave.)	2004
Laveen Area Conveyance Channel	Area bounded by Southern Ave. (N), South Mtn. Ave. alignment (S), GRIC (W), 43rd Ave. (E)	2009
Powerline Floodway	Powerline FRS, southwest to Ray Rd. alignment at GM, to EMF at Sossaman Rd.	1968
Powerline FRS	US-60 and Guadalupe Rd. alignment	1967
Price Road Drain	SR-101L (Price), Salt River to 1/2 mi. south of Guadalupe Rd. (Carriage Lane Park)	1993
Queen Creek Channel (Hawes Rd to Power Rd)	Queen Creek, Hawes Rd. to Power Rd.	2006
Queen Creek Channel (Recker to Higley)	Queen Creek, Recker Rd. to Higley Rd.	2009
Queen Creek Road Basin	McQueen Rd. and Queen Creek Rd.	2009
Rittenhouse FRS	US-60, Queen Creek Rd. alignment	1969
Rittenhouse Road Channel	Rittenhouse Rd., Queen Creek Rd. to the EMF at Pecos Rd.	1997
S.E. Phoenix Regional Drainage System	SR-202L and 48th St.	2002
S.E. Valley Regional Drainage System	SR-202L to Pecos Rd. 1/2 mi. west of Kyrene Rd., to I-10, south to the Gila Drain floodway	2002

8. Risk Analysis by Watershed

Project	Location	Completed
Salt River Channel (McClintock Dr to Price Rd)	North bank of Salt River, McClintock Dr. to Price Rd.	1998
Salt River Channel (Price Rd to McKellips Rd)	Salt River, Price Rd. to McKellips Rd.	1998
Salt River Channel (SR-143 to McClintock Dr)	Salt River, SR-143 to McClintock Dr.	1991
Salt River Low Flow Ch. (19th Ave to I-10)(Phx Rio Salado)	Salt River, 19th Ave. to I-10 at approximately 30th St. alignment	2002
Signal Butte Floodway	Between McClellan Rd. and Adobe Rd., Signal Butte FRS to CAP at Ellsworth Rd.	1984
Signal Butte FRS	Southwest of Signal Butte Rd. and McKellips Rd.	1987
Sonoqui Wash Channelization (Higley Rd to Chandler Heights Rd)	Sonoqui Wash, Higley Rd. and Ocotillo Rd. to Chandler Heights Rd. and Sossaman Rd.	2008
Sossaman Channel and Basin	Sossaman Rd., Southern Ave. to Guadalupe Rd. (Basin at US-60)	1977
Spook Hill FRS and Floodway	SR-202L, Power Rd. to 1/4 mi. south of Brown Rd.; CAP, SR-202L, north 1 1/2 mi.	1979
Spook Hill FRS Rehabilitation	SR-202L, Power Rd. to 1/4 mi. south of Brown Rd.; CAP, SR-202L, north 1 1/2 mi.	2008
University Drive Basin	Area bounded by SR-101L (N), Bell Rd. (S), 9th St. (W), 32nd St. (E); 4 basins & PVCC	1996
Vineyard FRS	US-60 and Ray Rd. alignment	1968

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Gila/Queen Creek Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes.

Identification

The District will complete 20 miles of additional delineations by studying the washes

around Spook Hill in FY 2010. The District will identify flooding problems and solutions for 180 square miles by completing four area drainage master plans.

Table 8-17: Five-Year Planning Program in Gila/Queen Creek Watershed

Study Name	Study Area (square miles)	Timeframe
East Mesa ADMP Update	60	FY 2010-2011
Hohokam ADMP	43	FY 2010-2012
Northwest Mesa ADMP	67	FY 2010-2012
Upper East Maricopa Floodway ADMP	10	FY 2012-2014

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the communities for which the District performs floodplain management duties. The District will also work with other jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

The five-year Capital Improvement Program recommends the construction of infrastructure to mitigate flooding in the Gila/Queen Creek Watershed (see Map 8-3, Capital Improvement Projects FY 2010-2014). Non-structural measures to remediate flooding in this watershed include the Floodprone Properties Assistance Program, to purchase or floodproof homes located in the 100-year floodplain, and in ponding areas. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Table 8-18: Five-Year Capital Improvement Program in Gila/Queen Creek Watershed

Project	CIP Map Code	Benefitted Area (Sq. Miles)	Timeframe
Central Chandler Storm Drain Improvements	022	1.9	FY 2010-2014
Cloud Rd. & Sossaman Rd. Basin and Outlet	043	0.66	FY 2010-2014
Sossaman Channel Improvements	108		FY 2010-2011
23rd Ave./Roeser Rd. Storm Drain and Detention Basin	117	1.1	FY 2010-2011
Rittenhouse Basin	121	58.3	FY 2010-2014
Chandler Heights Basin	121	58.3	FY 2010-2014
East Maricopa Floodway Low Flow Channel	121		FY 2010-2014
Tres Rios	126	4.9	FY 2010-2014

8. Risk Analysis by Watershed

Project	CIP Map Code	Benefitted Area (Sq. Miles)	Timeframe
Spook Hill FRS/Red Mountain Freeway Modification	300		FY 2010
PVR Rehabilitation/Replacement	310	168.8	FY 2010-2014
Oak St. Detention Basin and Storm Drain	420	0.5	FY 2010-2014
Ellsworth Rd. and McKellips Rd. Drainage System	420	1.53	FY 2010-2014
Siphon Draw Drainage Improvements	442	6.9	FY 2010-2011
East Mesa Drains Reaches 4&7	121		FY 2010-2014
Sonoqui Wash Channelization (Chandler Heights to Crismon)	480	3.6	FY 2010-2014
Sonoqui Wash Channelization (Main Branch)	480	0.51	FY 2010-2014
Upper Camelback Wash Improvements	027	0.59	FY 2010-2014

Hassayampa

The Hassayampa watershed is 1,063 square miles and is located in western Maricopa County, centered along the Hassayampa River. The three Buckeye flood retarding structures (Nos. 1, 2 and 3) form the southeastern boundary of the watershed.

Physical Characteristics

Three major rivers and washes run primarily north to south in the Hassayampa watershed: The Hassayampa River, Jackrabbit Wash and Sols Wash. The Hassayampa is a tributary of the Gila River.

The Hassayampa River is an unregulated river, meaning that no upstream dam controls its flow. It appears to be a dry, sandy watercourse. The only visible flow is during flood events. In actuality, the Hassayampa River flows underground for most of its length through Maricopa County, except for a reach near Wickenburg. The river near Wickenburg is part of a nature preserve operated by the Nature Conservancy. Valuable wildlife habitat also exists at the confluence of the Gila and Hassayampa rivers.

The Hassayampa River was the site of one of the worst flooding disasters in Arizona history. On February 22, 1890, 15 feet of water overtopped the Walnut Grove Dam just north of Wickenburg. A construction camp downstream of the dam was washed away when the dam collapsed, killing 50 people.

Socioeconomic Characteristics

All or parts of the municipal boundaries of Buckeye, Surprise and Wickenburg fall within this watershed. Over three-quarters of the watershed is unincorporated county.

The Hassayampa watershed had a population of 17,301 in 2005. By 2020, the popula-

tion is expected to increase to 115,406 persons. The majority of the development will occur in master planned communities along the Hassayampa River (see Map 8-10, Delineated Floodplains & 2020 Population Projections, Hassayampa Watershed).

The master-planned communities being developed within the lower Hassayampa River valley and along the lower Hassayampa River have proposed encroachments into the watercourse. The District has also received several new applications to mine aggregate from the floodplain and floodway of the lower reach of the Hassayampa River. These mining applications under consideration may join several mines that are already operational.

An extensive transportation network is planned to service the projected population. The Hassayampa Conceptual Transportation Framework Study developed by the Maricopa Association of Governments identifies the need for the Hassayampa North-South Freeway to connect Highway 74 to I-10 to State Route 85.

Approximately 227 square miles of private land, most of which is currently in agricultural production, and 127 square miles of state trust land are poised for development (see Map 8-11, Developable Areas, Hassayampa Watershed). Existing land use in the area is a mix of open space, agriculture, mining and low-density residential. Nearly 40% of the watershed is under federal ownership.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Hassayampa watershed will experience an 85% increase in population by 2020. There are currently 599 parcels with residential structures in the identified 100-year floodplain. Since 2005, 19 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

Approximately 75% of the watershed is unincorporated. Single-lot development is the predominant residential type in unincorporated areas. Single-lot development does not benefit from the large-scale drainage features constructed in master planned communities. Several "wildcat" subdivisions sprung up in the watershed in the 1980s. A few of these subdivisions are located in the floodway and floodplain of the Hassayampa River.

Flooding Risk Summary

- There are 592 miles of delineated floodplains in the Hassayampa watershed. The District estimates that an additional 329 miles of floodplains still require delineation.
- Almost 40% of the soils have a high runoff potential (see Table 8-19).
- Two dams – Buckeye FRS No.1 and 2 – have dam safety deficiencies as identified by the Arizona Department of Water Resources.
- General flooding and erosion issues in this watershed include:

8. Risk Analysis by Watershed

- Numerous alluvial fans on the western side of the White Tank Mountains
- Riverine flooding and erosion along the major watercourses
- Wide floodplain at the confluence of the Gila and Hassayampa rivers
- Uncertified levees along the Hassayampa River
- Shallow flooding and sheet flow associated with areas transitioning from agricultural to suburban residential land use.

Table 8-19: Hydrologic Soil Type of Hassayampa Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	6.6%
B	Moderately low runoff potential	38.8%
C	Moderately high runoff potential	15.8%
D	High runoff potential	39.0%

Completed District Activities

In addition to the 592 miles of delineated floodplains, the District has identified flood control solutions for a significant portion of this watershed and developed a preliminary watercourse master plan for the Hassayampa River. The following list includes 1) area drainage master plans, area drainage master studies, and watercourse master plans completed since 1985; and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District.

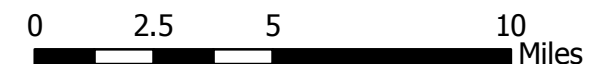
Delineated Floodplains & 2020 Population Projections

Hassayampa Watershed

Map 8-10

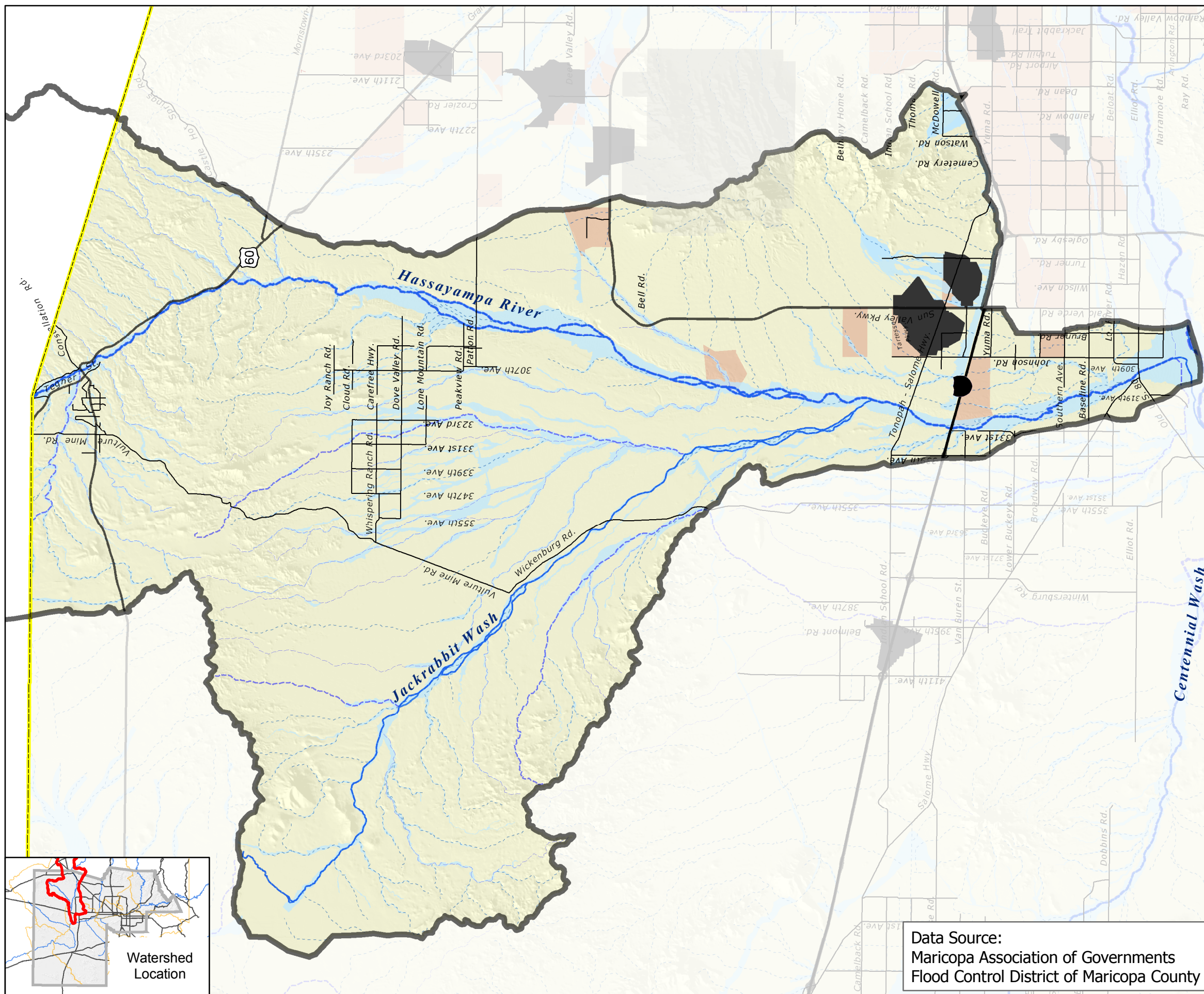
Legend

-  Hassayampa
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas

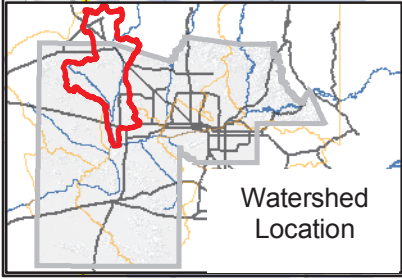
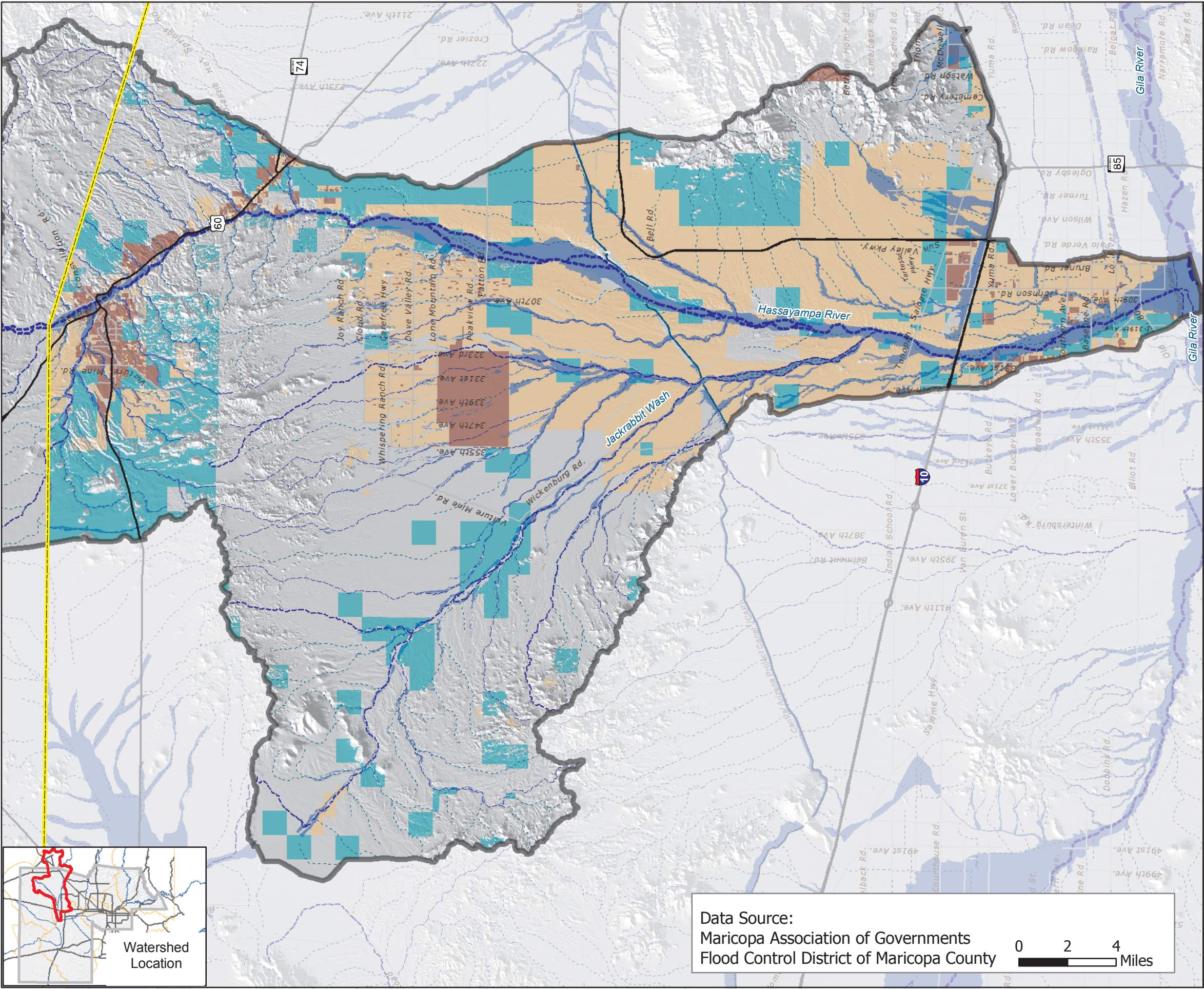


Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

May 2009

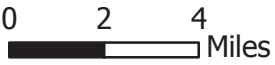


Watershed Location



Watershed Location

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



Developable Areas

Hassayampa Watershed

Map 8-11

Legend

- Hassayampa Watershed- 1063 sq mi
- Developable Private Land-227.17 sq. mi.
- Developable State Trust Land-126.58 sq. mi.
- Existing Development (2007)-29.48 sq. mi
- Freeways & State Routes
- Arterial Roads
- 100 Year Floodplains
- Maricopa County boundary



Table 8-20: Completed Studies and Plans in Hassayampa Watershed

Name	Boundaries	Study Area (Sq Mi)	Completed
Buckeye ADMP	I-10 (N), Gila River (S), Airport Rd (E), Johnson Rd (W)	103	2008
Buckeye/Sun Valley ADMS	Gates Rd (N), White Tank Mountains (E), Gila River (S), Hassayampa River (W)	280	2007
Wickenburg ADMS	Yavapai County (N), Wittmann watershed boundary (E), Morristown (S), Township 5V/6V boundary (W)	146	1992
Sun Valley ADMP	Gates Rd (N), White Tank Mountains (E), I-10 (S), Hassayampa River (W)	183	2006
Lower Hassayampa River WCMP (Phase I)	Confluence with Gila River (S) to CAP Canal crossing (N), and Jack-rabbit Wash from the Hassayampa River confluence to the CAP Canal crossing.		2006

Table 8-21: Completed Capital Improvement Program in Hassayampa Watershed

Project	Location	Completed
Buckeye FRS No. 1	I-10, 331st Ave. to 257th Ave.	1975
Buckeye FRS No. 2	I-10, 254th Ave. to 237th Ave.	1975
Buckeye FRS No. 3	I-10, 235th Ave. to 215th Ave.	1975
Casandro Wash Dam	North of US-60, between Mariposa Dr. alignment and Los Altos Dr. alignment	1996
Casandro Wash Outlet	Jackson St., Navajo St. to Mohave St.; Mohave St., Jackson St. to Casandro Wash	1996
Sunnycove Dam	Kellis Rd. alignment and Turtleback Ln. alignment	1976
Sunset Dam	South of US-60, between Cucuracha St. alignment and Whipple Ct. alignment	1976
Sunset/Sunnycove Pipeline	Sunnycove Dam, to a point 1 mi. northeast	1976
Wickenburg Downtown Flooding Hazard Mitigation Project	Sols Wash, approximately Mariposa Dr. alignment to Hassayampa River	2009

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Hassayampa Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes.

Identification

The District will complete 100 miles of additional delineations for Jackrabbit Wash and its tributaries. The delineations will be completed by FY 2011. Several area drainage master plans are recommended for the watershed, as well as the development of a final recommended plan for the management of the Hassayamapa River.

Table 8-22: Five-Year Planning Program in Hassayampa Watershed

Study Name	Study Area (square miles)	Timeframe
Jackrabbit Wash ADMP	442	FY 2013-2014
Upper Hassayampa WCMP	25	FY 2010-2012
Wickenburg ADMP	299	FY 2012-2014

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the communities for which the District performs floodplain management duties. The District will also work with other jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

The five-year Capital Improvement Program recommends the construction of infrastructure to mitigate flooding in the Hassayampa Watershed (see Map 8-3, Capital Improvement Projects FY 2010-2014). Rehabilitation of the flood retarding structures with deficiencies is a key issue in this watershed. Non-structural measures to remediate flooding in this watershed include the Floodprone Properties Assistance Program. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Table 8-23: Five-Year Capital Improvement Program in Hassayampa Watershed

Project	CIP Map Code	Benefitted Area (Sq. Miles)	Timeframe
Gila River Bank Stabilization	126	0.23	FY 2010-2014
Buckeye FRS No. 1 Rehabilitation	265	61.4	FY 2010-2013
Wickenburg Downtown Flooding Hazard Mitigation	343		FY 2010

Lower Gila

The Lower Gila watershed is 1,522 square miles in size and is located in southwestern Maricopa County.

Physical Characteristics

The Gila River and its tributaries are the key features of this watershed. Smaller mountain ranges surround the northern and southern portions of the watershed, while vast amounts of flat lands cover most of the watershed. The lowest elevations are along the Gila River; these elevations gradually increase.

Socioeconomic Characteristics

The entire Lower Gila watershed is located in unincorporated Maricopa County. The 2005 population of 794 in this watershed is expected to increase to 2,583 by 2020 (see Map 8-12, Delineated Floodplains & 2020 Population Projections, Lower Gila Watershed.) The only developable lands are the privately owned lands near the Gila River and state trust lands near the Gila River and I-10, which means all future population would locate in these areas (see Map 8-13 Developable Areas, Lower Gila Watershed). Development will be at a slower pace due to the remote location.

Less than four percent of the land is privately held. An additional six percent of the property in the watershed is owned by the Arizona State Land Department. The majority of the land is under the control of the federal or state government. Over 50% of the watershed is part of the Barry M. Goldwater Air Force Range.

Painted Rock Dam borders the eastern edge of the watershed and lies along the Gila River. I-10 and SR-85 are the major highways in this watershed, with other streets connecting agricultural areas with highways. This area is sparsely populated, but some homes exist to support agricultural activities.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifi-

cally describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Lower Gila watershed is the least populated watershed. There are no structures in the identified 100-year floodplain. The public safety risk is low in the Lower Gila watershed due to the existing development character and the minimal projected population growth.

The majority of completed delineations in this watershed are approximate. Future work could include detailed delineations in preparation for the small amount of prospective development that could locate along the Gila River north of I-8.

Flooding Risk Summary

- There are 85 miles of delineated floodplains in the Lower Gila watershed. The District estimates that an additional 1159 miles of floodplains still require delineation.
- Almost 50% of the soils have a high runoff potential (see Table 8-24).
- General flooding and erosion issues in this watershed include:
 - Riverine flooding and erosion along the major watercourses

Table 8-24: Hydrologic Soil Type of Lower Gila Watershed*

Hydrologic Soil Type	Description	Percentage of Watershed*
A	Low runoff potential	6.8%
B	Moderately low runoff potential	40.9%
C	Moderately high runoff potential	4.3%
D	High runoff potential	48.0%

*Percentage calculations are based on the total area within each watershed for which the hydrologic soils group is known, and thus does not represent the total watershed area. The hydrologic soil type of the Air Force range has not been surveyed.

Completed District Activities

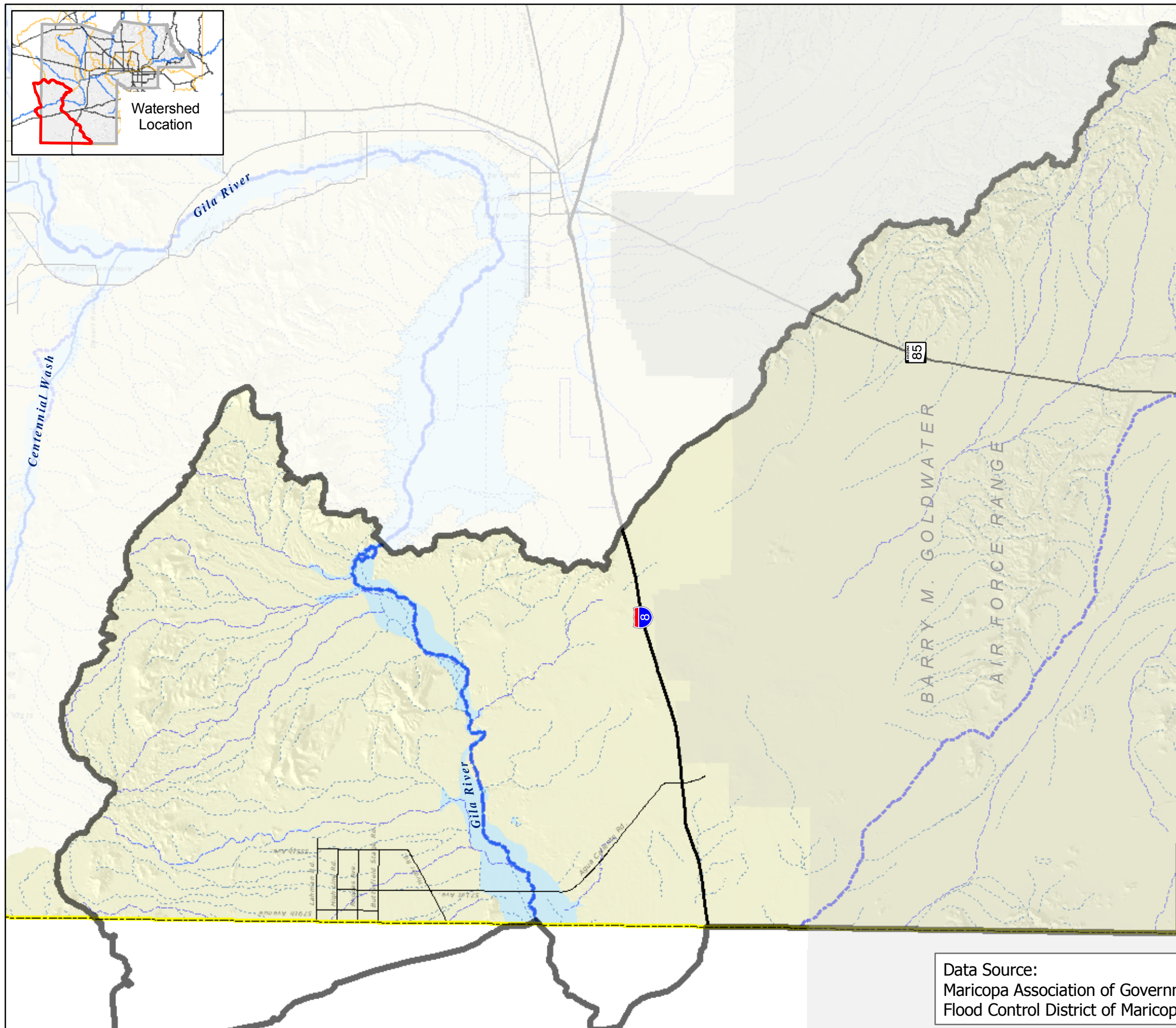
There are no regional flood control structures in the Lower Gila Watershed. The District has delineated 85 miles of floodplains to date.

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Lower Gila Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves



Delineated Floodplains & 2020 Population Projections

Lower Gila Watershed

Map 8-12

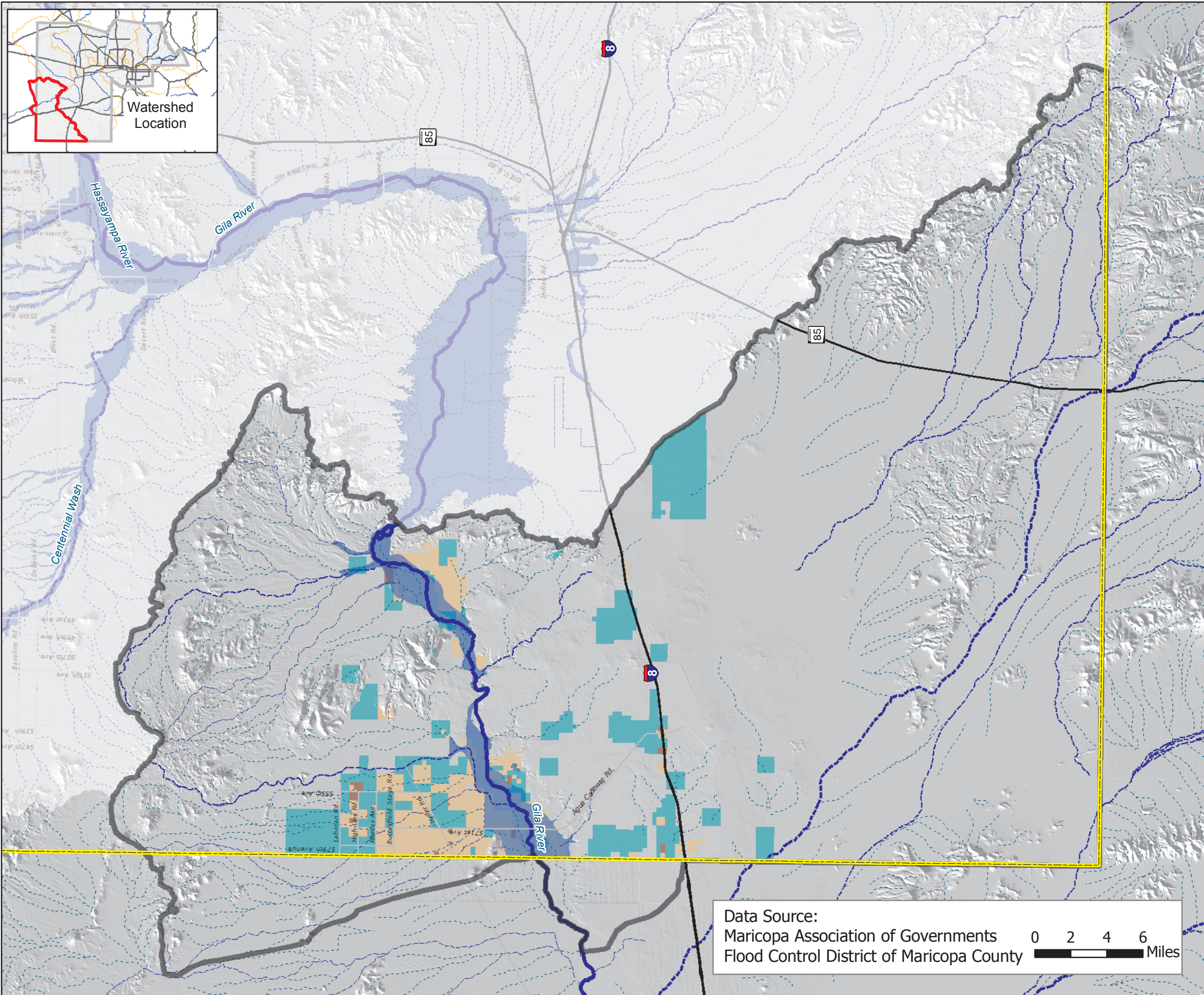
Legend

-  Lower Gila Watershed
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
-  Significant Growth Areas



0 2.5 5 10 Miles

Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



Developable Areas

Lower Gila Watershed

Map 8-13

Legend

Lower Gila - 1522 sq. mi.



Developable Private Land- 44 sq. mi.



Developable State Trust 78 sq. mi.



Existing Development (2007) - 2 sq. mi



Freeways & State Routes



Arterial Roads



100 Year Floodplains



Maricopa County boundary



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

0 2 4 6
Miles



and their property. Education and media messages will focus on the danger of crossing flooded washes.

Identification

The District will complete 50 miles of delineations, and identify flooding problems and solutions for 806 square miles of the watershed area where existing and future population is concentrated.

Table 8-25: Five-Year Delineation Program in Lower Gila Watershed

Delineation Name	Study Area (linear miles)	Timeframe
Upper Painted Rock tributaries to Gila River	30	FY 2010-2011
Gila River (below Painted Rock)	20	FY 2012-2013

Table 8-26: Five-Year Planning Program in Lower Gila Watershed

Study Name	Study Area (square miles)	Timeframe
Painted Rock ADMP	567	FY 2014-2015
Sentinel ADMP	239	FY 2011-2012

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county.

Remediation

Due to the low population density in the watershed, there are no structural flood control measures planned for the Lower Gila watershed in the next five years.

Verde

The Verde Watershed has an area of 3,216 square miles, a large portion of which lies outside of the county. Several major flood control structures are at least partly located in this watershed including Apache Junction, Signal Butte and Spook Hill flood retarding structures.

Physical Characteristics

The Verde Watershed is composed of mountainous areas, the Verde and Salt rivers, and Saguaro and Canyon lakes. While this area has the most diverse geography in the county, much of this watershed lies within the Tonto National Forest. The challenging terrain creates significant sheet flows in developed areas. The area also supports varied biotic communities including Arizona Upland Sonoran Desert Shrub, grasslands, chaparral, and conifer woodlands.

Socioeconomic Characteristics

Unincorporated Maricopa County, including the community of Rio Verde, accounts for 94% of the land area in the Verde Watershed. The remaining six percent of the watershed is located within the jurisdictional boundaries of Fountain Hills, Mesa and Scottsdale.

Population projections show that the 2005 population of 79,146 is estimated to increase to 109,516 in this watershed. All of the population in this watershed will fill in existing urbanized areas in the eastern portion of the watershed (see Map 8-14, Delineated Floodplains & 2020 Population Projections, Verde Watershed).

Much of the existing developed land is former state trust land. The remaining state trust land is prime developable land, located north of Loop 202 near Thomas Road. Significant private, developable land also occupies much of the western portion of this watershed (see Map 8-15 Developable Areas, Verde Watershed).

Over 80% of this area is national forest. Another four percent is part of the Fort McDowell Indian Community.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

There are currently 271 structures in the identified 100-year floodplain. Since 2005, 402 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

The Rio Verde area, which comprises over 50 square miles of the watershed, exhibits a unique drainage character. Growth and development in the area began in the 1970s. Due to the rural setting of the area and the proximity to Phoenix, Rio Verde's population increased significantly, with the area rapidly developing one-acre single-lot family residences and subdivisions.

The majority of the area is subject to distributary and sheet flow. Although 100-year storm flow depths are generally not extreme in the Rio Verde area, averaging less than two feet, the potential for damage is high due to steep slopes, highly erodible soils, and debris collected and conveyed by storm water. The District manages the floodplains in the Rio Verde through a set of "rules" specifically developed for the area.

Flooding Risk Summary

- There are 80 miles of delineated floodplains in the Verde Watershed. The District estimates that an additional 329 miles of floodplains still require delineation.
- Approximately 70% of the soils have moderate runoff potential (see Table 8-27).
- General flooding and erosion issues in this watershed include:
 - Riverine flooding and erosion along the major watercourses

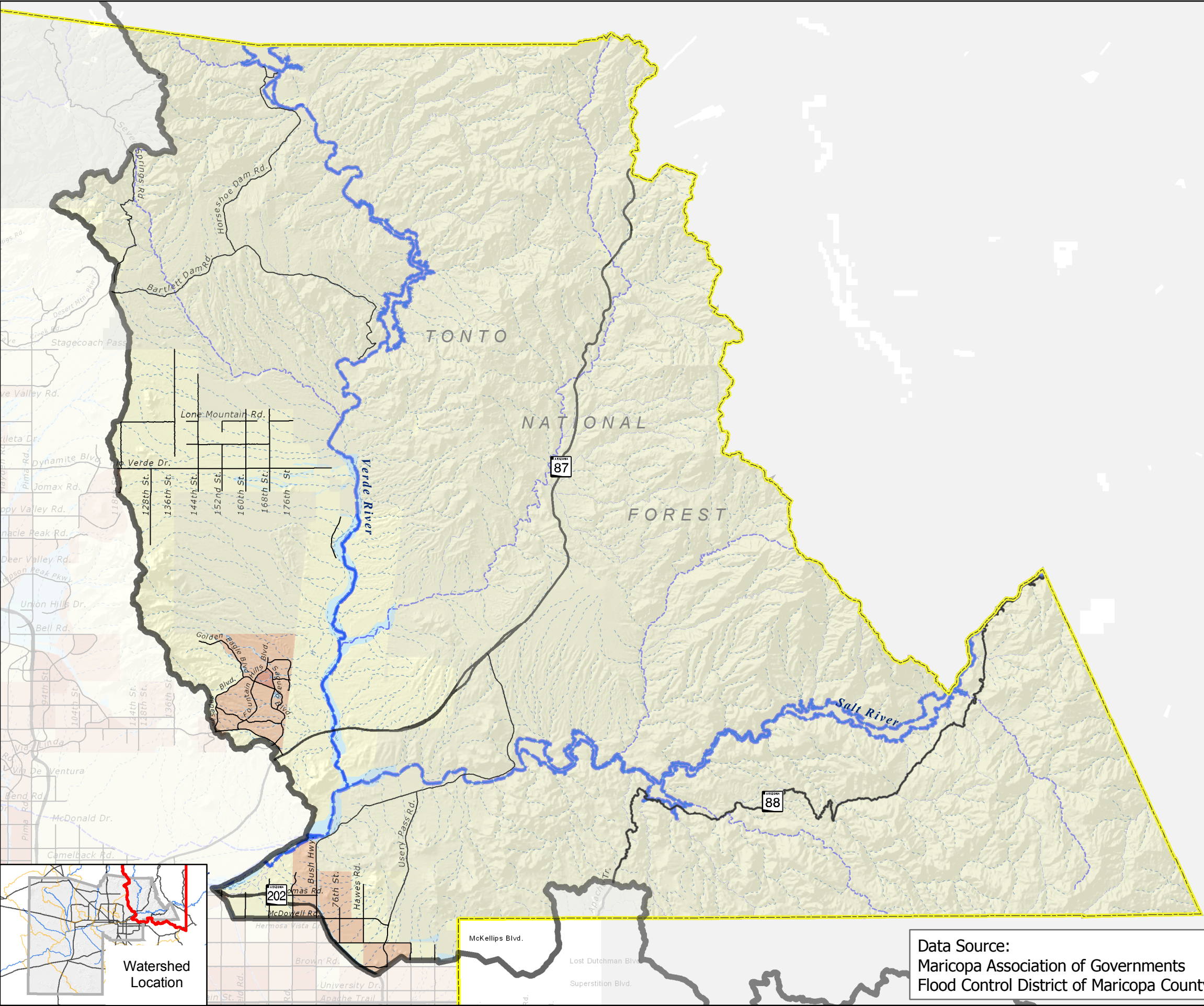
Delineated Floodplains & 2020 Population Projections

Verde Watershed

Map 8-14

Legend

-  Verde Watershed
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas

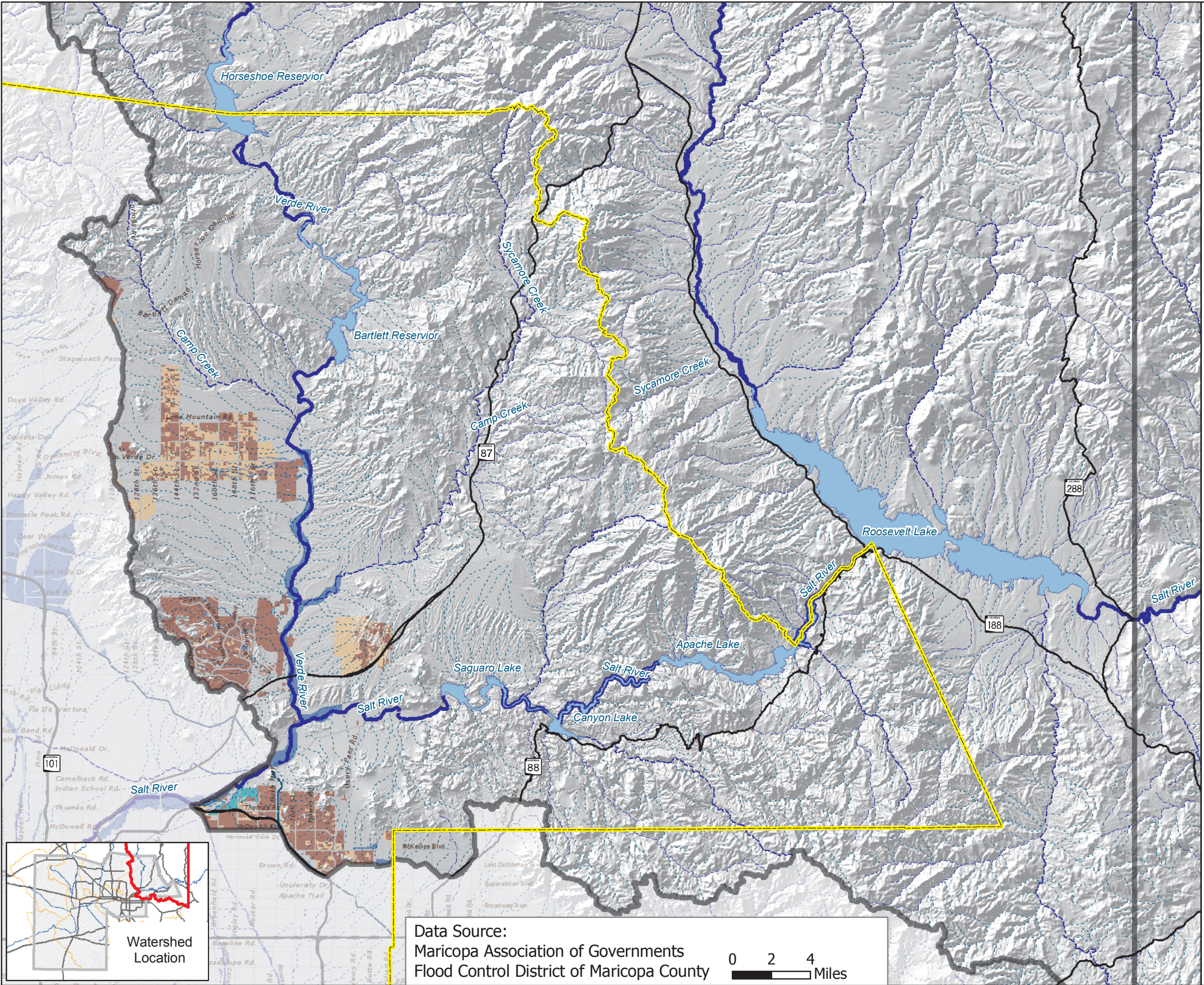


Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

Watershed
Location



0 2.5 5 10 Miles



Developable Areas

Verde Watershed

Map 8-15

Legend

Maricopa County boundary

Verde Watershed - 3216 sq. mi.



Freeways & State Routes



Arterial Roads



100 Year Floodplains

Developable State Trust Land - 1 sq. mi.



Developable Private Land - 22 sq. mi.



Existing Development 2007 - 45 sq. mi



Lakes



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County

0 2 4
Miles

- Distributary flow and alluvial fans
- Numerous braided channels with moveable sandy bottom beds
- Flash flooding and flooded wash crossings

Table 8-27: Hydrologic Soil Type of Verde Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	1.7%
B	Moderately low runoff potential	37.4%
C	Moderately high runoff potential	32.6%
D	High runoff potential	28.2%

Completed District Activities

In addition to the 80 miles of delineated floodplains, the District has identified flood control solutions for a significant portion of this watershed and constructed or maintains several regional flood control structures. The following list includes 1) area drainage master plans, area drainage master studies, watercourse master plans completed since 1985; and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District.

Table 8-28: Completed Planning Studies and Plans in Verde Watershed

Name	Boundaries	Study Area (Sq. Mi.)	Completed
Fountain Hills ADMP			1997
Fountain Hills Dam Break Analysis	McDowell Mountain Park (N), Fort McDowell Indian Reservation (E), City of Scottsdale (W)	16.5	1997
Rio Verde ADMP	Verde River (E), Tonto National Forest (N), 115th St. alignment (W), McDowell Mountain Regional Park (S)	50	2008
Spook Hill ADMP	Spook Hill Floodway & FRS (W), Signal Butte Floodway, Bulldog Floodway and Apache Junction FRS (S), Utery and Goldfield mountains (N)	35	2002

Table 8-29: Completed Capital Improvement Program in Verde Watershed

Project	Location	Completed
Apache Junction FRS and Floodway	Lost Dutchman Blvd. and Idaho Rd.	1988
Bulldog Floodway	Apache Junction FRS to Signal Butte FRS	1988
Golden Eagle Park Dam	Golden Eagle Blvd. and Palisades Blvd.	2002
Hermosa Vista/Hawes Road Project	Area bounded by McDowell Rd. (N), Hermosa Vista Dr. (S), Spook Hill FRS (W), 90th St. (E)	2009
Pass Mountain Diversion Channel	McKellips Rd., Crismon Rd. to Signal Butte Rd., south to behind Signal Butte FRS	1987
Signal Butte Floodway	Between McClellan Rd. and Adobe Rd., Signal Butte FRS to CAP at Ellsworth Rd.	1984
Signal Butte FRS	Southwest of Signal Butte Rd. and McKellips Rd.	1987
Spook Hill FRS and Floodway	SR-202L, Power Rd. to 1/4 mi. south of Brown Rd.; CAP, SR-202L, north 1 1/2 mi.	1979
Spook Hill FRS Rehabilitation	SR-202L, Power Rd. to 1/4 mi. south of Brown Rd.; CAP, SR-202L, north 1 1/2 mi.	2008

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Verde Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes. Flood warning systems should be installed at wash crossings that frequently flood.

Identification

The District will complete 60 miles of additional delineations. The District will also start the Goldfield Ranch Area Drainage Master Plan in FY 2013, scheduled to be completed in FY 2015.

Table 8-30: Five-Year Delineation Program in Verde Watershed

Delineation Name	Study Area (linear miles)	Timeframe
Spook Hill Area Washes	20	FY 2012-2013
Goldfield Ranch	10	FY 2011-2012
Fountain Hills	30	FY 2013-2014

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the communities for which the District performs floodplain management duties. The District will continue to manage the floodplains in the Rio Verde through a set of “rules” specifically developed for the area. The District will also work with jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

The five-year Capital Improvement Program recommends the construction of the McDowell Rd. Basin and Storm Drain and the Oak St. Basin projects (see Map 8-3 Capital Improvement Projects FY 2010-2014). Non-structural measures to remediate flooding in this watershed include the Floodprone Properties Assistance Program. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Waterman

The Waterman Watershed is located in southwestern Maricopa County. The watershed contains 2,472 square miles. The Buckeye and White Tanks flood retarding structures form a portion of the northern boundary of the watershed.

Physical Characteristics

The Waterman Watershed is typified by many isolated mountain ranges, including the Estrellas and Buckeye Hills, that are separated by low-lying desert valleys. The valleys are ringed by alluvial fans. The multiple land forms within the watershed create variable flow characteristics ranging from sheet flow to riverine flooding.

The principle feature of the Waterman watershed is the Gila River and its tributaries—Luke Wash and Waterman Wash. The Gila River watershed is over 50,000 square miles in size, covering portions of New Mexico, Arizona, and Mexico. Nearly all of the large tributaries in Arizona drain to the Gila River including the Salt, Verde, Agua Fria, and Santa Cruz rivers. The majority of the river’s flow is captured at Coolidge Dam. In the Waterman watershed, the Gila has perennial flows due to a high groundwater table and effluent discharges from the 91st Avenue Wastewater Treatment Plant.

The Gila River provides suitable habitat for threatened and endangered species, including the Southwestern Willow Flycatcher and the Yuma Clapper Rail. The majority of vegetation along the Gila is salt cedar, an invasive species. There are distinct

stands of native mesquite, cottonwood and willow, however, interspersed amongst the salt cedar.

Socioeconomic Characteristics

All or parts of the municipal boundaries of Avondale, Buckeye, Gila Bend, Glendale, and Goodyear fall within this watershed. Over 80% of the watershed is unincorporated county.

The Waterman Watershed had a population of 103,761 in 2005. By 2020, the population is expected to triple to 373,892 persons. The majority of the watershed will consist of low to medium density suburban development (see Map 8-16, Delineated Floodplains & 2020 Population Projections, Waterman Watershed).

Industrial land uses include several large landfills, many of which are located near the community of Mobile, and numerous sand and gravel mining operations. The sand and gravel mining is located predominately along the Gila River.

Approximately 285 square miles of the watershed are already developed. An additional 454 square miles are potentially developable, meaning that the land is either privately held or is owned by the Arizona State Land Department. The majority of the existing development is concentrated in the southern portions of the watershed (see Map 8-17, Developable Areas, Waterman Watershed).

The Estrella Mountain Regional Park is a significant recreational feature in the area.

Needs Assessment

The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's general flooding risk, specifically describing 1) floodplains requiring delineations; 2) soil type; 3) integrity of the dams and flood retarding structures protecting the watershed; and 4) flooding type and characteristics.

The Waterman watershed is one of the fastest growing areas in the county. There are currently 637 residential parcels in the identified 100-year floodplain. Since 2005, 158 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

The 100-year peak discharge on the Gila River is 220,000 cubic feet per second. Since the late 1800s, this reach of the Gila River has been subject to numerous flood events causing millions of dollars in damage, and leading to the relocation of the community of Allenville in the 1980s.

The most intensive development in the watershed will occur in three areas:

- Centered on the Buckeye downtown area between I-10 and the Gila River. The Buckeye General Plan has identified that this area will transition from agriculture to master planned communities and commercial development.
- Expansion of the development around the existing Estrella Ranch master-planned community.

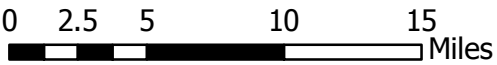
Delineated Floodplains & 2020 Population Projections

Waterman Watershed

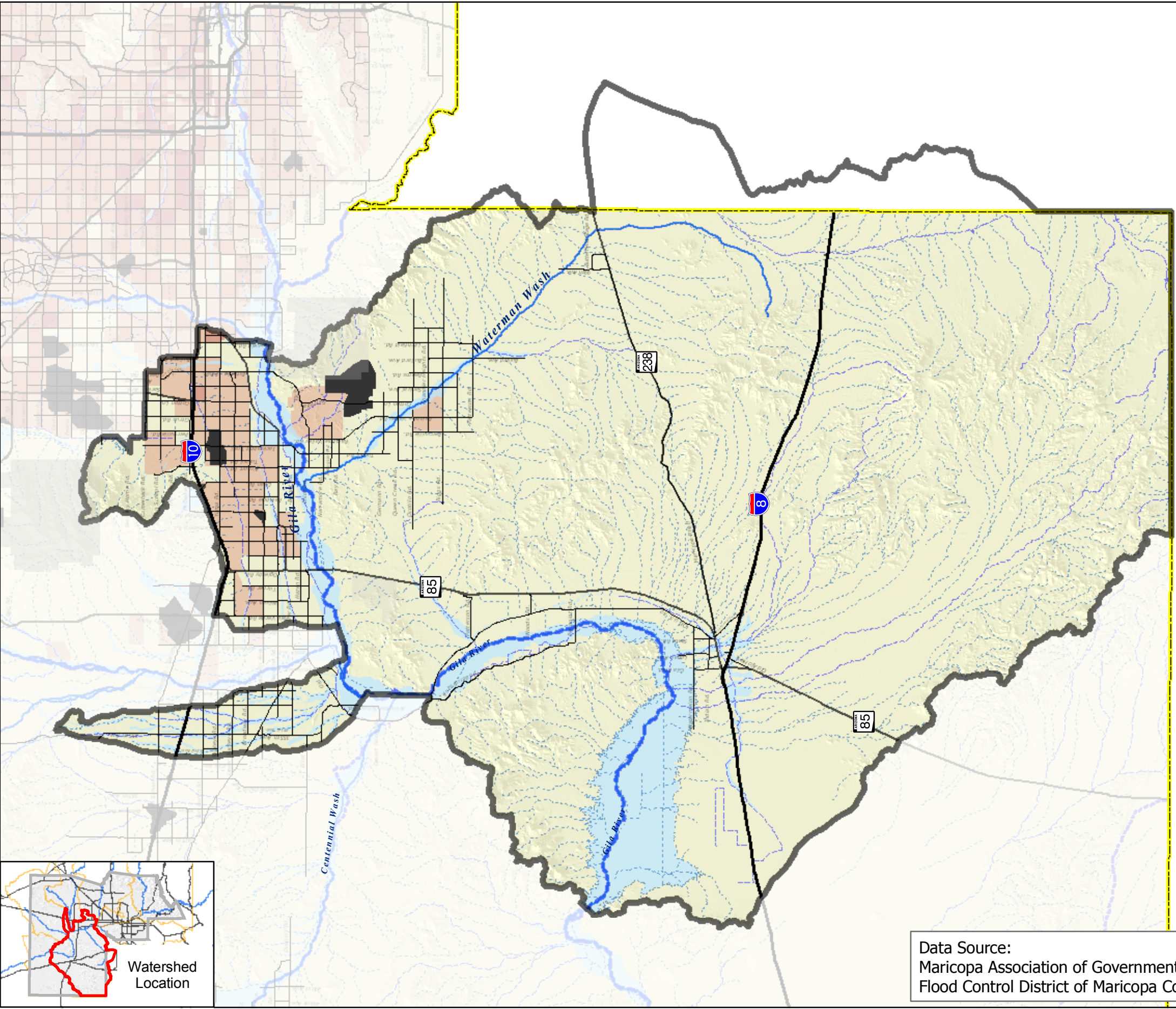
Map 8-16

Legend

-  Waterman Watershed
-  FEMA Floodplains
- Estimated 2020 Population
 -  Low Density
 -  Medium Density
 -  High Density
 -  Very High Density
 -  Significant Growth Areas



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



Developable Areas

Waterman Watershed

Map 8-17

Legend

Waterman Watershed - 2472 sq. mi



Developable Private Land- 423 sq. mi.



Developable State Trust Land - 130 sq. mi.



Existing Development - 60 sq. mi



Freeways & State Routes



Arterial Roads



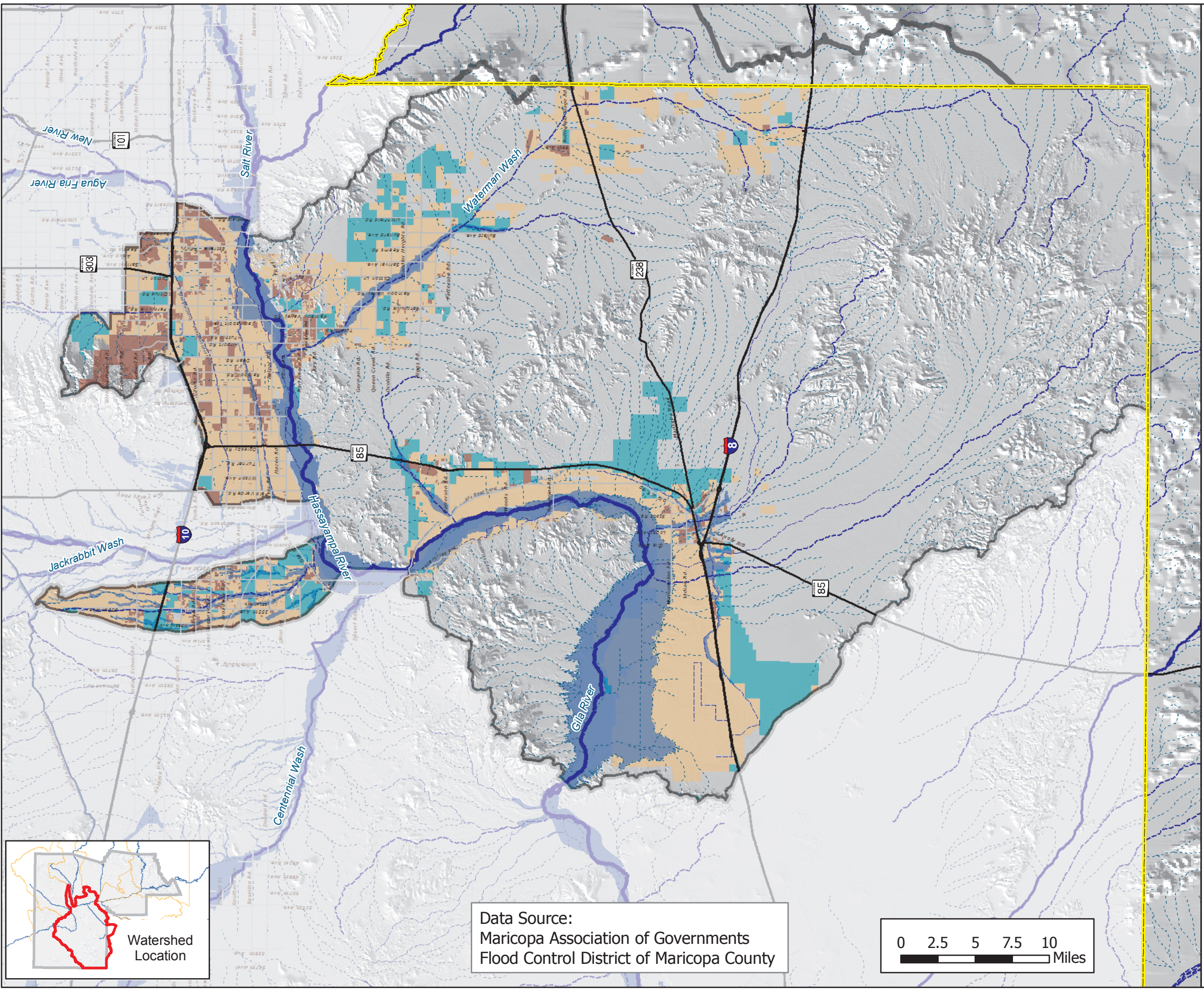
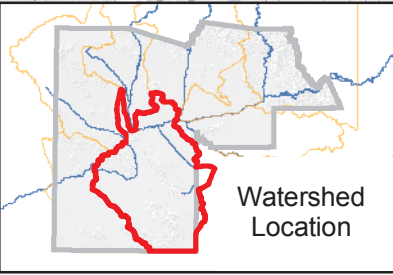
100 Year Floodplains



Maricopa County boundary



Data Source:
Maricopa Association of Governments
Flood Control District of Maricopa County



- The area near Mobile, which was recently annexed by the City of Goodyear.

The remainder of the watershed will primarily develop as single-family lots in unincorporated county or remain as open space. This type of development will not benefit from the large-scale drainage features constructed in master planned communities.

Flooding Risk Summary

- There are 444 miles of delineated floodplains in the Waterman Watershed. The District estimates that 2,507 miles of floodplains still require delineation.
- Approximately 65% of the soils have a high runoff potential (see Table 8-31).
- Four dams—Buckeye FRS Nos. 1 and 2 and White Tanks FRS Nos. 3 and 4—have dam safety deficiencies as identified by the Arizona Department of Water Resources.
- General flooding and erosion issues in this watershed include:
 - Alluvial fans along the Estrella Mountains and other steep slopes
 - Sheet flow across the valley floor
 - Major riverine flooding along the Gila River. The 100-year flood discharge on the Gila River is in excess of 220,000 cubic feet per second.
 - Lateral migration of the Gila River. The river's erosion hazard zone extends beyond the floodplain in some reaches.
 - Shallow flooding and sheet flow associated with areas transitioning from agricultural to suburban residential land use.

Table 8-31: Hydrologic Soil Type of Waterman Watershed

Hydrologic Soil Type	Description	Percentage of Watershed
A	Low runoff potential	6.3%
B	Moderately low runoff potential	64.8%
C	Moderately high runoff potential	4.9%
D	High runoff potential	24.1%

Completed District Activities

In addition to the 444 miles of delineated floodplains, the District has completed the El Rio Watercourse Master Plan, which defines a vision for restoring and preserving the Gila River. The following list includes 1) area drainage master plans, area drainage master studies, watercourse master plans completed since 1985; and 2) capital improvement projects completed by the District since its inception, as well as key regional structures completed by other entities and maintained by the District.

Table 8-32: Completed Studies and Plans in Waterman Watershed

Name	Boundaries	Study Area (Sq. Mi.)	Completed
Buckeye ADMP	I-10 (N), Gila River (S), Airport Rd (E), Johnson Rd (W)	103	2008
Buckeye/Sun Valley ADMS	Gates Rd (N), White Tank Mountains (E), Gila River (S), Hassayampa River (W)	280	2007
El Rio WCMP	Confluence with Agua Fria River to State Route 85 bridge		2005
Gila Bend ADMP	Gila River (N), Citrus Valley Road (W), Barry Goldwater Gunnery Range (S), Gila Bend Municipal Airport (E)	48	2001
Loop 303/White Tanks ADMP	McMicken Dam (N), Gila River (S), White Tanks Mountain (E), Agua Fria River	220	2005
White Tanks/Agua Fria ADMS/ADMP	McMicken Dam (N), Gila River (S), White Tanks Mountain (E), Agua Fria River	215	1994

Table 8-33: Completed Capital Improvement Projects in Waterman Watershed

Project	Location	Completed
Agua Fria Channelization	Agua Fria River, Camelback Rd. to 1/4 mi. south of Lower Buckeye Rd.	1988
Buckeye FRS No. 1	I-10, 331st Ave. to 257th Ave.	1975
Buckeye FRS No. 2	I-10, 254th Ave. to 237th Ave.	1975
Buckeye FRS No. 3	I-10, 235th Ave. to 215th Ave.	1975
Bullard Wash (Phase I)	Bullard Wash, Lower Buckeye Rd. alignment to Gila River	2001
Perryville Bank Stabilization	North bank of Gila River, between Perryville Rd. and Citrus Road.	1984
White Tanks FRS No. 3	Jackrabbit Tr. alignment and Glendale Ave. alignment	1954
White Tanks FRS No. 3 North Inlet Channel	Beardsley Canal, Olive Ave. to White Tanks FRS No. 3	2008
White Tanks FRS No. 4	Jackrabbit Tr. and Van Buren St.	1954

Recommendations

The following five-year program of work is proposed to mitigate flooding in the Water-

man Watershed. The recommended activities are categorized by District program. A summary of these actions, along with other county-wide general activities, is captured in the action plan presented in Chapter 9.

Outreach

The District will continue its public education program to assist residents in recognizing potential flooding and erosion hazards and inform them on how to protect themselves and their property. Education and media messages will focus on the danger of crossing flooded washes.

Identification

The District will complete 110 miles of additional delineations, and identify flooding problems and solutions for 1,141 square miles. The Rainbow Valley Area Drainage Master Study which started in FY 2008 will be completed in FY 2011.

Table 8-34: Five-Year Delineation Program in Waterman Watershed

Delineation Name	Study Area (linear miles)	Timeframe
Gila River (below Painted Rock)	20	FY 2012-2013
Buckeye Hills	30	FY 2011-2012
Gila Bend	40	FY 2011-2012
Vekol	20	FY 2012-2013

Table 8-35: Five-Year Planning Program in Waterman Watershed

Study Name	Study Area (square miles)	Timeframe
Gila Bend ADMP	148	FY 2011-2013
Gillespie ADMP (Woolsey)	378	FY 2010-2012
Lower Hassayampa WCMP Phase II	25	FY 2010-2012
Rainbow Valley ADMS	457	FY 2010-2011
Theba ADMP	158	FY 2014-2015

Regulation

The District will enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the communities for which the District performs floodplain management duties. The District will also work with jurisdictions to adopt and enforce the recommendations of area drainage master plans and other studies.

Remediation

The five-year Capital Improvement Program recommends the construction of infrastructure to mitigate flooding in the Waterman Watershed (see Map 8-3, Capital Improvement Projects FY 2010-2014). Non-structural measures to remediate flooding

8. Risk Analysis by Watershed

in this watershed include the Floodprone Properties Assistance Program. Operation and maintenance of existing structures will be ongoing to preserve the life of facilities and prevent flooding from occurring due to maintenance issues.

Table 8-36: Five-Year Capital Improvement Program in Waterman Watershed

Project	CIP Map Code	Benefitted Area (Sq. Miles)	Timeframe
Gila River Bank Stabilization	126	0.23	FY 2010-2014
White Tanks FRS No. 4 Outlet Channel	201	16.7	FY 2010-2014
White Tanks FRS No. 4 Rehabilitation	201	9.5	FY 2010-2012
Buckeye FRS No. 1 Rehabilitation	207	61.4	FY 2010-2013
Downtown Buckeye Regional Basin & Storm Drain	211	1.7	FY 2010-2014
White Tanks FRS No. 3 Modifications	470	13.7	FY 2010-2011
White Tanks FRS No. 3 Outlet Channel	470	13.8	FY 2010-2014
Loop 303 Drainage Improvements	470	77.8	FY 2010-2014
Elm Lane Drainage Mitigation	470	0.2	FY 2010-2011
Bullard Wash (Phase II)	470	0.7	FY 2010-2014

Summary

This chapter provided a watershed by watershed description of flooding problems and recommends both county-wide and watershed-specific flood control or floodplain management actions. These recommendations are part of the five-year flood hazard mitigation action plan for Maricopa County. The individual watershed needs assessment has four components: watershed description, needs assessment, completed projects and an action plan.



Wickenburg, 2005. Photo courtesy of Flying M Air, LLC, Wickenburg, Arizona

9. Recommendations and Action Plan

The 2009 Comprehensive Floodplain Management Plan and Program presents a broad assessment of flooding hazards within Maricopa County, and describes the possible activities the District can undertake to mitigate those hazards. This chapter summarizes a county-wide program of actions to reduce or eliminate flooding problems¹. These proposed activities comprise Maricopa County's five-year flood hazard management action plan and program.

The total five-year flood hazard mitigation identified need is estimated to be \$330 million². A discussion of implementation and funding options follows the action plan.

Action Plan

The action plan specifies flood control and floodplain management activities that the District expects to continue or complete over the next five years. This list is not inclusive of all District activity, but captures

Recommendations and Action Plan Outline

Action Plan

Implementation

Funding

Revenue Sources

Expenditures

Future Updates

¹ Watershed specific actions and projects are presented in Chapter 8.

² This figure represents the five-year CIP, planning and delineation budgets.

key elements. The action plan includes activities in unincorporated county, as well as incorporated areas.

The flood control activities outlined in the action plan are grouped by floodplain management categories as defined by the NFIP in the CRS Coordinator's Manual, Section 510. The categories are:

- Preventative activities which seek to avoid flooding problems through pro-active floodplain regulations, open space preservation, and planning and zoning.
- Property protection activities are implemented on an individual structure basis and include property acquisition or flood-proofing.
- Natural resource protection measures enhance the natural resources and functions of floodplains.
- Emergency service activities minimize the impact of a flood event.
- Structural activities control flooding through the construction of a capital project, such as a channel, basin or levee.
- Public information helps residents understand how to protect themselves from flood hazards.

The action plan lists the particular action, the District program under which the action will be implemented, and the approximate timeframe for implementation.

Preventive Action	Responsible	Timeframe
Enforce existing floodplain regulations to minimize and prevent flood-related damage in unincorporated county and the 12 communities for which the District performs floodplain management duties.	Regulation, Floodplain Management Services Division	Ongoing
Complete 22 ADMS/ADMPs.	Identification, Planning Branch	FY 2010-2015
Complete 530 miles of delineations.	Identification, Floodplain Delineations Branch	FY 2010-2015
Coordinate with jurisdictions to adopt and enforce the recommendations of area drainage master plans, watercourse master plans and other studies.	Identification, Planning Branch	Ongoing
Develop a standardized model of assessing flooding risk and vulnerability at a watershed and sub-watershed level. This method will be used to develop structural and non-structural flooding solutions as part of the ADMP and WCMP planning processes.	Identification, Planning Branch	FY 2010-2011

Develop model guidelines for land use planning and site development within floodplains that protect public safety and preserves the natural functions of floodplains.	Identification, Planning Branch; Regulation, Floodplain Management Services Division	FY 2010-2011
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Property Protection Action	Responsible	Timeframe
Acquire eight properties through the Floodprone Properties Acquisition Program.	Remediation	FY 2010
Improve the unincorporated Maricopa County's rating in the NFIP-CRS program from Class 5 to Class 4.	All	FY 2015
Implement flood warning systems to ensure safe crossings of rivers and washes.	Identification, Remediation, in cooperation with Maricopa County Department of Transportation	Ongoing

Natural Resource Protection Action	Responsible	Timeframe
Accommodate wildlife corridors and habitat, when feasible, during planning and construction of flood control solutions.	Identification, Remediation in cooperation with Arizona Game and Fish Department and other entities	Ongoing
Create an exploratory committee that is tasked with investigating tools for preserving floodplains for conveyance and other beneficial uses; and defining the District's role in river management and restoration efforts.	Identification, Planning Branch serves as lead for establishing committee. Participation required from all divisions.	FY 2010
Develop a sensitive-lands management plan for District-owned floodplain property.	Real Estate in cooperation with environmental planning staff.	FY 2010-2012
Develop a habitat mitigation banking program to assist with regulatory compliance related to construction of flood control projects.	Identification and Remediation	FY 2010-2011

9. Recommendations and Action Plan

Emergency Services Action	Responsible	Timeframe
Update and support Emergency Action Plans (EAP) for the 22 dams maintained by the District.	Remediation, Structures Branch	Ongoing
Provide reliable weather, water level and stream flow information to other jurisdictions and the community.	Outreach, Engineering Division	Ongoing
Conduct and participate in annual multi-hazard emergency drills.	All	Ongoing
Perform a county-wide vulnerability assessment that simulates the impacts of a major storm event. Use this tool to update flood response plans, emergency action plans and to prioritize future District work.	Identification and Remediation, including Engineering Division	FY 2010-2012
Structural Projects Action	Responsible	Timeframe
Initiate construction or rehabilitation of 57 structures, providing flood protection for over 755 square miles.	Remediation, Project Management, Construction Management branches	FY 2010-2014
Ensure that all Priority 1 Work Orders (work required to assure safety, or for a structure to function as designed) are completed within 14 days.	Remediation, Operations and Maintenance Branch	Ongoing
Public Information Action	Responsible	Timeframe
Visit 12 schools in unincorporated county to discuss how to keep safe during flood events.	Outreach, Public Involvement Branch	FY 2010
Produce 24 media messages regarding flood hazards, flooded wash crossings and other public safety issues.	Outreach, Public Involvement Branch	FY 2010
Maintain a library that contains all past studies and reports and is accessible online from the District's Web site (www.fcd.maricopa.gov).	Outreach, Engineering Branch	Ongoing
Offer technical assistance to 12 of the 24 municipalities in Maricopa County as their Floodplain Management Agency, to residents seeking information, and to municipalities that do their own floodplain management at their request.	All	Ongoing

Implementation

Flooding is a regional issue that transcends political boundaries. The flood control program outlined in this chapter and by watershed in Chapter 8 requires ongoing collaboration with cities, towns and other agencies to implement. Implementation will also require developing new partnerships with the development community and other private interests in the floodplain.

The District as a regional entity will provide leadership and funding for the outreach, identification and maintenance efforts. Structural projects will be implemented through cost-sharing partnerships with impacted jurisdictions and other parties. Other activities will be implemented through agreements with government agencies that have expertise in that area. For example, natural resource enhancement opportunities are identified through the District's flood hazard identification process, and executed through partnerships with municipalities, Arizona Game and Fish Department or federal agencies. Another partnership opportunity is through services provided by the Maricopa County Department of Transportation such as bridge projects or flood warning systems at road crossings.

The Comprehensive Plan provides general guidance for flood control and floodplain management in Maricopa County. The intent is that the feasibility of implementing the actions will be further explored by District staff in collaboration with municipalities, government entities and the community.

Funding

Implementation of the varied flood control activities requires diverse funding sources. The following two sections describe the District's revenue sources and expenditures for flood hazard mitigation in Maricopa County.

Revenue Sources

Under Arizona Revised Statute §48-3603, the District is designated as a special taxing district and is given the authority to levy a secondary property tax on parcels within Maricopa County. Flood control projects are also funded by a variety of state, county, and city cost sharing arrangements. The revenue from the property tax generally covers the Capital Improvement Program projects. Revenue from other sources, which include the sale or lease of rights-of-way, and licensing and permit fees, make up the rest of the District's budget.

Property Tax

The majority of the District's revenue is derived from the secondary property tax for flood control placed on each parcel in Maricopa County. The county Board of Supervisors, acting as the District's Board of Directors, sets the rate of this tax and the assessed real property valuation to which the tax is applied on an annual basis. More than 15 years ago the tax rate was 50 cents for every \$1,000 of valuation. This rate has been steadily declining and is set at 13 cents for Fiscal Year 2009 (see Table 9-1).

Table 9-1: Flood Control Tax Rates and Revenue by Fiscal Year

Fiscal Year	Tax Rate	Tax Revenue
2009	0.1367	\$73,355,561
2008	0.1367	\$69,683,115
2007	0.1533	\$65,099,622
2006	0.2047	\$62,733,411
2005	0.2119	\$54,427,000
2004	0.2119	\$50,050,367
2003	0.2119	\$44,302,534
2002	0.231	\$44,622,753
2001	0.2534	\$43,874,335
2000	0.2858	\$43,992,461
1999	0.327	\$44,995,000

Licenses and Permits

Developers and individuals are required to pay fees in order to obtain floodplain clearance or use permits within Maricopa County. This revenue stream is closely tied to the number of building permits issued each year in Maricopa County. Permits are also required for sand and gravel mining activities in the floodplain.

Table 9-2: License and Permit Revenue by Fiscal Year

Fiscal Year	Revenue
2006	\$3,168,079
2007	\$1,571,000
2008	\$1,883,000
2009 (est)	\$4,949,102

Intergovernmental Participation

The construction of major flood control works is accomplished through cost-share arrangements with municipalities and other entities that benefit from the project. Revenue generated from intergovernmental agreements is substantial, generating in excess of \$17 million in FY 2008.

Table 9-3: Intergovernmental Cost Share Revenue by Fiscal Year

Fiscal Year	Revenue
2006	\$19,877,514
2007	\$13,807,213
2008	\$17,192,456
2009 (est)	\$12,368,023

Miscellaneous

The District receives revenues from the sale of real property or lease of rights-of-way. This figure can vary widely from year to year depending on the size and location of land available and the strength of the real estate market at any given time.

Table 9-4: Miscellaneous Revenue by Fiscal Year

Fiscal Year	Revenue
2006	\$3,415,610
2007	\$6,257,750
2008	\$2,765,426
2009 (est)	\$27,302,919

Expenditures

The District's budget is separated into two main categories: the Operating Budget, and the Capital Improvement Program (CIP). The revenue derived from the property tax and the other sources is used for the CIP and operations expenditures. The District's budget for Fiscal Year 2008 was \$95,241,666. About \$60 million of this was dedicated to the Capital Improvement Program, and \$35 million for operations. These break-downs remain fairly constant each fiscal year.

Future Updates

The District's Comprehensive Floodplain Management Plan and Program will be updated every five years in accordance with the District's statutory requirement for the publication of a flood control report and NFIP - Community Rating System requirements for the development of a floodplain management plan. Implementation of the action plan presented in this chapter will be monitored annually in the form of a progress report submitted to the NFIP. Annual updates of the Capital Improvement Program, planning and delineation budgets will assist in tracking progress toward completion of the watershed-specific activities recommended in Chapter 8.

Information to be addressed in future plans includes completed delineations, plans and structures; development activity within the floodplain or watershed; and progress toward implementation of the strategic initiatives identified in this chapter and Chapter 9. It is rec-

9. Recommendations and Action Plan

ommended that future updates include an expanded public and stakeholder participation process, including the development of a Comprehensive Plan Committee to provide input on flooding problems and review recommended solutions.

Appendix A: Acronyms and Glossary of Terms

Acronyms

ACDC	Arizona Canal Diversion Channel
ADMP	Area Drainage Master Plan
ADMS	Area Drainage Master Study
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
ALERT	Automated Local Evaluation in Real Time
ARS	Arizona Revised Statutes
ASLD	Arizona State Land Department
BLM	U.S. Bureau of Land Management
CAP	Central Arizona Project
CAR	Candidate Assessment Report
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CRS	Community Rating System
EAP	Emergency Action Plans
EMF	East Maricopa Floodway
ESA	Endangered Species Act
FCAB	Flood Control Advisory Board
FCD	Flood Control District of Maricopa County
FCDMC	Flood Control District of Maricopa County
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FPIC	Flood Protection Improvement Committee
FRS	Flood Retarding Structure
FY	Fiscal Year
GIS	Geographic Information Systems
IGA	Intergovernmental Agreement
MAG	Maricopa Association of Governments
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
PPM	Planning and Project Management
SR	State Route

SRP	Salt River Project
USACE	United States Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WCMP	Watercourse Master Plan

Glossary of Terms

100-Year (or Base) Flood: A flood event that statistically has a 1 out of 100 (or one percent) chance of being equaled or exceeded on a specific watercourse in any given year. A flood event of this magnitude is often used to determine if flood insurance is either advisable or required on a property.

100-Year Storm: A rainfall event that has a one percent chance of occurring or being exceeded in any given year.

Acre-foot: The volume of water necessary to cover an acre of land to a depth of one foot. It equals 43,560 cubic feet or 325,851 gallons.

Aggradation: A progressive buildup or raising of the channel bed due to sediment deposition. Permanent or continuous aggradation is an indicator that a change in the stream's discharge and sediment characteristics is taking place.

Alluvial Fan: A geomorphologic feature characterized by a cone or fan shaped deposit of boulders, gravel and fine sediments that have been eroded from mountain slopes, transported by flood flows and then deposited in the valley floors and which is subject to flash flooding, high velocity flows, debris flows, erosion, sediment movement and deposition, and channel migration.

ALERT: An acronym for Automated Local Evaluation in Real Time. ALERT was developed in the late 1970s as a format for data transmission and for the manufacture of compatible hardware and software. ALERT systems are used primarily as flood warning

Approximate Study: A graphic illustration of a delineation of the floodplain by the Floodplain Administrator made from the most reliable sources available where neither a floodplain nor a floodway has been determined by detailed methodology.

Apex: A point on an Alluvial Fan below which the flow of the major stream that formed the fan becomes unpredictable and Alluvial Fan Flooding may occur.

Area Drainage Master Study (ADMS): A study to develop hydrology for a watershed, to define watercourses, identify potential flood problem areas, drainage problems and recommend solutions and standards for sound floodplain and stormwater management. The ADMS will identify alternative solutions to a given flooding or drainage problem.

Area Drainage Master Plan (ADMP): A plan that identifies the preferred alternatives of those identified in an ADMS. An ADMP provides minimum criteria and standards for flood control and drainage relating to land use and Development.

Bankfull Stage: The point at which the water level in a stream overtops the banks and spreads out onto the floodplain.

Base Flood Elevation: The water surface elevation produced by a base flood or one hundred year flood.

Braided Stream: A stream whose flow is divided at normal stage by small islands.

Capacity: The volume of water stored by a dam at the emergency spillway elevation, usually expressed in acre-feet. It differs from storage, which is the volume of water stored at any specific elevation.

Channel (Conveyance): Defined landforms that carry water. The deepest portion of a watercourse through which the majority of runoff is conveyed.

Catch Basin: A chamber or well, usually built at the curb line of a street, for the admission of surface water to a storm sewer or sub-drain

Clearing/Grubbing: Removal of vegetation without disturbance of existing land surface contours.

Community Rating System (CRS): A program administered by the Federal Emergency Management Agency (FEMA) that recognizes and rewards communities working to reduce flood damages through a variety of approved floodplain management and flood awareness activities. Through the program, a community can reduce the flood insurance premiums that floodprone property owners pay.

Culvert: A hydraulically short conduit that conveys surface water runoff through a roadway embankment or through some other type of flow obstruction.

Dam: An earthen, metal, masonry or wooden wall or barrier across a flow of water, which is used to restrict or prevent the water from flowing.

Degradation: A deepening of a channel over time, or in a single storm event due to erosion processes.

Delineated Floodplain: A graphic illustration of the area susceptible to inundation by a 100-year flood based upon the results of an authorized study that is included on either the Flood Management Maps for Maricopa County or the Flood Insurance Rate Maps, or both.

Delineation: Defining the physical boundaries of a stream, floodplain, jurisdictional wash, etc.

Detention Basin: A basin or reservoir where water is stored for regulating a flood. It has outlets for releasing the flows during the floods.

Development: Any man made change to improved or unimproved real estate, including, but not limited to, Buildings or other Structures, mining, dredging, Filling, grading, paving, excavation, drilling operations, and storage of materials and equipment located within the Special Flood Hazard Area.

Discharge: The amount of water that passes a specific point on a watercourse over a given period of time. Rates of discharge are usually measured in cubic feet per second (cfs).

Diversion: A waterway used to divert water from its natural course.

Drainage Basin: A geographical area that contributes surface water runoff to a particular point. The terms "drainage basin," tributary area," and "watershed" can be used interchangeably.

Elevation: A water-level expressed in terms of mean sea level. It differs from stage, which is a water-level in terms of some local datum.

Elevation Certificate: The Elevation Certificate is an important administrative tool of the National Flood Insurance Program (NFIP). It is to be used to provide elevation information necessary to ensure compliance with community floodplain management ordinances, to

determine the proper insurance premium rate, and to support a request for a Letter of Map Amendment or Revision (LOMA or LOMR-F).

Embankment: A man-made earth structure constructed for the purpose of impounding water.

Emergency Spillway: An outflow from a detention or retention facility that provides for the safe overflow of floodwaters for large storms that exceed the design capacity of the outlet or in the event of a malfunction. The emergency spillway prevents the water from overtopping the facility.

Encroachment: The advance or infringement of uses, plant growth, Fill, excavation, Buildings, permanent Structures or Development into a floodplain which may impede or alter the flow capacity of a floodplain.

Ephemeral Watercourse: A watercourse or portion of a watercourse that flows only in direct response to rainfall.

Erosion: The process of the gradual wearing away of landmass.

Erosion Hazard Zone: Land adjacent to a watercourse regulated by Maricopa County that is subject to flood-related erosion losses.

Evapotranspiration: Evapotranspiration is the sum of water lost to the air via transpiration by plants and evaporation from water surfaces.

FEMA (Federal Emergency Management Agency): An independent federal agency established to respond to major emergencies that state and local agencies don't have the resources to handle. FEMA seeks to reduce the loss of life and protect property against all types of hazards through a comprehensive, risk-based emergency management program.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of flood waters; (2) the unusual and rapid accumulation or runoff of surface waters from any source; and/or (3) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in this definition.

Flood Control: Various activities and regulations that help reduce or prevent damages caused by flooding. Typical flood control activities include: structural flood control works (such as bank stabilization, levees, and drainage channels), acquisition of floodprone land, flood insurance programs and studies, river and basin management plans, public education programs, and flood warning and emergency preparedness activities.

Flood Control Advisory Board: A Board of seven members appointed by the Board of Directors. Five members shall be resident taxpayers and qualified electors of the District, at least three of whom shall be residents of the cities in the District. At least one of the Board members who are residents of cities shall be a resident of the largest city in the District. The city engineer of the largest city in the District and the chief engineer or manager of a major irrigation or agricultural improvement District, or their representatives, shall be ex officio members of the advisory Board with all rights and privileges granted to other Board members.

Flood Hazard Zone: Any land area located partially or wholly within a Delineated Floodplain susceptible to flood related damage as designated on the Floodplain Management Maps. Such Flood Hazard Zones may include but not limited to areas highly susceptible to erosion, stream meander sensitivity, moveable bed, scour, wave action, and subsidence.

Flood Insurance Rate Map (FIRM): An official map on which the Federal Insurance Administration has delineated both the 100-year flood Special Flood Hazard Areas and the risk premium zones applicable to a community.

Flood Insurance Study: The official report provided by the Federal Insurance Administration. The report includes flood profiles and Base Flood Elevations.

Flood Management Map: An official map, which can be either hard copy or in electronic format, for Maricopa County on which the Floodplain Administrator has Delineated Floodplains and other flood related Flood Hazard Zones for the purpose of Floodplain administration.

Flood Proofing: Any combination of structural and non-structural additions, changes or adjustments to Structures that reduce or eliminate flood damage to real estate or improved property, water and sanitary facilities, Structures and their contents.

Flood Response Plan: A plan developed for a particular waterway, watershed or jurisdiction that identifies flood hazards and defines methods for avoiding them and for minimizing losses to property.

Flood Stage: The point at which the water level in a stream begins to cause damage to structures. It may be below bankfull stage if structures are located in a floodway.

Floodplain: The area adjoining the channel of a watercourse susceptible to inundation by a base flood including areas where drainage is or may be restricted by man made Structures that have been or may be covered partially or wholly by flood water from the one hundred year flood.

Floodplain Administrator: The individual appointed by the Board to administer and enforce these Regulations. **Floodplain Clearance:** Review and approval of a use of property in or adjacent to a Delineated Floodplain or other delineated flood related hazard zone for which a Floodplain Use Permit is not required as specified in Section 505 and Section 506.

Floodplain Management: A program that uses corrective and preventative measures to reduce flood and erosion damage and preserve natural habitat and wildlife resources in flood-prone areas. Some of these measures include: adopting and administering Floodplain Regulations, resolving drainage complaints, protecting riparian habitat communities, and assuring effective maintenance and operation of flood control works.

Floodplain Regulations: The regulations and other codes, ordinances and regulations adopted pursuant to the authority granted in A.R.S 48-3603 through 48-3628 relating to the use of land and construction within a Delineated Floodplain and Floodway or other Special Flood Hazard Areas.

Floodplain Use Permit: A permit that must be obtained from the Floodplain Administrator prior to commencement or continuance of any non-exempt use within the Area of Jurisdiction.

Floodway: The channel of a river or other watercourse and the adjacent land areas necessary in order to discharge the one hundred year flood without cumulatively increasing the water surface elevation more than one foot.

Floodway Fringe: The areas of a Delineated Floodplain adjacent to the Floodway where encroachment may be permitted.

Flowage Easement: Legal right to allow water to flow across someone's property.

Flood Retarding Structure: A term most commonly used to describe earthen dams built by the Soil Conservation Service between 1950 and 1985 to protect agricultural lands.

Gage: An instrument that measures some property in the environment, like temperature, wind speed or precipitation. It is used interchangeably with "sensor". It is spelled g-a-g-e because that's how the USGS spells it.

Grade Control Structure: A structure used across a stream channel placed bank to bank to control bed elevation, velocity, pressure, etc.

Groundwater: Water within the earth that supplies wells and springs; water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table.

Habitat Mitigation: The compensation for the removal of natural vegetation during the construction of a flood control project by establishing new vegetation elsewhere.

Hydraulics: A field of study dealing with the flow pattern and rate of water movement based on the principles of fluid mechanics.

Hydrology: A field of study concerned with the distribution and circulation of surface water, as well as water dynamics below the ground and in the atmosphere.

Impoundment: Floodwater stored in a basin or behind a dam. It can be described in terms of a water depth (ft) or a volume (acre-ft).

Intensity: When applied to rainfall, intensity is the depth of rain in a specified time. Examples are 1 inch per hour or ½ inch in 20 minutes.

Inactive Alluvial Fan: An Alluvial Fan where flood water typically is within incised channels and adjacent stable land.

Lateral Stream Migration: Change in position of a channel by lateral erosion of one bank and simultaneous deposition on the opposite bank.

Levee: A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control or divert the flow of water so as to provide protection from temporary flooding.

LOMA (Letter of Map Amendment): An official amendment of a current Flood Insurance Rate Map (FIRM) accepted by FEMA for a property or a structure. The LOMA verifies that the structure or portions of the property have been removed from a designated-floodplain area.

LOMR (Letter of Map Revision): An official revision of a current Flood Insurance Rate Map (FIRM) accepted by FEMA, which reflects changes in mapped areas for flood zones, floodplain areas, floodways and flood elevations.

Low Flow Channel: A channel within a larger channel which typically carries low and/or normal flows

Multi-Use Facility: A detention or retention basin that provides additional benefits to its primary function of flood control. Such benefits include recreation, parking, visual buffers, or water harvesting.

National Flood Insurance Act of 1968: An Act passed by Congress that established the National Flood Insurance Program as a means of mitigating flood damages. The Act makes flood insurance available to communities that adopt and enforce measures to reduce flood losses. Prior to the Act, property owners in floodprone areas typically were not able to obtain this coverage through private insurance companies.

National Flood Insurance Program (NFIP): A federal program that allows property owners to purchase insurance protection against losses due to flooding. In order to participate in this program, local communities must agree to implement and enforce measures that reduce future flood risks in special flood hazard areas.

Natural and Beneficial Functions of Floodplains: Includes, but is not limited to the following: natural flood and sediment storage and conveyance, water quality maintenance, groundwater recharge, biological productivity, fish and wildlife habitat, harvest of natural and agricultural products, recreation opportunities, and areas for scientific study and outdoor education.

Outlet Structure: A hydraulic structure placed at the outlet of a channel, spillway, pipe, etc., for the purpose of dissipating energy and providing a transition to the channel or pipe downstream.

Peak Flow: The maximum rate of flow through a watercourse for a given storm.

Percolation: The movement of water through the subsurface soil layers, usually continuing downward to the groundwater or water table reservoirs.

Perennial Flow: Watercourses, or a portion of a watercourse, that flow year round.

Precipitation: All forms of water that fall to the earth's surface - including rain, snow, sleet and hail.

Probable Maximum Flood: The flood runoff that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Reach: A term used to describe a specific length of a stream or watercourse. For example, the term can be used to describe a section of a stream or watercourse between two bridges.

Regulatory Flood Elevation: The elevation which is one (1) foot above the base flood elevation for a watercourse and one (1) foot above the height of the effective outfall or the height of the backwater feature for ponding areas, whichever is greater. Where a Floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow.

Regulatory Floodplain: A portion of the geologic floodplain that may be inundated by the base flood where the peak discharge is 100 cubic feet per second (cfs) or greater. Regulatory floodplains also include areas which are subject to sheet flooding, or areas on existing recorded subdivision plats mapped as being floodprone.

Retention Basin: A basin or reservoir where water is stored for regulating a flood. Unlike a detention basin, it does not have outlets for releasing the flows, the water must be disposed by draining into the soil, evaporation, or pumping systems.

Riparian Habitat: Plant communities that occur in association with any spring, cienega, lake, watercourse, river, stream, creek, wash, arroyo, or other body of water. Riparian habitats can be supported by either surface or subsurface water sources.

Runoff: The portion of precipitation on land that ultimately reaches streams, especially water from rain or melted snow that flows over ground surface.

Sediment: Soil particles, sand, and minerals washed from the land into aquatic systems as a result of natural and human activities.

Setback: The minimum distance required between a man-made structure and a watercourse. This distance is measured from the top edge of the highest channel bank or the edge of the 100-year flood water surface elevation.

Shallow Flooding: Area of flooding with average depths of one (1) to three (3) feet.

Sheet Flooding: A condition where stormwater runoff forms a sheet of water to a depth of six inches or more. Sheet flooding is often found in areas where there are no clearly defined channels.

Special Flood Hazard Area: Land in a Floodplain subject to a one-percent or greater chance of flood in any given year. These areas are designated as Zone A, AO, AE or AH on the FIRM or Floodplain Management Maps and other areas determined by the criteria adopted by the Director of the Arizona Department of Water Resources.

Spillway: An outlet pipe or channel serving to discharge water from a dam, ditch, gutter, or basin.

Stage: A water-level expressed in terms of some local datum. It differs from elevation, which is a water-level in terms of mean sea level.

Station: An ALERT station is a local collection of sensors at a common geographic point. Stations have an ID number corresponding to the precipitation sensor if there is one, or to the water-level sensor at stage-only stations.

Storage: The volume of water stored in a basin or behind a dam—usually expressed in acre-feet. It differs from capacity, which is the volume of water stored at the emergency spillway elevation.

Stormwater: Precipitation from rain or snow that accumulates in a natural or man-made watercourse or conveyance system.

Surface Water: Water that flows in streams and rivers and in natural lakes, in wetlands, and in reservoirs constructed by humans.

Thalweg: The line of maximum depth in a stream. The thalweg is the part that has the maximum velocity and causes cutbanks and channel migration.

Tributary: A stream that contributes its water to another stream or body of water.

Water quality standards: Laws or regulations, promulgated under Section 303 of the Clean Water Act, that consist of the designated use or uses of a waterbody or a segment of a waterbody and the water quality criteria that are necessary to protect the use or uses of that particular waterbody. Water quality standards also contain an antidegradation statement. Every State is required to develop water quality criteria standards applicable to the various waterbodies within the State and revise them every 3 years.

Water table: Level below the earth's surface at which the ground becomes saturated with water. The surface of an unconfined aquifer which fluctuates due to seasonal precipitation.

Watercourse: A lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

Watercourse Master Plan (WCMP): A hydraulic plan for a Watercourse that examines the cumulative impacts of existing Development and future encroachment in the Floodplain and future Development in the watershed on potential flood damages and/or erosion hazards, and establishes technical criteria for subsequent Development so as to minimize potential flood damages for all flood events up to and including the one hundred year flood.

Waters of the U.S.: All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce.

Watershed: An area from which water drains into a lake, stream or other body of water. A watershed is also often referred to as a basin, with the basin boundary defined by a high ridge or divide, and with a lake or river located at a lower point.

Wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Zone A: An area with an approximate delineation of a Floodplain. Floodway boundaries and Base Flood Elevations have not been determined.

Zone AE: An area with a detailed delineation of a Floodplain and in which Base Flood Elevations have been determined.

Zone AH: An area with Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations have been determined.

Zone AO: An area with Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average flood depths have been determined. For areas of Alluvial Fan flooding, velocities may have also been determined.

Zone D: Areas in which flood hazards are undetermined, but possible.

Zone X (shaded): Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from the 100-year flood.

Zone X (unshaded): Areas to be determined outside the 500-year Floodplain.

Appendix B: Regulatory Governance

The District is governed by federal, state, county and local mandates. Summarized below are the key regulations that influence the District's implementation of flood hazard mitigation solutions. The following list is not exhaustive.

Federal

Occupational Safety and Health Act (OSHA). 29CFR Ch XVII (7-1-88).

Flood Control Maintenance and Operations of Flood Control Works. 33CFR Title 33 Title 2, Chapter II-Corps of Engineers, Department of the Army, Part 208.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). 42USC 9601(35)(A)(B) and 9607(a).

Clean Water Act, Section 402–National Pollutant Discharge Elimination System (NPDES). 33 U.S.C. §1251 et seq. Sec. 402. NPDES is also known as Section 402 of the Clean Water Act (CWA). NPDES regulates discharges of point source pollutants into waters of the United States. The goal of the NPDES program is to restore and protect the quality of surface water. This program is administered by the Environmental Protection Agency (EPA).

Clean Water Act, Section 404–Wetlands or Dredge and Fill Program. 33 U.S.C. §1251 et seq. Sec. 404. The CWA protects water quality within jurisdictional waters of the United States. In Maricopa County, typically most streams and washes are considered to be jurisdictional. Section 404 specifically regulates the discharge of dredge or fill material into jurisdictional waters. Under the 404 permitting process, the permittee must document how the proposed project or action affects the environment. The proposed action should consider alternatives that minimize environmental impacts. For environmental impacts that can not be prevented, then the impacts must be mitigated. In addition, when a 404 permit is required, other federal regulations, such as the Endangered Species Act and the National Historic Preservation Act, are triggered and the permittee must document whether or not that endangered species or cultural resources will be affected. As a result, the Section 404 of the CWA indirectly protects riparian habitat, endangered species, and cultural resources. Section 404 is administered by the Corps of Engineers.

National Flood Insurance Act of 1968. (PL 90-448, Title XIII). This Act led to the creation of the National Flood Insurance Program (NFIP). The NFIP enables property owners in participating communities to purchase insurance protection from the government against flooding losses.

Flood Disaster Protection Act of 1973. This Act expanded the national flood insurance program by substantially increasing limits of coverage and by requiring known flood-prone communities to participate in the program.

Disaster Mitigation Act of 2000 (DMA2K). Public Law 106-390–Oct. 30, 2000. Code of Federal Register Amendments, effective date February 26, 2002. Federal Emergency Management Agency (FEMA), 44 CFR Parts 201 and 206. The purpose of this Public Law is to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1974 authorize a program for pre-disaster mitigation, streamline the administration of disaster relief, control the Federal costs of disaster assistance, and for other purposes. This law is part of FEMA's tools for proactive response to disaster management.

Endangered Species Act. 7 U.S.C. §136; 16 U.S.C. §460 et seq. The Endangered Species Act (ESA) protects federally listed threatened or endangered species. The ESA prohibits activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, collect, or attempt to engage in any such activity (i.e., also known as “take”). The ESA can affect development in the floodplain because floodplains contain riparian habitat, which is suitable habitat for seven (including five fish species) of the 12 listed species in Maricopa County. It is administered by the US Fish and Wildlife Service and the NOAA’s National Marine Fisheries Service.

Federal Agencies and Actions

The ESA applies to federal agencies by requiring all federal agencies to consult with the USFWS to ensure that their actions do not endanger listed species or destroy or adversely modify critical habitat. Federal actions include the issuance of federal permits to non-federal land owners.

Incidental Take Permits

Incidental take permits can be issued to non-federal land owners if the take is incidental to and not the purpose of engaging in an otherwise legal activity. Incidental take permits are issued in accordance with a Safe Harbor Agreement or a Habitat Conservation Plan.

Safe Harbor Agreement

A non-federal landowner can enter into a Safe Harbor Agreement (SHA) with the USFWS, which is a voluntary agreement that promotes the voluntary management for listed species on non-federal property. Under a SHA, a landowner can maintain or enhance suitable habitat for listed species with the assurance that that additional restrictions will not be imposed. An “enhancement of survival” permit authorizes incidental take that may occur as a result of the landowner’s typical land management activities.

Migratory Bird Treaty Act. (16 USC 703 through 712). Migratory birds in United States, which includes most of the birds in Arizona, are protected under the federal Migratory Bird Treaty Act (MBTA) of 1918. This means it is illegal to pursue, hunt, kill, take, capture, injure, and attempt to pursue, hunt, kill, take, capture, injure, any migratory bird, any part, nest, or eggs of any such bird. To comply with this regulation, the District conducts surveys before any construction activity starts to determine if migratory birds are nesting or inhabiting the area. If birds are actively nesting or inhabiting the area, there are several options to ensure compliance. One option is to relocate the birds, which is the option the District has previously chosen for the Western burrowing owl. The US Fish and Wildlife Service oversees the MBTA.

National Historic Preservation Act. The National Historic Preservation Act of 1966 requires each federal agency to consider the affects of their actions on historic properties. Federal actions include actions undertaken by the agency or the issuance of federal permits to non-federal entities and land owners. Preservation of historic resources is encouraged but not mandated.

State

A.R.S. §33-1324. Requires the District to maintain residential owned facilities that are rented in a clean and safe condition in full compliance with the applicable building codes.

A.R.S. §45-1212. Requires the State to inspect dams in order to ensure proper maintenance.

A.R.S. §45-1423. Requires the District to operate in accordance with Federal guidance that is normally issued in the form of structure Operating and Maintenance Manuals.

A.R.S. §48-3609. Directs the Board of Directors to "...adopt and enforce regulations governing floodplains and floodplain management in its area of jurisdiction...."

A.R.S. §48-3610. Requires the District to perform floodplain responsibilities for all jurisdictions within the District boundaries unless an incorporated city or town declares by resolution that it will manage its own floodplain.

A.R.S. §48-3613. Requires the District to evaluate and when appropriate grant written authorization to construct within the floodplain.

A.R.S. §48-3616. Directs the Board of Directors to require the Chief Engineer and General Manager to present "...recommendations and a preliminary plan for the construction or other acquisition of facilities to carry out the purpose of the district...."

A.R.S. §48-3616. Requires the preparation of and approval by the Flood Control Advisory Board and the Board of Directors of a comprehensive plan to "...eliminate or minimize flood control problems..."

State of Arizona Executive Order 77-6, dated September 27, 1977, directs each state agency to "...provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare and to restore and preserve the natural and beneficial values served by floodplains carrying out its responsibilities...."

Arizona State Historic Preservation

Arizona has several historic preservation regulations that the District complies with when proposing construction projects or other significant land disturbance activities. The State Historic Preservation Act of 1982 directs state agencies to consider impacts their plans may have on lands that are owned or controlled by the agency. There are also two burial protection laws in Arizona. One law (ARS 41-865) states that anyone that finds or disturbs human remains on privately owned land in Arizona must notify the Director of the Arizona State Museum (ASM) and shall protect those remains while the Director consults with the Tribes. The Arizona Antiquities Act prohibits excavation of historic or prehistoric sites on land owned or controlled by the state of Arizona except by permit from the ASM Director. It also requires a person in charge of construction or other activities on lands owned by the state, any town, city, or county in the state to report the discovery of archeological or historic sites or artifacts to the ASM Director.

Arizona Native Plant Law

According to the Arizona Department of Agriculture (ADA), there are more rare and unusual native plants in Arizona than in anywhere in the U.S. The Arizona Native Plant Law protects most of the native plants in Arizona by requiring authorization to remove protected native plants from state or federal land. On private land, landowners have the right to destroy or remove the protected plants but must notify the ADA at least 20 days before the protected native plants are removed. Also, an ADA permit is required if protected native plants are taken or transported from the property.

County

Floodplain Regulations for Maricopa County, adopted August 4, 1986 (subsequently amended) provides for the review and regulation of development in the floodplain.

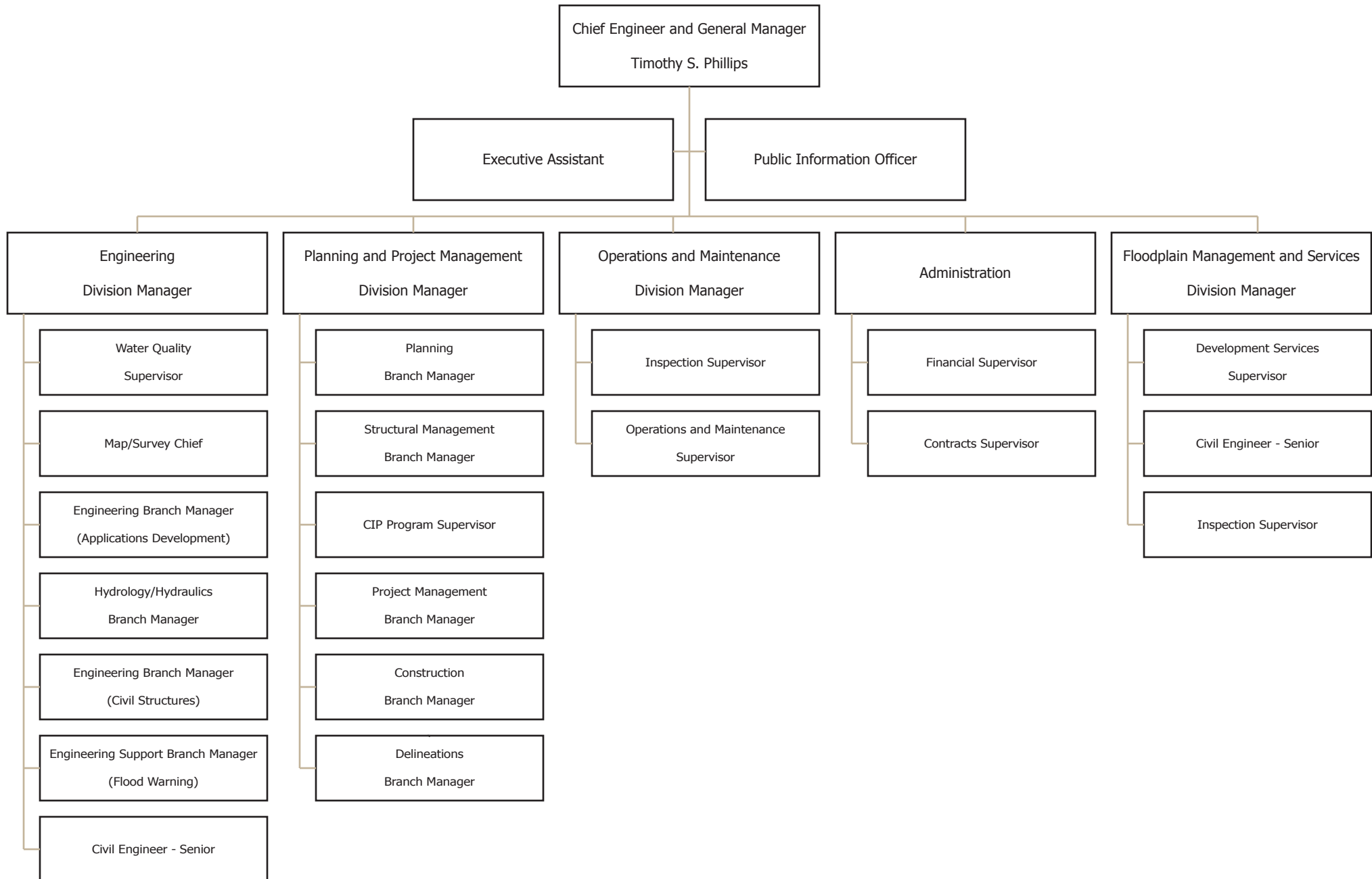
The Revised Drainage Regulation for the Unincorporated Area of Maricopa County, adopted September 2004, provides for the regulation and drainage review for unincorporated areas of Maricopa County and defines requirements for drainage retention and grading plans.

Local Codes, Ordinances and Policies

Certain jurisdictions have enacted codes or ordinances that:

- Require the District to maintain property to certain minimum standards (no weeds, debris, etc.).
- Encourage environmentally-sensitive flood control solutions or development.

Flood Control District of Maricopa County Organizational Chart



Appendix D: Public and Stakeholder Involvement

Contents

Public Meeting Advertisements
Fact Sheets
Sign-in and Comment Sheets
Public Survey Results
Web Page Materials
Public Meeting Presentations
Correspondence

Flood Control District of Maricopa County
We Need Your Input
PUBLIC MEETING

**Thursday,
April 23, 2009
3:00 – 7:00 p.m.**

**Flood Control District
2801 W. Durango St.
Phoenix, 85009**



The Flood Control District of Maricopa County invites you to a public meeting to learn about and participate in the development of the 2009 update of our Comprehensive Floodplain Management Plan and Report (Plan). This is the first public meeting for the Plan and will be conducted in an open house format.

The Plan is part of our flood control and floodplain management planning process. It identifies historic flooding, reviews efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.

Citizens may contribute to the overall Plan by offering valuable input. Those citizens unable to attend the meeting may provide input through an online questionnaire at: www.fcd.maricopa.gov/CompPlan.

For more information, contact:
Jen Pokorski
Project Manager
(602) 506-2935
FloodCompPlan@mail.maricopa.gov
www.fcd.maricopa.gov/CompPlan



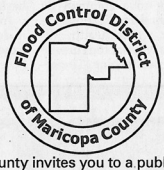
A sign language interpreter will be made available upon request with 72 hours notice. Alternative format materials or FM or Infra-Red Listening Devices are also available upon request with 72 hours notice. Additional reasonable accommodations will be made available to the extent possible within the timeframe.

www.fcd.maricopa.gov

Flood Control District of Maricopa County
PUBLIC MEETING

**Tuesday July 14, 2009
4:00 – 6:00 p.m.**

**Flood Control District
2801 W. Durango St.
Phoenix, 85009**



The Flood Control District of Maricopa County invites you to a public meeting to learn about the 2009 update of our Comprehensive Floodplain Management Plan and Report (Plan). This is the final public meeting for the Plan and will be conducted in an open house format. The draft Plan is available on the Website at www.fcd.maricopa.gov/CompPlan.

The Plan is part of our flood control and floodplain management planning process. It identifies historic flooding, reviews efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.

For more information, contact:
Jen Pokorski
Project Manager
(602) 506-2935
FloodCompPlan@mail.maricopa.gov
www.fcd.maricopa.gov/CompPlan



A sign language interpreter will be made available upon request with 72 hours notice. Alternative format materials or FM or Infra-Red Listening Devices are also available upon request with 72 hours notice. Additional reasonable accommodations will be made available to the extent possible within the timeframe.

www.fcd.maricopa.gov



Flood Control District of Maricopa County

2801 West Durango Street
Phoenix, Arizona 85009
Phone: 602-506-1501
Fax: 602-506-4601
TT: 602-506-5897

FOR IMMEDIATE RELEASE
For more information please call:
Jen Pokorski
Project Manager
(602) 506-2935

Flood Control District to Host Public Meeting for Development of Comprehensive Floodplain Management Plan

PHOENIX (April 20, 2009) – The Flood Control District of Maricopa County (District) will be hosting a public meeting to encourage county citizens to learn about and participate in the development of the 2009 update of the District's Comprehensive Floodplain Management Plan and Report (Plan).

**Thurs., April 23
3 p.m. to 7 p.m.**

Flood Control District administrative office
2801 W. Durango St., Phoenix, 85009

Citizens will have the opportunity to contribute to the overall Plan by providing valuable input. Those persons unable to attend the public meeting may provide input through an online questionnaire on the District's Web site at: www.fcd.maricopa.gov/CompPlan.

The Plan is updated approximately every five years as part of the District's flood control and floodplain management planning process. It identifies historic flooding, reviews our efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.

The District's first comprehensive plan in 1963 was the blueprint for the design and construction of flood control dams, channels and other facilities in Maricopa County which have provided flood hazard safety over the past 50 years. While regional flooding has been solved in large portions of the county's urban core, floodplain management and planning is ongoing in rural areas and newer urban communities. Updating the Comprehensive Plan provides District staff with the latest information to increase the effectiveness of our ongoing, forward-thinking countywide flood control efforts.

The Plan also serves to maintain the District's high ranking in the National Flood Insurance Program's Community Rating System, which provides residents in unincorporated Maricopa County with up to a 25 percent reduction in the cost of a flood insurance policy.

Celebrating 50 Years of Flood Protection and Service to Maricopa County

The Flood Control District of Maricopa County is tasked to provide regional flood hazard identification, regulation, remediation, and education to Maricopa County residents so that they can reduce their risk of injury, death, and property damage from flooding, while still enjoying the natural and beneficial values served by floodplains.

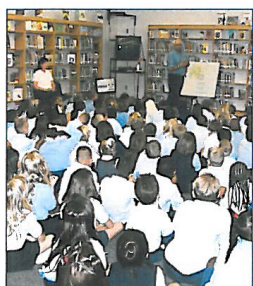
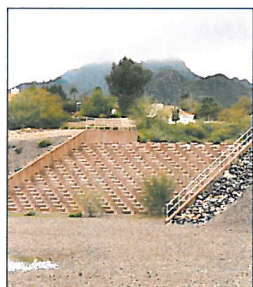
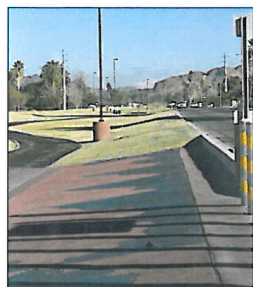
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Board of Directors

Fulton Brock, District 1
Don Stapley, District 2
Andrew Kunasek, District 3
Max Wilson, District 4
Mary Rose Wilcox, District 5

Comprehensive Floodplain Management Plan and Report 2009 Update



The Flood Control District of Maricopa County (District) is updating our Comprehensive Floodplain Management Plan and Report (Plan). The Plan is a roadmap for future District activities. It prioritizes areas for future studies and projects, and serves as a guide for policy-making and program development.

Plan Basics

The Plan is a critical component in the development of the District's flood control and floodplain management programs. The Plan identifies historic flooding events, reviews our efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.

The District's first comprehensive plan in 1963 was the blueprint for the design and construction of flood control dams, channels and other facilities in Maricopa County which have provided flood hazard safety to county residents over the past 50 years. While regional flooding has been reduced or eliminated in large portions of the county's urban core in the period since 1963, floodplain management and planning is ongoing in rural areas and newer urban communities.

The preparation of the Comprehensive Plan and Report is required under Arizona law. The Plan also serves to maintain the District's high ranking in the National Flood Insurance Program's Community Rating System, which provides residents in unincorporated Maricopa County with up to a 25 percent reduction in the cost of a flood insurance policy.

www.fcd.maricopa.gov

Revised Date: April 2009

Flood Control District of Maricopa County

Updates for 2009

The Plan is updated approximately every five years with the most up-to-date information to increase the effectiveness of the District's ongoing, forward-thinking countywide flood control efforts.

Future trends and challenges identified during the 2009 Plan update process include:

- protecting the most lives and property with the efficient use of funding;
- sustainable, environmentally sensitive projects which provide opportunities for recreation, wildlife corridors and community enhancement;
- maintenance and rehabilitation of aging flood control structures, in particular the dams;
- floodplain delineation and regulation;
- developing plans to address issues unique to the Sonoran Desert, including rivers, intermittent washes and alluvial fans; and
- forging partnerships with cities and towns to best utilize the District's regional flood control expertise and leadership.

We Need Your Input

County residents have the opportunity to contribute to the overall 2009 Plan updates by offering valuable input.

The District would like to know which flood control strategies you feel are the best use of our funding. We would also like to know what considerations (such as recreational opportunities, aesthetics, or habitat restoration) are important to you when we engage in flood control activities.

You may provide your input in these ways:

1. Visiting the District's Web site at www.fcd.maricopa.gov/CompPlan and completing an online survey
2. E-mailing your comments to Jen Pokorski, Project Manager at: FloodCompPlan@mail.maricopa.gov

Next Steps

A draft version of the Plan will be presented to the public and stakeholders for review in June 2009. After consideration of stakeholder and public input, the Plan will be completed in August 2009 to coincide with the District's 50th anniversary.

Contact

Jen Pokorski

Project Manager

602-506-2935

Fax: 602-506-8561

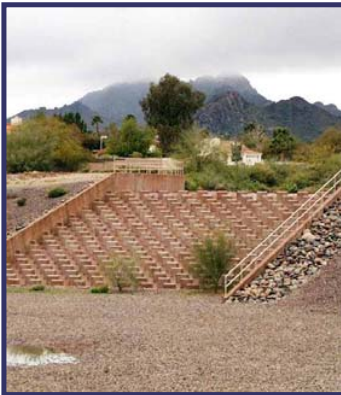
FloodCompPlan@mail.maricopa.gov



Board of Directors

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Andrew Kunasek, District 3
Max Wilson, District 4
Mary Rose Wilcox, District 5

2009 Comprehensive Floodplain Management Plan and Program



The Flood Control District of Maricopa County (District) is updating the Comprehensive Floodplain Management Plan and Program (Plan). The Plan is a roadmap for future District activities. It prioritizes areas for future studies and projects, and serves as a guide for policy-making and program development.

Plan Basics

The Plan is a critical component in the development of the District's flood control and floodplain management programs. The Plan identifies historic flooding events, reviews our efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.



The District's first comprehensive plan, completed in 1963, was the blueprint for the design and construction of flood control dams, channels and other facilities in Maricopa County. These projects have provided flood hazard safety to county residents over the past 50 years. While regional flooding has been reduced or eliminated in large portions of the county's urban core in the period since 1963, floodplain management and planning is ongoing in rural areas and newer urban communities.



The preparation of the Comprehensive Plan and Program is required under Arizona law. The Plan also serves to maintain the District's high ranking in the National Flood Insurance Program's Community Rating System, which provides residents in unincorporated Maricopa County with up to a 25 percent reduction in the cost of a flood insurance policy.

Flood Control District of Maricopa County

Updates for 2009

The Plan is updated regularly with the most up-to-date information to increase the effectiveness of the District's ongoing, forward-thinking countywide flood control efforts. Future trends and challenges identified during the 2009 Plan update process include:

- protecting the most lives and property with the efficient use of funding;
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- floodplain delineation and regulation;
- developing plans to address issues unique to the Sonoran Desert, including rivers, intermittent washes and alluvial fans; and
- forging partnerships with cities and towns to best utilize the District's regional flood control expertise and leadership.

We Need Your Input

County residents have the opportunity to comment on the current draft. You may provide your input in these ways:

1. Filling out a comment card at the July 14 Public Meeting.
2. E-mailing your comments to Jennifer Pokorski at:

FloodCompPlan@mail.maricopa.gov

Next Steps

- A draft version of the Plan was approved by the Flood Control Advisory Board in June 2009.
- District staff will continue to seek public and stakeholder comment throughout July 2009.
- The Plan will be completed in August 2009 to coincide with the District's 50th anniversary.
- The Board of Directors will hold a public hearing to consider adoption of the Plan in late August or early September.

Contact

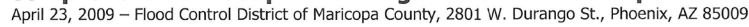
Jennifer Pokorski, AICP
Project Manager

602-506-2935

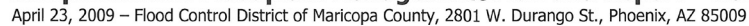
Fax: 602-506-8561

FloodCompPlan@mail.maricopa.gov

Rev. July 6, 2009



Name	Address	Phone	E-mail Address	How did you learn about this meeting? (please circle)
Sam Hanna	City of Phoenix Aviation	602 273 4582	Samuel.Hanna@phoenix.gov	Arizona Republic advertisement Internet Word of mouth Other <u>AGENCY</u>
Cory Wilder	Michael Baker Jr. Inc 2929 N. Central Phoenix	602 798 7554	cwilder@mbakercorp.com	Arizona Republic advertisement Internet Word of mouth Other <u>AGENCY</u>
Radinare Unnikrishna	---	602-798-7554	PUnnikrishna@mbakercorp.com	Arizona Republic advertisement Internet Word of mouth Other <u>AGENCY</u>
Rick Gillen	2141 P. Broadway Tempe Az 85281-1111	480-557-7771	LEADER@FLAND.COM	Arizona Republic advertisement Internet Word of mouth <u>Arizona Republic</u> Other _____
Greg Rudzenko	City of Glendale	623-930-3623	grudz@cityofglendaleaz.com	Arizona Republic advertisement Internet Word of mouth Other _____
Mike Duncan	35228 N 34th Ave. Desert Hills, AZ	---	---	Arizona Republic advertisement Internet Word of mouth Other _____



Name	Address	Phone	E-mail Address	How did you learn about this meeting? (please circle)
Peter W Schaefer	15025 N 53 rd Street	602-795-7746	peter_schaefer@yahoo.com	Arizona Republic advertisement Internet <u>Word of mouth</u> Other _____
				Arizona Republic advertisement Internet Word of mouth Other _____
				Arizona Republic advertisement Internet Word of mouth Other _____
				Arizona Republic advertisement Internet Word of mouth Other _____
				Arizona Republic advertisement Internet Word of mouth Other _____
				Arizona Republic advertisement Internet Word of mouth Other _____



2009 Comprehensive Floodplain Management Plan and Program

July 14, 2009 – Flood Control District of Maricopa County administrative office

SIGN-IN SHEET

Name	Address	Phone	E-mail
Jason Harrington	817 N-Central Ave Phoenix, AZ	602-421-9000	Jason@egnyteinc.com

Public Comment Sheet

Flood Control District of Maricopa County
2009 Comprehensive Floodplain Management Plan and Program



Additional space is on the reverse side.

Name: _____

Phone: _____

E-mail Address: _____

Title: _____

Company or organization: _____

Comments may also be sent to:

Jennifer Pokorski

2801 W. Durango St.

Phoenix, AZ 85009

602-506-2935

FloodCompPlan@mail.maricopa.gov



Comprehensive Floodplain Management Plan and Report Public Survey

If you had a total budget of \$100, how much money would you allocate to the following ways or "strategies" to reduce flooding?

Constructing and maintaining flood control structures (dams, levees, channels, basins) to solve flooding problems	\$ _____
Developing plans and recommendations to solve flooding problems. The plans can be implemented by government agencies, developers, or private citizens.	\$ _____
Purchasing homes that have been flooded or are at risk of severe flooding	\$ _____
Preserving floodplains (lands adjacent to rivers and washes)	\$ _____
Identifying floodplains and regulating development within floodplains	\$ _____
Educating the public regarding flood safety and the danger of crossing flooded washes	\$ _____
Other (please specify) _____	\$ _____

When we are solving flood control problems (building structures or regulating floodplains), how important are the following considerations?

	<u>Not Important</u>	<u>Somewhat Important</u>	<u>No Opinion or Not Sure</u>	<u>Important</u>	<u>Very Important</u>
Building structures that blend in or complement the surrounding area or landscape	☐	☐	☐	☐	☐
Incorporating recreational opportunities	☐	☐	☐	☐	☐
Improving water quality	☐	☐	☐	☐	☐
Ensuring safe crossings of rivers and washes	☐	☐	☐	☐	☐
Restoring and maintaining the natural function of washes, rivers and floodplains	☐	☐	☐	☐	☐
Protecting or enhancing wildlife habitat	☐	☐	☐	☐	☐

Background Information (Optional):

How long have you lived in Maricopa County? _____

Has your property ever been flooded?

☐ Yes ☐ No

Is your property in an identified floodplain?

☐ Yes ☐ No

If yes, do you have flood insurance?

☐ Yes ☐ No

Additional Comments _____

Comprehensive Floodplain Management Plan and Report Public Survey - Compiled Results

Average Response

1A	\$39
1B	\$14
1C	\$3
1D	\$20
1E	\$12
1F	\$4
1G	\$45
1G Comment	develop pro-active strategies to prevent flooding situations preserve existing desert fix problems with upstream development

	Not Important	Somewhat Important	No Opinion/ Not Sure	Important	Very Important
2A	2	3		9	8
2B	2	5	2	7	5
2C	1	1	3	3	13
2D	1	1	2	5	13
2E		1		6	14
2F		3		5	14
3A	30				
	Y	N			
3B	6	15			
3C	12	8			
3D	10	6			

General Comments

can't afford flood insurance (2)
 preserve existing desert
 keep channels open and free of growth and trash
 property may have flooded before
 404 permit is "overdone"
 owner is erroneously in floodplain; faulty zoning upstream affects flows nearby
 doesn't need flood insurance, has not flooded in 30 years, can't afford on fixed income
 diversion of flows kills existing vegetation



The Flood Control District of Maricopa County

[Home](#) | [Maps](#) | [Rainfall](#) | [FAQs](#) | [Links](#) | [Site Map](#) | [Feedback](#) | [Contact Us](#)

Search Our Site [Go](#)



About the District

- District Overview
- Message from the Chief Engineer
- Strategic Programs
- History of the District
- Flood Control Advisory Board
- District Board of Directors
- Annual Report
- Awards

Public Information & Flood Safety

Education Center

Geographic Information Systems

Projects

Permitting

Rainfall & Weather

Procurement/Contracting

Software

Publications & Library

Real Estate Division

Land Management (Auctions, Sales, Leases)

Floodplain Management

Water Quality

Employment Opportunities

Public Record Requests

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The Flood Control District
of Maricopa County

Comprehensive Floodplain Management Plan and Report

The District's Comprehensive Floodplain Management Plan and Report is a critical component in the formulation of our flood control and floodplain management programs. The Plan identifies historic flooding events, reviews our efforts to solve flooding problems, and formulates five-year plans to reduce flooding through flood control project construction, floodplain identification and planning programs throughout the county.

The Plan is updated approximately every five years to provide our stakeholders with the most up-to-date information to increase the effectiveness of the District's ongoing, forward-thinking countywide flood control efforts.

Future trends and challenges reflected in the 2009 Plan update include:

- protecting the most lives and property with the efficient use of funding
- sustainable, environmentally sensitive projects which provide opportunities for recreation, wildlife corridors and community enhancement
- developing plans to address issues unique to the Sonoran Desert, including rivers, intermittent washes and alluvial fans
- maintenance and rehabilitation of aging flood control structures, in particular the dams
- floodplain delineation and regulation
- forging partnerships with cities and towns to best utilize the District's regional flood control expertise and leadership

County residents have the opportunity to contribute to the overall 2009 Plan updates by providing input for solutions to flooding problems. Click the "Plan Questionnaire 2009" link on this page to share your thoughts with us.

The District's first comprehensive plan in 1963 was the blueprint for the design and construction of flood control dams, channels and other facilities in Maricopa County which have provided flood hazard safety over the past 50 years. While regional flooding has been reduced or eliminated in large portions of the county's urban core in the period since 1963, floodplain management and planning is ongoing in rural areas and newer urban communities.

The Comprehensive Plan also serves to maintain the District's high ranking in the National Flood Insurance Program's Community Rating System, which provides residents in unincorporated Maricopa County with up to a 25 percent reduction in the cost of a flood insurance policy.

If you have any questions or comments regarding the plan, please address them to:

Jennifer Pokorski
Project Manager
(602) 506-2935
FloodCompPlan@mail.maricopa.gov

PDFs (Portable Document Files) require the free Acrobat Reader version 5.0 or higher to view. If you do not already have Acrobat, click on the following 'Get Adobe Reader' button:



Comprehensive Plans

- Comprehensive Plan 2009
- Comprehensive Plan 2005

Questionnaire

- Plan Questionnaire 2009

Maps

- Completed CIP Projects East of I-17
- Completed CIP Projects West of I-17
- Current CIP Projects
- Delineated Stream Lengths
- Growth - Historic
- Growth - Projected
- Land Ownership
- Residential Completions
- Status of Master Plans & Studies



Supervisor Fulton Brock, District 1
Supervisor Don Stapley, District 2
Supervisor Andy Kunasek, District 3
Supervisor Max Wilson, District 4
Supervisor Mary Rose Wilcox, District 5

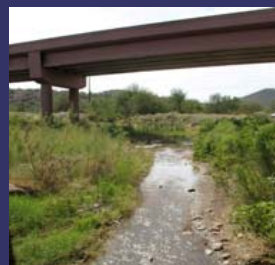
Comprehensive Floodplain Management Plan and Report

Public Meeting

April 23, 2009

Presentation Overview

- Comprehensive Plan Purpose
- Flooding in Maricopa County
- District Overview
- We Need Your Input



Comprehensive Floodplain Management Plan and Report Purpose

- Identify areas for future studies and projects
- Guide policy-making and program development
- Provide public information and education
- Fulfill a requirement under the National Flood Insurance Program
- Comply with State of Arizona Revised Statutes



Flood Hazards in Maricopa County

- Over \$1 billion in flood damages since 1955
- 17 state or federally declared disasters since 1966

Risk of flooding due to:

- Unique soil and topography;
- Winter and summer rainy seasons; and
- Numerous natural riverbeds, washes and channels.



Salt River near Mill Avenue, 1891



Salt River at Mill Avenue, 1993



Northern Ave & Litchfield Rd, 1951



Widespread Flooding, June 1972



7th Avenue & Grand Canal/Hazelwood St.



2nd Avenue & Fillmore

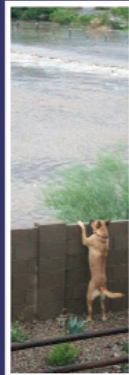
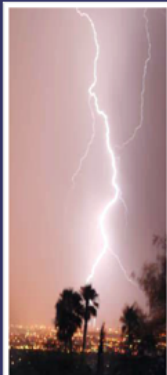
Gila River at SR 85 Bridge, 1983



Winter Storms, February 2005



Summer Monsoons, July 2006



Flood Control District of Maricopa County

- Established 1959
- The **mission** of the Flood Control District is to provide regional flood hazard identification, regulation, remediation, and education to Maricopa County residents so that they can reduce the risk of injury, death, and property damage from flooding, while still enjoying the natural and beneficial values served by floodplains.



Flood Control District

- Education
- Identification
- Regulation
- Mitigation



Photograph taken by Thomas McGuire



Strategic Programs Education

- Flood warning and forecasting program



Strategic Programs Identification

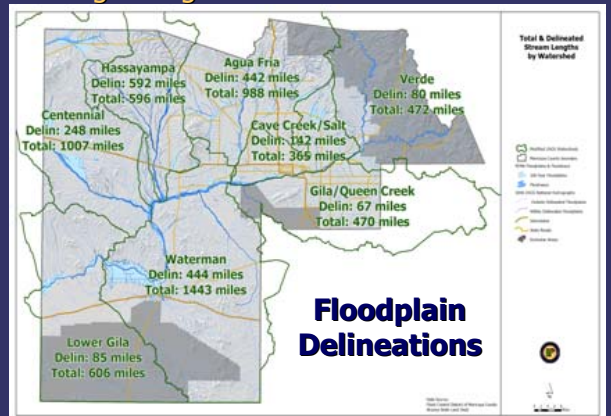
Identification of the areas where flood hazards exist and how the hazards can be minimized.

This program includes:

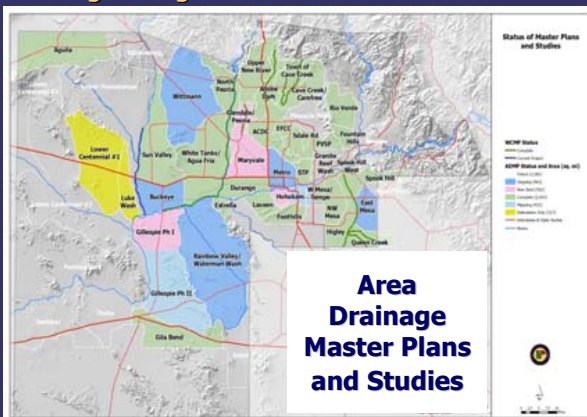
- Floodplain Delineation
- Area Drainage Master Plans
- Area Drainage Master Studies
- Watercourse Master Plans
- Dam safety inspections and assessments



Strategic Programs: Identification



Strategic Programs: Identification



Strategic Programs Regulation

- Enforcement of federal, state and local rules regarding development in areas prone to flooding
- Regulatory functions include:
 - Floodplain management;
 - Floodplain use permits;
 - Sand & gravel permitting; and
 - Floodplain map information.

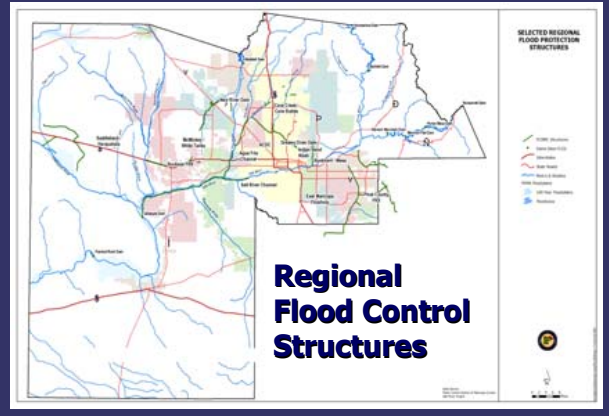


Strategic Programs Remediation

- The District constructs and maintains flood control facilities to reduce flood-related loss of life and property damage.



Strategic Programs: Remediation



Bethany Home Outfall Channel: SR 101 to 83rd Avenue

Before

After



83rd Ave. & Pinnacle Peak Rd. Drainage Improvements

Before

After



Laveen Area Conveyance Channel

Before

After



Comprehensive Plan We Need YOUR Input

- How should we solve flooding problems?
- What considerations are important to you when we engage in flood control activities?
- Do you have any general concerns regarding flooding or flood control in Maricopa County?



Comprehensive Plan Next Steps

- Draft Comprehensive Plan available for public comment in late June.
- Final Plan completed in late July.



Cave Creek Floodplain: Before & After Construction of the Arizona Canal Diversion Channel



Supervisor Fulton Brock, District 1
Supervisor Don Stapley, District 2
Supervisor Andy Kunasek, District 3
Supervisor Max Wilson, District 4
Supervisor Mary Rose Wilcox, District 5

Comprehensive Floodplain Management Plan and Report Public Meeting

April 23, 2009





Supervisor Fulton Brock, District 1
Supervisor Don Stapley, District 2
Supervisor Andy Kunasek, District 3
Supervisor Max Wilson, District 4
Supervisor Mary Rose Wilcox, District 5

Comprehensive Floodplain Management Plan and Program Public Meeting #2

July 14, 2009

Presentation Overview

- Comprehensive Plan Purpose
- Flooding in Maricopa County
- District Background
- Comprehensive Plan Overview
- Comprehensive Plan Recommendations
- How Flood Control Structures Reduce the Floodplain and Flood Hazard (simulation)



Comprehensive Plan and Program Purpose

- Comply with State of Arizona Revised Statutes
- Fulfill a requirement under the National Flood Insurance Program
- Identify areas for future studies and projects
- Guide policy-making and program development
- Provide public information and education



Flood Hazards in Maricopa County

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Risk of flooding due to:

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2nd Avenue & Fillmore

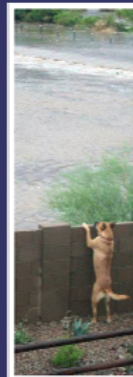
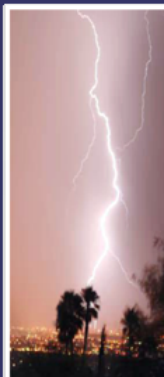
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Strategic Programs

Remediation

- The District constructs and maintains flood control facilities to reduce flood-related loss of life and property damage.

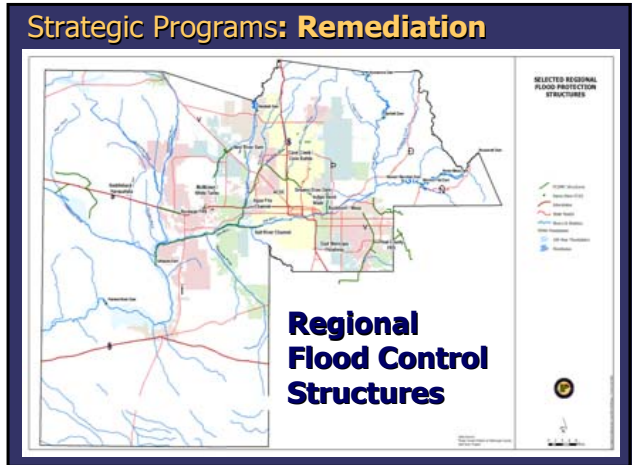


The first photograph shows a large, rectangular concrete detention basin with a flat, light-colored surface, surrounded by a concrete wall and a road. The second photograph shows a grassy flood control area with a bridge in the background and mountains in the distance. The third photograph shows a dry, landscaped flood control area with trees and shrubs, and a road in the background.

- ## Strategic Programs
- ### Remediation
- The District constructs and maintains flood control facilities to reduce flood-related loss of life and property damage.
- 
- The first photograph shows a large, rectangular concrete detention basin with a flat, light-colored surface, surrounded by a concrete wall and a road. The second photograph shows a grassy flood control area with a bridge in the background and mountains in the distance. The third photograph shows a dry, landscaped flood control area with trees and shrubs, and a road in the background.



Strategic Programs: Remediation



Strategic Programs: Remediation

**Bethany Home Outfall Channel:
SR 101 to 83rd Avenue**

The image is a side-by-side comparison of the Bethany Home Outfall Channel. The left side, labeled 'Before', shows a dry, muddy, and eroded channel bed with some standing water. The right side, labeled 'After', shows the same area after construction, featuring a wide, green grassy slope, a concrete curb, and a paved walkway. A small tree is planted on the grass. In the background, there are mountains and some buildings.

**Bethany Home Outfall Channel:
SR 101 to 83rd Avenue**

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83rd Ave. & Pinnacle Peak Rd. Drainage Improvements

Before



After



83rd Ave. & Pinnacle Peak Rd. Drainage Improvements

Before



After



83rd Ave. & Pinnacle Peak Rd. Drainage Improvements

Before



After



Laveen Area Conveyance Channel

Before



After



The 'Before' image shows a narrow, muddy conveyance channel with a dirt road and power lines in the background. The 'After' image shows a wide, green, landscaped park area with a paved path and a small fenced-in field.

Laveen Area Conveyance Channel

Before



After



The 'Before' image shows a narrow, muddy conveyance channel with a dirt road and power lines in the background. The 'After' image shows a wide, green, landscaped park area with a paved path and a small fenced-in field.

Laveen Area Conveyance Channel

Before



After



The 'Before' image shows a narrow, muddy conveyance channel with a dirt road and power lines in the background. The 'After' image shows a wide, green, landscaped park area with a paved path and a small fenced-in field.



Comprehensive Plan and Program Content

- Completed Activities
- Future Need
- Recommendations and Action Plan
- Other Components
 - Strategic Analysis
 - District History
 - Flooding in Maricopa County
 - District Programs
 - Natural and Developed Environment

- ## Comprehensive Plan and Program Content
- Completed Activities
 - Future Need
 - Recommendations and Action Plan
 - Other Components
 - Strategic Analysis
 - District History
 - Flooding in Maricopa County
 - District Programs
 - Natural and Developed Environment

Comprehensive Plan and Program Completed Activities

Since 1959...

- Constructed more than 140 structures
- Delineated 4,100 linear miles of floodplains
- Studied nearly 4,000 square miles



Comprehensive Plan and Program Future Need

Category	Totals
Un-delineated watercourses	1,800 linear miles
Area needing hazard identification	3,000+ sq. miles
Capital Improvement Program needs	\$300 M+
Dams w/ safety deficiencies	6
Residential structures in floodplain	27,800

Comprehensive Plan and Program Recommended Five-Year Program

Program	Actions
Outreach	Public Education Flood Warning
Identification	530 miles of delineations 2,800 sq. mi. of ADMS/Ps
Regulation	Floodplain management for unincorporated county & 12 communities Adoption of ADMP/WCMPs by cities
Remediation	Initiation of 57 projects FPAP O&M to preserve life of facilities

We Need YOUR Input

- **Complete Comment Sheet on Draft Plan**
- Public Hearing on Final Plan in Early September
- Final Plan Available in Late September



Cave Creek Floodplain: Before & After Construction of Cave Buttes Dam and the Arizona Canal Diversion Channel



April 8, 2009

(Address – see list of addresses)

Dear (see list of addresses):

The Flood Control District of Maricopa County (District) is updating its Comprehensive Floodplain Management Plan and Report (Plan). This Plan is a roadmap for existing and future District activities, prioritizing areas for studies and projects and serving as a guide for policy and program development. This Plan is part of the National Flood Insurance Program's Community Rating System, and will satisfy our state statutory requirement to publish a flood control report.

As a valued partner in the District's flood control projects, studies and efforts, it is important to have your input on the Plan. **The stakeholder and public input phase of the Plan update begins with a public meeting to be held at the Flood Control District on April 23, 2009.** In late May, the District will submit a draft of the 2009 Plan update for your review, with completion expected in July.

The 2009 Plan is an update to the 2005 Plan, and will look at all of the District's activities for providing flood control and floodplain management – from structural solutions to non-structural measures, education, and regulation. The updated Plan will review the District's 50 years of history and regional leadership in solving or reducing the threat of flooding in Maricopa County. In addition, the Plan will examine flooding and the natural environment, population and development trends, hazard and problem assessment, and provide recommendations on a watershed basis.

For more information, visit our website at www.fcd.maricopa.gov/CompPlan. If you have any questions, please contact Jen Pokorski, Comprehensive Plan Project Manager at (602) 506-4695 or jmp@mail.maricopa.gov. We look forward to your participation.

Sincerely,

Timothy S. Phillips
Chief Engineer and General Manager

June 9, 2009

(Address – see list of addresses)

Dear (see list of addresses):

The Flood Control District of Maricopa County (District) is updating its Comprehensive Floodplain Management Plan and Program (Plan). The Plan is part of the National Flood Insurance Program's Community Rating System for unincorporated Maricopa County, and satisfies our state statutory requirement to publish a flood control report.

Attached is an electronic copy of the District's draft 2009 Plan Update for your review. Comments are due to the District by July 30, 2009.

The District developed the latest Comprehensive Plan in 2005. The 2009 update is necessary to reflect completed District studies and projects, as well as changes in watershed conditions, population, and community expectations. The flood hazard information presented in the 2009 Plan is a compilation of data developed during the preparation of Area Drainage Master Plans and other District studies.

The Plan is designed to present adequate background data to help District leadership, in partnership with cities and other agencies, prioritize areas for future studies and projects. The Plan is also intended to provide the public with enough information to fully participate in developing effective solutions to flooding. The recommended program of work presented in the Plan is based on the District's five-year delineations, planning and Capital Improvement Program budgets.

The Plan is scheduled to go to the Flood Control District's Board of Directors for public hearing and adoption in early September. The final formatted Plan with complete appendices will be available following Board action.

Please forward your comments or questions to Jen Pokorski, Comprehensive Plan Project Manager at (602) 506-4695, jmp@mail.maricopa.gov or 2801 W. Durango Street, Phoenix, 85009.

Sincerely,

Timothy S. Phillips, P.E.
Chief Engineer and General Manager

Title	First	Last	Position	Agency	Address	City	State	Zip
Mr.	Wayne	Anderson	Town Engineer	Town of Cave Creek	37622 N. Cave Creek Rd.	Cave Creek	AZ	85331
Mr.	Charles	Andrews	Senior Project Manager	City of Avondale	11465 W. Civic Center Dr., Ste. 120	Avondale	AZ	85323
Ms.	Sandy	Bahr	Conservation Outreach Director	Sierra Club Grand Canyon Chapter	202 E. McDowell Rd., Suite 277	Phoenix	AZ	85004
Mr.	Peter	Bierly	Environmental Program Specialist	Arizona Department of Environmental Quality	1110 W. Washington St.	Phoenix	AZ	85007
Mr.	Jim	Bond	Assistant City Engineer	City of Tempe	31 E. 5th St.	Tempe	AZ	85281
Mr.	Larry	Broyles	Engineering Director	City of Glendale	5850 W. Glendale Ave.	Glendale	AZ	85301
Mr.	Rick	Buss	Town Manager	Town of Gila Bend	644 W. Pima St., P.O. Box A	Gila Bend	AZ	85337
Mr.	R.J.	Cardin	Director	Maricopa County Parks and Recreation Department	234 N. Central Ave., Ste. 6400	Phoenix	AZ	85004
Mr.	Burton	Charron	Senior Civil Engineer	City of Peoria	8401 W. Monroe St.	Peoria	AZ	85345
Mr.	Andrew	Cooper	Public Works Director	Town of Paradise Valley	6401 E. Lincoln Dr.	Paradise Valley	AZ	85253
Mr.	B.J.	Cornwall	City Manager	City of El Mirage	12145 N.W. Grand Ave., Ste. 8	El Mirage	AZ	85335
Mr.	Brian	Cosson	State NFIP Coordinator	Arizona Department of Water Resources	3550 N. Central Ave.	Phoenix	AZ	85012
Mr.	Ashley	Couch	Stormwater Management Director	City of Scottsdale	7447 E. Indian School Rd., No. 205	Scottsdale	AZ	85251
Mr.	Darryl	Crossman	City Manager	City of Litchfield Park	214 W. Wigwam Blvd.	Litchfield Park	AZ	85340
Mr.	Jeff	Davidson	Civil Engineer	City of Surprise	12425 W. Bell Rd., Ste. D-100	Surprise	AZ	85374
Mr.	Jason	Earp	Public Works Director	City of Tolleson	9501 W. Pima Rd.	Tolleson	AZ	85353
Mr.	Gary	Edwards	Town Manager	Town of Wickenburg	155 N. Tegner, Ste. A	Wickenburg	AZ	85390
Ms.	Carol	Erwin	Area Manager	United States Bureau of Reclamation	6150 W. Thunderbird Rd.	Glendale	AZ	85306
Mr.	Herb	Fidel	President	Maricopa Audubon Society	3255 S. Dorsey Ln., Apt. 2004	Tempe	AZ	85282
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Mr.	Ed	Gerak	General Manager	Buckeye Water Conservation and Drainage District	P.O. Box 1726	Buckeye	AZ	85326
Mr.	John	Hauskins	Director	Maricopa County Department of Transportation	2901 W. Durango St.	Phoenix	AZ	85009
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Mr.	Larry	Langer	Asst. State Engineer, Valley Project Mgt.	Arizona Department of Transportation	1611 W. Jackson St., Mail Drop EM01	Phoenix	AZ	85007
Mr.	Michael	Leonard	General Manager	Roosevelt Water Conservation District	2344 S. Higley Rd.	Gilbert	AZ	85295
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Mr.	David	McKay	State Conservationist	Natural Resource Conservation Service	230 N. 1st Ave., Ste. 509	Phoenix	AZ	85003
Mr.	Jesse	Mendez	Public Works Director	Town of Youngtown	12030 Clubhouse Square	Youngtown	AZ	85363
Mr.	Brian	Meyers	Community Manager	Salt River-Pima Indian Community	10005 E. Osborn Rd.	Scottsdale	AZ	85256
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Mr.	David	Ramirez	Engineer	City of Goodyear	P.O. Box 5100	Goodyear	AZ	85338
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Mr.	Fred	Rustam	Deputy Engineer-Design	City of Mesa	P.O. Box 1466	Mesa	AZ	85201
Mr.	Dick	Schaner	Transportation Director	Town of Queen Creek	22350 S. Ellsworth Rd.	Queen Creek	AZ	85242
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Mr.	Lou	Trammell	Director	Arizona Division of Emergency Management	5636 E. McDowell Rd.	Phoenix	AZ	85008
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Mr.	Larry	Voyles	Director	Arizona Game and Fish Department	5000 W. Carefree Hwy.	Phoenix	AZ	85086
Mr.	Tom	Ward	Public Works Director	Town of Fountain Hills	16705 E. Ave. of the Fountains	Fountain Hills	AZ	85268
Mr.	Ken	Waters	Warning Coordinator	National Weather Service Phoenix Forecast Office	PO Box 52025	Phoenix	AZ	85072
Ms.	Connie	Wilhelm	President and Executive Director	Home Builders Association of Central Arizona	7720 N. 16th St., Suite 310	Phoenix	AZ	85020



Floodplain Regulations

for Maricopa County

Published by:

Flood Control District of Maricopa County

2801 West Durango Street, Phoenix, Arizona 85009, 602-506-1501

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FINDINGS OF FACT

It is the finding of the Board of Directors of the Flood Control District of Maricopa County that:

1. The flood hazard areas of Maricopa County are subject to periodic inundation that may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety and general welfare.
2. These flood losses are caused in part by the cumulative effect of obstructions in Special Flood Hazard Areas that increase flood heights and velocities, and when inadequately anchored, cause damage in other areas. Uses that are inadequately floodproofed, elevated or otherwise protected from flood damage also contribute to the flood loss.
3. Pursuant to the authority granted in A.R.S. 48-3609(B), judicious floodplain management requires the permitting of Development within a watercourse or areas designated by the Floodplain Administrator as Special Flood Hazard Areas as authorized in A.R.S. 48-3609(A) with contributing watersheds that have flows greater than 50 cubic feet per second (cfs) during a 100-year flood event so as not to cause obstruction, retardation, or diversion of flows within the area of jurisdiction

ARTICLE I. AUTHORITY, PURPOSE, TITLE AND APPLICABILITY

Section 101. Statutory Authority

Sections 48-3603 and 48-3609 of the Arizona Revised Statutes direct each County Flood Control District Board of Directors to adopt and enforce floodplain regulations consistent with criteria adopted by the Director of Arizona Department of Water Resources pursuant to A.R.S. 48-3605. Therefore, the Board of Directors of the Flood Control District of Maricopa County, Arizona adopts these regulations.

A Floodplain Regulation for Maricopa County has been in force since February 25, 1974. The version that these Regulations supersede are the Floodplain Regulations for Maricopa County, Arizona that were adopted on August 4, 1986, and amended March 23, 1987, April 6, 1988, September 18, 1989, September 3, 1991, December 15, 1993 and November 1, 2000. These Regulations supersede all previous Regulations and continue the Statutory Authority vested in the District to regulate Development

Section 102. Statement of Purpose

It is the purpose of these Regulations to comply with the directive of A.R.S 48-3609 and 44 CFR Ch.1. et seq. (pertaining to the National Flood Insurance Program) to promote and protect the health, peace, safety, comfort, convenience, and general welfare of the residents within the jurisdictional area of Maricopa County, Arizona, to minimize public and private losses due to flood conditions in specific areas, and to enable Maricopa County and its residents to participate in the National Flood Insurance Program, receive Federal Disaster Assistance, obtain flood insurance and reduce the cost of flood insurance.

It is the intent of the Flood Control District Board of Directors to:

1. Protect the life, health, and property of county residents;
2. Minimize expenditure of public money for costly flood control projects;
3. Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
4. Minimize prolonged business interruptions;

5. Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, fiber optics and sewer lines, streets and bridges located in Special Flood Hazard Areas;
6. Help maintain a stable tax base by regulating Development of Special Flood Hazard Areas so as to minimize future flood blight areas;
7. Take all reasonable action so that potential buyers have notice that property is in a Special Flood Hazard Area;
8. Take reasonable action so that those who occupy the Special Flood Hazard Areas assume responsibility for their actions;
9. Minimize flood damages and reduce the height and violence of floods that are caused by obstructions restricting the capacity of floodways;
10. Prevent unwise encroachment, building and Development within Special Flood Hazard Areas;
11. Reduce the financial burden imposed on the community, its governmental units and its residents when such land is flooded;
12. Protect the natural and beneficial function of the floodplains; and
13. Maintain eligibility for disaster relief.

Section 103. Title

These Regulations may be referred to as the Floodplain Regulations for Maricopa County.

Section 104. Applicability

These Regulations are applicable to all lands located within delineated floodplains and watercourses or areas designated by the Floodplain Administrator as Special Flood Hazard Areas as authorized in A.R.S. 48-3609(A) with contributing watersheds that have flows greater than 50 cfs during a 100-year flood event that is within the Area of Jurisdiction of the Flood Control District of Maricopa County.

ARTICLE II. RULES, GENERAL PROVISIONS, AND CONSTRUCTION AND INTERPRETATION

Section 201. Rules

When not inconsistent with the context, words used in the present tense include the future tense, words in the singular include the plural; words in the plural include the singular. Words or phrases not specifically defined in these Regulations shall be interpreted so as to give them the meaning they have in common usage. The word “shall” is mandatory and the word “may” is permissive. No provision of these Regulations shall be construed to require written authorization for those exemptions set forth in A.R.S. 48-3613(B) nor shall the Board of Directors prohibit said exemptions; however, those Exempt Uses must comply with A.R.S. 48-3613(C) which states: Before any construction authorized by Subsection B of this section may begin, the person must submit plans for the construction to the Board for review and comment.

Section 202. Floodplain Administrator

The Floodplain Administrator as designated by the Board of Directors shall be the Chief Engineer and General Manager of the District who shall administer and enforce these Regulations. The Floodplain Administrator may delegate signature authority to District staff for permitting purposes.

For those Communities who have delegated that the District shall assume powers and duties as authorized in A.R.S. 48-3610.1(D), each Community shall appoint a Community National Flood

Insurance Program (NFIP) Coordinator who will be responsible to coordinate with the District's staff for providing floodplain management responsibility, and to verify that the Community's participation in the NFIP is maintained and remains in good standing through adoption and enforcement of these Regulations.

Violators of any provision of these Regulations shall be notified by the Floodplain Administrator, or his designee, who shall state the nature of the violation and order corrective action.

Failure to comply with ordered corrective action may result in submission of a declaration for denial of flood insurance for otherwise insurable structures to the Administrator of the Federal Insurance Administration pursuant to Section 1316 of the National Flood Insurance Act of 1968, as amended.

Failure to appeal the Floodplain Administrator's order pursuant to a variance to the Floodplain Review Board within the time period set forth in Section 602 shall render the order of the Floodplain Administrator final and enforceable as provided in Article XI of these Regulations. Failure to appeal the Floodplain Administrator's order pursuant to a violation hearing to the Board of Hearing Review within the time period set forth in Section 1102 shall render the order of the Floodplain Administrator final and enforceable as provided in Article XI of these Regulations.

Section 203. Construction and Interpretation

These Regulations shall be liberally construed to effectuate its purposes. The requirements set out herein shall be construed as minimum requirements.

Nothing contained in these Regulations shall be construed to limit or repeal any powers granted to the Flood Control District of Maricopa County under state statute. If the provisions of these Regulations conflict with or overlap with other regulations, ordinances and statutes, the regulation, ordinance or statute which imposes the more stringent requirement or restriction shall prevail.

This ordinance is not intended to repeal, abrogate or impair any existing easements, covenants or deed restrictions. However, where this ordinance and another ordinance, easement, covenant or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

In the interpretation and application of this ordinance, all provisions shall be:

1. Considered as minimum requirements;
2. Liberally construed in favor of the governing body; and
3. Deemed neither to limit nor repeal any other powers granted under state statutes.

Section 204. Coordination

The Board and the Floodplain Administrator shall coordinate the provisions of these Regulations with all other interested and affected political subdivisions, federal and state agencies, as required by A.R.S 48-3609 and 48-3610.

Section 205. Definitions

In these Regulations, unless the context requires otherwise, the following words shall be used as set forth in this article:

Accessory Use: A use that is incidental and subordinate to the principal use of the parcel of land on which it is located.

Active Alluvial Fan Hazard: Active alluvial fan flooding is a type of flood hazard that occurs only on alluvial fans. It is characterized by flow path uncertainty so great that this uncertainty cannot be set-aside in realistic assessments of flood risk or in the reliable mitigation of the hazard. An active alluvial fan flooding hazard is indicated by three related criteria: (A) Flow path uncertainty below the hydrographic apex, (B) Abrupt deposition and ensuing erosion of sediment as a stream or debris flow loses its

competence to carry material eroded from a steeper, upstream source area, and (C) An environment where the combination of sediment availability, slope and topography creates a hazardous condition for which elevation on Fill will not reliably mitigate the risk.

Administrative Floodway: The Special Flood Hazard Area designated on either the Flood Insurance Rate Maps (FIRM) or flood management maps as areas that are subject to local regulation requirements. These areas may include Active Alluvial Fan Flooding, Alluvial Fan High Hazard Area Flooding, Inactive Alluvial Fan Flooding, and Conveyance Corridors. These areas are designated as the corridors that must be reserved to maintain the continuity of flow and sediment for the one (1) percent flood event without causing cumulative adverse impact to adjacent properties.

Alluvial Fan: A geomorphologic feature characterized by a cone or fan shaped deposit of boulders, gravel and fine sediments that have been eroded from mountain slopes, transported by flood flows and then deposited in the valley floors and which is subject to flash flooding, high velocity flows, debris flows, erosion, sediment movement and deposition, and channel migration.

Alluvial Fan Flooding: Flooding occurring on the surface of an Alluvial Fan that originates at the apex and is characterized by high velocity flows, sediment transport and deposition, and unpredictable flow paths.

Alluvial Fan High Hazard Area (AFHH): An area of active Alluvial Fan Flooding that is reserved to convey and receive sediment and floodwater without altering and thereby increasing the distribution of hazard across the fan to inactive areas and to areas downslope.

Alluvial Fan Uncertain Flow Distribution Area (AFUFD): A transitional area for sheet flooding and channelized flow located below the AFHH area.

Approximate Alluvial Fan Floodways (AAFF): Major conveyance corridors defined within AFUFD and AFZA areas for unimpeded through flow of floodwater and sediment.

Alluvial Fan Zone A (AFZA): An area of inactive Alluvial Fan Flooding characterized by flooding along stable flow paths and sheet flow or sheet flooding. These stable flow paths may still be subject to erosion hazards, channel bed and bank scour, and deposition.

Approximate Study: A graphic illustration of a delineation of the floodplain by the Floodplain Administrator made from the most reliable sources available where neither a floodplain nor a floodway has been determined by detailed methodology.

Apex: A point on an Alluvial Fan below which the flow of the major stream that formed the fan becomes unpredictable and Alluvial Fan Flooding may occur.

Appeal: A request for a review of the Floodplain Administrator's interpretation of any provision of these Regulations, or any determination made under these Regulations.

Area Drainage Master Study (ADMS): A study to develop hydrology for a watershed, to define watercourses, identify potential flood problem areas, drainage problems and recommend solutions and standards for sound floodplain and stormwater management. The ADMS will identify alternative solutions to a given flooding or drainage problem.

Area Drainage Master Plan (ADMP): A plan that identifies the preferred alternatives of those identified in an ADMS. An ADMP provides minimum criteria and standards for flood control and drainage relating to land use and Development.

Area of Jurisdiction: The 100-year Delineated Floodplains in the incorporated and unincorporated areas of Maricopa County, including public lands, excluding those incorporated areas of cities or towns that have elected to assume floodplain management powers and duties pursuant to A.R.S. 48-3610. For Floodplain Management purposes, Area of Jurisdiction includes watercourses or areas designated by the Floodplain Administrator as Special Flood Hazard Areas as authorized in A.R.S. 48-3609(A) with contributing watersheds with flows greater than 50 cfs in the unincorporated areas of the county.

Area of Shallow Flooding: An area with flood depths from one to three feet where a clearly defined channel does not exist, the path of flooding is indeterminate, and where ponding may be evident.

Backfill: The placement of Fill Material within a specified depression, hole or excavation pit below the surrounding adjacent ground level, as a means of improving flood water conveyance, or to restore the land to the natural contours existing prior to excavation.

Basement: The lowest level or story of any area of a Building that has its floor sub grade (below ground level) on all sides.

Base Flood or One-Hundred-Year Flood: A flood that has a one percent chance of being equaled or exceeded in any given one-year period.

Base Flood Elevation: The water surface elevation produced by a base flood or one hundred year flood.

Breakaway Wall: A wall that is not part of the Building and is intended through its design and construction to collapse under specific lateral loading forces without causing damage to the elevated portion of the Building or the supporting foundation system.

Board: The Board of Directors of the Flood Control District of Maricopa County.

Building: A Structure affixed to the land having a roof supported by columns or walls built for housing, shelter or enclosure of persons, animals, or property of any kind.

Clearing/Grubbing: Removal of vegetation without disturbance of existing land surface contours.

Conveyance Corridor: A land area adjoining a body of water or adjacent to or located partially or wholly within a Floodplain which due to the soil instability, is likely to suffer flood related erosion damage. Conveyance corridors are areas that may not be defined by traditional encroachment methods due to directional changes when trying to achieve the increase in base flood of one foot or less.

Community: Any state, area or political subdivision thereof, or any Indian tribe or authorized tribal organization who is charged with the authority to implement and administer laws, ordinances and regulations for that community.

Community NFIP Coordinator: For Communities who have delegated that the District shall assume powers and duties as authorized in 48-3610.1(D), each Community shall appoint a Community Official to coordinate with the District's staff for providing floodplain management responsibility to verify that the Community's participation in the National Flood Insurance Program is maintained and remains in good standing through adoption and enforcement of these Regulations.

Compensation of Flood Volume Displacement: The replacement of the quantity of stormwater volume below the Base Flood Elevation that could be lost due to import of Fill by the proposed Development.

Cumulative Substantial Damage: The total of all repairs to a repetitive loss Structure shall not cumulatively increase the market value of the Structure more than 50 percent of the market value during the life of the Structure. This term does not, however, include either:

Any project for improvement of a Structure to correct existing violations of state or local health, sanitary or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions; or

Any repair of flood damage to "historic Structure," provided the repair will not preclude the Structure's continued designation as a "historic Structure."

Cumulative Substantial Improvement: Improvements, modifications, or additions to existing Buildings are counted cumulatively for at least five (5) years and reconstruction and repairs to damaged Buildings are counted cumulatively for at least five (5) years. When the improvements, modifications,

additions, reconstruction or repairs reach the 50% substantial improvement threshold, the Structure must be brought into compliance.

Delineated Floodplain: A graphic illustration of the area susceptible to inundation by a 100-year flood based upon the results of an authorized study that is included on either the Flood Management Maps for Maricopa County or the Flood Insurance Rate Maps, or both.

Development: Any man made change to improved or unimproved real estate, including, but not limited to, Buildings or other Structures, mining, dredging, Filling, grading, paving, excavation, drilling operations, and storage of materials and equipment located within the Special Flood Hazard Area.

District: The Flood Control District of Maricopa County.

Dwelling: A residential Building intended for human habitation.

Enclosure: That portion of a Building that is below the residential lowest floor and is above ground.

Encroachment: The advance or infringement of uses, plant growth, Fill, excavation, Buildings, permanent Structures or Development into a floodplain which may impede or alter the flow capacity of a floodplain.

Erosion: The process of the gradual wearing away of landmass.

Erosion Control Zone: A land area adjoining a body of water or adjacent to or located partially or wholly within a Delineated Floodplain which due to the soil instability, is likely to suffer flood related erosion damage.

Erosion Hazard Zone Delineation and Development Guidelines: The document developed by the District to aid in identifying and delineating Erosion Control Zones and Erosion Setbacks.

Erosion Setback: The minimum horizontal distance between a Structure and a channel bank necessary to protect the Structure from flood related erosion damage.

Exempt Use: Any use of the Delineated Floodplain specifically exempted from these Regulations by applicable law.

Existing Manufactured Home Park or Subdivision: A manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, construction of streets and either final site grading or the pouring of concrete slabs) was completed before the August 8, 1973 effective date of the floodplain management regulations adopted by the community.

Expansion to an Existing Manufactured Home Park or Subdivision: The preparation of additional sites by the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including the installation of utilities, the construction of streets and either final site grading or the pouring of concrete pads).

Fill: The placement of Fill Material at a specified location to bring the ground surface up to a desired elevation.

Fill Material: Natural sand, dirt, soil and rock. For the purposes of Floodplain Management, Fill Material may include concrete, cement, soil cement, brick or similar material as approved by the Floodplain Administrator on a case-by-case basis.

Flood or Flooding: A general and temporary condition of partial or complete inundation of normally dry land areas from: (1) the overflow of flood waters; (2) the unusual and rapid accumulation or runoff of surface waters from any source; and/or (3) the collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm or by an unanticipated force of nature, such as flash flood or an abnormal

tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in this definition.

Flood Control Advisory Board: A Board of seven members appointed by the Board of Directors. Five members shall be resident taxpayers and qualified electors of the District, at least three of whom shall be residents of the cities in the District. At least one of the Board members who are residents of cities shall be a resident of the largest city in the District. The city engineer of the largest city in the District and the chief engineer or manager of a major irrigation or agricultural improvement District, or their representatives, shall be ex officio members of the advisory Board with all rights and privileges granted to other Board members.

Flood Hazard Zone: Any land area located partially or wholly within a Delineated Floodplain susceptible to flood related damage as designated on the Floodplain Management Maps. Such Flood Hazard Zones may include but not limited to areas highly susceptible to erosion, stream meander sensitivity, moveable bed, scour, wave action, and subsidence.

Flood Insurance Rate Map (FIRM): An official map on which the Federal Insurance Administration has delineated both the 100-year flood Special Flood Hazard Areas and the risk premium zones applicable to a community.

Flood Insurance Study: The official report provided by the Federal Insurance Administration. The report includes flood profiles and Base Flood Elevations.

Flood Management Map: An official map, which can be either hard copy or in electronic format, for Maricopa County on which the Floodplain Administrator has Delineated Floodplains and other flood related Flood Hazard Zones for the purpose of Floodplain administration.

Floodplain: The area adjoining the channel of a watercourse susceptible to inundation by a base flood including areas where drainage is or may be restricted by man made Structures that have been or may be covered partially or wholly by flood water from the one hundred year flood.

Floodplain Administrator: The individual appointed by the Board to administer and enforce these Regulations.

Floodplain Clearance: Review and approval of a use of property in or adjacent to a Delineated Floodplain or other delineated flood related hazard zone for which a Floodplain Use Permit is not required as specified in Section 505 and Section 506.

Floodplain Regulations: These Regulations and other codes, ordinances and regulations adopted pursuant to the authority granted in A.R.S 48-3603 through 48-3628 relating to the use of land and construction within a Delineated Floodplain and Floodway or other Special Flood Hazard Areas.

Floodplain Use Permit: A permit that must be obtained from the Floodplain Administrator prior to commencement or continuance of any non-exempt use within the Area of Jurisdiction.

Flood Proofing: Any combination of structural and non-structural additions, changes or adjustments to Structures that reduce or eliminate flood damage to real estate or improved property, water and sanitary facilities, Structures and their contents.

Floodway: The channel of a river or other watercourse and the adjacent land areas necessary in order to discharge the one hundred year flood without cumulatively increasing the water surface elevation more than one foot.

Floodway Fringe: The areas of a Delineated Floodplain adjacent to the Floodway where encroachment may be permitted.

Grading: Disturbance of existing land contours.

Hazardous Waste: Garbage, refuse, sludge from a waste treatment plant, water supply treatment plant or air pollution control facility, or other discarded materials, including solid, liquid, semisolid or contained

gaseous material, resulting from industrial, commercial, mining, and agricultural operations or from community activities that because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating irreversible illness, or pose a substantial present or potential hazard to human health or the environment if improperly treated, stored, transported, disposed of or otherwise managed, or any waste identified as hazardous pursuant to A.R.S. 49-922. Hazardous Waste does not include solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under 402 of the Federal Water Pollution Control Act (P.L. 92-500; 86 STAT. 816) as amended, or source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954 (68 STAT. 919), as amended.

Highest Adjacent Finished Grade: The highest finished ground elevation after construction next to the walls of a Structure.

Highest Adjacent Natural Grade: The highest natural elevation of the ground surface prior to construction next to the proposed walls of a Structure.

Historic Structure (44 CFR 59.1): Any Structure that is:

Listed individually in the National Register of Historic Places, a listing maintained by the Department of the Interior, or preliminarily determined by the Secretary of the Interior (Secretary) as meeting the requirements for individual listing on the National Register;

Certified or preliminarily determined by the Secretary as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the Secretary; or

Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either by A.) an approved state program as determined by the Secretary; or B) directly by the Secretary in states without approved programs.

Inactive Alluvial Fan: An Alluvial Fan where flood water typically is within incised channels and adjacent stable land.

Landfill: See "Solid Waste Landfill"

Levee: A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control or divert the flow of water so as to provide protection from temporary flooding.

Levee System: A flood protection system that consists of a levee, or levees, and associated Structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

Lowest Floor: The Lowest Floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, Building access or storage in an area other than a basement area is not considered a Building's Lowest Floor provided that such enclosure is not built so as to render the Structure in violation of the applicable non-elevation design requirements of these Regulations.

Market Value: Market Value is determined by estimating the cost to replace the Structure in new condition and adjusting that cost figure by the amount of depreciation that has accrued since the Structure was constructed. The cost of replacement of the Structure shall be based on a square foot cost factor determined by reference to a Building cost estimating guide recognized by the Building construction industry. The amount of depreciation shall be determined by taking into account the age and physical deterioration of the Structure and functional obsolescence as approved by the Floodplain

Administrator, but shall not include economic or other forms of external obsolescence. Use of replacement costs or accrued depreciation factors different from those contained in recognized Building cost estimating guides may be considered only if such factors are included in a report prepared by an independent professional appraiser and supported by a written explanation of the differences.

Mean Sea Level: For purposes of the NFIP, the National Geodetic Vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a community's FIRM are referenced.

Mobile/Manufactured Home: A Structure transportable in one or more sections that is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For Floodplain management purposes, the term "Mobile/Manufactured Home" also includes park trailers, travel trailers and other similar vehicles placed on a site for greater than 180 consecutive days. For flood insurance purposes the term "Mobile/Manufactured Home" does not include park trailers, travel trailers, and other similar vehicles.

Natural and Beneficial Functions of Floodplains: Includes, but is not limited to the following: natural flood and sediment storage and conveyance, water quality maintenance, groundwater recharge, biological productivity, fish and wildlife habitat, harvest of natural and agricultural products, recreation opportunities, and areas for scientific study and outdoor education.

New Construction: For the purposes of determining insurance rates, Structures for which the "start of construction" commenced on or after the effective date of an initial FIRM or after December 31, 1974, whichever is later, and includes any subsequent improvements to such Structures. For floodplain management purposes, "new construction" means Structures for which the "start of construction" commenced on or after the effective date of a floodplain management regulation adopted by a community and includes any subsequent improvements to such Structures.

New Manufactured Home Park or Subdivision: A manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets and either final site grading or the pouring of concrete pads) is completed on or after the effective date of floodplain management regulations adopted by the community.

Nonconforming Use: The use of any land, Building or permanent Structure lawfully existing either on the effective date of the adopted Floodplain delineation in which the land, Building or permanent Structure is located, or August 3, 1984, the effective date of A.R.S. 48-3601 et. seq., whichever is the earlier date.

One-Hundred Year Flood: The flood having a one percent chance of being equaled or exceeded in any given year. (See Base Flood definition)

Obstruction: Anything in, along, across or projecting into any watercourse that may alter, impede, retard or change the direction and/or velocity of the flow of water, or due to its location, its propensity to snare or collect debris carried by the flow of water, or its likelihood of being carried downstream, including but not limited to, any dam, wall, wharf, embankment, levee, dike, pile, abutment, protection, excavation, channelization, bridge, conduit, culvert, Building, wire, fence, rock, gravel, refuse, Fill, Structure, vegetation or other material.

Person: An individual or his agent, firm, partnership, association, corporation, municipality, or agent of the aforementioned groups, or this State or its agencies or political subdivisions.

Piedmont Assessment Manual: The document developed by the District to aid in the identification and delineation of Active and Inactive Alluvial Fan flood hazard areas.

Policies and Standards: The document developed by the District (Drainage Policies and Standards for Maricopa County) to provide technical guidance for application of the Floodplain Regulation and Drainage Regulations for Maricopa County.

Recreation Vehicle: Any vehicle or portable unit designed for living, sleeping, housekeeping or office purposes that is: A) not more than forty (40) feet in length or eight (8) feet in width; B) transportable on its own chassis; and c) maintained in a readily transportable condition at all times. This definition includes motorized and non-motorized vehicles, travel trailers and camping trailers, but does not include Mobile/Manufactured Homes or Buildings as defined by these Regulations.

Regulatory Flood Elevation: The elevation which is one (1) foot above the base flood elevation for a watercourse and one (1) foot above the height of the effective outfall or the height of the backwater feature for ponding areas, whichever is greater. Where a Floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow.

Sand and Gravel Permitting Guideline: The document developed by the District to aid in preparing permit applications for sand and gravel operations.

Shallow Flooding: Area of flooding with average depths of one (1) to three (3) feet.

Solid Waste: Any garbage, trash, rubbish, refuse, sludge from a waste treatment plant, water supply treatment plant or pollution control facility and other discarded material, including solid, liquid, semisolid or contained gaseous material but not including domestic sewage or Hazardous Waste.

Solid Waste Landfill: Either a public or private facility at which Solid Waste is placed on or in land for the purpose of long-range storage or disposal. Solid Waste Landfill does not include a land application unit, surface impoundment, injection well, compost pile or agricultural on-site disposal areas covered under A.R.S 49-766.

Special Flood Hazard Area: Land in a Floodplain subject to a one-percent or greater chance of flood in any given year. These areas are designated as Zone A, AO, AE or AH on the FIRM or Floodplain Management Maps and other areas determined by the criteria adopted by the Director of the Arizona Department of Water Resources.

Start of Construction: Includes substantial improvement, and means the date the Building permit was issued, provided the actual start of construction, repair, reconstruction, rehabilitation, addition, placement or other improvement was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a Structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns or any work beyond the stage of excavation, or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading and Filling, nor does it include the installation of streets and/or walkways, nor does it include excavation for a basement, footings, piers or foundations or the erection of temporary forms, nor does it include the installation on the property of accessory Buildings, such as garages or sheds not occupied as dwelling units or not part of the main Structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor or other structural part of a Building, whether or not that alteration affects the external dimensions of the Building.

State Standards: Documents defining standards for Floodplain management as adopted by the Director of the Arizona Department of Water Resources pursuant to A.R.S. 48-3605(A).

Structure: Anything affixed to the ground or attached to something located on the ground, including but not limited to fences, walls, berms, levees, Fill, gas or liquid storage tanks, Buildings and Mobile/Manufactured Homes as defined by these Regulations, or other features that have the potential to obstruct, divert or retard flood flows.

Substantial Damage: Damage of any origin sustained by a Structure whereby the cost of restoring the Structure to its before damaged condition would equal or exceed fifty percent (50%) of the market value of the Structure before the damage occurred, as determined by a duly licensed appraiser.

Substantial Improvement: Any repair, rehabilitation, addition or other improvement of a Structure, the estimated cost of which as determined by a licensed contractor equals or exceeds fifty percent (50%) of

the fair market value or the appraised value, whichever may be higher, of the Building or Structure either: 1) before the improvement or rehabilitation is started, or 2) if the Building or Structure has been damaged by any origin and is being restored, before the damage occurred. In the case of Structures that have been damaged, the value of the rehabilitation or restoration must include the fair market cost of all material and labor required to return the Structure to its pre-damaged condition, regardless of the actual work performed. "Substantial Improvement" is considered to occur when the first alteration of any wall, ceiling, floor or other structural part of the Building or Structure commences, whether or not that alteration affects the external dimensions of the Building or Structure. The term does not include any project for improvement of a Building or Structure which has been identified by the local Building official to correct violations of existing state and local health, sanitary or safety code requirements; nor does it include any alteration of a Building or Structure listed on the National Register of Historic Places or State Inventory of Historical Places.

Variance: A grant of relief from the requirements of these Regulations that permits construction or other uses of property in a manner that would otherwise be prohibited or restricted by these Regulations.

Violation: The failure of a Structure or other Development to be fully compliant with the community's floodplain management regulations. A Structure or other Development without the elevation certificate, other certifications or other evidence of compliance required in this ordinance is presumed to be in violation until such time as that documentation is provided.

Watercourse: A lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

Watercourse Master Plan (WCMP): A hydraulic plan for a Watercourse that examines the cumulative impacts of existing Development and future encroachment in the Floodplain and future Development in the watershed on potential flood damages and/or erosion hazards, and establishes technical criteria for subsequent Development so as to minimize potential flood damages for all flood events up to and including the one hundred year flood.

Zone A: An area with an approximate delineation of a Floodplain. Floodway boundaries and Base Flood Elevations have not been determined.

Zone AE: An area with a detailed delineation of a Floodplain and in which Base Flood Elevations have been determined.

Zone AH: An area with Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations have been determined.

Zone AO: An area with Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average flood depths have been determined. For areas of Alluvial Fan flooding, velocities may have also been determined.

Zone D: Areas in which flood hazards are undetermined, but possible.

Zone X (shaded): Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from the 100-year flood.

Zone X (unshaded): Areas to be determined outside the 500-year Floodplain.

ARTICLE III. FLOOD HAZARD BOUNDARIES

Section 301. Minimum Area for Floodplain Jurisdiction

All zones designated A, AH, AO, or AE on the current flood insurance study, the flood insurance rate maps and Flood Management maps for Maricopa County, Arizona, shall constitute the minimum area for management under these regulations.

Section 302. Other Delineations

In areas without delineated Flood Hazard Zones A, AH, AO, or AE, where Development is imminent or ongoing, the District may require developers of land to delineate Floodplains to be administered under these Regulations.

1. For any Development, the developer shall delineate the 100-year Floodplains and Erosion Setbacks per Arizona State Standards or other Guidelines, Policies and Standards developed by the District for this purpose. Such delineations shall be consistent with criteria established by the Director, State Department of Water Resources and may be forwarded to the Federal Emergency Management Agency for adoption.
2. Per 44 CFR ch.1 et seq., if the State of Arizona has not adopted floodplain regulations, any Development on state land shall comply with local regulations.
3. The District may forward to the Federal Emergency Management Agency other delineations obtained from other sources, provided they are determined to be consistent with criteria established by the Director of the Arizona Department of Water Resources.
4. Other sources include but are not limited to (1) a developer of Floodplain property, (2) State or County agency, (3) any agency which must delineate a Floodplain as a result of completion of a Flood Control Structure, or (4) the Federal Emergency Management Agency.
5. Such delineations shall be submitted to the Floodplain Administrator to be reviewed for technical adequacy. The Floodplain Administrator may forward such delineations to the Arizona Department of Water Resources and to the Federal Emergency Management Agency with a recommendation for approval or denial.
6. All delineations approved by the Federal Emergency Management Agency are hereby adopted as referenced and shall be included on the Flood Management Maps for Maricopa County.

Section 303. Basis for Establishing the Areas of Special Flood Hazard

The areas of special flood hazard identified by the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA) in scientific and engineering report entitled "The Flood Insurance Study for Maricopa County, dated July 2, 1979" with accompanying Flood Insurance Rate Maps (FIRMs) and Flood Boundary and Floodway maps (FBFM), dated July 2, 1979 and all subsequent amendments and/or revisions, including Digital Flood Insurance Rate Maps (DIRMs), are hereby adopted by reference and declared to be a part of these Regulations. This Flood Insurance Study (FIS) and attendant mapping is the minimum area of applicability of these Regulations and may be supplemented by studies for other areas that allow implementation of these Regulations and are recommended to the Board of Directors by the Floodplain Administrator. The Board, within its Area of Jurisdiction shall delineate or may require developers of land to delineate, as authorized by A.R.S. 48-3609, for areas where Development is ongoing or imminent, and thereafter as Development becomes imminent, Floodplains consistent with the criteria developed by the Federal Emergency Management Agency (FEMA) and the Director of the Arizona Department of Water Resources. The FIS, FIRMs and FBFMs are on file at the Flood Control District of Maricopa County, 2801 W. Durango St., Phoenix, Arizona, 85009.

See Addendum for the communities for which the Flood Control District performs Floodplain Management.

Section 304. Other Flood Hazard Boundaries

Whenever the District determines through a flood hazard study, Watercourse Master Plan or other flood related study authorized by the Board that a flood related hazard exists due to such factors as high velocity flows, erosion, sediment transport, deposition, unstable soil conditions or land subsidence, the

Floodplain Administrator shall designate such hazard areas on the Flood Management Maps for Maricopa County. The Floodplain Administrator shall establish technical criteria and enforce rules and regulations for subsequent Development that meet or exceed criteria adopted by the Director of Arizona Department of Water Resources and when appropriate such studies may be forwarded to the Federal Emergency Management Agency.

Section 305. Publication of Flood Hazard Boundaries

All flood hazard designations as authorized by these Regulations including but not limited to Erosion Control Zones, Watercourse Master Plans, moveable bed Watercourses and other special flood related designations and, including all zones A, AH, AO, and AE on the Flood Insurance Rate Maps for Maricopa County, Arizona, shall be shown on the official Flood Management Maps for Maricopa County.

For Floodplain Management purposes, areas that are under current flood hazard study shall be designated by the Floodplain Administrator as preliminary delineations on the Flood Management Maps for Maricopa County as the best technical data available pending final approval of the study by the Federal Emergency Management Agency.

Section 306. Public Notice

Whenever a flood hazard identification study has been authorized by the Board, the District shall publish a notice concerning the intent and scope of the study and notify affected adjacent political jurisdictions. The District shall also mail information concerning the study or hold a public meeting for the affected property owners.

Section 307. Determination in Case of Dispute

If the boundary of any floodplain with a Zone A Delineation, Floodway, Floodway Fringe, Area of Shallow Flooding including Ponding Areas, Alluvial Fans or other flood hazard boundaries is in dispute, the Floodplain Administrator shall determine the boundary using the best technical data available. In cases where a revision of the Floodway becomes necessary, the required public notice and public hearing process shall be followed and the necessary information shall be submitted to the Federal Emergency Management Agency.

ARTICLE IV. ALLOWABLE USES

Section 401. Allowable Uses within Zone AE Floodway

Uses for which a Floodplain Use Permit may be granted include:

1. Drive-in theaters, roadside stands, signs and billboards.
2. Operations for extraction of sand, gravel and other materials.
3. Marinas, boat rentals, docks, piers and wharves.
4. Railroads, privately owned and maintained streets, bridges, utility transmission lines and pipelines.
5. Privately owned and maintained dikes and culverts.
6. Stockyards, corrals and shade Structures.
7. Private and public recreational uses including, but not limited to, golf courses, tennis courts, driving ranges, archery ranges, picnic grounds, parks, wildlife and nature preserves, game farms, shooting preserves, target ranges, trap and skeet ranges, hunting and fishing areas, hiking and horseback riding trails.

8. Agricultural uses including, but not limited to, general farming, pasture, grazing, outdoor plant nurseries, horticulture, truck farming, sod farming, and wild crop harvesting.
9. Industrial-commercial uses including, but not limited to, loading areas, airport landing strips, and parking areas.
10. Accessory residential uses including, but not limited to, lawns, gardens, parking areas and play areas.

Section 402. Allowable Uses within Zone AE Floodway Fringe

All new uses and substantial improvements to existing Structures within a Floodway Fringe (AE Zones) specified in Sections 800 through 810 below require a Floodplain Use Permit issued by the Floodplain Administrator subject to the provisions of Section 501.

Uses for which a Floodplain Use Permit may be granted:

1. Any use permitted in Section 401.
2. Structures and Buildings, including dwellings and mobile/manufactured homes, recreational vehicles and other residential uses.
3. New and replacement water supply systems, water treatment and sewage collection and disposal systems provided that they are designed to prevent or minimize floodwater contamination during the base flood.
4. New and replacement sanitary sewage systems, provided that they are designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters, unless otherwise allowed by a permit in conformance with the Federal Water Pollution Control Act.
5. Septic systems and Solid Waste Landfills, whether public or privately owned, provided that they are located in such a way as to avoid impairment to them or contamination from them during flooding and provided that no part of a Solid Waste Landfill is within one-half mile of a one-hundred year Floodplain that has one-hundred year flows in excess of twenty-five thousand cubic feet per second as determined by the Federal Emergency Management Agency.
6. Any other uses which will not be subject to substantial flood damage and will not cause a hazard to life or property or to the public. These may include uses that can be readily removed from Delineated Floodplain areas during times of flooding.

Section 403. Allowable Uses within Zone A

Any use permitted in Section 401 and Section 402 that will not increase the threat of flooding to surrounding property.

Any other use not specifically named in Sections 401 or 402 provided the applicant submits an analysis of the Zone A Floodplain consistent with Article VIII. Such analysis shall be subject to review and approval by the Floodplain Administrator prior to issuance of a Floodplain Use Permit and may be forwarded to the State Department of Water Resources and the Federal Emergency Management Agency in the manner described in Article III, Section 303.

Section 404. Allowable Uses within Zone AH Ponding

Any use permitted in Section 401 and Section 402 that will not increase the threat of flooding to surrounding property. Additional criteria include:

1. Any other use not specifically named in Sections 401 or 402 provided the applicant submits an analysis of the Zone AH Floodplain consistent with Article VIII. Such analysis shall be subject to review and approval by the Floodplain Administrator prior to issuance of a Floodplain Use Permit

and may be forwarded to the State Department of Water Resources and the Federal Emergency Management Agency in the manner described in Article III, Section 303.

2. Require adequate drainage paths around Structures on slopes to guide floodwaters around and away from proposed Structures.

Section 405. Allowable Uses within Zone AO

Any use permitted in Section 401 and Section 402 that will not increase the threat of flooding to surrounding property. Additional criteria include:

1. Require adequate drainage paths around Structures on slopes to guide floodwaters around and away from proposed Structures.

Section 406. Allowable Uses in Other Flood Hazard Zones

This article regulates uses located in Flood Hazard Zones designated by the Floodplain Administrator not specifically regulated elsewhere in these Regulations including but not limited to erosion control zones, Watercourse Master Plans, Area Master Drainage Plans, moveable bed watercourses and other special flood related designations determined based upon authorized studies. Additional criteria include:

1. New uses and substantial improvement to existing uses shall require a Floodplain Use Permit and are subject to the provisions of Article IV. Issuance of a Floodplain Use Permit does not exempt the holder of the Floodplain Use Permit from any additional requirements necessary to obtain flood insurance.
2. Uses for which a Floodplain Use Permit may be granted are: Uses permitted elsewhere in these Regulations provided the applicant submits technical information which demonstrates that neither the use nor the specific flood hazard will be adversely affected by such use.

ARTICLE V. FLOODPLAIN USE PERMITS

Section 501. Floodplain Use Permit Required

A Floodplain Use Permit shall be obtained prior to commencing any new or proposed addition, alteration or change of any Building, Structure, land or other use within a Delineated Floodplain, except as exempted by applicable law.

A Floodplain Use Permit shall be obtained in all delineated floodplains prior to commencing Development in the unincorporated county and in a watercourse or contributing watershed that has flow greater than 50 cfs during a 100-year event unless a Drainage Clearance has been issued.

Floodplain Use Permits shall be obtained for improvements, modifications, reconstruction, repair or additions to existing Buildings. When the improvements, modifications, additions, reconstruction or repairs reach the 50% Substantial Improvement threshold, then the entire structure must be brought into compliance. The value of the improvements, modifications, reconstruction, repair or additions is counted cumulatively for at least five (5) years to determine whether the Substantial Improvement threshold has been met.

Section 502. Application Requirements

The applicant shall submit any information that the Floodplain Administrator considers necessary in making determinations required by these Regulations. The applicant may also be required to provide certification that all requirements of the Floodplain Use Permit have been met.

The applicant must submit all items pertinent to the review and approval of the Floodplain Use Permit within 90 calendar days of the original application date. Submittal of information beyond the 90-day

period may be treated as a new application and will be subject to all submittal/payment procedures. If the applicant is unable to meet the 90-day deadline for submittal of required items, and would like the District to continue processing the request, he/she must request an extension of the deadline. This request must be submitted in writing and must provide (1) the reason why the data cannot be submitted within the requested timeframe, and (2) a new date for the submittal of the data. If the District requests additional data, the data must be submitted by the applicant within 90 calendar days from the date the data was requested. Fees will be forfeited for any request for which either the requested data or a written extension request is not received within 90 calendar days.

Section 503. Permit Conditions

The Floodplain Administrator may place a time limit and any other conditions or restrictions designed to reduce or eliminate potential hazards to life or property on the permit.

As a condition of issuance of this permit:

1. The Floodplain Administrator shall review proposed Development to assure that all necessary permits have been received from those governmental agencies from which approval is required by Federal or State law and the permit is valid upon receipt of copies of required permits.
2. The applicant may be required to execute deed restrictions running with the land or to post performance bonds, assurances or other security to guarantee the performance of the conditions and restrictions imposed.
3. The Floodplain Use Permit is subject to review, suspension and revocation for any substantial deviation from the approved plan or for any violation of the Floodplain Regulation or any stipulation or other terms and agreements made a part of the Floodplain Use Permit.
4. The Floodplain Use Permit will automatically expire if construction has not commenced within one (1) year of permit issuance unless an extension has been requested in writing and acknowledged by the District.
5. The rights and responsibilities under a Floodplain Use Permit are non-delegable and cannot be transferred without the written authorization of the District. A Floodplain Use Permit cannot be obtained without the express, written consent and agreement of the owner of the land for which the use permit is sought.

Section 504. Elevation/Floodproofing Certificate

An Elevation Certificate Form prepared by an Arizona Registered Professional Engineer, or Land Surveyor shall be submitted in a form acceptable to the Floodplain Administrator prior to occupancy or use of any Building within a Flood Hazard Zone designated on the Flood Management Maps, except those uses exempted by applicable law.

1. A Floodproofing Certificate Form prepared by an Arizona Registered Civil Engineer shall be submitted for any Development that has not been elevated up to the Regulatory Flood Elevation as approved by the Floodplain Administrator.
2. The required elevation certificate within a Zone AO may be completed by District staff as approved by the Floodplain Administrator.
3. The Floodplain Administrator shall maintain a record of all Elevation and Floodproofing Certificates and may record such certification with the office of the Maricopa County Recorder in a manner so that it appears in the chain of title of the affected parcel of land.

Section 505. Exemptions

In accordance with A.R.S 48-3609, nothing in these Regulations shall affect:

1. Existing legal uses of property or the right to continuation of such legal uses. However, if a legal nonconforming use of land, or a Building or Structure is discontinued for twelve consecutive months or destroyed to the extent of fifty percent (50%) of its market value, as determined by a competent appraiser, any further use shall comply with these Regulations.
2. Reasonable repair or alteration of property for the purposes for which the property was legally used on August 3, 1984 or on the date any regulations affecting such property take effect, except that any alteration, addition, rehabilitation or repair to a legal nonconforming Building or Structure regardless of the cost of the work performed as determined by a licensed contractor which would result in increasing its flood damage potential by fifty percent (50%) or more of the value of such Building or Structure prior to alteration, addition, rehabilitation or repair as determined by a competent appraiser shall be either floodproofed or elevated to or above the Regulatory Flood Elevation. On February 25, 1974, the Maricopa County Board of Directors and the Board of Supervisors adopted the 1974 Floodplain Regulations for unincorporated areas of Maricopa County with certain amendments recommended by the Planning and Zoning Director and the sand and gravel industry's suggested revisions to be effective on that day. This is the date used for purposes of establishing existing legal nonconforming use on all properties. The Floodplain Regulations have been subsequently revised and amended in response to changes in the State Statutes and Code of Federal Regulations pertaining to the National Flood Insurance Program.
3. Reasonable repair of Structures constructed with the written authorization required by A.R.S 48-3613.
4. Facilities constructed or installed pursuant to a certificate of environmental compatibility issued pursuant to Title 40, Chapter 2, Article 6.2 of the Arizona Revised Statutes.

In accordance with A.R.S 48-3613, written authorization shall not be required, nor shall the Board prohibit the following except that before any construction authorized by this subsection may begin, the person shall submit plans for the construction to the Floodplain Administrator for review and comment.

1. Construction of bridges, culverts, dikes and other Structures necessary to the construction of public highways, roads and streets intersecting or crossing a watercourse.
2. Construction of dams for the conservation of flood waters as permitted by Title 45, Chapter 6 of the Arizona Revised Statutes and construction of storage dams for watering livestock or wildlife and Structures on the banks of a watercourse to prevent erosion of or damage to adjoining land if the Structure will not divert, retard or obstruct the natural channel of the watercourse.
3. Construction of tailing dams and waste disposal areas used in connection with mining and metallurgical operations. This paragraph does not exempt those sand and gravel operations that may divert, retard or obstruct the flow of waters in a watercourse from complying with and acquiring authorization pursuant to these Regulations.
4. Any political subdivision from exercising powers granted to it under A.R.S Title 48, Chapter 18, Article 10.
5. Construction of streams, waterways, lakes and other auxiliary facilities in conjunction with Development of public parks and recreation facilities by a public agency or political subdivision.
6. Construction and erection of poles, towers, foundations, support Structures, guy wires, and other facilities related to power transmission as constructed by any utility whether a public service corporation or a political subdivision.

In addition to the statutory exemptions, any other use or Development within the jurisdiction of these Regulations as may be determined by the Floodplain Administrator to be exempt if the applicant for the exemption satisfies the Floodplain Administrator that such use is not prohibited by any other regulation, code or ordinance, and has a low flood damage potential, will not cause a change in watercourse

mechanics including but not limited to obstruction, diversion or other changes detrimental to the natural flow of water and will not cause a hazard to life or property.

Exemptions to these rules are as set out in A.R.S. 48-3609(H) and A.R.S. 48-3613(B) & (C).

Section 506. Floodplain Clearance

Before any construction authorized under Section 505 may begin, plans for construction shall be submitted to the Floodplain Administrator for review and comment and to determine whether a Floodplain Clearance or any of the exemptions set forth in this Section are applicable. A Floodplain Clearance may be issued for Structures located outside the Floodplain and the Erosion Control Zone; or for other incidental uses not requiring a Floodplain Use Permit.

Section 507. Personal Liability

The exemptions contained in Section 505 do not relieve any person from liability if that person's actions cause flood damage to any other person or property.

ARTICLE VI. FLOODPLAIN REVIEW BOARD, APPEALS AND VARIANCES

Section 601. Floodplain Review Board

Pursuant to the authority granted in A.R.S 48-3612, the Board of Directors hereby appoints the Flood Control Advisory Board as the Floodplain Review Board to sit in review and make decisions in accordance with A.R.S 48-3612. The members of the Floodplain Review Board shall serve without compensation except that their reasonable and necessary expenses incurred on Board business may be reimbursed.

The Floodplain Review Board shall elect a chairperson and a vice chairperson from among its own members who shall have power to administer oaths and to take evidence.

The Floodplain Review Board shall by resolution fix the time and place of its meetings. The meetings shall be open to the public. Minutes of its proceedings and records of its interpretations, Variances and other official actions shall be kept and filed in the office of the Flood Control District as a public record.

The Board of Directors shall adopt rules of procedure consistent with the provisions of these Regulations for the conduct of Floodplain Review Board business including establishment of a fee schedule to cover administrative costs incurred in the processing of Appeals, Floodplain Use Permits, Floodplain Clearances, Floodplain Variances, plan reviews and performance bonds.

Property shall be posted pursuant to procedures adopted by the Floodplain Review Board.

The Floodplain Review Board may prescribe, in connection with the grant of any Variance or appealed use permit, conditions determined necessary to fully carry out the provisions and intent of the Regulations.

If the Floodplain Review Board has cause to believe, after approval of a Variance, that any stipulations or conditions may have been violated, it may set a hearing for the purpose of determining possible revocation of the Variance for such violation. The Floodplain Review Board may revoke the Variance for finding a violation of the stipulations or conditions, or it may grant a limited time within which to correct the violation in order to avoid revocation of the Variance.

Section 602. Appeals

Appeals of any decision of the Floodplain Administrator to the Floodplain Review Board shall be filed with the Floodplain Administrator within 30 days of the receipt of notice of the decision to be appealed,

or 60 days from the date of the decision whichever is earlier. The notice of appeal shall be in writing on a form provided by the Floodplain Administrator and specify the grounds for appeal.

During the pendency of an appeal all existing Floodplain delineations shall remain in effect. All other matters regarding the proceeding shall be stayed during its pendency unless the Administrator certifies to the Floodplain Review Board that by reason of facts surrounding the application the stay would, in his or her opinion, cause imminent peril to life or property.

The Floodplain Review Board shall fix a time for hearing the appeal and give notice to the parties in interest and to the public as set forth herein. The Floodplain Review Board shall hear and decide the appeal within a reasonable time.

Any person aggrieved by a decision of the Floodplain Review Board may, within 30 days of such decision, appeal to the Board of Directors by filing a written notice of appeal with the Clerk of the Board on a form provided by the Floodplain Administrator. Said notice shall specify the grounds of the appeal. The Board of Directors shall conduct the appeal under such rules of procedure, as they shall adopt.

Any person aggrieved by a decision of the Board of Directors may file a special action in Superior Court of the State of Arizona to determine if an abuse of discretion by the Board of Directors, the Floodplain Review Board or the Floodplain Administrator may have occurred.

Section 603. Floodplain Variance

Conditions for the issuance of a Variance:

1. A Variance may be issued by the Floodplain Administrator, Floodplain Review Board, or affirmed by the Board of Directors when all of the following criteria are met:
 - a. That no increase in the Base Flood Elevation would result;
 - b. That special circumstances, such as size, shape, topography, location or surroundings of the property, would cause the strict application of the Regulations to deprive the property of privileges enjoyed by similar property in the jurisdictional Floodplain;
 - c. That the Variance does not constitute a grant of special privileges inconsistent with the limitations on similar property in the jurisdictional Floodplain;
 - d. That the Variance requested is the minimum necessary, considering the flood hazard, to afford relief;
 - e. That there is a showing of good and sufficient cause;
 - f. That a determination that failure to grant the Variance would result in exceptional hardship to the applicant;
 - g. That granting the Variance will not result in additional threats to public safety, extraordinary public expense, create a nuisance, cause the victimization of or fraud on the public; and
 - h. That the Variance does not conflict with existing local laws or ordinances.
2. In addition to the above requirements, the Floodplain Administrator, Board of Directors or the Floodplain Review Board, may attach such conditions or restrictions to the granting of a Variance as it determines necessary to eliminate potential threats to public safety or to public or private property resulting from the granting of the Variance. The applicant, among other things, may be required to post performance bonds, assurances or other security to guarantee compliance with the conditions and restrictions imposed.
3. The burden of proof of compliance with the above conditions shall be on the applicant.

ARTICLE VII. RECORDATION/NOTIFICATION

Section 701. Recordation/Notification of Variance

Upon the granting of a Variance for the construction of a dwelling unit or commercial or industrial Structure, where the construction of such unit or Structure is otherwise contrary to these Regulations, the Board shall notify the grantee in writing that:

1. The issuance of the Variance may result in increased premium rates for flood insurance;
2. Construction below the Regulatory Flood Elevation will increase risks to life and property and flooding may occur by channel meander or by a more frequent flood or a larger flood than the 100-year flood event;
3. If the Structure is a dwelling unit or business, as defined by A.R.S. 26-321, the land upon which the Structure is located is ineligible for exchange of land pursuant to the flood relocation and land exchange program provided for by Title 26, Chapter 2, Article 2 of the Arizona Revised Statutes.
4. The original of the above written notice shall be recorded with the Maricopa County Recorder in a manner so that it appears in the chain of title of the affected parcel of land. Proof of such recordation shall be maintained on file with the District and be available to any agency requiring any subsequent permits.
5. The Floodplain Administrator shall maintain a record of all Variance actions. This record shall be included in the biennial report to the Federal Emergency Management Agency.

Section 702. Recordation of Flood Hazard Determination

Upon approval of a Floodplain Use Permit, or when through the course of performing other authorized duties it is determined that any portion of a parcel of land is within a delineated Flood Hazard Zone, or a previously noticed parcel has been removed from the delineated Flood Hazard Zone, a notice of such determination may be recorded with the office of the Maricopa County Recorder in a manner so that it appears in the chain of title of the affected parcel of land. The District may also record the Floodplain Use Permit.

Section 703. Recordation of Floodplain Violations

The District may cause to have recorded any notice of violation or non-compliance issued pursuant to Section 1102.

ARTICLE VIII. DEVELOPMENT STANDARDS

Section 800. General Development Standards

Section 800. See additional requirements for specific Flood Hazard Zones under that zone (Zone A, Zone AH or Zone AO).

General Development Standards (Applicable to all 100-year Floodplains except AE Floodway):

1. New construction or substantial improvement to any existing Structure shall be constructed with methods that minimize flood damage with materials and utilities resistant to flood damage.
2. Dwellings other than mobile/manufactured homes shall have the lowest floor elevated and all utilities, including ductwork, floodproofed up to or above the Regulatory Flood Elevation. The applicant shall provide an Elevation/Floodproofing Certificate prepared by an Arizona Registered Professional Engineer or Land Surveyor certifying that the elevation or floodproofing requirement has been met.

3. Mobile/manufactured homes including permanently placed Recreation Vehicles shall be elevated so that the bottom of the structural frame is at or above the Regulatory Flood Elevation and is anchored to prevent floatation, collapse or movement. Methods of anchoring may include, but not be limited to, use of over the top or frame ties to ground or foundation anchors. Specific requirements shall be as follows:
 - a. Over the top or frame ties shall be provided at each of the four corners of the mobile/manufactured home, with additional ties on each side at intermediate locations;
 - b. Mobile/manufactured homes more than 50 feet long require one additional tie per side;
 - c. All components of the anchoring system shall be capable of carrying a force of 4,800 pounds;
 - d. Adequate surface drainage and access for a hauler are provided;
 - e. If the mobile/manufactured home is elevated on piers, setbacks shall be sufficient to permit steps; pier foundations shall be placed in stable soil no more than ten feet apart, and reinforcement is provided for piers more than six feet above ground level. A scour analysis may be required when elevating on piers;
 - f. Any additions to the mobile/manufactured home shall be similarly anchored; and
 - g. Attached appliances and all utilities, including ductwork, shall be either elevated or floodproofed up to the Regulatory Flood Elevation.

The above requirements do not apply to units in storage, and may be waived by the Floodplain Administrator on a case by case basis for units placed for less than 180 consecutive days that are properly licensed and ready for highway use, or are on jacks or wheels with quick disconnect of utilities and have no permanently attached additions.

4. For all mobile/manufactured home parks and mobile/manufactured home subdivisions, an evacuation plan indicating alternate vehicular access and escape routes shall be filed with the Maricopa County Department of Emergency Management.
5. Buildings, other than dwellings or any type of residence may have the lowest floor below the Regulatory Flood Elevation provided that they shall be watertight with walls substantially impermeable to the passage of water and structural components and utilities, including ductwork, having the capacity of resisting the effects associated with a base flood. Designs for meeting this criteria shall be certified on a Flood Proofing Certificate by an Arizona Registered Professional Engineer or the design must meet or exceed the following minimum criteria: A minimum of two openings, on at least two sides, having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided. The bottom of all openings shall be no higher than one foot above grade. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided they allow the automatic entry and exit of floodwaters.
6. All new construction and substantial improvements that fully enclose areas below the lowest floor that are solely for parking of vehicles, Building access or storage in an area other than a basement, and are subject to flooding, shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. The applicant shall provide a Flood Proofing Certificate by an Arizona Registered Professional Engineer certifying that the Flood Proofing requirements have been met, or the design shall meet the provisions of Section 504.
7. The applicant shall provide an Elevation/Flood Proofing Certificate by an Arizona Registered Professional Engineer or Land Surveyor to the Floodplain Administrator stating that the elevation or Flood Proofing requirement has been met. Whenever an Elevation or Flood Proofing Certificate is required, a separate certificate shall be furnished for each Building.
8. Recreation Vehicles (44 CFR 60.3(C)(14)): All recreation vehicles placed on site will either:

- a. Be on-site for fewer than 180 consecutive days, and be fully licensed and ready for highway use. A recreation vehicle is ready for highway use if it is on wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions; or
 - b. Meet the permit requirements of Article V, Section 503 of these Regulations and the elevation and anchoring requirements for manufactured homes in Article VIII, Section 800.
9. Fill Material, if used to elevate Structures, shall meet all of the following standards:
 - a. The top of such Fill Material shall be at no point lower than the Base Flood Elevation.
 - b. Such Fill Material shall extend at least 5 feet beyond the walls or supporting frame of the Structure, or as approved by the Floodplain Administrator.
 - c. Fill Material shall be placed and compacted in accordance with the applicable Building code.
 - d. Fill Material shall not interfere with local drainage or tributary flow of the channel of any watercourse.
10. Fill Material proposed in excess of the amount and extent required herein shall be shown by the applicant to have no detrimental effect on the purposes of these regulations and the amount of Fill Material shall not be greater than is necessary to achieve the purpose for which it is intended as demonstrated by a plan submitted by the applicant indicating the uses to which the filled land will be put and the final dimensions and extent of the proposed Fill Material.
11. Adequate erosion protection shall be provided for Fill slopes exposed to moving floodwaters (slopes exposed to flows with velocities of up to five (5) feet per second (fps) during the base flood must, at a minimum, be protected by a permanent cover of grass, vines, weeds, or similar vegetation; slopes exposed to flows with velocities greater than five (5) fps during the base flood must, at a minimum, be protected by appropriately designed stone, rock, concrete, or other durable materials).
12. Fill Material for purposes other than Solid Waste Landfills shall not include solid waste, wood or other buoyant materials nor hazardous, toxic or deleterious material and shall be protected as needed against scour and erosion by riprap or other protective measures as approved by the Floodplain Administrator.
13. Permitted Landfills shall be protected against scour, erosion and contamination by and contamination of the 100-year flood event.
14. All subdivision proposals and other proposed new Developments greater than fifty (50) lots or five (5) acres, whichever is the lesser, shall include within such proposals Base Flood Elevation data.
15. In order to control erosion and preserve the natural and beneficial functions of the Floodplain, removal of vegetation shall be the minimum necessary for the Development.
16. Issuance of a Floodplain Use Permit does not exempt the holder of the Floodplain Use Permit from any additional requirements necessary to obtain flood insurance.
17. For Buildings elevated greater than five (5) feet, enclosures, including breakaway walls, below the Base Flood Elevation are prohibited. Screening and open latticework is not considered an enclosure. Applicant must sign a non-conversion agreement, agreeing not to enclose the area for habitable use.
18. Residential homes with a basement are not permitted within the 100-year Floodplain.
19. Sand & Gravel Development shall meet the requirements of this Article.
20. The storage or processing of materials that are, in time of flooding, buoyant, flammable, explosive or could be injurious to human, animal or plant life is prohibited.

21. Storage of other material or equipment may be allowed if not subject to major damage by floods and if firmly anchored to prevent flotation, or if readily removable from the area within the time available after flood warning.
22. All preliminary subdivision proposals shall identify the Special Flood Hazard Area and the elevation of the base flood.
23. All final subdivision plans will provide the elevation(s) of proposed Structure(s) and pads. If the site is filled above the base flood, the final lowest floor and pad elevation shall be certified by a Registered Professional Engineer or Surveyor and provided to the Floodplain Administrator.
24. All subdivision proposals shall be consistent with the need to minimize flood damage.
25. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage.
26. All subdivisions shall provide adequate drainage to reduce exposure to flood hazards.

Section 801. Development Standards within AE Floodway

- A. No Structure, excavation or Fill Material (including Fill Material for roads, dikes, and levees), deposit, obstruction, storage of material or equipment or other uses shall be permitted which alone or in combination with existing or future uses, in the opinion of the Floodplain Administrator, would cause an increase in the Base Flood Elevations or flood damage potential. Additional Standards in AE Floodway are:
 1. Regulatory Flood Elevation is one (1) foot above the Floodway elevation or one (1) foot above the Base Flood Elevation, whichever is higher.
 2. Septic systems, whether public or privately owned, shall not be located wholly or partially within a Floodway.
 3. In accordance with A.R.S 49-772(A)(2) Solid Waste Landfills or any part of such facility, whether public or privately owned, shall not be located wholly or partially within a Floodway or within one-half mile of a one-hundred year Floodplain that has one hundred year flows in excess of twenty-five thousand cubic feet per second, as determined by the Federal Emergency Management Agency. In addition, A.R.S 49-772(C) applies to non-FEMA Floodplains.
 4. Any Fill Material proposed in the Floodway must be shown by the applicant to have no detrimental effect on the purposes of these Regulations. The amount of Fill Material shall not be greater than is necessary to achieve the purpose for which it is intended as demonstrated by a plan submitted by the applicant indicating the uses to which the Filled land will be put, the final dimensions, and the extent of the proposed Fill Material. Such Fill Material shall not include junk, trash, tires, garbage, wood or other buoyant materials, or hazardous, toxic or deleterious materials, and shall be protected against scour and erosion.
 5. Structures and uses permitted within the Floodway shall not include Buildings and shall have a low flood damage potential, shall be located so as to minimize obstruction to flood flows with any utilities floodproofed, and shall not be designed or utilized for human habitation.
 6. The processing or the outside storage of materials and equipment may be permitted if flooding would cause minimal damage to the material or equipment and such material or equipment is either non-buoyant or firmly anchored or located so as to prevent flotation or is maintained in a readily transportable condition so as to be readily removed from the area within the time available after flood warning.
 7. In order to control erosion and preserve the natural and beneficial functions of the Floodplain, removal of vegetation shall be the minimum necessary for Development.

- B. A Floodplain Use Permit for the extraction of sand and gravel or other materials within the Floodway shall be granted if the applicant shows that excavations will not have a cumulative adverse impact nor be of such depth, width, length, or location as to present a hazard to life or property or to the watercourse in which they are located, and that they will comply with any applicable Watercourse Master Plan adopted by the Board of Directors subject to the following conditions:
1. Plans of Development submitted in support of a permit application shall follow the Sand and Gravel Permitting Guidelines, when adopted, and the Erosion Hazard Zone Delineation and Development Guidelines, when adopted, in addressing the technical requirement of permitting.
 2. Excavations shall not be permitted so close to any floodway crossings, utility Structures or facilities as to cause or have the potential to cause an adverse effect on such crossings, utilities or similar facilities.
 3. No stockpiling of tailings, overburden or sand and gravel which may obstruct, divert, retard or disrupt the continuity of the natural flow of water shall be permitted, except as approved by the Floodplain Administrator in a Floodplain Use Permit.
 4. A plan of Development shall be submitted with an application for a Floodplain Use Permit to the Floodplain Administrator. The Floodplain Administrator will determine whether an engineered plan will be required and whether a sediment transport analysis is necessary, based upon the procedures outlined within the Sand and Gravel Permitting Guidelines, when adopted.
 5. The plan of Development shall be required to include a plan of reclamation to leave the land when the approved use is terminated in such a condition as to maintain stability of the floodway by backfilling, contouring, leveling, revegetation, removal of equipment and materials or other appropriate means. In addition to a plan of reclamation, a schedule of implementation of reclamation shall be included as part of the plan of Development for each site. Alternatively, the plan of reclamation shall be in accordance with the requirements of any applicable adopted Watercourse Master Plan. Failure to maintain implementation of reclamation progress in accordance with the approved plan of reclamation shall be a violation of these Regulations and the Floodplain Administrator may revoke or suspend the Floodplain Use Permit for failure to comply with this provision, as per Section 503 of these Regulations.
 6. Any significant change, as determined by the Floodplain Administrator, in a previously approved plan of Development shall require an application to amend the approved plan of Development.
 7. In order to control erosion and preserve the natural and beneficial functions of the floodplain, removal of vegetation shall be the minimum necessary for the Development, and in accordance with the approved plan of Development.
 8. The plan of Development is subject to post-flood review and possible modification if necessary due to flood related changes in river morphology.
 9. Erosion setbacks, within the 100-year floodplain shall meet Arizona state standards or as determined by the Floodplain Administrator, using the Erosion Hazard Zone Delineation and Development Guidelines, when adopted.
 10. The operator of an active sand and gravel extraction operation permitted under these regulations shall maintain a set of Development plans bearing the approval seal of the District. Failure to maintain the approved plans on site shall be a violation of these regulations, subject to revocation or suspension of the Floodplain Use Permit as detailed in Section 503 and a fine as detailed in Section 1103 of these regulations.
 11. If the Floodplain Administrator determines that no substantial mining activity has taken place within 12 months of approval of the Floodplain Use Permit for sand and gravel mining, or during any consecutive 12 month period of an active permit, the Floodplain Administrator shall cancel forthwith the remaining time of the active permit, upon discovery of this inactivity by

- inspection. Any resubmittal to re-activate a permit cancelled under this section shall be treated as a new permit application, including the requirement of any fee pertaining to a new application for the intended use.
12. Sand and gravel Floodplain Use Permits shall not exceed a five (5) year duration and may be issued for a lesser duration of time as determined by the Floodplain Administrator.
 13. The Floodplain Use Permit shall be issued to the owner of the land or his approved designee. The District shall require written proof of ownership and express, written consent and agreement of the owner of the land acknowledging responsibility for following the plan of Development, including the reclamation of the site.
 14. The rights and responsibilities under a Floodplain Use Permit for an aggregate mining operation are non-delegable and cannot be transferred without the written authorization of the District.

Section 802. Development Standards within Zone AE Floodway Fringe

Uses shall meet Section 800 General Development Standards. Additional Standards in AE Floodway Fringe are:

1. The Regulatory Flood Elevation is two (2) feet above the Base Flood Elevation if no floodway has been delineated.
2. For Elevation Certificate purposes, the adjacent grade in an AE Zone is finished grade.
3. A Floodplain Use Permit for the extraction of sand and gravel or other materials within AE Floodway Fringe shall be granted under the same conditions as Section 801. The following additional conditions are:
 - a. Dikes or levees are permitted provided it can be shown by the applicant that such dikes or levees will not adversely affect structures, road or utility crossings, easements, or right-of-way or other public or private property, and will not cause erosion or diversion of flood flows onto property outside the Delineated Floodplain, and will not create a danger to life or property.

Section 803. Development Standards within Zone A

Uses shall meet Section 800 General Development Standards. Additional Standards for Zone A are:

1. The Regulatory Flood Elevation is two (2) feet above the community determined Base Flood Elevation.
2. For Elevation Certificates, the adjacent grade is natural grade, unless a datum Base Flood Elevation is determined, then the adjacent grade is finished grade.
3. Sand and Gravel Development shall meet the Development Standards of Section 801 or Section 2, whichever is applicable. The applicant for a sand and gravel permit in Zone A shall delineate the Floodway portion of the Floodplain in order to meet the Development Standards of Section 801.

Section 804. Development Standards within Zone A Ponding

Uses shall meet Section 800 General Development Standards. Additional requirements for Zone A Ponding Area are:

1. The Regulatory Flood Elevation is one foot (1) above the height of the effective outfall or the height of the feature causing the ponding.
2. For Elevation Certificate purposes, the adjacent grade is finished grade.
3. Any volume displacement shall be equally compensated for from within the same Ponding Area.

4. The effective lateral conveyance shall be preserved.

Section 805. Development Standards within Zone A Shallow Flooding

Uses shall meet Section 800 General Development Standards. Additional standards for Zone A Area of Shallow Flooding are:

1. Regulatory Flood Elevation is two (2) feet above the community determined Base Flood Elevation.
2. For Elevation Certificate purposes, adjacent grade is natural grade.

Section 806. Development Standards within Zone AH Ponding

Uses shall meet Section 800 General Development Standards. Additional Development Standards for Zone AH Ponding are:

1. Regulatory Flood Elevation is one (1) foot above the Base Flood Elevation.
2. For Elevation Certificate purposes, the adjacent grade is finished grade.
3. Any volume displacement shall be equally compensated for from within the same Ponding Area.
4. The effective lateral conveyance shall be preserved.

Section 807. Development Standards within Zone AO Ponding Area

Uses shall meet Section 800 General Development Standards. Additional Development Standards for Zone AO are:

1. The Regulatory Flood Elevation is one (1) foot above the flood depth.
2. For Elevation Certificate purposes, the adjacent grade is natural grade.
3. Any volume displacement shall be equally compensated for from within the same Ponding Area.
4. The effective lateral conveyance shall be preserved.

Section 808. Development Standards within Zone AO Shallow Flooding

Uses shall meet Section 800 General Development Standards. Additional Development Standards for Zone AH are:

1. Regulatory Flood Elevation is one (1) foot above the flood depth.
2. For Elevation Certificate purposes, the adjacent grade is natural grade.

Section 809. Development Standards within Zone AO Alluvial Fan

Uses shall meet Section 800 General Development Standards. Additional Development Standards for Zone AO are:

1. Regulatory Flood Elevation is one (1) foot above the flood depth.
2. For Elevation Certificate purposes, the adjacent grade is natural grade.

Section 810. Development Standards within Other Flood Hazard Areas

1. Standards adopted for Development contained in a Watercourse Master Plan, Area Drainage Master Plan or other hydrologically or hydraulically oriented master plan shall be consistent with sound floodplain management practices and these regulations.
2. The applicant for any proposed use may be required to provide against encroachment into or protection from the delineated flood hazard.

3. The placement of Fill Material or extraction of materials may require the Floodplain Administrator's approval of plans prepared by an Arizona Registered Professional Engineer.
4. Whenever a proposed use is located within a Delineated Floodplain regulated elsewhere in these Regulations as well as another designated Flood Hazard Zone regulated by this article, the article with the most stringent requirements shall take precedence.
5. The standards, provisions, criteria and requirements for Development in Flood Hazard Zones imposed by an authorized master plan shall meet or exceed the requirements of these Regulations.
6. In areas where floodways have not been defined using traditional equal conveyance encroachment methods, the Floodplain Administrator may require that the Regulatory Flood Elevation be two (2) feet above the Base Flood Elevation.

ARTICLE IX. ZONE A ALLUVIAL FAN AREAS

Uses shall meet Section 800 General Development Standards. Additional Standards for Piedmont Assessment Manual Alluvial Fan Zones are noted below.

Section 901. Development Standards within Alluvial Fan Zone A Administrative Floodway

Development within an Alluvial Fan High Hazard area (AFHH), Alluvial Fan Uncertain Flow Distribution Area (AFUFD), and Alluvial Fan Floodway (AAFF) as determined using the Piedmont Assessment Manual or other Floodway designation by other Alluvial Fan analysis methods approved by FEMA in Appendix G of the Guidelines and Specifications for Flood Hazard Mapping Partners shall be regulated in a manner similar to a Floodway as described in Article VIII, Sections 801 and 802 of these Regulations.

1. Mitigation: Only major engineering measures as outlined in 44 CFR 65.13 can be used to mitigate the Alluvial Fan flood hazard in these areas.
2. Refinement: Refinement of the Floodway limits may be allowed depending on the level of detail of the original Floodway analysis and level of detail of the proposed revision.

Section 902. Development Standards within an Alluvial Fan Zone A

Development within an Alluvial Fan Zone A (AFZA) as determined using the Piedmont Assessment Manual or other Zone A Alluvial Fan analysis methods approved by FEMA in Appendix G of the Guidelines and Specifications for Flood Hazard Mapping Partners shall be regulated in a manner similar to a Zone A Riverine Floodplain. Development may require an engineered plan.

Uses shall meet Section 800 Development Standards. Additional Standards for Zone A Alluvial Fan are:

1. The Regulatory Flood Elevation is one (1) foot above flood depth.
2. For Elevation Certificate purposes, the adjacent grade is natural grade unless a datum Base Flood Elevation is determined, then the adjacent grade is finished grade.
3. Minimum Development requirements in these areas shall include:
 - a. Detailed site topography;
 - b. Identification of lowest floor elevations in relation to flood elevation/depth;
 - c. Identification of all washes through the site including ingress and egress locations; and
 - d. Adequate provisions to maintain all natural and improved drainage or flood conveyance systems with minimal disruption of the water/sediment system.

- e. When Development plans propose Structures located in the proximity of a wash or with an area of significant sheet flow depth, the applicant shall submit a plan of Development prepared by an Arizona Registered Engineer. The plan shall include engineering analysis to mitigate all hazards associated with Alluvial Fan flooding including inundation, ground erosion, scour around Structures, debris and sediment flow and accumulation in addition to aggradation and degradation of conveyance systems. The plan shall also include Building pad and lowest floor elevations. The plan shall be consistent with the following Arizona State Standards:
 - 1) State Standard 7-98 – Watercourse Bank Stabilization
 - 2) State Standard 5-96 – Watercourse System Sediment Balance

Section 903. Development Standards within Inactive Alluvial Fan Zone AO

Development within an Inactive Alluvial Fan Zone AO using the Piedmont Assessment Manual shall be regulated in a manner similar to a Zone AO Shallow Flooding Floodplain. Development may require an engineered plan.

- 1. Uses shall meet Section 800 and Section 901 Development Standards.

ARTICLE X. WATERCOURSE MASTER PLANS

Section 1001. Authorization

Pursuant to A.R.S. 48-3609.01, the District, whenever it has completed a Watercourse Master Plan, may submit the plan, including uniform rules for Development to the Board for adoption. If adopted by the Board, the District shall enforce the Watercourse Master Plan under these Regulations.

Section 1002. Public Notification

During the preparation of a Watercourse Master Plan, the owners of record of real property within and immediately contiguous to the Watercourse or Watercourses included in the planning shall be publicly notified by the District so that the owners may have input to the planning process. In addition, the Sand and Gravel Recommendations Committees organized pursuant to A.R.S. 11-830(D), if any, shall be notified.

Section 1003. Recharge Techniques

All Watercourse Master Plans shall consider recharge techniques including but not limited to: swales, dry wells, sand tanks and small dams.

Section 1004. Minimum Standards

Requirements for a Watercourse Master Plan shall meet or exceed the minimum requirements under the National Flood Insurance Program or the criteria adopted by the Director of The Arizona Department of Water Resources or these Regulations. In case of conflict the most stringent requirements shall prevail.

ARTICLE XI. ENFORCEMENT

1101. Violation

- 1. It is unlawful for any person to engage in any Development or to divert, retard or obstruct the flow of waters in any watercourse without securing written authorization from the Flood Control District Board of Review or the Floodplain Administrator as required by these regulations.

2. It is a civil offense for any person to violate any regulations, ordinances or rules of the Flood Control District.

1102. Enforcement

Pursuant to regulations, ordinances, rules and guidelines as adopted from time to time by the Board of the Flood Control District, the District shall:

1. Conduct inspections to determine if violations of its regulations, ordinances, rules or permit conditions exist.
 - a. The District and its agents may have reasonable access for inspection pursuant to written authorization under A.R.S. 48-3613 or the terms of a Floodplain Use Permit. If no written authorization has been issued, the District may inspect during regular business hours, or in the case of emergency, at any time.
 - b. If the District and its agents are denied reasonable access for inspection, the Chief Engineer of the District may apply for an administrative search warrant to be served by a certified peace officer.
2. If a violation of the District regulations, ordinances, rules or permit conditions is found, the District will serve upon the property owner or permit holder a notice of violation.
3. If the violation is not resolved in the time set by rules adopted pursuant to A.R.S. 48-3615.01, the District may set the matter for an administrative hearing before a Hearing Officer and serve notice of the hearing date to the property owner or permit holder.
4. Upon written request, any party to a decision rendered in the administrative hearing may request review by the Board of Hearing Review within fifteen (15) days of the decision. The final decision of the Board of Hearing Review is subject to judicial review pursuant to A.R.S. 12-901 et.seq. Any decision not appealed in a timely fashion becomes the final enforceable order of the District.

1103. Penalties

1. It is a Class 2 Misdemeanor to engage in any Development or to divert, retard or obstruct the flow of waters in a watercourse without securing the written authorization of the District. A violator may be subject to jail and fines.
2. The penalty for the civil offense of violation of Flood Control District regulations, ordinances or rules is a fine not in excess of that which is chargeable for a Class 2 Misdemeanor. Each day the violation continues constitutes a separate offense.
3. All Development located or maintained in a floodplain since August 8, 1973, in violation of flood control statutes or regulations without authorization from the District is a public nuisance per se and may be abated, prevented or restrained.
4. Nothing in this section precludes any private right of action by any person damaged by another's unauthorized diversion, retardation or obstruction of a watercourse. Further, the District is not precluded by anything herein from pursuing injunctive and other remedies as provided by law.

ARTICLE XII. WARNING AND DISCLAIMER OF LIABILITY

The degree of flood protection required by these Regulations is considered reasonable for regulatory purposes and is based on engineering and scientific methods of study. Compliance with these Regulations does not insure complete protection from flooding and is not to be construed as a warranty. Larger floods may occur or the flood height may be increased by man-made or natural causes, such as bridge openings restricted by debris, natural erosion, streambed meander or man-made obstructions and diversions. These Regulations are not intended to imply that areas outside the Floodplain or land uses

permitted within such areas will be free from flooding or flood damage. These Regulations shall not create liability on the part of the Flood Control District of Maricopa County or any officer or employee thereof for any flood damages that may result from reliance on these Regulations or any administrative decision lawfully made there under.

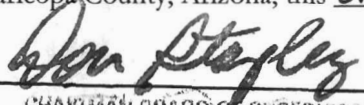
ARTICLE XIII. SEVERABILITY

These Regulations and the various parts thereof are hereby declared to be severable. Should any section of these Regulations be declared by the courts to be unconstitutional or invalid, such decision shall not affect the validity of these Regulations as a whole, or any portion thereof other than the section so declared to be unconstitutional or invalid.

ARTICLE XIV. EFFECTIVE DATE

These Regulations as amended is adopted by the Board of Directors of the Flood Control District of

Maricopa County, Arizona, this 20th day of December 20 06



CHAIRMAN BOARD OF SUPERVISORS



CLERK OF THE BOARD

DEC 20 2006
DATE

PROPOSED FEE SCHEDULE
FLOODPLAIN REGULATION
for
MARICOPA COUNTY, ARIZONA

July 2006-June 2007

The following administrative fees shall be charged for the processing of Appeals, Floodplain Use Permits, Floodplain Variances, plans review and performance bonds with no provision for refund:

FLOODPLAIN USE PERMITS

Category 1: Permits which require a minimum of technical review.

Single Family Residence, Mobile/Manufactured Buildings, Commercial/Industrial

Non- engineered	\$ 145
Engineered.....	\$ 200
Site inspection (when required).....	\$ 50
Category 1 Amendment (When a site inspection is required)	\$ 50

Category 2: Permits, which require technical hydrologic or engineering review.

Residential Subdivisions, Commercial including strips and centers, Industrial

including parks.....	\$ 400
Category 2 Amendment	\$ 800

Sand and Gravel Operations

Initial Permit Application	\$ 4,000
Compliance Inspection (semi-annual or violation follow-up).....	\$ 100
Engineering Review	\$ 300
Non-compliance review	\$ 500
Major Amendment.....	\$ 2,300
Minor Amendment	\$ 1,200

OTHER FEES

Floodplain Clearance	\$ 50
Sand and Gravel Renewal (Five Year)	\$ 2,000

Appeals/Variances (FCAB or Board of Directors)

Residential/Commercial/Industrial (posting required)	\$ 750
Continuance of Hearing — Applicant's Request	\$ 50
If new posting is required	\$ 50

Floodplain Delineation Review

CLOMR/LOMR (MT 1)	\$ 825
CLOMR/LOMR (MT2)	\$ 2,800
CLOMR/LOMR Alluvial Fan	\$ 2,365
Regulation (per copy).....	\$ 5

Performance Bond: 100% cost of requested improvement or cost to abate violation, or 50% of value at risk, whichever is higher.

PROPOSED FEE SCHEDULE
FLOODPLAIN REGULATION
for
MARICOPA COUNTY, ARIZONA

July 2007-June 2008

The following administrative fees shall be charged for the processing of Appeals, Floodplain Use Permits, Floodplain Variances, plans review and performance bonds with no provision for refund:

FLOODPLAIN USE PERMITS

Category 1: Permits which require a minimum of technical review.

Single Family Residence, Mobile/Manufactured Buildings, Commercial/Industrial	
Non- engineered	\$ 305
Engineered.....	\$ 420
Site inspection (when required)	\$ 105
Category 1 Amendment (When a site inspection is required)	\$ 130

Category 2: Permits, which require technical hydrologic or engineering review.

Residential Subdivisions, Commercial including strips and centers, Industrial including parks.	
	\$ 835
Category 2 Amendment	\$ 825

Sand and Gravel Operations

Initial Permit Application	\$ 8,400
Compliance Inspection (semi-annual or violation follow-up).....	\$ 265
Engineering Review	\$ 660
Non-compliance review	\$ 1,050
Major Amendment.....	\$ 4,870
Minor Amendment	\$ 2,450

OTHER FEES

Floodplain Clearance	\$ 50
Sand and Gravel Renewal (Five Year)	\$ 4,200

Appeals/Variances (FCAB or Board of Directors)

Residential/Commercial/Industrial (posting required)	\$ 1,675
Continuance of Hearing — Applicant's Request	\$ 50
If new posting is required	\$ 110

Floodplain Delineation Review

CLOMR/LOMR (MT 1)	\$ 850
CLOMR/LOMR (MT2)	\$ 2,900
CLOMR/LOMR Alluvial Fan	\$ 4580
Regulation (per copy).....	\$ 5

Performance Bond: 100% cost of requested improvement or cost to abate violation, or 50% of value at risk, whichever is higher.

PROPOSED FEE SCHEDULE
FLOODPLAIN REGULATION
for
MARICOPA COUNTY, ARIZONA

July 2008 - revised annually per NCPI

The following administrative fees shall be charged for the processing of Appeals, Floodplain Use Permits, Floodplain Variances, plans review and performance bonds with no provision for refund:

FLOODPLAIN USE PERMITS

Category 1: Permits which require a minimum of technical review

Single Family Residence, Mobile/Manufactured Buildings, Commercial/Industrial

Non- engineered \$ 465

Engineered..... \$ 635

Site inspection (when required) \$ 160

Category 1 Amendment (When a site inspection is required) \$ 215

Category 2: Permits, which require technical hydrologic or engineering review.

Residential Subdivisions, Commercial including strips and centers, Industrial
including parks. \$ 1,270

Category 2 Amendment \$ 850

Sand and Gravel Operations

Initial Permit Application \$12,800

Compliance Inspection (semi-annual or violation follow-up)..... \$ 430

Engineering Review \$ 1020

Non-compliance review \$ 1600

Major Amendment..... \$ 7440

Minor Amendment \$ 3,700

OTHER FEES

Floodplain Clearance \$ 50

Sand and Gravel Renewal (Five Year) \$ 6,400

Appeals/Variances (FCAB or Board of Directors)

Residential/Commercial/Industrial (posting required) \$ 2,600

Continuance of Hearing — Applicant's Request \$ 50

If new posting is required \$ 170

Floodplain Delineation Review

CLOMR/LOMR (MT 1) \$ 880

CLOMR/LOMR (MT2) \$ 3,000

CLOMR/LOMR Alluvial Fan \$ 6,800

Regulation (per copy)..... \$ 5

Performance Bond: 100% cost of requested improvement or cost to abate violation,
or 50% of value at risk, whichever is higher.

Fees will be adjusted on a fiscal year per the National Consumer Price Index.

ADDENDUM

Listed below are the dates of the original firms, FIRMS, FBFM and FIS studies for the communities for which the Flood Control District of Maricopa County performs floodplain management:

COMMUNITY

ORIGINAL FIS & MAP DATES

Maricopa County Unincorporated Areas	July 2, 1979
Town of Buckeye	February 15, 1980
Town of Carefree	July 2, 1979
Town of Cave Creek	September 29, 1989
City of Chandler	July 16, 1980
City of El Mirage	December 1, 1978
Town of Gila Bend	December 4, 1979
Town of Guadalupe	April 15, 1988
City of Litchfield Park	September 29, 1989
City of Mesa	May 15, 1980
Town of Queen Creek	September 4, 1991
City of Surprise	January 15, 1978
City of Tolleson	January 16, 1980

Appendix F: Major Flooding Events

2008

July 13: A surprise, late-afternoon storm hit Tempe hard, where more than two inches of rain fell in less than two hours. A five-mile section of the U.S. 60 freeway through Tempe was shut down for three hours due to deep standing water across several lanes and beneath underpasses. The Arizona Department of Transportation activated pumps to drain the water.

July 10: The first major monsoon storm of the season hit with a fury, dropping more rain in a 12-hour period than during the entire 2007 monsoon season. A cluster of severe thunderstorms moved across northwest Maricopa County causing strong winds and dense blowing dust. A second cluster of severe thunderstorms moved into east-central parts of the county and converged over the Phoenix metropolitan area. The highest rainfall totals were in the Wickenburg area (one to three inches), and central Phoenix and northeast Mesa (one to three inches). 0.83 inches was recorded at Phoenix Sky Harbor International Airport, where the runways were shut down for a short period. Areas of street flooding occurred. Rising water forced the closure of Interstate 17 near downtown Phoenix.

January 27: A daylong rainstorm soaked the county and dropped up to three inches of rain in the northeastern mountains. Cave Creek and New River flowed rapidly, with 14 feet of water held behind Cave Buttes Dam and 23 feet in the impoundment area behind New River Dam. A dozen roads in Cave Creek, Carefree and North Scottsdale were temporarily impassable due to flooded wash crossings. The Salt River Project (SRP) released more than 15,000 cubic feet per second of floodwater over Granite Reef Dam into the Salt River through the Phoenix metropolitan area.

2007

November 30-December 1: The combination of copious Pacific moisture associated with the Baja remnants and dynamic triggered within the coastal system resulted in about 30 hours of moderate to locally heavy rain bands moving east across Central Arizona with the heaviest rain over the higher terrain of Northeast Maricopa County.

July 31-August 1: Up to three inches of rain fell in parts of the northern Phoenix metropolitan area. Various east-west roads in North Scottsdale were closed due to flooded washes and mud flows. The impoundment pond behind Cave Buttes Dam received floodwater more than 20 feet deep.

July 26: In the area of Indian Springs road, just west of Phoenix International Raceway, rain fell in some areas at comparable magnitudes to the County 100-year and 500-year 1-hour rainfall.

July 23: Approximately two inches of rain fell in parts of the Phoenix metropolitan area, especially in the northern portion, where a mudslide closed a road in Cave Creek. The washes in the Gila Bend area were full due to the torrential rains in the area.

July 21-22: A late start of the monsoon brought heavy rain to the County. Sheet flooding in Queen Creek turned dirt roads to mud and caused a 1/4-mile-long, 12-foot-wide, 10-foot-deep fissure in the ground through a rural neighborhood. Several swift water rescues were performed, including a 2.5-hour rescue operation in Queen Creek to save a motorist who had driven into a flood retention area.

2006

September 7: Roads through Indian Bend Wash in Scottsdale were closed due to rainstorm runoff in the wash.

August 24: A rainstorm dropped two inches of rain in parts of the Northeastern Phoenix and North Scottsdale. Both bridged and bridgeless crossings on Indian Bend Wash were closed. Two motorists attempted to drive across the wash on Indian Bend Road in Scottsdale. They became stranded, prompting a rescue by 40 members of the Scottsdale Fire Department. Each motorist was fined for the rescue per the state law that prohibits motorists from driving on a road that is barricaded due to flood hazards.

August 21: Some streets in northern Tempe were flooded, and the right-hand lanes of both eastbound and westbound U.S. 60 at Rural Road were closed due to heavy rain.

July 25: Heavy rains created a sinkhole adjacent to an apartment building in Tempe, forcing residents to evacuate. Flood control basins in east Mesa were filled to capacity and pumping was required.

2005

September 3: Very heavy rainfall across the far northern portion of the Phoenix metropolitan area resulted in rapid runoff and flooding. The Seven Springs stream gage indicated a sudden jump of the water level, from zero to 8.5 feet, in only 20 minutes. The Camp Creek ALERT system gage recorded a total of 3.11 inches of rain, with 2.01 inches in one hour. Bartlett Road was washed out and impassable, trapping about 400 motorists as they were attempting to leave Bartlett Lake. In Phoenix, the heaviest rain storm was reported at the East Fork of Cave Creek at 7th Avenue, with flooding of many streets in north Phoenix.

August 23: Flooding was reported on State Route 85.

August 9: Heavy rains from widespread thunderstorms caused flash flood waters to over-flow washes from New River east to the Seven Springs area and Camp Creek. Rain gage networks indicated that up to 4.5 inches of rain falls during the late afternoon and early evening. Two fatalities occurred during this storm: A pickup truck driver drowned while attempting to drive across a flooded road, and a seven-year-old girl was evacuated from a home along Camp Creek slipped from the grasp of the adult she was with and was swept away by a flooded wash. Heavy rains during the afternoon flooded highways and roads in Queen Creek, while in Tonopah many roads were closed in the area due to rapid flooding.

August 2: One of the heaviest rainfall events of the 2005 season hit the Phoenix area, where almost three inches of rain fell in many locations in the metropolitan area, which caused roofs to collapse and streets to flood quickly. Nearly 120 residents of an apartment community in Phoenix were evacuated after 83 apartment units were damaged by floodwaters.

July 30: Very heavy rainfall, about two inches per hour, caused the flooding of low spots and washes in Wickenburg, where the peak flow in Hartman Wash was 1,200 cubic feet per second.

July 26: In Sun City, the occupants of a stranded vehicle in a flash flood were rescued at 128th Avenue and Galaxy Drive.

February 16: The governor declared a state of emergency in various counties due to 2005 winter storms and flooding. The declaration for Maricopa County only included the town of Wickenburg. The total damage for the February flooding was estimated at \$6.5 million.

February 12: Rains associated with a mid-winter storm system moved slowly across central and southern Arizona. Rainfall intensity increased significantly during the evening of February 11, and Flood Control District ALERT rain gages began to report excessive rainfall exceeding 1.5 inches per hour during the early morning hours of February 12. Rural roads in northern and northeastern Maricopa County became flooded by washes running heavy with the rain runoff. The Hassayampa River eroded its banks near Wickenburg, washing away two mobile homes and two vehicles. The Maricopa County Sheriff's Office rescued 21 individuals in 11 separate floodwater incidents during the weekend. Rock and mud slides along U.S. Highway 60 from Superior to Globe were reported by the afternoon of February 12. Eventually, the Salt River and Verde River started to receive the runoff, with Granite Reef Diversion Dam spilling 35,345 cubic feet per second. Downstream, the river bottom road crossings on the Salt, Verde and Gila rivers were flooded. Tempe Town Lake, located in the Salt River channel, lowered its inflatable dams to allow for increased water flow. This storm system was the final significant 2004-2005 winter event in a season of very heavy rainfall. The Carefree-Cave Creek area reported a three-month total of 13.66 inches.

2004

December 29: Heavy rains fell across a large portion of southern and central Arizona. The rapid runoff resulted in flooded washes.

August 15: Flash flooding was reported south of U.S. Highway 60 on Vulture Mine Road near Wickenburg. Three to four inches of rain fell in one hour.

2003

October 10: Heavy rain fell across parts of northern Maricopa County and the rapid runoff resulted in flooded washes and streams. Storm totals were up to 1.30 inches at Skunk Creek near New River and 2.24 inches at Pinnacle Peak in North Scottsdale. Many vehicles became stuck in the deep water and some motorists had to be rescued.

September 4: Near Wickenburg, Sols Wash grew to about 150 feet wide, Flying E Wash was full and Vulture Mine Road was closed due to flooding. Flash flooding occurred at the entrance to the White Tank Mountain Regional Park near the intersection of Olive Avenue and Citrus Road in the western part of the Phoenix area. Two occupants of a vehicle on Olive Avenue were rescued by law enforcement after they became trapped in three feet of rushing water.

August 28: Locally heavy rainfall affected a large part of the Phoenix metropolitan area. The heaviest rain fell north of Sun City where one gage records approximately four inches. More than two inches fell at Antelope Creek near Wickenburg. Washes overflowed and roads were flooded. Several swift-water rescues were performed and several homes were damaged by flooding.

August 26-27 and September 6: Late monsoon storms of 2003 in the Upper Trilby Wash Watershed.

August 14: At least 15 homes were flooded in Tolleson.

August 13: A flash flood in Sols Wash swept a vehicle downstream from Vulture Mine Road.

2001

August 1: Thunderstorms with heavy rainfall of up to one inch per hour caused flash flooding of washes and streets in Wickenburg.

March 7: Heavy rain over much of south-central Arizona left washes running and streets flooded or closed. More than two inches of rain fell in Wickenburg and two inches was recorded over much of the Phoenix area.

2000

October 27: The second major storm in a week caused considerable flooding in both rural and urban areas. A trailer park in Aguila and another in Buckeye were evacuated, while homes in Peoria, Youngtown, Surprise and surrounding areas were flooded. One unofficial rain gage 15 miles east of Aguila registered 8.79 inches for the month and another gage in Aguila records 5.05 inches. The Department of Transportation estimated the damage to roads and bridges alone at \$1 million. Dikes and ditches in agricultural areas sustained major damage in addition to crop losses. The Federal Emergency Management Agency (FEMA) declared a flood emergency for Maricopa County.

October 21: State Route 93 was closed north of Wickenburg due to high water. Sols Wash overflowed and floods Coffinger Park as well as nearby homes. Vulture Mine Road was closed and trapped motorists were rescued. Floodwaters produced considerable damage to agriculture in northwestern Maricopa County. The roads around Aguila were closed for several hours. The governor declared a flood emergency for Maricopa County.

October 10: A strong storm system moved through the Phoenix area producing very heavy rainfall, resulting in street flooding and road closures. The Phoenix Fire Department responded to four swift-water rescues. Flooding was reported around Indian Bend Wash.

August 29: Very heavy rainfall, with estimated rates of an inch per hour, moved slowly across the County. Sols Wash in Wickenburg was flooded as well as other streams and washes in the northern part of the County.

August 17: One inch of rain fell in 15 minutes, causing a flash flood that filled washes near New River.

June 20: About 2.5 inches of rain fell in just 90 minutes. In New River, a vehicle was swept downstream by heavy rainfall runoff.

March 5-7: A series of storm systems moved through Arizona during the three-day period, dropping as much as 3.5 inches of rain across north-central Maricopa County. Sky Harbor Airport recorded 2.77 inches and many areas of the city received more than two inches. Numerous motor-vehicle accidents were blamed on wet or flooded streets and intersections.

1999

August 31: Rainfall exceeded one inch per 30 minutes in parts of the eastern Phoenix metropolitan area, resulting in street flooding.

July 15: Showers and thunderstorms developed over a wide area between Wickenburg and Phoenix, with streets and roads flooded.

July 14: A major storm hit most of the Phoenix metropolitan area with numerous reports of street flooding. At least six swift-water rescues were performed, including a dramatic rescue using a sheriff's department helicopter.

March 5: A series of storms moved through Arizona over a three-day period and produced the third-wettest March on record in Phoenix, causing widespread street flooding.

1998

October 30: Sheriff's deputies formed a human chain to rescue a woman trapped in her car in a flooded wash on 14th Street south of the Carefree Highway in the northern Phoenix metro area.

September 5: Sheriff's deputies rescued at least one camper stranded by flash flood water at the campground at Apache Lake.

August 12: Very heavy rain caused considerable flash flooding around Wickenburg.

March 28: Three members of a Boy Scout troop perished after their SUV was swept away after they tried to drive across a flooded wash near Sunflower.

1997

September 26: An average of three to five inches of rain fell from storms caused by Hurricane Nora, leading to flash flooding in portions of northwestern Maricopa County. Two earthen dams gave way in Aguila, causing widespread flooding where approximately 40 people were evacuated from the town. Water flowing down the Sols Wash was so high that the Sols Wash bridge in Wickenburg was closed for more than two hours along with other highways in the vicinity. A total of 11.97 inches of rain fell in 24 hours on Harquahala Mountain, breaking the 24-hour record set at Workman Creek during the 1970 Labor Day storm.

September 25: Widespread flooding occurred in the town of Aguila, with many properties and roads are under six inches of water.

September 2: Many cross-streets were flooded along Thomas Road in Phoenix.

August 26: Water flowing through Indian Bend Wash rose to three feet. Automobiles became stranded in the wash at McCormick Parkway between Hayden Road and Scottsdale Road.

1996

August 18: Indian Bend Wash flooded quickly and forces the closure of two roads.

1995

September 28: More than two inches of rain fell in Scottsdale, flooding streets and homes and filling Indian Bend Wash.

February 15: Floodwaters from the Hassayampa River near Wickenburg caused some property damage.

1994

September 13: Extensive street flooding in Phoenix was caused by torrential rains.

September 4: More than 1.5 inches of rain fell in one hour in Litchfield Park, resulting in major street flooding.

September 2: Extensive street flooding was reported around the Phoenix area with water three to five feet deep in some freeway underpasses.

1993

October 6: Heavy rain caused Indian Bend Wash to overflow onto city streets and wash over the bridges on Camelback and Indian School roads. A few motorists were rescued from their cars when they became stranded after trying to cross the flooded wash.

February 8-10: Flooding on the Hassayampa River forced 30 people to leave their homes.

January 8-20: An extremely intense El Niño caused heavy rainfall. A large, garbage landfill in Mesa and portions of the new Mill Avenue Bridge that is under construction were washed away by the raging Salt River. The Gillespie Dam west of Phoenix was damaged as high water spreads throughout low-lying areas. One man drowned while trying to cross the Agua Fria River.

1984

July: A summer storm caused scattered flooding, particularly in east Mesa near the Central Arizona Project canal that was under construction.

1983

September 28-October 7: Tropical Storm Octave caused heavy rain over Arizona during a 10-day period. Southeastern Arizona is particularly hard hit, where at least 10,000 people were left temporarily homeless along with 14 fatalities and 975 injuries attributed to the flooding. Damage was estimated at \$370 million. This massive storm brought floodwater north along the Santa Cruz and Gila rivers to Maricopa County, causing extensive flooding of streets and highways with some flooding of homes and businesses. One freeway underpass was filled with nine feet of water.

1980

February: Salt River had a peak flow of 170,000 cubic feet per second. Damages were estimated at \$63,700,000.

January: Severe flooding occurred on the Salt, Verde, Agua Fria and Hassayampa rivers, and along the Gila River below the confluence with the Salt River. The Salt River below Granite Reef Dam and the Agua Fria below Lake Pleasant were raging torrents, with a peak flow of 170,000 cubic feet per second. The greatest flood damage was along the Salt River in the greater Phoenix area. Eleven of the 13 bridges or crossings were destroyed or damaged. Approximately 600 homes to the west of Phoenix were damaged and others are destroyed, with 6,000 residents being evacuated. Damage was estimated at \$63.7 million.

Between October 1977 and February 1980, seven regional floods occurred and Phoenix was declared a disaster area three times. There were 18 fatalities and approximately \$310 million in property damage.

1979

August: Tempe and Mesa streets flooded due to heavy rainfall.

1978

December: Salt River had a peak flow of 140,000 cubic feet per second. Damages were estimated at \$51,800,000.

November: Floodwaters virtually destroyed the community of Allenville near Buckeye and caused heavy damage in Holly Acres on the Gila River and Hound Dog Acres on the Agua Fria River. The Salt River had a peak flow of 140,000 cubic feet per second. Damage was estimated at \$51.8 million.

March: Phoenix received federal disaster assistance funds after the heaviest flooding and largest floodwater flow down the Salt River since 1891. The Salt River had a peak flow of 122,000 cubic feet per second. Thousands of homes were damaged and more than 100 homes are destroyed. There were four fatalities as more than 7,000 people seek emergency shelter. Damage estimated at \$33.1 million.

1976

September 11: Hurricane Kathleen caused severe flooding. Mud and rock slides damaged homes on Camelback Mountain.

1974

August: Excessive rain caused considerable flooding of streets and highways in the Phoenix area, with water up to eight feet deep at one of the underpasses of the Black Canyon Freeway (I-17). There was substantial flooding over much of Tempe and Southeastern Phoenix.

1972

October 17-21: Hurricane Joanne turned into a powerful tropical storm upon landfall, causing flooding, eight fatalities and more than \$10 million in damage.

June: Extensive damage due to flooding in downtown Phoenix, Paradise Valley and Scottsdale. Severe flooding occurred on Indian Bend Wash and the wash between Camelback and Mummy mountains. More than 800 homes were damaged or destroyed. Damage was estimated at \$10.5 million.

1970

September 5-7: The precipitation from Tropical Storm Norma created Arizona's deadliest storm to date. Known as the "Labor Day Storm of 1970," rainfall caused flooding that killed 23 people in the Phoenix area. Damage was estimated at \$5.8 million.

1967

August 29: Widespread flooding occurred, especially in central Phoenix, due to remnants of Hurricane Katrina.

1965-1966

December 22, 1965 – January 2, 1966: Heavy rains caused the first large flow of the Salt River through Phoenix since dams were constructed on the Verde River in 1939 created the Horseshoe and Bartlett reservoirs. All roads crossing the Salt River in Tempe, Phoenix, Scottsdale and Mesa were washed out. All bridges across the Salt River were at least partially damaged, floodwaters encircled Sun Devil Stadium on the Arizona State University campus, a runway was closed at Sky Harbor Airport in Phoenix and Phoenix International Raceway was threatened by floodwaters. Damage was estimated at \$10 million.

1964

July: Flooding caused property damage in Phoenix and Wickenburg, and the Arizona Canal was breached.

1963

October: Floodwaters inundated homes in Phoenix and caused considerable damage to roads in Scottsdale.

August 16: Floodwaters from a severe storm breach the Grand Canal and cause flooding in Glendale and the Maryvale neighborhood of Phoenix. Damage estimated at \$2.9 million.

1962

September 26-28: The remains of Tropical Storm Claudia caused flooding, one fatality and \$3 million in damage, mostly to agriculture near Casa Grande.

1954

August: The most severe storm since 1891 occurred in the Queen Creek area. Gilbert and Apache Junction were severely flooded. Damage estimated at \$446,000 for property and \$1.4 million for agriculture.

1951

August 24-28: Flash floods caused damage in Goodyear and Avondale. Canals and ditches were extensively damaged, Luke Air Force Base and the Harquahala Valley saw significant flooding, and Gila Bend was cut off from motor vehicle travel as bridges and roads were washed out. The total damages for this flood event exceeded \$750,000.

1938

March: Heavy flooding was recorded along the Verde River.

1937

February 16: Floodwaters halted the construction of Bartlett Dam on the Verde River.

1927

February 16: Water flowed over the apron of Gillespie Dam. The Agua Fria River washed out sections of the bridge at Coldwater. Two bridge spans over the Hassayampa were washed away near Arlington.

1926

September 20-25: The Verde and Salt rivers experienced severe flooding.

1921

August 21: Six inches of rain in two days flooded 4,000 acres in the Phoenix area, including the Arizona state capitol building, totaling \$240,000 in damage.

1919

November 28: Flooding was reported throughout the Phoenix area: the Central Avenue bridge over the Salt River was closed, Cave Creek flowed down Grand Avenue, Alhambra and the state fairgrounds site were under water, the Agua Fria River railroad bridge washed out and Paradise Valley was flooded.

1916

January 19-22: Intense rain and melting mountain snow produced large river flows in Central Arizona. There were four fatalities and \$300,000 in damage. The Salt and Verde rivers experienced severe flooding, with water flowing over the spillways of Roosevelt Dam.

1915

January 30: At least four Phoenix-area canals suffered damage from runoff from Cave Creek, Queen Creek and other washes. The Hassayampa River overflowed its banks.

1905

November 27-30: Several severe to moderate floods occurred, particularly in Phoenix and along the lower Gila River. The Arizona Diversion Dam disappeared under 11 feet of water. The railroad bridge across the Salt River in Phoenix was damaged.

1891

February 18-26: The maximum flood of record for Maricopa County occurred on the Verde, Salt and Gila rivers. The Salt River had an estimated 300,000 cubic feet per second water flow, expanding to nearly three miles wide in the Phoenix area and rising to 18 feet above the wooden Arizona Diversion Dam at the confluence with the Verde River. Adobe homes along the Salt River were demolished and the railroad bridge between Tempe and Phoenix is destroyed, leaving Phoenix without a rail connection for three months. Remarkably, no fatalities were recorded.

1890

February 22: At Phoenix, the Salt River rose 17 feet in 15 hours. Heavy rains and melting snow caused the failure of Walnut Grove Dam on the Hassayampa River 30 miles north of Wickenburg, drowning 128 people and causing considerable property damage.

1889

December 5: The Salt and Verde rivers rose very rapidly, and at Fort McDowell the Verde River overflowed its banks.

Appendix G: Context Sensitive Flood Hazard Mitigation (CSFHM)

The Flood Control District of Maricopa County (District) has a continuous goal of implementing flood hazard mitigation activities in ways that not only protect people and property from flooding threats, but also provide additional natural and societal benefits. These ancillary benefits can include increased protection of natural habitat, new recreational facilities and open space, and aesthetically pleasing design that enhance community character. To achieve the above stated goal, the District employs a Context Sensitive Flood Hazard Mitigation (CSFHM) planning and design approach.

Context sensitive refers to the relative ability of various District flood hazard mitigation activities, structural and non-structural, to complement the valued characteristics of the landscape settings in which they are placed. This ability is influenced by the visual characteristics, scale and magnitude of landscape modification typically associated with each structure type and structural method. Activities that preserve or mimic the dominant characteristics within a given landscape setting are more likely to be considered context sensitive and a valued component of the community.

The District routinely undertakes a land and resource assessment designed to help identify the valued resource characteristics of the landscape settings found in Maricopa County, including the natural resources that perform the beneficial functions of floodplains. This information is intended to be utilized by the District, other agencies and local communities to assist in identifying preferred management strategies for floodplains in Maricopa County. This information is also intended to be utilized as a tool to assist in “designing” implementation of floodplain management strategies to achieve context sensitivity with the landscape settings of Maricopa County and protect, maintain or restore the natural resources of floodplains.

Floodplain management strategies that entail development of flood control structures and/or modifications of landforms, vegetation and drainage features, by their nature, have the potential to either positively or negatively affect the quality of the natural and human-built environments in Maricopa County. These effects depend largely upon the extent to which these solutions are designed to be “context sensitive” with the valued characteristics of the settings in which they are located. Context-sensitivity is influenced by structure type, structure method and landscape design theme.

The District routinely considers and evaluates a variety of different structural solution “types” as a part of the planning and design of flood control projects. These solutions may include underground pipes, storm water conveyance channels, channel levees, storage basins, flood retarding structures, and dams.

The District also considers and evaluates a variety of structural “methods” as ways of implementing structural solutions. These “methods” can include a variety of different structural materials and forms that may be applied to a particular structural solution. Materials usage can range from “soft” (typically earthen structures) to “hard” (concrete or soil cement), while the overall form of these structures can range from organic to geometric configurations.

Additionally, the District has the ability to apply a variety of landscape design “themes” to flood control structures to support a desired multiple-use emphasis and complement the visual character of the landscape setting. These landscape design themes can range from those that are influenced predominantly by the characteristics of natural landscape settings, to those

that are influenced primarily by the characteristics of human-built landscape settings or those that may be influenced by combinations of both. The structure type, structural method and the landscape design theme that is applied to structural solutions has a major influence upon the ability of that solution to protect the valued characteristics and achieve context sensitivity with the landscape settings in Maricopa County.

Need for a Context Sensitive Flood Hazard Mitigation Approach

Urban and suburban growth in Maricopa County has led to increased public demand for the District to provide flood protection for the citizens of Maricopa County in ways that: 1) Complement and enhance the landscape settings in Maricopa County; 2) Create added value by providing year round opportunities for multiple uses; and 3) Protect the natural resources of floodplains and their beneficial functions. The District recognizes that these solutions are essential to maintaining continued public support and partnerships for the District's mission, programs, and activities. The CSFHM approach is a tool designed to assist the District in responding to these challenges.

District authority, direction, and responsibility for responding to the above public issues can be found in: federal laws, executive orders, regulations, and programs; state laws and executive orders; and county and District regulations, policies, mission and vision statements that govern District activities. The following is intended as a brief summary and overview of established District authority and direction related to these issues.

Federal Laws, Regulations, and Programs

The Floodplain Management Act of 1977 requires federal agencies, among other things, to restore and preserve the natural resources served by floodplains. The President of the United States, via Executive Order 11988, 1977, in furtherance of the National Environmental Policy Act of 1969, the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, directed federal agencies to provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out their responsibilities.

According to FEMA, "floodplain lands and adjacent water combine to form a complex, dynamic physical and biological system found nowhere else. When portions of floodplains are preserved in their natural state, or restored to it, they provide many benefits to both human and natural systems."¹ The natural and beneficial functions served by floodplains, as identified by the Federal Emergency Management Agency (FEMA) in the afore-referenced document, include: flood water storage and conveyance, erosion control, sediment reduction, flow velocity reduction, flood peak control, water quality filtering, water temperature moderation, groundwater recharge, enhancement of biological productivity, biodiversity and ecosystem integrity, habitat for fish and wildlife, breeding ground for wildlife, production of wild and cultivated agricultural products, provision of open space, opportunities for solitude, hiking and other forms of outdoor recreation, opportunities for viewing and enjoying the scenic landscapes and aesthetic beauty of floodplains, and opportunities for scientific study, outdoor education and study of environmental and cultural resources.

¹ National Flood Insurance Program (NFIP), Floodplain Management Requirements, A Study Guide and Desk Reference for Local Officials, FEMA 480, February, 2005, 1-16

The National Flood Insurance Program (NFIP), established in 1968, promotes the protection of the natural and beneficial functions served by flood plains through the establishment of a Community Rating System (CRS) that provides incentives, in the form of substantial reductions in flood insurance premiums, to communities that, for example, establish setbacks that prevent disruption to stream channels and/or preserve natural floodplain areas as open space. Federal community guidelines for protecting floodplain resources outline a planning process that includes an inventory and analysis of land use and environmental concerns².

Arizona State Law

Under the Arizona Revised Statutes, flood control districts may implement flood control enhancement solutions including preservation and restoration of floodplains and, thereby, protect the natural and beneficial functions served by floodplains³.

County Floodplain Regulations

The purpose of the Floodplain Regulations for Maricopa County is to promote and protect the health, peace, safety, comfort, convenience, and general welfare of the residents within Maricopa County⁴. One of the intents of the Board of Directors of the District, as stated in the Regulations, is to protect the natural and beneficial functions of the floodplains. As defined in the Regulations, the natural and beneficial functions of floodplains includes, but is not limited to, the following: natural flood and sediment storage and conveyance, water quality maintenance, groundwater recharge, biological productivity, fish and wildlife habitat, harvest of natural and agricultural products, recreation opportunities, and areas for scientific study and outdoor education.

District Aesthetic Treatment Policy

The District's Board-approved Policy for the Aesthetic Treatment and Landscaping of Flood Control Projects (Policy), dated December 16, 1992, was developed in response to increased public concern for preserving the visual beauty and other aesthetic qualities of the urban, rural, and natural settings in Maricopa County. The Policy was developed as part of a continuing effort by the District to improve the appearance of flood control projects. The primary objective of the Policy is for flood control projects to be planned and designed to protect the visual and cultural values at the project site and the surrounding area to the greatest extent practicable. The Policy contains guidelines for aesthetic treatment of flood control structures, acquisition of rights-of-way for incorporating aesthetic features and cost-ceiling guides for expenditure of funds for such treatments. The latter vary according to structure type and the landscape setting (urban, suburban and rural) for location of the structure. The Policy authorizes the retrofit of existing structures that do not contain aesthetic features, at the discretion of the Chief Engineer. The Policy also establishes a Project Aesthetics Advisory Committee, as a mechanism for promoting input and review from cost-share partners, local jurisdictions and citizens regarding aesthetic considerations in the planning and design of structural solutions. The Policy directs the District to coordinate and cooperate with pertinent jurisdictional agencies. The Policy encourages multi-purpose uses of flood control projects that

² Protecting Floodplain Resources, A Guidebook for Communities, Federal Interagency Floodplain Management Task Force, 2nd Edition, June 1966

³ ARS 48-3603.20

⁴ Floodplain Regulations for Maricopa County, FCDMC 2006 Revision, Article 1, Section 102, Flood Control District of Maricopa County

are compatible with the purpose, operation and maintenance of the project and authorizes use of District funds for modification of flood control features to make them more suitable for multi-purpose uses.

District Mission, Vision, and Pledge

The District mission, vision and pledge outline the main program areas of the District and reflect its core purpose, values and public service commitment to provide for the health, safety and welfare of the public. The mission, vision and pledge of the District are as follows.

- The mission of the Flood Control District of Maricopa County is to provide regional flood hazard identification, regulation, remediation, and education to Maricopa County residents so that they can reduce their risks of injury, death, and property damage from flooding, while still enjoying the natural and beneficial values served by floodplains.
- The District's vision is for the residents of Maricopa County and future generations to have the maximum level of protection from the effects of flooding through fiscally responsible flood control actions and multi-use facilities that complement and enhance the beauty of our desert environment.
- The District pledges to be responsive to our clients in an efficient, effective, and fiscally responsible manner. We will show personal integrity and professionalism in all our actions, and display continuous improvement, innovative thinking, and technical expertise. We will be stewards of the environment and the public's trust, and we will be concerned about the effects of our actions on not only the current, but also future generations.

District Land and Resource Goals and Objectives

The land and resource goals and objectives contained in this section were developed by the Landscape Planning Branch of the District. The goals and objectives are intended to serve as general guidance for carrying out the direction contained in the preceding section. These goals and objectives are provided to help define desired results for context sensitive flood hazard mitigation solutions and protection of the natural resources of floodplains and their beneficial functions as an integral part of the development of flood hazard mitigation planning studies and project designs. They also are intended to help focus the collection and analysis of resource data, the scope of alternatives development and establish a frame of reference for measuring and evaluating the performance of alternative solutions with regard to achievement of context sensitivity and protection of the natural resources of floodplains and their beneficial functions.

Scenery Resources

The goal of the District for protection of scenery resources in Maricopa County is to implement floodplain management strategies and flood protection solutions in ways that preserve, complement and/or enhance the visual beauty and other aesthetic qualities of the urban, rural and natural settings in Maricopa County. Project objectives related to the achievement of this goal are to:

- Preserve and complement the visual character of natural, rural, suburban and urban landscape settings of Maricopa County

- Retain and preserve distinctive natural and cultural landscape features and areas
- Maintain and enhance the traditional viewsapes of the Sonoran Desert, including opportunities for public viewing of mountains, uplands, washes and other scenic landscape features of Maricopa County
- Utilize flood control projects to improve and restore landscapes with visual disturbances to a condition that is complementary to the valued character of the surrounding landscape

Recreation Resources

The District's recreation goal is to promote recreation multiple-uses of its properties and partnerships with the Parks and Recreation Department of Maricopa County and local communities to assist in meeting public needs for parks and recreation in Maricopa County, to the extent that such uses do not compromise the flood control function, operation and maintenance of those facilities. Project objectives related to the achievement of this goal include planning and designing flood control solutions to:

- Preserve and complement the desired character and recreation experience of existing parks and recreation areas within Maricopa County
- Maximize opportunities to meet regional and local community needs for passive and active recreation uses
- Maximize opportunities to implement the Maricopa Regional Trail Master Plan and meet local community needs for trails

Open Spaces Resources

The District's open spaces goal is to promote the uses of its properties to assist in meeting public and local community needs for open space preservation in Maricopa County. Project objectives related to the achievement of this goal include planning and designing flood control solutions to:

- Achieve consistency with and assist in the implementation of the Maricopa Association of Governments' Desert Spaces Plan
- Achieve consistency with the goals and objectives of local community general plan open space elements

Biological Resources

The District's biological resources goal is to actively contribute to the preservation and enhancement of wildlife habitats and corridors in Maricopa County. Project scale objectives related to the achievement of this goal include flood hazard mitigation solutions that:

- Incorporate wildlife usage and movement into design of flood control facilities, when feasible
- Preserve integrity of existing habitat patches and corridors

Cultural Resources

The District's cultural resources goal is to minimize negative impacts to valued cultural resources known to be present or discovered during planning, design, construction, or maintenance of District facilities. Project scale objectives related to the achievement of the goal include solutions that:

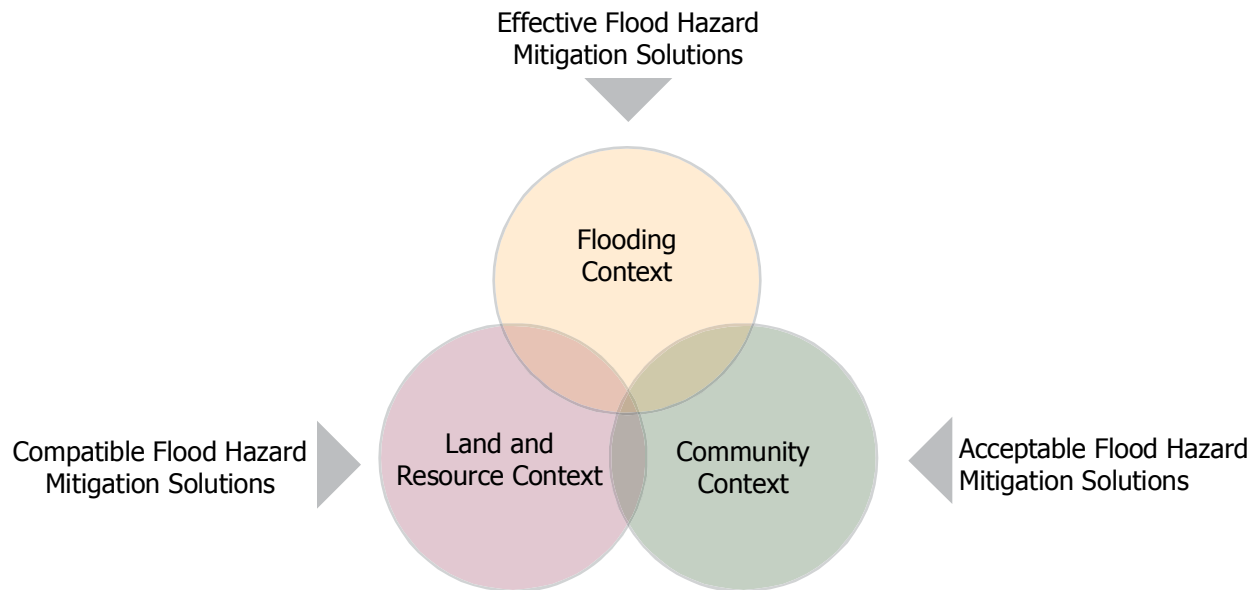
- Avoid disturbance to culturally significant resources
- Incorporate significant cultural periods into design themes
- Identify opportunities to incorporate cultural resources in interpretive opportunities

Application of the Context Sensitive Flood Hazard Mitigation Approach

The District utilizes a Context Sensitive Flood Hazard Mitigation (CSFHM) model to guide planning and design activities with the overall goal of implementing flood hazard mitigation solutions that complement and enhance the valued characteristics of the landscapes in which these solutions are placed. The process of formulating context sensitive solutions involves innovative and inclusive approaches that integrate community, aesthetic, historic, and environmental values with public safety, maintenance and performance goals. Context sensitive solutions are reached through a collaborative, interdisciplinary approach involving planning team members, stakeholders and concerned citizens.

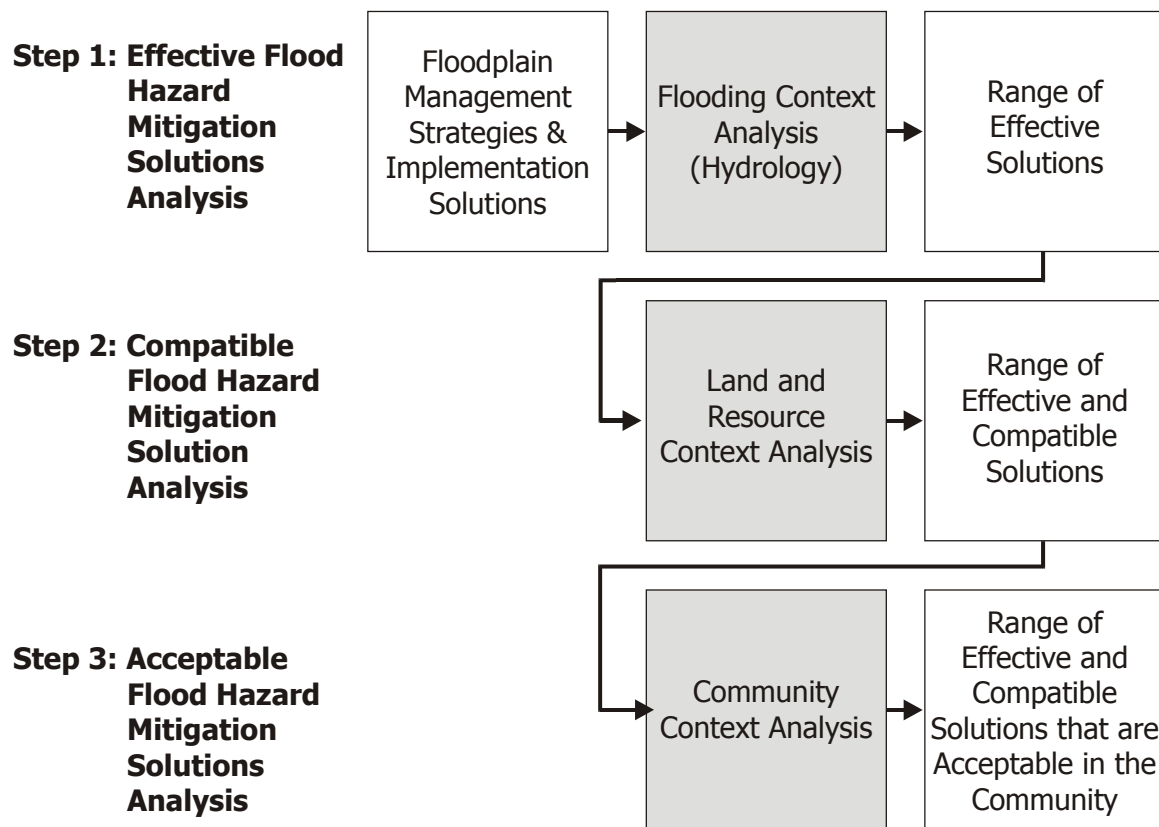
The CSFHM approach involves defining the Flooding, Land and Resource and Community Contexts. The Community Context is defined through public and stakeholder sensing and input. The Land and Resource Context is defined by an assessment of the visual, recreation, open space, biological and cultural resource environments. The Flood Hazard Context is defined through an assessment of flooding types, degree of risk and identification of performance requirements. Then, context sensitive solutions can be explored within the interface between these contexts. The application of the CSFHM model (Figure 1) is intended to formulate solutions within the "sweet spot" between three contexts: Flooding, Land and Resource, and Community.

Figure 1 - Context Sensitive Flood Hazard Mitigation Model



The CSFHM process (Figure 2) starts with an analysis of the Flooding Context that narrows a list of all possible flood mitigation solutions to the most effective solutions based on flooding types and degree of risk. The second step involves an analysis of the Land and Resource Context, in which the range of effective solutions is refined to those solutions that are also compatible with the surrounding landscape and resources. The third step involves the analysis of the Community Context that further refines the range of effective and compatible solutions to those that are acceptable to the community. The ideal Context Sensitive Flood Hazard Mitigation solutions are those that are effective in providing public safety, compatible with landscape resources and acceptable to the citizens of Maricopa County. These ideal solutions are within the interface of the three contexts.

Figure 2. Context Sensitive Flood Hazard Mitigation Process



The application of the CSFHM process serves as an effective means for focusing the efforts of planning and design teams to optimize the achievement of the goal of implementing flood hazard mitigation activities in way that not only protect people and property from flooding threats, but also provides additional natural and societal benefits. The Landscape Inventory and Analysis of Maricopa County, developed by the Landscape Planning Program, contains additional information and guidelines about the application of the Context Sensitive Flood Hazard Mitigation process.

Although the CSFHM approach has been developed specifically for application to flood hazard mitigation solutions for the Flood Control District of Maricopa County, it nevertheless lends itself to possible application to the functional activities of other state, county or local organizations. The District's context sensitive planning and design approach is functionally neutral and can be modified to provide an understanding of the context for virtually any proposed land use activity within Maricopa County where public concern for protecting the valued characteristics of the landscape settings in Maricopa County is an important issue.