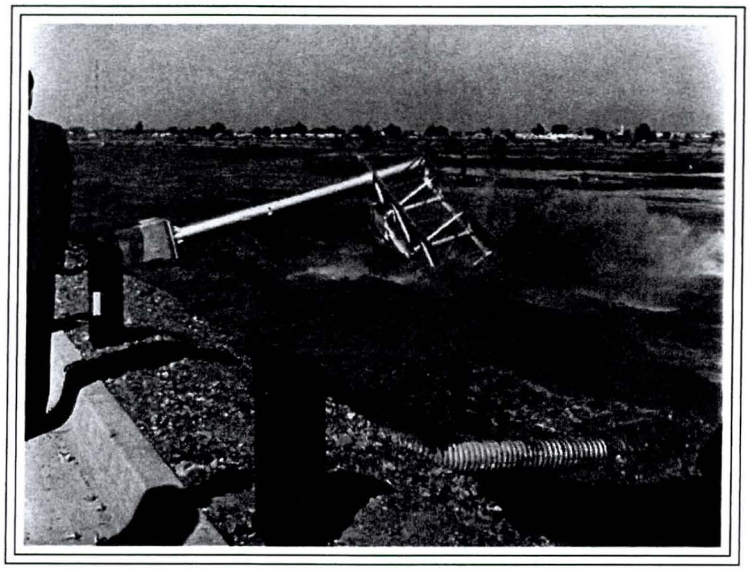
COMPREHENSIVE FLOODPLAIN MANAGEMENT PLAN AND PROGRAM REPORT



PREPARED BY THE

FLOOD CONTROL DISTRICT

OF

MARICOPA COUNTY, ARIZONA

2009

COMPREHENSIVE FLOODPLAIN MANAGEMENT PLAN AND PROGRAM REPORT

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Flood Control District of Maricopa County
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Phoenix, Arizona 85009
(602) 506-1501
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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

Board of Directors
Max Wilson, District 4, Chairman
Fulton Brock, District 1
Don Stapley, District 2
Andrew Kunasek, District 3
Mary Rose Wilcox, District 5

Flood Control Advisory Board
Hemant Patel, Chairman
Kent Cooper, Vice Chairman
Scott Ward, Secretary
DeWayne Justice
Melvin Martin
Wylie Bearup, Ex Officio
Paul Cherrington, Ex Officio

County Chief Administrative Officer
David Smith

Chief Engineer and General Manager
Timothy S. Phillips, P.E.

Comprehensive Plan Project Manager
Jennifer Pokorski, AICP, CFM

Comprehensive Plan Team
Steve Bruffy
Cade Furnas
Michael Gease, CFM
Jon Loxley
Theresa Pinto, CFM
Samantha Samples
Diane Smith
Jim Smith
Douglas Williams, AICP

OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
HELEN PURCELL
2009-0959343 10/16/09 12:36 PM
1 OF 2
JESSICAC

When Recorded Return to:
Contracts Branch
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009-6399

RESOLUTION FCD 2009R010

2009 COMPREHENSIVE FLOODPLAIN MANAGEMENT PLAN AND PROGRAM

Agenda Item: C-69-10-015-6-00

WHEREAS, the Chief Engineer and General Manager of the Flood Control District of Maricopa County (District) is required under Arizona Revised Statutes (ARS) §48-3616 to prepare or have prepared a report for a comprehensive program of flood hazard mitigation describing existing flood control facilities and identifying work proposed to eliminate or minimize flood control problems within Maricopa County; and,

WHEREAS, under ARS §48-3616, the District is required to update this comprehensive program at least every five years; and,

WHEREAS, the Board of Directors of the District on November 2, 2005 adopted Resolution FCD 2005R011 (C-69-06-020-6-00) for the "Comprehensive Plan 2005 – Flood Control Program Report" (Plan 2005); and,

WHEREAS, the "2009 Comprehensive Floodplain Management Plan and Program" (Plan) is an update to Plan 2005, and has been prepared based on information from the District's Capital Improvement Program, Area Drainage Master Studies/Plans, Floodplain Delineation Studies, and other District reports to identify work proposed or completed to eliminate or minimize flooding problems in Maricopa County; and,

WHEREAS, the Plan also serves as the floodplain management plan for unincorporated Maricopa County as required by the National Flood Insurance Program Community Rating System, Section 510; and,

WHEREAS, the residents of Maricopa County can continue to receive reduced flood insurance premium rates as part of the National Flood Insurance Program Community Rating System if the Plan is adopted by the District's Board of Directors; and,

WHEREAS, the Plan has been made available to the public, other jurisdictions and agencies for their review and comment; and,

WHEREAS, the Board of Directors of the District has held a public hearing as required under ARS §48-3616; and,

WHEREAS, the Flood Control Advisory Board of the District endorsed the Plan on June 24, 2009, recommending to the Board of Directors of the District that the Plan be adopted.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the District approve and adopt the "2009 Comprehensive Floodplain Management Plan and Program"; and,

BE IT FURTHER RESOLVED that the Chief Engineer and General Manager of the District is authorized and directed to forward the adopted Plan to the Federal Emergency Management Agency National Flood Insurance Program and provide copies of the Plan to local communities and other interested agencies and entities.

Dated this 7th day of October, 2009

Mary W Wilson
Chairman, Board of Directors

ATTEST:

Fran McCarroll
Clerk of the Board

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.

Table of Contents

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:

- 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.

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

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.

- 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.

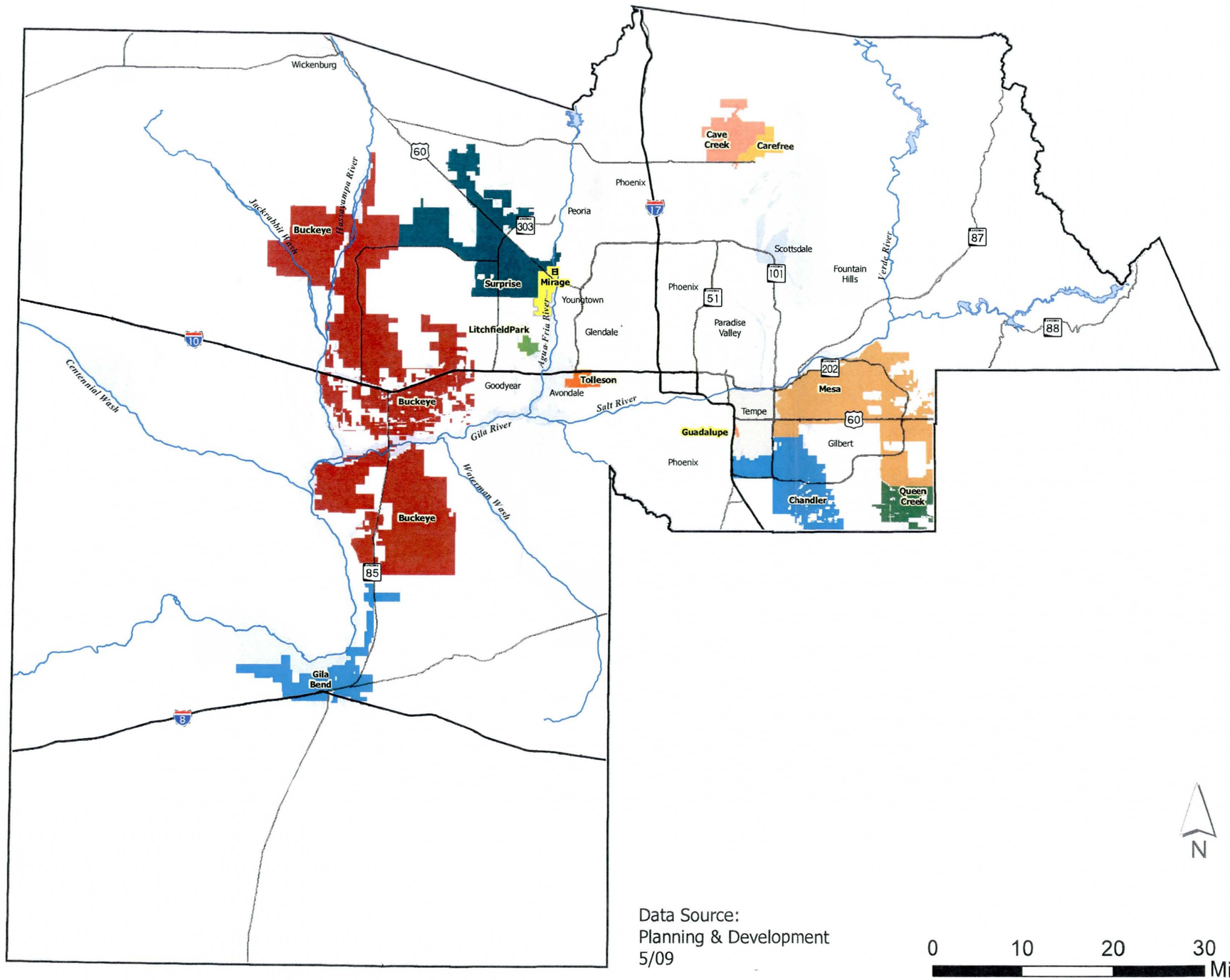
Future of Flood Control

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.

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

N

Data Source:
Planning & Development
5/09

0 10 20 30 Miles

Flood Control District of Maricopa County

\\Fcdspb\Collaborate\CompPlan09\Map1-2.mxd 03/2009

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 county[1]. To commemorate the 50th Anniversary of the District, this chapter provides an overview of key milestones and events in the District's history.

Fifty Years of Flood Control Outline

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

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.

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 issues[2]."

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.

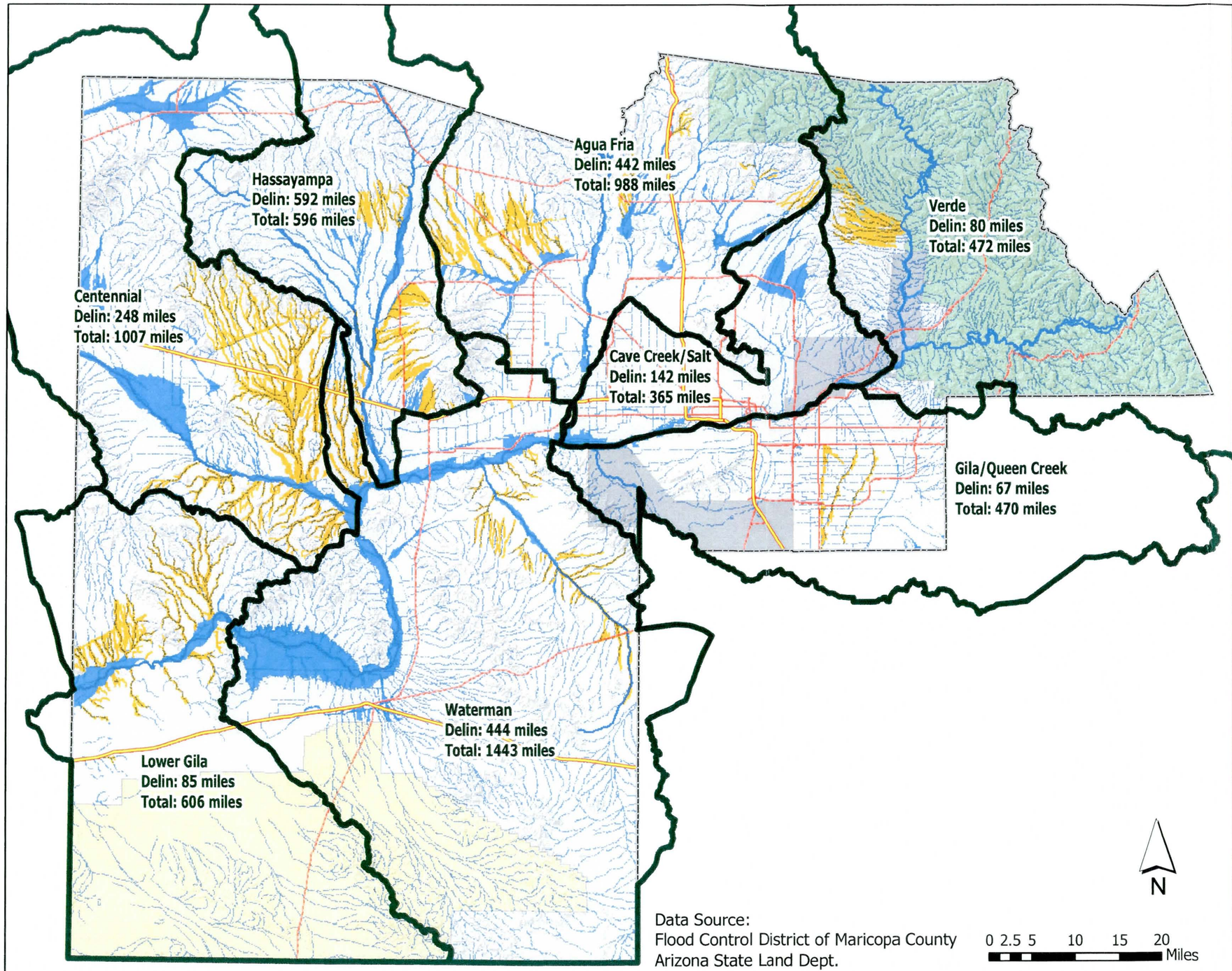
The resulting FPIC plan in 1958 detailed the process for the formation of the District and, in the interim, the Maricopa County Flood Control Agency. The Maricopa County Flood Control Agency began drafting legislation to allow the creation of flood control districts. On March 23, 1959 Arizona Governor 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 Report[3].

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

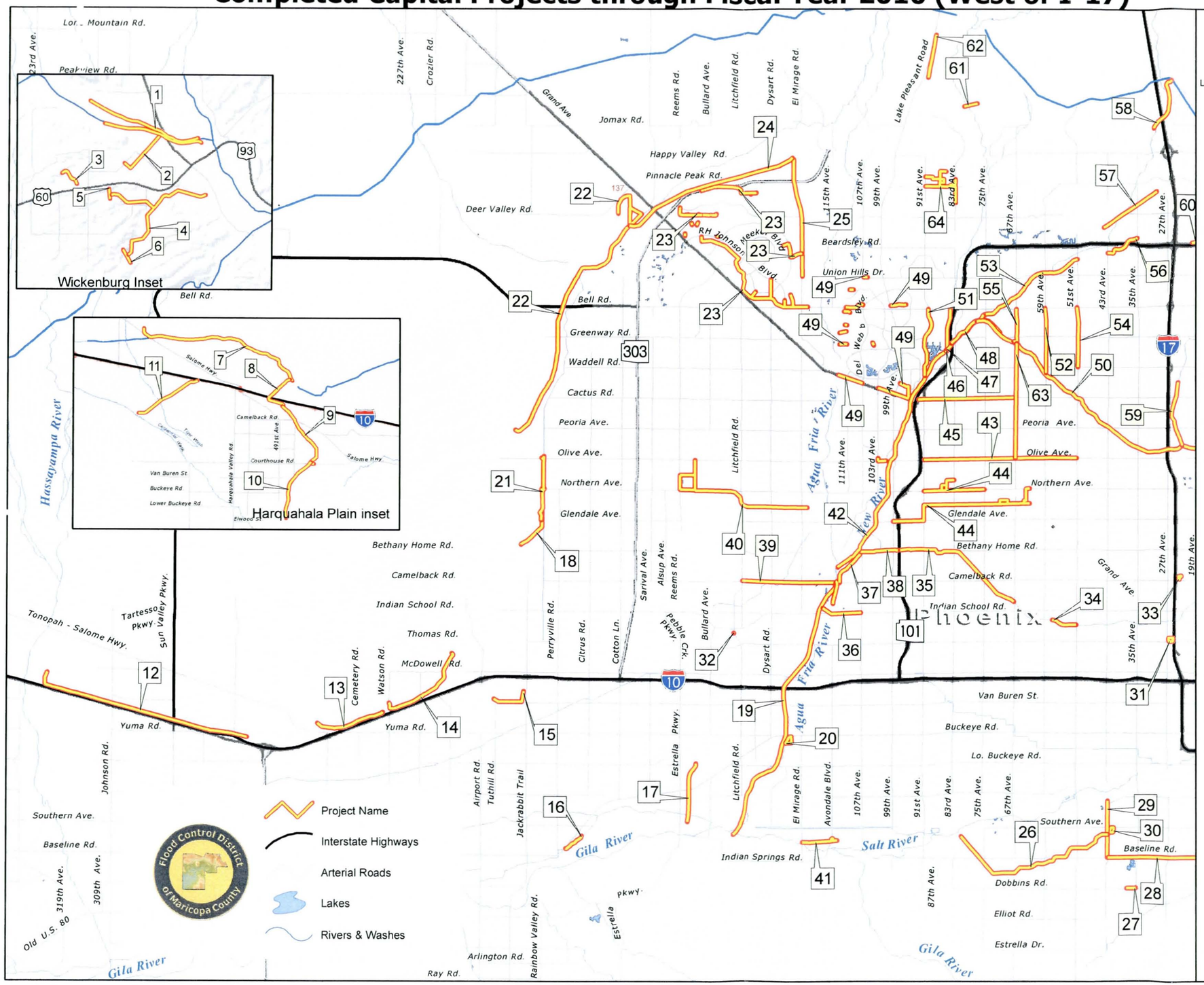
N

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 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

0 1 2 3 Miles

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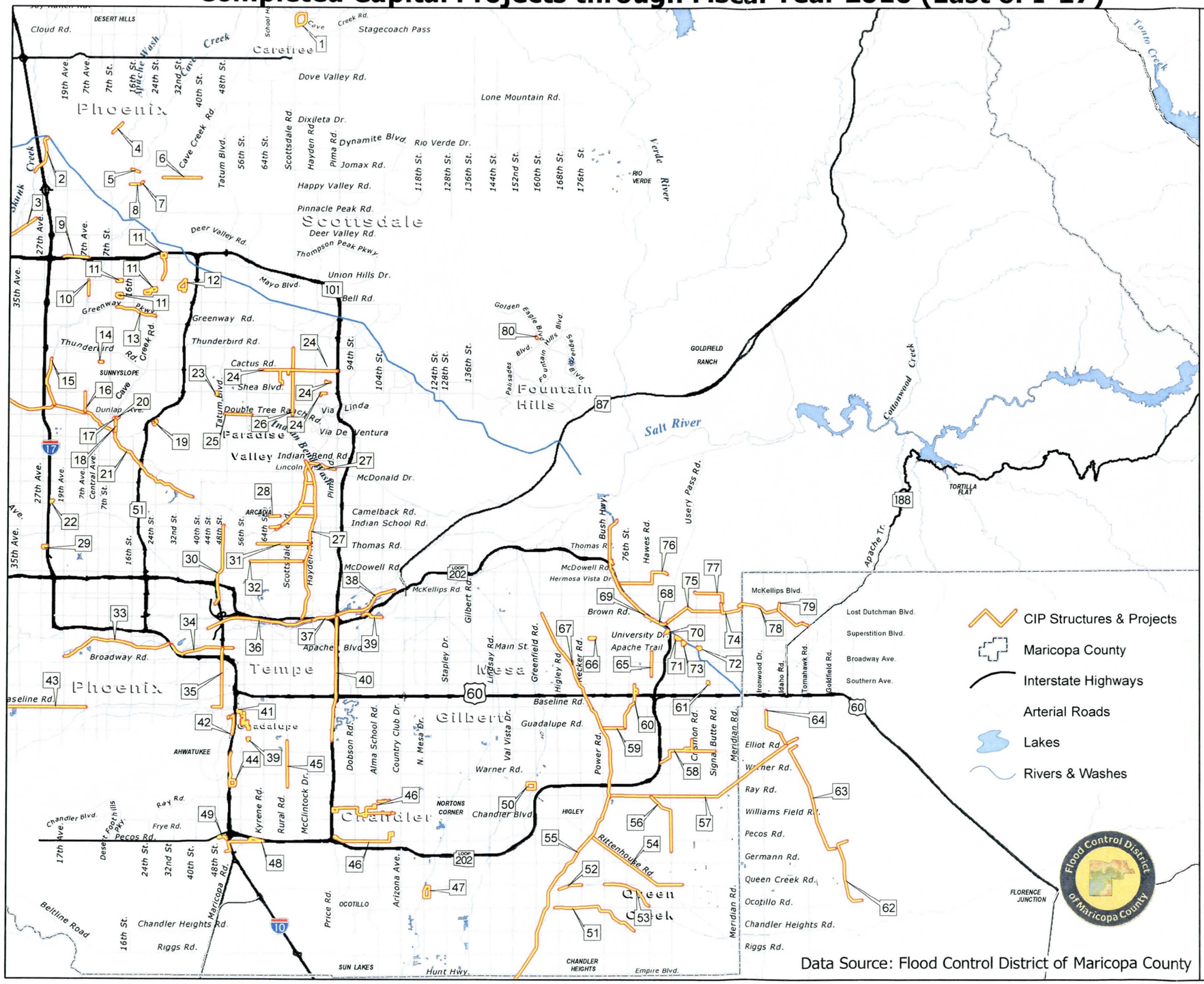
Completed Capital Projects through Fiscal Year 2010 (East of I-17)

Map 2-3



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	Beardsley 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 (Emilta 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

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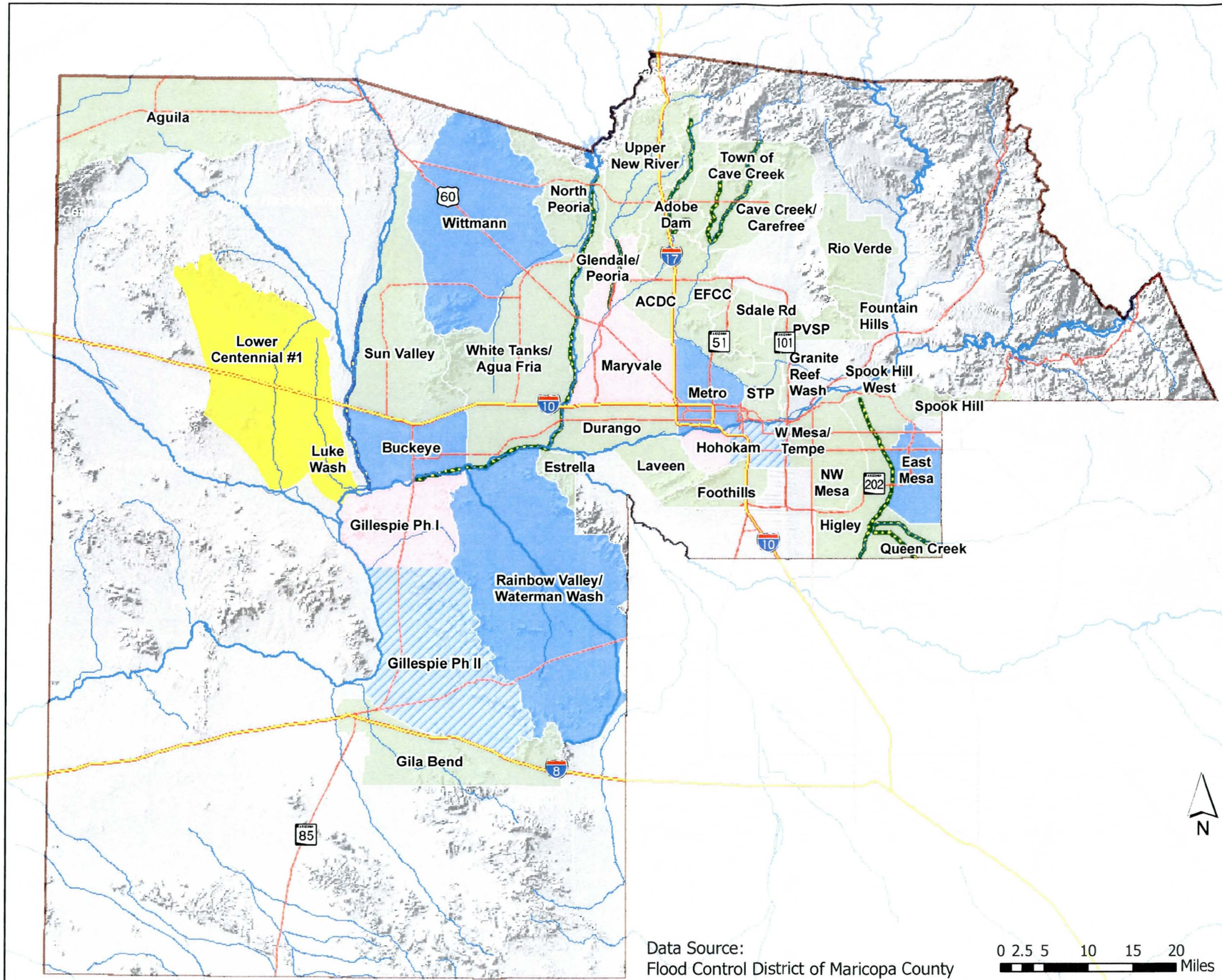
Status of Master Plans & Studies

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

0 2.5 5 10 15 20 Miles

N

Revised: 9 January 2009

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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 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.

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

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 statutes[1]. 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 Programs[3]

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-structural[4] 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.

- 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.

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 March1959.

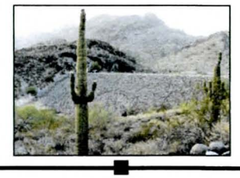
1963
The first Comprehensive Flood Control Program Report is adopted by the County Board of Supervisors.

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.

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 though 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-

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.

—Mrill 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

ages[1]. 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 warning[2].

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 times[3].

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 areas[4]. 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.

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

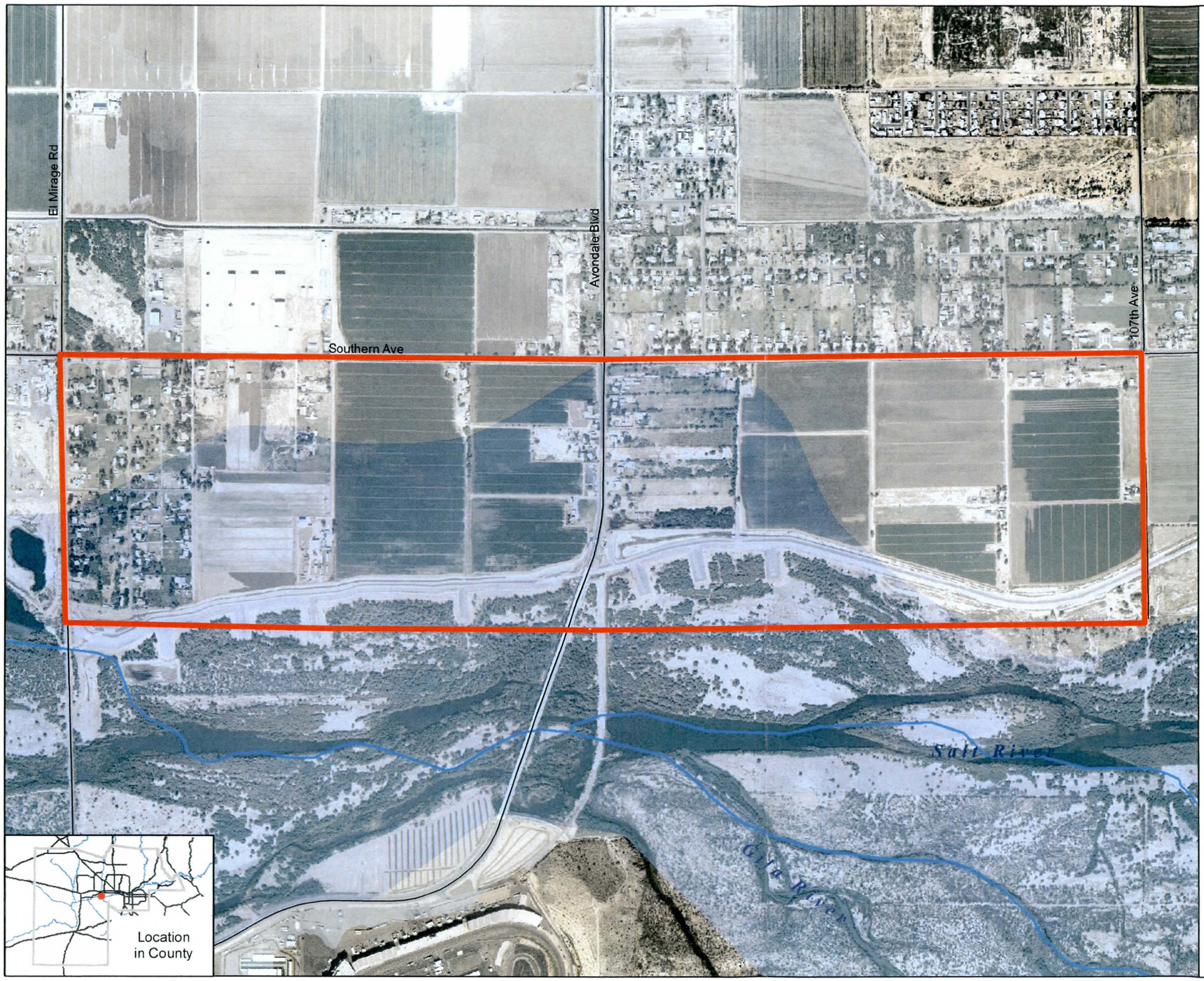
Erosion is a two-step process involving "detachment" and "mobilization." Detachment is the breaking away of particles at the surface of the soil. The rate of detachment depends upon the type of soil, the steepness and length of slope, amount and type of land cover, and external forces such as duration 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

N

Flood Control District of Maricopa County

0 1,000 2,000 Feet

May 2009

Wickenburg

Repetitive Loss Area

Map 4-2

Legend

- Repetitive Loss Area
- FEMA Floodplains

N

0 200 400 800 1,200 Feet

May 2009

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.

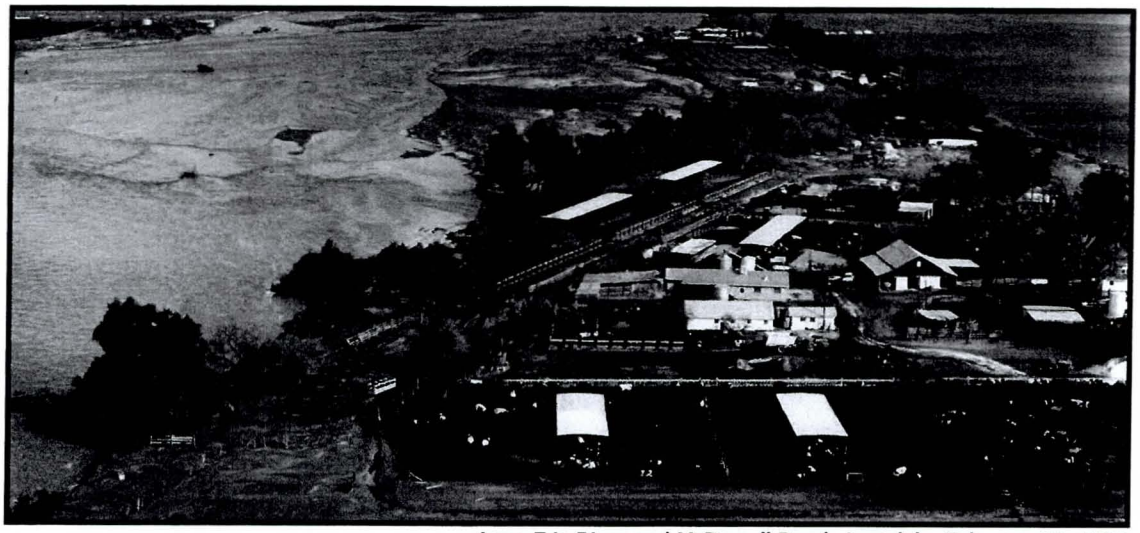
Summary

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

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

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 benefits[2]. These ancillary benefits can include increased

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

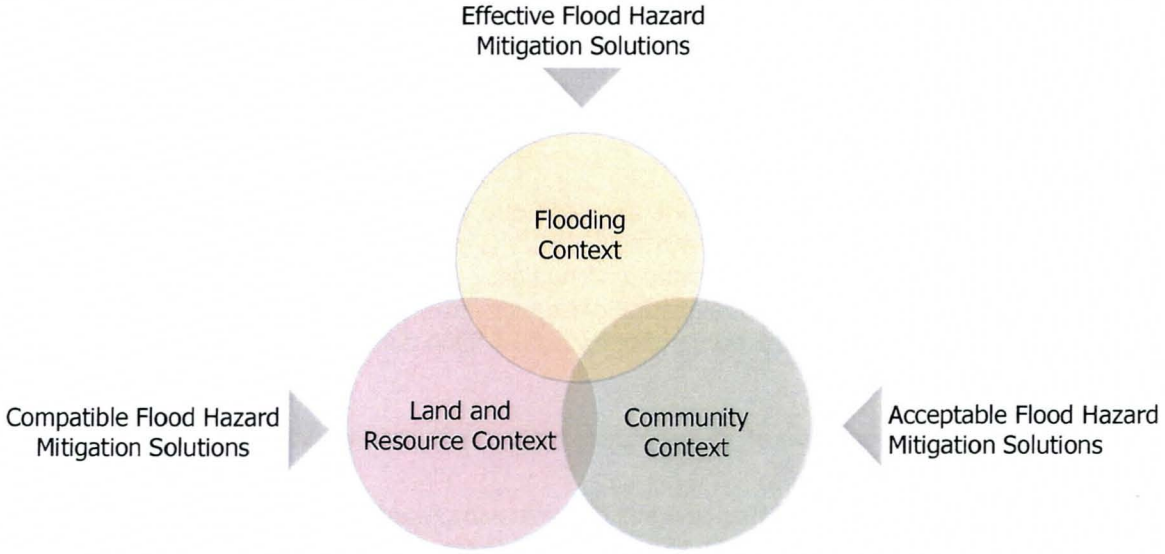
protection of natural habitat, new recreational facilities and open space, and aesthetically pleasing designs that enhance community character. To achieve the above stated secondary benefits, the District employs a Context Sensitive Flood Hazard Mitigation planning and design approach.

"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).

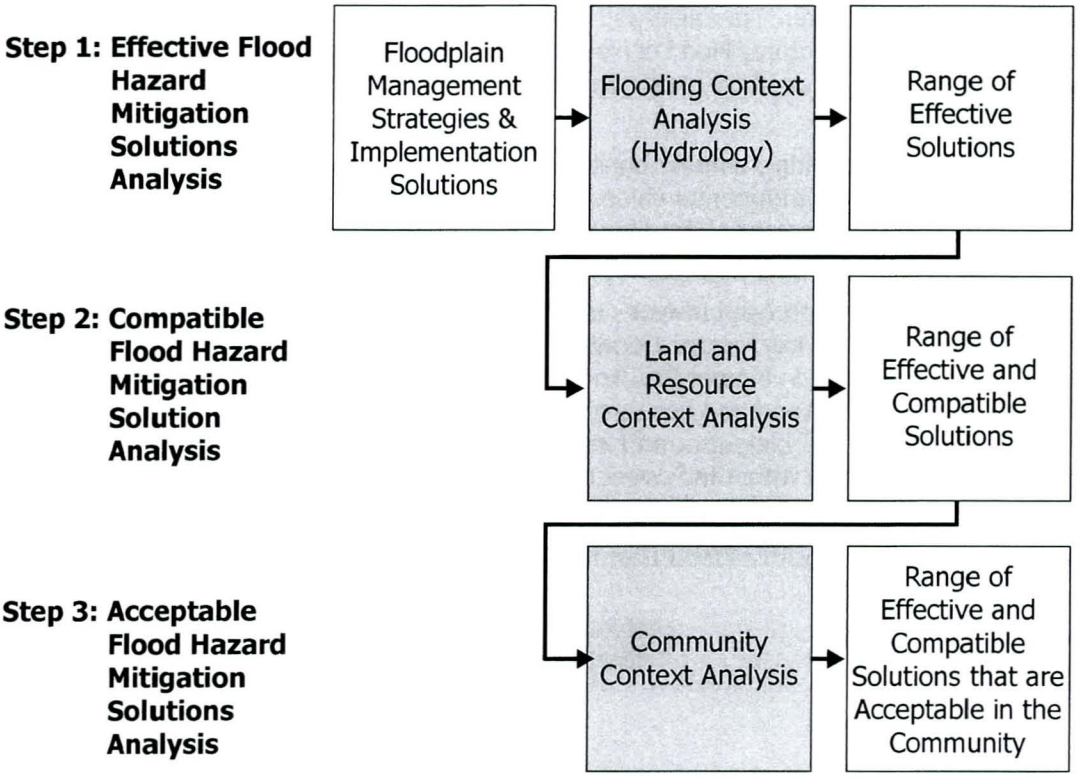
Figure 5-1: Context Sensitive Flood Hazard Mitigation Model



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:

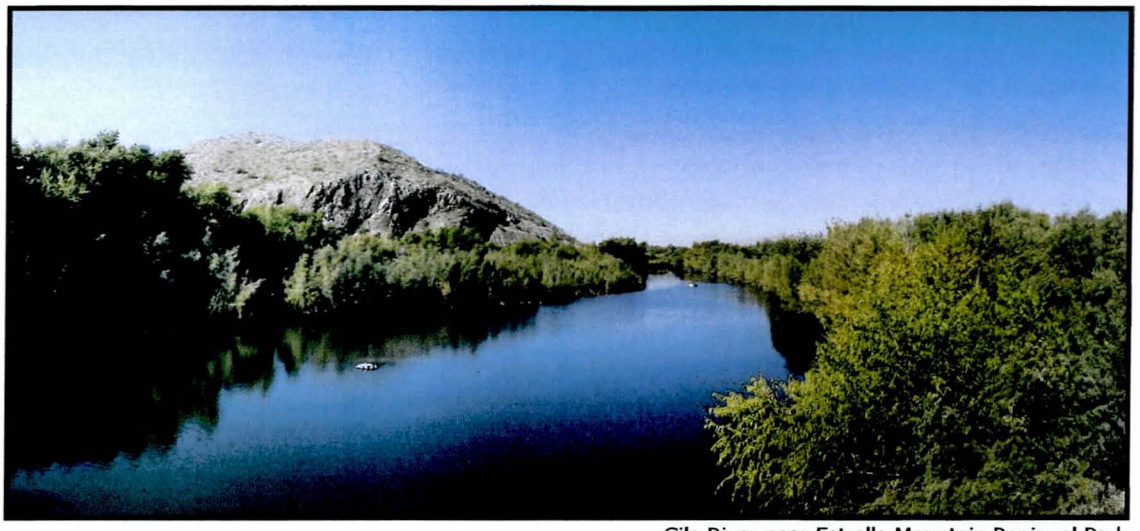
- Promotes the preservation of Sonoran Desert natural landscapes and protection of local community character;
- Authorizes expenditure of District funds for inclusion of landscaping and aesthetic features, and acquisition of right-of-way to provide for such features; and
- Promotes full integration of 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 varoius 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 benefits[3]. 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.

Natural Environment Outline

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

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

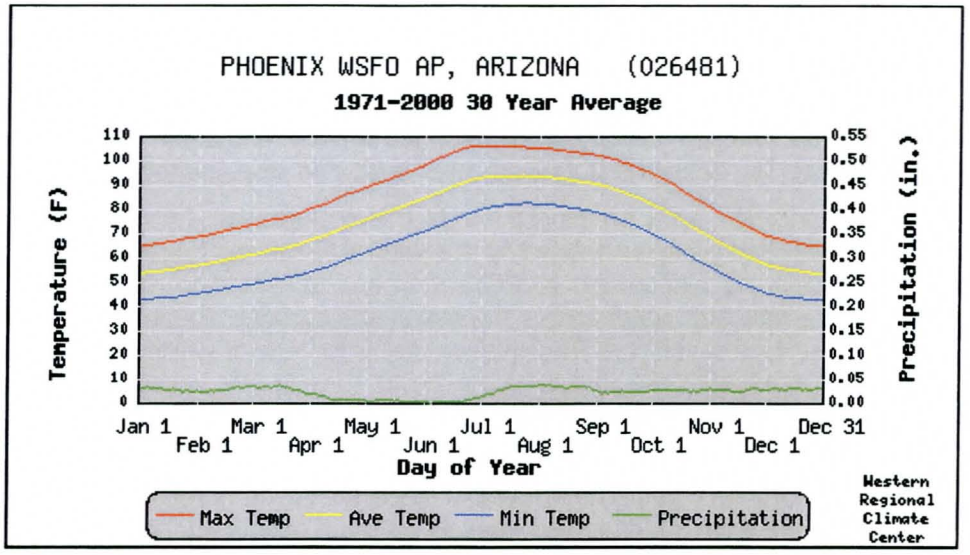
Maricopa County lies within a dry, subtropical desert climate zone. Average annual rainfall ranges from five inches in the lower elevations to over 16 inches in the higher elevations. Temperatures are high in the summer and moderate in the winter. Records kept at Phoenix Sky Harbor Airport indicate that, 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 infilitration 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

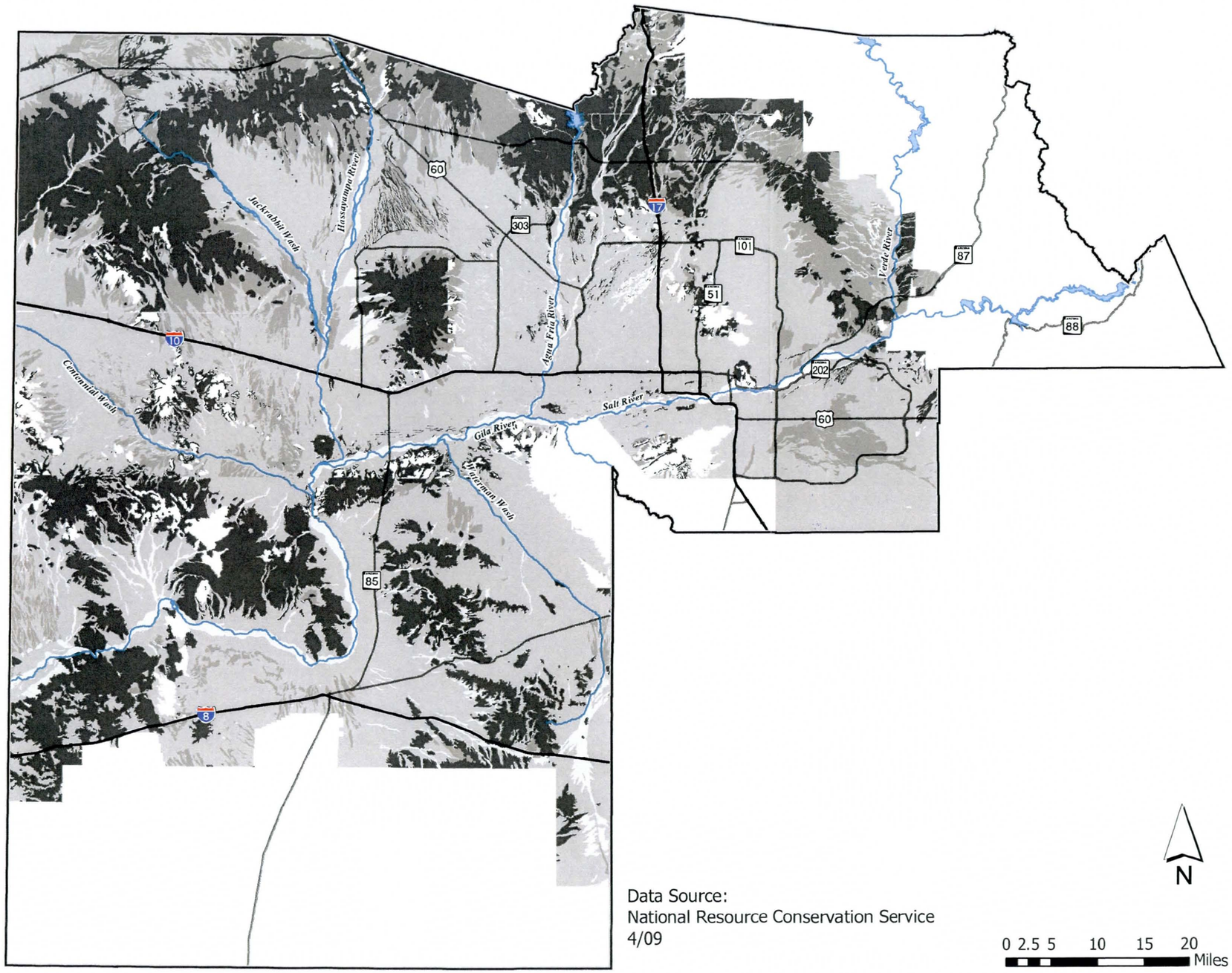
Six major watercourses flow through Maricopa County: Centennial Wash, and the Agua Fria, Gila, Hassayampa, Salt, and Verde rivers. These rivers drain an area of approximately 57,000 square miles, including areas of New Mexico and Mexico. The Agua Fria, the Hassayampa, and the Verde rivers flow from north 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



Data Source:
National Resource Conservation Service
4/09

N

0 2.5 5 10 15 20
Miles

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

Flood Control District of Maricopa County

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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 Arizona[1]

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.srnr.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 States[2]. 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 simple[3]. 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 areas[5].

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 identified[6]. 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 population[7]. 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 biodegredation. 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 health[8]." When introduced into new habitats, invasive species can quickly displace native species where

5 Lowe and Brown 1973

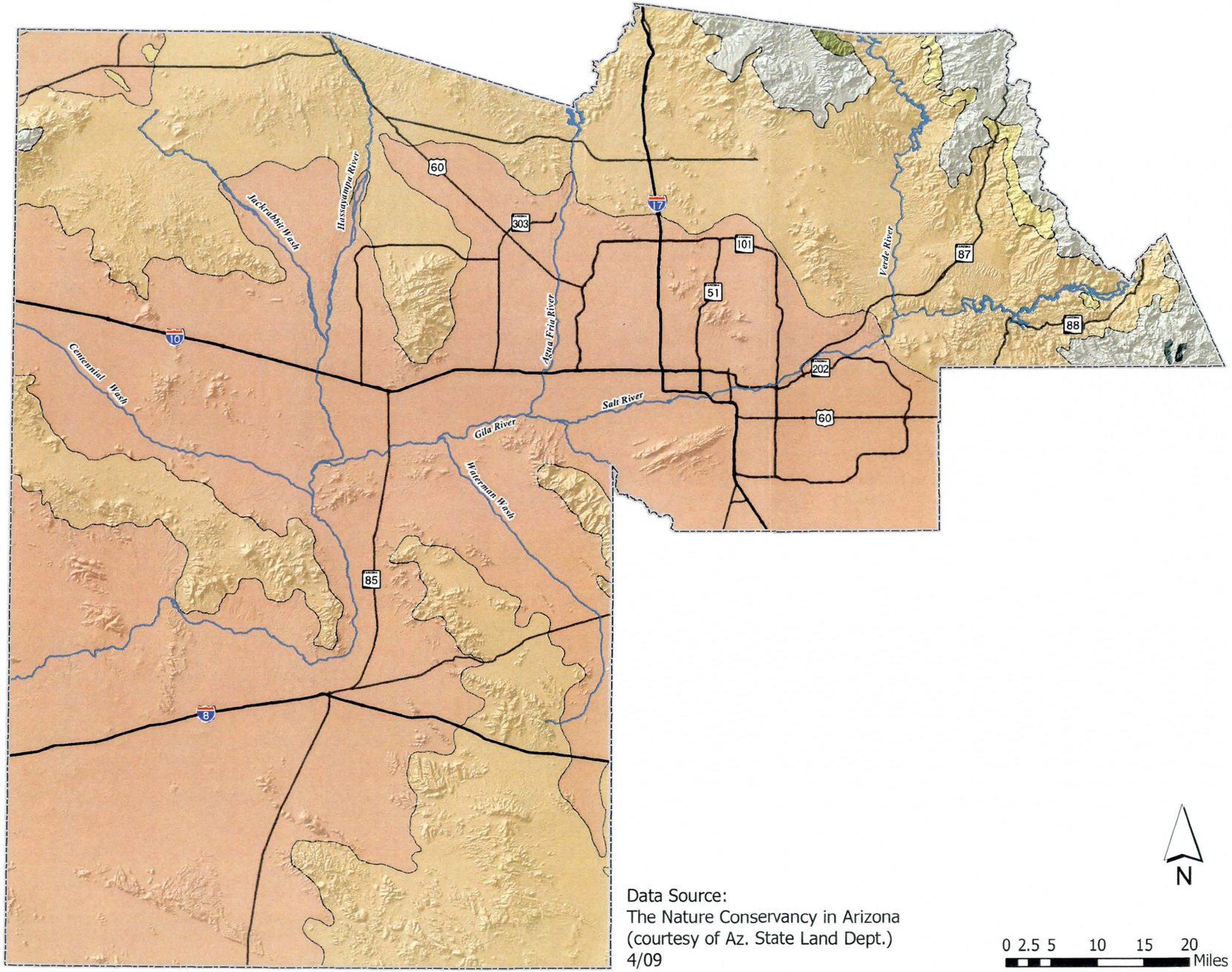
6 Arizona Riparian Council No 2 2004

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

N

0 2.5 5 10 15 20 Miles

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the invasive species' natural enemies are not present to control their growth. According to the Sonoran Institute[9], "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 Act[10]. The annual economic impact of invasive species has not been estimated for the State of Arizona; however, Pimental et al[11] 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.

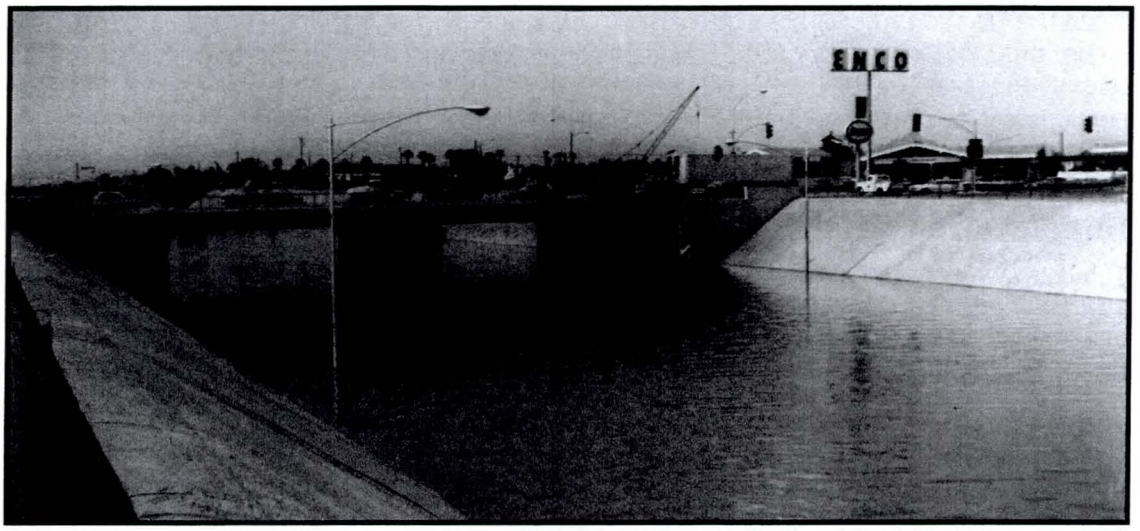
Similarly, people often do not recognize the flood hazards present in undeveloped or natural desert areas. The flood risk associated with sheet flow, alluvial fans or ephemeral washes are not evident to the average person. These areas–especially along washes or on alluvial fans –have dense vegetation 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 area[1]. 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

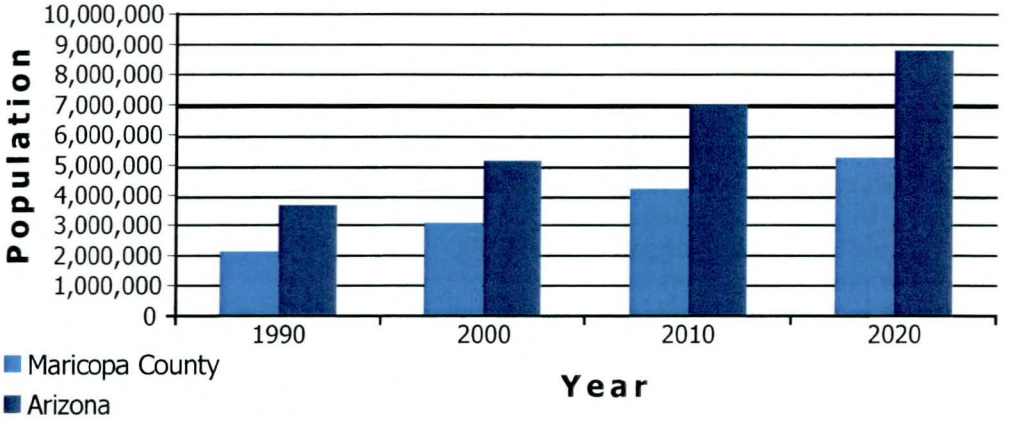
Since the District protects both the existing urban areas from flooding as well as developing areas, the District must prioritize flood control projects and programs in both contexts. This section discusses the regional development context and analyzes county-wide social and economic issues to provide 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 indicators[2].

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

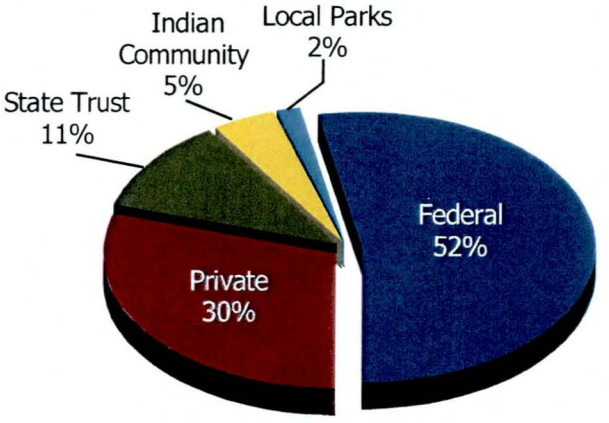
Municipal Planning Area	2005	2010	2020	Increase, 2005 to 2020	Percent Increase, 2005 to 2020
Avondale	70,160	83,856	105,989	35,829	51%
Buckeye	32,735	74,906	218,591	185,856	568%
Carefree	3,654	4,418	5,816	2,162	59%
Cave Creek	4,845	5,781	7,815	2,970	61%
Chandler	236,073	265,107	282,991	46,918	20%
County 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

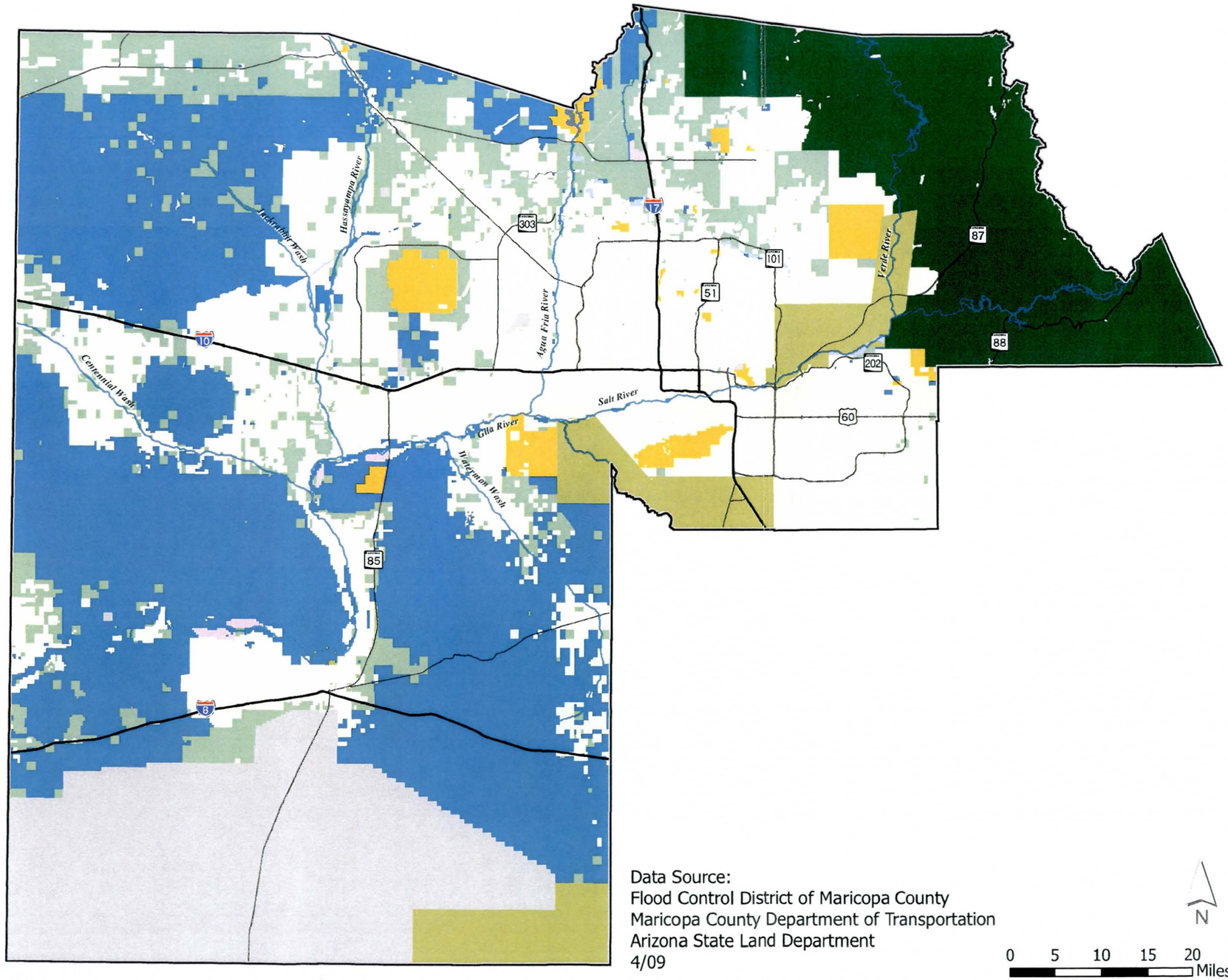
The State of Arizona controls a considerable amount of land in the county in the form of State Trust Land. Like the BLM, state trust land is used primarily for grazing but it may eventually be developed. Statewide, ranchers hold grazing leases on 93 percent of the state trust lands. Trust lands limit 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

N

0 5 10 15 20 Miles

Flood Control District of Maricopa County

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

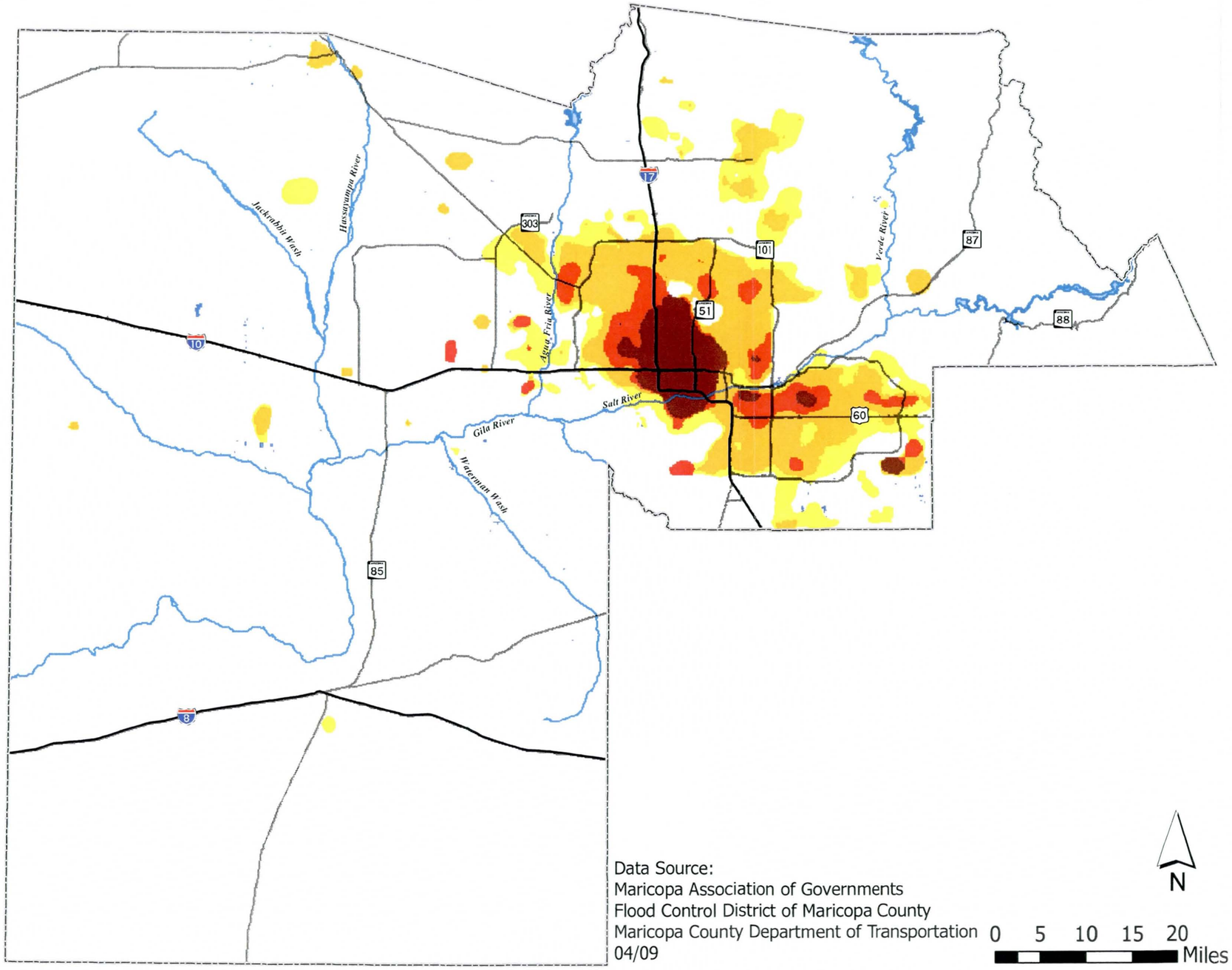
These future growth areas are forecasted to develop due to expanding transportation infrastructure and the availability of developable land. The west valley, along I-10, is likely to

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

N

0 5 10 15 20 Miles

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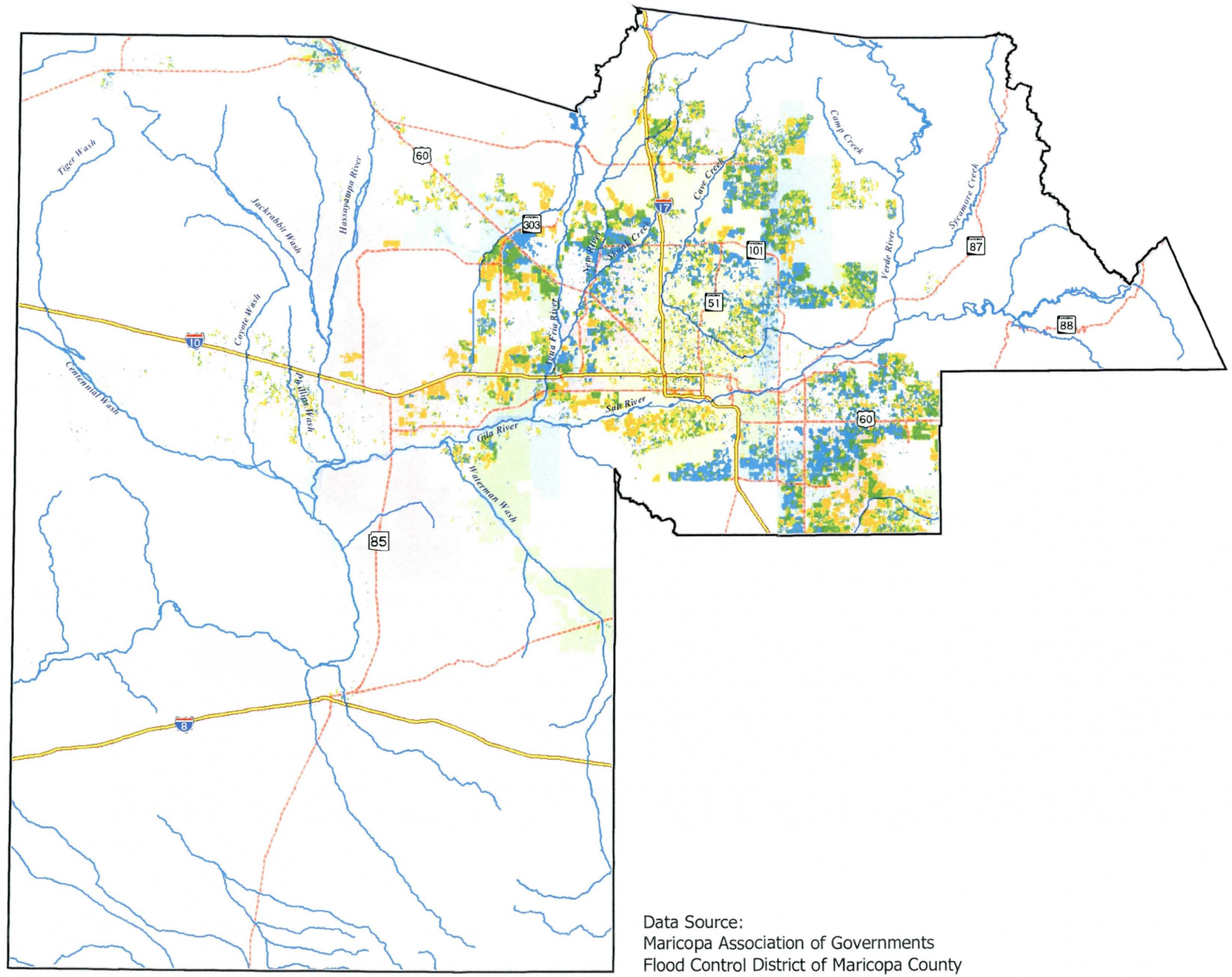
Residential Completions

Map 7-3



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

Legend

Residential Completions

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

Rivers & Washes

Interstate Highways

State Roads

FEMA Floodplains

100-year Floodplains

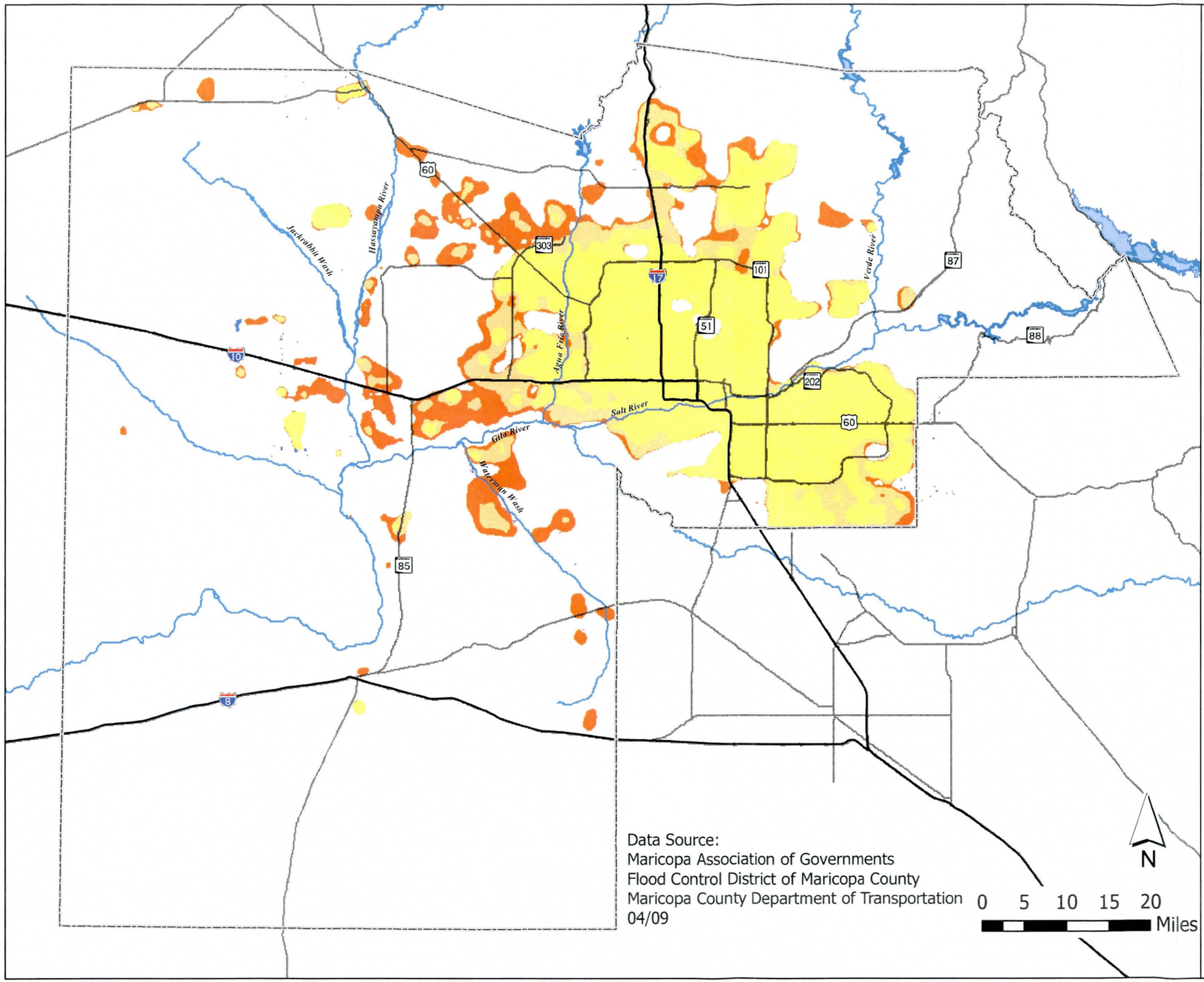
Floodways

N

0 2.5 5 10 15 20 Miles

Future Urban Growth Patterns

Map 7 - 4



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

N

0 5 10 15 20
Miles

Legend

- Interstates & State Routes
- Rivers & Washes

Projected Urban Growth

Year

- 2010
- 2020
- 2030

Flood Control District of Maricopa County

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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 Waterman[1]. 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 actions[2]. These recommendations are part of the five-year flood hazard mitigation action plan for Maricopa

Risk Analysis by Watershed Outline

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 River[3]. 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 Pleasant[4].

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 Wittmann, 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.

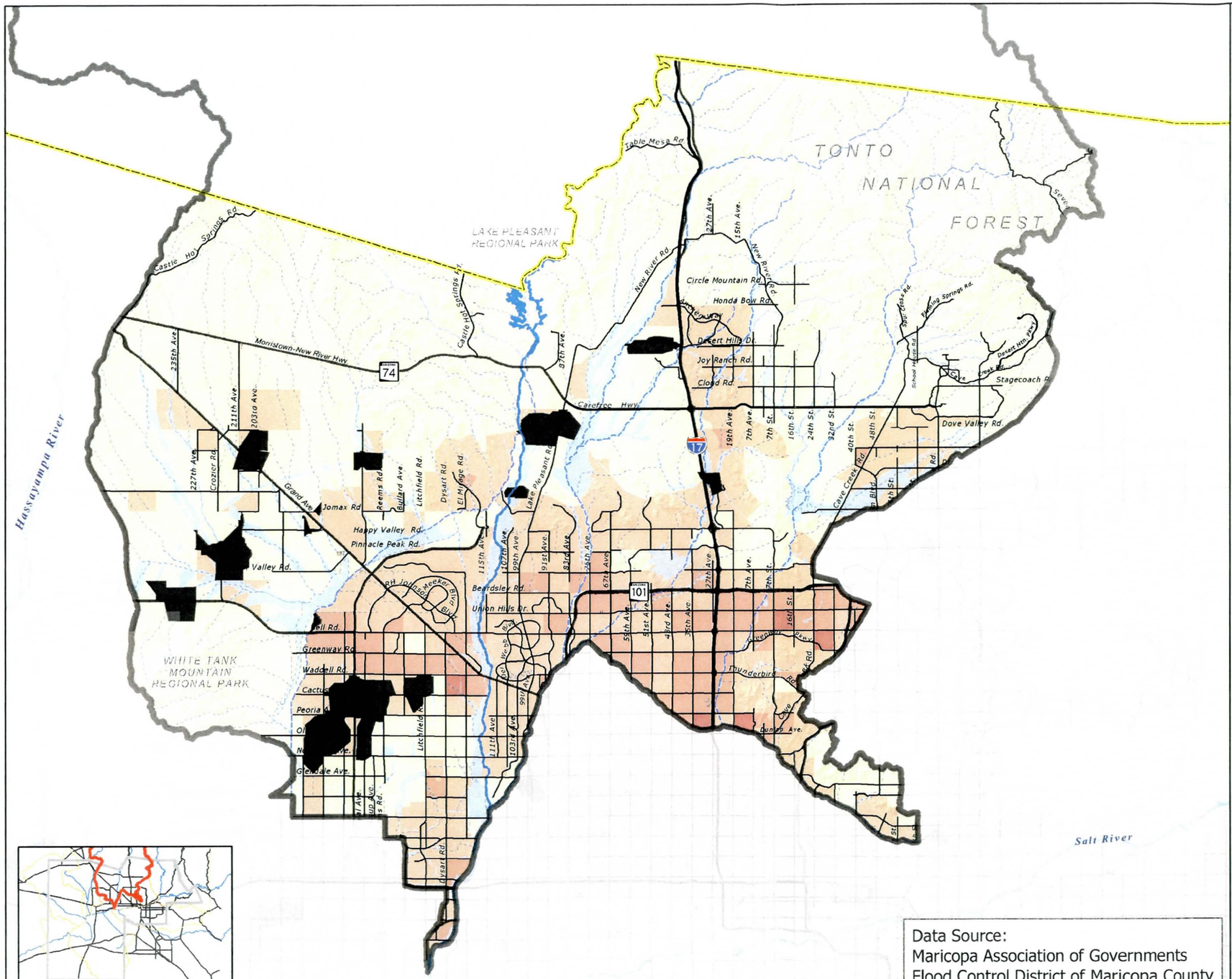
Flooding Risk Summary

- 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

N

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

Watershed Location

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

0 2 4 Miles

N

Flood Control District of Maricopa County

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 Addendum	Indian School Road to CAP siphon		2005
Apache Wash Drainage/Storm Drain Master Plan	Scatter Wash Basin and Cave Creek Wash with outfall to Cave Buttes Reservoir	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 Mountains (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

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 program[5]. 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

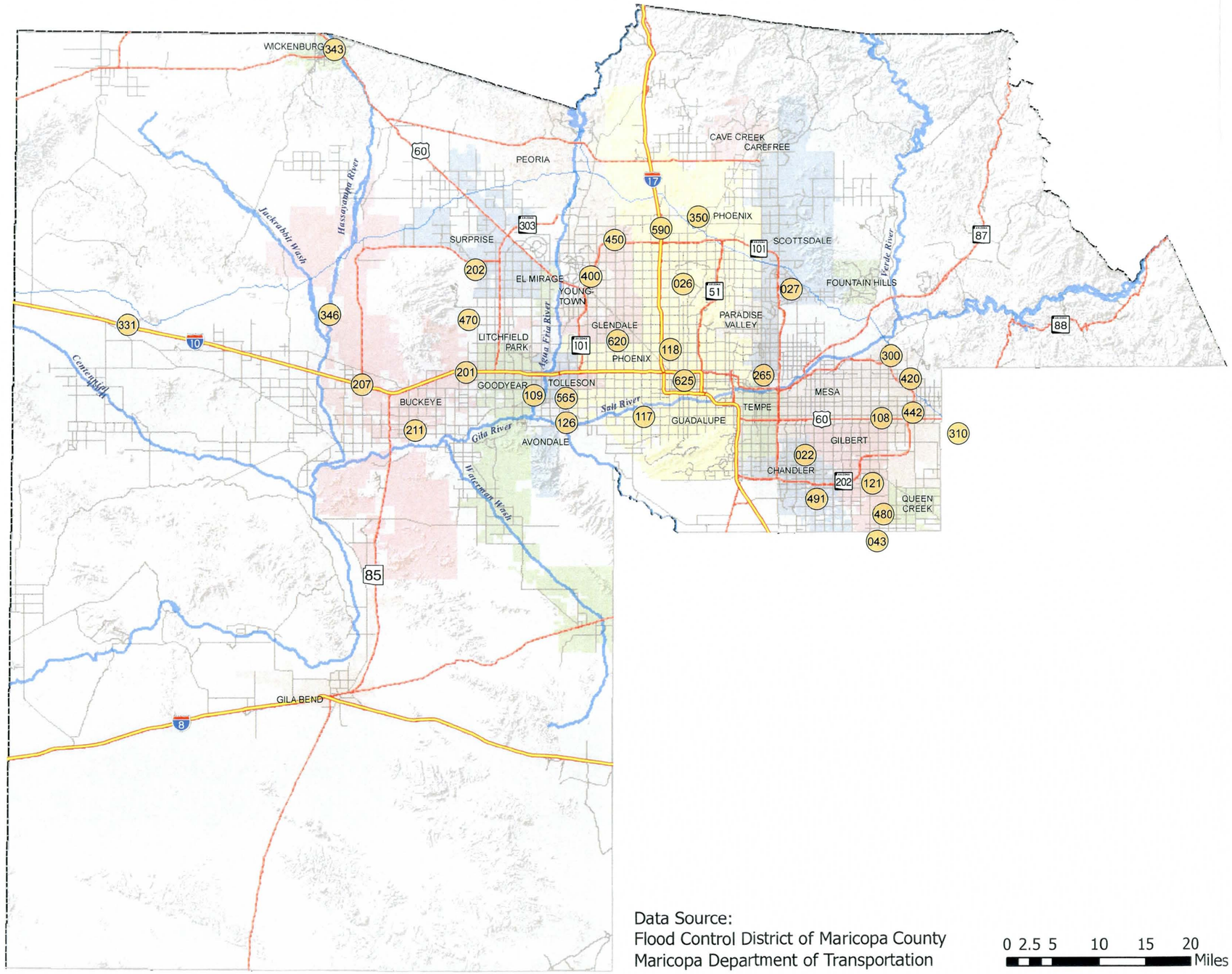
The five-year Capital Improvement Program recommends the construction of flood control infrastructure to mitigate flooding in the Agua Fria Watershed (see Map 8-3, Capital Improvement Projects, FY 2010-2014). Non-structural measures to remediate flooding in this watershed include purchasing homes located 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



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

0 2.5 5 10 15 20 Miles

N

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

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, Goodyear, 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.

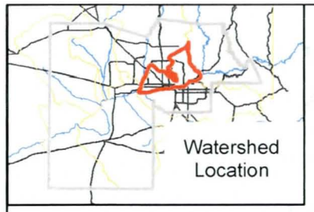
The Cave Creek/Salt Watershed is the most populated of the eight watersheds. This area experiences flooding problems associated with an urbanized watershed, such as changes in the timing of flows along tributaries to major watercourses, and the acceleration of flood flows through construction of storm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

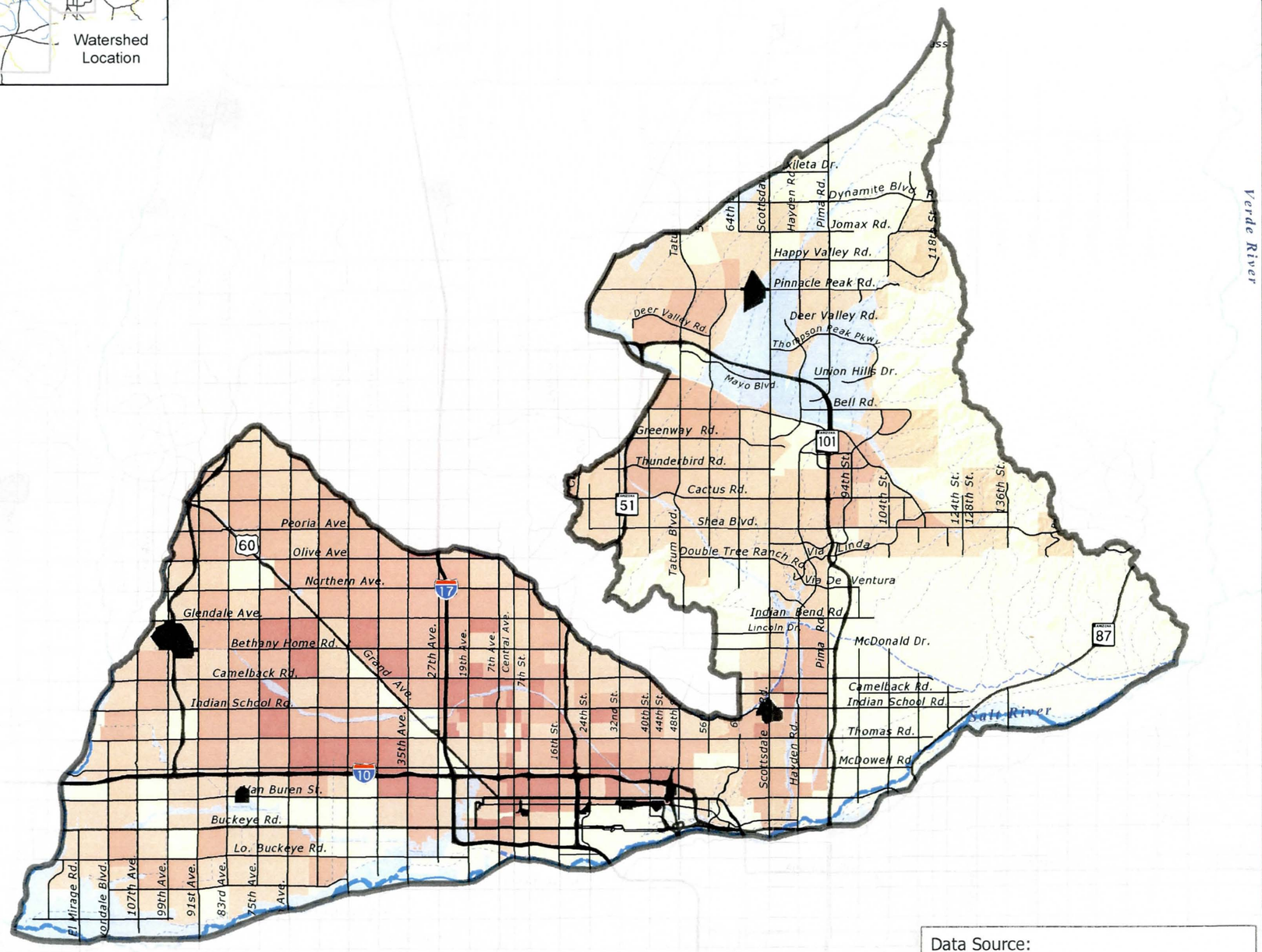
- There are 142 linear miles of delineated floodplains in the watershed; an estimated 440 miles remain to be delineated.



Delineated Floodplains & 2020 Population Projections

Cave Creek / Salt River Watershed

Map 8-4



Legend

- Cave Creek/Salt Watershed
- FEMA Floodplains

Estimated 2020 Population

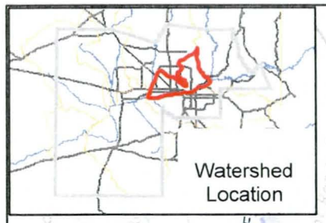
- Low Density
- Medium Density
- High Density
- Very High Density
- Significant Growth Areas

N

0 2.5 5 Miles

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

May 2009



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

0 1 2 3 4 Miles

N

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 program[6]. 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

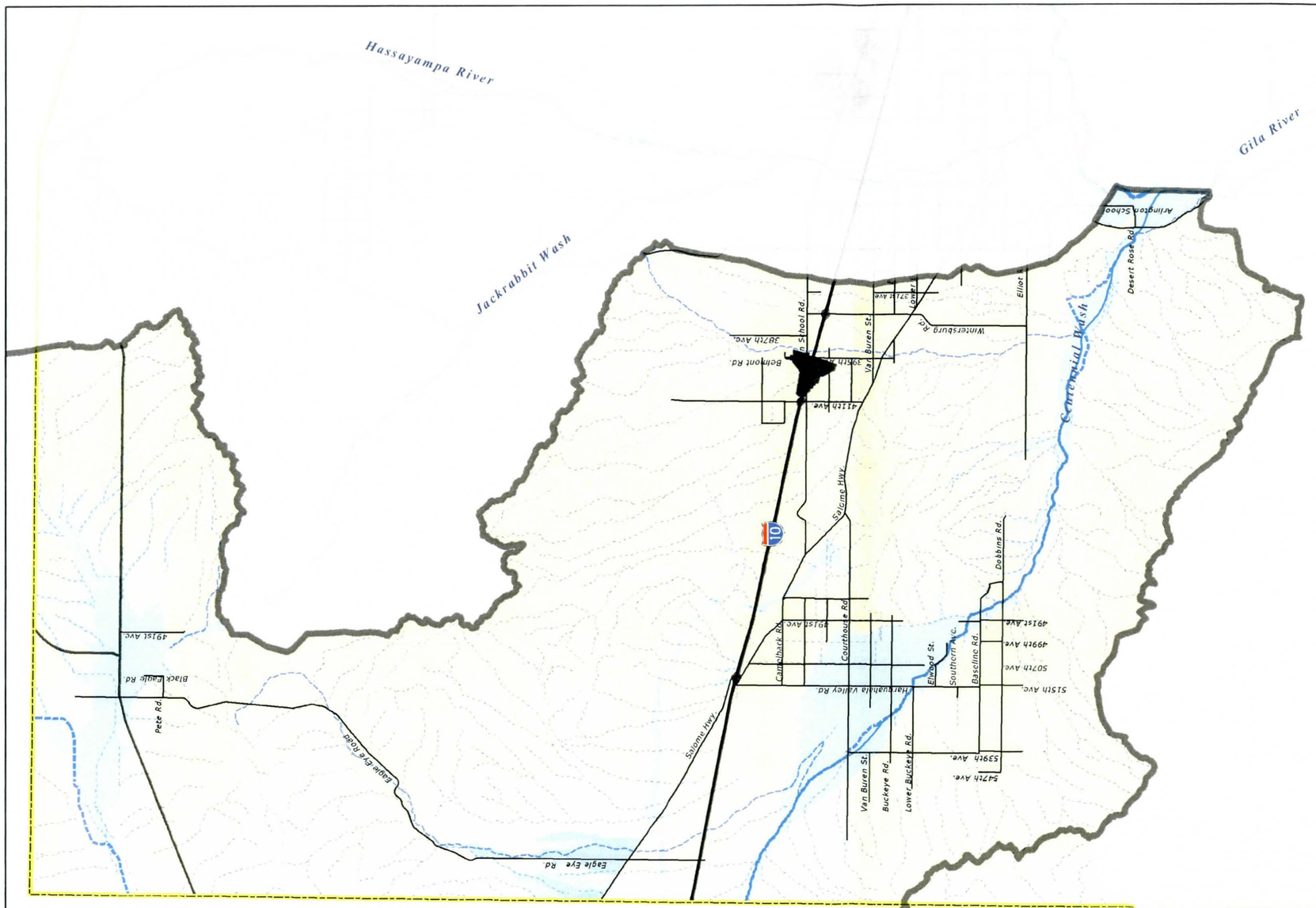
The needs assessment highlights the flooding characteristics and potential flood control problems of the watershed. A discussion of development patterns, repetitive loss areas, and other issues describe the public vulnerability to flooding. This section concludes with a brief summary of the watershed's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

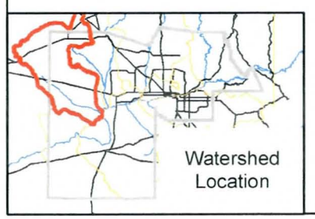
The Centennial Watershed is one of the least populated of the eight watersheds. There are currently 160 parcels with residential structures in the identified 100-year floodplain. Since 2005, 140 floodplain use permits were issued for floodplain construction within unincorporated Maricopa County.

Delineated Floodplains & 2020 Population Projections

Centennial Watershed

Map 8-6





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

Legend

- Centennial Watershed
- FEMA Floodplains

Estimated 2020 Population

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

N

0 2.5 5 10 Miles

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

Watershed Location

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

0 2 4 Miles

N

Flood Control District of Maricopa County

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

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 region[7]." 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%

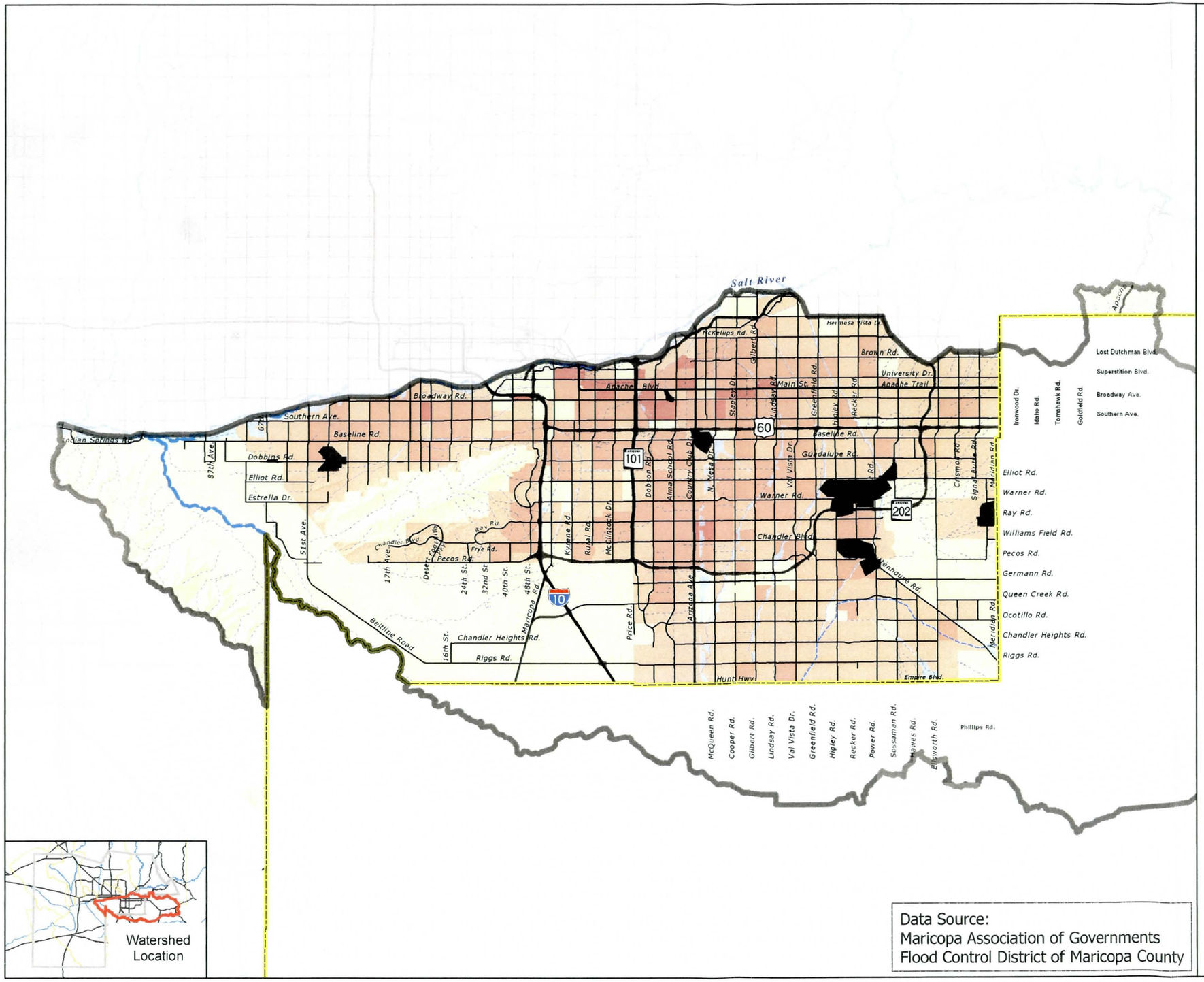
Completed District Activities

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



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

Legend

- Gila/Queen Creek Watershed
- FEMA Floodplains

Estimated 2020 Population

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

N

0 2.5 5 10 Miles

May 2009

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

N

Flood Control District of Maricopa County

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

0 2 4 Miles

Watershed Location

Agua Fria River
Verde River
Salt River
Waterman Wash
Indian Springs Rd.
Broadway Rd.
Southern Ave.
Baseline Rd.
Dobbins Rd.
Elliot Rd.
Estrella Dr.
Apache Blvd.
Main St.
Guadalupe Rd.
Warner Rd.
Chandler Blvd.
Pecos Rd.
Frye Rd.
Chandler Heights Rd.
Riggs Rd.
Hunt Hwy
Price Rd.
Beltline Road
Ray Rd.
Williams Field Rd.
Germann Rd.
Queen Creek Rd.
Ocotillo Rd.
Brown Rd.
University Dr.
Apache Trail
Ritterhouse Rd.
Phillips Rd.
Elliot Rd.
Meridian Rd.
Signal Butte Rd.
Crismon Rd.
Power Rd.
Sossaman Rd.
Hawes Rd.
Ellsworth Rd.
Greenfield Rd.
Lindsay Rd.
Gilbert Rd.
Cooper Rd.
McQueen Rd.
Val Vista Dr.
Country Club Dr.
Dobson Rd.
Alma School Rd.
McClintock Dr.
Rural Rd.
Kyrene Rd.
Arizona Ave.
Maricopa Rd.
17th Ave.
24th St.
32nd St.
40th St.
48th St.
51st Ave.
87th Ave.
Idaho Rd.
Goldfield Rd.
Ironwood Dr.
Tomahawk Rd.

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 (Emilta 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

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

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:

- 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 tje 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%

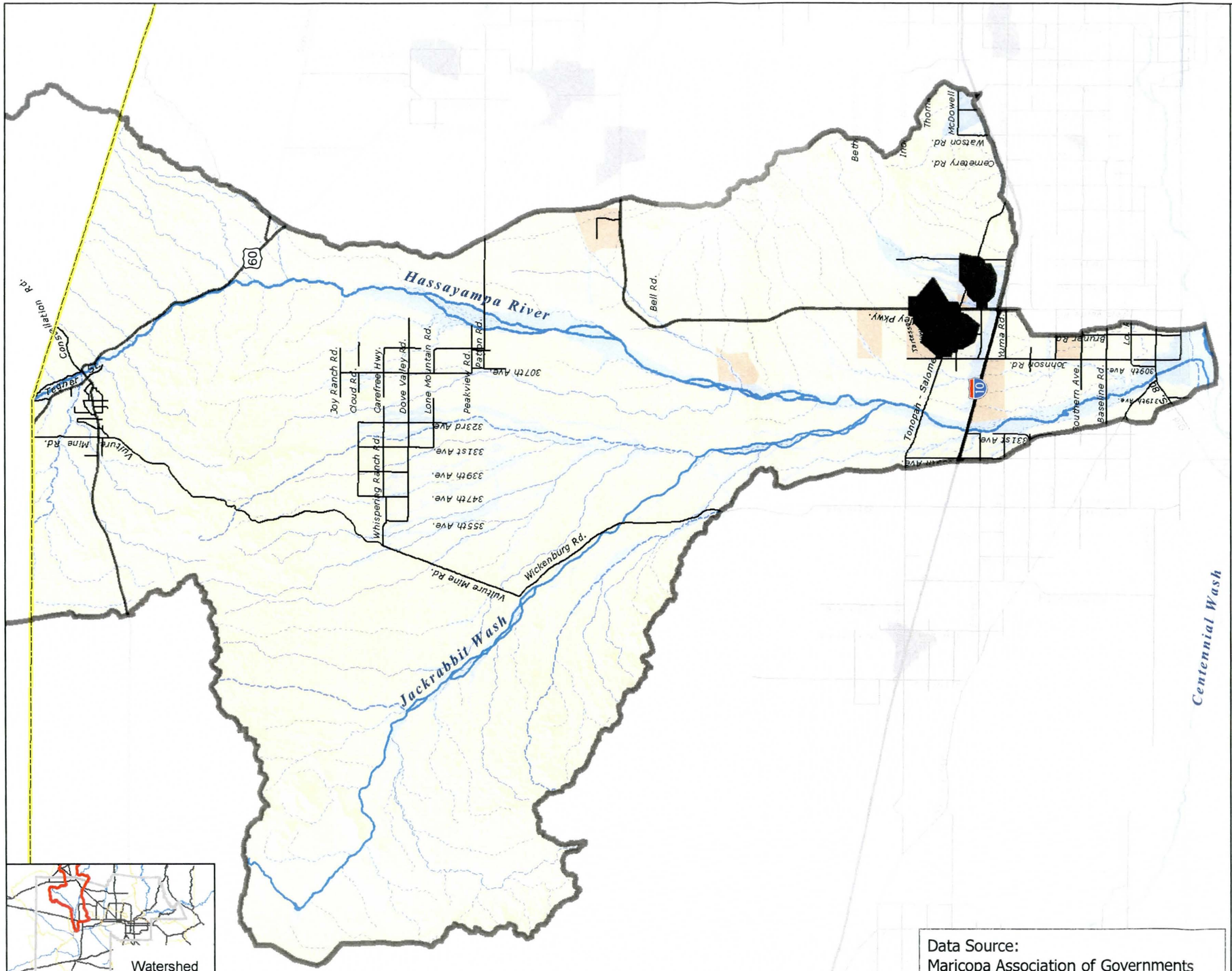
Completed District Activities

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

N

0 2.5 5 10 Miles

May 2009

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

Hassayampa River

Jackrabbit Wash

Gila River

Watershed Location

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

0 2 4 Miles

N

Flood Control District of Maricopa County

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 Jackrabbit 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

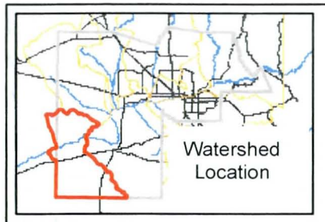
There are no regional flood control structures in the Lower Gila Watershed. The District has delineated 85 miles of floodplains to date.

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



Gila River

Centennial Wash

85

8

BARRY M. GOLDWATER
AIR FORCE RANGE

Gila River

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

Delineated Floodplains & 2020 Population Projections

Lower Gila Watershed

Map 8-12

Legend

- Lower Gila Watershed
- FEMA Floodplains

Estimated 2020 Population

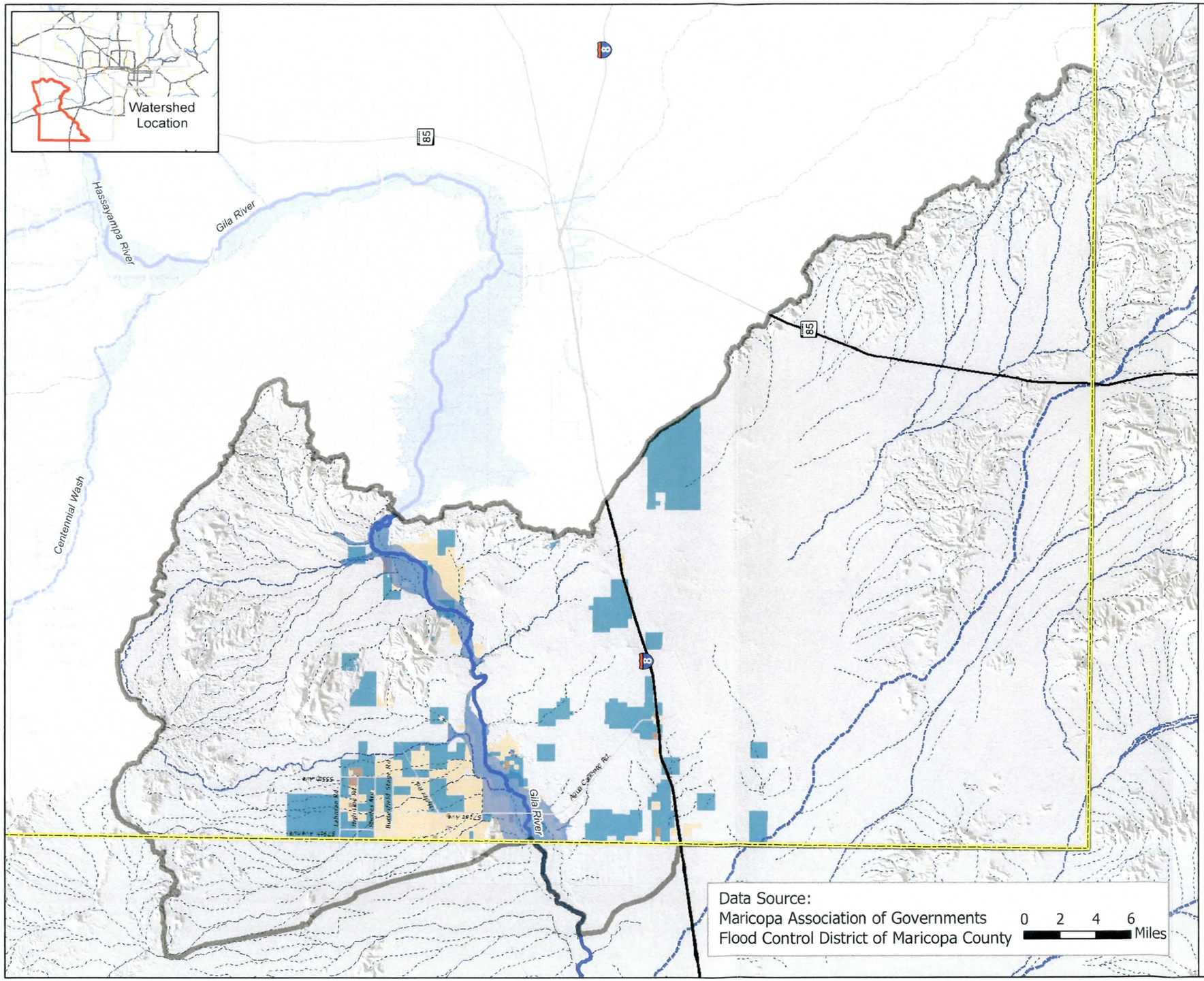
- Low Density
- Medium Density
- High Density
- Very High Density
- Significant Growth Areas

N

Flood Control District of Maricopa County

0 2.5 5 10 Miles

May 2009



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

N

Flood Control District of Maricopa County

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.

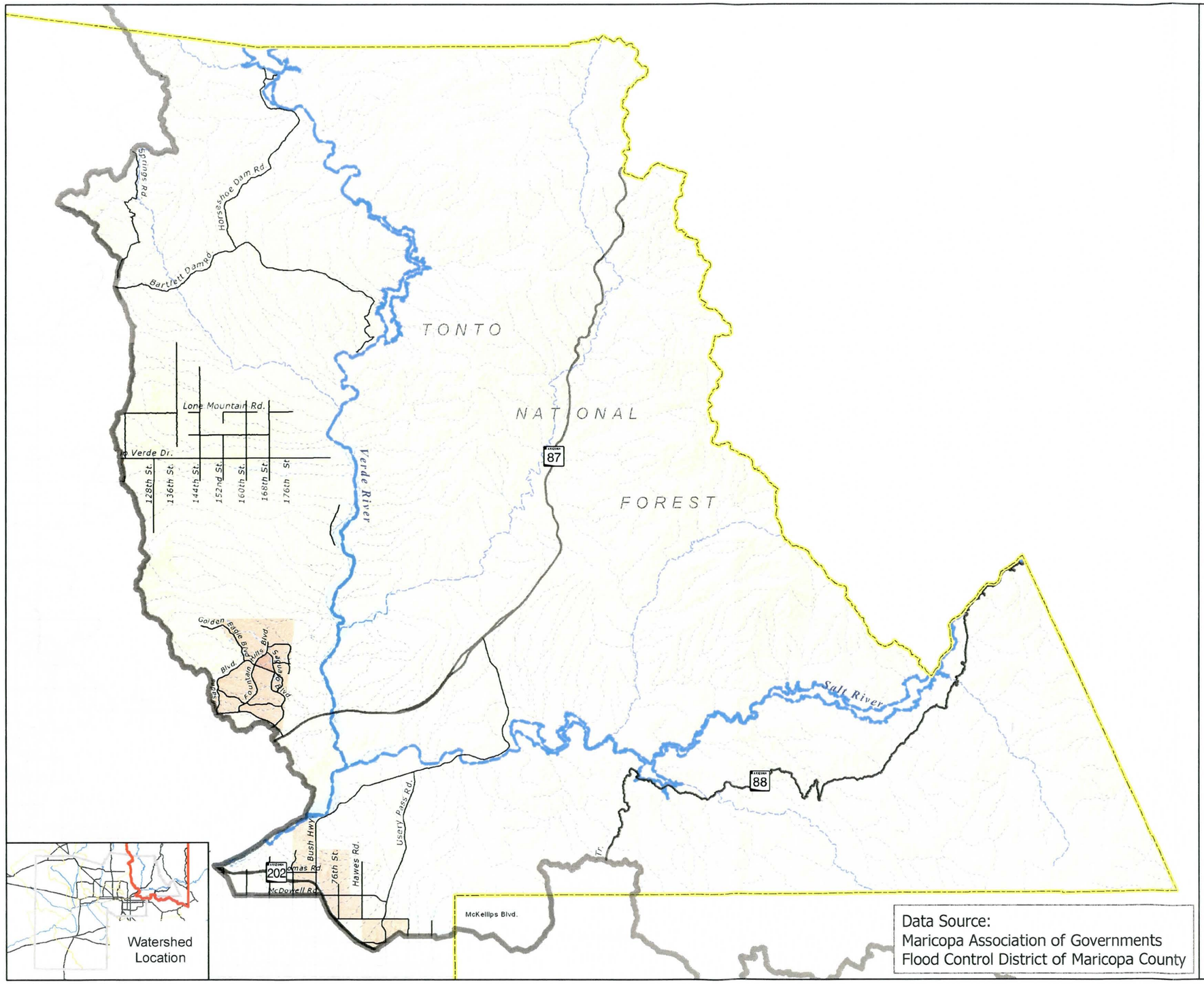
Flooding Risk Summary

- 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

N

0 2.5 5 10 Miles

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

May 2009

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

N

Flood Control District of Maricopa County

Horseshoe Reservior

Verde River

Bartlett Reservior

Camp Creek

Sycamore Creek

Lone Mountain Rd

Verde Dr

87

288

Roosevelt Lake

Salt River

188

Apache Lake

Saguaro Lake

Canyon Lake

88

101

Verde River

Salt River

Watershed Location

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), Usery 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.

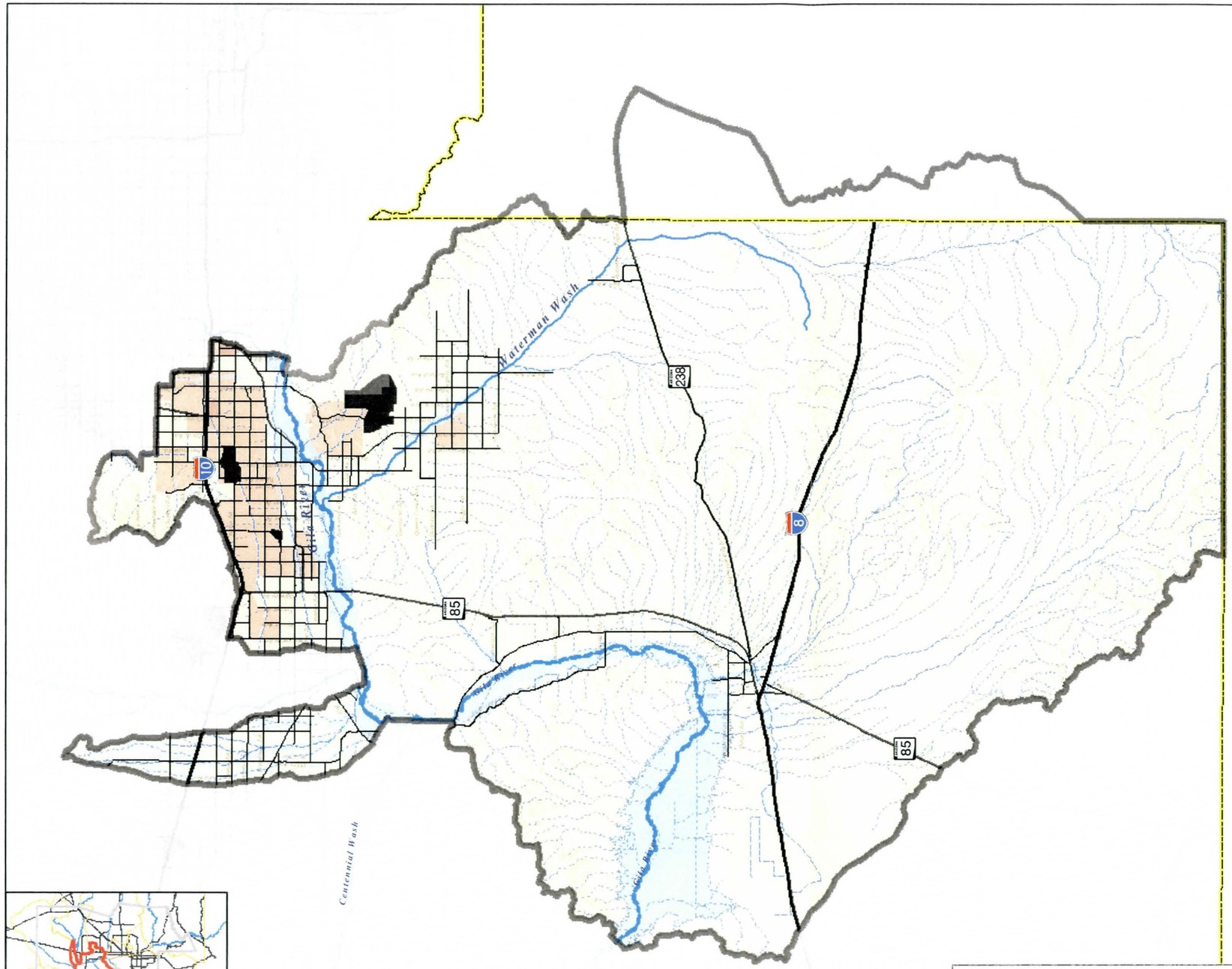
The most intensive development in the watershed will occur in three areas:

- 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

N

0 2.5 5 10 15 Miles

May 2009

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.

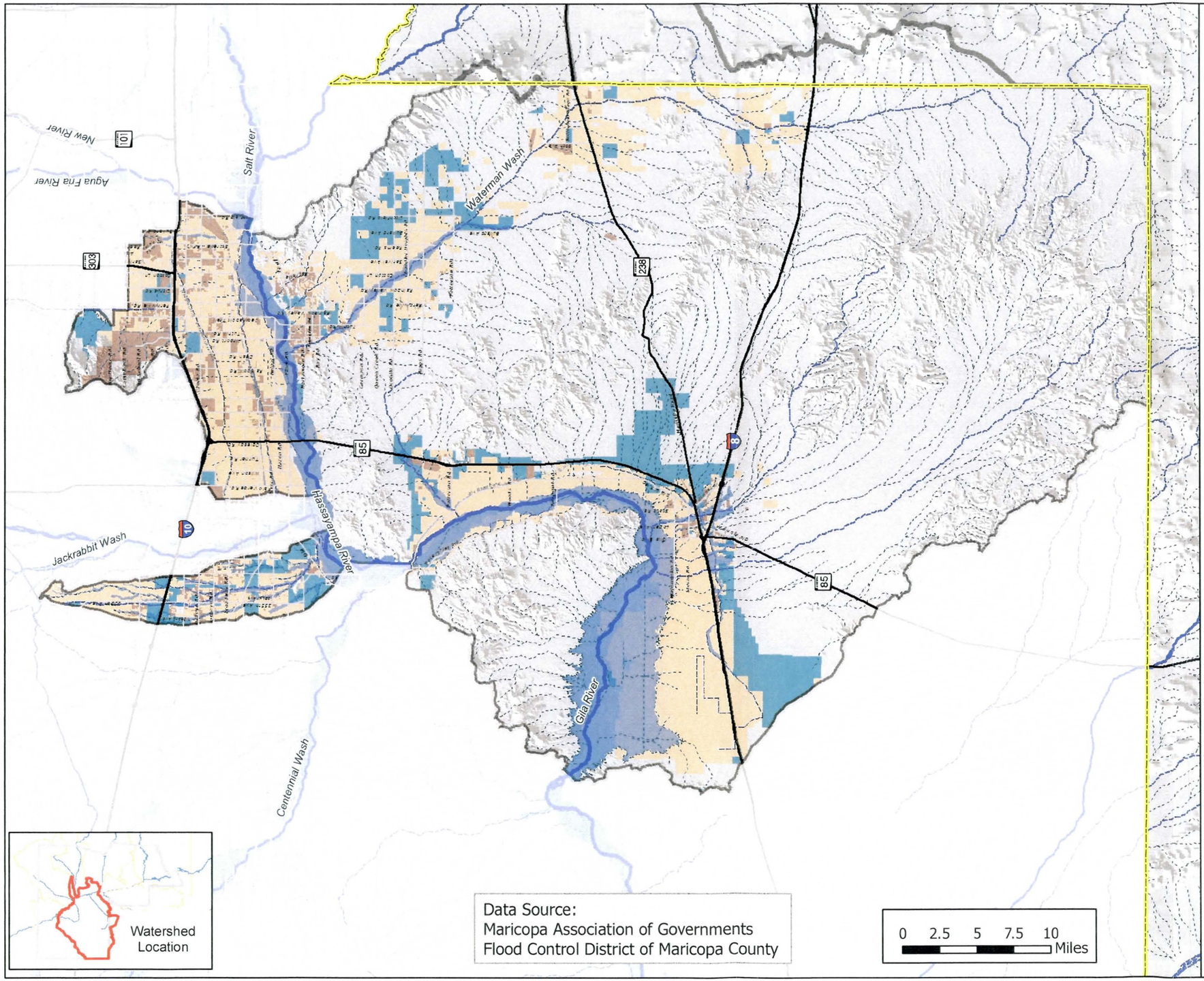
Existing Development - 60 sq. mi

Freeways & State Routes

Arterial Roads

100 Year Floodplains

Maricopa County boundary



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

0 2.5 5 7.5 10 Miles

N

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 2010-0212
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

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 problems[1]. 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 million[2]. A discussion of implementation and funding options follows the action plan.

Recommendations and Action Plan Outline

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

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

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

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 breakdowns 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-

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.