Pima County Multi-Jurisdictional Hazard Mitigation Plan 2022

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SECTION 1: INTRODUCTION

1.1 Purpose

The purpose of the Plan is to identify natural hazards that impact the various incorporated jurisdictions located within Pima County, assess the vulnerability and risk posed by those hazards to community-wide human and structural assets, develop strategies for mitigation of those identified hazards, present future maintenance procedures for the plan, and document the planning process.

Pima County and all the incorporated Cities and Towns are political subdivisions of the State of Arizona and are organized under Title 9 (cities/towns) and Title 11 (counties) of the Arizona Revised Statutes. This Pima County Multi-Jurisdictional Hazard Mitigation Plan was prepared by the Pima County Office of Emergency Management (PCOEM) and the listed participating jurisdictions, along with interested public, appointed representatives, and elected officials of these jurisdictions. Accordingly, each of the participating jurisdictions is empowered to formally plan and adopt the Plan on behalf of their respective jurisdictions.

1.2 Background and Scope

Each year in the United States, disasters take lives, cause injury, and damage human-made items. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event. The goal of risk reduction is to reduce the risk to life and property, which includes existing structures and future construction, in the pre- and post-disaster environments. This is achieved through regulations, local ordinances, land use, and building practices and mitigation projects that reduce or eliminate long-term risk from hazards and their effects."

Hazard mitigation involves the whole community and is one of the phases of a comprehensive emergency management program. FEMA encourages the Whole Community approach to mitigation, prevention, protection, response, and recovery activities. The vision of Whole Community, includes engagement with local, tribal, state, and federal emergency management entities, academia, non-governmental organizations, community members, and the private sector in all phases of emergency management.

Hazard mitigation planning is the process of identifying natural hazards likely to occur in a geographic location, measuring threat probability, analyzing the risk, setting mitigation goals and strategies to lessen impacts to the community associated, and implementing actions. This Plan documents the planning process employed by the planning teams for Pima County's Multi-Jurisdictional Hazard Mitigation Plan (MJHMP). The Plan reflects hazards, risks, and strategies identified by the Whole Community.

Examples of hazard mitigation strategies include, but are not limited to the following:

- Development of mitigation standards, regulations, policies, and programs
- Land use/zoning policies
- Building code and floodplain management regulations
- Dam safety program and levee systems
- Acquisition of flood-prone and environmentally sensitive lands.
- Retrofitting/hardening/elevating structures and critical facilities
- Relocation of structures, infrastructure, and facilities out of vulnerable areas
- Public awareness/education campaigns
- Improvement of warning and evacuation systems

This Plan was prepared according to the requirements of the Disaster Mitigation Action of 2000 (hereafter, these requirements will be referred to collectively as the DMA2K). While the act emphasized the need for mitigation plans and coordinated mitigation planning and implementation efforts, the regulations established the requirements that hazard mitigation plans must meet to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Relief and Emergency Act.

Currently, four FEMA grant programs provide funding to local entities that have a FEMA-approved local mitigation plan that meets federal hazard mitigation plan requirements. Two of the grant programs are authorized under the Stafford Act. The remaining two programs are authorized under the National Flood Insurance Act and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act.

The grant programs available include:

- Hazard Mitigation Grant Program (HMGP)
- The Building Resilient Infrastructure and Communities (BRIC) Program [formerly Pre-Disaster Mitigation (PDM)]
- Flood Mitigation Assistance (FMA)
- Repetitive Flood Claims Program (RFC)

Information in this Plan will be used to help guide and coordinate mitigation activities and decisions for future land use. Proactive mitigation planning will help reduce the cost of disaster response and recovery to the community and its property owners by protecting structures, reducing exposure, and minimizing overall community impacts and disruption. The community has been affected by hazards in the past and is thus committed to reducing future disaster impacts and maintaining eligibility for Federal funding. In the future, climate variability could affect the outcome of hazards by either reducing or increasing disaster impacts. This plan will attempt to address potential variables in each of the hazards addressed.

This is a multi-jurisdictional plan that geographically covers the participating communities within the Pima County boundaries (hereinafter referred to as the planning area). The following jurisdictions participated in the planning process:

- Pima County (Unincorporated)
- Town of Marana
- Town of Oro Valley
- Town of Sahuarita
- City of Tucson
- Pascua Yaqui Tribe

1.3 Tribal Assurance

The Pascua Yaqui Tribe is a federally recognized tribe, organized and established as a sovereign nation pursuant to the provisions of the Indian Reorganization Act of June 18, 1934. The Pascua Yaqui Tribe achieved federal recognition as an established tribe on September 18, 1978 and became recognized as a historic tribe in 1994.

The Pascua Yaqui Tribe will comply with all applicable Federal Statutes and regulations during the periods for which it receives grant funding, in compliance with DMA 2000 requirement §201.7(c)(6), and will amend its plan whenever necessary to reflect changes in tribal or Federal laws and statutes as required.

1.4 Plan Organization

This Plan is organized as follows:

- Section 1: Introduction
- Section 2: Community Descriptions
- Section 3: Planning Process
- Section 4: Risk Assessment
- Section 5: Mitigation Strategy
- Section 6: Plan Maintenance

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SECTION 2: COMMUNITY DESCRIPTIONS

2.1 County Overview

History

Pima County is unique for being one of the oldest continuously inhabited areas of the United States. Originally named for the Native American tribe inhabiting the area, evidence of human settlement in Pima County dates back over 9,000 years with Native Americans have lived here from ancient times to the present. The Tohono O'odham Nation has lived in this region from their Hohokam ancestors to contemporary times and concentrated along the Santa Cruz and Gila Rivers. The Tohono O'odham reservation that covers almost half of Pima County is the second-largest in Arizona. The arrival of the Spanish in the 1690s marked the first European peoples to establish settlements in the area. Missionary and explorer Father Eusebio Francisco Kino established the San Xavier del Bac mission. Throughout the 1700s, the Spanish continued to settle throughout southern Arizona. In 1775, the Tucson Presidio was built to protect settlers from raiding tribes of Apaches. Residents of the fort began to refer to it as the "Old Pueblo", which remains today as a nickname for Tucson

Pima County was created in 1864 and included all of southern Arizona acquired from Mexico by the Gadsden Purchase. It is the second-largest of the four original counties. Over time, portions of Pima County were carved off to create Maricopa, Pinal, Cochise, and Graham Counties.

Development began to flourish around the middle of the 18th century when silver and gold were discovered in the geographical area and the arrival of prospectors from Mexico. With the expansion of mining and ranching in the late 1800s, Pima County continued to witness increasing populations as new residents migrated to the Tucson region settling in proximity to major transportation corridors. Slowly, development moved eastward from Tucson until abutting with federally owned land resulting in a trend reversal with new growth occurring to the northwest. In the 1960s the county flourished due to the copper industry, and by the 1970s, the industry was responsible for the employment of almost 9,000 people.

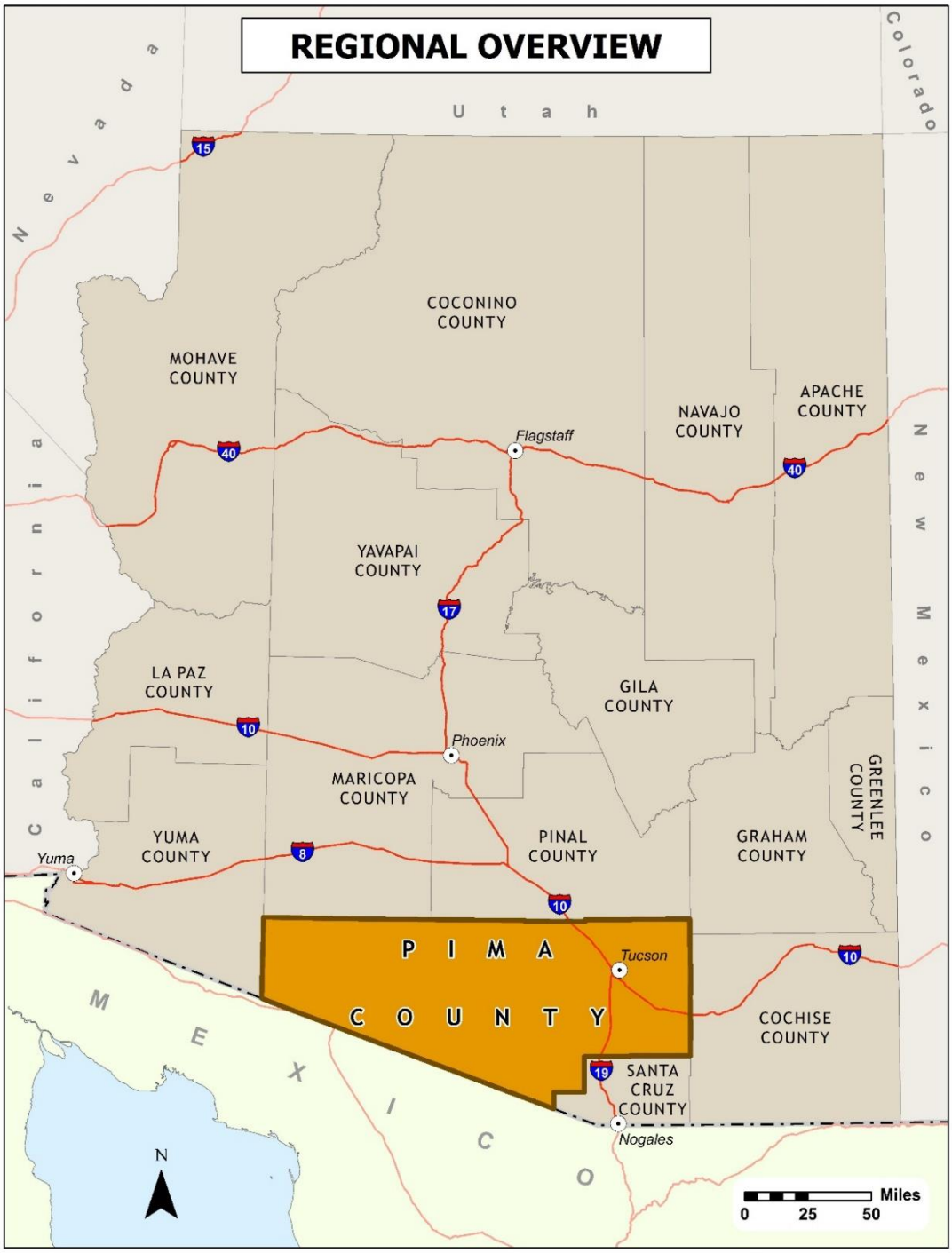
According to recent 2020 data, Pima County has a population of around 1,043,433, with a projected population increase to 1.4 million by 2041. Pima County is multi-culturally diverse and unique in the sense that it is a very urbanized county, with more than one-third of the population living outside of any incorporated cities or towns. The county seat of Pima County is Tucson, where most of the population is located. Tucson is a major commercial and academic hub, and is home to the University of Arizona, Pima Air & Space Museum, and the Arizona-Sonora Desert Museum.[1]

Geography

Pima County is in southern Arizona and encompasses 9,184 square miles, which is roughly equal in area to the states of Rhode Island and Connecticut combined. Pima County shares a 120-mile border in common with Mexico. Pima County lies within the Basin and Range Physiographic Province, characterized by northwest-trending mountain ranges separated by alluvial basins. Separated by the Tucson and Sierrita Mountains, a large portion of Pima County lies in two alluvial basins: Avra Valley to the west and the Tucson basin to the east. The regional drainage network, primarily formed by the Santa Cruz River and its tributaries, is dry for most of the year except during the spring runoff or from heavy storms.

Varying in elevation from desert valleys at roughly 1,200 feet to the 9,185-foot peak of Mount Lemmon, the county is home to diverse plant and animal communities. Numerous mountain ranges ring the Tucson basin, including the Santa Catalina, Rincon, Empire, Santa Rita, Sierrita, and Tucson mountains. Two cactus forests traverse the county – Saguaro National Park to the northeast and Organ Pipe Cactus National Monument in the southwestern portion. In addition, the county is home to the Cabeza Prieta National Wildlife Refuge nestled along the western boundary of the county and the Coronado National Forest in the eastern portion of the county within the Santa Catalina Mountains.

[1] Source: http://webcms.pima.gov/government/about_pima_county/, 2021



Source: Pima County GIS, 2021

Figure 2-1: Regional Overview

The geographical characteristics of Pima County have been mapped into the following three terrestrial ecoregions:

- **Chihuahuan Desert** – this ecoregion is typical of the high-altitude deserts and foothills and is found in much of the southeastern portion of Arizona. Elevations in this zone vary between 3,000-4,500 feet. The average temperatures for the Chihuahuan Desert tend to be cooler than the Sonoran Desert due to the elevation differences. However, like its lower elevation cousin, the summers are hot and dry interspersed with varying amounts of summer monsoon rainfall. Winters are mild to cool, relatively dry but interspersed with some widespread seasonal rainfall.
- **Sierra Madre Occidental Pine-Oak Forest** – this ecoregion is predominant in mountainous regions in southeast Arizona with elevations generally above 5,000 feet. The average temperatures tend to be cool during the summer and cold in winter.
- **Sonoran Desert** – this ecoregion is an arid environment that covers much of southwestern Arizona. The elevation varies in this zone from approximately sea level to 3,000 feet. Vegetation in this zone is comprised mainly of Sonoran Desert Scrub and is one of the few locations in the world where saguaro cactus can be found. The climate is typically hot and wet during the summer and mild during the winter with a very dry spring and fall.

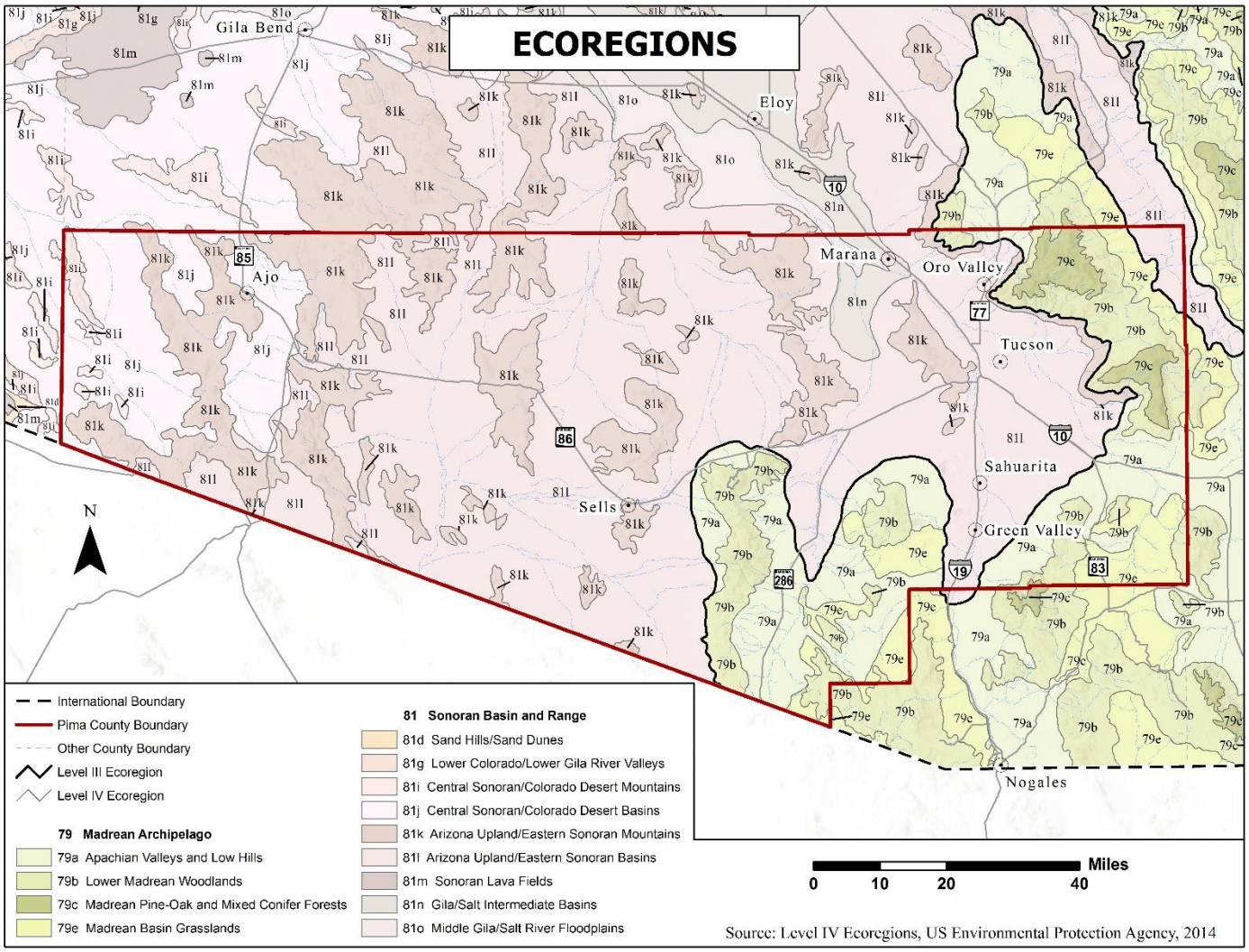
Land ownership within Pima County is divided between Native American tribal lands (42%), Private (12%), U.S. Forest Service and Bureau of Land Management (12%), State Trust Land (14%), and other public lands (20%).[2]

Government

The governmental and administrative affairs of the unincorporated areas of Pima County are directed by a five-member Board of Supervisors with each member elected from a designated district. Because of Arizona's constitutional provisions and the requirements promulgated by Arizona Revised Statutes, the government of Pima County is organized to have a direct and indirect relationship with the Board of Supervisors. The Board of Supervisors has direct control over the county's general government functions including community services; indigent defense; medical, health, and welfare services; and public works functions. These broad functions include the county's internal governmental administrative/management activities; maintenance and construction of the county's sewerage and sanitation infrastructures; county streets, roads, and bridges which comprise the county's transportation infrastructure; natural resources, parks, community centers, recreational facilities and libraries (in cooperation with the City of Tucson); and numerous clinics. Indirect relationships are maintained with the elected officials. The Board of Supervisors appoints a County Administrator to be responsible for the general direction, supervision, administration, and coordination of all affairs of the county.

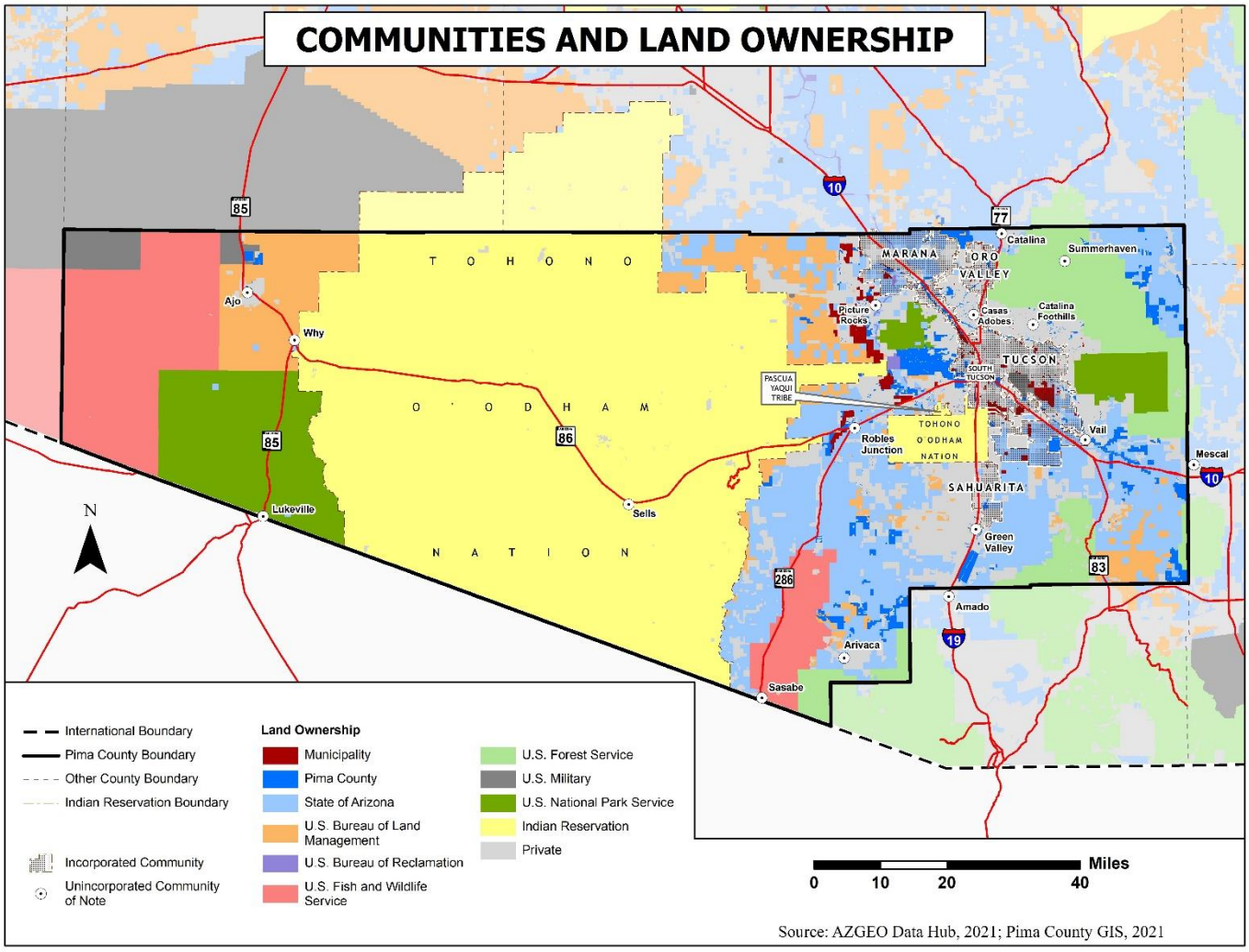
Each of the five municipalities in the county (Town of Marana, Town of Oro Valley, Town of Sahuarita, City of South Tucson, and the City of Tucson) are governed by a mayor and council form of government. An elected tribal council governs the Pascua Yaqui Tribe. Each of the municipalities and the tribal community are described in more detail in Section 2.2 below.

[2] Source: Pima County Geographic Information Systems, 2021



Source: Pima County GIS, 2021

Figure 2-2: Ecoregions



Source: Pima County GIS, 2021

Figure 2-3: Community Location and Land Ownership

Geology

Pima County is comprised of complex geology reflective of a history of faulting and folding of the earth's crust. The mountains include sedimentary, metamorphic volcanic, or intrusive igneous rock, or a combination of the three. The alluvial basins consist of well-consolidated sediments eroded from the surrounding mountain ranges with caliche, or hardpan, underneath. Caliche is formed as calcium carbonate and deposited within the soil through water seepage.

Transportation

As shown in Figure 2-4, several major roadways support both local and interstate transportation needs. I-10 provides connectivity with the Phoenix metropolitan area to the north and I-19 with Mexico to the south. Several other State and US highways, most notably State Highways 85 and 86, coupled with Federal Indian Routes provide local and regional access throughout southern Arizona. Pima County is host to four municipal airports providing commercial and general aviation services to the region. In addition, the county is home to the Davis-Monthan Air Force Base in Tucson.

Climate

For the majority of Pima County, the climate is typical of the Sonoran Desert areas of the state and is characterized by abundant sunshine, a long summer, mild winter, low average annual precipitation, relatively low humidity, and generally light winds. In the relatively small areas of the county above 4,000 feet mean sea level, the climate tends to be more moderate. Climatic statistics for weather stations within Pima County are produced by the Western Region Climate Center and span records dating back to the early 1900s. [1].

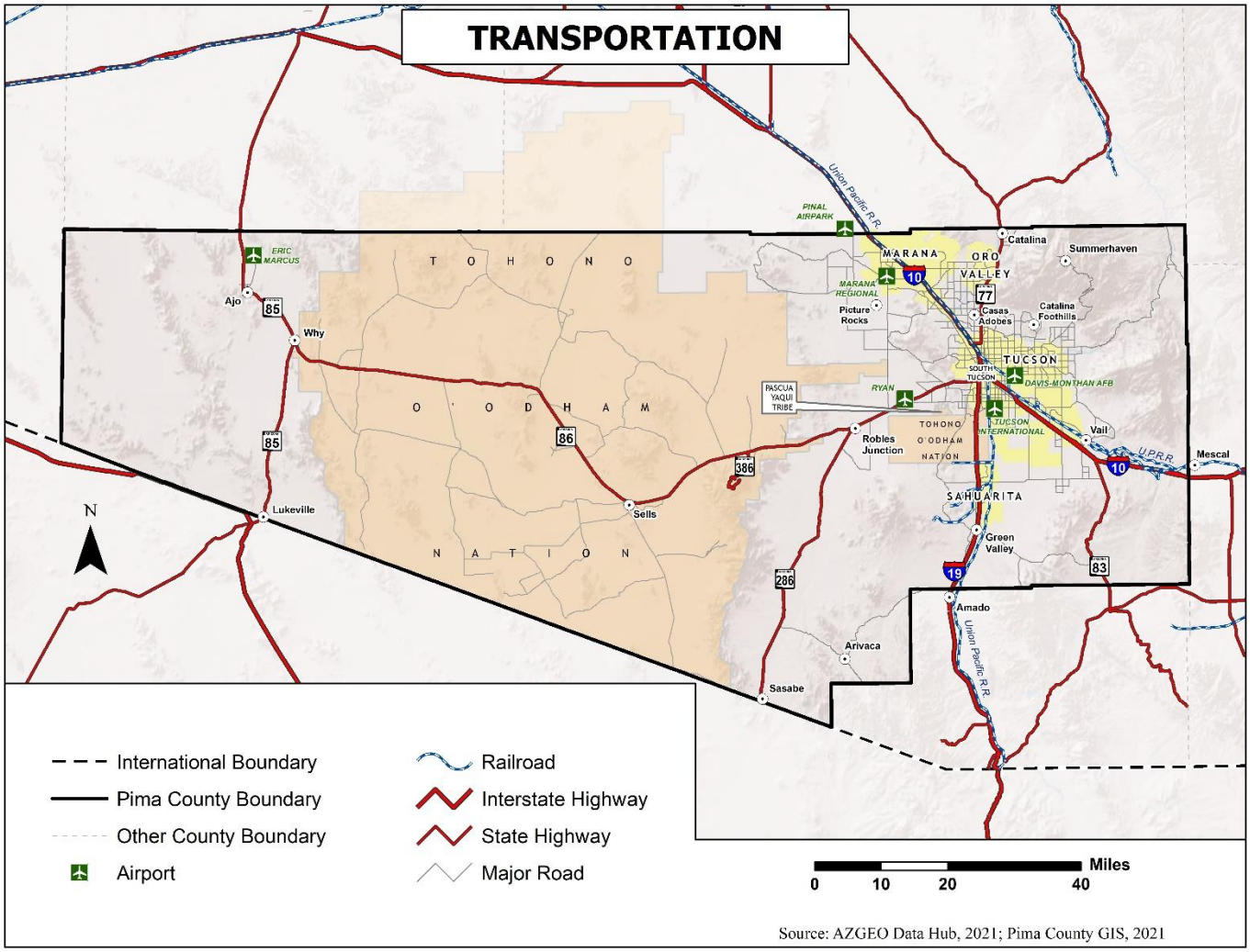
Table 2-1 lists some partial climate statistics for several of the weather stations located within the county. Average temperatures within Pima County range from near freezing during the winter months to over 100°F during the hot summer months. The severity of temperatures in either extreme is highly dependent upon the location, and more importantly the altitude, within the county. For instance, temperature extremes in the foothill communities will generally be about 10°F less than those in valley communities.

Table 2-1: Climate Statistics for Stations in Pima County

	Average Temperature (F)				Precipitation (inches)		
	January		July				
Location	Min	Max	Min	Max	Wettest Month	Driest Month	Total Annual Average
Ajo	41.6	64.2	77.8	103	1.90 (August)	0.07 (May)	8.37
Cascabel	30.0	64.8	65.3	99.2	2.59 (August)	0.31 (May)	13.33
Kitt Peak	33.0	49.6	60.8	80.4	4.53 (August)	0.44 (May)	23.16
Sabino Canyon	37.1	66.4	72.4	101.9	2.41 (August)	0.19 (May)	12.73
Green Valley/Sahuarita	37.0	67.7	73.6	98.8	3.23 (July)	0.21 (May)	13.42
Sells	36.9	66.0	72.1	101.1	2.58 (July)	0.15 (May)	11.76
Tucson Magnetic Observatory	34.2	64.8	71.3	100.5	2.25 (August)	0.24 (May)	12.62
Tucson, University of Arizona	37.6	65.5	73.9	100.1	2.15 (August)	0.18 (May)	11.5

Note: Period of record varies by station but generally spans from the early 1900's to 2010. Sabino Canyon 1941-2002. Green Valley 1988-2016 is near Sahuarita.
Source: Western Regional Climate Center, 2021.

[1] Most of the data provided and summarized here is taken from the WRCC website beginning at the following URL: https://wrcc.dri.edu/summary/Climsmaz.html



Source: Pima County GIS, 2021

Figure 2-4: General Location and Transportation

Precipitation throughout Pima County is governed largely by elevation and season of the year. From November through March, storm systems from the Pacific Ocean cross the state as broad winter storms producing mild precipitation events and snowstorms at the higher elevations. Summer rainfall begins early in July and usually lasts until mid-September. Moisture-bearing winds move into Arizona at the surface from the southwest (Gulf of California) and aloft from the southeast (Gulf of Mexico). The shift in wind direction, termed the North American Monsoon, produces summer rains in the form of thunderstorms that result largely from excessive heating of the land surface and the subsequent lifting of moisture-laden air, especially along the primary mountain ranges. Thus, the strongest thunderstorms are usually found in the mountainous regions of the central southeastern portions of Arizona. These thunderstorms are often accompanied by strong winds, blowing dust, and infrequent hailstorms.[1]

Wind speeds are similar across Arizona, averaging approximately 6-9 miles per hour annually. Pima County generally experiences average wind speeds at approximately 8 mph. However, significant variations can exist throughout the year, as a consequence of extreme changes in topography in the area. The surrounding mountains and topography of the region influence wind velocities and directions in the Tucson basin.

Population

As of April 1, 2020, 1,043,433 residents call Pima County home.[2] Most of the citizens still live in the incorporated communities or reservation portion of Pima County. The largest community is the City of Tucson. The two incorporated cities and three towns are geographically located in the eastern portion of Pima County.

Table 2-2: Population Estimates

Jurisdiction	2010	2015	2020
Pima County	981,168	1,009,371	1,043,433
Town of Marana*	35,051	41,655	51,908
Town of Oro Valley	40,984	43,499	47,070
Pascua Yaqui Tribe (Pascua Pueblo Reservation)	3,745	8,831**	6,782***
Town of Sahuarita	25,259	27,637	34,134
City of South Tucson	5,672	5,712	5,701
Tohono O'odham Nation	9,051	Not reported	Not Reported
City of Tucson	520,795	529,845	542,629
Unincorporated County	353,319	361.023	367,904

2010 Pascua Yaqui Tribe and Tohono O'odham Nation estimates from 2010 Census Block data
2010 2015, 2021 data from AZDOA: https://population.az.gov/population-estimates
*A portion of Marana is in Pinal County
** Provided by Pascua Yaqui Tribe and current as of September 2016
***Provided by Pascua Yaqui Tribe and current as of September 2021

Economy

The metropolitan Tucson area is the center of economic activity for the county. As of September 2021, the countywide labor force was estimated at 491,351 with an unemployment rate of 4.2%.[3] A majority of workers in Pima County are employed in the educational services, healthcare, and social assistance sector of the economy, followed by arts and entertainment, and then professional, scientific and management. The labor force is reflective of the influence of tourism, academia, and the retirement population in the Tucson metropolitan area.

[1] Office of the State Climatologist for AZ, 2021.
[2] U.S. Census Bureau, Quick Facts, 2020. U.S. Census Bureau QuickFacts: Pima County, Arizona; United States
[3] AZ Department of Administration Employment and Population Statistics, July 2019. https://laborstats.az.gov/sites/default/files/Emp-Report.pdf

2.2 Jurisdictional Overviews

Town of Marana

Nestled along Interstate 10 (I-10), northwest of Tucson, the Town of Marana has experienced dramatic growth for over two decades because of annexation policies and the development of master-planned communities. It is now the fastest-growing community in southern Arizona.

Founded in 1881, in conjunction with the development of rail transportation, Marana solidified itself as a destination with its appearance on Southern Pacific Railroad maps in 1890. Although ranching and the railroad dominated the community prior to World War I, the post-war years brought significant change to the region with the implementation of extensive agricultural irrigation systems and the development of cotton farming. Other substantial factors in Marana's development were the location of Marana Army Air Field (now Pinal Airpark and Evergreen Air Center) and the removal of the downtown business district due to the widening of I-10 in the early 1960s.

In March of 1977, the Town of Marana incorporated with an area roughly 10 square miles. Governed by a seven-member Town Council consisting of a Mayor and six council members elected for four-year terms, the Town utilizes a Council-Manager form of government. The Town Council appoints a Town Manager responsible for the daily operation of town services and the orderly administration of affairs.

Although a majority of Marana's topography is flat, much of the area is designated as a floodplain. In addition, the existing Town boundaries include portions of the Tortolita and Tucson Mountain foothills that are dominated by slopes exceeding 15%. The development constraints posed by these environmentally sensitive lands provide the potential for natural open space and habitat conservation areas to balance with the urban development occurring. Several riparian features, including major wash crossing in the Tortolita Fan and the Santa Cruz River, provide natural wildlife habitat for diverse species native to the Sonoran Desert. The Santa Cruz River has also provided the opportunity for a Shared Use Path (SUP) to be constructed from Ina Road north to Sanders Road approximately 13.5 miles. This SUP is a world-class outdoor recreation amenity and contributes greatly to the health and wellness of the Marana community.

Although witnessing substantial urban growth during the past two decades, Marana continues to hold onto its agricultural and ranching roots and serves as the main trade and transportation center for the surrounding rural periphery for the eastern portion of Pima County. As illustrated in Table 2-2, the 2020 Census population of Marana is 51,300. On average between the years of 2010-2014, the civilian labor force was 64.5% of the town's population. New building permits issued in 2020 were 2,664. Of these, 915 were for new homes.

Marana's General Plan, adopted on December 10, 2019, reflects the Town's shared values that include a sense of community, quality development, and economic growth. Marana's Land Use Map (Figure 2-5) defines a pattern of growth that is logical, fiscally responsible, and financially sustainable. The Resources and Sustainability Theme of the Marana General Plan seeks to balance growth and development with the need to protect and conserve natural resources to support a healthy environment for generations to come. This theme is supported by five general plan elements, Open Space, Water Resources, Environmental Planning, Conservation, and Energy Elements. Lower density and intensity use in proximity to environmentally sensitive areas provide a transition to more intensive commercial and industrial uses located in proximity to major transportation corridors including I-10, major thoroughfares, and the Marana Regional Airport.

Although agriculture remains a factor in Marana's economy, a continuing influx of residential and commercial development has occurred due to its location between Phoenix and Tucson along I-10 and the Union Pacific Railroad, to the south, adjacent to Tucson, is a new commercial business district. Continental Ranch/Peppertree Ranch Industrial Park has several new tenants and new industrial properties will soon be available at Marana Northwest Regional Airport. Marana's major private employers include Arizona Portland Cement, Costco, Home Depot, Wal-Mart, Lowes, Sargent Controls & Aerospace, and Tucson Ready Mix. Major public employers include the Marana Unified School District and the Town of Marana. Marana's planning area encompasses approximately 228 square miles in Pima and Pinal Counties. Existing land uses include residential of varying densities (rural residential, low-density residential, traditional neighborhood), open space, airport and commercial, and industrial development. A majority of the planning area beyond the Town boundaries to the north and west is undeveloped.

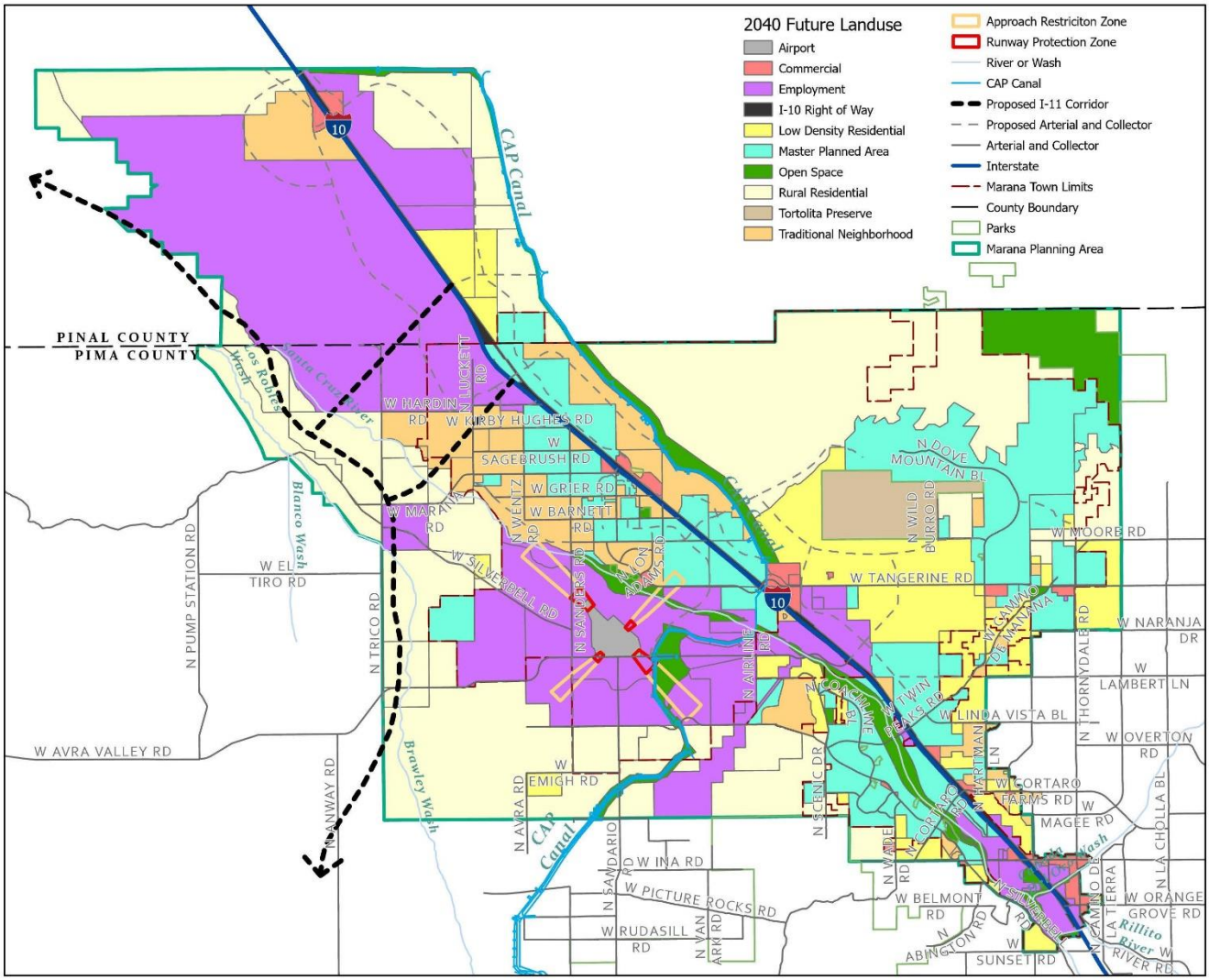
Marana's Town limits reflect the many changes and transitions that have occurred since its incorporation. Marana's rural heritage is reflected in traditional family farms and agricultural activities that continue on many acres of land historically used for agriculture. Older, low-density residential and commercial development was located west of I-10 in and near the traditional Town area where many Marana pioneer families settled. This northwest part of Marana began a transition to a more densely populated area in the early 2000s. At that time, the Cactus Ferruginous Pygmy-Owl was listed as an endangered species, which limited development in much of the area east of I-10. This shifted the development focus to the farm fields in northwest Marana. The extension of bank protection along the Santa Cruz River to Sanders Road removed many of the farm fields from the floodplain and opened them up to development opportunities; along with the extension of sewer lines brought urban services to the northwest area. By 2021, there were more than 6,000 lots platted in this area of the Town, with an additional 21,000 lots planned. The new growth brought approximately 10,000 new residents to this once rural area.

Marana's planning area includes natural areas, such as the Tortolita Mountain Alluvial Fan in the northeast, which provide physical constraints that limit development. Characterized by steep slopes, natural drainage ways, native vegetation, and floodplains, this area provides natural undisturbed open space and habitat for a multitude of plant and animal species. The Town has proactively moved to direct new growth and development away from the fan to other more appropriate areas.

The Town of Marana 2040 General Plan indicates that residential development is the predominant land use, occupying more than 50% of the total land area. The residential categories provide a range of densities within each designation. However, the maximum density cannot always be achieved because of land use policies or physical constraints. Commercial and industrial uses may potentially accommodate a wide range of uses.

Much of the current development activity in northeast Marana is occurring along the Twin Peaks Road corridor. Related to this, Tangerine Road was improved to four lanes with a central median, turn-lanes, multi-use paths, and sidewalks from La Cañada Drive to Dove Mountain Boulevard. The segment from Dove Mountain Boulevard to I-10, is currently in design for the expansion of up to four lanes that will facilitate the expected growth in the region. Just east of the Tangerine/I-10 freeway interchange is the new Mandarina Boulevard/Adonis Extension, which connects the existing San Lucas and Adonis neighborhoods through the proposed Tortolita Shadows and Mandarina developments to Tangerine Road. These infrastructure projects will allow for the capacity necessary for continued growth in the area as well as provide better circulation and connectivity in the community including access to the Town of Oro Valley.

At the Marana Regional Airport, a future focal point of the town's local economy, continual upgrading, and expansion of the facility has benefit to the airport and to the Town's ability to attract commerce. The recent addition of road and utility infrastructure in the I-10 area directly east of the airport will attract new businesses to the Town while others will be attracted to the airport because of its business-class jet capabilities, convenient location, and access for business or pleasure.



Source: Town of Marana Technology Services

Figure 2-5: Town of Marana Land Use

Town of Oro Valley

Located between the Santa Catalina Mountains to the east and the Tortolita Mountains to the northwest, Oro Valley is located six miles northwest of the Tucson city limits. Other nearby communities include the Town of Marana to the west and the unincorporated community of Catalina to the north. Oro Valley serves as a gateway to regional parks, sharing its eastern border with Catalina State Park and the Coronado National Forest. These areas provide vast recreational and natural open space opportunities for the community and are integral to the Town's identity as a community known for its integration of residential uses within the natural Sonoran Desert and as a resort area. Major access to Oro Valley is via I-10, located approximately 12 miles to the west, and SR 77, or Oracle Road, which runs north-south through the Town and is the original transportation corridor linking Tucson with the Phoenix metropolitan area to the north. The Town was incorporated in April of 1974 and operates under a Council-Manager form of government, which includes a mayor and six council members elected at large. The Mayor is directly elected while the Vice Mayor is selected by the Council from among the six Council members.

Oro Valley is a growing community. The 2020 estimated population of Oro Valley is 47,070. The population is forecasted to grow to more than 51,000 by 2030. Residential growth has been a large part of economic activity in the past and will remain important into the future. In recent years, more diverse employment opportunities have become part of the community. Oro Valley's large employers include Roche Tissue Diagnostics; Honeywell Aerospace; Town of Oro Valley; Oro Valley Hospital; Amphitheater Public Schools; Casa de la Luz Hospice; SimpleView; Splendido at Rancho Vistoso; El Conquistador Tucson, A Hilton Resort; and Meggitt Securaplane Technologies, Inc. Oro Valley is emerging as a regional center for biotech, biomed, and high-tech industries featured on the campuses of Innovation Park.

The Town of Oro Valley's General Plan guides the character and future directions for the community over a 10-year period. The *Your Voice, Our Future* General Plan was adopted by Town Council on September 21, 2016, and ratified by the Oro Valley voters on November 8, 2016. The Plan supports the potential of an evolving community, with a focus on family-friendly features, economic development, and amenities contributing to a "complete community". This is balanced with long-held values for the natural environment and lower density development. Future commercial growth will likely be concentrated in designated growth areas, primarily the Oracle Road corridor and secondarily smaller neighborhood commercial clusters dispersed throughout the Town. Residential growth will likely occur in both smaller infill projects as well as a few larger tracts of land on the western portion of Town.

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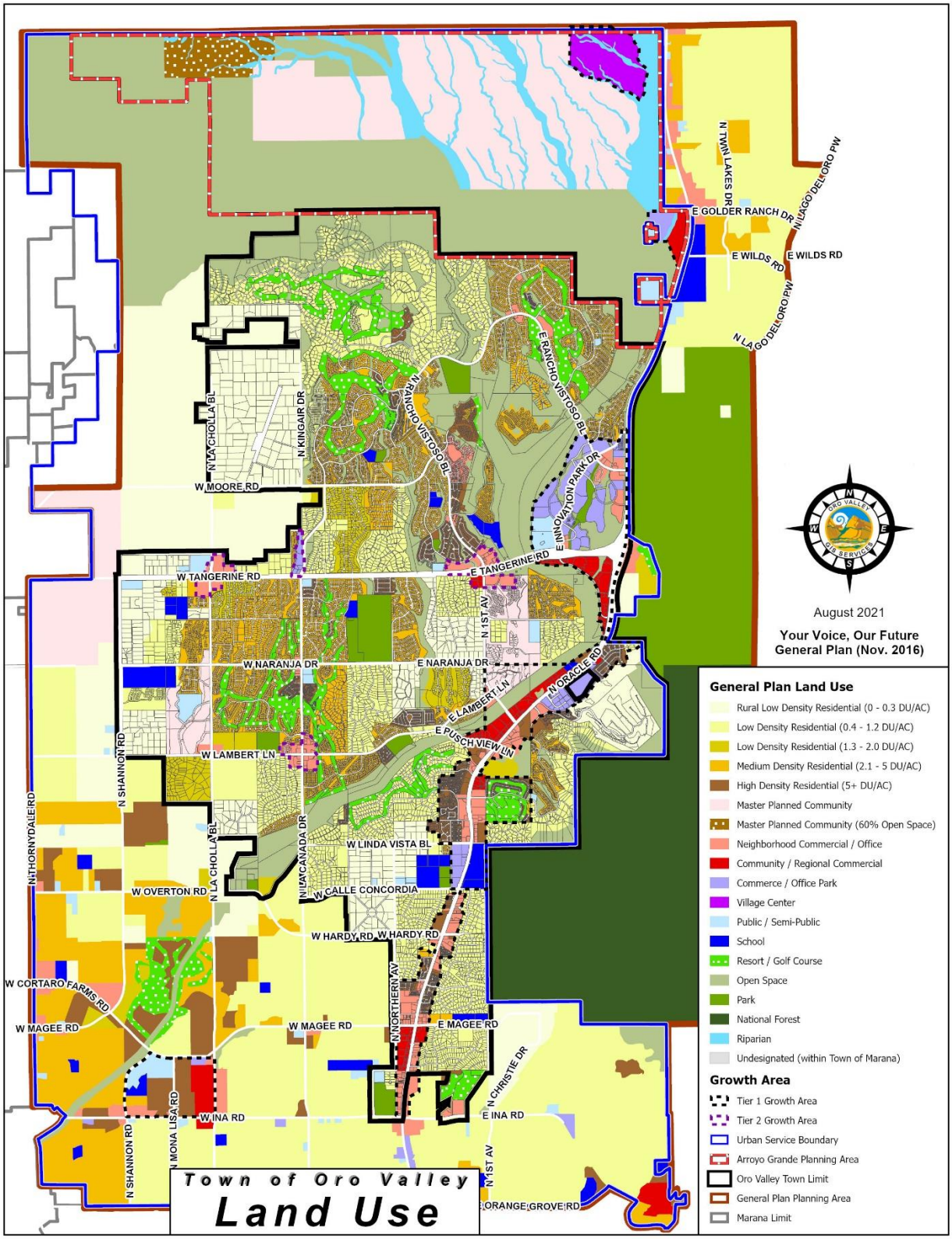


Source: Town of Oro Valley, 2021

Figure 2-6: Town of Oro Valley Land Use

Pascua Yaqui Tribe

The lands of the Pascua Yaqui became part of the United States in the 1870s. Calling themselves the Yaquis, the first modern settlements of these descendants from the ancient Uto-Azteca people, were near Nogales and South Tucson. Over time, the Yaquis spread out, settling north of Tucson in an area they named Pascua Village and in Guadalupe near Tempe. Retaining their religious and cultural ways of life, the Yaquis began calling themselves the Pascua Yaqui Tribe and accepted political integration into American society during the 1950s. In 1952, the Pascua Yaqui Tribe was annexed by the City of Tucson. In 1964, Congress transferred 202 acres of desert land southwest of Tucson to the Pascua Yaquis who were looking for an area to preserve their tribal identity. Members of the Pascua Yaqui Tribe relocating to the reservation struggled to secure federal recognition for the Tribe until finally being recognized in 1978. The Tribe acquired an additional 690 acres in 1988. In 1994, the Tribe's status was changed from a created tribe to a historic tribe.

Today, the Pascua Yaqui Tribe is scattered throughout eastern Pima County and includes several small communities. These communities include Yoem Pueblo in Marana, Old Pascua in Tucson, Barrio Libre in South Tucson, and the Pascua Pueblo, a 1.87-square mile reservation located southwest of the City of Tucson.

According to Tribal sources, the population as of August 2021 for the Pascua Yaqui Tribe within Pima County communities was 11,109. Table 2-3 summarizes enrolled Tribal membership by the various Pascua Yaqui communities located both within Pima County and outside. Enrollment demographics for the Pascua Yaqui Tribe have increased due to housing development. The community of New Pascua reservation proper is comprised of approximately 876 residential structures, 73 office and commercial buildings, and 5 commercial buildings under construction. An estimated 8,000 citizens reside within the exterior boundaries of the New Pascua reservation proper that includes tribal and non-tribal citizens.

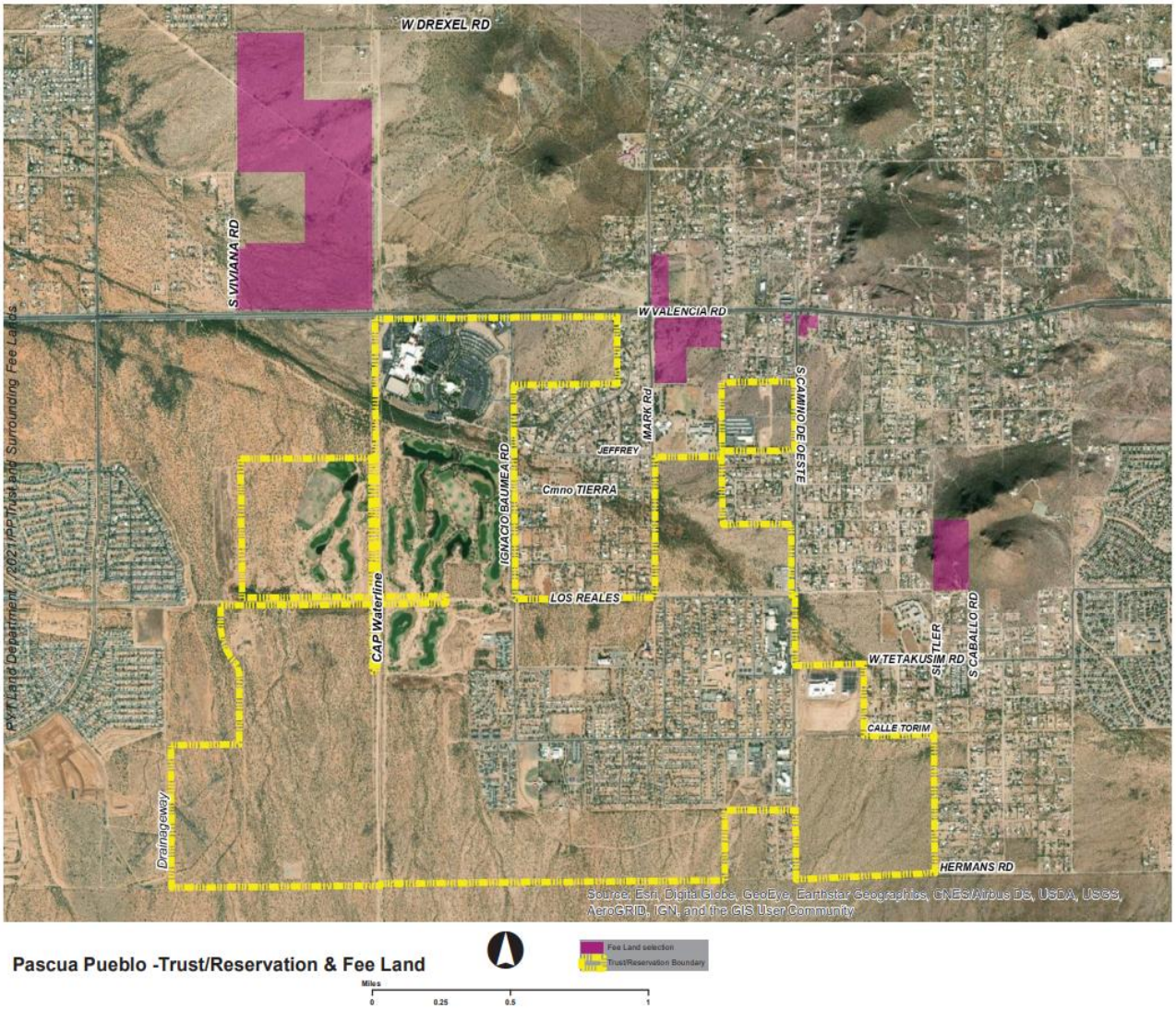
The Pascua Yaqui Tribe also had proposed amendments to its constitutions effecting the Tribe's base enrollment to its tribal members. The amendments were passed by the federal government that gave the authority to the Pascua Yaqui Tribal Council to have the power to enact ordinances, subject to the approval of the Secretary of the Interior, governing future membership and loss of membership. This rise in enrolment is reflected in Table 2-3 demographics with the Yaqui Communities of New Pascua and Marana falling under the Tribe and included in the Plan.

Table 2-3: Pascua Yaqui Tribal Enrollment Demographics

Pascua Yaqui Communities	Enrolled Members	
	2016	2021
New Pascua	5,086	5,137
Old Pascua	775	775
Barrio Libre (South Tucson)	741	748
Yoem Pueblo (Marana)	123	122
Guadalupe (Maricopa County)	3,537	3,616
High Town (Chandler)	113	118
Penjamo Pueblo (Scottsdale)	250	242
Eloy/Coolidge (Pinal County)	247	351
Community Total	**10,872**	**11,109**
Other Arizona Cities	6,446	9,966
Outside the State of AZ	2,011	
Total Active Membership	**19,329**	**21,075**

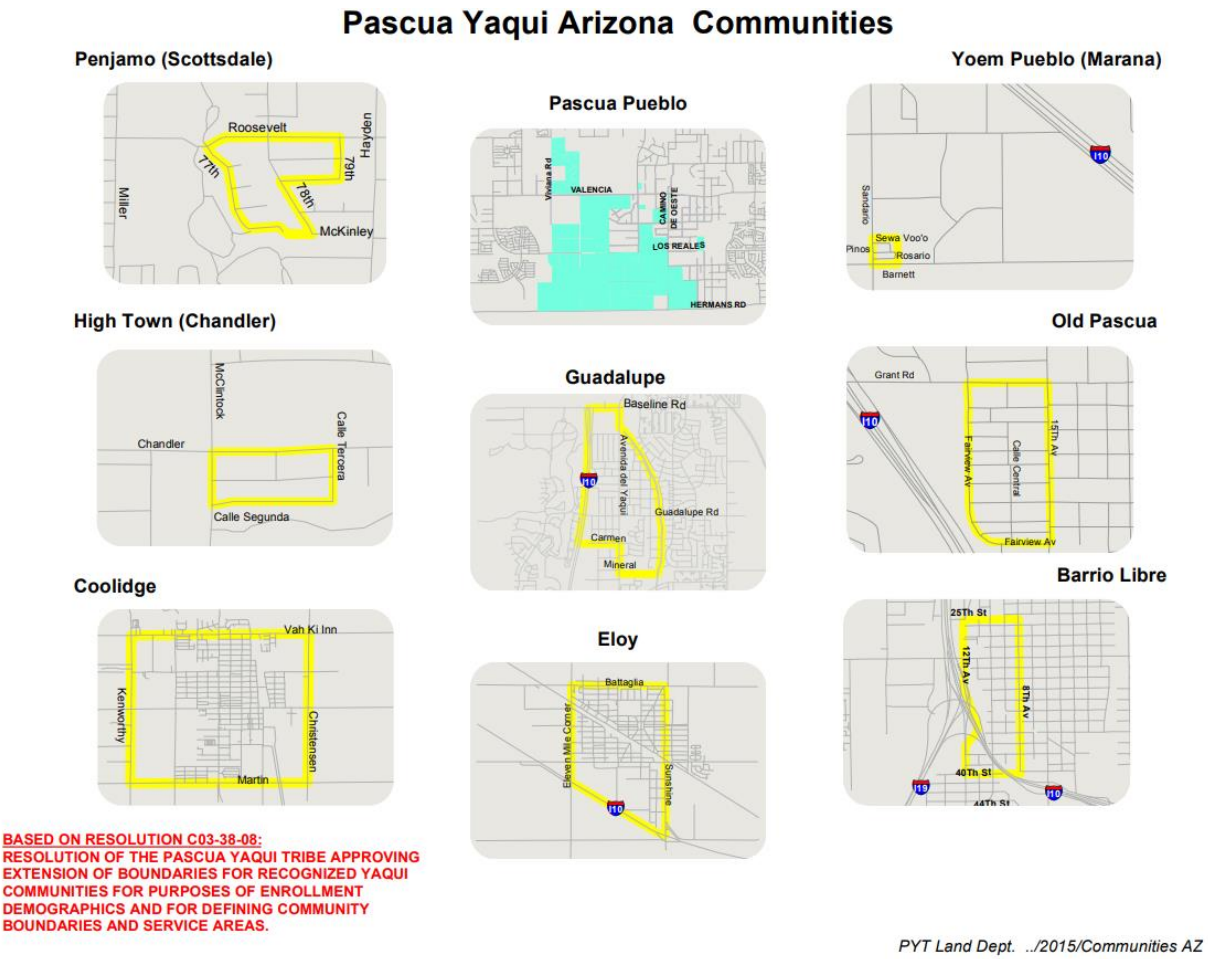
Source: Pascua Yaqui Tribe, September 2021

The Pascua Yaqui Tribe operates two casinos within Pima County, the 40,000 square foot Casino of the Sun and the 75,000 square foot Casino del Sol. Other tribal enterprises include the Sol Casino Hotel and Convention Center, which includes 215 rooms and a 20,000 square foot ballroom; Estrella Tower, which includes 151 rooms and a 1,081 square foot conference room(s) area; the Anselmo Valencia Amphitheater 4,470 seat open-air concert venue, and the Del Sol Marketplace. The Sewailo Golf Course opened in 2013 measures 7,400 yards from the championship tees, with 5 different tee boxes on each hole to allow for players of all abilities. It is known as one of the finest golf courses in Tucson and the state of Arizona.



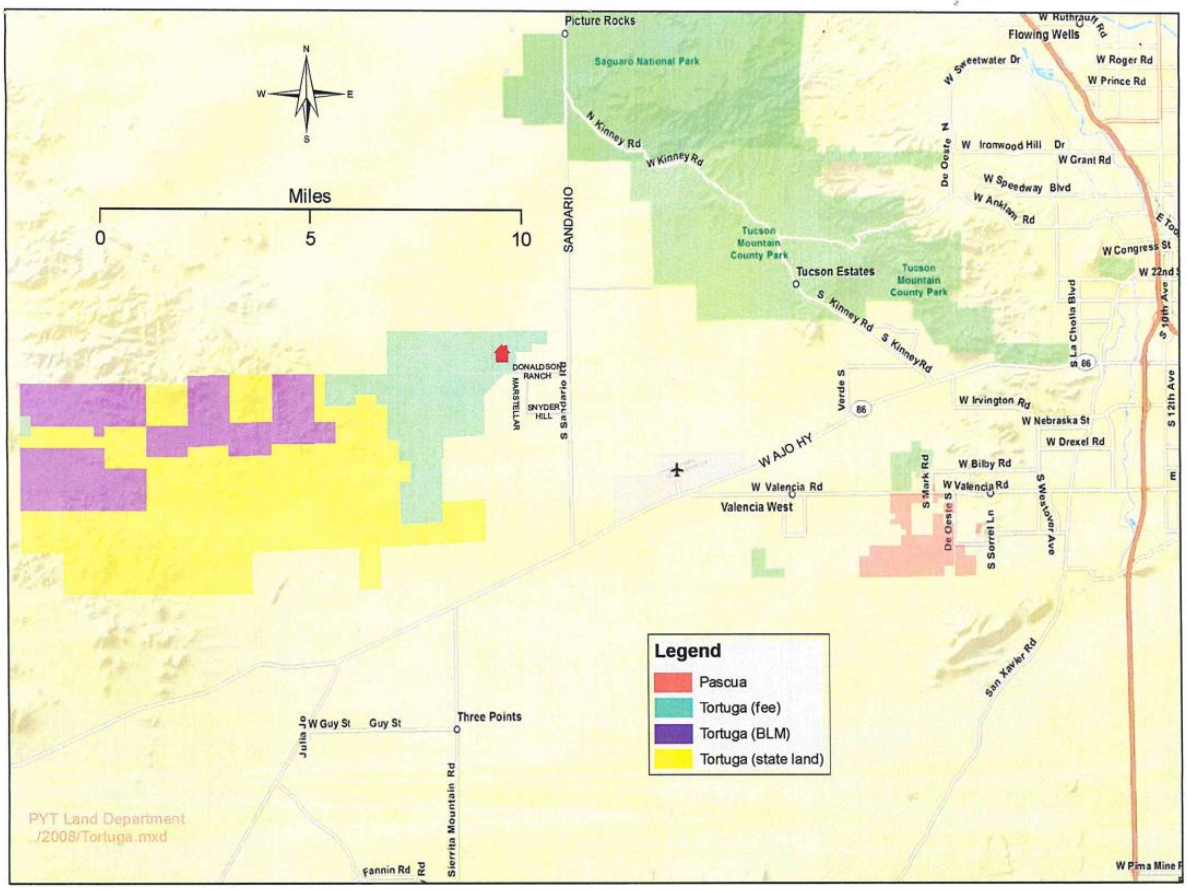
Source: PYT Land Department, 2021

Figure 2-7: Pascua Pueblo – Trust/Reservation & Fee Land



Source: PYT Land Department, 2021

Figure 2-8: Pascua Yaqui Communities



Source: PYT Land Department, 2021

Figure 2-9: Tortuga Ranch

Mochik – Tortuga Ranch is land located in western Pima County that is a combination of tribal, state, BLM, and Fee land. The Pascua Yaqui Tribe are stewards of this area that is used to house a number of tribal services to include:

- Desert planting and harvesting
- Equine Wellness Groups
- Green House: Teach cultivation and production to youth and community
- Hoop House: Habitat for growing cultural herbs and plants
- Ranch Skills Training
- Youth Horsemanship Skills
- Youth Ranch Skills

Town of Sahuarita

The Town of Sahuarita, incorporated in 1994, now encompasses a little over 31 square miles. Land uses within the incorporated boundaries of the Town include primarily residential and agricultural uses and vacant land. The next largest land use in the town is institutional, which includes schools, public uses, and utilities. In addition to these, there are commercial and light industrial land and recreational/open space uses.

The 2020 census found 13,569 dwelling units and 12,075 occupied households with a population of 34,134 (see Table 2-2). The Town population increased by 8,875 between the years of 2000 to 2020.

Table 2-4 Population and Housing

	2020 Total Census Population	Total Units 2020	Total Occupied 2020	Total Vacant 2020	Group Quarters Population 2020	Owner Occupied 2020	Renter Occupied
Sahuarita	34,134	13,569	12,075	1,494	87	75.5%	13.5%

Source: U.S. Census Bureau; 2020 Census

Using the 2020 Census average household size and average family size of 2.77 and 3.16, respectively, the Town calculates future population projections using 2.89 persons per unit. The 2020 Census found an almost equal male/female ratio within the study area. The Town does not currently have a large group quarters facility.

Within Sahuarita are five age-restricted communities: Quail Creek, a fully age-restricted master-planned community; Rancho Resort and Sonora within Rancho Sahuarita; La Jolla Verde, which lies southeast of I-19, and Duval Mine Road; and the Green Valley RV Resort that lies west of I-19 and north of Duval Mine Road. The Town shows a more traditional mix of population by age category not indicative of being skewed to the senior age groups. The Town of Sahuarita prides itself in being open to families with children as well as other household types.

Nearly 75.5% of the 12,075 occupied housing stock within the Town was owner-occupied in 2020. Based on this demographic holding in the future, the Town should plan either on ensuring that there is an adequate supply of single-family housing or assume that a significant part of its housing stock will likely be owner-occupied units. National trends, however, show a shift towards smaller household sizes and an increase in renting vs homeownership. It is unclear if this trend will affect Sahuarita, but it may be prudent to plan for a variety of housing types to best position the Town for the future.

Sahuarita represents five predominant land use themes today. First are the existing, older residential areas, primarily on larger lots, located in the western portion of the town, and interspersed by undeveloped properties.

Secondly, there is the rise of the master-planned community from Rancho Sahuarita to the northwest and Madera Highlands and age-restricted Quail Creek to the southeast. Most of the growth anticipated in the Town during the life of the 2015 general plan will occur within master-planned communities. Each is unique and caters to its individual market but differs from more rural Sahuarita.

Third, are the developing commercial and potentially mixed-use centers in the southern portion of the Town around the intersection of I-19 and Duval Mine Road. These centers provide regional services to Green Valley and much of the Upper Santa Cruz Valley in addition to Town residents.

Fourth are the production of agriculture orchards and ranches in the eastern portion of the Town. Some of this land lies within the 100-year floodplain, but some of it lies outside and is imminently developable. Agricultural employment, in particular, the pecan orchards owned and operated by Farmers Investment Company (FICO), provides a source of employment in the community that brings in revenues from outside the Town and helps the local economy. It is expected that over time, FICO holdings will likely convert to more urban scale development, completely or in part. The Sahuarita Farms Specific Plan and River Master Plan reflect the type of transition anticipated in this area.

Lastly, the Santa Cruz River and its large floodplain, which bisect the Town, provide both a constraint and an opportunity. Most of the river's floodplain within the Town is not in a natural condition today; indeed, there are several structural uses, particularly around the historic Sahuarita town site as well as irrigated agriculture and institutional uses. Currently, there are no flood control measures planned for the Santa Cruz River within the Town of Sahuarita; however, consideration of such measures in the future may occur, pursuant to pre-existing agreements and the recently approved Sahuarita and Continental Farms River Master Plans.

Major employers in the area include Freeport-McMoRan and Asarco; Caterpillar Proving Grounds; FICO; Wal-Mart; Fry's; Safeway; Desert Diamond Casino, an Enterprise of the Tohono O'odham Nation; the Sahuarita School District; and the Town of Sahuarita itself.

Size and Location

Currently 31 square miles in area, Sahuarita is located just 15 minutes south of Tucson and approximately 40 minutes north of the Mexican border. Tucson International Airport is within a 20-minute drive.

Located along I-19, 40 minutes north of the U.S./Mexico border and 18 miles south of downtown Tucson, Sahuarita is uniquely positioned to capture 24 million annual visitors from Mexico. Sahuarita is overflowing with retail opportunities, executive living, and a viable center for companies and employers to conduct business with Mexico.

Each day, on average, more than 65,000 Mexican residents come to Arizona to work, visit friends and relatives, recreate, shop, and spend over $7,350,000. This contributes substantially to Arizona's export trade with Mexico. Familial ties, long-term friendships, work opportunities, leisure activities, and shopping experiences not yet available in Mexico continue to support strong cross-border interactions between Arizona and its neighbor, Sonora.

Town Government

The Town of Sahuarita operates under the council-manager form of government. The Sahuarita Town Council is responsible for the policy matters of the town, and the town manager oversees staff and carries out the day-to-day functions of the town. Sahuarita is administered by the seven-member town council, which includes a Mayor and Vice Mayor. The Mayor and Vice Mayor are not elected into those positions but are instead chosen among elected council members. The Town Council oversees all issues pertaining to Sahuarita, including residential and commercial development and natural preservation.

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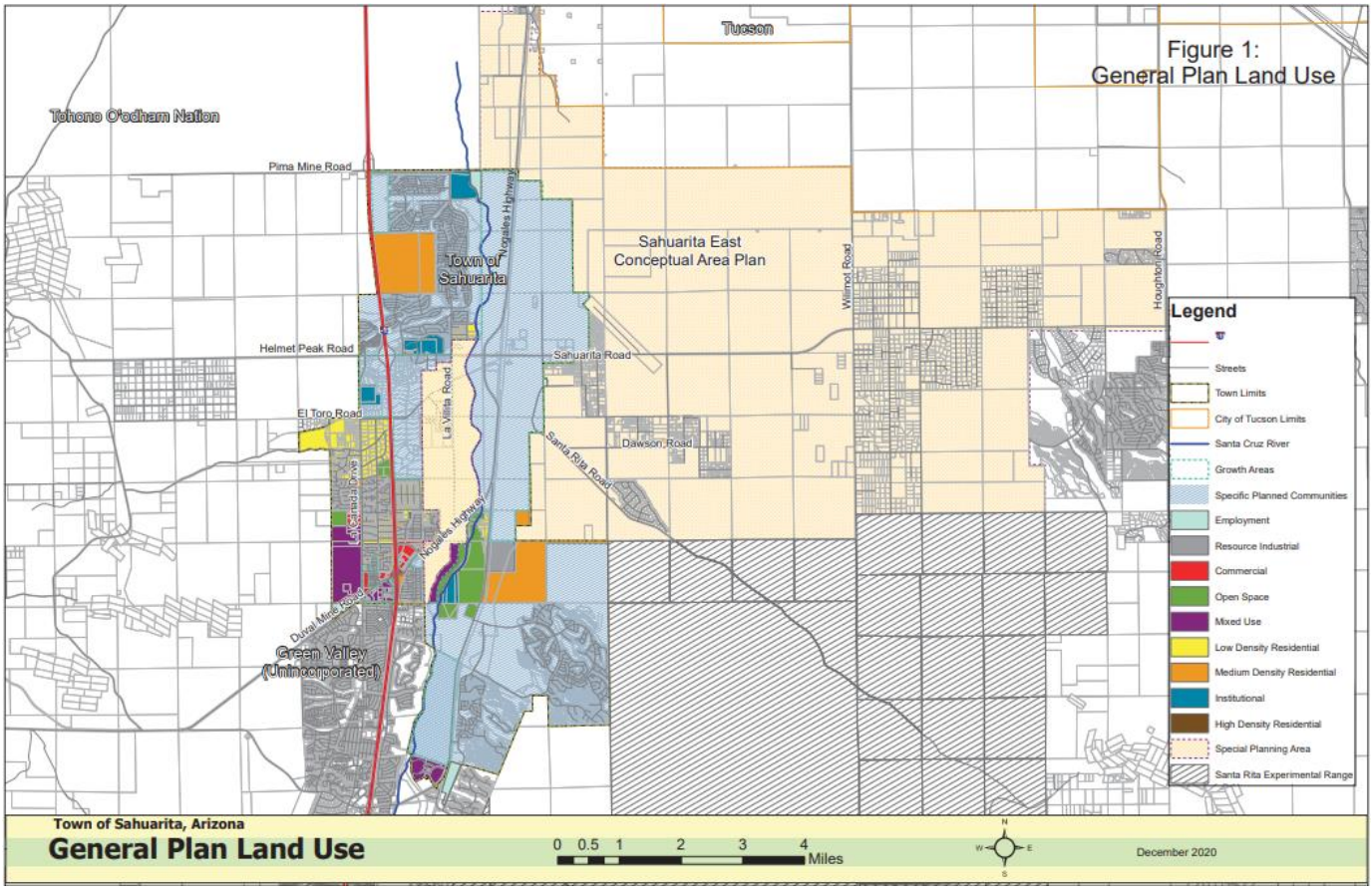

Source: Town of Sahuarita

Figure 2-10: Town of Sahuarita General Plan Land Use

City of South Tucson

Surrounded by the City of Tucson, the City of South Tucson is a one square mile community just south of historical downtown Tucson nestled between the junction of Interstates 10 and 19. Rich in ethnic heritage, this small community services a population of which 83% are Mexican-American and 10% are Native American. Developed as a suburban community to Tucson, South Tucson enjoyed a colorful history after incorporation in 1936, un-incorporation in 1938, and reincorporation in 1940.

The City of South Tucson is located within a U.S. Department of Housing and Urban Development (HUD) –designated Empowerment Zone and Tucson Pima Enterprise Zone, both of which are dedicated to revitalizing dilapidated areas in the greater Tucson metropolitan area. The City of South Tucson has also been designated a rural 'Colonia' by the United States Department of Agriculture.

A Mayor, Six Council Members, and a City Manager govern the City of South Tucson. The local police and fire department have both full-time and volunteer personnel.

In 2020, the population of South Tucson was 4613, an 18.4% decrease over the 2010 population of 5652. South Tucson will continue to provide a small declining percentage of Pima County's overall resident population. This pattern is reflective of the strong growth throughout eastern Pima County and the City's inability to gain in available landmass. Similarly, South Tucson's small labor force is anticipated to parallel the Town's population growth by comprising a smaller share of the region's employment opportunities. The City of South Tucson updated their General Plan in 2002. Although not mandated to contain Growing Smarter elements due to their small size, this information was added to the 2002 revision to provide consistency with other municipalities in the region.

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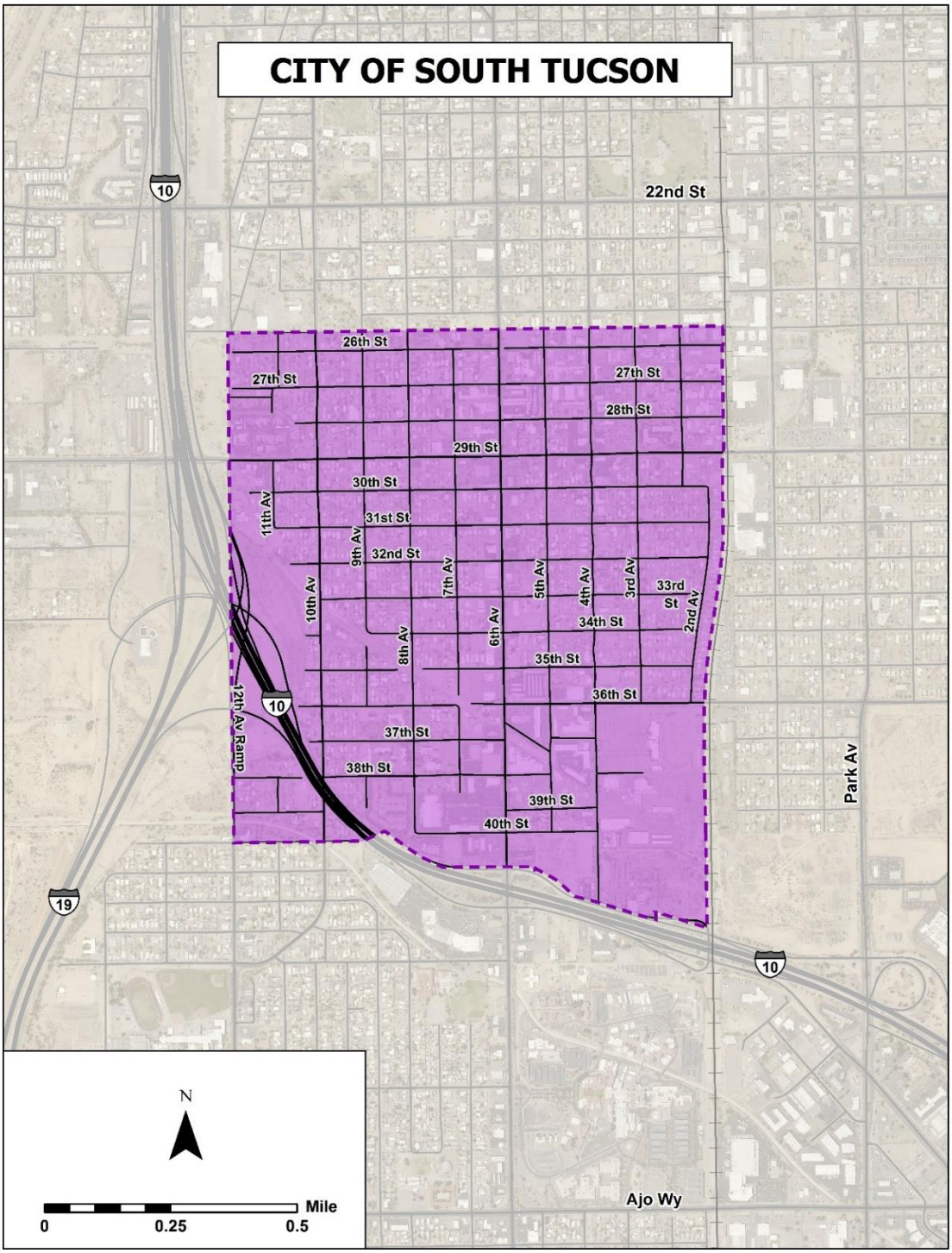

Source: Pima County Geographical Information Systems, 2021

Figure 2-11: City of South Tucson Land Ownership and Location

City of Tucson

The City of Tucson, Arizona's second-largest and oldest city, serves as the focal point for political, economic, and cultural activities for Pima County. Prior to the establishment of the first Spanish mission in 1700, San Xavier del Bac, and the arrival of the Spanish Conquistadors, various Native American tribes including the Pima, Hohokam, and the Tohono O'odham inhabited the area presently occupied by the City of Tucson. Founded in 1775, Tucson began as a Spanish military garrison to protect settlers from Indian raids from nearby tribes. Receiving independence from Spanish colonial rule in 1821, governance of the area passed to the Republic of Mexico and remained part of the State of Sonora until 1854 when it became part of the United States with the Gadsden Purchase. Formally incorporated in 1877 with an area of 2 square miles, the City of Tucson presently includes 240 square miles and is the nation's thirty-third (33rd) most populous city. Fueled by the availability of cheap and abundant land, Tucson experienced rapid growth in the 1950s following World War II. Much of this new growth, however, occurred outside the city limits leading to a widespread lineal development pattern. Surrounded by unincorporated portions of Pima County, Tucson completely surrounds the City of South Tucson and is in close proximity to the smaller communities of Marana to the northwest, Oro Valley to the north, and Sahuarita to the south. A mayor and six City Council Members representing various wards within the City govern Tucson. Operating under a charter form of government, the Mayor and City Council set policies to be carried out by an appointed City Manager and other city officials.

Known for its natural beauty, Tucson's natural environment is characteristic of the Sonoran Desert with diverse habitats and conditions ranging from low land deserts to the highlands of the Santa Catalina and Rincon Mountains. In addition to the rich biodiversity of the region, the proximity of the Mexican border and the presence of the University of Arizona and the Davis-Monthan Air Force Base, which draw residents from throughout the United States as well as from other countries, influence the City's cultural diversity and tradition for cultural heritage preservation. As depicted in Figure 2-12, Tucson's primary transportation corridors are Interstates 10 and 19, which provide accessibility to distant urban locations, and a well-developed arterial network providing connectivity within the metropolitan area. Tucson International Airport, providing commercial air service, and Ryan Airfield, serving business and general aviation traffic, provide additional transportation service to Tucson.

The City of Tucson has experienced tremendous growth in the infrastructure and population since its incorporation over 145 years ago. This growth has led to a current population of 554,146 people with positive growth in 2020 of 5.19%. The population of Tucson represents 53% of the county according to the 2020 Census. Regardless of its role as the regional focal point, Tucson's relative position as the population center will slow in the future as other incorporated jurisdictions and unincorporated communities in the urban periphery absorb a larger share of the regional growth. Tucson has a broad-based economy anchored in tourism, higher education, retail, military, government, and various high-tech and health care employers. With 350 days of sunshine every year, tourism is a major economic engine for the Tucson community. Major world-class attractions include Saguaro National Park, the Arizona-Sonora Desert Museum, and the Pima Air and Space Museum. Thousands of visitors attend annual signature events, such as the Tucson Gem and Mineral Show, El Tour de Tucson, 4th Avenue Street Fair, All-Souls Procession, and the Tucson Rodeo and Parade (La Fiesta de los Vaqueros). These visitors generate sales in lodging, dining, retail, recreation, and transportation and have an estimated local impact of $150 million.

The economic forecast is calling for expansion at a moderate pace with gains in jobs, income, and population. In 2018, retail sales increased approximately 5.3%, while personal income increased 5.7%. The preliminary estimate for the October 2018 unemployment rate is 4.4%, a slight increase from 4.0% in October 2017, and median home sale prices increasing by 3.7%. The City's revenues, particularly business privilege and transient occupancy taxes, were increasing at a more significant percentage than any other year. With sales tax revenues comprising approximately 41% of the City's General Fund, and retail sales being a major component, the City experienced strong sales tax growth from fiscal year 2019 amount of $219.3 million to the fiscal year 2020 amount of $225.9 million; a 3% increase.[1] Even during the Coronavirus Virus 2019 (COVID-19) Pandemic brought uncertainty the City of Tucson

[1] Comprehensive Annual Financial Report 2020 https://www.tucsonaz.gov/files/finance/Accounting/City_of_Tucson_CAFR_FY_2020.pdf Pg.vii

still growth one example was in permits issued for new buildings from 2019 at 1,151 permits issued to 1,169 permits issued in 2020.

Approved in December of 2013, Tucson's General Plan reflects a community that is responding to the diverse nature of its residents and the natural character of the region as represented in Figure 1. The plan anticipates that new growth will be accommodated primarily through infill development; higher density, mixed-use activity centers; and corridor planning to reduce the peripheral sprawl. Tucson is positioning itself to take advantage of its distinctive natural setting by clearly separating urban uses from rural and natural resource-based areas. Economic development activity will be encouraged to locate transportation hubs along existing transportation corridors including I-10, I-19, the Southern Pacific Railroad, and airports. As an alternative to the linear pattern of commercial development, small-scale neighborhood commercial centers will be focused on major street intersections with regional centers positioned in mixed-use activity centers.

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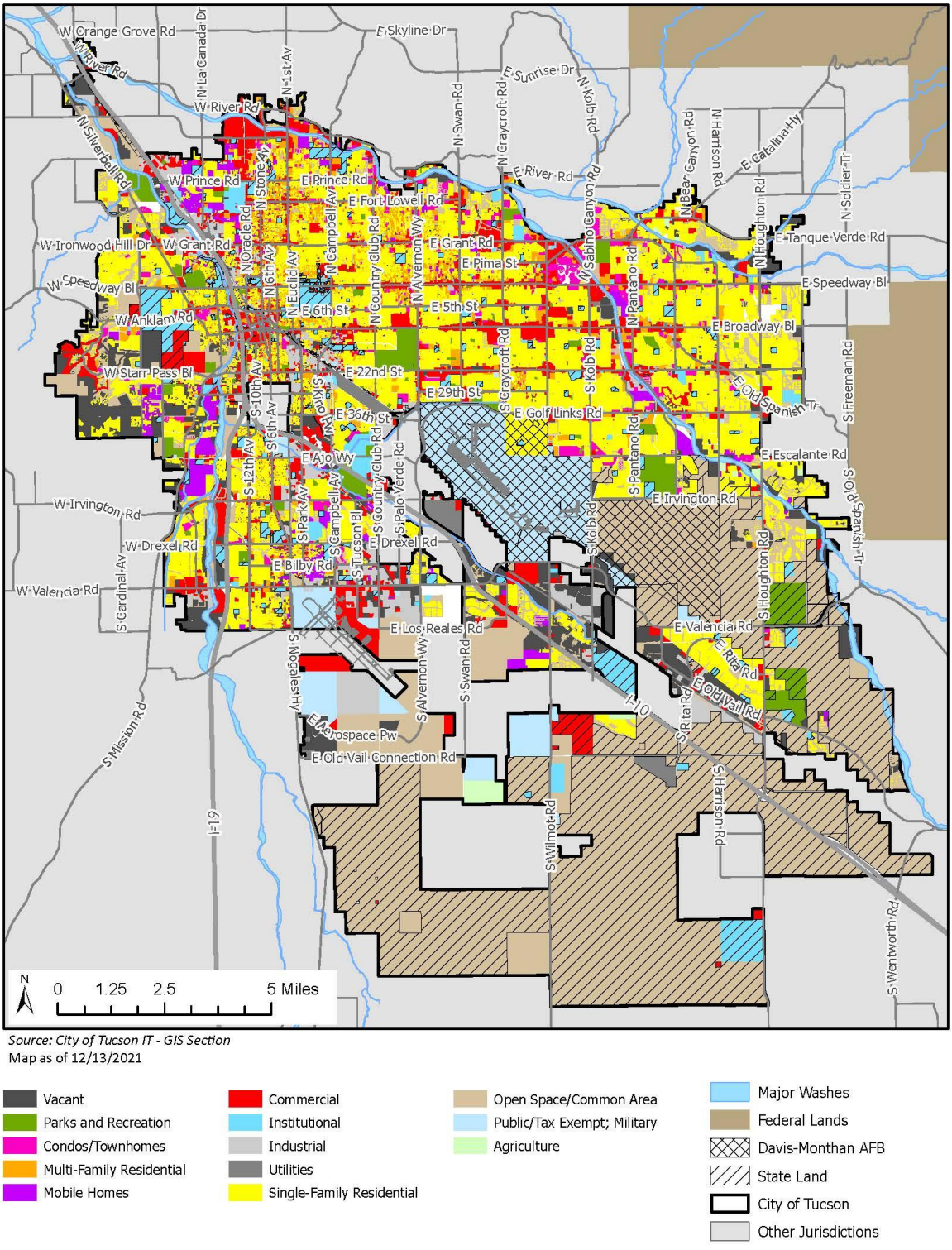


Source: City of Tucson GIS

Figure 2-12: City of Tucson Land Ownership and Location

SECTION 3: PLANNING PROCESS

3.1 Planning Process

The 2022 Plan update was a countywide effort that included revising and updating the previous plan, integrating new components into the plan, and incorporating new participants into the planning process.

A multi-jurisdictional planning team was assembled to review the 2017 plan, evaluate its efficacy over the last five years, and propose revisions for the 2022 plan. County Administration extended invitations to participate in the planning process to each jurisdiction's Mayors, Town Managers, and Emergency Managers within the planning area. In addition, invitations to participate were extended to over 80 partners and community stakeholders, including non-government organizations, academia, and the private sector.

Two levels of planning teams were organized for this Plan update. The first was a Multi-Jurisdictional Planning Team (MJPT) comprised of one or more representatives from each participating jurisdiction and predominantly the primary points of contact. The second level planning team was the jurisdiction's Local Planning Team (LPT).

PCOEM served as the lead planning agency for the process, with support from the Arizona Department of Emergency and Military Affairs (DEMA). Pima County's Emergency Management Planner took the lead in recruiting participants, conducting planning team meetings, tracking progress, editing documents, and keeping the project on schedule. The MJPT members were responsible for evaluating and updating the sections of the plan for their respective jurisdictions and supporting Pima County in completing the plan.

3.2 Planning Activities and Teams

The planning team facilitated the coordination, research, and planning element activities to update the 2022 Plan. Four multi-jurisdictional planning team meetings were conducted over the period of August 2021 through February of 2022, beginning with the first meeting on August 11, 2021. Representatives from each jurisdiction were required to participate in all planning team meetings, as the meetings were structured to take the jurisdictions through a systematic planning process. At each meeting, next steps and procedures were presented and discussed, progress was reported, and the action items assigned. Subsequent meetings built on the information discussed previously and on the individual assignments completed between meetings. In addition, jurisdictions also conducted independent meetings and coordination efforts to compile and contribute to the overarching planning efforts.

The MJPT representatives, noted in Table 3-1, had the responsibility of being the liaison to the jurisdictional LPT, and were tasked with the following primary responsibilities:

- Conveying information and assignments to the jurisdictional LPT of which several jurisdictions organized for specific plan parts or for mitigation ideas.
- Ensuring all requested assignments were completed fully and returned on a timely basis.
- Arranging for review and official adoption of the final Plan.

To support MJPT, the jurisdictional LPT, noted in Table 3-2, were tasked with:

- Convening meetings as needed to work through assignments from the Planning Team.
- Providing support and data.
- Developing and refining mitigation strategies.
- Assisting with the prioritization of hazards and plan objectives.
- Assisting the MJPT representatives with assignments.
- Making planning decisions regarding Plan components.
- Reviewing the Plan draft documents.

Cultivating a well-rounded, representative planning team was the responsibility of the PCOEM. Using the list of participants from the 2017 Plan as a guide, the PCOEM identified a list of potential participants and contributors to the 2022 Plan update. PCOEM initiated contact with and extended invitations to participate to jurisdictional representatives and agencies from all incorporated communities within Pima County, the Pascua Yaqui Tribe, and the Tohono O'odham Nation.

Pascua Yaqui tribal members/citizens and partners were invited to participate in the process. Due to the ongoing COVID-19 Pandemic, all planning meetings were conducted via virtual workshops, emails, phone calls, and one-on-one sessions throughout the process.

Table 3-1: Multi-Jurisdictional Planning Team Participants (participants in **bold** returning members)

Name	Jurisdiction / Organization	Planning Team Role
Ackerman, Char	Town of Oro Valley	MJPT Member, Jurisdictional Point of Contact, Lead Planner for the Town of Oro Valley
Hill, Sgt. David	City of Tucson / Office of Emergency Management	MJPT Member, Jurisdictional Point of Contact and Lead Planner for City of Tucson
Lebsack, Rita	Town of Marana	MJPT Member, Jurisdictional Point of Contact, Lead Planner for Town of Marana
Galvale, Galovale	Town of Sahuarita	MJPT Member, Jurisdictional Point of Contact, Lead Planner for the Town of Sahuarita, LPT Lead for the Town's Wastewater and Floodplain Hazard
Maese, Alexandria	AZ Department of Emergency and Military Affairs	State Mitigation Strategic Planner, Management Level Support for Planning Effort, Mitigation Strategy Development
Mesa, Paul	Pascua Yaqui Tribe Office of Emergency Management	MJPT Member, Lead Jurisdictional Point of Contact, Lead Planner for Pascua Yaqui Tribe
Moya-Flores Griselda	Pima County Office of Emergency Management	Lead Planner

An integral part of the planning process was working with other agencies and organizations, both within and outside of the participating jurisdiction's governance, to obtain specialized information and data for inclusion into the Plan or to provide more public exposure to the planning process. In addition to the adopting jurisdictions, several agencies and organizations that operate within, or have jurisdiction over small and large areas of Pima County were invited to participate in the planning process. Some were invited to the first planning meeting, while others were brought in as the MJPT discovered a need for their assistance.

The other agencies and organizations who assisted by providing data or otherwise contributing to this Plan are listed in Table 3-2. The specific jurisdiction with whom they collaborated is noted.

Table 3-2: Local Planning Team and Content Resources (participants in **bold** returning members)

Name	Agency/Dept./Division	Role/Contribution
Abraham, Peter	Town of Oro Valley	Local Planning Team Member for Town of Oro Valley
Abramovitz, Beth	Town of Sahuarita	Local Planning Team Leader for Town of Sahuarita

Table 3-2: Local Planning Team and Content Resources (participants in **bold** returning members)		
Name	**Agency/Dept./Division**	**Role/Contribution**
Acuña, Guy	Pima County Office of Emergency Management	Local Planning Team Member for Pima County, Wildfire Hazard Technical Information
Adler, Margie	Town of Oro Valley	Local Planning Team Member for Town of Oro Valley
Armendariz, Xavier	Pima County Information Technology	Local Planning Team Member for Pima, GIS Lead
Bahe, Jason	Pascua Yaqui Tribe Facilities Department	LPT Member for Pascua Yaqui Tribe, Flood Information Resource
Bellavance, Bailey	Town of Marana	LPT Member Town of Marana GIS Support
Bowlden, Michael	City of Tucson General Services Department	LPT Member for City of Tucson
Boyce, Karn	Town of Oro Valley	LPT Member for Town of Oro Valley, Water Resources
Boyer, Chuck	Town of Oro Valley	LPT Member for Town of Oro Valley
Boyle, Erin	NOAA	Climate and Weather Expert
Bran, Keith	Town of Marana	LPT Member Town of Marana, Engineering and Planning
Browning, Sharon	Pima County Health Department	LPT Member for Pima County
Burk, Daniel	Tucson Fire Department	LPT Member for City of Tucson
Canale, Todd	Davis-Monthan AFB/Fire Emergency Services	Local Planning Resource
Cardnal, Chris	City of Tucson GIS	LPT Member for City of Tucson, GIS Lead
Casadei, Anna	Town of Sahuarita	Local Planning Team Member for the Town of Sahuarita, Planning and Zoning
Catanzaro, Michael	City of Tucson General Services Department	LPT Member for City of Tucson
Chavez, Kathy	Pima County Office of Sustainability	LPT Member for Pima County, Climate Resource, Drought Hazard Lead
Conroy, Jim	Town of Marana	LPT Member for Town of Marana, Fire Hazard Mitigation Information
Conway, Michael	Arizona Geological Survey, The University of Arizona	Climate and Geological Expert
Crowe, Jonathan	Pima County Department of Transportation	LPT Member for Pima County, Landslide Hazard lead
Drozd, Ken	NOAA	Climate and Weather Expert
Espinoza, Sandra	Pima County Office of Emergency Management	LPT Member for Pima County, Management Level Support
El-Ali, Mo	Town of Marana	LPT Member for Town of Marana Public Works Information

Table 3-2: Local Planning Team and Content Resources (participants in **bold** returning members)		
Name	**Agency/Dept./Division**	**Role/Contribution**
Felix, Fred	City of Tucson Transportation and Mobility	LPT Member for City of Tucson
Flood, Jennifer	Town of Marana	LPT Member for Town of Marana, Floodplain Information
Flores, Carlos	Pascua Yaqui Tribe Fire Pascua Yaqui Tribe Department	LPT Member for Pascua Yaqui Tribe, Fire Ordinances, Laws and Codes Resource
Fortes, Tony	Land Department	LPT Member for Pascua Yaqui Tribe, GIS planning resource
Freer, Richard	Town of Oro Valley	LPT Member for Town of Oro Valley , GIS Support
Hathaway, Vic	Town of Marana	LPT Member for Town of Marana, Community Description Resource
Hitt, Greg	Pima County Capital Program Office	LPT Member for Pima County, Designated Liaison for City of South Tucson
Hoyos, Artemio	Pascua Yaqui Tribe Economic Development	LPT Member for Pascua Yaqui Tribe, Community Description, Economic and Land Use Planning Resource
Jackson, Greg	City of Tucson Parks and Recreation	LPT Member for City of Tucson
Johnson, Sgt. Steven	Town of Marana Police Department	LPT Member for Town of Marana
Kosiorowski, Joey	Green Valley Fire District	Historical Information for Wildfire Hazard
Ladd, Keith	University of Arizona	Climate Resource
Lee, Jenette	Pima County Regional Wastewater Reclamation	LPT Member for Pima County, Wastewater, Wind Hazard Lead
Leibold, Elizabeth	City of Tucson Transportation and Mobility	LPT Member for City of Tucson
Lewis, Lt. Dan	Tucson Police Department/Emergency Management	LPT Member for City of Tucson, Supervisor City of Tucson project
Luna, Fatima	City of Tucson Mayor and Council	LPT Member for City of Tucson
Lunde, Steve	Golder Ranch Fire District	LPT Member for Town of Oro Valley
Macias, Barbara	Pascua Yaqui Tribe Information & Technology Department	LPT Member for Pascua Yaqui Tribe, IT Network Resource
Matus Sr., Andre	Pascua Yaqui Tribe Office of Emergency Management	LPT Member for Pascua Yaqui Tribe, Hazard Mitigation Actions and Projects Development
Matus, Andre	Pascua Yaqui Tribe Fire Department	LPT Member for Pascua Yaqui Tribe, Wildland Fire Resource
McDowell, Jennifer	Pima County Health Department	LPT Member, Lead Planner for Pima County Health Department

Table 3-2: Local Planning Team and Content Resources (participants in **bold** returning members)		
Name	**Agency/Dept./Division**	**Role/Contribution**
McGlone, Matt	Pima County Office of Emergency Management	LPT Member, Community Outreach, Public Information Assistance for Pima County
Orchard, Lynn	Pima County Regional Flood Control	Advisory Information for Flood Hazard and Flood Notifications
Overstreet, Glenna	City of Tucson Parks and Recreation	LPT Member For City of Tucson
Quintanar, Dan	Tucson Water	LPT Member For City of Tucson
Romero, Lisa	Pima County Office of Emergency Management	LPT Member, Jurisdictional Administrative Support for Pima County
Saxe, Greg	Pima County Regional Flood Control	LPT Member, Flood Hazard Lead
Shepp, Eric	Pima County Regional Flood Control	LPT Member For Pima County, Flood Information Source
Simms, Karen	Pima County National Resources, Parks and Recreation	LPT Member For Pima County
Simms, Millini	Town of Oro Valley	LPT Member for Town of Oro Valley
Simon, Michelle	Pima County Library	Local Planning Resource, Ask A Librarian Resource For Community Profile
Small, Elias	Davis-Monthan AFB 355th Wing	Local Planning Resource
Spiker, John	Town of Oro Valley	LPT Member for Town of Oro Valley
Toma, Michael	Pascua Yaqui Tribe Fire Department	LPT Member for Pascua Yaqui Tribe, Environmental Resource
Trevillyan, Clayton	City of Tucson Planning and Development	LPT Member for City of Tucson
Valenzuela, Louie	Pima County Health Department	LPT Member, Jurisdictional Point of Contact for Pima County Health Department
Valenzuela, Steve	Pascua Yaqui Tribe Facilities Department	LPT Member for Pascua Yaqui Tribe, Community Description, Transportation, Traffic Resource

3.3 Public and Stakeholder Involvement

Public involvement and input to the planning process was encouraged cooperatively among all the participating jurisdictions using several venues throughout the revision planning cycle. This Plan remains on the county and individual jurisdiction's websites on a continual basis throughout all phases of the planning process. Once approved and adopted by each jurisdiction it will remain on Pima County's website for public review and comment. Public comments submitted through Pima County's website will be managed by Pima County disseminated to local jurisdictions for consideration and incorporation into the Plan. Stakeholders are assumed jurisdictional representatives, technical and subject matter experts and others not considered members of the public who have an interest in the development or use of the plan.

The pre-draft public involvement strategy for the Plan development included public web notices. The 2017 Plan was posted to the county website and made available for public review and comment. The local jurisdictions placed announcements on their websites linking the reader to the Plan on the county website. The post-draft strategy included

posting the draft plan to the county website, with website links from local jurisdictions, and requesting public comment. The PCOEM monitored the public notices through the county website, no questions or comments were received from either the draft or post-draft version of the Plan from the general public.

The PCOEM also reached out to surrounding counties during plan revision at regional meetings held by the Arizona Department of Emergency and Military Affairs.

For the Pascua Yaqui Tribe specifically, the Tribal Local Planning Team developed public notices that included links for capturing public feedback and comments. The initial notification of the 2022 Plan update was coordinated through the Pascua Yaqui Tribe Office of Emergency Management (PYT-OEM). In the notice circulated to the tribal communities and stakeholders, all requests for additional information, questions, or comments were routed to the PYT-OEM. The notice was also posted at the tribal administration office and included an area for comments to be submitted.

The PYT-OEM also distributed the notice for public comment on the draft of the 2022 Plan update. The notice included a link to Pima County's website for public review and comment. In addition, PYT-OEM's contact information was included as an additional method for collecting information, questions and, comments from tribal communities and stakeholders. The PYT-OEM monitored all online forums as well as in-person opportunities for public comment or feedback over the planning process update; however, no comments or feedback were submitted to be consolidated and incorporated into the Plan.

Tribal Definition of "Public"

While the Tribe does not have a specific legal definition of "public" the Tribe acknowledges its general public audience consists of enrolled tribal members, tribal-enterprise employees, and its visitors. The Pascua Yaqui Tribe has formulated the following statement to define "public" for the purposes of this planning effort to satisfy the Tribal Planning requirements:

"All residents of the Pascua Yaqui Reservation, as its boundaries may be revised from time to time."

Table 3-3: Past Public and Stakeholder Involvement

Jurisdiction	Activity or Opportunity
Pima County	• Maintained the county website that included the current Plan and provided contact information for continued comment and input. • Attended community events and engaged with the public on mitigation and preparation activities. • Conducted Emergency Management meetings with local emergency management professionals on a quarterly basis and discussed hazard mitigation events. • Worked with Pima County Regional Flood Control District on Community Rating System requirements such as planning and exercising. • Continued to improve and expand Public Notification and Warning capability, working with County DOT and PRFCD to expand monitoring, in addition to increasing awareness for partners and community members. • Maintained social media presence and focus on mitigation measures that citizens can take before monsoon and fire seasons. • Posted warning notices/pamphlets at public trailheads managed by Pima County Natural Resources, Parks, and Recreation regarding risks associated with flooding and overheating. • Provided environmental education programs that included components of monsoon safety, wildfire danger, and heat injury awareness.

Table 3-3: Past Public and Stakeholder Involvement	
Jurisdiction	**Activity or Opportunity**
City of Tucson	• City of Tucson Office of Emergency Management webpages were dedicated to preparedness and mitigation topics. • Performed annual "Operation Splash" outreach efforts to raise awareness of the dangers of driving through flooded washes and roadways. • Performed annual "Operational Freeze" outreach effort to raise awareness of the dangers of cold and freezing weather. • Utilized "Don't Get Swept Away, Find a Safer Place to Play" campaign to encourage people to avoid flooded washes and other storm water infrastructure during the monsoon season. • The Tucson Office of Emergency Management routinely utilized social media sites to share preparedness and mitigation information to the public. • Declaration signed by the Mayor and Council of September Preparedness Month, with public preparedness outreach at public events, via social media, on television etc. • Regular water conservation outreach efforts from Tucson Water Department via bill inserts, social media, television etc. • Weekly preparedness and safety tips via the Tucson Fire Department posted online and aired on television. • Monthly safety tips via the Tucson Police Department posted on social media. • Provided preparedness and mitigation brochures and pamphlets to each of the City Council Ward offices for their constituents, along with an orientation for Council staff on the mission of emergency management including mitigation efforts.
Town of Oro Valley	• Provided hazard awareness and preparedness information to the community through articles, social media, PSAs, podcasts, website, newsletters, public surveys, videos, meetings, youth outreach and education through the schools, and community presentations. • Partnered with Pima County Regional Flood Control District on post Bighorn Fire flood risks, mitigation projects, and outreach activities to properties affected. • Provided staff support and technical guidance to homeowners, businesses, and HOAs about flood mitigation projects on private property. • Expanded annual pre-monsoon education campaign and free sandbag program for Oro Valley residents. • Annual proclamation for September as National Preparedness Month, with associated messaging. • Provided information on how to sign-up for emergency notifications through CodeRed and Pima County MyAlerts. • Provided access to customer "WaterSmart" portal which encourages customers to conserve water and track usage. • Collaborated with regional partners on opportunities to engage the public through different methods.
Town of Marana	• Provided information to the public, business and first responders by participating in the Local Emergency Planning Committee (LEPC) for hazardous materials preparedness. • Provided floodplain related hazard and mitigation information to targeted properties in high-risk areas. • Provided flood hazard outreach to residents of the Town of Marana, located within the flood plain. • Provided a library of pamphlets in the Marana Municipal Complex (MMC) Lobby area for all interested parties to peruse and take for reference. • Established Water Academy which educates the community on water conservation and drought considerations.

Table 3-3: Past Public and Stakeholder Involvement	
Jurisdiction	**Activity or Opportunity**
Pascua Yaqui	• Continued mitigation activities in correlation to the Pascua Yaqui Tribe Improvement Projects program. • The Pascua Yaqui Tribe continued to use the plan for reference for profiling of cultural sites for economic development. • The Pascua Yaqui Department of Public Safety, who oversees mitigation planning, has supported the plan by referencing the plan with other tribal departments for grants and infrastructure improvement opportunities. • During Tribal Recognition Days, an information booth was set up to promote mitigation opportunities and hazard reduction.
Town of Sahuarita	• Town of Sahuarita website (https://sahuaritaaz.gov). • Town of Sahuarita Resident/Citizen Portal. • Town of Sahuarita Facebook.

Table 6-1 summarizes opportunities for continued public engagement and dissemination of information each jurisdiction plans to pursue when relevant and appropriate.

3.4 Reference Documents and Resources

Additional reference material, such as other plans, studies, reports, and technical information, was obtained during the planning process and reviewed for incorporation or reference in the updated plan. Much of the additional reference material pertained specifically to the risk assessment and the capabilities assessment. To a lesser extent, the community descriptions and mitigation strategy also benefitted from additional document and technical information research. Table 3-4 provides a reference listing of the primary resource documents and technical resources reviewed and used in the Plan. Detailed bibliographic references for the risk assessment are provided in each hazard risk profile in Section 4 as footnotes.

Table 3-4: Resource documents reviewed and incorporated in this plan	
Resource	**Description of Reference and Its Use**
AZ Department of Emergency and Military Affairs	Resource for state and federal disaster declaration information for Arizona. Also a resource for hazard mitigation planning guidance and documents.
AZ Department of Water Resources	Resource for data on drought conditions, statewide drought management, and land subsidence all used in risk assessment.
AZ Geological Survey	Resource for earthquake, fissure, landslide/mudslide, subsidence, and other geological hazards. Used in the risk assessment.
Census Bureau	Source for 2020 Census demographics.
Federal Emergency Management Agency	Guidance (How-To series) for floodplain and flooding related NFIP data (mapping, repetitive loss, NFIP statistics), and historic hazard incidents. Used in the risk assessment and mitigation strategy.
HAZUS-MH	Based data sets within the program were used in the vulnerability analysis.
National Climatic Data Center	Online resource for weather related data and historic hazard event data. Used in the risk assessment.
National Weather Service	Source for hazard information, data sets, and historic event records. Used in the risk assessment.
National Wildfire Coordination Group	Source for historic wildfire hazard information.
Pima County Hazard Mitigation Plan (2017)	FEMA approved hazard mitigation plan that is the subject of the plan update process.
Arizona State Climatologist	Reference for weather characteristics for the county. Used for community descriptions and risk assessment.
US Forest Service	Source for local wildfire data.
US Geological Survey	Source for geological hazard data and incident data. Used in the risk assessment.
Western Regional Climate Center	Online resource for climate data used in climate discussion.

SECTION 4: RISK ASSESSMENT

4.1 Risk Assessment

One of the key elements to the hazard mitigation planning process is the risk assessment. In performing a risk assessment, a community determines "what" can occur, "when" (how often) it is likely to occur, and "how bad" the effects are, are generally categorized into the following measures:

Hazard Identification and Screening

Assessing Vulnerability to Hazards

Hazard Profiling

The risk assessment for Pima County and participating jurisdictions was performed using a countywide, multi-jurisdictional perspective, with much of the information gathering and development being accomplished by the MJPT. This integrated approach was employed because many hazard events are likely to affect numerous jurisdictions within the county and are not often relegated to a single jurisdictional boundary. The vulnerability analysis was performed in a way such that the results reflect vulnerability at an individual jurisdictional level and at a countywide level. For most of the hazards, quantitative vulnerability was removed, and a qualitative vulnerability created by each of the jurisdictions for the hazards that they identified as priorities in their area.

4.2 Hazard Identification

For this Plan, the list of hazards identified in the 2017 Plan were reviewed by the planning team with the goal of refining the list to reflect the hazards that pose the greatest risk to the jurisdictions represented by this Plan.

Table 4-1: Comparison of Plan Hazards

2017 Hazards for Plan	2022 Hazards for Plan
• Drought	• Drought
• Earthquake	• Earthquake
• Extreme Cold	• Extreme Cold
• Extreme Heat	• Extreme Heat
• Flood	• Flood
• Landslide	• Landslide
• Severe Wind	• Severe Wind
• Wildfire	• Wildfire

The review included an initial screening process to evaluate each of the listed hazards based on the following considerations:

- Experiential knowledge on behalf of the planning team regarding the relative risk associated with the hazard;
- Documented historic context for damages and losses associated with past events (especially events that have occurred during the last plan cycle);
- The ability/desire of planning team to develop effective mitigation for the hazard under current DMA 2000 criteria;
- Compatibility with the state hazard mitigation plan hazards; and
- Duplication of effects attributed to each hazard.

Each jurisdiction evaluated and rated the hazards using the Calculated Priority Risk Index (CPRI) and met to discuss results amongst the jurisdictions after they had chosen hazards for their jurisdiction to address.

The table below summarizes federal and state disaster declarations that included Pima County. If a hazard is not listed, that means there were no events reported for that hazard.

Table 4-2: Pima County Declared Disaster Costs (1995 – 2020)

Incident Type	Disaster Area	Declaration Date		State Declaration	Expenditures	
		State	Federal	Terminated	State	Federal
	Statewide - Wheat (Karnal Bunt)	03/13/96		10/21/98	$ 796,455.78	
Wildfire	Wildfire – Statewide	05/16/96		10/21/98	$ 1,000,728.63	
Drought	Drought – Statewide	06/07/96		10/22/98	$ 211,499.19	
	Red Imported Fire Ant – Statewide	01/20/99				
	Wildland – Statewide	05/06/99		05/10/00	$4,894.09	
Drought	Statewide Drought	06/23/99			$ 4,894.09	
Flooding	Pima County Flash Flood Emergency - Pima County	08/16/99		02/23/00	$ -	
	Y2K – Statewide	01/05/00		02/23/00	$ 23,073.19	
Severe Wind, Flooding	Gila Bend/Ajo Storm Emergency Maricopa & Pima County	08/01/17		02/02/19	$14,237	
	Terrorism Incident September 2001 – Statewide	09/12/01		05/19/09	$ 2,913,677.35	
	Forest Health Emergency – Statewide	05/22/03		05/19/09	$ 2,378,061.14	
Wildfire	Aspen Fire - Pima & Pinal County	06/19/03		07/14/03	$675,568	$5,363,459
	Mediterranean Fruit Fly Emergency - La Paz, Pima, Santa Cruz & Yuma	09/23/04		09/16/05	$197,421	
	Border Security Emergency - Cochise, Pima, Santa Cruz & Yuma	08/15/05		05/19/09	$1,492,758.44	
	Operation Good Neighbor – Statewide	09/03/05	09/12/05	10/12/12	$ 113,040.05	$ 5,726,164.08
Flooding	Flash Flood Emergency - Pima County	09/16/05		02/07/08	$256,948.47	
	Glassy-Winged Sharpshooter Inf. - Cochise, Yuma, Pima, Pinal, Maricopa & Santa Cruz	06/23/06		05/19/09	$567,257	
Severe Wind, Flooding	Monsoons & Flooding - Pinal, Pima, Gila, Graham, Greenlee, Navajo	08/08/06	09/07/06		Est. $2,409,278	$12,141,752
Flooding	January 2008 Severe Precipitation Emergency - Pima County	02/19/08		01/28/11	$231,798	
Winter Storm	January 2010 Severe Winter Storm - Apache, Coconino, Gila, Greenlee La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Yavapai, City of Yuma	01/21/10	03/18/10		Est. $4,497,895	Est. $14,210,904

Table 4-2: Pima County Declared Disaster Costs (1995 – 2020)						
	State Wide Opioid Health Emergency	06/05/17		05/29/18		
	State Wide Wildfire Suppression	04/23/17		06/30/17	$ 5,450,375.34	
Winter Storms	February 2019 Winter Storms - Apache, Coconino, Gila, Mohave, Navajo, Pima, and Yavapai Counties	02/28/19 #1 07/18/19			Est $ 2,200,000.00	
	Riots - Phoenix, Flagstaff, Gilbert, DPS, Kingman, Cochise County, Eloy, NAU, Pima County, Tucson, ASU, Buckeye, Chandler, Glendale, Maricopa County Sheriff's Office, Mesa, Paradise Valley, Scottsdale, Surprise, Tempe	05/31/2020 12/21/2020			Est. $200,000	
				Totals	$ 25,812,670.36	$ 37,442,279.75
Source: DEMA Emergency Declarations 1966 to Present, 2021 https://dema.az.gov/emergency-management/operationscoordination/recovery-branch/infrastructure						

4.3 Vulnerability Analysis Methodology

General

The following sections summarize the methodologies used to perform the vulnerability analysis portion of the risk assessment. For this update, the entire vulnerability analysis was either revised or updated to reflect the availability of new hazard and census data. Individual jurisdictions discuss their vulnerably to chosen hazards in the appropriate section.

Climate Change

Climate is a major driver of our weather and influences the severity of cascading effects we confront as Emergency Managers. The quantity and intensity of disasters continues to increase. As such, it is important to increase awareness and understanding of climate change as a compounding threat and existing and future vulnerabilities as well as potential solutions. In recent years, FEMA and others have begun to take a harder look at the impacts of climate change on natural hazards and the mitigation planning process. In March 2016, FEMA released new state mitigation planning guidance that will require all state hazard mitigation plans to address climate change beginning with all updates submitted after March 2016[1]. FEMA's National Advisory Council noted that the effects of climate change could manifest as a "threat multiplier". When considering probabilities of hazard events, it is typical to make the implicit assumption that the past is a prologue for the future; however, trending changes to climate related variables may require broader thinking and projections to develop mitigation actions and projects that account for those changes.[2]

The scope and severity of cause and impacts relating to climate change are still difficult to predict and highly debated. There is, however, a growing body of science and research that indicates a few noticeable trends that should be considered when evaluating natural hazard vulnerability and risk. In 1989, the U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative and later mandated by Congress in the Global Change Research Act of 1990 with the stated purpose of assisting "the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change." In 2018, the USGCRP released the 4th National Climate Assessment (NCA), which is a comprehensive compilation of the latest body of work and science on the topic of

[1] FEMA, 2016, State Mitigation Plan Review Guide, released March 2016, effective March 2016, FP 302-094-2
[2] Greenlee County All Hazard Mitigation Plan, 2021

climate change. The NCA results and discussion are divided into regions to focus the discussions and conclusions to a regional perspective. The Southwest region includes the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah. According to Chapter 25 of the NCA[3], the Southwest regional climate change impacts noted in the recent research include increased heat, drought, and insect outbreaks that result in more wildfires, declining water supplies, reduced agricultural yields, health impacts in cities due to heat, and flooding and erosion in coastal areas. In its 2018 report, the NCA released the following "Key Messages" for the Southwest Region:

- Water for people and nature in the Southwest has declined during droughts, due in part to human-caused climate change. Intensifying droughts and occasional large floods, combined with critical water demands from a growing population, deteriorating infrastructure, and groundwater depletion, suggest the need for flexible water management techniques that address changing risks over time, balancing declining supplies with greater demands.

- The integrity of Southwest forests and other ecosystems and their ability to provide natural habitat, clean water, and economic livelihoods have declined as a result of recent droughts and wildfire due in part to human-caused climate change. Greenhouse gas emissions reductions, fire management, and other actions can help reduce future vulnerabilities of ecosystems and human well-being.

- Many coastal resources in the Southwest have been affected by sea level rise, ocean warming, and reduced ocean oxygen—all impacts of human-caused climate change—and ocean acidification resulting from human emissions of carbon dioxide. Homes and other coastal infrastructure, marine flora and fauna, and people who depend on coastal resources face increased risks under continued climate change.

- Traditional foods, natural resource-based livelihoods, cultural resources, and spiritual wellbeing of Indigenous peoples in the Southwest are increasingly affected by drought, wildfire, and changing ocean conditions. Because future changes would further disrupt the ecosystems on which Indigenous peoples depend, tribes are implementing adaptation measures and emissions reduction actions.

- The ability of hydropower and fossil fuel electricity generation to meet growing energy use in the Southwest is decreasing as a result of drought and rising temperatures. Many renewable energy sources offer increased electricity reliability, lower water intensity of energy generation, reduced greenhouse gas emissions, and new economic opportunities.

- Food production in the Southwest is vulnerable to water shortages. Increased drought, heat waves, and reduction of winter chill hours can harm crops and livestock; exacerbate competition for water among agriculture, energy generation, and municipal uses; and increase future food insecurity.

- Heat-associated deaths and illnesses, vulnerabilities to chronic disease, and other health risks to people in the Southwest result from increases in extreme heat, poor air quality, and conditions that foster pathogen growth and spread. Improving public health systems, community infrastructure, and personal health can reduce serious health risks under future climate change.

FEMA has established that future changes in probabilities and severity of hazard events influenced by climate change should be addressed during mitigation planning. Accordingly, the risk assessment portion of the Plan provides the factual basis for activities that reduce future losses from the identified hazards impacting our community.

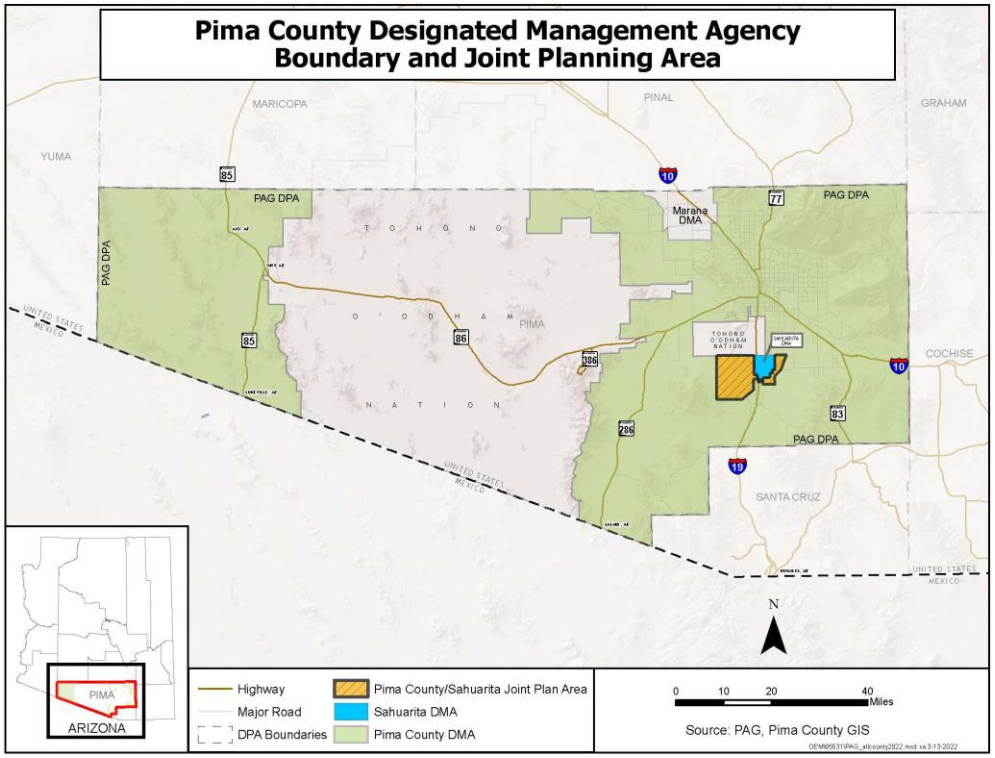
Wastewater - Multi-Jurisdictional Overview

Public wastewater collection systems and wastewater treatment facilities are located within one of three wastewater Designated Management Areas (DMAs) in Pima County: (1) Pima County DMA - operated by the Pima County Regional Wastewater Reclamation Department (PCRWRD), (2) the Town of Marana DMA and (3) the Town of Sahuarita DMA. The Pima County DMA area includes the entire county area, excluding Tohono O'odham Nation and Pascua Yaqui Tribe lands and the areas associated with the Sahuarita and Marana DMAs. Pascua Yaqui Nation and

[3] Fourth National Climate Assessment, Chapter 25: Southwest, https://nca2018.globalchange.gov/chapter/25/

the Tohono O'odham Nation lands are not part of the DMA but sewer service is provided through Intergovernmental Agreements with Pima County. Also within Pima County are non-DMA, non-municipal, wastewater facilities that are operated by private entities (e.g. Town of Ajo, Desert Museum, etc.).

- City of Tucson
- City of South Tucson
- Pascua Yaqui Nation (Intergovernmental Agreement – Sewer Service)
- Tohono O'odham Nation (San Xavier District – Sewer Service Agreement)
- Town of Marana – (excluding Marana DMA)
- Town of Oro Valley
- Town of Sahuarita – (excluding Sahuarita DMA)
- Unincorporated Pima County – (e.g. Mt. Lemmon-Summerhaven, Green Valley, Avra Valley, Corona de Tucson, Arivaca Junction)



Source: Pima County GIS

Figure 4-1 Designated Management Agency Boundary

In service of the jurisdictions noted above, Pima County owns and operates two major metropolitan and five sub-regional water reclamation facilities with the combined total capacity to treat up to 95 million gallons of wastewater per day. Wastewater conveyance and treatment assets within Pima County include 3,500 miles of sewer lines, 21 active pump stations, 67,000 manholes, 8,400 cleanouts, 28 odor control sites, and 36 permanent flow meters. Pima County treats and recycles more than 58 million gallons daily of the community's wastewater into reclaimed water.

High-quality recycled wastewater supports aquatic habitat along the Santa Cruz River, allowing the return of the endangered Gila Topminnow and increasing the potential for the return of other native species. Clean, high-quality treated wastewater also contributes to community drought mitigation measures, such as reclaimed water irrigation programs and groundwater recharge.

All-Hazard incidents (such as power outages, flood, landslides and subsidence, extreme weather, drought, pandemic, cyber, and wildfires) have the potential for significant impacts to public health, the environment and other infrastructure sectors due to loss of wastewater service.

Calculated Priority Risk Index (CPRI) Evaluation

The first step in the vulnerability analysis (VA) is to assess the perceived overall risk for each of the plan hazards using the Calculated Priority Risk Index (CPRI). The CPRI value is obtained by assigning varying degrees of risk to four categories for each hazard and then calculating an index value based on a weighting scheme. Table 4-3 summarizes the CPRI risk categories and provides guidance regarding the assignment of values and weighting factors for each category. Table 4-4 summarizes the CPRI results for each jurisdiction and unincorporated Pima County. Jurisdictions each worked under their lead planner to complete their own CPRI scores and then the MJPT met to review all scored hazards for consistency. In addition to Table 4-4, each hazard section has a CPRI table where the jurisdictions in bold have chosen that hazard for the 2022 Plan.

Table 4-3: Calculated Priority Risk Index Categories and Risk Levels

CPRI Category	Degree of Risk			Assigned Weighting Factor
	Level ID	Description	Index Value	
Probability	Unlikely	▪ Extremely rare with no documented history of occurrences or events. ▪ Annual probability of less than 0.001.	1	45%
	Possibly	▪ Rare occurrences with at least one documented or anecdotal historic event. ▪ Annual probability that is between 0.01 and 0.001.	2	
	Likely	▪ Occasional occurrences with at least two or more documented historic events. ▪ Annual probability that is between 0.1 and 0.01.	3	
	Highly Likely	▪ Frequent events with a well-documented history of occurrence. ▪ Annual probability that is greater than 0.1.	4	
Magnitude/ Severity	Negligible	▪ Negligible property damages (less than 5% of critical and non-critical facilities and infrastructure). ▪ Injuries/illnesses are treatable with first aid and there are no deaths. ▪ Negligible quality of life lost. ▪ Shut down of critical facilities for less than 24 hours.	1	30%
	Limited	▪ Slight property damages (greater than 5% and less than 25% of critical and non-critical facilities and infrastructure). ▪ Injuries/illnesses do not result in permanent disability and there are no deaths. ▪ Moderate quality of life lost. ▪ Shut down of critical facilities for more than 1 day and less than 1 week.	2	
	Critical	▪ Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure). ▪ Injuries/illnesses result in permanent disability and at least one death. ▪ Shut down of critical facilities for more than 1 week and less than 1 month.	3	
	Catastrophic	▪ Severe property damages (greater than 50% of critical and non-critical facilities and infrastructure).	4	

Table 4-3: Calculated Priority Risk Index Categories and Risk Levels				
		▪ Injuries/illnesses result in permanent disability and multiple deaths. ▪ Shut down of critical facilities for more than 1 month.		
Warning Time	Less than 6 hrs	Self-explanatory.	4	15%
	6 to 12 hrs	Self-explanatory.	3	
	12-24 hrs	Self-explanatory.	2	
	More than 24 hours	Self-explanatory.	1	
Duration	Less than 6 hrs	Self-explanatory.	1	10%
	Less than 24 hrs	Self-explanatory.	2	
	Less than one week	Self-explanatory.	3	
	More than one week	Self-explanatory.	4	

Table 4-4: Hazards to Be Mitigated by Jurisdiction								
Jurisdiction	**Drought**	**Earthquake**	**Extreme Cold**	**Extreme Heat**	**Flood**	**Landslide**	**Severe Wind**	**Wildfire**
Unincorporated Pima County	x			x	x	x	x	x
Marana					x			x
Oro Valley	x			x	x			x
Pascua Yaqui Tribe				x	x			x
Sahuarita	x			x	x			
South Tucson	No data provided							
Tucson	x	x	x	x	x		x	

Asset Inventory

In 2017, the PCOEM obtained the critical infrastructure dataset from the Department of Homeland Security but was unable to use the data in HAZUS. The Pima County Geographical Information System team member was unable to integrate the data in a meaningful way. A detailed asset inventory was performed for the 2022 Plan to establish an accurate baseline data set for assessing the vulnerability of each jurisdiction's assets to the hazards previously identified.

Each jurisdiction is responsible for identifying its critical facilities and infrastructure. For the purpose of the Plan, the working definition for:

Assets are: *Any natural or human-caused feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.*

Critical facilities and infrastructure is: *Systems, structures and infrastructure within a community whose incapacity or destruction would:*

- *Have a debilitating impact on the defense or economic security of that community*
- *Significantly hinder a community's ability to recover following a disaster*

The following criteria were used to define critical facilities and infrastructure for this analysis:

1. **Communications Infrastructure:** Telephone, cell phone, data services, radio towers, and internet communications, which have become essential to the continuity of business, industry, government, and military operations.
2. **Electrical Power Systems:** Generation stations and transmission and distribution networks that create and supply electricity to end-users.
3. **Gas and Oil Facilities:** Production and holding facilities for natural gas, crude and refined petroleum, and petroleum-derived fuels, as well as the refining and processing facilities for these fuels.
4. **Banking and Finance Institutions:** Banks, financial service companies, payment systems, investment companies, and securities/commodities exchanges.
5. **Transportation Networks:** Highways, railroads, ports and inland waterways, pipelines, and airports and airways that facilitate the efficient movement of goods and people.
6. **Water Supply Systems:** Sources of water; reservoirs and holding facilities; aqueducts and other transport systems; filtration, cleaning, and treatment systems; pipelines; cooling systems; and other delivery mechanisms that provide for domestic and industrial applications, including systems for dealing with water runoff, wastewater, and firefighting.
7. **Government Services:** Capabilities at the local, tribal, state, and federal levels of government required to meet the needs for essential services to the public.
8. **Emergency Services:** Medical, police, fire, and rescue systems.

Table 4-5 summarizes the facility counts based on data from the HAZUS general building stock database. It should be noted that the facility counts summarized in Table 4-5 do not represent a comprehensive inventory of all the category facilities that exist within the county.

Table 4-5 Asset inventory structure counts by category and jurisdiction as of December 2021

Jurisdiction	Communication Infrastructure	Electrical Power systems	Gas and Oil Facilities	Banking and Finance institutions	Transportation Networks	Water Supply Systems	Government Services	Emergency Services	Educational*	Cultural*	Business*	Flood Control*	Residential*	Agriculture*
Marana	104	5	0	2	78	23	18	6	17	0	857	44	34,733	26
Oro Valley	31	1	0	2	53	60	13	8	16	0	790	24,479	13,078	17
Pascua Yaqui Tribe	4	0	1	0	1	0	1	5	2	0	3	0	3610	0
Sahuarita	16	1	0	1	75	16	13	3	11	0	40	7	5,834	3
South Tucson	1	0	0	0	3	0	3	1	4	1	169	0	1573	1
Tucson	657	13	1	15	413	17	83	53	302	4	7952	282	164,285	263
Pima County	723	9	0	10	424	61	75	56	130	12	4,104	714	152,617	253
County-Wide Totals	1,536	29	3	30	1,047	177	206	132	482	17	13,915	1179	375,730	563

*Assets were derived from HAZUS and included for context.

Other assets such as public libraries, schools, businesses, museums, parks, recreational facilities, historic buildings or sites, churches, residential and commercial subdivisions, apartment complexes, and so forth, are typically not classified as critical facilities and infrastructure unless they serve a secondary function to the community during a disaster emergency (e.g. - emergency housing or evacuation centers).

Loss Estimations

The hazards profiled in this Plan revision may not include quantitative exposure and loss estimates. The vulnerability of people and assets associated with some of the hazards is nearly impossible to evaluate given the uncertainty associated with where these hazards will occur as well as the relatively limited focus and extent of the damage. Instead, a qualitative review of vulnerability will be discussed to provide insight into the nature of losses that are associated with the hazard. For subsequent updates of this Plan, the data needed to evaluate these unpredictable hazards may become refined such that comprehensive vulnerability statements and thorough loss estimates can be made. Loss estimations for Flood to meet National Flood Insurance Program requirements are updated in the 2022 revision and found in the Flood Hazard Section 4.4.5.

Development Trend Analysis

The updated analysis will focus on the potential risk associated with projected growth patterns and their intersection with the Plan identified hazards.

Specifically, for the Pascua Yaqui Tribe, a subdivision of 30 homes were developed within the last reporting period. This was a HUD project; the homes have safe zones around them for the wildfire urban interface. They worked with their Land and Development, Facilities Management, and Housing Department to make sure the development has adequate drainage and infrastructure to reduce flood hazards. The Housing Department has increased the standard for windows and insulation and other construction materials to reduce the exposure to extreme temperatures with energy efficient design and construction. The Pascua Yaqui Tribe will continue working to improve residential and rental properties to provide affordable housing solutions for its membership; Phase I of these projects consists of the construction of 50 single-family units, currently in process. Phase II will consist of 27 town-home dwellings within 7 building structures. Phase III is in its incipient development; however, initial plans are for 50, one to two-bedroom units within a three-four story structure.

Cultural and sacred sites are of high priority to the Pascua Yaqui Tribe and special attention is needed when considering hazard mitigation of these areas. Because of their cultural importance, these sites require special attention and protection. Normally, the Tribe does not share the location of these sites and areas. For this reason, these sites and areas will not be included in this Plan. The Pascua Yaqui Tribe will ensure within its internal planning efforts that these sites and areas are included in their mitigation activities. Cultural and Sacred sites are protected but are available for tribal use. Information on sites can be requested through the Land Department which is located at 7474 S. Camino Del Oeste. The Land Office Director can be reached at 520-879-5288. A separate appendix will be provided as an appendix to this plan for tribal use upon adoption with approximate areas but not exact locations of cultural and sacred sites.

4.4 Hazard Risk Profiles

The following sections summarize the risk profiles for each of the Plan hazards identified in Section 4.1. For each hazard, the following elements are addressed to present the overall risk profile:

- **Description**
- **History**
- **Extent**
- **Probability of Future Events**
- **Vulnerability**
    - **CPRI Results**
    - **Loss Estimations**
- **Changes in Development in Hazard Area**

Much of the 2022 Plan data has been updated, incorporated, and revised to reflect current conditions and planning team changes. Discussions for each hazard are limited to state and county impacts; however, jurisdictions may discuss historical events in their vulnerability statements.

4.4.1 Drought

Description

Drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Drought is a temporary aberration from normal climatic conditions; thus, it can vary significantly from one region to another. Drought is different from aridity, which is a permanent feature of the climate in regions where low precipitation is the norm, as in a desert.[1]

Drought is a complex natural hazard on which human factors, such as water demand and water management, can exacerbate the impact. The following are three commonly used definitions:[1]

- Meteorological drought is usually defined based on the degree of dryness, as compared to some "normal" or average, and the duration of the dry period.
- Hydrological drought usually occurs following periods of extended precipitation shortfalls that affect water supplies such as stream flows, reservoir and lake levels, or groundwater.
- Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focusing on precipitation shortages, soil water deficits, reduced groundwater or reservoir levels needed for irrigation, and so forth.

The effects of drought increase with duration as more moisture-related activities are impacted. Non-irrigated croplands are most susceptible to precipitation shortages. Many rangelands and irrigated agricultural crops do not respond to moisture shortage as rapidly but yields during periods of drought can be substantially affected. During periods of severe drought, lower moisture in plant and forest fuels create an increased potential for devastating wildfires. In addition, lakes, reservoirs, and rivers can be subject to water shortages that affect recreational opportunities, irrigated crops, and availability of water supplies for activities such as fire suppression and human consumption, and the natural habitats of animals. Socioeconomic effects include higher unemployment and lower land values. Insect infestation can also be a particularly damaging impact by severe drought conditions.

The US Drought Monitor's (USDM) drought intensity scale is composed of five different levels: D0, D1, D2, D3, and D4. The abnormally dry category, D0, corresponds to an area experiencing short-term dryness that is typical with the onset of drought. This type of dryness can slow crop growth and elevate fire risk to above average. This level also refers to areas coming out of drought, which have lingering water deficits and pastures or crops that have not fully recovered. It is also important to note that scientists only consider D0 level areas to be dry, and they are not necessarily experiencing drought conditions.

The moderate drought category, D1, corresponds to an area where damage to crops and pastures can be expected and where fire risk is high, while stream, reservoir, or well levels are low. The severe drought category, D2, corresponds to an area where crop or pasture losses are likely, fire risk is very high, water shortages are common, and water restrictions are typically voluntary or mandated. The extreme drought category, D3, corresponds to an area where major crop and pasture losses are common, fire risk is extreme, and widespread water shortages can be expected requiring restrictions. The highest category, exceptional drought, or D4, corresponds to an area experiencing exceptional and widespread crop and pasture losses, fire risk, and water shortages that result in water emergencies.[2]

[1] National Weather Service. (2008, May). *Drought Public Fact Sheet*. Retrieved 2016, from http://www.nws.noaa.gov/os/brochures/climate/DroughtPublic2.pdf

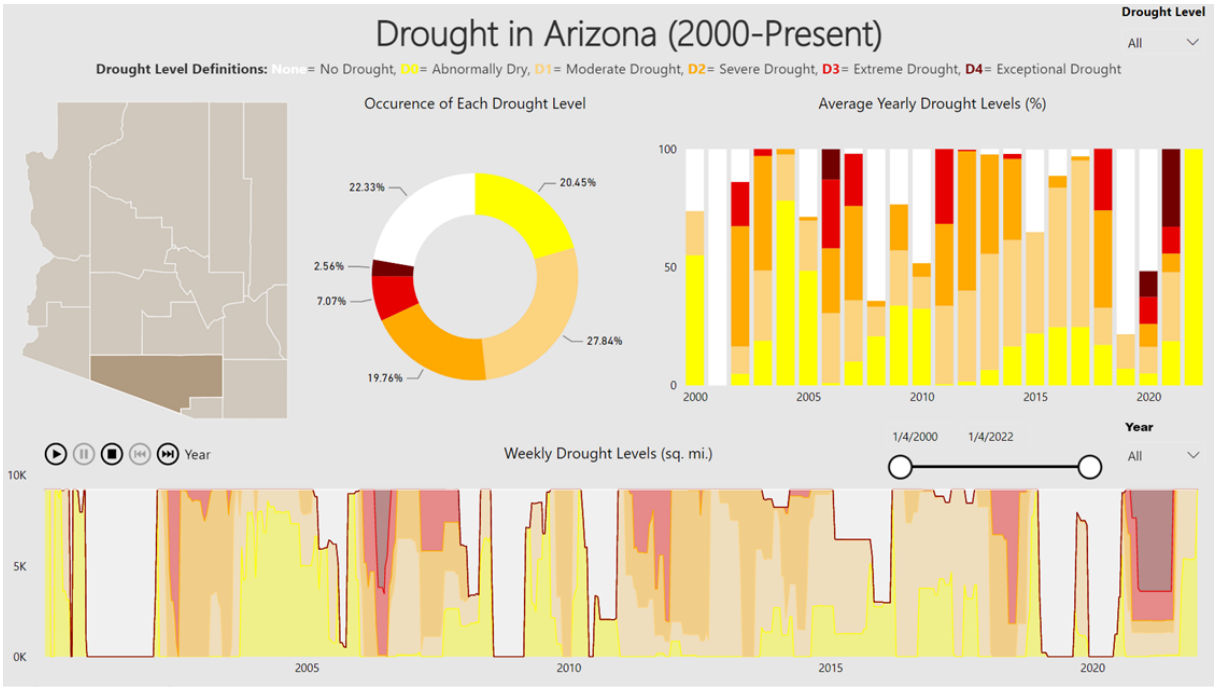
[2] DROUGHT: Degrees of Drought Reveal the True Picture | National Centers for Environmental Information (NCEI) formerly known as National Climatic Data Center (NCDC) (noaa.gov)

History

Arizona has been in a state of long-term drought since the mid-1990s according to the Arizona Department of Water Resources 2020 Arizona Drought Preparedness Annual Report[3]. Figure 4-2 shows the weekly drought conditions from 2000 to 2022 for Pima County.

Over the past plan cycle (2016-2021), Pima County has been included as a primary county in USDA Secretarial drought disaster declarations for crop years 2017, 2018. 2019, 2020, and 2021. (USD) [4]

Figure 4-2 also illustrates the time series of drought conditions in Pima County from January 4, 2000 and January 4, 2022. The donut-shaped graph, to the right of the Arizona map, shows the average percentage of each drought level from 2000 to present. The bar chart, to the right of the donut-shaped graph, shows the average percentage of each drought level by year from 2000 to present. The time-series graph on the bottom of the dashboard shows weekly drought levels in square miles for the state.



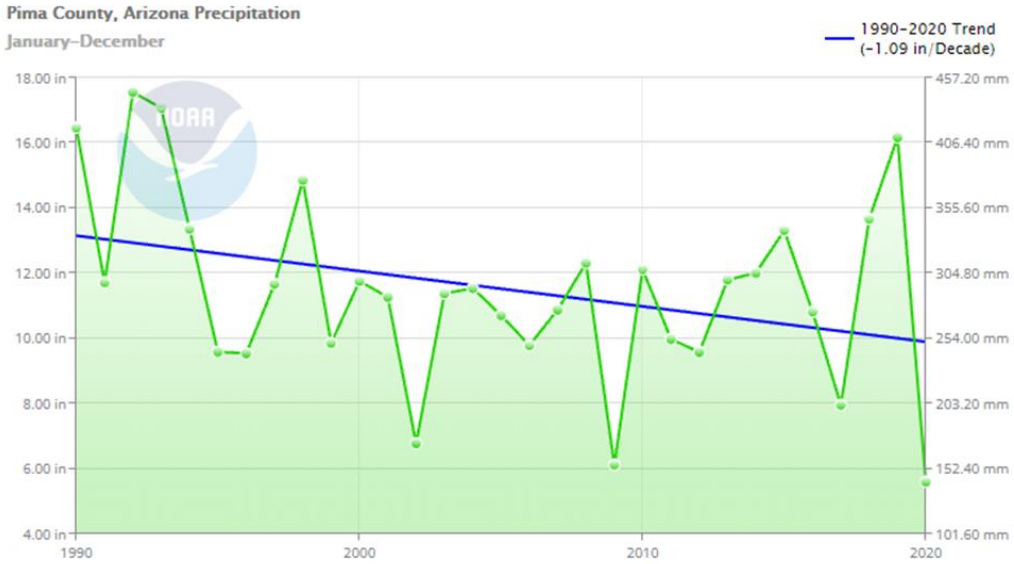
Source: ***Drought Data Dashboard | Arizona Department of Water Resources (azwater.gov)***

Figure 4-2: ADWR Drought Dashboard 2000-2022

[3] ADWR's 2020 Arizona Drought Preparedness Annual Report, https://new.azwater.gov/sites/default/files/media/2020_AZDroughtPrepAnnualReport.pdf

[4] USDA Disaster Designation Information https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index

Figure 4-3 depicts precipitation data from NCEI regarding average Pima County precipitation variances from normal.



Source: Graph created at NCEI Climate at a Glance https://www.ncdc.noaa.gov/cag/county/time-series

Figure 4-3: Pima County average precipitation variances based on 1990-2020 trend.

The following is a representative sample of drought events that have impacted the County:

2017-2018
The extreme drought (D3) category was reached in late January across southeast Pima County, Santa Cruz County, and far southwest Cochise County including portions of the Tohono O'odham Nation, the Baboquivari and, Santa Rita, Mountains.

Below normal precipitation occurred each month from August of 2017 through January of 2018. Soil moisture readings were well below normal and ranked below the 20th percentile. Although most of the area received between 2 and 4 inches of precipitation from one storm system in mid-February, overall soil moisture readings only improved slightly, and generally remained ranked below the 20th percentile. Wildfire activity was suppressed as a result of the widespread precipitation. While some rain did fall in the extreme drought area, amounts were light, ranging from 10% to 50% of normal for March in northern areas and less than 25% of normal in southern areas. Wildfire activity picked up in April with at least five notable human-caused wildfires occurring in or near the Extreme Drought area.

Extreme drought (D3 category) expanded across the western half of Pima County and parts of southeast Pinal County in May. Light rainfall amounts occurred on one day during the month, but this was not sufficient to stave off the drought's expansion. Soil moisture values in the western deserts were ranked below the 10th percentile.

2019
The ADWR Annual Report Water Year 2019 describes conditions for Pima County as follows: [5]

Short-Term (USDM): Water Year 2019 started with a mix of Moderate Drought in western and eastern Pima County and a central pocket of Severe Drought. Through November, drought improved across Pima County as Moderate Drought receded and Abnormally Dry conditions expanded across the County. By January, there was improvement

[5] ADWR's 2019 Arizona Drought Preparedness Annual Report, https://new.azwater.gov/sites/default/files/media/2019_ArizonaDroughtPreparednessAnnualReport_Final_WebVersion.pdf

with Abnormally Dry conditions covering the eastern and southeastern Pima County with no drought in central and western corners. In February, drought receded all across Pima County leaving the county drought-free. By September, Abnormally Dry conditions returned in northern Pima County. Abnormally Dry conditions expanded across the County with Moderate drought across most of Pima County as drought worsened.

Long-Term (MTC): From October to December, western Pima County was in Extreme and Severe Drought that was radiating to the east with a large part of Moderate Drought in east corners. By January, Extreme Drought had receded in the western areas, and Abnormally Dry conditions and No Drought expanded in eastern Pima County. Drought conditions continued to recede through the end of the water year with expansion of drought recovery into eastern Pima County.

2020
The extreme drought (D3) category was reached during late August and continued throughout September across the sections of southeast Arizona.

Below normal precipitation occurred each month from April through August of 2020 and the summer was the hottest on record in many locations. Several lightning-caused wildfires and at least one human-caused wildfire spread rapidly due to dry fuels and continued into September.

Dry, hot conditions in May created prime growth conditions for the lightning-caused Bighorn fire. The Bighorn fire started in June and ran across the Santa Catalina Mountains consuming more than a hundred thousand acres before being put out in late July.

Aside from isolated thunderstorms that produced heavy rain near the Pima/Cochise county line on the September 8th, most of the area received less than 0.25 of rainfall during September, with continued record-breaking heat. While the heavy rain on the 8th doused the relatively small Spud Rock Fire in the Rincon Mountains, several other lightning-caused wildfires that started in August continued into September due to dry conditions and the lack of monsoon rainfall.

In October, the extreme drought (D3) category, expanded further to include all of the Tohono O'odham Nation. Extreme drought continued across all of southeast Arizona and the exceptional drought (D4) category began in eastern portions of Pima County.
Tucson recorded its fifth warmest October on record and while most of October was dry and warmer than normal, Tucson recorded its 4th earliest fall freeze on record, which was brought on by an early-season winter storm that also produced low elevation snow during the last week of the month. Nevertheless, precipitation totals from this storm were generally less than a quarter-inch in the valleys and not enough to stop drought conditions from deteriorating further. Several human-caused wildfires took hold during October. The largest that month was the Encinos Fire which consumed nearly 15,000 acres along and east of the Baboquivari Mountains in Pima County. Soil moisture readings remained well below normal, falling to below the 5th percentile ranking in most areas.

The exceptional drought (D4) category expanded across central Pima County during November. The extreme drought (D3) category, which began in late August and expanded through October, expanded slightly into the Huachuca Mountains and continued across the rest of southeast Arizona except for western Pima County. Precipitation totals for the month, which fell in the form of valley rain and mountain snow primarily November 7th through the 9th, totaled 0.10 to 1 inch. The 0.15 inch of rain recorded at the Tucson International Airport was the only measurable rainfall received during September, October, and November, resulting in the 2nd driest autumn on record. November totals across southeast Arizona were 0.5 to 1.5 inches below normal for the month and were not enough to keep drought conditions from further deteriorating. Soil moisture readings remained below the 5th percentile ranking in most areas.

2021
The exceptional (D4) and extreme (D3) drought categories continued across a large part of southeast Arizona during January through June, with the exception of western Pima County. Most areas only tallied 0.5 or less for the month, which is close to normal. A few locations received 1-1.5 inches of rain, but that was not enough to make up for record rainfall deficits over the past 12 to 15 months. Soil moisture readings remained below the 5th percentile ranking across

most of southeast Arizona. Numerous human and lightning-caused wildfires occurred, five of which grew to more than 10,000 acres during the hot, dry, and windy month.

A wet July caused the exceptional (D4) drought category and extreme (D3) drought category to cease across nearly all of southeast Arizona. The extreme (D3) drought category remained across parts of the Tohono O'odham Nation. July rainfall varied widely from 2 to 15 inches across southeast Arizona. In areas where the drought lingered through the end of the month, this equated to 75% to 125% of normal rainfall while areas in which the drought eased further rainfall tallied as much as 400%of normal. July ranked as the wettest on record for any month at the Tucson International Airport where 8.06 inches was recorded. The rainfall caused wildfire season to end and soil moisture readings to improve from below the 10th percentile to between the 30th and 70th percentiles by month's end.

Extent

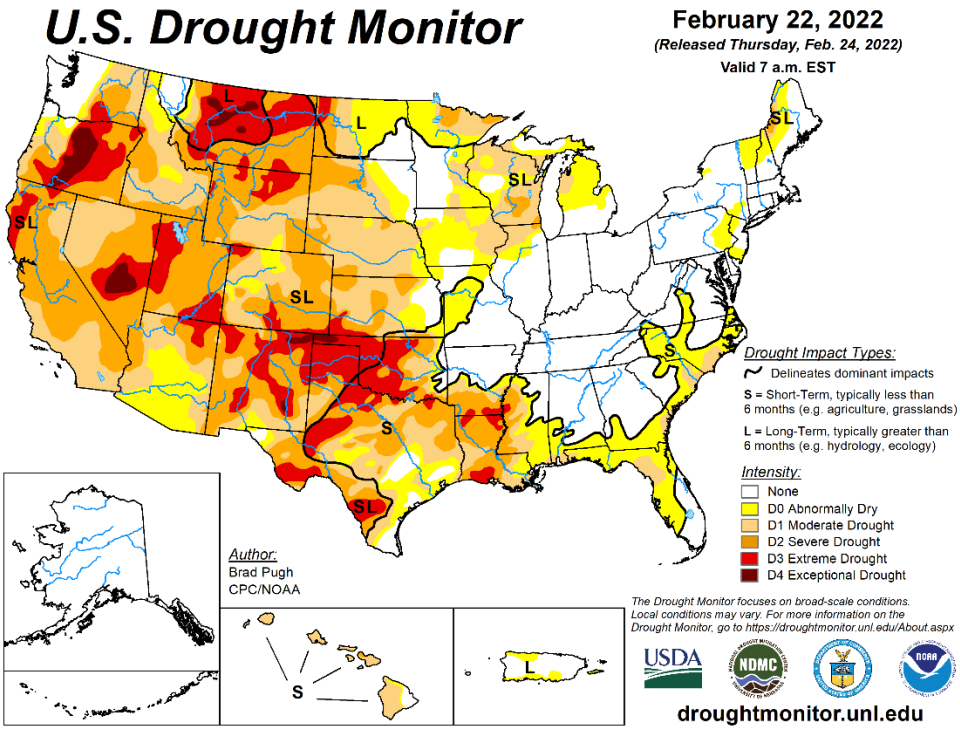
An extreme, multiyear drought could impact the region with little warning. There is no commonly accepted return period or non-exceedance probability for defining the risk from drought (such as the 100-year or 1% annual chance of flood). The magnitude of drought is usually measured in time and the severity of the hydrologic deficit. There are several resources available to evaluate drought status and even project expected conditions for the very near future.

The National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) prescribes an interagency approach for drought monitoring, forecasting, and early warning.[6] The NIDIS maintains the U.S. Drought Portal, which is a centralized, web-based access point to several drought-related resources including the U.S. Drought Monitor (USDM) and the U.S. Seasonal Drought Outlook (USSDO). [7] The USDM, shown in Figure 4-2, is a weekly map depicting the status of drought and is developed and maintained by the National Drought Mitigation Center. The USSDO, shown in Figure 4-3, is a 6-month projection of potential drought conditions developed by the National Weather Service's Climate Prediction Center. The primary indicators for these maps for the Western U.S. are the Palmer Hydrologic Drought Index and the 60-month Palmer Z-index. The Palmer Drought Severity Index (PSDI) is a commonly used index that measures the severity of drought for agriculture and water resource management. It is calculated from observed temperature and precipitation values and estimates soil moisture. However, the Palmer Index is not considered consistent enough to characterize the risk of drought on a nationwide basis and neither of the Palmer indices is well suited to the dry, mountainous western United States. [8]

Probability of Future Events

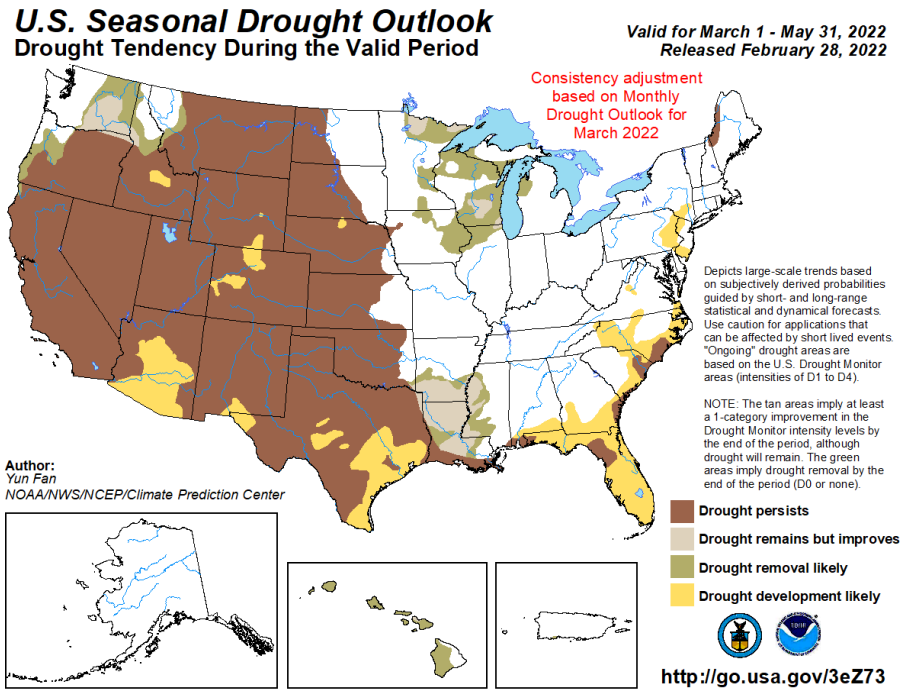
More widespread drought and associated crop failure, more frequent or necessary larger reductions in livestock numbers grazing on grassland pastures, movement of invasive species, more frequent wildland fire, increased energy emergencies, and more intense climate events such as storms and extreme heat will occur throughout the County. Extreme variability of precipitation across the southwest, combined with the trend of increasing temperatures, has led to extremely dry conditions within the forest and grasslands of Pima County. A good monsoon season may provide short-term relief, but it will do very little for the long-term drought.

[6] National Integrated Drought Information System, 2016, *National Integrated Drought Information System Implementation Plan*, NOAA.
[7] NIDIS U.S. Drought Portal website is located at: https://www.drought.gov/drought/home
[8] Federal Emergency Management Agency, 1997, *Multi-Hazard Identification and Risk Assessment – A Cornerstone of the National Mitigation Strategy.*



Source: United States Drought Monitor, 2021: http://droughtmonitor.unl.edu/

Figure 4-4: U.S Weekly Drought Monitor Map



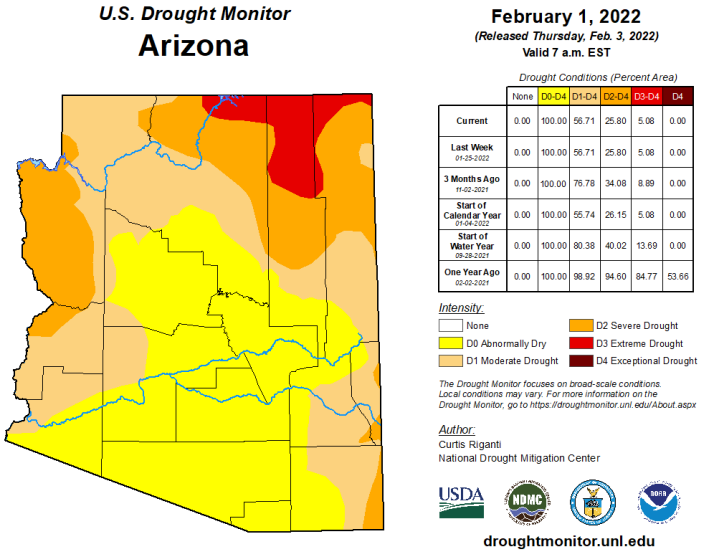
Source: United States Drought Monitor, 2021: http://droughtmonitor.unl.edu/

Figure 4-5: U.S. Seasonal Drought Outlook

Due to climate variability, there is a likelihood of continuously higher temperatures and below-normal precipitation, all aiding in drought conditions. The local vulnerability depends on duration, intensity, geographic extent, and regional water supply demands by humans and vegetation.

Realizing the need for drought preparedness in Arizona, a Governor's Drought Task Force was created in 2003 and the Arizona Drought Preparedness Operational Plan, including the Arizona Water Conservation Strategies Report, was developed and adapted in 2004. The principal intent of the Drought Preparedness Operational Plan was to establish a flexible framework to refine Arizona's drought monitoring process as well as the understanding of drought impacts and mechanisms for limiting future vulnerability in Arizona.

Led by the Arizona Department of Water Resources (ADWR), the plan includes criteria for determining both short and long-term drought status for each of the 15 major watersheds in the state using assessments that are based on precipitation and streamflow. The plan also provides the framework for an interagency group that reports to the governor on drought status, in addition to local drought impact groups in each county and the State Drought Monitoring Technical Committee. Twice a year this interagency group reports to the governor on the drought status and the potential need for drought declarations. The counties use the monthly drought status reports to implement drought actions within their drought plans. The State Drought Monitoring Technical Committee defers to the U.S. Drought Monitor (USDM) for the short-term drought status and uses a combination of the Standardized Precipitation Index (SPI), evaporation, and streamflow for the long-term drought status. Figures 4-6 and 4-7, present the most current short and long-term maps available for Arizona as of the writing of this plan.



Source: Data Graphs | U.S. Drought Monitor (unl.edu)

Figure 4-6 Short-Term Drought Status

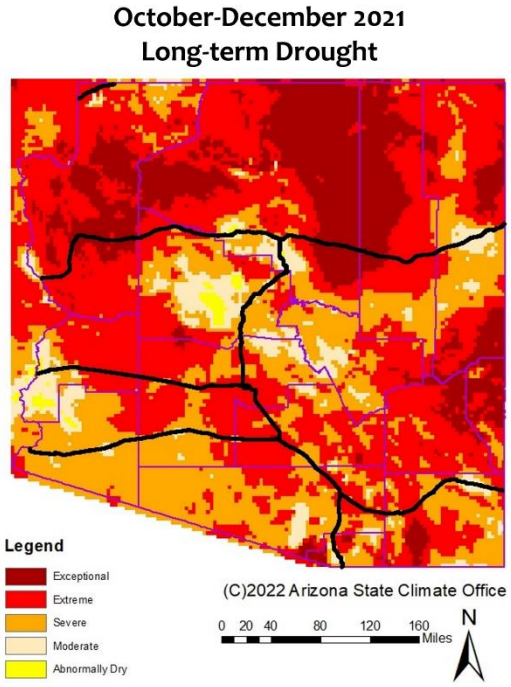


Figure 4-7 Long-Term Drought Status

The current drought maps are in general agreement that Pima County is currently experiencing an abnormally dry to extreme drought condition for the short term and in a moderate drought condition for the long term. The consensus of the Monitoring Technical Committee is that several years of above normal precipitation would be needed before the drought status is removed.[9] Figure 4-3 indicates that the drought conditions are projected to persist or intensify for Pima County over the next few months.

[9] AZ Department of Water Resources, 2021 https://new.azwater.gov/sites/default/files/media/JointCAPADWR-FactSheet-CoRiverShortage-2022.pdf

When attempting to evaluate the probability of future events, it is important to note that potable water in Pima County is derived from both surface water and groundwater. Surface water to Pima County users comes from, the Colorado River, (through the Central Arizona Project (CAP) Canal).

Due to ongoing drought conditions in the Colorado River watershed, the US Bureau of Reclamation in 2021 declared a Tier 1 shortage on the Colorado River beginning 2022. The shortage will impact CAP water supplies by reducing 512,000 acre-feet to Arizona's allocation of Colorado River water. The shortage declaration was not unexpected, and Arizona, the Basin states, and the federal government are continuing to work in re-consultation of the 2007 Operating Guidelines and other consultations to reduce the decline of Lake Powell and Lake Mead in light of a hotter and drier climate. The Tier 1 shortage will not reduce municipal and industrial deliveries to water providers in Pima County.

The other major source of water for Pima County is groundwater. This water has been pumped out of large subsurface natural reservoirs known as aquifers. While a significant supply of water remains stored in the aquifers, groundwater has historically been pumped out much more rapidly than it can be replenished through natural recharge and has led to a condition known as overdraft. In 1980, Arizona implemented the Groundwater Management Code to promote conservation and long-range planning of water resources, including reducing reliance on groundwater supplies. Active Management Areas (AMAs) were formed based on groundwater basin areas and Pima County is mostly covered under the Tucson AMA which covers 3,866 square miles in southern Arizona.[10]

Reclaimed water, or effluent, is the only increasing source of water in the county, although it constitutes only a small amount of the overall water used. As the regional population grows; increasing amounts of reclaimed water will be available for agriculture, golf courses, and landscape irrigation, as well as industrial cooling, and maintenance of wildlife areas.

Vulnerability

Table 4-6: CPRI Results for Drought

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Likely	Critical	12-24 hours	>1 week	3.25
Oro Valley	Highly likely	Critical	>24 hours	>1 week	**3.25**
Pascua Yaqui Tribe	Likely	Limited	>24 hours	>1 week	2.50
Sahuarita	Highly likely	Critical	>24 hours	>1 week	**3.25**
Tucson	Highly likely	Limited	>24 hours	>1 week	**2.95**
Unincorporated Pima County	Highly likely	Limited	>24 hours	> 1week	**2.95**
				County-wide average CPRI =	**3.03**

*Jurisdictions in **bold** chose to mitigate against the hazard*

Drought is considered a high significance hazard for most of the region due to the extensive economic and environmental impacts. Drought can be widespread and pervasive for several years.

Town of Marana: The Town has a 100-year assured water supply designation from the State of Arizona. Additionally, Marana has been steadily working toward the use of renewable supplies rather than relying solely on our groundwater. Working with the regional partners, Marana developed and adopted a Drought Preparedness Plan. The Town of Marana Water Plan differs in some ways from other local provider plans and stages. The Town's plan was adopted to heighten awareness and provide response to the potential reduction in the Town's available water supply due to drought.

Town of Oro Valley: The susceptibility of the desert southwest to drought conditions continues to be a focus area across the federal, state, county, and local levels. The Town of Oro Valley, as part of the larger system, is not immune to the vulnerability to drought. For example, the management of the Colorado River is a multi-state system for power generation, drinking water, agriculture, and tourism. In 2021, drought conditions across the southwest triggered the first water shortages and restrictions on the Colorado River, having significant economic impacts across the entire system. The shortages cause water resources to be significantly more expensive, leading to direct increased economic

[10] Tucson AMA | Arizona Department of Water Resources (azwater.gov)

costs to the Town. Continued trends of higher average temperatures and less precipitation may also trigger power generation and additional water supply across the region issues in the future. Extended drought conditions also lead to a higher risk for wildfire, which also increases the risk for post-fire flooding. These many variables all impact the public health, safety, and economic resiliency of the community.

Town of Sahuarita: Currently, the Town of Sahuarita does not own or operate a water company. Within the town a limits, there currently are six independent privately owned water companies and smaller areas served by on-site wells. The list of providers includes:

- Community Water of Green Valley
- Farmers Water
- Las Quintas Serenas Water
- Quail Creek Water
- Sahuarita Village Water
- Sahuarita Water

Recognizing that all water companies are vulnerable to drought, the water companies have worked with each other and the town to develop an area wide drought plan. The drought plan considers Arizona Department of Water Resources goal of safe yield. Including obtaining an assured water supply certificate for many of the master plan communities.

City of Tucson: The City of Tucson has seen continual growth in populations and in size of the city limits. The natural growth of the City of Tucson has put an increased need on water usage, which has effected City of Tucson water reserves. The City of Tucson uses two thirds of its annual delivery of CAP water on an annual basis, which only allows for one third of its allotment to go into the aquifers for future use. In 2020, the National Weather Service reported the driest year on record for Tucson area with only 1.64 inches during the monsoon season. Since 2016, Tucson has received on an average of 12.4 inches of rain per year where the national average in the United States is over 30 inches per year.

The Tucson Water Department utilized the area's ground water resource to supply water to its customers (citizens and businesses) within the City via a large system of wells for decades. Over a decade of drought, leading to the lack of replenishment of ground water tables, has stressed the water supply and lead to measurable subsidence (drop in elevation) in area of the city as ground water tables are drained.

While the Tucson Water Department has begun to use its allotment of Colorado River Water to replenish water tables, and while they continue to undertake several water conservation programs for residents and business owner, continued periods of drought place stress on the water system leading to increase vulnerability for water storages in the future.

Unincorporated Pima County: The County is vulnerable to drought for the same reasons as the other jurisdictions. Pima County-owned and maintained open space and riparian habitat are most vulnerable to the impacts of sustained drought conditions. It is important the County continue to implement adaptive management strategies that include land conservation, riparian habitat restoration and protection of groundwater-dependent ecosystems. Existing building and land use codes requiring low water use fixtures and drought tolerant, native landscaping have helped reduce residential and commercial water consumption. Improved water quality at its wastewater reclamation facilities allows more uses of reclaimed water to support riparian habitat, replenish the aquafer and replace groundwater uses on parks and landscaping. Continued monitoring of local and state-wide drought conditions through the Local Drought Impact Group and ADWR Drought Program will enable Pima County to take proactive, planned mitigation measures should drought conditions persist or worsen. Pima County has a Drought Response Plan that establishes a four-stage trigger category corresponding to the Arizona Drought Monitor Report. Each "Stage" declaration within the county triggers drought stage reduction measures.[11] Actions within the plan will provide for maximum beneficial use of water resources for the interest of the public health, safety and welfare.

[11] Pima County Drought Management, 2021: Drought Management - Pima County

Loss Estimations

No standardized methodology exists for estimating losses due to drought and drought does not generally have a direct impact on critical and non-critical facilities, except perhaps water supply systems. A direct correlation to loss of human life due to drought is improbable for Pima County. Instead, drought vulnerability is primarily measured by its potential impact to certain sectors of the county economy and natural resources including:

- Crop and livestock agriculture
- Municipal and industrial water supply
- Recreation/tourism
- Wildlife and wildlife habitat

Sustained drought conditions will also have secondary impacts on other hazards such as fissures, flooding, subsidence, and wildfire. Extended drought may weaken and dry the grasses, shrubs, and trees of wildfire areas, making them more susceptible to ignition. Drought also tends to reduce the vegetative cover in watersheds, and hence decrease the interception of rainfall and increase the flooding hazard. Subsidence and fissure conditions are aggravated when lean surface water supplies force the pumping of more groundwater to supply the demand without the benefit of recharge from normal rainfall.

According to the 2021 annual report of the Pima County Local Drought Impact Group, the following drought impacts were noted:

- Flooding in the fire burn scar of the 2020 Bighorn wildfire in the Santa Catalina Mountains continues to be a concern. Long-term drought conditions intensified the wildfire extent and severity.
- Cienega Creek, a perennial stream in southeast Pima County continues to experience the impacts of sustained drought and shifts to the seasonal pattern of flow. In June 2021 Pima Association of Governments recorded 0.641 miles of flow in the monitored reach of Cienega Creek, about 37% less flow than recorded in June 2020.
- Drought impacts on saguaros and other vegetation were observed along with resurgence of invasive species, including buffelgrass, following an above normal summer monsoon season was reported.

From 2017 to 2020, farmers and ranchers in Pima County received $902,928 in disaster-related assistance funding from the U.S Department of Agriculture (USDA) for crop and livestock damages. Nearly half, $437,801 or 48%, was issued in 2018, following a record dry and hot fall, winter and spring in Water Year 2017-2018, and Extreme and Exceptional long-term drought in Pima County.

Other direct costs such as increased pumping costs due to lowering of groundwater levels and costs to expand water infrastructure to compensate for reduced yields or to develop alternative water sources, are a significant factor but very difficult to estimate due to a lack of documentation. There are also the intangible costs associated with lost tourism revenues and impacts to wildlife habitat and animals. Typically, these impacts are translated into the general economy in the form of higher food and agricultural goods prices and increased utility costs.

Changes in Development in the Hazard Area

With anticipated population growth, Pima County's water providers will require additional water resources to meet the demands of a projected population of 1.45 million by 2041 and focused water conservation efforts to reduce demand. Significant growth in the ranching and farming sectors is unlikely given the current constraints on water rights, grazing rights, and available rangeland.

The Pima County Local Drought Impact Group (LDIG), which is comprised of water providers and local, state, and federal agencies and serves as the local component of the Arizona Drought Preparedness Plan, is tasked with identifying local drought conditions and impacts, assessing severity and scope of impacts, ascertaining response and mitigation options and recommending drought staging to County Administration. LDIG submits annual drought reports to the state's Drought Monitoring Technical Committee. Pima County has also developed a Drought Response Plan and Water Wasting Ordinance that is administered and enforced through the Pima County Health Department for unincorporated areas of the county.

Drought planning should be a critical component of any domestic water system expansion or land development planning. Arizona Department of Water Resources ensures local water providers reduce their vulnerability to drought and prepare response plans in the event of a water shortage through the development of System Water Plans that are comprised of three components:

- Water Supply Plan – describes the service area, transmission facilities, monthly system production data, historic demand for the past five years, and projected demands for the next five, ten, and twenty years.
- Drought Preparedness Plan – includes drought and emergency response strategies, a plan of action to respond to water shortage conditions, and provisions to educate and inform the public.
- Water Conservation Plan – addresses measures to control lost and unaccounted for water, considers water rate structures that encourage efficient use of water, and plans for public information and education programs on water conservation.

Town of Marana: In the Town of Marana, the Marana Water Department requests voluntary conservation, asking that customers limit landscape irrigation and avoid outdoor water uses like misters and car washes when possible. In the years since its adoption, the Marana Water Department has diligently acquired renewable water supplies and grown its service area. This year, the Marana Water Department will work with regional partners and the Citizens' Water Academy to recommend updates to its Drought Preparedness Plan. The Marana Water Department partners with state and local entities to monitor drought.

Town of Oro Valley: Within the Town of Oro Valley, the use of potable water for the irrigation of higher use vegetation such as turf in commercial and residential developments is the only option due to water system limitations. This increases the Town's risk and vulnerability to drought by not transitioning to lower water use irrigation systems, alternative water supplies such as reclaimed water, and to lower water use landscaping and native plants (zero scape) which support water conservation efforts and improve community resiliency to drought.

Town of Sahuarita: In the Town of Sahuarita, CAP water has been extended from Pima Mine Road to Nogales Highway. FICO and Community Water of Green Valley have plans for CAP water**.**

City of Tucson: The City of Tucson continues to review and update the Tucson Water Department Drought Preparedness and Response Plan.

Unincorporated Pima County: The following are the major water providers that operate within unincorporated Pima County and have developed System Water Plans with specific recommendations and requirements during times of drought:

- Tucson Water
- Marana Water
- Metropolitan Domestic Water Improvement District
- Flowing Wells Irrigation District
- Oro Valley Water Utility
- Community Water Company of Green Valley

4.4.2 Earthquake

Description

An earthquake is a sudden motion or trembling caused by an abrupt release of accumulated strain along faults that can be found near or far from the Earth's tectonic plates. These rigid tectonic plates move slowly and continuously over the Earth's interior, where they move away, past or under each other at rates varying from less than a fraction of an inch up to 5 inches per year. While this sounds small, at a rate of 2 inches per year, 30 miles would be covered in approximately one million years[1]. The tectonic plates continually bump, slide, catch, and hold as they move past each other which causes stress that accumulates along faults. When this stress exceeds the strength of the rocks, an earthquake occurs, immediately causing sudden ground motion and shaking. Secondary hazards may also occur, such as surface fault ruptures, ground failure, landslides, liquefaction, and tsunamis. While most earthquakes occur near the edges of the tectonic plates, many damaging earthquakes also occur in the interior of plates.

Ground motion is the vibration or shaking of the ground during an earthquake caused by the radiation of seismic waves. The severity of vibration generally increases with the amount of energy released and decreases with distance from the causative fault or epicenter of the earthquake. Additional factors, such as soft soils or the presence of topographic ridges can further amplify ground motions. Ground motion causes waves in the earth's interior, also known as seismic waves, and along the earth's surface, known as surface waves. Seismic waves include P (primary) waves and S (secondary) waves. P waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel (vertical motion), with particle motion in the same direction as wave travel. They move through the earth at approximately 15,000 mph. S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side-to-side (horizontal motion) due to particle motion at right-angles to the direction of wave travel. Unreinforced masonry buildings are prone to damage from surface waves: Raleigh waves (retrograde particle motion), and Love waves (with horizontal particle motion perpendicular to the direction of propogation).

Seismic activity is commonly described in terms of magnitude and intensity. Magnitude (Mw), usually reported as moment magnitude replacing the more well-known Richter scale, is a measure of the total energy released during an earthquake. Intensity (I), as expressed by the Modified Mercalli Intensity (MMI) scale, subjectively describes the severity of an earthquake in terms of its effects on the earth's surface and on human society. Although an earthquake has only one magnitude, intensity varies by location – proximity to the epicenter-, substrate, building styles, and population density, among other factors. Magnitude is the measure of the amplitude of the seismic wave and is expressed by a logarithmic scale that represents the amount of energy released from the movement of the fault. An increase in the Magnitude scale by one whole number represents a tenfold increase in measured amplitude of the earthquake and a 30-fold increase in energy.

Another way of expressing an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. If an object is dropped while standing on the surface of the earth (ignoring wind resistance), it will fall towards earth and accelerate faster and faster until reaching terminal velocity. The acceleration due to gravity is often called "g" and is equal to 9.8 meters per second squared (980 cm/sec/sec). This means that every second something falls towards earth, its velocity increases by 9.8 meters per second, per second. Peak ground acceleration (PGA) measures the rate of change of motion relative to the rate of acceleration due to gravity. For example, acceleration of the ground surface of 244 cm/sec/sec equals a PGA of 25.0%. PGA is commonly estimated for an area and applied to building and infrastructure design. PGA, and similar calculations, are important input factors in determining the amount of shear stresses a structure can withstand.

One of the secondary hazards from earthquakes is surface faulting, the differential movement of two sides of a fault at the earth's surface. Linear structures built across active surface faults, such as railways, highways, pipelines, and tunnels, are at high risk to damage from earthquakes. Displacement along faults, both in terms of length and width, varies but can be significant (e.g., up to 20 feet), as can the length of the surface rupture (e.g., up to 200 miles). Surface rupture is rare in small magnitude events and is usually associated with earthquake magnitudes greater than Mw 6+.

Earthquake-related ground failure, due to liquefaction, is also a secondary hazard. Liquefaction occurs when seismic waves pass through saturated granular soil, distorting its granular structure, and causing some of the empty spaces

[1]Federal Emergency Management Agency, 1997, *Multi-Hazard Identification and Risk Assessment – A Cornerstone of the National Mitigation Strategy.*

between granules to collapse. Pore-water pressure may also increase sufficiently to cause the soil to behave like a fluid (rather than a soil) for a brief period, causing substantial ground deformation. Liquefaction causes lateral spreads (horizontal movement commonly 10-15 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet, but up to 12 miles), and loss of bearing strength (soil deformations causing structures to settle or tip). Liquefaction typically occurs where groundwater levels approach the ground surface, e.g., the Santa Cruz river valley of eastern Pima County.

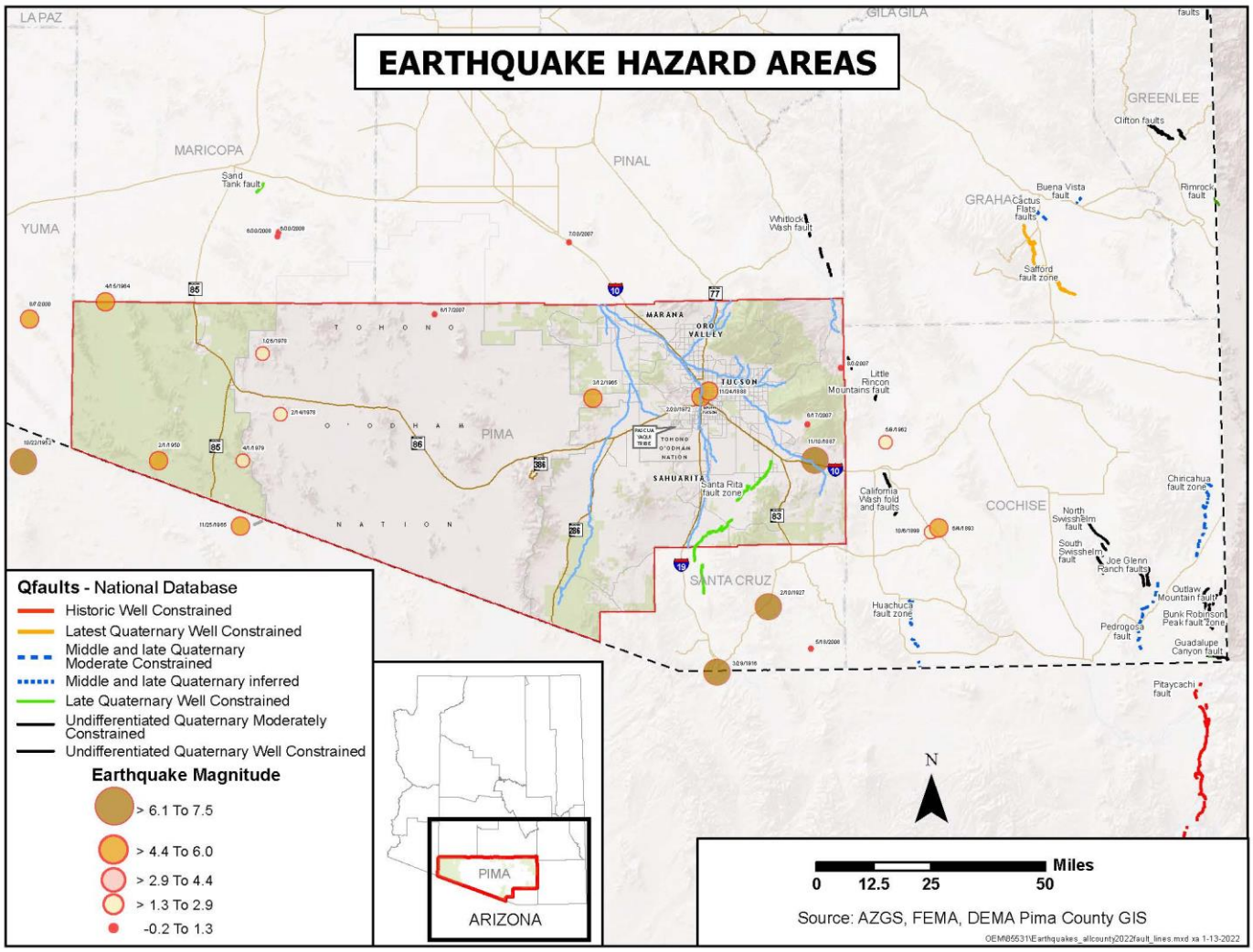
History

Seismic activity occurs on a regular basis throughout the State of Arizona, although most events are not felt, but are recorded by the Arizona Broadband Seismic Network. Although rare, damaging earthquakes affecting Pima County have been recorded in the past as follows:

- The earliest recorded earthquake affecting Arizona, and possibly the largest, occurred in 1830. With an estimated Modified Mercalli Intensity (MMI) of IX recorded at San Pedro, AZ, approximately 25 miles west of Tucson, the earthquake would have caused massive damage to built structures.[2]
- 1887, the Sonoran earthquake caused significant destruction in southern Arizona towns, including Tucson, and was one of the largest earthquakes in North American history. The earthquake was caused by the reactivation of a basin and range normal fault that is like other faults in Arizona.[3] The epicenter was located approximately 100 miles south of Douglas, Arizona, along the Pitaycachi Fault in Mexico, and caused great destruction near its epicenter. The earthquake was so large that it was felt from Guaymas, Mexico to Albuquerque, New Mexico. It is estimated variously to have been an intensity VIII and M7.6 earthquakes. In Arizona, water in tanks spilled over, buildings cracked, chimneys toppled, and railroad cars were set in motion. An observer at Tombstone, near the Mexican border, reported sounds ``like prolonged artillery fire"[4]. With the increase in development, if such an earthquake occurred today it would cause extensive damage in southeastern Arizona[5].

The main faults of concern in Pima County are as follows and shown in Figure 4-8. The three main Quaternary faults are the Pitaycachi, Santa Rita and the Huachuca faults. There have been no earthquake events of significance since the 2017revision. The Mw 5.3 earthquake near Duncan, Arizona on 28 June 2014 caused some light shaking – intensity of II-IV in Tucson and elsewhere in Pima County.

[2] Arizona Division of Emergency Management, *State of Arizona Multi-Hazard Mitigation Plan*
[3] DuBois, S.M., and Smith, A.W., 1980, *The 1887 earthquake in San Bernardino Valley, Sonora; historic accounts and intensity patterns in Arizona*: Arizona Bureau of Geology and Mineral Technology Special Paper no. 3, 112 p.
[4] Arizona Division of Emergency Management, *State of Arizona Multi-Hazard Mitigation Plan;* Bausch, Douglas B. and David S. Brumbaugh, May 23, 1994. Seismic Hazards in Arizona –Arizona Ground Shaking Intensity & 100 yr Acceleration Contour Maps, http://www4.nau.edu/geology/aeic/staterep.txt; D.B. Bausch and D.S. Brumbaugh, 1994, *Seismic hazards in Arizona:* Flagstaff, AZ Earthquake Information Center, 49 p., 2 sheets, scale 1:1,000,000.; US Geological Survey (USGS): September 12, 2003, "Earthquake History of Arizona." http://wwwneic.cr.usgs.gov/neis/states/arizona/arizona_history.html
[5] Jenny, J.P. and S.J. Reynolds, 1989. "Geologic Evolution of Arizona" in Arizona Geological Society Digest, No. 17.



Source: Pima County GIS, 2021

Figure 4-8 Southeastern Arizona Earthquake Fault Systems

Extent

Pima County is situated in the Basin and Range Province, characterized by rugged mountain ranges separated by deep sedimentary basins. Rupture of mountain range faults in Arizona's Basin and Range Province is infrequent, nonetheless they do occur and are capable of moment magnitudes of potentially damaging moderate (Mw4) to large (Mw7+) earthquakes. An enhanced continuous GPS network operated by Broermann and others, 2021 identified an anomalously high strain rate for southwestern Arizona. The authors warn that this magnitude of strain could portend release in one or more rare large-magnitude earthquakes in the future.[6]

Probability of Future Events

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps estimate the probability of exceeding a certain ground motion, expressed as peak ground acceleration (PGA),

[6] Broermann, James, Bennett, R.A., Kreemer, C., Blewitt, G., Pearthree, P.A., 2021, Geodetic Extension Across the Southern Basin and Range and Colorado Plateau: Journal of Geophysical Research: Solid Earth, 126, e2020JB021355. https://doi.org/10.1029/2020JB021355.

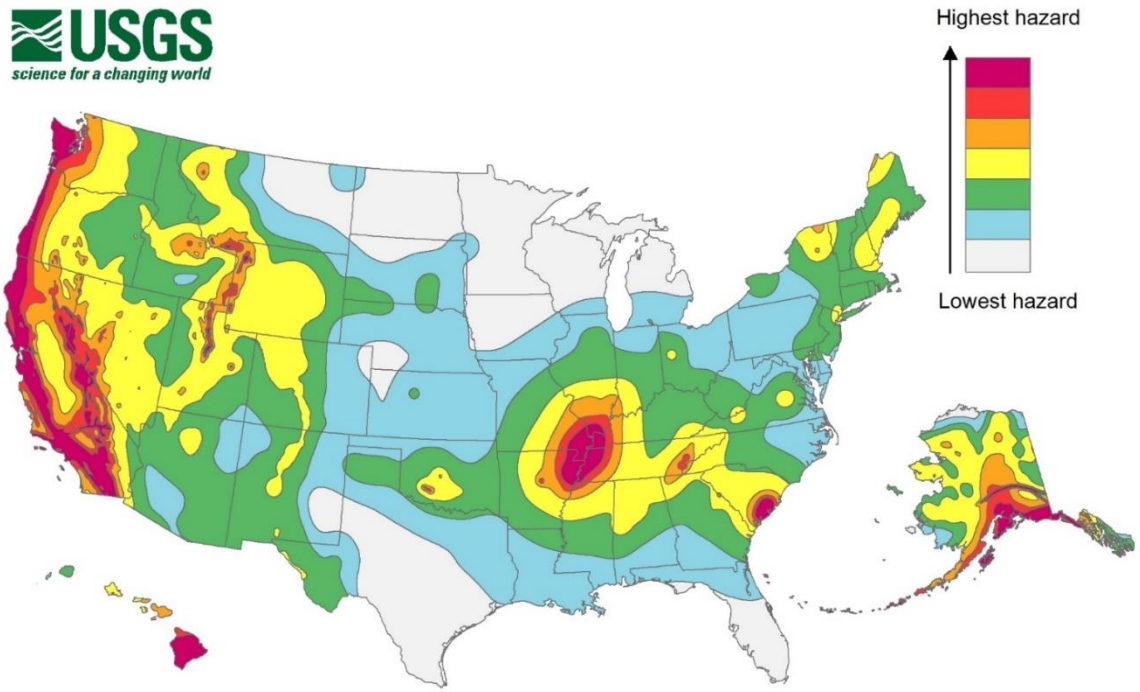
over a specified period of years. For example, Figure 4-9 displays the probability of exceeding a certain ground motion, expressed as PGA, in 50 years in the Western United States. This is a common earthquake measurement that shows the geographic area affected (colored areas on map below), the probability of an earthquake of each level of severity (e.g., 2% chance in 50 years), and the severity (PGA) as indicated by color.

Note that Figure 4-9 expresses a 2% probability of exceedance and, therefore, there is a 98% chance that the peak ground acceleration displayed will not be exceeded for 50 years. The 50-year return period use is based on statistical significance and does not imply that the structures are thought to have a useful life of only 50 years. Similar maps exist for other measures of acceleration, probabilities, and time periods.

It is useful to note that according to the USGS, a PGA of approximately 10% gravity (0.10 g) is the approximate threshold of damage to older (pre-1965) dwellings or dwellings not made resistant to earthquakes. The 0.10 g measure was chosen because, on average, it corresponds to the MMI VI to VII levels of threshold damage in California within 25 km of an earthquake epicenter.

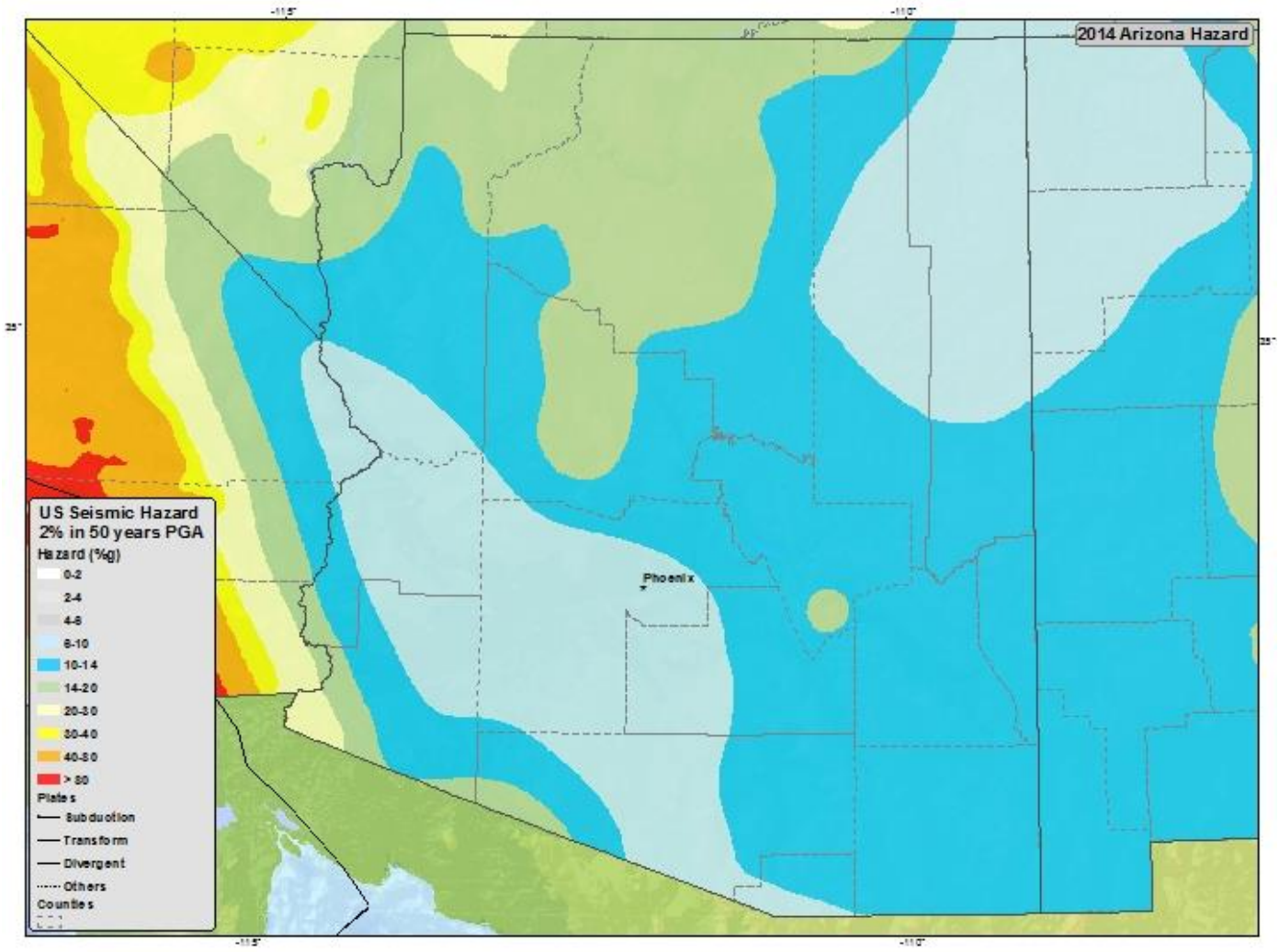
Figure 4-10 provides a more detailed view of the 2%, 50-year PGA map for Pima County. As demonstrated by this map, the central portion of Pima County has a PGA that ranges between 0.06g and 0.10g. The eastern third of the county is within the 0.10g to 0.12g range. The western portion of the county ranges from 0.08g to 0.16g with the highest PGA values occurring along the Yuma County and Mexico border. Overall, PGA values for Pima County are low in comparison with other counties within the State, and especially in areas of high population.

The possible effects of climate variability on earthquake probability should be low since earthquakes are non-climatic in nature.



Source: United States Geological Survey:
https://www.usgs.gov/programs/earthquake-hazards/science/2018-united-states-lower-48-seismic-hazard-long-term-model

Figure 4-9: USGS Simplified 2018 Earthquake Hazard Map



Source: United States Geological Survey 2014 Seismic Hazard Map: https://www.usgs.gov/media/images/2014-seismic-hazard-map-arizona

Figure 4-10: PGA for a 2% Chance in 50 Years' Recurrence

In general, the risk of seismic hazard in the urbanized portions of Pima County are relatively low; however, denser populations, existence of high rise buildings, existence of unreinforced masonry buildings, and the lack of earthquake awareness among its population elevate the risks associated with seismic activity.

The rate of seismicity in Pima County has historically been low, with the area's most recent quakes originating in San Luis in 1976 (M 6) and Baja, Mexico in 2010 (M 7.2). The largest impact of an earthquake on the metropolitan area would be the economic impact from a catastrophic southern California earthquake, which would disrupt approximately 60% of Arizona's fuel and 90% of Arizona's food goods. The Tucson metropolitan area could also be significantly affected by a major quake in the Yuma or Northern Arizona Seismic Belt (NASB). A repeat of the 1887 earthquake would result in significant damage to Arizona's population centers, particularly where development is located on alluvial plains and steep slopes. It should also be noted that although the small earthquakes occurring in Pima County are of low seismic risk to buildings, the repeated shaking could eventually cause structural damage. In unstable areas, small earthquakes may also trigger landslides and boulders rolling off mountain slopes.[7]

[7] Jenny, J.P. and S.J. Reynolds, 1989. "Geologic Evolution of Arizona" in Arizona Geological Society Digest, No. 17.

Vulnerability

Table 4-7: CPRI Results for Earthquake

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Possible	Critical	6-12 hours	< 1 week	2.55
Oro Valley	Possible	Limited	< 6 hours	< 6 hours	2.20
Pascua Yaqui Tribe	Possible	Limited	< 6 hours	< 6 hours	2.20
Sahuarita	Possible	Limited	< 6 hours	< 1 week	2.20
Tucson	Possible	Critical	< 6 hours	< 6 hours	**2.50**
Unincorporated Pima County	Possible	Limited	< 6 hours	> 1 week	2.50
				County-wide average CPRI =	**2.36**

*Jurisdictions in **bold** chose to mitigate against the hazard*

Only the City of Tucson chose Earthquake as a hazard to mitigate. Other jurisdictions gave it the same rating as 2.50 or higher, but it was not a priority for mitigation for those MJPT.

While earthquakes are not a regular occurrence in and around the City of Tucson - none have occurred within the last planning cycle and the last documented earthquake occurring more than a century ago - there is nonetheless a recognized and documented history of large earthquakes in the vicinity that have caused damage within the city. The lack of earthquake awareness and preparedness over the last century as Tucson has built up and out, and without specific building codes to protect buildings from seismic damage places the city is in a vulnerable position. Due to the development over the past century, it is understood that an earthquake many years ago may have only tipped over water towers and startled horses would today be likely to cause widespread damage and injury within the city.

The earthquake risk assessment performed for Pima County did not explore the potential for collateral hazards such as liquefaction or landslide. However, losses associated with these ground failures would have been negligible given the level of shaking expected for Pima County (i.e., not enough strong shaking to trigger significant ground failure). However, Landslide has been added to this Plan as a hazard for unincorporated Pima County.

Changes in Development in the Hazard Area

Future development in the Region is not anticipated to extensively change vulnerability to earthquake significantly. The major Quaternary faults within Pima County are generally located within the mountain ranges where development is limited due to state and local land ownership. The earthquake risk in the identified growth areas of the Pima County jurisdictions is at the borderline of the 10% g PGA, which as previously stated, is the approximate threshold of damage for older (pre-1965) dwellings or dwellings not made resistant to earthquakes. Throughout the county, new development is typically regulated to comply with current building codes that will provide for more stable seismic designs of new construction.

4.4.3 Extreme Cold

Description

Pima County's desert climate is generally prone to mild winters. The average overnight low temperature in the coldest months, December and January, hovers around 40°F in the valleys. During the rest of the cooler parts of the year, in late fall and early spring, low temperatures range from the lower 40s to the lower 50s.

This tendency for mild winters has led to infrastructure design that is not resistant to, nor built with the capacity for, extended cold periods. Additionally, the tendency for mild winters means that the people, residences, pets, as well as plants, and wildlife in the county are not prepared for cold weather. It is for this reason that temperatures that would be considered typical in other parts of the country where cold winters are the norm are instead considered extreme cold in Pima County.

While on average winters in Pima County are mild, it is not unusual to see brief periods where overnight lows drop below freezing or even reach hard freeze warning levels as described by the National Weather Service. While rare, very cold temperatures (colder than 20°F) can also occur during the winter months especially in the eastern portion of the county including the Tucson Metro area. The coldest temperatures often occur after winter storms move past the region, precipitation ends, and skies clear allowing for rapid cooling at night.

Since many water lines and inlets to residences and businesses are above ground and exposed to the elements, and since the populace is not well aware of the need to protect these pipes with proper insulation, these extremely cold temperatures can result in frozen and burst pipes. This can cause extensive water damage to homes, businesses, and government buildings.

Additionally, during extreme cold events, the populace seeks to keep warm by heating their home. However, due to the typically mild winters, natural gas distribution systems to and within the City of Tucson have not been built to handle peak loads during extreme cold events. This has led to instances of large-scale heating fuel outages during spells of extreme cold, putting residents at risk, especially those vulnerable populations with access and functional needs.

Finally, the culture in Pima County is to expect mild winters and therefore the populace is under-informed regarding the potential for and possible impacts of extreme cold. This has and can lead to damage to homes, crops, and injuries or deaths to people or their pets.

History

The National Weather Service qualifies "Extreme Cold" as incidents where temperatures or wind chills <-35F, and "Cold" threshold of -18F. While temperatures throughout Pima County do not meet the NWS definition of extreme cold or cold criteria, our community and infrastructure are at risk when we experience below-average temperatures. These risks may include hypothermia to individuals resulting in death or damage to infrastructure such as frozen or burst pipes. Events have occurred throughout Pima County with some regularity over the past years. A few examples follow:[8]

- January 2017, very heavy snow and strong damaging winds occurred on the Santa Catalina and Rincon Mountains. Numerous trees were toppled over along Catalina Highway near Mt. Lemmon. Additionally, one felled tree damaged a cable line on one of Ski Valley's ski lifts. Power was lost to most of the mountain for nearly 48 hours, and several of the communication and broadcast transmission towers were inoperable for several hours before backup generators functioned properly. Reports of 18 to 24 inches of snow were common. At lower elevations, rain caused rock slides that blocked portions of Catalina Highway and damaged guard rails. Heavy snow and strong winds occurred on the higher elevations of the Baboquivari Mountains including Kitt Peak.

- December 2018, heavy snow fell in the Catalinas with Summerhaven and Mount Lemmon Ski Valley reporting more than 15 inches of snow. A semi-tractor trailer jackknifed in the snowy conditions on Mount Lemmon Highway, blocking both lanes of traffic. The road closure resulted in about twenty people whose vehicles were farther up mountain having to spend the night in a shelter.

[8] National Centers for Environmental Information (NCEI), https://www.ncdc.noaa.gov/stormevents/

- January 2019, a relatively strong and cold weather system impacted southeast Arizona New Year's Eve through January 2nd. This storm resulted in heavy snow across area mountain ranges through New Year's Day, especially over 7000 feet in elevation with some locations receiving over a foot of snow. Heavy snow shifted to the lower elevations south and east of Tucson overnight on January 1st and on January 2nd. Snow levels dropped to 2500 feet and snow reports ranged from 2 to 7 inches on the valley floors.

- February 2019, a relatively strong and cold weather system impacted southeast Arizona on February 21st and 22nd. This storm resulted in heavy snow across area mountain ranges with locations above 5000 feet receiving one to two and a half feet of snow. Snow levels dropped to 2000 feet during the morning of the 22nd with snow reports ranging from 2 to 10 inches on the valley floors. Green Valley, Vail, and Corona de Tucson reported 3 to 7 inches of snow. There was an accident on I-10 eastbound near Vail. There were also multiple accidents along I-19 including a rollover near Duval Mine Road. Snow fell in the City of Tucson for several hours, with visibility reduced to less than a mile at times. While several inches of snow accumulated on non-paved surfaces, city streets remained wet or saw light slush accumulations.

- March 2019, a late winter weather system impacted southeast Arizona March 11th through 13th. This system along with anomalously high moisture caused the Catalina, Rincon, and White Mountains to receive over a foot of snow above 6500 feet. Snow began the evening of March 11th and continued into the evening of the 12th. By the afternoon of March 12th, a foot of snow had fallen in the Santa Catalina Mountains. Mount Lemmon Highway was closed to everyone but residents for a time due to heavy snow.

- January 2021, a pair of winter storm systems moved across Arizona January 24th through 26th. The first brought moderate snow accumulations to several mountain ranges above 6000 feet on January 24th. Mt. Lemmon Highway was closed at the base as a result. Thunderstorms produced hail and gusty winds at lower elevations. The second storm brought widespread heavy snow to southeast Arizona above 3500 feet and even brought slushy snow accumulations and slippery road conditions to parts of the greater Tucson Metro area. The bulk of the snow fell from the evening of January 25th through the morning of January 26th and was accompanied at times by wind gusts of 35 to 45 mph. Snow accumulations of 3 to 6 inches occurred between 3500 and 5000 feet with 6 to 12 inches from 5000 to 7000 feet and 12 to 20 inches above 7000 feet. The additional snow forced the closure of Mt. Lemmon Highway near Tucson to continue. Rain and snow showers created slippery roads in parts of eastern Pima County, which led to numerous, mainly minor, traffic accidents along I-19 near Green Valley and Sahuarita and along I-10 in northwest Tucson Metro area.

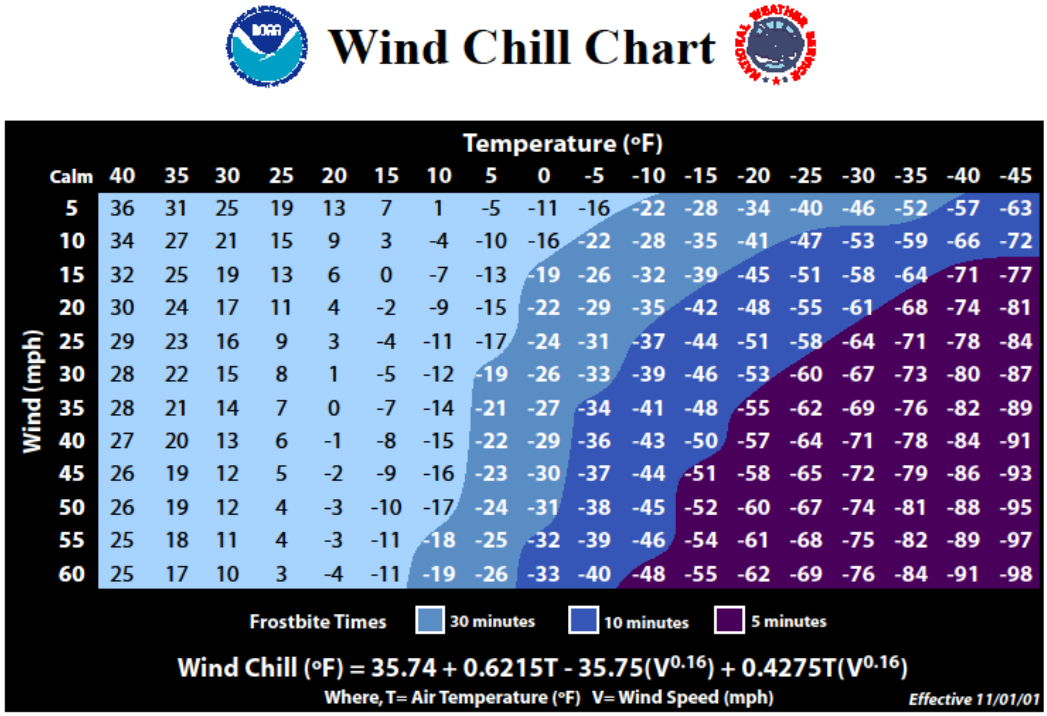
Extent

To calculate a magnitude and severity rating for comparison with other hazards, and to assist in assessing the overall impact of the hazard on the planning area, information from the event of record is used. In some cases, the event of record represents an anticipated worst-case scenario, and in others, it is a reflection of common occurrence. Based on the NCEI records, the most recent event of record for extreme cold in Pima County occurred on February 2, 2011 when record cold temperatures dropped into the mid to upper teens across the Tucson area for several nights in a row. There was also minimal daytime heating and high winds which combined resulting in two fatalities. The cold also led to numerous burst water pipes. As a result, at least 2000 residents and businesses were without water at some point for a day. Due to cold temperatures along the natural gas route from El Paso to Tucson, Southwest Gas could not meet natural gas demand, which resulted in about 14,000 Tucson customers being without heat. In Green Valley, over $17,000 in damage was sustained at 11 Green Valley recreational centers due to broken sprinkler systems. Pima County and the City of Tucson collaborated to open a warming shelter for residents without heat. Untold numbers of plants, trees, and shrubs were also killed by the record cold, including many saguaro cacti. This event resulted in $1M in damages.[9]

Extreme cold can occasionally cause problems with communications facilities and utility transmission lines. Danger to people is highest when they are unable to heat their homes and when water pipes freeze. In 2001, the NWS implemented an updated Wind-Chill Temperature index. This index was developed to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat

[9] NCEI Storm Events Database - Event Details | National Centers for Environmental Information (noaa.gov)

loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.



Source: NWS, 2021 https://www.weather.gov/media/safety/windchillchart3.pdf

Figure 4-11: National Weather Service Wind Chill Chart

Extreme cold in Pima County would be cold temperatures that would induce hypothermia in an individual either over an interval, such as several days of temperatures that cause body temperature to drop below 96°F or from a singular drop in air temperature below 32°F, and without an adequate heat source, a person's temperature would fall below 96°F.

Probability of Future Events

Despite the generally mild winters, over the last decade, the National Weather Service averages three published hard freeze warnings in eastern Pima County each year.[10] Thus, the probability of extremely cold weather is highly likely on an annual basis. While any of these hard freeze events have the potential to cause infrastructure damage, damage to the environment, and, most importantly loss of life, the most extreme cold events noted above impact eastern Pima County with a high magnitude due to the nature of the typical building techniques, the design of utility infrastructure in the region, as well as the culture where the residents expect mild winters and are mostly unprepared for extreme cold.

[10] National Weather Service, Tucson

Vulnerability

Table 4-8: CPRI Results for Extreme Cold					
Participating Jurisdiction	**Probability**	**Magnitude/ Severity**	**Warning Time**	**Duration**	**CPRI Score**
Marana	Possibly	Limited	12-24 hours	< 24 hours	2.00
Oro Valley	Possibly	Limited	< 6 hours	< 1 week	2.25
Pascua Yaqui Tribe	Possibly	Limited	> 24 hours	< 1 week	1.95
Sahuarita	Possibly	Limited	12-24 hours	< 1 week	2.10
Tucson	**Likely**	**Limited**	**> 12-24 hours**	**<1 week**	**2.55**
Unincorporated Pima County	Likely	Limited	12-24 hours	< 1 week	2.55
				County-wide average CPRI =	**2.23**
*Jurisdictions in **bold** chose to mitigate against the hazard*					

The inherent nature of extreme cold makes it a regional threat, impacting most or all of the jurisdictions simultaneously as well as extending the effects into the surrounding jurisdictions. Lower elevations and valley bottoms can be more susceptible to trapping cold air, thus portions of Pima County are more prone to this hazard.

Town of Marana: The Town of Marana is rarely susceptible to extreme cold hazards. When events do occur they may include frozen feeder line residential-scale pipes which may burst and lead to additional damages on public and private properties.

Town of Oro Valley: While the Town of Oro Valley is potentially vulnerable to rare extreme cold events over a multiple-day period, most of the community's susceptibility to harm and damages is from cascading events. This for example includes electrical or gas outages, frozen or burst pipes, and loss of vegetation due to frost. Frozen and burst pipes can lead to damages, repair/replacement costs, and insurance claims due to flooding and water damages. As a result of the extreme cold event in February 2011, the Water Utility updated standard details to make their water infrastructure more resilient to freezing temperatures. Loss of electrical or gas heating during high-demand periods of extreme cold would put many residents at risk, especially vulnerable populations. Due to the relatively mild average winters, when these rare extreme cold events occur, the community may not be as prepared to highlight the importance of messaging and education.

Pascua Yaqui Tribe: While there were no significant extreme cold events that impacted the Pascua Yaqui Tribe specifically, both human and infrastructure losses could be expected with any significant extreme cold event. The at-risk population needs to include Elders and Access and Functional Needs (AFN) populations will be incorporated in planning methodologies and educational mitigation awareness.

City of South Tucson: While the City of South Tucson is potentially vulnerable to rare extreme cold events over a multiple-day period, most of the community's susceptibility to harm and damages is from cascading events. This for example includes electrical or gas outages, frozen or burst pipes, and loss of vegetation due to frost. Frozen and burst pipes can lead to damages, repair/replacement costs, and insurance claims due to flooding and water damages. While not limited to just the City, a loss of electrical or gas heating during high demand periods of extreme cold would put many residents at risk, especially vulnerable populations. Due to the relatively mild average winters, when these rare extreme cold events occur, the community may not be as prepared thus highlighting the importance of messaging and education.

City of Tucson: The City of Tucson chose it as a primary hazard to address due to its costly response costs particular to their jurisdiction. The most extreme cold events impact Tucson with a high magnitude due to the nature of the typical building techniques, the designs of utility infrastructure in the region, as well as the culture in Tucson where the residents expect mild winters and are mostly unprepared for the extreme cold. During the wintertime, extremely cold temperatures are something the City is less accustomed to and prepared for. Local building practices and codes do not consider the protection of water pipes from extremely cold weather, and local natural gas supply infrastructure was not built to take into account the demand for heating fuels when the temperatures drop well below freezing for extended periods of record-breaking cold. This type of cold weather has and can again lead to widespread failure to deliver heating fuel and failure of water delivery systems, again leaving large populations within the City vulnerable.

Loss Estimations

There is no standardized method for estimating losses associated with extreme cold events and none is made for this Plan. From a historical perspective, both human and infrastructure losses could be expected with any significant extreme cold event especially regarding loss of human life for those exposed to the cold weather for long periods, and damage to water supply infrastructure. This is especially true in Pima County non-mountainous areas, such as the City of Tucson, since extreme cold events are rare, and the general population is not likely to be prepared for such an event.

Changes in Development in the Hazard Area

While the extreme cold is a yearly threat, it is unlikely to affect future development. Enforcement and implementation of modern building codes to regulate new developments, in particular the proper installation and protection of water supply lines, in conjunction with public education on how to respond to hazardous cold conditions is probably the best way to mitigate against such losses.

Pascua Yaqui Tribe: To address the hazard area of impacts from extreme cold events, over the reporting period, Pascua Yaqui Tribe developed residential properties in order to provide affordable housing solutions, especially for elderly and AFN populations. Adequate and modern housing for Pascua Yaqui tribal membership will address and alleviate additional costs for temporary sheltering/heating for individuals/households who would otherwise fall into a vulnerable population. Phase I of these projects consists of 50 single-family units, currently under construction. Phase II will consist of 27 town-home dwellings within 7 building structures. Phase III is in its incipient development; however, initial plans are for 50, one to two-bedroom units within a three to four-story structure.

Another significant update that would address the hazard area for extreme cold events was a project developed using funding from the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) to install and or replace central heating/cooling units for Pascua Yaqui homeowners and renters that live on and off the reservation lands. This project was able to fund the installation/replacement of heating, ventilation and air conditioning (HVAC) units for 200 homes and 450 rental units within New Pascua reservation proper. Additionally, the Pascua Yaqui Tribe installed or replaced HVAC units for 550 members that reside off the reservation. The project was established to provide service to priority households that consisted of COVID positive patients with inadequate or no HVAC unit, elders and or individuals with comorbidities, and general population individuals

City of Tucson: Continued development also implies continued population growth, which raises the number of individuals potentially exposed to variations in weather patterns. Education efforts should continue to help the population understand the risks and vulnerabilities of outdoor activities, property maintenance, and regular exposures during periods of extreme cold. The City of Tucson continues to actively implement a winter weather risk awareness program to educate the public on the risks of severe cold during winter storms

In preparation for freezing temperatures, the City of Tucson implements several different programs such as Operation Deep Freeze, which works with voluntary organizations in providing shelter and temporary housing during the extreme cold. In addition, Operation Freeze, a road treatment program, is put into place to make sure the City's bridge decks are free of ice and safe for motorists to drive over. During Operation Freeze, City crews place "Wet Road Ahead" signs at bridge entrances and spray magnesium chloride on the bridge decks to lower the freezing temperature of water and prevent ice from forming on a roadway.

4.4.4 Extreme Heat

Description

Extreme temperatures can occur within any area and can often have adverse impacts on the health and welfare of a community or region. These extreme temperatures can affect people, pets, plants, and infrastructure throughout the area. Extreme heat is considered a risk to Pima County residents.

Extreme heat is either high temperature above the 95th percentile for the date or the combination of very high temperatures and exceptionally humid conditions that exceed regionally based indices for perceived risk. According to the National Weather Service, heat is one of the leading weather-related killers in the United States. Heat is responsible for hundreds of fatalities and even more heat-related illnesses.[11]

The major human risks associated with extreme heat are as follows:

- Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.
- Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.
- Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal to moderately elevated. The prognosis is usually good with fluid treatment.
- Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15% even with treatment.

Extreme heat affects individuals who work outdoors, as well as the homeless who have no access to shade or cooling, particularly at night. Nearly 3,000 people visit Arizona emergency rooms because of heat-related illnesses annually.[12]

Hikers and others involved in outdoor recreation frequently succumb to extreme heat when they run out of water. Extreme heat can stress the elderly and people with compromised immune systems or other health issues, leading to heart attacks and respiratory distress. Many of the elderly and those in poverty either have no air conditioning or have insufficient resources to use air conditioning during a heat wave. In the southwest deserts, air conditioning in the summer is as critical as home heating in the winter is for those in the northern tier of states. Other vulnerable populations during a heat wave include infants, young children, and those with functional or access needs.

In addition to the loss of life, extreme heat can affect infrastructure. Power lines are de-rated based on the ambient air temperature, which provides cooling to this equipment. High temperatures and windless conditions can lead to power lines as well as power transformers overheating, resulting in widespread power outages. Transportation systems also suffer during extreme heat or cold. Rail lines can buckle in extreme heat as the metal expands. Thermal expansion and contraction cause roadways to crack, leading to moisture penetration and degradation of asphalt or other road construction materials. Extreme heat also threatens pavement markings and signage, shortening their life and requiring more frequent replacement.

History

Extreme temperature events occur in Pima County on a regular basis, but damaging events typically occur during the summer months. History would indicate that multiple deaths due to extreme heat are highly likely, especially for the homeless, low-income, elderly, young, and people with access and functional needs. These populations are particularly vulnerable to extreme heat due to the increased exposure to the natural elements and decreased ability to compensate in the form of cooling apparatus.

Deaths of undocumented border crossers in the desert areas along the Arizona-Mexico border are also attributed to extreme heat. In the majority of the cases, the Pima County Medical Examiner lists the cause of death as undetermined,

[11] National Weather Service, 2016: http://www.nws.noaa.gov/os/heat/index.shtml
[12] Arizona Department of Health Services, 2020: Heat-Related Illness Summary 2016-2020 Arizona Residents and Non-Residents (azdhs.gov)

primarily due to limitations of examination of decomposed and skeletal remains. Environmental exposure to extreme heat combined with dehydration contributed to 90 deaths from 2017 to 2020.[13]

During the summer of 2020, the National Weather Service issued numerous excessive heat warnings during a persistently hot and dry summer/monsoon. New daily record high temperatures were established on 11 days during the summer in Tucson and the high temperature exceeded 105°F on 57 days. August was the hottest month ever recorded in Tucson for any month of the year.[14] According to the Pima County Medical Examiner, there were 185 heat-related deaths in Pima County between 2017 and 2020 with the highest total for a single year was 47 deaths in 2020. [15]

In the past, excessive heat events have produced these statistics:[16]

- June 2017, an extended period of excessive heat occurred across nearly all of southeast Arizona on June 6th. The highest temperatures during the period were 118°F at Ajo and 117°F at Organ Pipe National Monument. While no heat-related deaths occurred, there were numerous instances of heat-related illnesses in the Tucson Metro area.

  An extended period of excessive heat occurred across nearly all of southeast Arizona from June 18th through the 25th. The Tucson International Airport reached 115°F on three consecutive days for the first time and recorded the 2nd warmest reading on record of 116°F on the 20th. The low temperature of 87°F on the 20th was the warmest on record for June. Dozens of heat-related illnesses were reported in the Tucson Metro and two heat-related fatalities occurred west of Ajo.

- April 2018, hot temperatures were experienced in parts of southeast Arizona on April 25th with a temperature of 97°F recorded at Organ Pipe National Monument. One heat-related fatality occurred in western Pima County. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male.

- May 2018, hot temperatures were experienced in parts of southeast Arizona on May 5th and 6th with a temperature of 102°F recorded at Sells. One heat-related fatality occurred east of Sells. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult female east of Sells.

- June 2018, hot temperatures were experienced in parts of southeast Arizona on June 3rd and 4th with temperatures of 107°F and 104°F recorded at Sells. One heat-related fatality occurred east of Sells.

  Well above normal temperatures occurred in southeast Arizona on June 22nd and 23rd. Temperatures as hot as 108°F occurred at Ajo, with a record high of 107°F at Sasabe and Sells and 106 at Tucson International Airport and Green Valley. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult on the Tohono O'odham Nation on the 23rd.

- August 2018, above normal temperatures occurred in Western Pima County on August 2nd and 3rd. Organ Pipe Cactus National Monument recorded high temperatures of 106 on the 2nd and 108 degrees on the 3rd, while Ajo reached 109°F and 108°F, respectively. Low temperatures were also above normal, in the lower 80s. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male just northeast of Ajo on the 3rd.

- September 2018, above normal temperatures occurred in southern Pima County on September 10th and 11th. Sells recorded high temperatures of 102°F on the 10th and 104°F on the 11th, while Sasabe reached 101°F on both days. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male just east of Sasabe on the 10th and another adult male northwest of Topawa on the Tohono O'odham Nation on the 11th.

- July 2019, above normal temperatures occurred in eastern Pima County on July 21st. The Tucson International Airport recorded a high temperature of 104°F after a morning low of 81. Green Valley topped

[13] Pima County Medical Examiner Reports, , Medical Examiner - Pima County

[14] National Weather Service, Tucson, 2021

[15] Arizona Department of Health Services, 2020: https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/extreme-weather/pubs/heat-related-mortality-year.pdf

[16] National Centers for Environmental Information (NCEI) Storm Events Database https://www.ncdc.noaa.gov/stormevents/

out at 103°F. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one female found in the desert southeast of Ryan Field.

- August 2019, above normal temperatures occurred in southeast Arizona on August 27th. High temperatures included 105°F at the Tucson International Airport, 107°F at Sells, and 104°F (record high) at Sasabe. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male 11 miles south of Three Points.
- May 2020, above normal temperatures occurred in southeast Arizona on May 26th. High temperatures included 100°F at Sells, and 98°F at Sasabe, Anvil Ranch, and the Tucson International Airport. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male 2 miles east of Sells, about 2 miles south of Tohono O'odham Community College.
- June 2020, above normal temperatures occurred in south-central Pima County on June 21st. High temperatures included 106°F at Sells and 104°F at Sasabe. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one adult male 2 miles southwest of Topawa, on the Tohono O'odham Nation.

  On June 28th, high temperatures included 98°F at Sells and 103°F at Sasabe. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one young adult male 5 miles southwest of Topawa, on the Tohono O'odham Nation.
- August 2020, above normal temperatures around 105°F occurred in central Pima County causing the Moderate Heat Risk category to be reached on August 8th. The Pima County Medical Examiner confirmed that heat was the primary cause of death for two adult males, one near Sells and another 15 miles southeast of Santa Rosa on August 8th. A second death heat-related death for one adult male just east of the Baboquivari Mountains on August 10th.
- September 2020, very hot temperatures were experienced in the lower elevations of southeast Arizona from September 4th through the 7th. Many locations approached or exceeded 110°F and set new daily record high temperatures. The Pima County Medical Examiner confirmed that heat was the primary cause of death for five individuals found in the desert in Pima and Cochise counties during the period.
- June 2021, very hot high temperatures of 106°F to 119°F, or 8°F to 13°F above normal, occurred in the lower elevations of southeast Arizona June 12th through the 20th and caused the High Heat Risk category to be reached. New record daily high temperature records were established at numerous sites on several days during this period. The Pima County Medical Examiner confirmed that heat was the primary cause of death for 14 people found in the desert of Pima and Santa Cruz counties during this period.
- August 2021, very hot temperatures of 101°F to 107°F, or 8°F to 12°F above normal were experienced in much of southeast Arizona on August 3rd and 4th with high temperatures equaling or exceeding established records in a few locations, and approaching record levels in most others. The Pima County Medical Examiner confirmed that heat was the primary cause of death for two males found in the desert in Pima County.

  During August 25th through the 27th, temperatures reached 104°F to 114°F or 5°F to 11°F above normal occurred, with high temperatures equaling or exceeding established records in a few locations, and approaching record levels in most others. The Pima County Medical Examiner confirmed that heat was the primary cause of death for one male found in the desert.
- September 2021, very hot temperatures were experienced west and south of Tucson September 11th through the 14th. The hottest two days were the 12th and 13th when high temperatures fell just shy of records across much of Pima County and topped out between 104°F and 109°F. During the four days, the Pima County Medical Examiner confirmed that heat was the primary cause of death for six individuals found in the desert, one at Organ Pipe Cactus National Monument and five on the Tohono O'odham Nation.

Extent

Climate change analysis predicts that the southwest will continue with an increase in daily temperatures during all months in the year resulting in warmer winters and hotter summers.[17] In addition, the climate models also predict less rainfall or snowfall, which will cause water shortages for human consumption as well as for generating electrical power.[18] During the 2021 summer, levels fell in Lake Mead to the lowest level seen in twenty years. In addition, the ongoing drought is forecasted to continue through the 2021 winter season. As noted in Figure 4-12, we experience extreme heat with temperatures above 95°F from April to October in any given year.

Probability of Future Events

There are no recurrence or non-exceedance probabilities developed for extreme temperature events in Arizona or Pima County. Table 2.1 *Climate Statistics for Stations in Pima County* provides example normal and extreme temperature ranges for various weather stations within the county. In general, extreme temperatures vary from normal by 10°F to over 30°F, with highs that exceed 110°F and the trend (though not linear) is toward increased number of days with high temperatures at or above 105°F and 110°F.

One indicator of the degree of danger associated with extreme heat is the Heat Index (HI) or the "Apparent Temperature." According to the NWS, the HI is an accurate measure of how hot it feels when the Relative Humidity (RH) is added to the actual air temperature. Figure 4-14 is a quick reference chart published by the NWS that shows the HI based on current temperature and relative humidity, and levels of danger for HI values. It should be noted that the HI values were devised for shady, light wind conditions and that exposure to full sunshine can increase HI values by up to 15°F. In addition, strong winds, particularly with very hot, dry air, can be extremely hazardous.

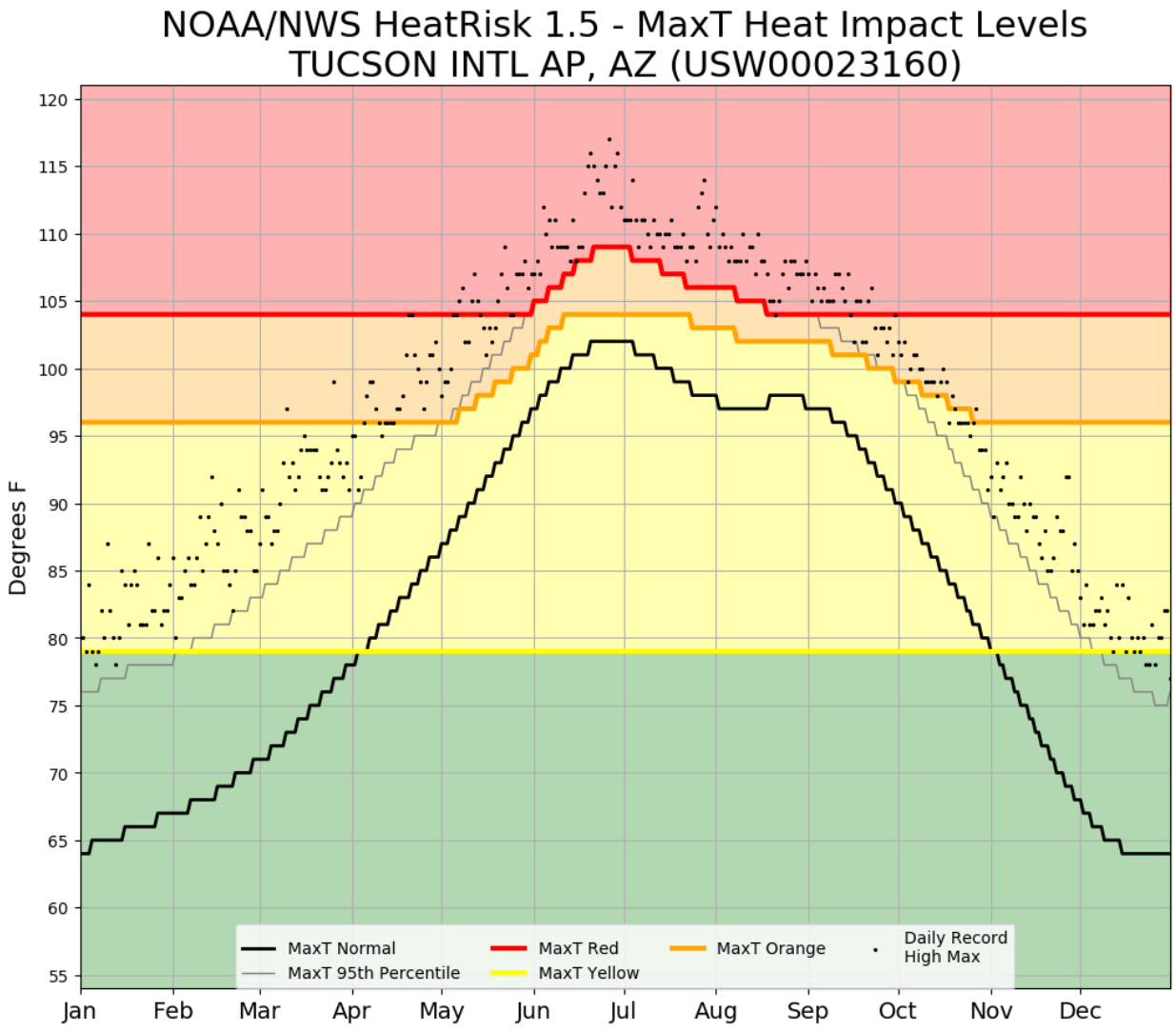
While the heat index is a valuable component toward understanding heat risk for people, there are not an adequate number of stations across the country, particularly in the West, that report hourly humidity values for a long enough period of years to develop a high resolution gridded climatology. Additionally, in most approaches to heat index warning criteria, the impacts of excessively warm nights are not considered. The HeatRisk approach utilizes the many more observations of temperature that exist across the country, along with leveraging well-known relationships between temperature and humidity to approximate the role of humidity. Hence, the HeatRisk approach does account for humidity, but in a more general sense, and its output will differ somewhat from specifically calculated heat index values.[19]

The HeatRisk takes into consideration:

1. How significantly above normal the temperatures are a given location,
2. The time of the year (for example, is this early season heat that you likely haven't become used to, or late-season heat that you have become more used to),
3. The duration of unusual heat (for example, are temperatures overnight at levels that would lower heat stress, or will warm overnight low temperatures continue to add to heat stress into the next day), and
4. If those temperatures are at levels that pose an elevated risk for heat complications, such as heat stress, based on peer-reviewed science.

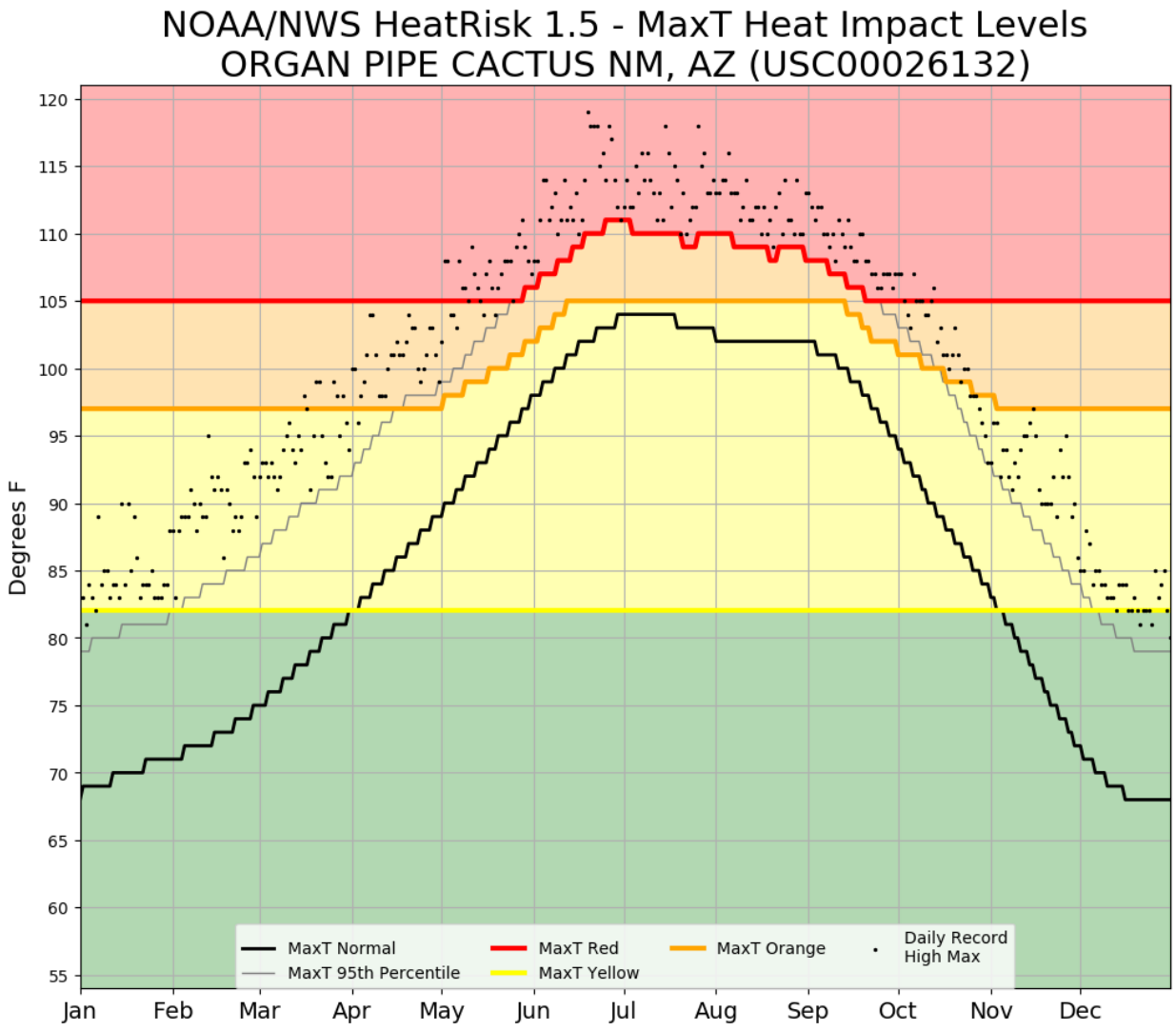
These factors are used to create daily dynamic heat thresholds for different locations for every day of the year which are plotted so that the climatological heat risk for particular locations on specific days of the year can be visualized.[20]

[17] Climate Change - Science of the American Southwest (U.S. National Park Service) (nps.gov) (https://www.nps.gov/subjects/swscience/climate-change.htm)
[18] Lake Mead level continues to drop, affecting power production - USA News Lab (https://usanewslab.com/us-news/las-vegas/lake-mead-level-continues-to-drop-affecting-power-production/)
[19] NWS Experimental HeatRisk: Identifying Potential Heat Risks in the Seven Day Forecast: https://www.wrh.noaa.gov/wrh/heatrisk/
[20] NWS Experimental HeatRisk Historical Data https://www.wrh.noaa.gov/wrh/heatrisk/historical/



Source: National Weather Service - Tucson

Figure 4-12 NOAA/NWS HeatRisk Maximum Heat Impact Levels for Tucson

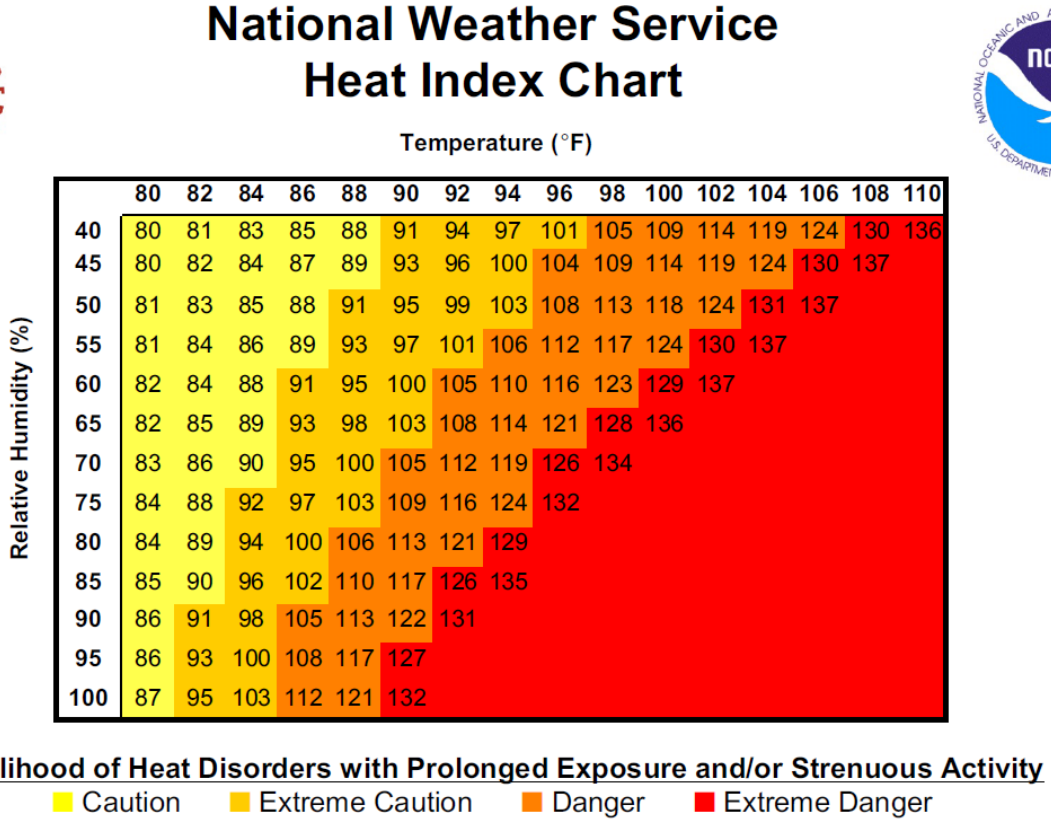


Source: National Weather Service - Tucson

Figure 4-13 NOAA/NWS HeatRisk Maximum Heat Impact Levels for Organ Pipe National Monument

Climate variability may have a strong impact on extreme temperatures and extreme heat. The Centers for Disease Control says that rare extreme heat events that may occur once every 20 years could start occurring every two to four years in certain parts of the country including Arizona.[21] Events could become more severe and last longer as well as being more common.

[21] Centers for Disease Control, Climate Change and Extreme Heat Events, retrieved 2017: https://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf



Source: NWS, 2021 https://www.weather.gov/images/wrn/social_media/2017/heat_index.jpg

Figure 4-14: National Weather Service Heat Index Chart

Vulnerability

Table 4-9: CPRI Results for Extreme Heat

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Likely	Limited	12-24 hours	> 1 week	2.65
Oro Valley	Highly Likely	Limited	> 24 hours	> 1 week	**2.95**
Pascua Yaqui Tribe	Highly Likely	Limited	> 24 hours	< 1 week	**2.85**
Sahuarita	Highly Likely	Critical	> 24 hours	> 1 week	**3.25**
Tucson	Highly Likely	Critical	12- 24 hours	<1 week	**3.40**
Unincorporated Pima County	Highly Likely	Critical	12-24 hours	>1 week	**3.40**
				County-wide average CPRI =	**3.08**

*Jurisdictions in **bold** chose to mitigate against the hazard*

Town of Oro Valley: The Town of Oro Valley is vulnerable to extreme heat. Extreme heat events occur on a regular basis, typically in the summer months resulting in threats to public health and safety. In recent years, temperatures in the summer months have been the warmest on record. Extreme heat, combined with less precipitation, and high wind days also increases the potential for major wildfires. Fluctuation in temperatures may also lead to higher uses of electricity, gas, or water that can lead to outages or interruptions in service. Oro Valley has susceptible populations in children and the elderly. Tourism, in the form of outdoor recreational activities, brings people from locales unfamiliar with the desert climate that can expose their susceptibility to the effects of extreme heat.

Pascua Yaqui Tribe: The Tribe's vulnerability to extreme temperature is primarily heat-related. The Tribe operates two casinos and one golf course that receive numerous heat-related emergency calls annually. As with other jurisdictions, elderly and AFN populations are also vulnerable to the temperature extremes and we will continue to identify vulnerable populations for heat-related illness, provide education targeted toward recreational activities, sustained education for tribal and enterprise workforce, visitors/travelers, and hospitality industry.

Town of Sahuarita: The Town of Sahuarita, like other neighboring communities, is vulnerable to heat and heat-related emergencies. Sahuarita, a planned community, emphasizes outdoor activities such as golf as one of its benefits for its residents and is home to several golf courses. Sahuarita has many senior communities and elder care facilities as well as neighborhoods for young families. As the elderly and young are more vulnerable to heat, the Town of Sahuarita chose extreme temperature as one of its hazards.

City of South Tucson: The City of South Tucson is vulnerable to extreme heat. Extreme heat events occur on a regular basis, typically in the summer months resulting in threats to public health and safety. In recent years, temperatures in the summer months have been the warmest on record. Extreme heat, combined with less precipitation, and high wind days also increases the potential for major wildfires. These compounding factors increase the potential for harm, damages, and losses. Fluctuation in temperatures may also lead to higher uses of electricity, gas, or water which can lead to outages or interruptions in service. South Tucson has susceptible populations in children elderly and low-income residents.

City of Tucson: Situated in a high-desert climate, Tucson is a place of extremes. The City of Tucson sees very high summer temperatures, and just months later will experience sub-freezing winter temperatures. While this is the norm, over the last decade the range of extremes has grown with recent summer temperatures breaking multiple records in one month and winter temperatures dropping to a point that the community, and infrastructure owners, are not prepared for.

During the summertime, extreme heat is generally handled well by the community dependent on the reliable delivery of electric power so that residents and businesses can cool their homes and buildings. The potential for electrical system failure during the summer due to storms, wildfires, or overuse/stress on the system are realities that Tucson as a city has begun to address more thoroughly in our planning processes as electrical system failure resulting in a long-term power outage would leave a large portion of the city vulnerable to heat-related illness during late spring, summer, and early fall where daytime temperatures exceed 90°F.

Unincorporated Pima County: Residents and visitors are vulnerable to extreme heat. Full-time citizens of Pima County are generally prepared for the hot climate; however, the homeless and visitors can be overcome due to exposure and lack of awareness. The Pima County Health Department maintains a "Beat the Heat" campaign and various other departments get involved during heat emergencies. Like others, unincorporated Pima County is vulnerable to electrical outages that moves the emergency from individuals outdoors to those indoors as well including the vulnerable elderly and young.

In fall 2021, Pima County was awarded a small grant to further efforts using the BRACE (Building Resilience Against Climate Effects) principles and practices from the Center of Disease Prevention and Control (CDC). To this aim, Pima County will research the installation of "cooling centers" that may be developed into "resilience centers" to support an all-hazard response within Pima County. In addition, Pima County is working with the US Environmental Protections Agency (EPA) to identify the infrastructure changes needed to enable schools, particularly high schools, to be regional locations for cooling as well as a source of good air quality, should air quality be compromised during heat waves.

One of the goals of the BRACE grant will be to determine the types of data that should be collected for decision making through a health equity lens. As such, the research will employ the social determinants of health as well as other principles that govern access or barriers to individuals and communities achieving their health and wellness aspirations. From anecdotal evidence, succumbing to heat-related illness often involves multiple factors mediated by the individual's exposure to heat. One known factor is prevalence of cardio-vascular disease in the community. Another factor is the relationship between taking prescription drugs that have as side effect the increased susceptibility to negative outcome from heat exposure

Loss Estimations

Losses due to extreme heat primarily occur in the form of death and illness for people and animals as mentioned at the beginning of this section. Arizona Department of Health Services tracks data and monitors trends and other factors to determine if a statistical significance exists. History would indicate that multiple deaths due to extreme heat are highly likely, especially for illegal immigrants that attempt to cross the Arizona deserts during the summer months. Homeless, low income, elderly, young and access and functional needs populations are particularly vulnerable to extreme heat due to the increased exposure to the natural elements and decreased ability to compensate in the form of cooling apparatus.

Changes in Development in the Hazard Area

Growth in Pima County has significantly increased the population and infrastructure exposed to extreme heat. There is also an increased demand on resources for electric power during the summer months. The primary intersect of extreme high temperature hazards and future development of the county is in the general increase in population and commensurate infrastructure development required.

Over the decades as the metropolitan area has dramatically grown, the "urban heat island" effect has developed. This has caused temperatures in the center of metropolitan areas to become much warmer than those in rural areas have. The concrete and asphalt of urban areas retains the heat of the day, and releases it slowly as compared to the surrounding desert terrain, which cools much quicker at night. As development continues to occur within Tucson and its surrounding area, heat-island conditions will continue to increase.

Pascua Yaqui Tribe: The Tribe's vulnerability to extreme temperature is primarily heat-related. The Tribe operates two casinos and one golf course that receive numerous heat-related emergency calls annually. As with other jurisdictions, elderly and AFN populations are also vulnerable to the temperature extremes and we will continue to identify vulnerable populations for heat-related illness, provide education targeted toward recreational activities, sustained education for tribal and enterprise workforce, visitors/travelers, and hospitality industry.

To address the hazard area of impacts from extreme hot events, over the reporting period, Pascua Yaqui Tribe improved residential/rental properties to provide affordable housing solutions, especially for the elderly and AFN populations. Adequate and modern housing for Pascua Yaqui tribal membership has addressed and alleviated additional costs for temporary sheltering/cooling for individuals/households who would otherwise fall into a vulnerable population. Phase I of these projects consists of 50 single-family units, currently under construction. Phase II will consist of 27 town-home dwellings within 7 building structures. Phase III is in its incipient development; however, initial plans are for 50, one to two-bedroom units within a three to four-story structure.

Another significant update that would address the hazard area for extreme heat events was a project developed using funding from the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) to install and or replace central heating/cooling units for Pascua Yaqui homeowners and renters that live on and off the reservation lands. This project was able to fund the installation/replacement of HVAC units for 200 homes and 450 rental units within the New Pascua reservation proper. Additionally, the Pascua Yaqui Tribe installed and or replaced HVAC units for 550 members that reside off the reservation. The project was established to provide service to priority households that consisted of COVID positive patients with inadequate or no HVAC unit, elders and or individuals with comorbidities, and general population individuals.

City of Tucson: The City of Tucson continues to actively implement a heat weather risk awareness programs to educate the public on the risks of severe hot temperatures during summer months. Tucson works to assess and identify at risk populations who are vulnerable to extreme heat and works with voluntary organizations in providing shelter and temporary housing during the extreme heat.

4.4.5 Flood

Description

Floods result from precipitation. Other floods due to dam or levee failures are addressed separately. Three seasonal atmospheric events tend to trigger floods in Pima County:

- *Tropical Storm Remnants*: The worst flooding tends to occur when the remnants of a hurricane that has been downgraded to a tropical storm or tropical depression enter the State. These events occur infrequently and mostly in the early autumn and usually bring heavy and intense precipitation over large regions causing severe flooding.
- *Winter Rains*: Winter brings storms that are low intensity; but long duration rains covering large areas that cause extensive flooding and erosion, particularly when combined with snowmelt.
- *Summer Monsoons*: In mid to late summer, the monsoon winds bring humid subtropical air into the state. Solar heating triggers afternoon and evening thunderstorms that can produce extremely intense, short-duration bursts of rainfall. The thunderstorm rains are mostly translated into runoff and in some instances, the accumulation of runoff occurs very quickly resulting in a rapidly moving flood wave referred to as a flash flood. Flash floods tend to be localized and cause significant flooding in local watercourses.

Damaging floods in the county include riverine, sheet, alluvial fan, and local area flooding. Riverine flooding occurs along established watercourses where the overbank areas become inundated. Sheet flooding occurs in regionally low areas with little topographic relief that can generate floodplains over a mile wide, such as in Avra Valley. Alluvial fan flooding is generally located near the base of mountains, such as the Tortolita Fan, which are characterized by multiple, highly unstable flow paths that can rapidly change during flooding events. Local area flooding is often the result of poorly designed or planned development wherein natural flow paths are altered, blocked, or obliterated, and localized ponding and conveyance problems result. Erosion is also often associated with damages due to flooding.

Another major flood hazard comes as a secondary impact of wildfires in the form of dramatically increased runoff from ordinary rainfall events that occur on burned watersheds. Loss of vegetation and soil changes are contributing to significantly increased runoff, turning a routine annual rainfall event into a raging flood with drastically increased potential for soil erosion, mud and debris flows.

History

Historical records of flooding in Pima County date back to the late 1800s. As one would expect, the frequency of reports of flood damage and loss increased over time as the population of the metropolitan area grew. By the late 1970s, the population in Pima County had grown to almost 500,000. By 2000, that number had risen to nearly 850,000.[1]

Pima County has been part of 13 disaster declarations for flooding, with none of those declarations occurring in the past five years, while disaster for fire has. The following historical incidents represent examples of major flooding that has affected the county:

- The October 1983 flood was the largest flood of record in the Tucson area. During August and September of 1983, nearly 7 inches of rain fell over the Tucson metropolitan area. Bridges in the area, including all spanning the Santa Cruz River except one, were damaged or partially washed away. Additional damage occurred along the other watercourses throughout the area. Several buildings fell into Rillito Creek due to bank erosion and extensive damage occurred to agriculture in Marana. Cost estimates (using 1984 dollars) to repair and mitigate flood damage were estimated at $105.7 million. Four deaths in Eastern Pima County were attributed to the flood. Due to the magnitude and extent of flooding and related damage, this flood is the one to which subsequent floods have been compared.
- The January 1993 Flood occurred during a 14-day period in 1993, from January 5th through the 19th. A series of severe winter storms produced record-breaking precipitation amounts. Heavy rains combined with melting snowpack caused heavy flooding throughout Pima County. Nearly every community and city within the county were impacted by the storms at some level. Although these were the most damaging floods to occur

[1]Pima County Regional Flood Control – Historical Flood Events: https://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=60316

in almost 10 years, no lives were lost and no residential and commercial structures were destroyed, with the exception of some horse barns associated with a business along Rillito Creek. The high water levels in the streams lasted almost two weeks, rather than the typical few days; Most of the heavy damage was associated with the Gila, San Pedro, and Santa Cruz Rivers. According to the USACE Flood Damages Report, the total public and private damages from the 1993 floods were estimated to exceed $12 million in Pima County alone. The flooding prompted a federal disaster declaration (FEMA-977-DR-AZ) for almost the entire state[2].

- August 14, 2005, and August 23, 2005, intense heavy rains caused significant damage to public infrastructure throughout Pima County. The severe runoff resulted in damages to numerous roads, traffic lights, water well fields, berms, crossings, and police vehicles. After over an inch of rain fell across a large portion of the Tucson metro area, some locations with more than 2 inches, several roads became flooded, closed, and impassable. In addition to all the impassible flooded roadways, several trailer homes located in the southern portion of the Tucson metro area, were flooded and surrounded by rising water. Rescue teams evacuated several people from their homes. Brawley Wash was out of its banks and flooding roadways causing them to be impassable. Over $260,000 in damages were estimated[3].
- In July and early August 2006, several areas of the state were struck by severe storms and monsoon flooding during the period of July 25-August 4, 2006. Tropical moisture poured into Southeast Arizona, saturating the ground at most locations. As rainfall continued, additional runoff quickly filled rivers and washes, exceeding bank full capacities and flooding homes, and businesses as well as nearby roads. Some roadways were washed away due to the strong floodwaters. Lots of flash flooding occurred throughout the Tucson metro area due to saturated grounds and extremely heavy rainfall. Numerous roads were closed due to flooding throughout the entire metro area for many hours. A USGS stream gage was destroyed by floodwaters in Rincon Creek. Additionally, there were numerous swift water rescues and nearly 100 vehicles stranded in flooded roadways. It was estimated that nearly 100 vehicles were flooded. Several rivers running through the Tucson metro area flooded on July 31, 2006. The Rillito River flooded with water over the cement banks near Dodge Boulevard. Additionally, the Rillito River was over bank full just east of the Swan Road Bridge. River Road near La Cholla Road was flooding from the Rillito River. Sabino Creek was out of its banks and houses were flooded near Sabino Canyon and Bear Canyon. The flooding prompted a federal disaster declaration (FEMA-1660-DR-AZ) for Gila, Graham, Greenlee, Pima, and Pinal Counties. Total disaster expenditures exceeded $13.6 million (DEMA, 2010; PCRFCD, 2011).[4]

Between July 2017 and August 2021 there were 67 flash flooding incidents with two deaths, one injury and property damage amounting to over 6.441 million dollars. The 2021 monsoon was the third wettest monsoon on record. Most of the Tucson area received more than 10 inches of rain, and the Catalina Mountains received 30-45 inches of rain. While the amount of damage was surprisingly low for such an active monsoon, there were a number of notable flood incidents. [5]

- July 10 2018, scattered thunderstorms moved slowly northwest across southeast Arizona. Thunderstorms produced 2 to 3 inches of rain in around one hour on both sides of I-10 from Cortaro to Twin Peaks which caused flash flooding. Some of these areas had also received 1 to 2 inches of rain two days earlier. Many roads and intersections were closed due to flash flooding on the northwest side of Tucson encompassing an area from Tangerine Road and I-10 down to Ina Road and I-10.

  A restaurant and animal shelter were also flooded, along with damage to Sanctuary Cove foot trail. First responders performed eight swift-water rescues of motorists. Floodwaters damaged railroad tracks and derailed over two dozen Union Pacific railroad cars north of Twin Peaks Road, causing extensive damage and closing the access road to Interstate 10 (I-10) for several days.

- September 2, 2018, thunderstorms produced large hail, heavy rain, and flash flooding in Pima, Santa Cruz, and Cochise counties during the afternoon and evening hours. The most substantial damage occurred from

[2] US Army Corps of Engineers, Los Angeles District, 1994, *Flood Damage Report – State of Arizona – Floods of 1993*

[3] NCEI Storm Events Database: https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5522762

[4] Arizona Division of Emergency Management, Pima County Regional Flood Control District

[5] Historical Flood Events - Pima County

flash flooding in the Amado area where thunderstorms produced 3 to 5 inches of rain along Sopori Wash. Water flowed at depths ranging from 2 to 5 feet deep through several commercial properties including a restaurant, feed store, automotive shop, and youth center causing substantial damage to the buildings and their contents. Some of these structures were in Pima County and others were in Santa Cruz County. Additionally, several recreational vehicles (RV) suffered water damage at an RV storage park. Minor damage also occurred to Arivaca Road and other roads in the area. Property damage was estimated at $750,000.

- October 2018, what was Major Hurricane Rosa crossed the northern Baja peninsula as a tropical depression on October 1st. The remnant circulation entered southwest Arizona on October 2nd. Moisture ahead of these remnants fueled thunderstorms in southeast Arizona on September 30th. Rain associated with the remnant circulation moved northeast across southeast Arizona through October 2nd. The primary period of heavy rain occurred from 8 pm MST October 1st through 8 am MST October 2nd. Rainfall totals averaged 2 to 4 inches on the west half of the Tohono O'odham Nation with isolated heavier amounts of 5 to 8 inches. The heavy rain initially resulted in flash flooding but evolved into a longer-term period of flooding which led to evacuations of several villages, road closures, considerable infrastructure damage, and a subsequent disaster declaration. Property damage was estimated to be over 3.75 million dollars.

- February 2019, heavy rain fell on the mountains near Tucson beginning the morning of February 14th and continuing into the early morning hours of February 15th. Three to 7 inches of rain was recorded at the Santa Catalina Mountains causing flooding downstream along Sabino Creek, Tanque Verde Creek, and the Rillito River. Flooding also occurred along Rincon Creek from runoff down the Rincon Mountains. Multiple roads needed to be closed due to flooding and multiple swift-water rescues were performed. Mount Lemmon Highway was also closed due to several rock slides.

- July 23, 2020, scattered thunderstorms developed and moved west across southeast Arizona from the predawn hours through early afternoon. Some storms produced heavy rain and flash flooding in and around the Tucson metro area, including the Bighorn Fire burn scar area. Around 2 inches of rain fell in 60-90 minutes from the Catalina Foothills near Alvernon Way west through Flowing Wells and south to Tucson Estates, Drexel Heights, and the Pascua Pueblo. Rain totals of at least 3 to 4 inches in southwest Tucson caused numerous road closures, including San Xavier Rd near the Mission. Interstate 10 at Sunset Road was also closed briefly. Multiple vehicles became stranded in floodwaters and several swift-water rescues occurred in midtown. One man drowned after a rapid rise in the normally dry Santa Cruz River.

- August 20, 2020, a moisture surge from remnants of Hurricane Genevieve near lower Baja helped fuel thunderstorms that moved west and produced damaging winds and flash flooding in parts of Santa Cruz and eastern Pima counties. Heavy rain of 1 to 2 inches caused the closure of several streets in southwest Tucson between Drexel and Valencia Roads due to flash flooding.

- August 29, 2020, scattered thunderstorms developed and moved northeast across southeast Arizona during the afternoon and evening. One storm produced wind damage at Marana High School and another produced flash flooding over the Bighorn Fire burn scar. An inch of rain fell in less than an hour over the headwaters of the Bighorn Fire burn scar on the Santa Catalina Mountains. An 8-foot rise was noted along the Cañada del Oro Wash at Rancho Solano upstream in Pinal County. Strong flows continued downstream into Pima County causing water to flow across Edwin Road. Catalina State Park Road was also closed due to flows in Sutherland Wash.

- September 8, 2020, isolated to scattered thunderstorms developed and moved southeast across parts of southeast Arizona during the late afternoon and evening hours of September 8th. The strongest storms produced heavy rain and gusty winds across far eastern Pima and western Cochise counties. Flash flooding occurred late in the evening into the very early hours of September 9th. Flash flooding of small streams occurred in the Rincon Mountains causing the closure of roads at lower elevations.

Two to 5 inches of rain fell in the Rincon Mountains in a 2-hour period with at least 4 inches of rainfall in the upper reaches of the Tanque Verde Creek watershed. A four-foot rise in Tanque Verde Creek was measured at Chiva Tank and a 2.5-foot rise was measured downstream at Guest Ranch. Over a foot of water flowed across Wentworth Road about 3 hours after the crest at Chiva Tank.

The 2021 monsoon was the third wettest monsoon on record. Most of the Tucson area received more than 10 inches of rain, and the Catalina Mountains received 30-45 inches of rain. Below are several notable flood incidents:

- July 22-25, 2021, several rounds of thunderstorms were triggered by a westward-moving upper-level weather system across southeast Arizona from the afternoon of July 22nd into the early morning of July 23rd. Thunderstorms produced wind damage and flash flooding in, Green Valley and the Tucson Metro area. The widespread heavy rain across eastern Pima County resulted in widespread flooding of roadways and high flows along Pantano Wash and Rillito River and eventually downstream along the Santa Cruz River. Significant damage to the Loop hiking and biking trail system occurred.

  1 to 2 inches of rain fell in less than 90 minutes in southeast Pima County and caused extensive flash flooding from southeast Tucson and Vail southwest to Sahuarita and Green Valley. In the Vail area, three to four feet of water washed out East Andrada Road at the Santa Rita Wash, and a car was swept downstream 300 yards, but the occupants escaped unharmed. Many roads in Saguaro National Park East were also flooded or closed. In southeast Tucson, a person was rescued from a sandbar in the Pantano Wash near Harrison Rd. Farther south, Sahuarita Road and Wilmot Road were closed. In Sahuarita, a woman was rescued from her vehicle at Beta Street and the I-19 Frontage Road. In Green Valley, several roads were closed and homes were flooded in the Casa de Abrego neighborhood east of I-19.

- On July 23rd, 1 to 3 inches of rain fell in less than 1 hour over much of the Tucson Metro area, including parts of the Bighorn burn scar. Around ten swift-water rescues were performed during the overnight hours for motorists trapped in vehicles including near Escalante and Sarnoff. Plus, two people were rescued from the Rillito River near La Cañada Dr. Also, many trails were damaged at Sabino Canyon Recreation Area and six homes were flooded in near Finger Rock Wash in the Catalina Foothills due to runoff from the Bighorn burn scar. No injuries were reported.

  Near the Town of Marana, 1 to 2 inches of rain fell in less than an hour from the Tucson Mountains west to Picture Rocks. Numerous streets were flooded, closed, or damaged as a result. At least one vehicle was stranded in floodwaters, on Manville Road.

- On July 24th, a slow-moving upper-level weather system produced periods of heavy rain across southeast Arizona on July 24th and 25th. Flash flooding occurred where soils were already saturated from heavy rains of July 22th and 23rd and runoff continued to fill the Santa Cruz River downstream. Floodwaters caused considerable road damage. Green Valley received heavy rain of 1 to 1.5 in less than 1 hour and caused flash flooding and the closure of several roads. Five homes were flooded in the Casa de Abrego neighborhood, some of which had just been flooded less than 48 hours earlier. Early morning rainfall of 1 to 1.5 on the saturated ground quickly resulted in flash flooding and closure of several roads in north Marana. In Sahuarita more than 1 inch of rain fell on the saturated ground causing flash flooding of several roadways from Sahuarita to Corona de Tucson, including Sahuarita Road near Wilmot Road. In the Vail area, 1 to 2 inches of rain on the saturated ground caused numerous flooded and closed roads from just east of Rita Ranch to Old Spanish Trail and south to near I-10. One vehicle was stuck in floodwaters near Old Spanish Trail and Drexel Road. Up to 1 of rain on the saturated ground caused Franco Wash to rise rapidly and flood and damaged several roads in the Summit area.

  Before the weather system exited the area, another round of heavy rain during the afternoon and evening of July 27th caused additional flash flooding in the Tucson Metro area. At Mt. Lemmon, around 2.5 of rain in less than an hour was measured near the headwaters of Sabino Creek in the Bighorn burn scar and caused a two-foot rise in the stream that crosses trails in the Sabino Canyon Recreation Area. Six hikers had to be rescued after becoming trapped by the high flows. Heavy rain of 2.5 inches in less than 90 minutes occurred in Vail near the headwaters of Rincon Creek. Flash flooding occurred downstream in the Rincon Ranch Estates area. Camino Loma Alta became flooded and impassable.

- July 30, 2021, more than 1 inch of rain fell on the saturated ground causing flash flooding of several roadways from Sahuarita to Corona de Tucson, including Sahuarita Road near Wilmot Road. 1 to 2 inches of rain fell in less than an hour northeast of the Tucson International Airport causing flash flooding of area roads. One swift water rescue was conducted for a vehicle stalled in a wash. 1 to 2 inches of rain in less than 1 hour fell from south of Ajo to east of Why. This caused flash flooding of area washes and the closure of Highway 86 east of Why and Highway 85 between Ajo and Why. In the Vail area, 1 to 2 inches of rain on the saturated ground caused numerous flooded and closed roads. One vehicle was stuck in floodwaters near Old Spanish Trail and Drexel Road.

- August 17, 2021, multiple rounds of thunderstorms developed and moved across southeast Arizona from mid-morning of August 16th through the early evening of August 17th. Individual storms produced heavy rain of 1 to 2 inches per hour, but some locations where multiple thunderstorm events occurred received 3 to 4 inches of rain during the period. The result was numerous reports of flash flooding, road closures, and swift water rescues.

  Up to 3 inches of rain west and northwest of Tucson late in the evening caused flash flooding of Brawley Wash and smaller washes that flow into it. An additional 1 to 2 inches of rainfall during the predawn hours south of Three Points flowed through the Altar Wash into the Brawley Wash causing flooding from northeast of Three Points through the Garcia Strip of the Tohono O'odham Nation, north to Marana from early that morning into the late afternoon that resulted in damage to area roads. 1 to 2 inches of rain in two hours caused flash flooding and road closures in Marana and Avra Valley. More than one inch of rain in less than an hour caused a rapid rise in the Alamo Wash where a storm had produced an inch of rain three hours earlier. A motorist was rescued from a vehicle stuck in floodwaters on Chantilly Roadd. at the Alamo Wash.

  In Vail, the widespread heavy rain resulted in widespread flooding of roadways and high flows along Pantano Wash and Rillito River. Significant damage to the Loop hiking and biking trail system occurred. Damage from thunderstorm winds and lightning also occurred in the Tucson Metro.

- August 28, 2021, scattered thunderstorms moved west across southeast Arizona during the afternoon and evening. Thunderstorm wind gusts downed power poles in Catalina and Vail while more than 1 inch of rain in less than an hour caused flash flooding in central and eastern Tucson.

- August 31, 2021, moisture from the remnants of tropical system Nora produced moderate to heavy rainfall during the afternoon and evening hours with totals of 1 to 2 inches common and up to 3 inches in mountains, but the prolonged nature of the rain led to little if any significant flooding. However, flash flooding did occur along the Artesia Wash west of Sells where heavier rain fell in a shorter amount of time.

Pascua Yaqui Tribe: The Tribe has significant concerns regarding flooding. Rain runoff from the Black Mountain watershed has the potential to cause hazards to roadways and or built structures. As a result of runoff at times throughout the monsoon, Pascua Yaqui Tribe experiences localized flooding, and road closures occur primarily for areas along the Black Wash.

While not within the reporting period, in 2015, a monsoon flood event washed out critical communications infrastructure including phone and data lines. This event continues to be a relevant indication of the level of potential impacts Pascua Yaqui Tribe faces because of flooding.

In July 2020, a monsoon flood event caused significant localized flooding of major roadways prohibiting access in and out of the New Pascua reservation proper area including emergency and first responder agencies. This event also resulted in damages:

- A drainage channel near the PYT - Education Department Building was damaged because of water levels.
- Floodwaters caused significant erosion damage to two concrete box culverts within the Community Cemetery.
- Residential flooding at the PYT 5-Plex Apartment complex east of Ignacio Baumea Rd, south of Calle Torim; residents had to be temporarily sheltered at the local wellness center during the event.

Town of Sahuarita: Monsoon Season 2021 brought the Town of Sahuarita an unusual amount of rain. The months of August and September saw that Town face flooding in a few areas. There were a few damages to channels and a lot of debris and sediment accumulation in drainage structures. A couple of homes in one of the communities received some water due to debris blocking a private retention/detention basin**.**

City of Tucson Flooding is a regular occurrence in the City of Tucson area and can occur during either of our two primary rainy seasons – the monsoon season (which can be further impacted by remnants of Pacific hurricanes) and our winter rains. Flooding can make roads impassable, can create dangerous conditions in and around usually dry washes, and can flood homes and businesses within the City. Many incidents of flooding have been recorded in the Tucson area. Recent and large-scale flooding events have occurred in and around Tucson, which results in yearly deaths, and destruction of property to the citizens of Tucson.

Extent

The magnitude or strength of floods is measured in rainfall intensity, depth, and velocity. Within Pima County, rainfall intensity above 1.5 inches per hour is the first warning system trigger at which dry washes flow bank to bank and may create flash floods or road closures. Overbank floods may occur when these rainfall intensity rates are sustained over several hours. Predetermined flow depth and velocity readings expressed as cubic feet per second from streamflow gages are then used to trigger additional warning and response. During the last five years pre-scripted warning messages utilizing the County's Mass Communication platform were added to the ALERT Flood Threat Recognition and Early Warning system operated by the Pima County Regional Flood Control District (PCRFCD) throughout the County.

On June 5, 2020, as a result of the Big Horn Fire, the District analyzed post-fire flood risk based on fire-caused hydrologic changes and installed additional gauges in the burn area to facilitate updated warning information for the District's Automated Local Evaluation in Real Time (ALERT) system, Office of Emergency Management (OEM) and the first responders. The District distributed enhanced warning outreach letters to affected properties. Since July 11, 2020, 4 alerts were sent. While in 2021 there have 16 notifications.

Probability of Future Events

For the purposes of this Plan, the probability and magnitude of flood hazards in Pima County jurisdictions are based on the 1% probability floodplains (also known as the 100-year flood, as the flood has a 1% chance of being equaled or exceeded in any single year) delineated on FEMA Flood Insurance Rate Maps (FIRMs)[6]. FEMA completed a map modification program to update the FIRMs for the county into a digital FIRM (DFIRM) format. The PCRFCD is responsible for keeping these current as revisions are made. Floodplain GIS base files were obtained from the PCRFCD and are the basis for the flood hazard depictions in this Plan.

Vulnerability

Table 4-10: CPRI Results for Flood

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Highly Likely	Catastrophic	12-24 hours	< 24 hours	**3.50**
Oro Valley	Likely	Critical	< 6 hours	< 24 hours	**3.05**
Pascua Yaqui Tribe	Likely	Limited	6-12 hours	< 24 hours	**2.60**
Sahuarita	Likely	Critical	12-24 hours	< 1 week	**2.85**
Tucson	Highly Likely	Critical	6hours	< 24 hours	**3.50**
Unincorporated Pima County	Highly Likely	Critical	< 6 hours	> 1 week	**3.60**
				County-wide average CPRI =	**3.18**

*Jurisdictions in **bold** chose to mitigate against the hazard*

The different types of weather in Pima County described above produces distinctively different types of vulnerability.

[6] FEMA 100 Year Flood Zones, http://www.arcgis.com/home/item.html?id=e9aa2179f31b4b9cbe5c7f8b1b91cea3, 2016

Tropical storms, have historically caused the most damage in Pima County due to their regional extent. Weather systems moving from coastal waters inland toward the State of Arizona and over Pima County represent a distinct hazard because the predictability of occurrence is much lower than the winter and summer seasonal storms which are a regular part of the County's weather pattern. While weather is overall difficult to predict, the occurrence of tropical storms and their paths are especially difficult. While monitoring the potential for inland storm paths for remnants of tropical storms, the National Weather Service typically presents a band of possible storm paths. This band may or may not encompass the County, and the strength of the storm after passing overland may or may not be intense. If the storm continues to produce winds and heavy rainfalls after proceeding inland toward Pima County, the extent of severe weather is typically regional rather than more watershed-based as is the case with summer and winter storms. Tropical weather systems create more vulnerable conditions for Pima County because flooding may occur in numerous riverine and distributary floodplains simultaneously, and the duration of flooding may be between 24 to 72 hours in contrast to summer storms which tend to dissipate more quickly and affect a circumscribed area and winter storms which tend to be of lower intensity and to affect less aerial extent than tropical storms.

Summer monsoon storms produce intense rainfall over relatively small areas. Monsoon storms are more likely to trigger flood events on smaller watercourses. Furthermore, monsoon rainfall may affect just one watershed. In most years, the annual peak monsoon flow will occur on different days at different gauging stations. Flash floods are generally associated with summer monsoon thunderstorms. Several factors make flash floods a challenging hazard to mitigate.

1. Real-time precipitation gages may miss storm cells that are small enough in aerial extent although large enough in volume to cause flash flooding.
2. Extreme rainfall intensities can generate runoff that reaches peak flow in periods measured in minutes, providing little or no ability to provide the public with a warning about any specific event.
3. The leading edge of the flood may extend miles below the storm event that created it, flooding an area that may have received no rainfall and may not have even been cloudy, thus catching individuals completely unaware of the threat.

Thus monsoon hazards are severe but tend to be localized.

Winter mesoscale storms, as implied by the name produce bands of precipitation over days. Though characterized by low rainfall intensity, these long-duration storms yield the high volumes of water necessary to produce significant flow events on the major watercourses. In general, the largest floods on the Santa Cruz River have occurred because of tropical storms that come up from the Sea of Cortez in the fall, but do not produce significant flooding in most years. While high rainfall depths and extended duration certainly produce conditions conducive for flooding, saturated soils that have limited capacity to absorb rainfall also play a role. They may also include frontal systems that can provide more sustained flow durations, even as flood peaks tend to remain low. On rare occasions, winter frontal systems have produced rain on snow from January to March.

In addition to flash floods largely associated with mountain front drainage, sheet flow flooding is a phenomenon unique to watersheds with low topographic relief and a severe lack of adequate flow conveyance through channels. The lack of defined drainage channels often deceives the public into thinking that there are no flood hazards in the area. Sheet flow flooding may develop quickly but where slopes are particularly shallow, the duration of sheet flow flooding may extend more than 24 hours. Private roadways not designed for all-weather access are common in these areas. As a result, and in combination with the widespread nature of sheet flow flooding, during times of flooding, residents and emergency services ability to gain safe or reliable access to and from the affected area may be limited.

Alluvial fans create a special type of floodplain that has characteristics that are like sheet flow floodplains. Alluvial fans occur below mountain fronts and consist of an accumulation of sediment carried out of the mountains via riverine flow. At the margin of the mountain front, flow containment is lost, and floodwaters spread out across the alluvial fan. Alluvial fans may have better-defined channels or flow corridors, but they are not large enough to convey large storm events and, due to their location below the break-in slope, channels often aggrade and lose capacity. Since alluvial fans often consist of poorly consolidated alluvium, the loss of channel capacity in existing channels leads to the creation of new channels or the reestablishment of old channels. This characteristic of alluvial fans leads to significant uncertainty with respect to the location and severity of flood flows. The combination of severe, directed flow at uncertain locations, unconsolidated soils, and the likelihood of flash floods in this environment results in potentially extreme flood and erosion hazards.

Historically, flood events of limited aerial extent occur at least every few years in Pima County. These floods may not affect many people, but the effects of these floods may be severe for those affected. Floods on the major watercourses occur approximately once every ten years. Historically, these floods had a significant impact on the community; however, flood and erosion hazard improvements within the urban core have largely limited the hazards to the public from large flood events on the major watercourses. In addition, improved regulation of development through elevating structures above the base flood, protecting structures from erosion hazards, and protection of natural floodplains has ensured that new development is more flood resilient than was previously the case in unincorporated Pima County.

This section contains a map and data table for unincorporated areas known to flood frequently and where a warning is required per the NFIP (see Figures 4-15 and 4-16). Figure 4-15 is the Special Studies Floodplains maps showing locally mapped floodplains. These are mapped either by a developer or by PCRFCD. Table 4-16 contains data for these Special Studies Floodplains areas including exposure estimates.

While bank protection installed by the PCRFCD along major watercourses has reduced erosion and overbank flooding in much of the urbanized areas of the county, some development pre-exists floodplain regulations and infrastructure is at risk. These areas include:

- The Forty Niner's Country Club Subdivision on Tanque Verde Creek geologic floodplain Repetitive Loss Area.
- The alluvial fan areas of Lee Moore, Franco, and Flato washes particularly in the Summit neighborhood south of Sahuarita Road.
- The broad floodplains of Avra Valley and the Black Wash.
- Numerous canyon washes are impacted by wildfires within National Forests in the upper watershed and encroachment in the Catalina Foothill's residential areas.
- Private drainage ways in Green Valley. Urban areas with undersized, historic, or unimproved drainage infrastructure. This includes the Ruthrauff Basin Management Plan area which includes unincorporated Pima County and the City of Tucson, as well as a separate study conducted for South Tucson.

  The results of the Ruthrauff Basin Management Study (RBMS) were adopted by the Pima County Board of Supervisors and the Tucson City Council. The RBMS mapped eight square miles of urbanized floodplains southeast of the confluence of the Santa Cruz and Rillito Rivers including areas within unincorporated Pima County and the City of Tucson. This area is impacted by obstruction to flow created by Union Pacific Railroad features which historically have designed drainage infrastructure under their rail systems for smaller flow rates than those expected during a 1% chance storm event.

  Prior to urbanization, the area was used for irrigated agriculture with little topographic relief. Most of the subsequent development including mixed commercial and industrial uses and residential uses consisting of a good proportion of manufactured housing occurred prior to the adoption of the National Flood Insurance Program (NFIP) in 1968. Without NFIP guidelines, little planning for drainage and drainage infrastructure occurred. Structures were not elevated and streets were not designed to confine and convey flows to designated outfalls as they are elsewhere in many older urban areas. Today, flooding due to storm events tends to result in wide shallow flooding encompassing structures and properties located upstream of the Union Pacific Railroad which serves as an embankment prohibiting sufficient drainage to the Santa Cruz and Rillito Rivers.

  The RBMS produced new regulatory and FEMA floodplain maps and a list of alternatives for mitigating flooding. The alternatives include both structural and non-structural solutions. The District incorporates identified projects into its Capital Improvement Program as funding is available. Full flooding mitigation has not been accomplished due to feasible District funding schedules, significant delays in negotiating drainage easements with the Union Pacific Railroad and the extensive cost of obtaining private properties needed for flow conveyance and the construction of structural measures.

- Another urban area with similar characteristics is the City of South Tucson. In 2020 the District completed a floodplain study and identified alternatives to resolve urban flooding safety issues therein including undersized storm drains and culverts and flow within streets.

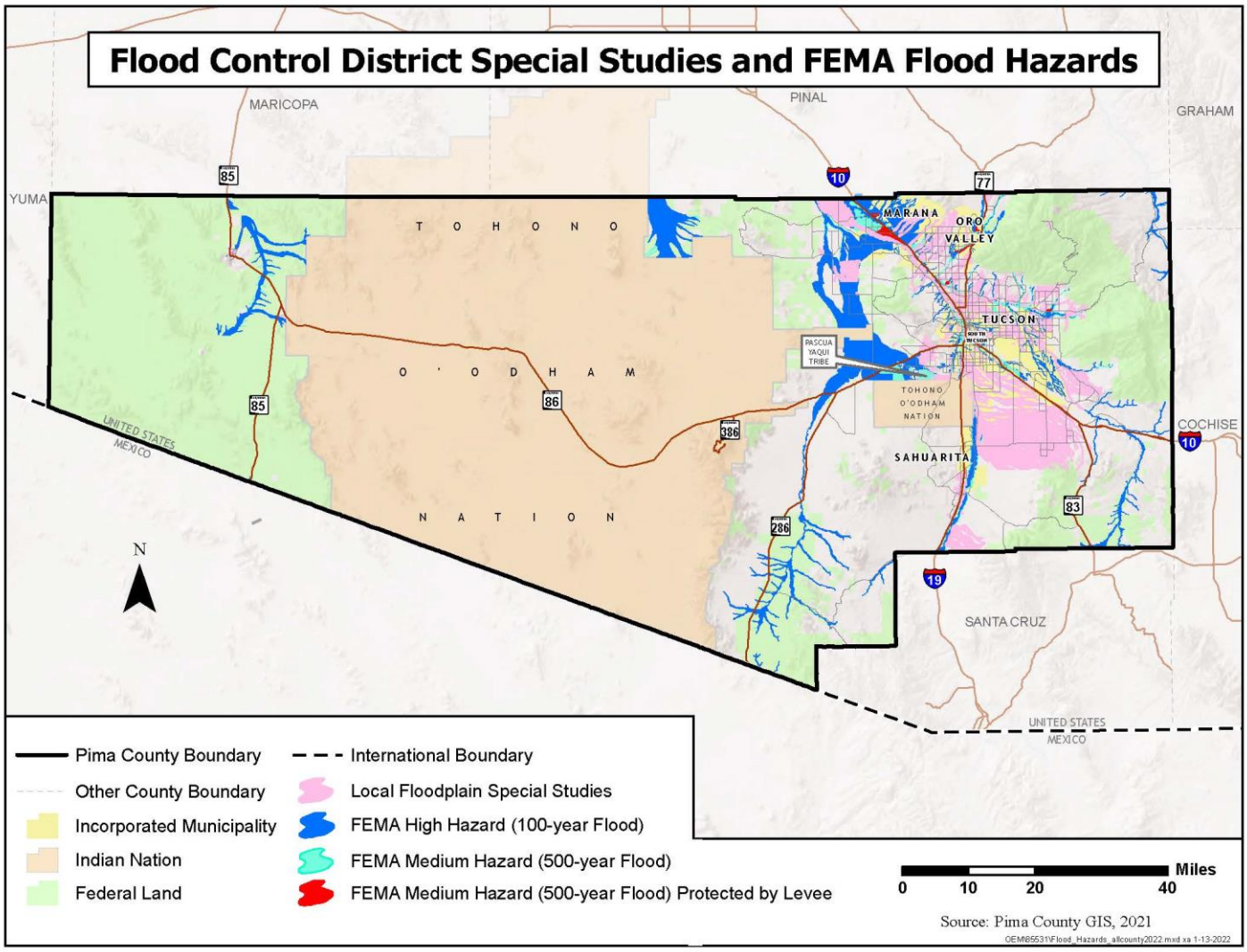


Figure 4-15: Flood Control District Special Studies and FEMA Flood Hazards

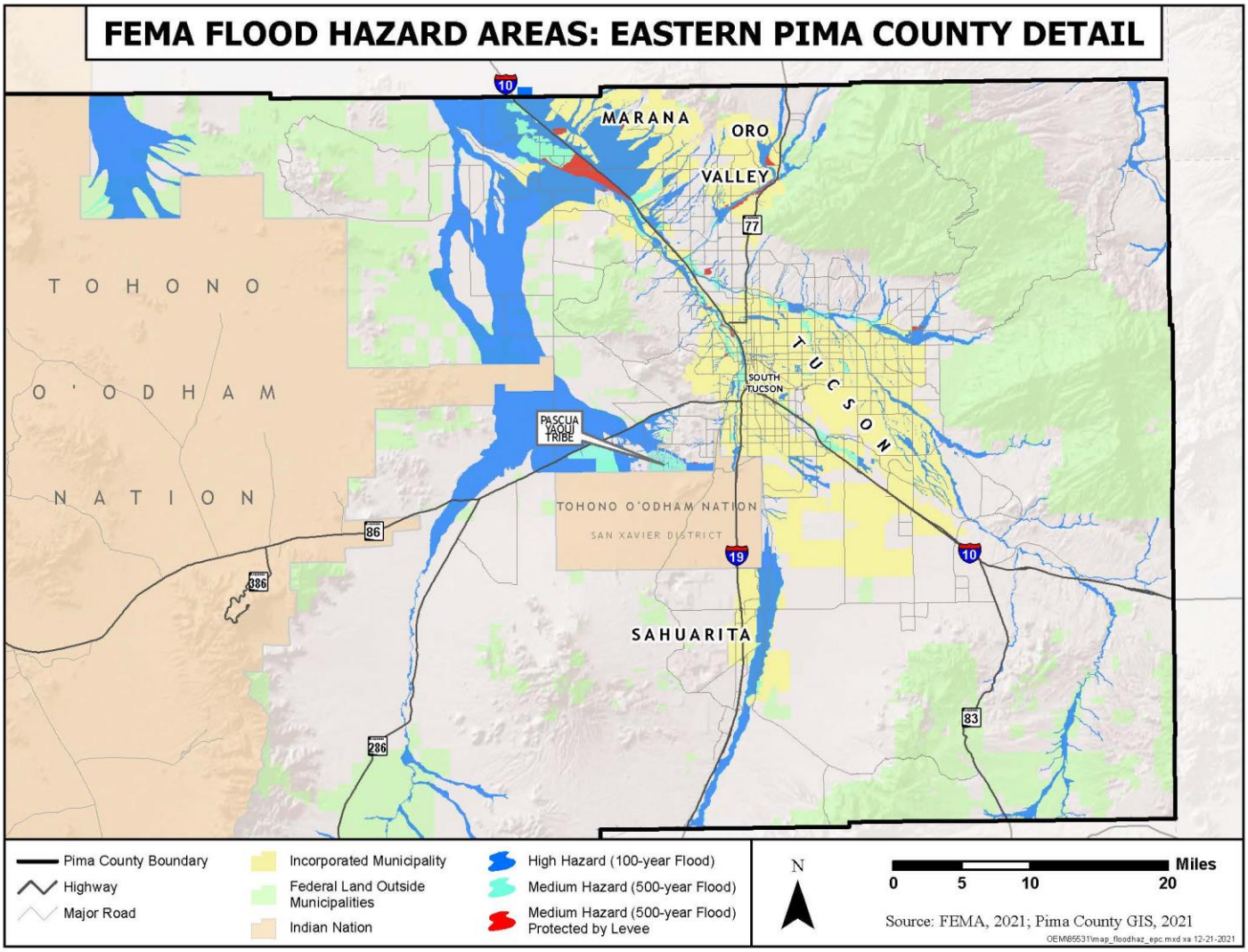


Figure 4-16: FEMA Flood Hazards: Eastern Pima County Flood Hazards Detail

Town of Marana: There are several flooding sources within the Town of Marana that can cause hazards to property or roadways. They include runoff from the Tortolita Mountains, runoff from the Tucson Mountains, and overbank flow from the Santa Cruz River. Two additional flooding sources include the Rillito River and the Cañada del Oro Wash, are contained within their banks during the base flood (commonly known as the "100-year flood") but are susceptible to hazardous erosive failures. Areas include:

- *Santa Cruz River*: Major regional storm events, such as significant rainfall in the Catalina Mountain watershed, can send enough Stormwater runoff into the Cañada del Oro or Rillito River systems that will direct floodwaters to the Santa Cruz River potentially causing the closure of the Ina Road bridge for structural precautions, the closure of the Sanders Road bridge due to overtopping, the capturing of the El Rio Open Space preserve, and evacuation due to overbank flows of the Berry Acres subdivision in far north Marana. Major storm systems south of Tucson, potentially all the way from Mexico, within the Santa Cruz watershed can also cause these issues. Some areas of Continental Ranch adjacent to the Santa Cruz River and the Town's airport could be impacted by Santa Cruz flood events above the base flood.

- *Tortolita Mountain Alluvial Fan*: The Tortolita Mountain watershed consists of several major washes that leave the mountain system whose floodplains overlap in a broad alluvial floodplain. Higher on the alluvial fan and closer to the mountains, the washes are well defined and the floodplains are more certain. The lower you travel on the floodplain the more the floodplain broadens out into overlapping sheet flow areas. Tangerine Road in its current condition is susceptible to flooding and road closures due to at-grade dip crossings. At the end of the alluvial fan lies the CAP canal system that has a protective berm on its upstream side and over chute pipe outlets to carry floodwaters across the canal at various locations. This berm/over chute system interrupts the sheet flow characteristics of the lower alluvial fan and re-concentrates the floodwaters at the pipe outlet locations. Localized flooding and road closures occur downstream of the over chutes. A similar situation occurs where the Tortolita Fan runoff is intercepted by the Union Pacific Railroad and I-10. These facilities are raised higher than the adjacent ground, impounding water on their upstream sides and creating focused flooding issues where culverts or interchange openings allow focused floodwaters through. There are also some areas of the interstate and railroad that can be outright overtopped. Should there be a rainfall event significant enough to cause runoff by the sandy soils of the Tortolita Fan; the water will go through the series of impoundments and discharges noted above through the CAP canal, Union Pacific Railroad, and I-10 to arrive at northwest Marana. These floodwaters then either sheet flow or are carried in the bar ditch and irrigation canal system in a northwesterly pattern throughout northwest Marana. Property damage and road closures occur until the floodwaters recede.

- *Tucson Mountain floodplain*: The Tucson Mountain watershed consists of several washes that leave the mountain system but unlike the Tortolita Fan, the washes remain well confined due to the rockier nature of the terrain and the closer proximity of the mountain range to the Santa Cruz River. The Town has not experienced major property damage from Tucson Mountain runoff but several roads both east and north of the mountain range are subject to closure during major rain events in the watershed. FEMA mapping categorizes the Town's airport as being in a sheet floodplain from the Tucson Mountains but the mapping does not appear to consider the raised CAP canal immediately east of the airport.

- *Cañada del Oro wash and Rillito River*: Both of these systems contain the base flood for their watersheds. However, property and roadways adjacent and crossing these systems could be susceptible to flooding from events above the base flood. A segment of the Cañada del Oro Wash west of Thornydale Road that is not armored with bank protection could experience erosive failure. Prior to the development of this area, the Town will require bank protection to be put in place. The most hazardous aspect of these systems however is where they come together at the Santa Cruz River just west of I-10. No part of this confluence is bank protected. A sand and gravel pit within the confluence area has been mined well below the bed of the river. If the berm protecting the sand and gravel pit were to fail, the resulting pit capture could cause a headcut eastwards and erode the adjacent portion of I-10, the Union Pacific Railroad, a major Tucson Electric Power transmission line, transcontinental high-pressure gas pipeline, and a transcontinental fiber optic line.

Town of Oro Valley: The Town of Oro Valley is susceptible to flood hazards on a relatively frequent basis due to tropical storm remnants, winter rains, and summer monsoons. Localized events are the most common and frequent types of flooding in Oro Valley, however, there are occasions of more widespread or regional flooding events. While the 2021 monsoons were the third wettest on record, the 2020 monsoons were the driest, highlighting the variability in precipitation from one year to the next. The Cañada del Oro Wash (CDO) divides the Town geographically and streamflow can be impacted by precipitation on the upper CDO and Mt. Lemmon. The CDO was identified through post-fire risk assessment to be at a heightened flood risk for the next three to five years, with 109 homes being added into the floodplain.

Other washes identified for post-fire risk include Sutherland Wash; Alamo Wash; Steam Pump Wash; Rooney Wash; Pusch Wash; and Rams Canyon. Major flooding in these washes would likely have significant impacts on residential and commercial structures, accessibility, utilities, and infrastructure.

Local flood mitigation projects and stormwater system maintenance, along with those completed in partnership with the PCRFCD have helped manage vulnerability to flooding. These projects are prioritized based on potential risks of damages/losses and available funding. In the event of a major flood, there would be other cascading events such as damages to infrastructure, severe wind (microbursts), downed power poles, power outages, uprooted trees, flooded homes, and other related damages.

Pascua Yaqui Tribe: The Tribe's flood vulnerability is mainly related to the main body of land for the Tribe that is in the Black Wash flood plain. The Black Wash gathers waters from washes from the Tohono O'odham and Pima County, runs through the jurisdiction and then back into Pima County. The flooding affects the residences as well as the business and gaming communities by cutting off critical services from citizens. In 2015, a monsoon flood event washed out critical communications infrastructure including phone and data lines.

Town of Sahuarita: The Town of Sahuarita is vulnerable to flooding mainly due to its proximity to the Santa Cruz River. Several large washes run through the Town and upstream rain events can overwhelm wash channels. Sahuarita Road runs from SR83 to the east to just west of I-19 through the town. Sahuarita Road has numerous low-level wash crossings that are vulnerable to flood events and can cut off citizens from emergency services. Numerous modular housing areas have structures with increased vulnerability to flooding when washes back up as well.

City of South Tucson: South Tucson is susceptible to flood hazards on a relatively frequent basis due to tropical storm remnants, winter rains, and summer monsoons. Localized events are the most common and frequent types of flooding in South Tucson, however, there are occasions of more widespread or regional flooding events. While the 2021 monsoons were the third wettest on record, the 2020 monsoons were the driest, highlighting the variability in precipitation from one year to the next. South Tucson is home to the former El Paso and Southwestern Railroad, while trains have not run on the old alignment in several decades, the raised rail bed continues to bisect the City, which creates a barrier in which floodwaters tend to collect and pool against. In addition to this, Union Pacific's Nogales line is the western city limit between South Tucson and the City of Tucson. This too creates a similar barrier for floodwaters within the City, which increases the chances of flooding businesses and homes.

City of Tucson: Flooding in the City of Tucson is a yearly expectation during the summer monsoons and often during the winter weather patterns. The community is generally well prepared for these storms and their short-term flash flooding effects. Although each year the damage is done to roadways and other infrastructure and people become stuck and sometimes injured or killed while trying to cross flooded washes that cross roadways. The flood vulnerably may come from two other sources. First, the potential for the track of tropical storms/hurricane remnants from the Pacific Ocean, usually via the Gulf of California, has led to widespread and large-scale rainfall causing severe flooding of large drainages such as the Santa Cruz River. These storms usually coincide with the tail end of the monsoon events. Second, there is a history of large-scale flooding events from El Nino weather patterns occurring during Tucson's winter rainy season. These weather patterns can again greatly increase overall rainfall over a short period of the season leading to flooding. They can create cascading events such as heavy snowpack on the mountains that border Tucson, followed by a warm tropical rainstorm that leads to heavy snowmelt and flooding of waterways and washes within the city.

While mitigation projects throughout the city have been underway since the record flooding in 1983, caused by remnants of Tropical Storm Octave, there is still a large length of waterways and washes that are vulnerable to erosion, bank degradation, and other flooding threats. Numerous bridges and roadways are vulnerable to substantial infrastructure damage during large-scale floods.

Loss Estimations

The estimation of potential exposure to high and medium flood hazards was accomplished by intersecting the human and facility assets with the flood hazard limits depicted on the Flood Hazard Maps. Population and residential building figures are from the 2010 Census; counts at the block level were intersected with those flood hazard areas using a more complex dasymetric technique from FEMA's HAZUS-MH software. This technique uses land cover information derived from satellite imagery to remove the areas in Census blocks that are largely without population or housing (e.g. vacant land, agricultural areas, etc.).

Table 4-11 summarizes the critical facility, population, and residential housing unit exposure and loss estimates for the high and medium flood hazards.

Table 4-11: Pima County Exposure and Loss Estimates Due to Flooding

Flood Hazard Exposure/Loss	Marana	Oro Valley	Pascua Yaqui Tribe	Sahuarita	South Tucson	Tucson	Unincorp Pima County	Total
Total Critical Facilities	348	185	17	148	23	1,976	1,358	4,692
Facilities in High Hazard Areas	107	13	0	32	1	133	157	4,443
Percentage of Total Facilities	2.28%	0.28%	0.00%	0.68%	0.02%	2.83%	3.35%	9.44%
Estimated Replacement Cost (x $1,000)	$ 347,974	$ 59,442		$ 164,753	$ 641	$ 345,899	$ 431,850	$ 1,350,559
Estimated Structure Loss (x $1,000)	$ 226,183	$ 38,637	$ -	$ 107,089	$ 417	$ 224,834	$ 280,703	$ 877,863
Facilities in Medium Hazard Areas **Not Protected by Levees** *	43	0	13	3	0	86	17	162
Percentage of Total Facilities *	0.92%	0.00%	0.28%	0.06%	0.00%	1.83%	0.36%	3.45%
Estimated Replacement Cost (x $1,000) *	$ 133,195.00	$ -	$ 89,150.00	$ 8,319.00	$ -	$ 339,930.00	$ 46,510.00	$ 617,103.00
Estimated Structure Loss (x $1,000) *	$ 86,577	$ -	$ 57,948	$ 5,407	$ -	$ 220,955	$ 30,232	$ 401,117
Facilities in Medium Hazard Areas **Protected by Levees** *	12	3	0	0	0	18	9	42
Percentage of Total Facilities *	0.26%	0.06%	0.00%	0.00%	0.00%	0.38%	0.19%	0.90%
Estimated Replacement Cost (x $1,000) *	$34,711	$19,510	0	0	0	$8,075	$71,747	$134,043
Estimated Structure Loss (x $1,000) *	$22,562	$12,682	$0	$0	$0	$5,249	$46,636	$87,128
Total Population	**58,835**	**47,927**	**3,466**	**36,255**	**4,895**	**565,628**	**414,285**	**1,131,291**
Population in High Hazard Areas	35,106	4,571	505	8,596	8	32,779	14,463	96,028
Percent Exposed	4.40%	9.10%	7.60%	3.20%	0.10%	6.10%	3.10%	12.09%
Population in Medium Hazard Areas **Not Protected by Levees** *	8,613	1296	0	0	blank	1,806	8,261	36,256
Percent Exposed *	11%	0.26%	0%	0	0	3.40%	1.70%	21.01%
Population in Medium Hazard Areas **Protected by Levees** *	801	364	0	0	0	42	544	1,751
Percent Exposed *	3.10%	2.45%	0.00%	0.00%	0.00%	0.14%	0.14%	5.77%
Total Residential Building Count	**14,771**	**16,922**	**952**	**10758**	**1,798**	**173,089**	**159,080**	**377,370**
Total Estimated Replacement Cost (x $1,000)	$ 6,033,773	$ 5,808,397	$ 621,677	$ 2,313,526	$ 733,753	$ 75,849,191	$ 76,428,859	$ 167,789,176
Structures in High Hazard Areas	895	27	-	105	-	3,550	6,374	10,951
Percentage of Total Structures	6	0.1	0	0.9	0	2	4	0.02
Estimated Replacement Cost (x $1,000)	$ 362,026.00	$ 9,267.00	$ -	$ 20,821.00	$ -	$ 1,516,983.00	$ 3,057,154.00	$ 4,966,251.00
Estimated Structure Loss (x $1,000)	$ 235,316.90	$ 6,023.55	$ -	$ 13,533.65	$ -	$ 986,038.95	$ 1,987,150.10	$ 3,228,063.15
Structures in Medium Hazard Areas **Not Protected by Levees** *	8,613	1,296	825	782	-	18,086	8,261	37,863
Percentage of Total Structures *	58.3	7.6	95	7.2	0	10.4	5.1	0.04
Estimated Replacement Cost (x $1,000) *	$ 3,386,295	$ 441,438	$ 590,593	$ 166,573	$ -	$ 7,888,315	$ 3,897,871	$ 16,371,085
Estimated Structure Loss (x $1,000) *	$ 2,201,092	$ 286,935	$ 383,885	$ 108,272	$ -	$ 5,127,405	$ 2,533,616	$ 10,641,205
Structures in Medium Hazard Areas **Protected by Levees** *	366	288	0	0	0	20	765	1439
Percentage of Total Structures *	2.00000%	1.70000%	0.00000%	0.00000%	0.00000%	1.50000%	0.48000%	0.00040%
Estimated Replacement Cost (x $1,000) *	$ 120,675	$ 987,427	$ -	$ -	$ -	$ 8,722	$ 366,858	$ 1,483,682
Estimated Structure Loss (x $1,000) *	$ 78,439	$ 641,828	$ -	$ -	$ -	$ 5,669	$ 238,458	$ 964,393

** Medium hazard area figures ONLY include critical facilities, population, or structures outside of high hazard areas (but within medium hazard areas)*

Sources: Pima County GIS, 2022; HAZUS Version 5.1 Release 16.1.0

Table 4-12: Pima County Exposure and Loss Estimates Due to Flooding in Local Flood Hazard Areas								
Flood Hazard Exposure/Loss*	**Marana**	**Oro Valley**	**Pascua Yaqui Tribe**	**Sahuarita**	**South Tucson**	**Tucson**	**Unincorporated Pima County**	**Total**
Total Critical Facilities	**270**	**132**	**17**	**72**	**20**	**1,552**	**1,375**	**3,438**
Facilities in Local Flood Hazard Areas	25	4	0	5	0	205	96	335
Percentage of Total Facilities	0.73%	0.12%	0.00%	0.15%	0.00%	5.96%	2.79%	9.74%
Estimated Replacement Cost (x $1,000)	$ 91,229	$ 751	$ -	$ 837	$ -	$ 353,833	$ 352,078	$ 798,726
Estimated Structure Loss (x $1,000)	$ 59,299	$ 488	$ -	$ 544	$ -	$ 229,991	$ 228,851	$ 519,172
Total Population	**58,835**	**47,927**	**3,466**	**36,255**	**4,895**	**565,628**	**414,285**	**1,131,291**
Population in Local Flood Hazard Areas	13,262	8,350	1	1,006	-	231,950	124,790	379,359
Percent Exposed	1.17%	0.74%	0.00%	0.09%	0.00%	20.50%	11.03%	33.53%
Total Residential Building Count	**14,741.0**	**21,112.0**	**953.0**	**13,588.0**	**1,808.0**	**233,112.0**	**169,030.0**	**454,344.0**
Estimated Replacement Cost (x $1,000)	**$ 6,033,773**	**$ 4,554,999**	**$ 211,728**	**$ 913,363**	**$ 733,753**	**$ 69,497,100**	**$ 48,072,053**	**$ 130,016,769**
Structures in Local Flood Hazard Areas	5,579	3,824	-	404	-	99,156	53,394	162,357
Percentage of Total Structures	1.23%	0.84%	0.00%	0.09%	0.00%	21.82%	11.75%	35.73%
Estimated Replacement Cost (x $1,000)	$ 2,283,591	$ 825,043	$ -	$ 27,156	$ -	$ 29,561,131	$ 15,185,228	$ 47,882,149
Estimated Structure Loss (x $1,000)	$ 1,484,334	$ 536,278	$ -	$ 17,652	$ -	$ 19,214,735	$ 9,870,398	$ 31,123,397
** Local Flood Hazard Areas are selected Special Studies Floodplains defined by Pima County, not by FEMA*								
Sources: Pima County GIS, 2022; HAZUS Version 5.1 Release 16.1.0								

It is noted that the loss and exposure numbers presented above represent a comprehensive evaluation of the county. It is unlikely that a storm event would occur that would flood all the delineated high and medium flood hazard areas at the same time. Accordingly, actual event-based losses and exposure are likely to be only a fraction of those summarized above. Furthermore, any flood event that exposes assets or populations to a medium hazard will also expose assets and populations to the high hazard flood zone. That is, the 100-year floodplain would be entirely inundated during a 500-year flood in the localized area of impact.

Changes in Development in the Hazard Area

While Pima County continues to outpace development in most parts of the Country, for those jurisdictions participating in the NFIP CRS, adequate planning and regulatory tools are in place to regulate future development. The PCRFCD conducts basin (watershed) studies to identify floodplains, assess exposure, and identify mitigation measures not mapped by FEMA. In addition to managing the major watercourse and operating the Flood Threat Recognition and Warning System throughout the County, the PCRFCD works with all jurisdictions on mitigation projects regardless of their participation in the regulatory components of the NFIP. However, events of greater magnitude than the base flood due to climate variability and changes in upper watershed conditions may increase flood-related hazards.

The PCRFCD has been actively creating new floodplain delineations outside of FEMA designated floodplains and continually strives to improve floodplain development to create a more flood resilient community. Because of mapping efforts, the aerial extent of local floodplains within unincorporated Pima County exceeds the extent of federally mapped floodplains. Protection of these floodplains removed development pressure on some of the most hazardous areas. As future development occurs avoidance is required in most cases.

Pima County's arid environment, combined with anthropomorphic alterations to the landscape, creates conditions that promote the lateral migration of watercourses. Erosion along major watercourses has been some of the most dramatic flood damage historically however a major bank protection program has removed this risk along the major watercourses. Where bank protection is not in place, erosion hazard setbacks are.

Natural floodplains benefit the community by reducing flood and erosion hazards, improving water quality, increasing groundwater recharge, and providing biological corridors for plants and wildlife to thrive, all while providing public health, safety, and economic benefit to the citizens of Pima County. To the greatest extent possible, the PCRFCD promotes maintaining the natural functions of floodplains over structural measures to control flooding.

Town of Marana: Over the last five years, the Town of Marana has completed the following changes to mitigate flood hazards and minimize the risk of future hazards. The completion of Tangerine Road, Phase One from Dove Mountain to Oro Valley significantly improved flood hazard issued for that roadway segment in 2018. Pima County also completed a 20-year levee along the El Rio preserve that helps to protect that area in 2021. The permitting and construction of a major interception channel and bank protection for the De Anza development protects both that new subdivision and the existing Cortaro Ranch neighborhood in 2021. Pima County cleared and smoothed the Santa Cruz River channel approaching the Marana Road bridge in 2020. The Town utilized an easement to clear obstructing vegetation on Silverbell Road near the Continental Reserve Loop roadways that caused flooding in 2018. Union Pacific performed significant maintenance of the drainage channel and culverts along their line that contributed to the 2018 train derailment.

Town of Oro Valley: Within the Town of Oro Valley, while there continues to be commercial and residential development, there are requirements to meet the Stormwater Utility's current floodplain management and other building codes. These include the subdivision design standards, drainage criteria manual, international building codes, and zoning codes to address floodplain management and site drainage. While there is development, the infrastructure is being constructed/remodeled to potentially be at less risk/vulnerability to flooding.

Pascua Yaqui Tribe: In order to address household and community impacts to flooding in late 2021, the Pascua Yaqui Tribe purchased a 4-chute, gravity-fed Sandbagger machine and are consolidating a cache of sandbags to provide timely response and mitigation for infrastructure protection and commercial/residential protection.

- An Assisted Living Center was created after renovation to the old Fire Department Station in New Pascua reservation proper.
- A Men's Path and Women's Path facilities were constructed, off Camino de Oeste, north of Jefferey Road.
- A Boys and Girls Club is currently being constructed, south of the PYT - Wellness Center.

- In 2021, the construction of a Food Pantry facility began, this facility will provide a sustained community service for families/individuals in need of resources.
- Six 5-plex/Housing on Calle Torim, just west of Ignacio Baumea.
- Construction of the Pascua Yaqui Health and Social Services Family Center was completed in 2021.

The Pascua Yaqui Tribe has continued to institute flood control implementation strategies including detention catchment basin practices for stormwater flood protection of the Tribe's developed lands. All new construction developments incorporate these flood control measures.

City of South Tucson: Within the City of South Tucson, there continues to be a small amount of commercial and residential development, there are requirements to help reduce offsite drainage, other building codes. These include international building codes and zoning codes to address floodplain management and site drainage. While there is development, the infrastructure is being constructed/remodeled to potentially be at less risk/vulnerability to flooding.

City of Tucson: The City of Tucson continues to maintain compliance with NFIP regulations by enforcement of the current floodplain management ordinances through review of new developments located in the floodplain and issuance of floodplain permits. Tucson continues to improve floodplain administration under NFIP program by sending inspectors into the field when the City receives a flood warning from NWS, to assess bridges, washes, and other critical infrastructures within the City's jurisdiction.

National Flood Insurance Program Participation

Participation in the NFIP is a key element of any community's local floodplain management and flood mitigation strategy. Pima County and the six other incorporated jurisdictions participate in the NFIP. Joining the NFIP requires the adoption of a floodplain management ordinance that requires jurisdictions to follow established minimum standards set forth by FEMA and the State of Arizona when developing in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by the 100-year flood and that new floodplain development will not aggravate existing flood problems or increase damage to other properties. As a participant in the NFIP, communities also benefit from having Flood Insurance Rate Maps (FIRM) that map identified flood hazard areas and can be used to assess flood hazard risk, regulate construction practices, and set flood insurance rates. FIRMs are also an important source of information to educate residents, government officials, and the private sector about the likelihood of flooding in their communities. Table 4-13 summarizes the NFIP status and statistics for each of the jurisdictions participating in this Plan.

Table 4-13: NFIP Statistics as of October 2021

Jurisdiction	Community ID	NFIP Entry Date	Current Effective Map Date	Number of Policies	Amount of Coverage (x $1,000)	Floodplain Management Role
Pima County	40073	2/15/1983	9/28/2012	2,030	$522,026	Managed through PCRFCD
Marana	40118	8/1/1984	6/16/2011	290	$81,176	Provides floodplain management for the town
Oro Valley	40109	12/4/1979	6/16/2011	155	$50,369	Provides floodplain management for the town
Pascua Yaqui Tribe	---	---	---	---	---	Not a Participant in the NFIP
Sahuarita	40137	6/30/1997	6/16/2011	45	$12,906	Provides floodplain management for the town

Table 4-13: NFIP Statistics as of October 2021

Jurisdiction	Community ID	NFIP Entry Date	Current Effective Map Date	Number of Policies	Amount of Coverage (x $1,000)	Floodplain Management Role
South Tucson	40075	1/31/1979	6/16/2011	0	$0	City defers floodplain management to PCRFCD
Tucson	40076	8/2/1982	9/28/2012	1,636*	$365,837*	Provides floodplain management for the city

*****based on date from the City of Tucson

Table 4-14 NFIP Compliance for: Pima County

Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:

The process is subject to Pima County Code section 16 the Floodplain and Erosion Hazard Management Ordinance as well as policies and procedures available here:

https://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=60970

These policies require permits and review of subdivision and entitlements for all development within floodplains, erosion hazard setbacks and Pima County Regulated Riparian Habitat. This includes any development that is substantially damaged, defined as 50% of fair market value, over the lifetime of the property.

Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:

The Pima County Regional Flood Control District budget supports an ongoing program of pro-active local floodplain studies which revise approximately mapped FEMA Special Flood Hazard Area and extensive local Special Studies Floodplains. Needs are identified in the approved Floodplain Management Plan. Many of these studies are conducted in-house while the largest involve consulting teams and stakeholder groups including affected municipalities. A complete set of DFIRMs including amendments are maintained by District GIS staff. The current effective FIRMs are the L Series DFIRMs, which became effective on June 16, 2011, though a number of panels in the Agua Caliente Wash area have since been replaced and are M Series DFIRMs. All of the previous K Series FIRMs have been superseded and should not be used for anything but historical comparison. A full list of completed studies is available here:

https://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=60308

Studies which are planned or underway are listed in the Floodplain Management Action Plan available here:

www.pima.gov/fmp

Storms, catastrophic fires and development may prompt studies not identified therein. Approved maps are available to the public by visiting our office and in several formats on-line including a GIS Application and individual parcel or address query. Consultants and researchers may also gain direct access to the data servers which are updated nightly as new data is entered.

GIS: PimaMaps - Pima County

Printable and downloadable pdf "flood hazard map": https://gis.pima.gov/apps/floodhazard/

Table 4-14 NFIP Compliance for: Pima County

Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):

The Pima County Regional Flood Control District provides map information services free of charge, and staff including Certified Floodplain Managers, hydrologists and engineers are available to assist those seeking elevation certificates, permits and entitlements to avoid the risks of floods. The District constructs projects to remove urbanized areas and critical facilities from the floodplain. The District conducts targeted outreach activities including mailers, advertisements and events which are all part of an approved Program for Public Information that is put together by a stakeholder committee. In the face of new flood insurance rating methodology effective in 2022 the District staff is developing additional expertise in this area. The same stakeholder committee guides the development of the Floodplain Management Plan discussed below and all District activities are overseen by the Flood Control District Advisory Committee that includes one member appointed by each Board of Supervisor District and one from each municipality in Pima County.

Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.

Pima County is a Class 3 NFIP Community and conducts the full spectrum of 6 creditable NFIP activity types and 161 discreet watershed specific activities identified in the Board approved Floodplain Management Action Plan. Needs identified therein include:

- Updating the definition, identification of and rules for development in "critical basins" as defined in PCC Section 16 the Floodplain and Erosion Hazard Management Ordinance and Stormwater Retention/Detention Manual.
- Providing pre-vent technical assistance to emergency responders and the public to identify and provide warning of road closures due to flooding.

Revising mapping procedures to address future conditions.

Table 4-15 NFIP Compliance for: Town of Marana

Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:

The town's floodplain regulations are contained in Town Code Chapter 17-15 "Floodplain and Erosion Hazard Management", which was recently modified to more closely align with ADWR's Model Ordinance; which goes above and beyond the State of Arizona requirements. Regulatory floodplains are mapped on the town's GIS system. Private and Public development reviews verify that no infringement occurs within the floodplain (or that infringement is appropriately mitigated within that project).

When a development is submitted through the Electronic Plan Review to Development Services staff, all plans and building permits undergo a floodplain status check, to determine the floodplain status. If a property is within the SFHA or EHS it is flagged in the Town's project tracking system and a series of restrictions are placed on the building permit which are cleared with each inspection/requirement. These restrictions are:

- Establishment of an elevation reference hub (HANG in AO Zone) to determine the elevation of the top of bottom floor.
- Verification of required structure elevation. Applicant's surveyor sets elevation on the top of form or completed pad with required slab thickness.
- Receipt and verification of the Elevation Certificate.

Table 4-15 NFIP Compliance for: Town of Marana
Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:
The Town utilizes Arc-View GIS to reflect the current DFIRM panels and LOMRs, which are downloaded from Pima County Regional Flood Control District, and paper/electronic FIRMS and LOMRs. The Town underwent re-mapping in 2008 with an effective date for the L-series mapping of 16 June 2011. The Town Engineers office is the official repository for floodplain documents for the jurisdiction.
Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):
The Town provides assistance to the community in determining floodplain status, elevation certificates, LOMRs and other associated floodplain questions. The Town also does a yearly public information effort that is targeted two groups; at real estate professionals, mortgage lenders, engineers and banks and the second for the general public. This outreach outlines the basic precautions for construction in the floodplain, associated risks, mitigation strategies and contact information.
Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.
The Town of Marana has updated the Floodplain Management Code in 2021 and is continually updating the policies and procedures for our floodplain management program as required or needed. The Town recently revised the floodplain use permit procedure to more closely align with ADWR and FEMA guidelines. The Town has performed several area-wide drainage studies in an effort to create a master drainage plan for the town. In these studies, areas that are determined to be within a new or re-mapped SFHA are marked and the appropriate floodplain management actions are then required by the Town. These actions help to reduce the risk to life and property and keep the Town's CRS rating.

Table 4-16 NFIP Compliance for: Town of Oro Valley
Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:
The Town's floodplain regulations are contained in Town Code Chapter 17 "Floodplain and Erosion Hazard Management" which is drafted from ADWR's Model Ordinance. Nearly all the Town's regulatory floodplain areas are contained within town-owned properties, and/or are within a platted (or granted) Drainage Easement on other properties. Town-owned washes are further restricted against development and/or modification by the "Floodplain and Erosion Hazard Management Ordinance" (Town Code Article 17-3-2). The Town has a maintenance/control program, and annually allocates funds to remove channel-obstructing vegetation and debris from selected watercourses and other town-owned property. Regulatory floodplains are mapped on the Town's GIS system. Private development reviews verify that no infringement occurs within the floodplain (or that infringement is appropriately mitigated within that project). When a development is submitted through the Electronic Plan Review to Community and Economic Development staff, and all or some portion of the property is in the SFHA, it is tagged in our tracking system (Munis). Once a development is tagged, the application is sent to both the Stormwater Utility and Building for review. This lets staff know that the development must comply with Oro Valley's ordinances as they relate to NFIP.

Table 4-16 NFIP Compliance for: Town of Oro Valley
Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:
Updated Town wide Federal Insurance Rate Map (FIRM) Panels became effective on June 6, 2011. Currently, these maps, in addition to Letters of Map Change (LOMC) may be used to determine if a particular piece of property is in a 100-year floodplain. FIRM panels will be updated for local LOMRs, updated community limits, and in certain locations, the FIRM panels will have new identification numbers and be printed at a closer scale.
Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):
The Town of Oro Valley has worked with the Pima County Regional Flood Control District to provide Elevation Certificates for properties that have been re-mapped into the 100-year flood zone as a result of the updated North Ranch Watershed LOMR completed in 2020. Throughout the year, Public Open House Home Owners Association Meetings are held within the town, to educate the public on flood hazard areas, and rules and regulations for development activities within the flood hazard areas, and maintenance responsibilities within drainage ways. These meetings are coordinated with the Town Manager's Office of Oro Valley under their lead role. The Town has also produced a publicly available Floodplain Mapping resource showing all the currently identified floodplains; FEMA, Locally Platted, and Special Studies to assist the public in identifying their property floodplain status.
Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.
The Town of Oro Valley updated its current Floodplain Management Ordinance on November 17, 2021 following the Arizona Department of Water Resources (ADWR) guidelines as published in their model ordinances for the communities within the state of Arizona. The Town has partnered with FEMA and the Pima County Regional Flood Control District to fund multiple Watershed Studies within and adjacent to the Town's boundaries. These studies will be used to identify areas subject to development activities with current or future flood hazard zones. These proactive steps help reduce the risk of loss of life and property within the flood-prone areas in the town

Table 4-17 NFIP Compliance for: Pascua Yaqui Tribe
Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:
The Pascua Yaqui Tribe, Facilities Management Department employs a full-time registered Architect, and relative to new construction projects on the reservation, the Pascua Yaqui Tribe refers to current requirements used by Pima County Floodplain which uses FEMA maps and flood area designations. FEMA provides flood hazard and risk data to help guide mitigation actions. The zones designated area provide recommended top of flood elevations that are used in subsequent designs. For example, the Tribe is currently constructing a Food Pantry building. By using Pima County Floodplain guidelines, Pima County contour maps, and FEMA maps the Tribe was able to determine the minimum pad elevation of two feet above existing grades, develop a fill area and use a standard rip-rap detail for erosion control. On larger projects, the Tribe contracts out to registered Civil Engineers and Hydrological Engineering consultants. When asked for flood maps relative to the Tribe, we direct them to our Reservation wide study by JE Fuller Hydrology which is applied subjectively to each project. The Pascua Yaqui Tribe revised its FIRM to reflect LOMR, effective date March 21, 2016

Table 4-17 NFIP Compliance for: Pascua Yaqui Tribe
Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:
The Pascua Yaqui Tribes' current Drainage Master Plan (JE Fuller) currently being used is slated for update in the next few years This along with current FEMA information provides flood hazard and risk data to help guide mitigation actions. Flood mapping is also part of the National Flood Insurance Program (NFIP), as it is the basis of the NFIP regulations and flood insurance requirements. FEMA's flood mapping program is a guide relative Risk Mapping, Assessment, and Planning, or Risk MAP panels included in the revision will be updated for local LOMRs, updated community limits, and in certain locations, the FIRM panels will have new identification numbers and be printed at a closer scale.
Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):
Along with information from Pima County, FEMA provides flood hazard and risk data to help guide mitigation actions. Flood mapping as part of the National Flood Insurance Program (NFIP), is the basis for determining NFIP regulations and flood insurance requirements.
Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.
The Drainage Master Plan provided by JE Fuller currently being used is slated for update in the next few years. This along with current FEMA information provides flood hazard and risk data to help guide mitigation actions.

Table 4-18 NFIP Compliance for: Town of Sahuarita
Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:
The Town of Sahuarita's floodplain regulations are contained in the Sahuarita Town Code Title 14 Floodplain and Erosion Hazard Management, which is modeled off the Pima County Code. The majority of the Town's regulatory floodplain areas are along the FEMA Floodplains of the Santa Cruz River. The Town has partnered with the majority of the local community HOAs to keep local washes maintained and clean. Improvement and Development Plan reviews verify that no infringement occurs within the floodplain (or that infringement is appropriately mitigated within that project). The Department of Public Works is the main administrator for the Town of Sahuarita's Floodplain and Erosion Hazard Management Program.
Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:
Since the majority of the Town's regulatory floodplain areas are along the FEMA Floodplains of the Santa Cruz River, the FEMA Map Service Center is a resource the Town uses for current floodplain hazard mapping. In addition, Tentative Plats are put through the Town's review process where flood and erosion hazard setback limits are identified and mitigated within that project when there's encroachment of the limits.
Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):
The Town of Sahuarita provides community assistance through plan review process as well as through our permitting process. The Department of Public Works and Planning/Building work well together to provide information to the community. The Department of Public Works have a Flood Hazard Information form as well as a Floodplain Use Permit that provides a lot of useful information to all applicants.
Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.

Table 4-18 NFIP Compliance for: Town of Sahuarita
The Town of Sahuarita's Floodplain and Erosion Management program is currently working well with the Town's growth. As the Town continues, it might need more of a local mapping to determine flood and erosion hazard setback limits of local washes as well as solidifying the enforcement process.

Table 4-19 NFIP Compliance for: City of Tucson
Describe your jurisdiction's current floodplain management / regulation process for construction of new or substantially improved development within your jurisdiction:
The City of Tucson's floodplain regulations are contained in Tucson Code Chapter 26 Article I Flood and Erosion Hazard Management Code, which is from ADWR's Model Ordinance. The City of Tucson maintains compliance with NFIP regulations by enforcement of the city's current flood and erosion hazard management codes through review of new development located in the regulatory flood prone and erosion hazard setback areas, and with the issuance of floodplain use permits. Many of the City of Tucson's regulatory floodplain areas are not contained within channels and some drainageways are on private properties maintained by homeowner associations, private owners, railroad, USA, county, schools, State, or other ownership. Some watercourses or stormdrain systems are within a platted (or granted) as public or private drainage easements. Some stormdrain systems are within public flowage easements. City-owned washes stormdrain system are inspected annually. The City of Tucson Department of Transportation and Mobility has an extensive drainage maintenance program, and hires environmental hazard companies, vactor services to supplement maintenance work. Regulatory floodplains, watercourse centerlines, flood elevations for FEMA zones and City Flood Hazard Areas are mapped on the City's GIS system MapTucson. Private development reviews verify that no encroachment occurs within the floodplain (that results in more than a tenth of a foot rise in floodplain fringe areas and zero rise in floodway). When a development is submitted through the electronic plan review to Department of Transportation and Mobility permitting staff for Right-of-way areas, or Planning and Development Services staff, and all or some portion of the property is in the SFHA or City regulatory flood area or within an erosion hazard setback, it is processed for a floodplain use permit that is issued concurrently or before other permits. Applications are sent to both Engineering (for flood and erosion reviews) as well as other staff such as Building review. Elevation / Construction Certificates are required for substantial improvements that need to show finished floor elevation and pad elevation compliance. When a certificate is required, a pre-slab certificate must be submitted in order for other inspections to continue. The hold is released after engineering staff has reviews the pre-slab certificate and then the foundation pour may then commence, otherwise woodwork for slab would need to be elevated to assure compliance with minimum elevation set forth in the floodplain use permit conditions.
Describe the status and/or validity of the current floodplain hazard mapping for your jurisdiction:
In compliance with the NFIP, the City of Tucson will continue to require the preparation and submittal of a CLOMR or CLOMR-F for all proposed developments within FEMA delineated Special Flood Hazard Areas. Through a FEMA grant, the City of Tucson obtained a Risk MAP identifying Flood Data and Risks and Areas of Mitigation Interests including Essential Facilities (Critical Facilities). The City of Tucson is looking to update this Tucson Flood Risk Map for flood risk mapping, flood assessment and flood risk planning purposes. The City will also continue to prepare record drawings and submit LOMR's per NFIP requirements. Updated Countywide Federal Insurance Rate Map (FIRM) Panels became effective on June 16, 2011 and revised September 28, 2012. Currently, these maps, in addition to Letters of Map Change (LOMC) may be used to determine if a particular piece of property is in a 100-year floodplain. The 500-year floodplain is also used to help determine critical facility compliance (elevating to higher standard for critical facilities as defined by floodplain ordinance), since the X-shaded areas in the City of Tucson are clarified on MapTucson for differentiating between 100-year shallow flood under a foot deep, protected by levee or 500-year flood. A PMR or Letter of Map Revision (LOMR) will be performed by Pima County Regional Flood Control District for the City's Downtown Links Project after the City of Tucson provides as-built data for the LOMR submittal by the county.

Table 4-19 NFIP Compliance for: City of Tucson
Describe any community assistance activities (e.g. – help with obtaining Elevation Certificates, flood hazard identification assistance, flood insurance acquisition guidance, public involvement activities, etc.):
As part of a NFIP participating community, the City of Tucson (040076) performs Elevation certificate review and inspection, Map information service, Outreach projects, Hazard disclosure, Flood protection information, Flood protection assistance, Flood insurance promotion, Floodplain mapping, Open space preservation, Higher regulatory standards, Flood data maintenance, Stormwater management, Repetitive loss outreach and mitigation assistance, Floodplain management planning, Acquisition and relocation, Flood protection, Drainage system maintenance, Flood warning and response, and Levees and Dams emergency response planning. City Floodplain Administration has held the TSMS Phase Va - Tucson Floodplain Management Plan Update in 2020 with open house and virtual public meetings. Outreach events including floodplain training for the Tucson real estate community was held in 2020, and in 2021 a Flood Insurance Meeting was held virtually for two sessions by the City of Tucson with assistance by the State and PCRFD. The City of Tucson works closely with PCRFCD on watershed studies. The City of Tucson also works with adjacent communities and agencies for development near and in the city boundaries (Unincorporated Pima County, City of South Tucson, Union Pacific Railroad, State of Arizona, Federal government, ADOT).
Describe identified needs in your floodplain management program. This could include things like updating the floodplain management code/regulation, establishing written review procedures, modifying, or adding flood hazard area mapping, etc.
The City of Tucson is seeking assistance to assure accurate regulatory floodplain delineations are being created during map updates; with the use of newer modeling software, there is now a need for quality check to assure smaller floodplain limits are not drawn for flowrates under regulatory flowrates of 100-cfs. The City of Tucson is also seeking funding for more floodplain management staff as well as money for projects that include a study, design plans, and construction to mitigate and prevent flood, erosion, drought, extreme heat, severe wind, and wildfire hazards. The City's Floodplain Management Plan adopted in December 2020 (updated from the 2016 FMP) has identified these and other action items.

Repetitive Loss Properties

Repetitive Loss (RL) properties are those NFIP-insured properties that since 1978, have experience multiple flood losses. FEMA tracks RL properties and to identify Severe RL (SRL) properties. RL properties demonstrate a record of accomplishment of repeated flooding for a certain location and are one element of the vulnerability analysis. RL properties are also important to the NFIP since structures that flood frequently put a strain on the National Flood Insurance Fund.

The table below lists the type of properties with RL, for the Town of Oro Valley there is one unmitigated property, but the type of structure is unknown.

Table 4-20: Repetitive Loss Property Statistics

Single Family Residential	Multi-Unit Residential	Commercial	Jurisdiction	No. of Properties	No. of Properties Mitigated	Total Payments
			Oro Valley	1	0	$41,805
3	2	2	Tucson	7	0	$153,971
23			Unincorporated Pima County	23	3	$1,056,184

Source: ADWR September 22, 2022 for Unincorporated Pima County. The City of Tucson provided their own data on September 23, 2002.

4.4.6 Landslide

Description

Landslide is the generic term used to describe the downslope movement of earth materials due to gravity. There are several different types of landslides that are categorized by the depth of failure, the type of material moved, the water content, and rate of movement. Landslides may be triggered by earthquakes, extreme precipitation, flooding, or otherwise removing support from the slope. Debris flows, a common type of landslide in Arizona, are moving masses of loose mud, sand, soil, rock, water and air. Such flows must have sparse vegetation and a supply of loose debris, so they often occur in areas disturbed by wildfires. They are closely associated with extreme precipitation and flooding, which is described in more detail in Section 4.4.5. Landslides may also cause flooding, either by displacing great volumes of water with surficial materials, or by damming a stream until it breaches and floods.

Cascading events are a hazard with landslides. The nature of cascading events associated with landslides stems from the mass, volume, water content, soil and rock conditions, rate of movement, and environs in which the landslide occurs. It is important to note, that landslides are commonly triggered by other events, e.g., an earthquake or flood, and thus may constitute a cascading event in their own right.

Common cascading events associated with landslides include:

- Damaged or destroyed transportation lines such as roads, railways, rivers.
- Flooding resulting from damming of river or water displacement resulting from the landslide mass encroaching on a body of water natural lake, river, canal, or reservoir.
- Broken infrastructure such as gas pipelines, water mains, sewer lines, utility lines, canals buildings.
- Secondary landslides following a primary slide.

History

Landslides, rock slides, and debris flows have occurred over the millennium in and around the mountainous regions of Pima County, typically associated with seasonal and heavy precipitation. In the summer of 2006, extreme precipitation caused a particularly significant occurrence of about 1,000 debris flows in four mountain ranges in southern Arizona.[1,2] Debris flows in the Santa Catalina Mountains north of Tucson occurred in nine canyons and exited or nearly exited the mouths of five of those canyons flowing into developed areas.[3] Debris flows and rockfalls temporarily closed portions of the Mt. Lemmon Highway and also destroyed a portion of the Mt. Lemmon Short Road at the base of Mt. Lemmon. Costs to repair infrastructure destroyed in Sabino Canyon was approximately $1.5 million. No landslides of major significance, such as multiple-day road closures, have since occurred between 2006 and 2021. During the 2021 monsoons, several small volume debris flows were observed in Finger Rock Canyon in the Santa Catalina during the 2021 monsoon. No damage was reported and the debris flows did not reach the canyon mouth.[4]

On July 22, 2021 there were between 1.5 to 2.5 inches of rain across the Town of Oro Valley, leading to some sediment and debris flows emanating from the Pusch Ridge area of the Santa Catalina Mountain Range. Residents in the Rancho Catalina and Sunnyslope subdivisions saw sediment and debris across their properties, local streets, and drainage ways. While no major damage was reported within the Town, this was a multiple-day storm system (between July 19-25) that required significant sediment and debris removal efforts on the part of the Town. Significant sediment and debris were noted in portions of the Catalina Foothills where more than 9 inches of rain was received over a four-day period, with reported damage due to sediment debris flows at homes in the foothills area. This storm was compared to a 2006 flood event within Pima County when an extraordinary meteorological event produced flash flooding and debris flow in southeastern Arizona in late July.

[1] Pearthree, P.A., Youberg, A., 2006, *Recent Debris Flows and Floods in Southern Arizona*, Arizona Geology, Vol. 36, No. 3
[2] Magirl, C.S., Webb, R.H., Griffiths, P.G., Schaffner, M., Shoemaker, C., Pytlak, E., Yatheendradas, S., Lyon, S.W., Troch, P.A., Desilets, S.L.E., Goodrich, D.C., Unkrich, C.L., Youberg, A., and Pearthree, P.A., 2007, Impact of recent extreme Arizona storms: Eos, Transactions American Geophysical Union, v. 88, no. 17, p. 191-193.
[3] Webb, R.H., Magirl, C.S., Griffiths, P.G., and Boyer, D.E., 2008, Debris Flows and Floods in Southeastern Arizona from Extreme Precipitation in Late July 2006: Magnitude, Frequency, and Sediment Delivery. U.S. Geological Survey Open-File Report 2008-1274, 95 p.
[4] Arizona Geological Survey at the University of Arizona | Facebook post December 19, 2021.

Location

Debris flows, rockfalls and translational landslides are the most common type of landslides in Pima County. Landslides typically occur on steep upper slopes of mountain ranges. Accordingly, the Mt. Lemmon Highway is particularly vulnerable to rockfalls and landslides and must be periodically repaired. Debris flows and rock material may be deposited at the base of slopes where failures occur or transported to valley floors and alluvial fans at canyon mouths. The front range of the Santa Catalina Mountains is vulnerable to debris flows as evidenced by geologic deposits and by recent events.[5]

Extent

There is not enough current data to estimate the potential magnitude of landslides. In general terms, landslides can threaten human life, impact transportation corridors and communication systems, and cause damage to property and other infrastructure. Actual losses can range from mere inconvenience to high maintenance costs where very slow or small-scale destructive slides are involved. Landslides, rockfalls, and debris flows are typically associated with heavy rainfall events during the summer monsoon or following winter snowfall and rains. Landslides can also be triggered by moderate to large magnitude temblors. During periods of heavy precipitation, the onset of such events can be swift and severe and events may last hours or longer depending on severity.

Probability of Future Events

The probability of a landslide causing damage in the planning area is difficult to determine because of the lack of historic data. However, high-intensity and long-duration precipitation may cause landslides by oversaturating hillslope soils. Disturbances to slopes, particularly from wildfires, changes in hydrologic conditions make slopes more susceptible to failure from rainfall-runoff generated by commonly occurring storms (high-frequency, low-magnitude storms). Removal of substrate support (soil or rock) from the slopes where highways and roads are built can also result in landslides. Earthquakes may also cause landslides.

Landslides range in size and frequency, from small, nuisance events (minor shallow landslides, rockfalls) along roads or uninhabited areas, to large, fast-moving, destructive debris flows, with varying effects depending on location. Future climate variability could increase the frequency and number of landslide events if that variability leads to an increase in erosional weather factors.

Vulnerability

The impacts from landslides can cause deaths and damages without warning. In the United States, some of the economic factors that result from landslides include:[6]

- Cost $3.5 billion a year in damages
- Causes 25 - 50 deaths annually
- Reduction in real estate values and tourist revenue
- Lead to lost human, industrial, agricultural, and forest productivity
- Cause damage to the natural environment

[5] Youberg, A.M., Webb, R.H., Fenton, C.R., and Pearthree, P.A., 2014, Latest Pleistocene–Holocene debris flow activity, Santa Catalina Mountains, Arizona; Implications for modern debris-flow hazards under a changing climate: Geomorphology, v. 219, p. 87-102.
[6] US Geological Survey, Landslides Hazards Program, online at http://landslides.usgs.gov/

The general population is not overly vulnerable to landslides, but rockfall can cause serious injury or death. Pima County-owned facilities most vulnerable to landslides are roadways and bridges or culverts along known debris flow areas on the Catalina Highway up to Mount Lemmon within the Coronado National Forest and at the base of the mountain. Further study is needed to assess the magnitude of these risks, document landslide sites, and determine if mitigation efforts are warranted and feasible. Some post-fire debris flows have been documented.[7] The calculated priority risk index (CPRI) for landslides in Pima County jurisdictions is presented in Table 4-21. The unincorporated area's score is higher due to more locations in vulnerable areas than other areas located further away from mountainous regions.

Table 4-21: CPRI Results for Landslide

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Unlikely	Limited	12-24 hours	< 24 hours	1.55
Oro Valley	Possible	Limited	< 6 hours	< 6 hours	2.20
Pascua Yaqui Tribe	Unlikely	Negligible	< 6 hours	< 6 hours	1.45
Sahuarita	Unlikely	Negligible	> 24 hours	< 6 hours	1.00
Tucson	Unlikely	Negligible	< 6 hours	< 6 hours	1.45
Unincorporated Pima County	Likely	Limited	< 6 hours	< 6 hours	**2.65**
				County-wide average CPRI =	**1.72**

*Jurisdictions in **bold** chose to mitigate against the hazard*

Due to the proximity to the Santa Catalina Mountains, the Town of Oro Valley has a few neighborhoods with potential susceptibility to landslides, debris flows, and sediment when there is significant precipitation and/or localized flooding events. These neighborhoods may have sediment and debris across their properties, local streets, and in drainage ways that require debris-clean up and removal. As a result of the potential for post-fire flooding, the US Forest Service continues to monitor, assess, and identify any possible mitigation projects in the Catalina's to reduce potential impacts of any flooding, landslides, debris flow, and sediment initiating on the mountain.

The Pascua Yaqui Tribe's vulnerability to a Landslide event would stem from high-intensity and long-durations of precipitation oversaturating hillslope soils within the Black Mountain range. Disturbances to slopes, particularly from wildfires, changes in hydrologic conditions make slopes more susceptible to failure from rainfall-runoff generated by commonly occurring storms. Most vulnerable to landslides are roadways, bridges, and culverts.

Due to the geographical make-up of the City of Tucson the jurisdiction is most unlikely to be directly affected by a landslide. The effect that a landslide may cause would be indirectly related to the result of the impact of landslides in other areas such as Unincorporated Pima County, which have direct ties to the City of Tucson either through residents, or businesses.

Loss Estimation

Losses are difficult to estimate given a lack of accepted measurement standards, however, the county spends significant time and money removing and repairing landslide occurrences along portions of General Hitchcock Highway as well as other roadways, especially following precipitation events. During rainfall events, residential properties in the Santa Catalina's and other regional ranges have suffered damage from land and mudslide events. The losses in the Santa Catalina Sabino Canyon flood and rockslide topped over 1 million dollars in 2006.[8] For more information on total flooding impacts and losses which include landslide losses, see Section 4.4.5 on Flooding.

[7] Youberg, A., 2015, Geodatabase of Post-Wildfire Study Basins: Assessing the predictive strengths of post-wildfire debris-flow models in Arizona, and defining rainfall intensity-duration thresholds for initiation of post-fire debris flow. Arizona Geological Survey, geodatabase, excel workbook, report 10 p. http://repository.azgs.az.gov/uri_gin/azgs/dlio/1635

[8] Arizona State Geological Survey, http://www.azgs.az.gov/Hazards_ocr/slopefailure/Landslide-fact-sheet3.pdf, retrieved 2017

Changes in Development in the Hazard Area

Increased temperatures are projected to contribute to more water evaporation making drought more common, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. To the extent that development continues along the margins of the Santa Catalina's and other mountain ranges of Pima County, more structures and infrastructure could be exposed to risks associated with landslides, rockfalls and debris flows. Zoning codes and building codes should be evaluated and updated, if necessary, to inform development decisions in vulnerable areas and reduce these risks. Roadway improvements should continue to follow current Federal Highway Administration design guidelines and best practices to avoid and minimize landslide, rockfall, and debris flow hazards.

Within the Town of Oro Valley, while there continues to be commercial and residential development, there are requirements to meet the Stormwater Utility's current floodplain management and other building codes. These include the subdivision design standards, drainage criteria manual, international building codes, and zoning codes to address scour, erosion, and sediment transport. While there is development, the infrastructure is being constructed or remodeled to potentially be at less risk/vulnerability to sediment and debris flows.

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4.4.7 Severe Wind

Description

The hazard of severe wind encompasses all climatic events which produce damaging winds. For Pima County, severe winds usually result either from extreme pressure gradients that occur in the spring and early summer months or from thunderstorms. Thunderstorms can occur year-round and are usually associated with cold fronts in the winter, monsoon activity in the summer, and tropical storms in the late summer or early fall.

The National Oceanic and Atmospheric Administration (NOAA) notes that damaging winds are often called straight-line winds to differentiate the damage they cause from tornado damage. Strong thunderstorm winds can come from a number of different processes. Most thunderstorm winds that cause damage at the ground are a result of outflow generated by a thunderstorm downdraft. Damaging winds are classified as those exceeding 50-60 mph.[9]

Three types of damaging wind-related features typically accompany a thunderstorm:

- Downbursts are columns of air moving rapidly downward through a thunderstorm. When the air reaches the ground, it spreads out in all directions, creating horizontal wind gusts of 80 mph or higher. Downburst winds have been measured as high as 140 mph. Some of the air curls back upward with the potential to generate a new thunderstorm cell. Downbursts are called macrobursts when the diameter is greater than 2.5 miles, and microbursts when the diameter is 2.5 miles or less. Downbursts can be either wet or dry. Wet downbursts contain precipitation that continues down to the ground, while the precipitation in a dry downburst evaporates on the way to the ground, decreasing the air temperature and increasing the airspeed. In a microburst, the wind speeds are highest near the location where the downdraft reaches the surface, and are reduced as they move outward due to the friction of objects at the surface. Typical damage from downbursts includes uprooted trees, downed power lines, mobile homes knocked off their foundations, block walls and fences blown down, and porches and awnings blown off homes. Aircrafts caught in the downdraft can also be forced to the ground.[10]
- Straight-line winds develop similar to downbursts, but are usually sustained for greater periods as a thunderstorm reaches the mature stage. Straight-line winds travel (or are pushed), parallel to the ground surface on the leading edge of a thunderhead, reaching speeds of 75 mph or higher. These winds are frequently responsible for generating dust storms, sometimes called haboobs, reducing visibility, and creating hazardous driving conditions.
- A tornado is a rapidly rotating funnel (or vortex) of air that extends from the cloud to the ground. Most funnel clouds do not touch the ground, but when the lower tip of the funnel cloud touches the earth it becomes a tornado and can cause extensive damage. Tornadoes can also form when a dust devil is stretched upward to contact a thunderstorm cloud. For the County, tornadoes are the least common severe wind.

History

Pima County has had one state/federal declaration involving severe winds.[11] The combined economic loss of thunderstorm wind events (for those declared and not declared) is approximately $30 million damage to property and agriculture in the last 50 years, and there have at least 3 deaths and 103 injuries, associated with dust storm-related accidents on I-10. Severe wind events occur on a significantly more frequent basis throughout the county, but do not always have reported damages associated with every event. A search of the NOAA National Center for Environmental Information (NCEI) Storm Event Database revealed the following examples of significant severe wind events that have occurred in Pima County:[12]

- January 21, 2017, a winter storm impacted southeast Arizona on January 20th and 21st. This storm resulted in very heavy snow across area mountain ranges, especially over 7000 feet in elevation with some locations seeing in excess of 2 feet of snow. Strong winds caused damage at both high and lower elevations. Damage

[9] NOAA- Severe Weather 101, https://www.nssl.noaa.gov/education/svrwx101/wind/
[10] Arizona Division of Emergency Management, State of Arizona Hazard Mitigation Plan (2018). https://dema.az.gov/sites/default/files/publications/EM-PLN_State_Mit_Plan_2018.pdf.
[11] Disaster Designation Information – State and County Level Records of Presidential Major Disaster and Presidential Emergency Declarations – Pima County, AZ October 1-2, 2018; Severe Storms and Flooding. https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/disaster-designation-information/index.
[12] NOAA National Centers for Environmental Information, Storm Events Database

due to strong winds occurred in the Tucson metro area. Tree damage constituted the majority of the wind damage, including substantial tree damage at Agua Caliente Park. Additionally, a power pole was blown down in Marana. Damage was estimated at $75,000.

- July 14, 2017, numerous thunderstorms moved southwest across southeast Arizona. One thunderstorm produced a brief landspout tornado in the Marana area. Blowing dust reduced visibility to less than a quarter mile along I-10 near Pinal Air Park. No damage was reported.

- August 10, 2017, scattered thunderstorms moved northwest across southeast Arizona. The most notable produced a large swath of tree damage across the east side of Tucson. Over one hundred eucalyptus and other large shallow-rooted trees were toppled and many other tree limbs were downed on the east side of Tucson. The damage path from this severe thunderstorm was about a mile and a half on either side of a line from Broadway Boulevard and Kolb Road to Tanque Verde and Sabino Canyon Roads. Several trees fell onto buildings near Speedway Boulevard and Pantano Road, including the Woodridge Apartment complex, which sustained significant damage to several units. One of the trees also crushed an automobile. Many other trees damaged retaining walls or power lines when they were downed. At least one power pole was also snapped. At least 7,000 customers were without power for several hours. Additionally, the roof was ripped off one house near 5th Street and Kent Drive. Damage was estimated at $250,000.

- August 10, 2019, scattered thunderstorms produced moderate to locally heavy rain in southeast Arizona. A landspout tornado formed north of Three Points and persisted for 3 minutes.

- September 23, 2019, an upper level low and tropical moisture created favorable conditions for severe weather with isolated to scattered storms forming mainly from Tucson eastward. These storms produced blowing dust in Pinal County, significant straight-line wind damage in Tucson, and an EF-1 tornado in Willcox. Dozens of trees were downed; there was damage to several residences roofs and fences. At least two vehicles were damaged from falling trees and limbs, and at least one road sign was bent over from the strong winds. Damage was estimated at $150,000.

- November 29, 2019 a line of thunderstorms caused extensive tree damage from the Rooney Ranch and Steam Pump Ranch area through Oro Valley Marketplace to Catalina Regional Park. A portion of the roof to an outbuilding was blown off at Steam Pump Ranch. An antenna on the Oro Valley Police substation located in the Marketplace was damaged. The most severe damage occurred to trees within the park and in a residential area immediately to the east. Several one-foot diameter trees were snapped off at the midpoint of the trunk while others were uprooted. Roof damage to mobile homes farther east was also noted. A tree fell on a car at one residence. Damage was estimated at $75,000.

- July 11, 2020, isolated to scattered thunderstorms developed and moved north across southeast Arizona, primarily south of I-10. The thunderstorms rolled northwest across the Tucson Metro area with thunderstorm outflow winds downing numerous trees and ten power poles. Power was out for several hours for at least 12,000 customers due to downed poles and lines as well as damaged transformers. Power poles were down at Broadway and Craycroft Road, Prince Road and Flowing Wells Road, and Ina Road and Oracle Road. Fallen trees caused damage to the Mission Palms Apartments near Orange Grove Road and La Cholla Boulevard. Trees also fell onto a vehicle at River and Craycroft and two cars in Oro Valley. A wind gust to 59 mph was recorded at KDMA Davis-Monthan AFB ASOS. Damage was estimated at $100,000.

- August 16, 2020, scattered thunderstorms developed and moved west-southwest across southeast Arizona during the late afternoon and early evening. Storms produced wind damage in the northwest Tucson Metro and Sells. Thunderstorm winds downed power poles along Silverbell Road north of Sunset Road in northwest Tucson resulting in the downed power lines that started a brush fire. Thunderstorm outflow winds caused a large dust storm to move southwest into parts of the Tohono O'odham Nation.

- July 2, 2021, scattered thunderstorms moved west across southeast Arizona, producing flash flooding and a swath of damaging winds across the Tucson Metro area which downed or uprooted numerous trees in

midtown Tucson including several at a cemetery on Prince Road and Oracle Boulevard. One tree fell on a house near Pima St. and Columbus Boulevard and another damaged a car at River Road and 1st Avenue. Winds also damaged a house under construction near Prince and Country Club Road and downed large power poles near Tucson Mall, causing the closure of 1st Avenue between River and Wetmore Roads. About 6000 customers lost electricity service. A landspout was also observed in northeast Tucson around Skyline Road and Kolb Road. Damage was estimated at $100,000.

- July 10, 2021, scattered thunderstorms developed across the Mogollon Rim and International Border and moved west across southeast Arizona. Several storms became severe with damaging winds of 60 to 90 mph that created blowing dust. Thunderstorms winds downed 30 power poles and dozens of trees in Green Valley and Sahuarita. One of the downed trees broke a water main and others blocked streets. Around 10,000 customers were without power into the overnight hours. A Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) observer on the southeast side of Green Valley measured a wind gust of 66 mph at 18:55 MST. The most extensive structural damage occurred in Green Valley/Sahuarita areas. Damage was estimated at $100,000.

- July 12, 2021, thunderstorm wind gusts downed several trees in western Oro Valley and Marana and downed power poles along Trico Road. Along with significant rainfall, there was also significant post-storm clean-up due to downed and uprooted trees and broken branches due to bursts of high winds during the storm in Oro Valley. Damage was estimated at $20,000.

- July 20, 2021, isolated thunderstorms developed and moved west across Pima County and thunderstorm winds caused damage at a church complex near Broadway Boulevard. and Craycroft Road in Tucson, blowing in one 50-foot tall stained glass window and blowing out another. An awning was damaged on the school building and the pastor's residence suffered shingle damage. A tree was also downed which damaged an iron post fence, and the church marquis was damaged. Nearby, a tree was downed damaging the wall of a house. Several other trees were downed farther north and west and a carport was destroyed near 5th Street and Alvernon Way. Damage was estimated at $100,000.

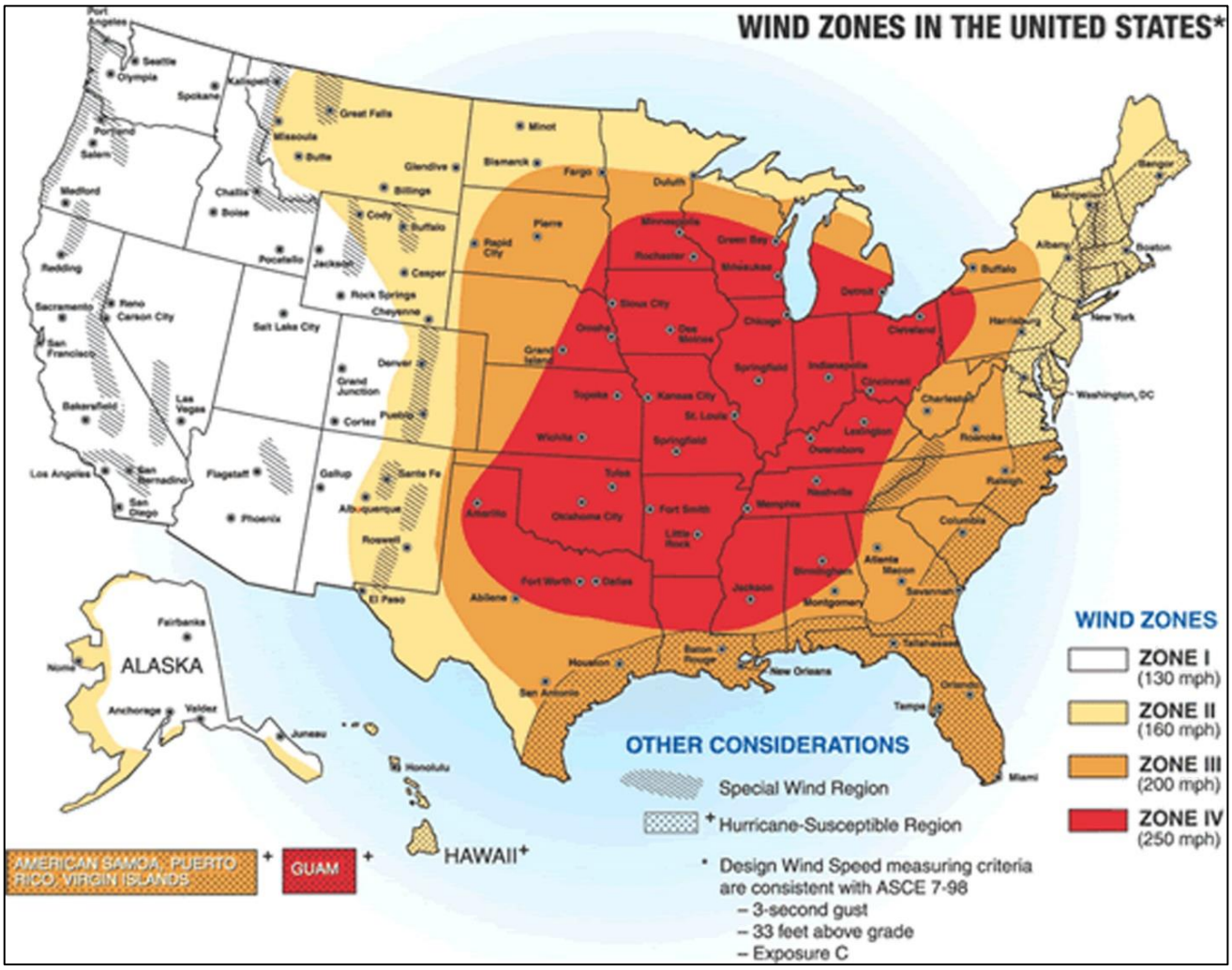
- July 22, 2021, several rounds of thunderstorms were triggered by a westward-moving upper-level weather system across southeast Arizona into the early morning of July 23. The thunderstorm winds downed 60 power poles and numerous trees and in Green Valley and Sahuarita, mostly along La Cañada Drive from Duval Mine Road to near Anamax Road and near the entrance to Quail Creek. A traffic signal was also damaged in Green Valley while the wall of a townhouse was blown over in Sahuarita. Wind damage and flash flooding occurred in Douglas, Green Valley, and the Tucson Metro area. Flooding also occurred along the San Pedro River as well as the Pantano Wash and Rillito River, and eventually downstream along the Santa Cruz River. Damage was estimated at $250,000.

City of Tucson: While windy days are not at all uncommon in the City of Tucson, there are times either during a winter storm or monsoon season that winds can become severe (caused by microburst, straight-line winds, and even a rare tornado), damaging homes, utilities and more as they pass through our City.

Extent

High winds, often accompanying severe thunderstorms, can cause significant property damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Windstorms in the planning area are rarely life-threatening, but do disrupt daily activities, cause damage to buildings, and structures, and increase the potential for other hazards, such as wildfire. Strong thunderstorm winds can start a dust storm. Dust storms usually arrive suddenly in the form of an advancing wall of dust and debris which may be miles long and several thousand feet high. They strike with little warning and can drastically reduce visibility making driving conditions hazardous. Dust storms usually last only a few minutes and the blinding, choking dust can quickly reduce visibility causing accidents that may involve chain collisions, creating massive pileups.

The wind zone map shows how the frequency and strength of extreme windstorms vary across the United States. Pima County is entirely located in Zone 1, as illustrated in Figure 4-17. Wind speeds in Zone I, where the risk of extreme windstorms is lowest, can be as high as 130 miles per hour.



Source: Federal Emergency Management Agency. Double Jeopardy: Building Codes May Underestimate Risks Due to Multiple Hazards.

Figure 4-17 Wind Zones in the United States

The **Beaufort Wind Scale**, indicated by Table 4-22, provides a measure of wind magnitude versus expected damages. The Beaufort scale is useful since it specifically addresses wind effects over landbased on wind speed. Wind speeds in the Beaufort Number 10-11 range impact the county annually. On rare occasions, wind gusts in the county can creep into the low end of the Beaufort Number 12 category.

Table 4-22: The Beaufort Wind Scale

Force	Name	Wind Speed (mpg)	Consequences
0	Calm	0	Smoke rises vertically
1	Light Air	1-3	Smoke drifts with air
2	Light Breeze	4-7	Weather vanes become active
3	Gentle Breeze	8-12	Leaves and small twigs move
4	Moderate Breeze	13-18	Dust and loose paper rises. Small branches sway
5	Fresh Breeze	19-24	Small trees sway
6	Strong Breeze	25-31	Large branches sway
7	Near Gale	32-38	Whole trees sway – difficult to walk against wind
8	Gale	39-46	Twigs break off trees
9	Strong Gale	47-54	Shingles blow off roofs – light structure damage
10	Storm	55-63	Trees uprooted – Considerable structural damage
11	Violent Storm	64-73	Widespread structural damage
12	Hurricane	Over 73	Considerable and widespread damage to structures

Source: See generally, National Weather Service - Weather Prediction Center. Meteorological Conversions and Calculations – The Beaufort Wind Scale.

Tornado damage severity is measured by the **Enhanced Fujita Tornado Scale**, which assigns a numerical value of 0 to 5 based on wind speeds and damage potential, as shown in Table 4-23. Most tornadoes last less than 30 minutes, but some last for over an hour. The path of a tornado can range from a few hundred feet to miles in length. The width of a tornado may range from tens of yards to more than a quarter of a mile.

Table 4-23: The Enhanced Fujita Scale (EF Scale)			
EF Rating	**Character**	**3 Second Gust (mph)**	**Description**
0	Weak	65-85	**Light Damage.** Some damage to chimneys; branches broken off trees, shallow-rooted trees uprooted, sign boards damaged.
1	Weak	86-110	**Moderate damage.** Roof surfaces peeled off; mobile homes pushed foundations or overturned; moving autos pushed off road.
2	Strong	111-135	**Considerable damage.** Roofs torn from frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light objects become projectiles.
3	Strong	136-165	**Severe damage.** Roofs and some walls torn from well-constructed houses; trains overturned; most trees in forested area uprooted; heavy cars lifted and thrown.
4	Violent	166-200	**Devastating damage.** Well- constructed houses leveled; structures with weak foundation blown some distance; cars thrown; large missiles generated.
5	Violent	Over 200	**Incredible damage.** Strong frame houses lifted off foundations, carried considerable distances, and disintegrated; auto-sized missiles airborne for several hundred feet or more; trees debarked.

Source: National Weather Service - Weather Prediction Center: The Enhanced Fujita Scale (EF Scale)

Probability of Future Events

High winds may be expected to occur in Pima County, several times a year. The probability of a severe thunderstorm winds occurring with high velocity winds increases as the average duration and number of thunderstorm events increases. According to the NCEI database, from January 2013 through July 31, 2021, the county averaged about 20.11 thunderstorm wind events a year totaling $4,217,300 in estimated damages. For that same period, approximately $4,526,300 million in damages were estimated for all wind events.

Although tornadoes occur less frequently, funnels clouds have been observed in recent years as well as landspout tornadoes which have occur approximately every two years within the planning area. Based on the historic record, the probability of tornadoes occurring in the county is limited. Since 1950, 24 tornadoes have been observed. While limited, tornadoes in the county have been rated at an EF2 or lower on the scale however three fatalities and 53 injuries have been attributed to tornadoes. Most tornadoes in southern Arizona last less than 15 minutes, have a path length of less than one mile, and are less than 100 yards in width.[13]

Vulnerability

Table 4-24: CPRI Results for Severe Wind					
Participating Jurisdiction	**Probability**	**Magnitude/ Severity**	**Warning Time**	**Duration**	**CPRI Score**
Marana	Likely	Limited	6 to 12 hours	< 24 hours	2.60
Oro Valley	Likely	Limited	< 6 hours	< 6 hours	2.65
Pascua Yaqui Tribe	Likely	Limited	6 to 12 hours	< 6 hours	2.50
Sahuarita	Likely	Limited	< 6 hours	< 6 hours	2.85
Tucson	Likely	Limited	< 6 hours	< 6 hours	**2.65**
Unincorporated Pima County	Highly Likely	Critical	< 6 hours	< 6 hours	**3.40**

[13] National Centers for Environmental Information (NCEI). *Storm Events Database* (Search Parameters for Pima County Arizona - Event Type: Tornado, Search Period: 01/01/1950 – 07/31/2021). https://www.ncdc.noaa.gov/stormevents/.

Table 4-24: CPRI Results for Severe Wind					
Participating Jurisdiction	**Probability**	**Magnitude/ Severity**	**Warning Time**	**Duration**	**CPRI Score**
				County-wide average CPRI =	**2.78**
*Jurisdictions in **bold** chose to mitigate against the hazard*					

Town of Oro Valley: Most of the Town of Oro Valley's vulnerability to severe wind events typically occurs during thunderstorms and other types of intense rainfall events. Thunderstorms can bring in high winds, create funnel clouds, and microbursts. Resulting damages from winds are typically reflected through downed trees and branches, roof's, traffic signals, and power lines. Private property owners may not report wind impacts, making it difficult to estimate community losses. Post storm clean-up on public property, generally falls under a normal/routine activity unless there was significant damages or costs associated with a particular event. Severe wind events are often associated with wildfires, with wind driven wildfires being more unpredictable and cause a more severe rate of spread, leading to additional impacts.

City of South Tucson: Most of the South Tucson's vulnerability to severe wind events typically occurs during thunderstorms, summer monsoons and other types of intense rainfall events. Thunderstorms can bring in high winds, create funnel clouds, and microbursts. Resulting damages from winds are typically reflected through downed trees and branches, roofs, traffic signals, and power lines. Private property owners may not report wind impacts, making it difficult to estimate community losses. Post storm clean-up on public property, generally falls under a normal/routine activity unless there was significant damages or costs associated with a particular event. Severe wind events are often associated with wildfires, with wind driven wildfires being more unpredictable and cause a more severe rate of spread, leading to additional impacts.

City of Tucson: Severe wind in the City of Tucson usually follows closely on the tails of the summer monsoon season[14]. While heavy rainfall is predictable at that time of year and leads to short-term flash flooding, and the community is resilient to these weather events, severe wind is less predictable with these storms. Thunderstorm wind gusts here in the Southwest commonly exceed 40 mph, with stronger wind gusts exceeding 100 mph and capable of producing damage similar to a tornado.[15]

Other storms, especially during the beginning of the monsoon in late July when there is still substantial daily ground heating, produce what are called microbursts (rapid pressure changes in the upper atmosphere that lead to large air masses dropping rapidly to the ground creating wind damage in a radius around the storm). Other storms have been reported near Tucson, with funnel clouds, and while most do not touch the ground, if a funnel cloud were to touch down and become a tornado, residents and businesses would find themselves vulnerable for wind damage to their homes and buildings and there would potentially be extreme damage to above-ground infrastructure like power distribution systems.

Unincorporated Pima County: The County's is vulnerability to monsoon-type storms. The Pima County Department of Transportation is working to reduce the vulnerability of signs and signal poles to severe wind events such as microbursts. High winds and monsoonal outflows can also damage power lines leading to outages causing loss of cooling for thousands of residents.

Loss Estimations

Severe wind events are unpredictable, and the exposure area includes the entire county. A thunderstorm microburst wind may knock down miles of power poles and lines and cause economic losses due to the power outages. The economic impact from a large-scale dust storm that closes down the highways can affect the local and regional economy and is difficult to quantify. A whitepaper by the Making Action Possible at the University of Arizona, attempts to compare the economic impacts of severe weather events.[16] For severe winds, this is complicated due to

[14] As per the National Weather Service, the monsoon season starts to develop in the "U.S. Southwest in July" and ends "by early- to mid-September".

[15] National Weather Service. *Monsoon Safety Page*. https://www.weather.gov/psr/MonsoonSafety.

[16] Making Action Possible (MAP). (February 2, 2017). The Economic Impacts of Extreme Weather: Tucson and Southern Arizona's Current Risks and Future Opportunities | MAP AZ Dashboard

the reporting as thunderstorms in the NCEI datasets. Based on the historic record over the last eight years, it is feasible to expect a range of annual losses from approximately $160,000 to over $1,200,000 countywide. It is difficult to estimate losses for individual jurisdictions within the county due to the lack of discrete data.[4]

Changes in Development in the Hazard Area

There have been no major changes since the last plan update regarding development impacted by severe wind within most of the planning area. Future development will expand the exposure of life and property to thedamaging effects of severe wind events.

Town of Marana: The Town of Marana is one of the fastest growing communities in Arizona. The rapid residential and business growth of the Town has resulted in more structures vulnerable to loss from severe wind. Building regulation requires that all new structures adhere to current building code to include roof and structural tie-downs.

Unincorporated Pima County: As severe wind events are relatively unpredictable and imprecise by nature, any further development in the Pima County may lead to more exposures. New traffic signaling meets the latest standards from the United States Department of Transportation's (USDOT's) Manual on Uniform Traffic Control Devices (MUTCD) and should be less vulnerable to severe wind by its design. Continued enforcement and implementation of modern building codes to regulate new developments in conjunction with public education on how to respond to severe wind conditions are arguably the best way to mitigate against losses.

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4.4.8 Wildfire

Description

A wildfire is an unplanned fire that burns in a natural area such as a forest, grassland, or prairie.[17] Wildfires are often caused by human activity or a natural phenomenon such as lightning, and they can happen at any time or anywhere. Examples of human activity resulting in wildfire may include acts such as arson, campfires, or the improper burning of debris. They often begin unnoticed, spread quickly, and are usually signaled by dense smoke that may fill the area for miles around while also exposing and possibly consuming structures. Wildfires can be categorized into four types:

- ***Wildland fires*** occur mainly in areas under federal control, such as national forests and parks, and are fueled primarily by natural vegetation. Generally, development in these areas is nonexistent, except for roads, railroads, power lines, and similar features.
- ***Interface or intermix fires*** occur in areas where both vegetation and structures provide fuel. These are also referred to as wildland-urban interface (WUI) fires. The WUI is commonly described as the zone where structures and other features of human development meet and intermingle with undeveloped wildland or vegetative fuels.[18]
- ***Firestorms*** occur during extreme weather (e.g., high temperatures, low humidity, and high winds) with such intensity that fire suppression is virtually impossible. These events typically burn until the conditions change, or the fuel is exhausted.
- ***Prescribed fires and prescribed natural fires*** are intentionally set or natural fires that can burn for beneficial purposes.

The following three factors contribute significantly to wildfire behavior and, as detailed more fully later, they can be used to identify wildfire hazard areas:

- ***Topography***: As slope increases, the rate of wildfire spread increases. South-facing slopes are also subject to greater solar radiation, making them drier and thereby intensifying wildfire behavior. However, ridgetops may mark the end of wildfire spread, since fire spreads more slowly or may even be unable to spread downhill.
- ***Fuel:*** Wildfires spread based on the type and quantity of available flammable material, referred to as the fuel load. The basic characteristics of fuel include size and shape, arrangement, and moisture content. Each fuel is assigned a burn index (the estimated amount of potential energy released during a fire), an estimate of the effort required to contain a wildfire, and an expected flame length.
- ***Weather:*** The most variable factor affecting wildfire behavior is the weather. Important weather variables are temperature, humidity, wind, and lightning. Weather events ranging in scale from localized thunderstorms to large fronts can have major effects on wildfire occurrence and behavior. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often signal reduced wildfire occurrence and easier containment. The wind has probably the largest impact on a wildfire's behavior and is the most unpredictable. Winds supply the fire with additional oxygen, further dry potential fuel, and push fire across the land at a quicker pace.

The frequency and severity of wildfires are also impacted by other hazards, such as lightning, drought, and infestations (e.g., Pine Bark Beetle). In Arizona, these hazards combined with the three other wildfire contributors noted above (topography, fuel, weather) present an ongoing and significant hazard across much of Arizona.

If not promptly controlled, wildfires may grow into an emergency or disaster. Even small fires can threaten lives, resources, and destroy improved properties. It is also important to note that in addition to affecting people, wildfires may severely affect livestock and pets. Such events may require emergency feeding, shelter, evacuation, and increased event-caused deaths and burying of animals.

The indirect effects of wildfires can also be catastrophic. In addition to stripping the land of vegetation and destroying forest resources and personal property, large, intense fires can harm the soil, waterways, and the land itself. Soil

[17] Wildfire-World Health Organization: www.who.int

[18] Pima County Community Wildfire Protection Plan, 2013: http://webcms.pima.gov/cms/One.aspx?pageId=45265

exposed to intense heat may temporarily lose its capability to absorb moisture and support life. Exposed soils in denuded watersheds erode quickly and are easily transported to rivers and streams thereby enhancing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased landslide hazards.

History

Wildfires have a prominent history in Pima County. Pima County has been included in 17 state and federal wildfire disaster declarations. Since 2017, the Coronado National Forest recorded over 130 wildfires reported in Pima County burning in excess of 172,000 acres and costing over $44.5 million dollars in fire suppression costs. [19] This data is not all inclusive nor a complete representation of all wildfires within Pima County due to multiple agencies having jurisdiction. For example, the Bureau of Land Management and Arizona Forestry and Fire Management maintain separate methodologies and platforms for archiving fire data. Accordingly, the following list of incidents provides a representative sample of moderate and major wildfire events that have impacted the County:

- May of 2002, the Bullock Fire started in Bullock Canyon in the Catalina Mountains on the Coronado National Forest. The fire started on May 21st and continued through June 10th. It was suspected to be human-induced. The fire burned 30,563 acres along with two cabins and several outbuildings. The residents of Summerhaven were evacuated on May 25th and Catalina Highway closed on May 22nd. The fire also threatened Mt. Bigelow which had several telecommunication towers and two telescopes; however, firefighters were able to contain the fire half of a mile away. The entire firefighting cost was estimated to be $11.5 million.[20]
- June of 2003, the Aspen Fire was started by human causes on June 17, 2003, and burned for about a month on Mount Lemmon, which is part of the Santa Catalina Mountains located in the Coronado National Forest north of Tucson. The fire burned 84,750 acres and destroyed 333 homes and businesses in the community of Summerhaven. Electric lines, phone lines, water facilities, streets, and sewers were also damaged. Total property damages were estimated to exceed $66 million. Firefight costs were estimated to exceed $17 million, and the Forest Service spent an estimated $2.7 million dollars to prevent soil loss. The losses in terms of timber for future lumber are estimated at $33 million. In 2002, the year before the fire started, Congress had been requested to allocate about $2,000,000 to cover the implementation of fire mitigation measures in the Coronado National Forest. However, that allocation was reduced to about $150,000 in the Congressional budget process. A presidential disaster declaration (FEMA-1477-DR) was made on July 14, 2003.[21]
- June of 2009, the Elk Horn Fire was started by human causes in an area 26 miles southwest of Three Points, Arizona. The fire started June 11th and was contained on June 22nd. The fire burned a total of 23,440 acres with five injuries reportedly associated with the fire. Firefighting costs were estimated at over $1 million.
- June of 2011, the Empire Fire located 8 miles North of Sonoita burned 1,100 acres.
- April of 2017, the human-caused Sawmill Fire located on the Coronado National Forest near the Empire Ranch and Arizona State Route 83, started 10 miles southeast of Green Valley near Box Canyon and quickly spread east northeast burning 28% of the Las Cienegas National Conservation Area. The fire burned from April 23rd to May 1st and consumed 46,991 acres. 400 people were evacuated and two Shelters were open including large animal shelter. No structures were damaged, however two miles of guard rails and supporting posts were destroyed including several power poles and road signs along State Route 83. The fire was managed by a Type 2 Incident Management Team. No injuries or fatalities were reported. Fire suppression costs were estimated at $8.6 million.
- May of 2017, the human-caused Mulberry Fire started on May 6th, eight miles southeast of Vail, east of State Route 83 in the Empire Mountains. The wildfire destroyed four structures including two homes as it spread rapidly northeast. A total of twenty rural residences were evacuated. The wildfire consumed 1,755 acres before being contained on May 9th. Property damages were estimated at $200,000.

[19] Data provide on spreadsheets constructed by the Coronado National Forest, Supervisor's Office. Coronado National Forest Fire History Occurrence 2017 - current (Pima County only) Excel file.
[20] National Wildfire Coordination Group, 2016, Historical ICS 209 reports at: http://fam.nwcg.gov/fam-web/hist_209/report_list_209
[21] Arizona Division of Emergency Management, 2013, State of Arizona Multi-Hazard Mitigation Plan; National Wildfire Coordination Group,2010, Historical ICS 209 reports at: http://fam.nwcg.gov/fam-web/hist_209/report_list_209

- June of 2017, the human-caused Burro Fire started in the foothills of the southeast side of the Santa Catalina Mountains on June 30, then quickly spread both northwest and southeast during July 19. Summerhaven and other residences on the mountain were evacuated for several days. Mt. Lemmon Highway and Redington Pass Road were both closed to traffic. The number of acres burned totaled 27,238 but no structures were lost. The cost is estimated at $9 million.
- May 2020, the human-caused Wentworth Fire started as two brush fires both south and north of Sahuarita Road and Wentworth Road merged. Corona de Tucson along with Corona de Tucson and Green Valley Fire provided initial attack and turned over command to the Department of Forestry and Fire Management.
- June of 2020, the Bighorn Fire was started by a lightning strike in the Catalina Mountains northwest of Tucson on the Coronado National Forest. The Big Horn Fire burned into the Pusch Ridge Wilderness in the Santa Catalina Mountains. The fire burned from June 5th to July 23rd and consumed 119,987 acres. The fire spread rapidly over the subsequent days and weeks, driven by multiple days of strong winds. The Town of Oro Valley, residents of Summerhaven, nearby mountain communities, those on the periphery of the mountains from the Catalina Foothills to southern Pinal County and near Redington Road were evacuated at times.

  The US Forest Service enacted the Burned Area Emergency Response (BAER) program to address the threat to life and property due to the large burn scar which encompassed upland watersheds. These watersheds drain rainfall and runoff into and through the urban area of Pima County. Segments of the population were now at greater risk of flooding, sediment, and debris runoff. The fire complexity escalated to the management of a Type 1 Incident Management Team, and at its peak, approximately 1,200 personnel fought the fire. No structures were destroyed. Estimated costs as reported by the National Interagency Coordination Center to fight the fire were $44.5 million.

  The Tortolita fire was started by a lightning strike after a thunderstorm rolled over the Tortolita Mountains, north of Oro Valley. The fire burned from June 11th to June 24th and consumed a total of 3,140 acres.

- July of 2020, the Fresnal Fire located on the Tohono O'odham Nation burned in an inaccessible area. The fire was monitored until it burned itself out. The Navarro Fire started July 11th, after a lightning storm moved across the area, approximately 14 miles west of Sahuarita and 10 miles northwest of Green Valley, in the Sierrita Mountains. The fire burned 2,306 acres and was contained on July 14th.
- August of 2020, there were multiple wildfires. The Spud Rock Fire and the Mica Bowl Fire were reported following a thunderstorm that passed through the Rincon Mountains on August 13th. The fires burned in remote and high elevation areas. The Spud Rock Fire burned 760 acres while fire activity for the Mica Bowl Fire was minimal. The Dove Fire started on August 27th in the Tortolita Mountains due to a lightning strike. The fire was contained on August 30 and burned 942 acres.
- October 6, 2020, the human-caused Encinos Fire started 11 miles northwest of Arivaca along the eastern slopes of the Baboquivari Mountains in southeast Pima County. The fire spread to over 10,000 acres by October 10th driven by strong winds, hot temperatures, and very dry fuel conditions. The fire consumed a total of 14,905 acres before becoming fully contained on October 26th. Fire suppression costs tallied $438,000.
- February of 2021, the West Fire burned west of the Elephant Head community with no evacuations or reported damage. The cause of the fire remains undetermined.
- March of 2021, the Cowboy Fire burned West of Freeport-McMoRan mine with no evacuations or reported damage. The cause of fire remains undetermined.
- May of 2021, the human-caused Sycamore Canyon Fire burned just north of the Baboquivari Peak on the Tohono O'odham Nation. The fire lasted from May 23rd to June 6th in southeast Pima County. The fire spread to approximately 1,858 acres onto the Bureau of Land Management, threatening fish and wildlife. The fire was managed by a Type 2 Incident Management Team. The cause of the fire remains undetermined.
- June of 2021, the human-caused Heavy Fire started June 16th in Santa Rita Mountains just north of the Rosemont Copper Mine. The fire spread to approximately 104 acres onto the Coronado National Forest, with no reported damage to structure. Nearby staff were evacuated temporarily. The fire lasted from June 16th through June 22nd. There were no evacuations nor reported damage.

Extent

The scale and complexity of any wildfire will determine the extent of the hazard. The extreme variability of precipitation across the southwest, combined with the trend of increasing temperatures, has led to extremely dry conditions within the forest and grasslands of Pima County. These dryer conditions will continue to increase the length and severity of wildfires. As the wildland/urban interface grows, the potential for catastrophic wildfire will increase as well. The increased wildfire damage will continue to devastate Pima County.

Probability of Future Events

In 2020, the National Interagency Fire Center ranked Arizona as number 3 in the top 10 states at risk for wildfires.[22] The probability and magnitude of wildfire incidents for Pima County are influenced by numerous factors including vegetation densities, previous burn history, hydrologic conditions, climatic conditions such as temperature, humidity, and wind, ignition source (human or natural), topographic aspect and slope, and remoteness of the area. It is the most threatening of the hazards within the County. Based on the historic data, wildfires will occur with near certainty on an annual basis. While the number of deaths, amount of property and other losses, and the acreage burned, are difficult to predict, the likelihood of substantial economic cost is extremely high.

The wildfire risk for Pima County was mapped based on the data revised for the 2013 Pima County Community Wildfire Protection Plan (PCCWPP).[23] Pima County and participating jurisdictions and organizations developed the PCCWPP to help local governments, fire departments, and districts, and residents identify at-risk public and private lands to protect those lands from a severe wildfire threat. Although the PCCWPP has not been recently updated, the base hazard data developed in the 2013 PCCWPP remains unchanged.

The PCCWPP identified two models of wildland fuel hazards to represent a typical year of rainfall and an extraordinarily heavy rainfall year to present a range of wildland fuel hazards across the county. Each model divided the fuel hazard into three categories, high, medium, and low, and accounted for previous burn areas and the major buffelgrass concerns.

Climate variability may have a positive or negative effect on wildfire risk in the future. Wildfire risk is intertwined with the risk of drought in Pima County as well. Figure 4-18 shows the Wildfire hazard potential for Pima County.

Vulnerability

Table 4-25: CPRI Results for Wildfire

Participating Jurisdiction	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI Score
Marana	Possible	Critical	< 6 hours	> 1 week	**2.80**
Oro Valley	Likely	Critical	< 6 hours	> 1 week	**3.25**
Pascua Yaqui Tribe	Likely	Limited	< 6 hours	< 24 hours	**2.75**
Sahuarita	Possible	Limited	< 6 hours	< 24 hours	2.20
Tucson	Possible	Limited	< 6 hours	< 24 hours	2.30
Unincorporated Pima County	Highly Likely	Critical	< 6 hours	> 1 week	**3.70**
County-wide average CPRI =					**2.83**

*Jurisdictions in **bold** chose to mitigate against the hazard*

Town of Oro Valley: The Town of Oro Valley is susceptible to wildfires due to close proximity to the Santa Catalina Mountains to the east side of Oracle Road (SR77), Catalina State Park, and Tortolita Mountains. The difficult mountain terrain and higher elevation can make fighting fires in these areas much more challenging. As highlighted by the 2020 Bighorn Fire, the fire burned down the mountain and threatened hundreds of homes and businesses within Oro Valley. Current trends indicate a likely future of less precipitation, lengthy droughts, more days of extreme heat, and any high wind days will likely fuel more wildfires due to drier vegetation. Major fires also heighten the community's vulnerability to post-fire floods in burn scar areas for years afterward. Small, localized brush fires are fairly common throughout the year, due to vegetation overgrowth in washes, buffelgrass, and other available fuels. In

[22] Insurance Information Institute Facts + Statistics https://www.iii.org/fact-statistic/facts-statistics-wildfires

[23] Pima County Community Wildfire Protection Plan 2013, http://webcms.pima.gov/cms/One.aspx?pageId=45265

the urban/city environment setting, these are small and quickly extinguishable, limiting potential risk to people and structures. Wildfires also cause concern to Oro Valley residents on a macro level due to air quality concerns, proximity to the mountains, and the potential of high visibility fire resources and staging areas for fire crews.

Pascua Yaqui Tribe: The Tribe's vulnerability to wildland fire is mainly through the wildland fire urban interface. Tribal residences and businesses are situated within areas of natural desert vegetation. In general, brushfires are smaller than three acres. The Tribe is a signee on the PCCWPP and has mutual aid agreements with fire departments in the immediate area and maintains a cooperative agreement with the Bureau of Indian Affairs (BIA) in addition to having access to the Tribal Nations Response Team (TNRT).

Unincorporated Pima County: The County is vulnerable to WUI fires in addition to fires on Federal or state landholdings due to high populations living in unincorporated areas in or near the Coronado National Forest, Saguaro National Parks East, and West, and other open spaces where fuels are moderate to high. The PCCWPP highlights the high population of at-risk communities adjacent to public lands administered by the Bureau of Land Management, the National Park Service, and the Coronado National Forest as well as state and county properties. The Arizona Department of Forestry and Fire Management evaluates all Arizona communities to determine those areas that may have the most potential to be affected by wildfire. In 2019, the communities of Summerhaven, Catalina, Catalina Foothills, Arivaca Junction, and Oro Valley were the top 5 areas in Pima County ranked as "high-risk" per the Arizona at Risk Communities Assessment System (data for communities on federal or tribal land was not available).[24]

Loss Estimations

The analysis in the PCCWPP includes all risk factors required by the Arizona State Forestry Department. The areas of concern for wildland fuel hazards, risk of ignition and wildfire occurrence, local preparedness, and protection capabilities, and loss of community values are evaluated to determine areas of highest wildland fire risk within Pima County. The analysis area included all of Pima County, including tribal lands. The initial analysis depicted all areas within the county at risk for unwanted wildland fire.[25]

Risk-influencing factors of developed land and other infrastructures within the area of highest flammability were given the highest priority for protection. In areas where community values occur within or adjacent to areas of high risk due to the fuel hazards of vegetation associations, a cumulative risk from catastrophic wildland fire was created.

According to FEMA'S National Risk Index, expected annual loss represents the average economic loss in dollars resulting from natural hazards each year. It is calculated for each hazard type and quantifies loss for relevant consequence types: buildings, people, and agriculture. In Pima County, expected loss each year due to natural hazards is relatively high when compared to the rest of the U.S with an expected annual loss of about $16M.[26]

There is a potential for large economic impacts from wildland fires due to business loss, population displacement, and loss of habitat and recreational opportunities among other things. Wildfire suppression costs can be substantial. The recent Bighorn Fire in Pima County burned over 119,978 acres and costs were estimated at $4.7 million.[27]

Changes in Development in the Hazard Area

By its very definition, the Wildland Urban Interface (WUI) represents the fringe of urban development as it intersects with the natural environment. As previously discussed, wildfire risks are significant for a sizeable portion of the county. Any future development will only increase the WUI areas and expand the potential exposure of structures to wildfire hazards. In Pima County, developments tend to create a clear line of demarcation between the wildland fuels and the built environment. The 2013, PCCWPP analyzed community development throughout the county and found a mix of high-density, single-family, and multi-acre parcels. Development of isolated subdivisions or with more dispersed structure development, such as one-to-three-acre parcels, are at the highest risk.[28]

As the County's population continues to grow and more development occurs at the urban/wildland interface, the risk to loss of life and property are likely to increase across the entire planning area.

[24]Arizona at Risk Communities https://dffm.az.gov/arizona-risk-communities
[25] Pima County Community Wildfire Protection Plan. (2013). Pima County Office of Emergency Management. http://webcms.pima.gov/cms/One.aspx?pageId=45265
[26] Map | National Risk Index (fema.gov)
[27] Sawmill Fire Executive Summary. (May 2, 2017). Southwest Area Incident Management Team#1. https://sites.google.com/site/swaimt1/
[28] Pima County Community Wildfire Protection Plan. (2013). Pima County Office of Emergency Management. http://webcms.pima.gov/cms/One.aspx?pageId=45265

Town of Oro Valley: Within the Town of Oro Valley, there has been an increase in commercial and residential development along the east side of Oracle Road (SR77) corridor, increasing the risk of wildfire due to the proximity to the Santa Catalina Mountains. This vulnerability was highlighted during the 2020 Bighorn Fire when certain neighborhoods impacted were being prepared for potential evacuation.

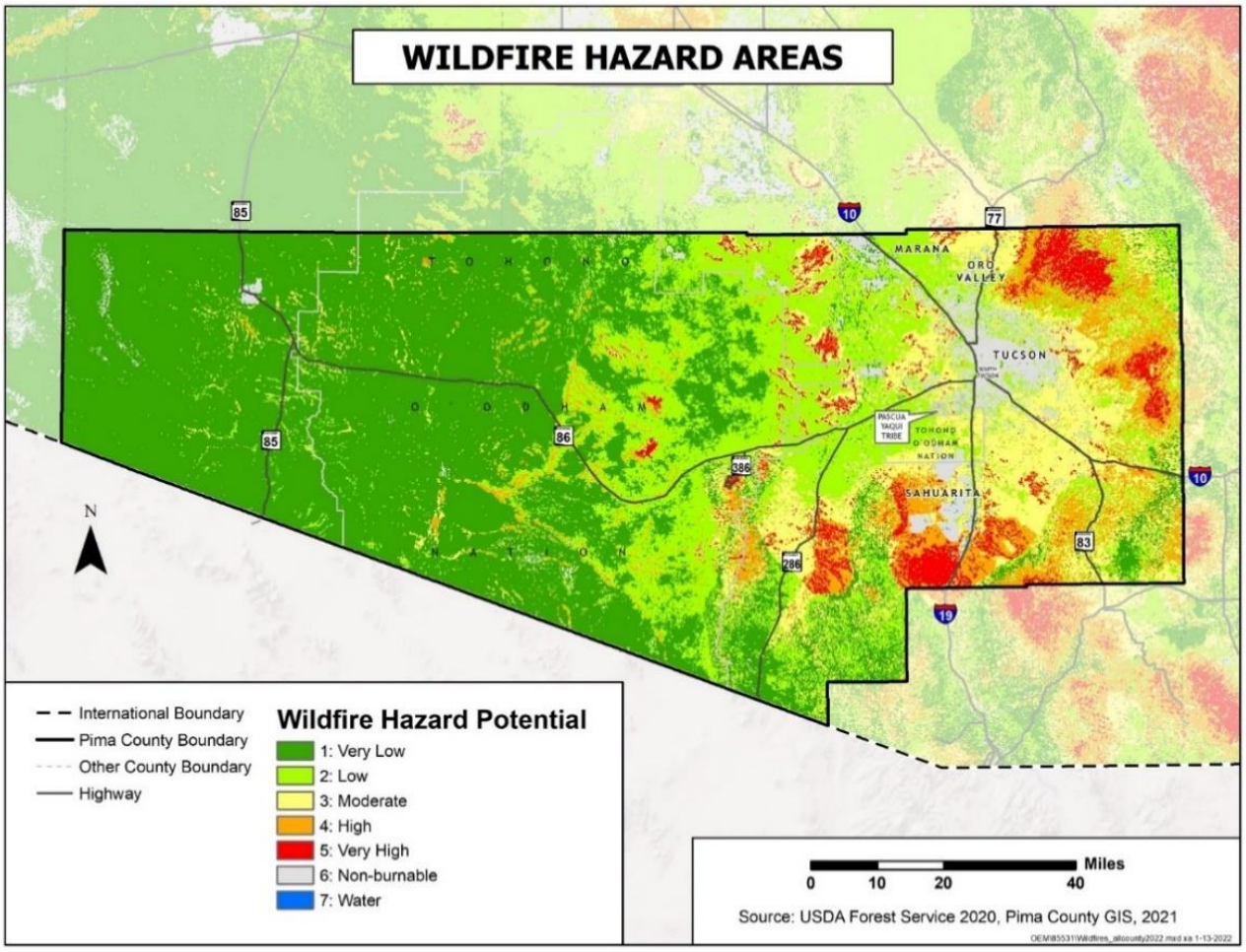
Vulnerability of homes and businesses increases as the distance of the property to wildfire-prone areas decreases; however, all residential or commercial construction projects in development within the Pascua Yaqui Tribe are required to follow Wildland Urban Interface standards. At minimum defensible firebreak lines are required; for areas with moderate fuel types, requires a 30'defensible space; for areas with high fuel types, requires a 50' defensible space; for areas with extreme fuel types, requires a 100' defensible space.

These firebreaks can be temporary or permanent and consist of fire-resistant vegetation, nonflammable materials, or bare ground. Firebreaks are to be located on the contour where practical to minimize the risk of soil erosion. Firebreak construction must comply with applicable local, tribal, state, and federal laws and regulations, including the state's Forest Practices Guidelines. Newly built infrastructure/built structures:

- An Assisted Living Center was created after the renovation was complete on the old Fire Department Station in New Pascua reservation proper.
- A Men's Path and Women's Path facilities were constructed, off Camino de Oeste, north of Jeffrey Road.
- A Boys and Girls Club is currently being constructed, south of the PYT - Wellness Center.
- In 2021, construction of a Food Pantry facility began, this facility will provide sustained community services for families/individuals in need of resources.
- Six 5-plex/Housing on Calle Torim, west of Ignacio Baumea.
- Construction of the Pascua Yaqui Health and Social Services Family Center was completed in 2021.

City of Tucson: The City of Tucson does have a limited susceptibility of damage and loss which could increase in the coming years with continued infrastructure expansion into the wildland-urban interface. The City of Tucson has identified urban interface hazard areas to the northeast, southeast, and west due to increased vegetation/fuel loads as well as existing and new infrastructure that has increased the risk and vulnerability profile. Due to the widespread propagation of non-native species, like buffelgrass, the Sonoran Desert has an unusually high fine dead fuel load that has never existed before.

In a response to the increased risk profile, the Tucson Fire Department has established a wildland firefighting program and purchased one Type 3 and two Type 6 apparatus as well as a team of personnel with specialized wildland firefighting training.



Source: USDA Forest Service Research Data Archive, 2020

Figure 4-18: Wildfire Hazard Potential Pima County

SECTION 5: MITIGATION STRATEGY

5.1 Hazard Mitigation Goal and Objectives

The three primary components of the mitigation strategy are:

Goals and Objectives

Capability Assessment

Mitigation Actions/Projects and Implementation Strategy

A reassessment of the goals and objectives was made with the planning team at the suggestion of the Arizona State Mitigation Planner. The Team considered the following before revising the goals for 2022:

1. Do the goals and objectives identified in the 2017 Plan reflect the updated risk assessment?
2. Did the goals and objectives identified in the 2017 Plan lead to mitigation projects and changes to policy that helped the jurisdiction(s) to reduce vulnerability?
3. Do the goals and objectives identified in the 2017 Plan support any changes in mitigation priorities?
4. Are the goals and objectives identified in the 2017 Plan reflective of current State goals?

Upon review of the 2017 goals and objectives, the planning team had no recommendations for modifications therefore the goals and objectives remain unchanged.

Goal

Reduce or eliminate the risk to people and property from natural hazards.

Objectives

- Reduce or eliminate risks that threaten life, critical facilities, and infrastructure.
- Promote hazard mitigation activities by increasing public awareness and education of hazards and risks.
- Integrate mitigation into planning efforts, capital improvement, grants and funding, multijurisdictional collaboration efforts, and training and exercising.

5.2 Capability Assessment

An important component of the Mitigation Strategy is a review of each participating jurisdictions' resources in order to identify, evaluate, and enhance the capacity of local resources to mitigate the effects of hazards. The capability assessment is comprised of several components:

- Legal and Regulatory Review: A review of the legal and regulatory capabilities, including ordinances, codes, plans, manuals, guidelines, and technical reports that address hazard mitigation activities.
- Technical Staff and Personnel: This assessment evaluated and describes the administrative and technical capacity of the jurisdiction's staff and personnel resources.
- Fiscal Capability: This element summarizes each jurisdiction's fiscal capability to provide the financial resources to implement the mitigation strategy.
- National Flood Insurance Program (NFIP) Participation- the NFIP contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments, but the program is promoted by FEMA as a basic first step for implementing and sustaining an effective flood hazard mitigation program and is a key indicator for measuring local capability as part of this assessment.

The planning team reviewed the information provided in the 2017 Plan. The planning team chose to keep the format of the tables summarizing the administrative, technical, and fiscal capabilities. Each jurisdiction listed their legal and regulatory capabilities by summarizing and identifying the codes, ordinances, plans, and studies/reports used by the

jurisdiction, as well as identify the appropriate agency/department with responsibility for maintaining and updating those documents. Each jurisdiction was asked to update its tables and pare down any unnecessary information. Additionally, each jurisdiction will continually seek opportunities for involvement in other planning, policy development, or ordinance development that could be beneficial to improving and implementing mitigation actions. Section 6.3 contains specific jurisdictional actions in the section discussing incorporation into future planning activities.

5.3 Jurisdictional Capabilities

Tables 5-1 through 5-24 summarize the legal and regulatory mitigation capability for each of the participating jurisdictions. The information provided includes a brief listing of current programs, polices, codes, mitigation relevant ordinances, plans, policies, and studies/reports. The tables summarize the legal and regulatory capabilities, financial resources, as well as staff and personnel resources for each jurisdiction.

Table 5-1: Pima County Programs & Policies		
Regional Flood Control Program	Purpose	The Regional Flood Control District strives to use forward-looking floodplain management practices to minimize flood and erosion damage for all county residents, property and infrastructure via the initiatives of flood hazard mitigation, warning and response in unincorporated Pima County and along major rivers within incorporated areas.
	Responsible Agency	Pima County Regional Flood Control District
	Hazards	Flood
	Effect on Mitigation Efforts	Reduces property damage, fatalities and the need for evacuation.
	Opportunities for Enhancement	Continue to improve identification and mitigation of flood risk exposure, expand warning capability, provide all-weather access and expand flood response coordination.
Pima County Comprehensive Plan Flood Control Resource Area Policy	Purpose	Floodplain Avoidance
	Responsible Agency	Development Services Department
	Hazards	Flood
	Effect on Mitigation Efforts	Requires floodplain avoidance
	Opportunities for Enhancement	Include a hazard element and clarify floodplain avoidance policy
Stormwater Program	Purpose	Beneficial Use of Stormwater
	Responsible Agency	Pima County Regional Flood Control District
	Hazards	Flood, Heat, and Drought
	Effect on Mitigation Efforts	Reduces neighborhood scale flooding, urban heat islands, and landscaping water demand.
	Opportunities for Enhancement	Work with partners to select, install and maintain neighborhood scale Green Infrastructure.
Pima County RWRD Continuity of Operations Plan 2021	Purpose	Identifies lines of succession; provides for the maintenance or re-establishment of the control and direction of continuity actions. The plan provides implementation strategies for RWRD's continuity personnel to continue essential functions during any disruption for up to 30 days.
	Responsible Agency	PCRWRD
	Hazards	All-Hazards
	Effect on Mitigation Efforts	The COOP Plan is applicable to all-hazards threats, ensures preparedness to provide critical services in an environment that is threatened, diminished, or incapacitated, and establishes PCRWRD COOP capability to respond to extended disruptions (loss of access; loss of services due to workforce reduction, equipment or system failure).

Table 5-1: Pima County Programs & Policies		
	Opportunities for Enhancement	Incorporate lessons learned, checklists, etc.
Pima County Emergency Operations Plan	Purpose	Provides a whole community overview of the County's emergency management structure and the responsibilities assigned to various county departments, non-governmental agencies, and the private sector, during emergency incidents and disasters.
	Responsible Agency	PCOEM and All County Departments
	Hazards	All-Hazards
	Effect on Mitigation Efforts	Outlines Pima County's response to incidents to include the NIMS, ICS and ESF structure to limit hazard impacts related to FEMA Community Lifelines. County Department ESF incident response protocols are designed to mitigate impacts to public health, property and the environment.
	Opportunities for Enhancement	Periodic review and updates is critical to enhance operational coordination, reduce future losses, and assist with mitigating the community's exposure to the impacts of future hazard incidents.
Pima County Community Wildfire Protection Plan (2013)	Purpose	Identifies at-risk public and private lands for protection from severe wildfire threat, and establishes incentives for communities to develop comprehensive wildfire protection plans (improving fire prevention and suppression activities).
	Responsible Agency	Coordination led by PCOEM and supported by Local Fire Departments and Districts
	Hazards	Wildfire
	Effect on Mitigation Efforts	Creation/Update and utilization of the CWPP is also an effective way to outline fire preparedness and planning, helping communities prioritize high-risk projects and to expedite overall project planning and solicit acquire federal funding.
	Opportunities for Enhancement	Identify funding to support comprehensive plan update.
Pima County Integrated Infrastructure Plan 2019-2029	Purpose	Unifies the infrastructure planning process across multiple disciplines and departments planning areas. The Plan encapsulates guiding policy directives adopted by the Board of Supervisors in Pima Prospers, the County's Comprehensive Plan; Resolution 2007-84 in Support of County Sustainability Initiatives; and the Pima County Economic Development Plan
	Responsible Agency	Led by Pima Capital Program Office and supported by Pima County Departments
	Hazards	All-Hazards
	Effect on Mitigation Efforts	The investment in physical infrastructure is a core function of county government and essential for a healthy community. Infrastructure and capital assets allow for the delivery of key public services and the movement of people and goods across the County.
	Opportunities for Enhancement	Consider this Integrated plan as a tool to allow Pima County to plan ahead for short-term and long-term mitigation strategies in support of the one year annual adopted capital budget.
Sustainable Action Plan for County Operations 2018-2025 (SWIP)	Purpose	Decisive action to cut greenhouse gas emissions in operations and implement climate adaptation strategies are put forward as part of the County's efforts to build cross-sector resilience to current and future climate variability.
	Responsible Agency	Led by Pima County Office of Sustainability and Conservation and supported by Pima County Departments.
	Hazards	All

Table 5-1: Pima County Programs & Policies		
	Effect on Mitigation Efforts	Implements climate adaptation measures in Pima County operations to support climate change preparedness, mitigation and resiliency.
	Opportunities for Enhancement	Identify future projects to support the plan outline of specific targets and recommended mitigation strategies the County will pursue to reduce current greenhouse gas emissions from operations to 26%-28% below 2005 levels by 2025.
Sonoran Desert Conservation Plan (SDCP)	Purpose	The Plan for balancing the conservation and protection of our cultural and natural resource heritage with our efforts to maintain an economically vigorous and fiscally responsible community. The SDCP identified the types of development that improved the tax base, and the relationship of these with the sewer service area. The CLS covers approximately 2 million acres in eastern Pima County.
	Responsible Agency	Office of Sustainability and Conservation and supported by Pima County Departments including NRPR and RFCD who manage the majority of CLS open space lands.
	Hazards	All
	Effect on Mitigation Efforts	Opportunity for Nature Based Solutions. Pima County Comprehensive Land Use Plan, integrating the land-use policies and principles of conservation developed in the SDCP, including the Conservation Lands System or CLS. The CLS identifies lands necessary to achieve SDCP biological goals, while delineating areas suitable for development.
	Opportunities for Enhancement	Identify Nature Bases Solution opportunities (e.g., grants) to incorporate mitigation strategies that support the SDCP.
Pima County RWRD 2016 Wastewater Facility Plan	Purpose	To help project PCRWRD long-term capital expenditure needs. The purpose of this document is to answers questions about future system needs; to contrast future needs with forecasts from previous Facility Plan Updates; and to examine likely future changes that have the potential to affect system capacity and service operations.
	Responsible Agency	PCRWRD
	Hazards	All
	Effect on Mitigation Efforts	PCRWRD's goal is to minimize chemical and energy consumption in operations; maximize use of renewable water and energy; and maximize resource recovery from wastewater collection and treatment processes to benefit the environment and the community. Reclaimed water is a renewable, consistent source of water and is prominent in water planning and drought mitigation.
	Opportunities for Enhancement	Identify technological advances in the beneficial reuse of reclaimed water and byproducts.
Pima County Rangeland Standards and Guidelines	Purpose	Maintain healthy and sustainable rangelands, particularly the grasslands on Pima County ranch fee and leased acres.
	Responsible Agency	Pima County Natural Resources Park & Recreation
	Hazards	Wildfire, Flood
	Effect on Mitigation Efforts	NRPR's goal is to maintain healthy rangelands with sufficient vegetative cover to support water infiltration and reduce flood flows.
	Opportunities for Enhancement	Development of drought strategy for ranchlands; opportunities to work with ranch partners to update Ranch Management Agreements to incorporate responses to applicable hazards; eg. implementing fuel breaks and other strategies in the WUI areas in coordination with OEM and local Fire Departments
Pima County Resource	Purpose	RMPs are developed to comply with the terms of the Pima County Multi-Species Conservation Plan (MSCP) for lands that were or will be allocated as mitigation for impacts of development that has been

Table 5-1: Pima County Programs & Policies		
Management Plans (RMPs)		permitted elsewhere under the terms of Pima County's Endangered Species Act Section 10 permit from U.S. Fish and Wildlife Service. The RMPs are intended to conserve and enhance ecological structure and functions; maintain or improve proper functioning floodplains; maintain or enhance wildlife habitat connectivity; provide for recreational opportunities and public safety; and protect culturally significant resources including visual resources. RMPs provide a local framework to aid decision-making regarding fire suppression tactics and fuel management treatments. The RMPs also address Safety and Security for agency personnel and visitors including addressing any hazardous materials, law enforcement, natural hazards, and visitor safety information.
	Responsible Agency	NRPR, RFCD, OSC
	Hazards	All Hazards
	Effect on Mitigation Efforts	Outlines relevant mitigation actions at a local, watershed scale to reduce hazards such as wildfire and flood and to educate public regarding risks of recreating on/visiting natural resource parks and open space properties of the CLS.
	Opportunities for Enhancement	RMPs identify Management Objectives, Desired Future Conditions, Policies and Procedures, and Ongoing and New Management Actions; which include those applicable to All Hazards encountered in the Planning area. Actions will address, for example, control of invasive species such as buffelgrass which would reduce fire danger in Sonoran Desert Plant Communities, development of fuel breaks to manage wildland fire ignitions, and notification to/education of the public about wildfire, excessive heat, and flood hazards.
Pima County Health Department All-Hazards Public Health Emergency Response Plan	Purpose	Core plan of PCHD's all-hazards response for managing public health incidents and details the local coordinating structures and processes used during incidents of public health significance that may impact the public's health.
	Responsible Agency	PCHD
	Hazards	All Hazards
	Effect on Mitigation Efforts	Outlines PCHD's response to incidents utilizing NIMS and ICS structure under ESF 8, Public Health and Medical Services. Response protocols are designed to mitigate impacts on public health.
	Opportunities for Enhancement	Timely reviews are essential to ensure key coordination elements and response protocols are up-to-date and assist with mitigating the community's exposure to the impacts of future hazard incidents.

Table 5-2: Pima County Codes & Regulations		
2018 International Building Code as Amended	Purpose	Building Safety
	Responsible Agency	Development Services
	Hazards	All Hazards
	Effect on Mitigation Efforts	Establishes minimum building construction standards and enforcement procedure. Adoption of building codes creates more resilient infrastructure which is able to withstand significant impacts to natural hazards.
	Opportunities for Enhancement	Continue to advocate for current code adoptions as released which benefit and apply to residents of Pima County.

Table 5-2: Pima County Codes & Regulations		
PCC Title 16: Floodplain & Erosion Hazard Management Ordinance	Purpose	Minimize public and private losses due to flooding and erosion; preserve and enhance the beneficial functions of floodplains; and to enable its residents to participate in the National Flood Insurance Program (NFIP), receive federal disaster assistance, obtain flood insurance, and reduce the cost of flood insurance.
	Responsible Agency	Pima County Regional Flood Control District
	Hazards	Flood
	Effect on Mitigation Efforts	Establishes minimum construction and site design standards and enforcement procedures for mitigation of flood and erosion hazards.
	Opportunities for Enhancement	Establish additional standards that are higher than the National Flood Insurance Program minimums. Identify additional flood prone areas.
PCC Title 18: Pima County Comprehensive Plan Land Use Classification and Zoning	Purpose	Ensure land use compatibility with the beneficial functions of floodplains and ensure development does not occur in flood prone areas, or areas without access.
	Responsible Agency	Development Services Department
	Hazards	Flood
	Effect on Mitigation Efforts	Floodplain and riparian habitat avoidance and conservation offsets.
	Opportunities for Enhancement	Update maps, clarify when avoidance is appropriate, and enforce strictly.
PCC Title 7 Environmental Quality	Purpose	Identifies the incorporation of pertinent federal, state and local, regulatory authorizations, requirements, mitigation, use, disposal, permits and fees related to the solid, liquid and hazardous wastes, water potability for the protection of public health and the environment.
	Responsible Agency	Pima County Department of Environmental Quality
	Hazards	All
	Effect on Mitigation Efforts	Ensures standards are in place to protect public health and the environment.
	Opportunities for Enhancement	Consider review of emergency temporary response use, permissions, and limits in an incident.
PCC Title 8 Health and Safety §§ 8.16, 8.20; PCC Title 13 Public Services § 13.36	Purpose	Identifies the sewage disposal requirements and other related limits for hotels, motels, tourist courts, mobile home parks and industrial wastewater.
	Responsible Agency	PCDEQ, PCRWRD
	Hazards	All
	Effect on Mitigation Efforts	Ensures standards are in place to protect public health and the environmental protections from contamination.
	Opportunities for Enhancement	Consider review of emergency temporary response use, permissions, and limits in an incident.
PCC Title 8 Drought Response Plan And Water Wasting § 8.70	Purpose	To provide a drought response plan for the unincorporated areas of Pima County.
	Responsible Agency	Office of Sustainability, Pima County Health Department
	Hazards	Drought
	Effect on Mitigation Efforts	Set triggers for drought declaration stages and mitigates response to drought, and ensures that water resource allocations are put to maximum beneficial use to protect public health, safety and welfare.
	Opportunities for Enhancement	Review underserved and disadvantaged communities' impact from drought related hazards and provide water conservation assistance and water supplies, if necessary. Review drought response measures and revise according to drought severity and extent. Review emergency responses in the event drought affects water supplies and provide assistance.

Table 5-2: Pima County Codes & Regulations		
PCC Title 14 Renewable Energy Incentive Districts	Purpose	Pima County may create a renewable energy incentive district (REID) with specific sites and an incentive plan designed to promote the development of utility-scale solar energy systems on environmentally-suitable lands within unincorporated Pima County.
	Responsible Agency	Pima County Development Services, PCDEQ, PCDOT, PCRFCD
	Hazards	All
	Effect on Mitigation Efforts	Incentives to mitigate climate change hazards impacts to the environment and continuity of county operations in energy related incident.
	Opportunities for Enhancement	Incorporate incentives for Microgrids to include critical infrastructure facilities to serve as emergency support energy areas in a long-term, widespread power outage to mitigate the effect climate related hazards.
PCC Title 15, Buildings and Construction	Purpose	The Pima County building code adopts by reference the 2018 International Building Code as amended by the local amendments incorporated into Ordinance 2018-30 as Exhibit A, together listed national and international codes.
	Responsible Agency	Pima County Development Services
	Hazards	All-Hazards
	Effect on Mitigation Efforts	Current International Building Code requirements are required to be eligible for competitive grant projects (e.g., BRIC Grant). Set the standard for quality mitigation building requirements for potential significant natural hazard exposure.
	Opportunities for Enhancement	Ensure building code adopted are updated to meet grant eligibility requirements.
RWRD Engineering Design Standards 2022 and Standard Specifications and Details for Construction	Purpose	To provide the minimum acceptable standards for the design, modification or construction of Public Sewage Conveyance facilities and Public Sewers in Pima County.
	Responsible Agency	RWRD
	Hazards	Flood
	Effect on Mitigation Efforts	Public Sewage Conveyance facilities and Public Sewer design, modification and construction standards will serve to mitigate potential of significant natural hazard exposure.
	Opportunities for Enhancement	Monitor for continuous improvement and update as needed to improve upon hazard mitigation activities.
PCDOT Subdivision and Street Development Standards (2016)	Purpose	Provide engineering standards for roadway design.
	Responsible Agency	PCDOT
	Hazards	Flood
	Effect on Mitigation Efforts	Minimize impacts of floods, ensure emergency access.
	Opportunities for Enhancement	Review and update guidelines periodically to ensure compliance with federal standards and best practices.
Guidelines for Establishing Scour and Freeboard for Bridges (2012)	Purpose	Provide guidance for bridge design.
	Responsible Agency	PCDOT
	Hazards	Flood
	Effect on Mitigation Efforts	Minimize impacts of floods.
	Opportunities for Enhancement	Review and update guidelines periodically to ensure compliance with federal standards and best practices.

Table 5-3: Pima County Financial Resources		
	Purpose	Flood risk mitigation, warning and response.

Table 5-3: Pima County Financial Resources		
Pima County Property Tax	Responsible Agency	Pima County Regional Flood Control District
	Hazards	Flood
	Effect on Mitigation Efforts	Provides an annual budget for the Regional Flood Control Program to support floodplain management practices to minimize flood and erosion damages for all county residents, property and infrastructure.
Post Fire Hazard Mitigation Grant Program	Purpose	Post Fire Hazard Mitigation
	Responsible Agency	PCRFCD
	Hazards	Flood, Wildfire
	Effect on Mitigation Efforts	Provide property protection for post catastrophic wildfire flood conditions.
Grant Funding or other funding opportunities (e.g., BRIC, HMGP, Bipartisan Infrastructure Act, Other).	Purpose	Hazard mitigation grant funding opportunities for the Critical Infrastructure and Community Resiliency from All-Hazards (natural and/or human-caused, as applicable).
	Responsible Agency	Pima County Grants Management Innovation in coordination with Pima County Departments and Federal or State Funding Authority.
	Hazards	All Hazards
	Effect on Mitigation Efforts	Grants and other funding sources are essential to provide opportunities to mitigate the effects of all-hazards in projects that might otherwise be delayed due to lack of financial resources.
Arizona State Revolving Funds	Purpose	Provides financing for the design and construction of water and wastewater infrastructure projects. Arizona Water Infrastructure Finance Authority is authorized to finance the construction, rehabilitation and/or improvement of drinking water, wastewater, wastewater reclamation, and other water quality facilities/projects.
	Responsible Agency	State of Arizona,
	Hazards	All-hazards
	Effect on Mitigation Efforts	Funding allows critical Water Sector infrastructure to reduce the risk of all-hazard cascading impacts through preparedness and hazard mitigation activities.
Pima County Capital Improvement Funding	Purpose	Provides comprehensive instructions designed to assist County departments' project management efforts, from project development through to successful project delivery (Exit Gate Process).
	Responsible Agency	All Pima County Departments
	Hazards	All
	Effect on Mitigation Efforts	All County departments are responsible for following the established CIP and Exit Gate procedures to successfully manage, develop, and deliver County CIP projects. Compliance with these County requirements is essential for completion of any large scale CIP project initiated as part of a hazard mitigation action or resiliency project.
Source/Name BRACE grant through ADHS(Arizona Department of Health Services)	Purpose	BRACE (Building Resilience Against Climate Effects) helps to build public health resilience against heat-related hazards.
	Responsible Agency	PCHD, NRPR, Pima County Library
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Interventions developed from BRACE partnership will help the community better prepare for heat-associated hazards.
Source/Name PHEP (Public Health Emergency Preparedness) grant	Purpose	Provides funding identify vulnerable populations for heat related illness, provide education targeted toward recreational activities, visitors/travelers, hospitality industry, unhoused populations, and build cooling center capacity.
	Responsible Agency	PCHD, PCOEM, Pima County Office of Sustainability
	Hazards	Extreme Heat

Table 5-3: Pima County Financial Resources		
	Effect on Mitigation Efforts	Education, outreach, and interventions will help mitigate heat-related effects to vulnerable populations.
Source/Name CDC Crisis Cooperative Agreement Grant	Purpose	PHEP domains include Strengthen Community Resilience and Strengthen Incident Management for Early Crisis Response. Both domains outline activities to identify and engage community partners and stakeholders in public-health risk mitigation efforts.
	Responsible Agency	PCHD
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Community partner and stakeholder engagement regarding risk mitigation efforts will help create effective measures to reduce both risk and disproportionate impacts to benefit the whole community.
FEMA	Purpose	Provides emergency funding for road repair.
	Responsible Agency	PCDOT
	Hazards	Flood, Landslides, Wildfire
	Effect on Mitigation Efforts	Funds road repair and reconstruction post incident to assist in reducing risk and the potential impact of future disasters.
Highway User Revenue Funds (HURF)	Purpose	Funds road construction and maintenance
	Responsible Agency	PCDOT
	Hazards	All
	Effect on Mitigation Efforts	Minimizes hazard risk through appropriate design and construction.
Regional Transportation Authority	Purpose	Funds road construction and maintenance
	Responsible Agency	PCDOT
	Hazards	All
	Effect on Mitigation Efforts	Minimizes hazard risk through appropriate design and construction.
Roadway Development Impact Fees	Purpose	Funds new road construction, not maintenance
	Responsible Agency	PCDOT
	Hazards	All
	Effect on Mitigation Efforts	Minimizes hazard risk through appropriate design and construction.

Table 5-4: Pima County Staff/Personnel Resources	
Department/Agency	**Involvement**
Planners	Provide flood risk assessment, property protection guidance and project management capability.
Planners/Resource Specialists/Program Managers (PCNRPR, RFCD, OSC)	Develop Resource Management Plans for local watershed areas to mitigate development impacts, conserve natural and cultural resources, manage public recreation and enhance safety by incorporating mitigation efforts from this Plan and others.
Geographic Information System Analysts	Knowledge and expertise on available technology, data, and GIS systems that can support hazard mitigation efforts.
Engineers	The Engineering Division delineates existing flood and erosion hazards to assist the Floodplain Management Division and undertakes activities intended to reduce flooding and erosion by designing and constructing improvements that will safely convey floodwaters and protect channel banks from erosion.
Hydrologists	Plan and collect surface water or groundwater and monitor data to support projects and programs that support hazard mitigation efforts directly or indirectly.

Table 5-4: Pima County Staff/Personnel Resources	
Department/Agency	**Involvement**
Communications Specialists and Public Information Officers	Provide community messaging and outreach through various media platforms and other activities that support hazard mitigation efforts.
RWRD Technical Services / Planning and Engineering Personnel	Wastewater treatment and conveyance systems design, capacity and hydraulic modeling, flow monitoring and other activities that support hazard mitigation efforts. Work with regulatory organizations to ensure all facilities and protocols meet strict environmental guidelines
PCRWRD Compliance and Data Acquisition Personnel: CRAO Laboratory, Hydrologist, Industrial Wastewater Control,	Analysis of water, wastewater, air and biosolids samples; Manage APP/AZPDES permits; Systems and asset mapping; Wastewater pretreatment program and industrial sampling to support projects and programs that support hazard mitigation efforts.
RWRD Capital Project staff assigned to mitigation improvements projects to include RWRD Subject Matter Experts (e.g. industrial electricians).	Mitigate hazard impact to sanitary sewage conveyance systems, pump stations, and treatment facilities and systems.
Public Works	Planning, permitting, engineering, inspections, and development services positions that know general plans, building and zoning codes, land use, land development, land management practices, construction practices, and other professional positions that know stormwater and floodplain management practices and other activities that support hazard mitigation efforts.
Information Technology	Use of technology, asset management systems, and other applications support and manage mitigation efforts.
Planning and Zoning Commission	Holds public meetings and makes recommendations to the Board of Supervisors on matters relating to zoning code amendments, rezoning, and other land use requests.
Emergency Management	Primary coordination role of hazard mitigation efforts across all county departments. Update the Hazard Mitigation Plan, Capability Assessment and Mitigation Strategies forms.
Grants Management & Innovation/Grant Writing	Grant support for the development, budget/finance and research/analysis of grant applications. Develops grant submissions to obtain funding for hazard mitigation efforts.
Program Managers and Coordinators	Engage with internal and external stakeholders to develop programs, education, and outreach to help mitigate hazards.
PCHD/Epidemiologists	Gather information and analyze data to inform heat-related mitigation efforts, including building cooling center capacity as well as other activities that support hazard mitigation efforts.

Table 5-5: Town of Marana Programs & Policies		
Marana General Plan/ Policy RS 10-1 through 10-5	Purpose	Proactively address wildfire hazards in the wildland-urban interface.
	Responsible Agency	Town of Marana
	Hazards	Wildfire
	Effect on Mitigation Efforts	Identify critical areas and manage areas to prevent wildfire.
	Opportunities for Enhancement	Identify a point of contact for this effort to ensure that someone is identifying the areas that the critical areas and/or working with the Northwest Fire District to identify these areas.
	Purpose	Identification and removal of invasive species including Buffelgrass.

Table 5-5: Town of Marana Programs & Policies		
Marana General Plan/ Policy RS 11-5	Responsible Agency	Town of Marana
	Hazards	Wildfire
	Effect on Mitigation Efforts	Minimize fire prone areas with removal of invasive species.
	Opportunities for Enhancement	Mapping of invasive species areas.
Marana General Plan/ Policy RS 3-3	Purpose	Encourage low-impact development standards along the Santa Cruz River Corridor that include habitat protection, flood control, and recreation.
	Responsible Agency	Town of Marana
	Hazards	Flood
	Effect on Mitigation Efforts	Minimize channelization of the Santa Cruz River increasing the flooding risk.
	Opportunities for Enhancement	Identify a point of contact for this effort to ensure that someone is working on low-impact development standards for flood control, recreation, and habitat protection. This effort needs a point of contact to progress this effort.
Marana General Plan/ Policy RS 7	Purpose	New developments are constructed in a manner that minimizes flooding.
	Responsible Agency	Town of Marana
	Hazards	Flood
	Effect on Mitigation Efforts	New developments are removed from floodplains as well as minimizing the effects on adjacent properties.
	Opportunities for Enhancement	Seek grant funding for regional drainage facilities. Drainage facilities will remove more property from the FEMA floodplains.
Marana General Plan/ Policy RS 8	Purpose	Stormwater is efficiently and sustainable managed in a way that reduces flood risks and respects water quality.
	Responsible Agency	Town of Marana
	Hazards	Flood
	Effect on Mitigation Efforts	Preserve the areas to convey water and preserve as open space to minimize flooding.
	Opportunities for Enhancement	Identify in a plan the areas of open space. If areas of open space are identified then the Town can work to preserve those. There is not currently any lands identified for preservation. Open spaces minimize flooding by having permeable areas where water can flow.

Table 5-6: Town of Marana Codes & Regulations		
Floodplain Management Ordinance	Purpose	To promote and protect the health, peace, safety, comfort, convenience, and general welfare of the residents within the jurisdictional area of Marana, Arizona; to minimize public and private losses due to flooding; and to enable its residents to participate in the National Flood Insurance Program (NFIP), receive federal disaster assistance, obtain flood insurance, and reduce the cost of flood insurance.
	Responsible Agency	Town of Marana
	Hazards	Flood
	Effect on Mitigation Efforts	Medium, this code was recently updated based on comments from ADWR. It has assisted in regulating building within flood prone areas.
	Opportunities for Enhancement	Was recently updated so the Town feels it is effective. This will be updated as necessary.
Town Code/ Title 17 Land Development	Purpose	Promote the health, safety, order, and general welfare of the present and future inhabitants of the Town.

Table 5-6: Town of Marana Codes & Regulations		
	Responsible Agency	Town of Marana
	Hazards	Flood and Fire
	Effect on Mitigation Efforts	Secure safety from fires, floods, traffic hazards, and other dangers.
	Opportunities for Enhancement	Update as necessary to stay current with issues.

Table 5-7: Town of Marana Financial Resources		
Development Agreements	Purpose	Provide infrastructure extensions serving new developments.
	Responsible Agency	Town of Marana/ Developers
	Hazards	Flooding and Erosion
	Effect on Mitigation Efforts	Minimize flooding with regional approaches and adequate infrastructure.
CIP/ General Fund/ Parks/ and Roads	Purpose	Provide funding for capital projects.
	Responsible Agency	Town of Marana/ Public Works
	Hazards	Flood and Erosion
	Effect on Mitigation Efforts	Construct large capital projects that address flood control and build necessary infrastructure.
Pima County Regional Flood Control CIP	Purpose	Fund Flood control projects.
	Responsible Agency	Pima County Regional Flood Control/ Town of Marana
	Hazards	Flooding
	Effect on Mitigation Efforts	Identify areas of flooding and minimize impacts with infrastructure projects.

Table 5-8: Town of Marana Staff/Personnel Resources	
Department/Agency	**Involvement**
Town of Marana Planning Commission	The Town of Marana Planning Commission is responsible for developing the Town's zoning ordinance, land use plan, Master Plan, and subdivision regulations.
Town of Marana Council	Act as Floodplain Board for floodplain decisions.
Town Engineer	Point of Contact to initiate flooding emergency. Reviews plans for flooding mitigation, Develops project recommendations to mitigate flooding.
GIS	Responsible for mapping hazards and mitigation stratifies.
Grants/ Finance	Responsible for identifying funding and applying for opportunities.
Risk Management Staff	Hazard Mitigation Planning.
Parks and Recreation	Wildland management for weeks and invasive.
CIP	Project design and construction of infrastructure to minimize flooding.

Table 5-9: Town of Oro Valley Programs & Policies		
Your Voice, Our Future General Plan (2016)	Purpose	The general plan is a community's "blueprint" for land use and development; it serves as the basis for decisions regarding a community's long-term development.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Medium. The general plan is another tool that can be used to help plan land use and development that can include considerations for hazards and potential methods to mitigate them.
	Opportunities for Enhancement	There is opportunity to expand the use the general plan goals, policies, and action items in the hazard mitigation planning process.
Parks and Recreation Master Plan	Purpose	The master plan sets a direction and meets program challenges relating to parks and recreation needs, services, concepts, next steps, and framework for the future.
	Responsible Agency	Town of Oro Valley Parks and Recreation
	Hazards	All
	Effect on Mitigation Efforts	Low. Parks and Recreation is at a time of considering future growth in programs, services, facilities, and capital improvement projects with the goal to integrate environmental design, safety, community needs with emerging trends in parks and recreation.
	Opportunities for Enhancement	As Parks and Recreation implements their master plan, opportunities may be identified for open and natural spaces, parks/walking trails, drainage, vegetation, and infrastructure improvements.
Stormwater Management Plan	Purpose	To ensure that water quality standards are being met.
	Responsible Agency	Stormwater Utility
	Hazards	Drought and Flood
	Effect on Mitigation Efforts	Medium. The plan promotes the reuse of groundwater resources through managing pollutants in stormwater runoff.
	Opportunities for Enhancement	Annual review of plan for opportunities for improvement.
Water Conservation Programs	Purpose	To provide the community with resources about water conservation efforts.
	Responsible Agency	Water Utility
	Hazards	Drought and Extreme Heat
	Effect on Mitigation Efforts	Medium. The program promotes water conservation through education, outreach, and the use of technology to reduce water waste.
	Opportunities for Enhancement	Expand use of technology as a tool to provide utility customers real-time data, trends, notifications (alerts) so they can better understand and manage their water usage.

Table 5-10: Town of Oro Valley Codes & Regulations		
Oro Valley Town Code • Chapter 6 - Building • Chapter 7- Streets, Highways, Public Ways- Subdivisions • Chapter 17- Floodplain and Erosion Hazard Management	Purpose	To promote the health, peace, safety, comfort, convenience, and general welfare of the residents within the jurisdictional area of the Town of Oro Valley.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Medium. The Town regularly updates codes to reflect changes in revised international building codes, development, best practices, and trends.
	Opportunities for Enhancement	Continue to update codes as needed to provide the town with modern and needed regulatory tools to mitigate exposure to the impacts of future hazards.
Oro Valley Town Code • Chapter 15 Water Code	Purpose	To promote the health, safety, order, and general welfare of the present and future inhabitants and those served outside of Town boundaries by the Water Utility.
	Responsible Agency	Water Utility
	Hazards	All
	Effect on Mitigation Efforts	Medium. Provides the Water Utility the authority to define water wasting, to enforce the water wasting policies, and establishes fines.
	Opportunities for Enhancement	Implementation of customer education and awareness about the code, possible fines, and benefits to reduce and mitigate water wasting.
Oro Valley Zoning Code • Chapter 27 – General Development Standards • Addendum C, Approved Native Plant List • Addendum A, Design Standards • Addendum D, Hydroseed List • Addendum E, Prohibited Plant List	Purpose	To promote the health, peace, safety, comfort, convenience, and general welfare of the residents within the jurisdictional area of the Town of Oro Valley.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Medium. The Town regularly updates codes to reflect changes in revised international building codes, development, best practices, and trends.
	Opportunities for Enhancement	Continue to update zoning codes as needed to provide the town with modern and needed regulatory tools to mitigate exposure to the impacts of future hazards.

Table 5-11: Town of Oro Valley Financial Resources		
Development and Impact Fees	Purpose	Development fees are one-time payments used to construct system improvements needed to accommodate new development. The fee represents future development's proportionate share of infrastructure costs and may be used for infrastructure improvements or debt service related to infrastructure.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Low. The Town manages the infrastructure improvements plan and development fees per the requirements, noting that improved infrastructure may also have the additional benefit of reducing impacts from hazards.

Table 5-11: Town of Oro Valley Financial Resources		
Town Capital Improvement Program (CIP)	Purpose	As part of the annual fiscal year budgeting and approval process, the capital improvement program may be used to identify and prioritize capital improvement projects.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Low. The Town identifies and completes capital improvement projects (CIP) on an annual basis, noting that certain types of projects may have added benefits of hazard mitigation.
Stormwater Utility Fees	Purpose	ADEQ requires municipalities of less than 100,000 people to implement programs and practices to meet various storm water quality and quantity standards. The fee supports street sweeping, vegetation control, culvert maintenance, minor repairs, and maintenance after storms. It also includes inspections, development of regulations and manuals, studies, and designs supporting mandated storm water activities.
	Responsible Agency	Stormwater Utility
	Hazards	Flooding, Wildfire
	Effect on Mitigation Efforts	High. The Stormwater Utility has an important role in the management of the community's flood risk to include identifying and implementing ways to eliminate, reduce, or minimize flood risks. Mitigation measures completed within stormwater systems also help minimize vegetation and invasive species in certain areas which support efforts to manage risk to wildfire.
Water Utility Enterprise Fund	Purpose	The Water Utility is a self-sustaining water enterprise fund, with revenues supporting and utility activities. The enterprise fund is separate than the general fund, so not supporting or receiving general fund dollars.
	Responsible Agency	Water Utility
	Hazards	All
	Effect on Mitigation Efforts	Medium. The Water Utility has an important role in the management of water resources to include identifying and implementing ways to eliminate, reduce or minimize delivery interruptions. The Utility has a diverse water resource portfolio, stores water for future use, has a robust water production and distribution system, and has a perpetual cycle of capital re-investments to ensure safe and reliable water delivery system.
Partnerships/ Grant Funding/Other	Purpose	To develop and maintain partnerships with other governmental, private, or nongovernmental organizations provide potential opportunities for projects and/or grant funding.
	Responsible Agency	Town of Oro Valley
	Hazards	All
	Effect on Mitigation Efforts	Medium. Partnerships and pursuing grant opportunities as applicable, help support larger projects that may for example involve flood mitigation, roadway and drainage system improvements, water conservation, vegetation management, and other projects that can support mitigation efforts.

Table 5-12: Town of Oro Valley Staff/Personnel Resources	
Department/Agency	**Involvement**
Emergency Management	Primary coordination role of hazard mitigation efforts across all town departments.
Community and Economic Development	Planning, permitting, engineering, inspections, and economic development positions that have knowledge of general plans, building and zoning codes, land use, land development, land management practices, construction practices, and other activities that support hazard mitigation efforts directly or indirectly.
Public Works	Engineers and other professional positions that have knowledge of engineering, construction, stormwater, and floodplain management practices.
Water Utility	Engineers and other professional positions that have knowledge of water conservation, drought plans, engineering, construction, and best practices relating to the management of water infrastructure and systems.
GIS	Knowledge and expertise on available technology, data, and GIS systems that can support hazard mitigation efforts.
Information Technology	Use of technology, asset management systems, and other applications support and manage mitigation efforts.
Police and Fire	Expertise relating to overall life and public safety considerations.
Planning and Zoning Commission	Holds public meetings and makes recommendations to the Town Council on matters relating to the General Plan, zoning code amendments, rezoning, and other land use requests.

Table 5-13: Pascua Yaqui Tribe Programs & Policies		
PYT – Emergency Operations Plan	Purpose	Provides Tribal government authorities, identifies roles and responsibilities, provides a framework for incorporating departments, divisions, and stakeholders.
	Responsible Agency	Office of Emergency Management, Tribal Administration
	Hazards	All
	Effect on Mitigation Efforts	Low. The plan provides a framework for tribal departments and stakeholders to come together to effectively to coordinate response and recovery activities and efforts.
	Opportunities for Enhancement	Updating the EOP is critical to capability building. Continuous education and awareness of the plan for tribal departments, stakeholders, and the public is equally important and will enhance operational coordination. The EOP is a just one component to a family of tribally developed plans to include its THIRA and MJHMP documents that assist with mitigating the community's exposure to the impacts of future hazard events.
PYT – Threat and Hazard Identification and Risk Assessment (THIRA)	Purpose	The Threat and Hazard Identification and Risk Assessment (THIRA) is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks.
	Responsible Agency	Office of Emergency Management, supporting tribal departments
	Hazards	Flood, Extreme Heat, Extreme Cold, Wildfire
	Effect on Mitigation Efforts	Medium. The outputs from this process lay the foundation for determining a community's capability gaps.
	Opportunities for Enhancement	The THIRA is a three-step risk assessment completed every three years, as it enables communities to assess year-over-year trends in changes to their capabilities, while still periodically reviewing the capability targets to keep them relevant. Threats and hazards identified in the THIRA will be used to develop exercises and capability building processes for the Tribe.

The Tribe has used the Hazard Mitigation Planning Process to inform other planning efforts, such as an assessment and complimentary planning document for the Tribe's Master Drainage plan, land use plan, etc.

During the planning process of the hazard mitigation plan, the Tribal Local Planning Team utilized the information within its THIRA/SPR to assist with the development of the hazard profiles within the Risk Assessment. The Tribal Local Planning Team created scenarios based on the Tribe's core capabilities to assess which hazard poses a greater risk to its community. The Tribe also integrated the planning process through the Public Assistance Grant Program. In response to COVID-19 Pandemic, the Tribe received a declaration of emergency, which in turn activated categories within the Public Assistant Grant Program.

Table 5-14: Pascua Yaqui Tribe Codes & Regulations		
International Fire Code - 2018 Edition	Purpose	2018 Edition Code Requirements for Inspection updates and new construction.
	Responsible Agency	Fire Department
	Hazards	Wildfire, (Life safety, protection of property)
	Effect on Mitigation Efforts	Strict code ensures construction and occupancies are compliant by establishing criteria for building, processing, design, service, and installation.
	Opportunities for Enhancement	International Fire Code establishes set standards and regulatory tools to mitigate the community's exposure to the impacts of future hazard events. The Tribe is researching / planning updating our Current International Building Codes from 2018 version to the updated 2021 International Building Codes. Enhancing these codes will help ensure more stringent safety updates and will help mitigate damage from adverse weather as well as enhance fire codes.
NFPA Standards	Purpose	Establishes Standards of Practice.
	Responsible Agency	Fire Department
	Hazards	Wildfire, (Life Safety, Protection of property, Protection of land and natural resources)
	Effect on Mitigation Efforts	Data driven provides analysis for best practices to minimize risk to life and property.
	Opportunities for Enhancement	An opportunity for the Tribe to increase its future mitigation efforts is regular updates to the NFPA standards. The Tribe's codes will be updated and will continue to update to model codes with minor amendments. When the codes are amended or updated in their various cycles the Tribe will ensure it has the appropriate people available to consult on changes to make the codes more adapted to the mitigation needs.
Resolution establishing the Pascua Yaqui Office of Emergency Management and enacting Title Two, Part II, Chapter 2-23 the Pascua Yaqui Office of Emergency Management Ordinance **ORD 20-21**	Purpose	To establish the Office of Emergency Management of the Pascua Yaqui Tribe and to provide authorization and guidance for its operations.
	Responsible Agency	Office of Emergency Management, Attorney General's Office
	Hazards	All
	Effect on Mitigation Efforts	Establishes guidance and authorities necessary for the execution of its mission, performance, of its mandated functions.
	Opportunities for Enhancement	The Pascua Yaqui Tribe Office of Emergency Management Ordinance has been integrated to the Pascua Yaqui Code and can be amended and revised as needed by the jurisdiction.

Table 5-15: Pascua Yaqui Tribe Financial Resources		
Community Development Block Grants	Purpose	Supports community development activities to build stronger and more resilient communities. To support community development, activities are identified through an ongoing process.
	Responsible Agency	Grants and Contracts Department; Developmental Services; Housing
	Hazards	All
	Effect on Mitigation Efforts	Activities may address needs such as infrastructure, economic development projects, public facilities installation, community centers, housing rehabilitation, public services, clearance/acquisition, microenterprise assistance, code enforcement, homeowner assistance, etc.
Capital Improvements Project funding	Purpose	Developed based on availability of funds. Rolling 5-year basis.
	Responsible Agency	Developmental Services; Housing Department; Facilities Management
	Hazards	All
	Effect on Mitigation Efforts	Activities may address needs such as infrastructure, public facilities installation, public services, and clearance/acquisition.

Current and past financial sources available to the Tribe for hazard mitigation planning and projects include potential disaster and mitigation funds through FEMA (Public Assistance, HMGP, and PDM funds), programs established through the Indian Self Determination Act (Public Law 93-638), casino and tribal enterprise revenues, and various departmental operation budgets. Other potential sources of funds may include the U.S. Department of Interior (Bureau of Reclamation, Bureau of Indian Affairs, U.S. Geological Survey, Bureau of Land Management), U.S. Army Corps of Engineers, U.S. Housing and Urban Development, U.S. Department of Health and Human Services (Indian Health Service), and the U.S. Department of Agriculture (U.S. Forest Service, Natural Resources Conservation Service), State of Arizona (Governor's Office of Economic Development, Arizona Department of Transportation, Arizona Department of Housing, Arizona Department of Health Services), Pima Association of Governments, and other federal, state and local sources. All grants are tracked through the Grants Department at the Tribe and over 21 departments utilize grant funds of one type or another. While the Tribal Local Planning Team identified federal funding sources for mitigation activities, within the last five-years the Tribe has not been awarded or have received mitigation grant funding.

Tribal Pre- and Post-Disaster Hazard Management

In addition to the tables listed above, the Pascua Yaqui Tribe is required to summarize and evaluate pre- and post-disaster hazard management to satisfy the §201.7 Tribal Planning capability assessment requirements. Accordingly, Table 5-13 summarizes hazard mitigation and pre- and post-disaster hazard management practices and roles that are currently accomplished through several Pascua Yaqui Tribe departments and programs.

Table 5-16: Pascua Yaqui Tribe Staff/Personnel Resources	
Department/Agency	**Involvement**
Emergency Manager	Emergency Management Director – oversees emergency management program and staff.
Grant writer(s)	Tribal Grants/Contracts assists with identifying federal and state grant funding programs related to mitigation.
Office of the Chairman	• General mitigation oversight. • Emergency response oversight. • General development oversight.
Tribal Council	• Final approval for all mitigation and pre-disaster planning, projects and funding allocation for pre- and post-disaster hazard management activities.
Land Department	• Regulates land use and development including zoning and flood management. • Lead planning department for all tribal development including flood control, transportation, and other physical improvements on the reservation.
Fire Department	• Shared emergency management role with Police Department. • Emergency response and mitigation responsibilities regarding fire and HazMat. • Hazmat awareness and operations, but not technical response for removal or clean up. • Wildland fire awareness and operations. • CERT Team collaboration. • Part of the AZ Mutual Aid Compact (AZMAC). • Pima County Fire Chiefs Mutual Aid Agreement. • Pima County Community Wildfire Protection Plan. • Tribal Salt River Region Fuel Management Plan.
Police Department	• Shared emergency management role with Fire Department • Response and mitigation for many of the human-caused hazards related to the civil population and terrorism. • Enforcement of tribal law. • Participates in a regional SWAT team.
Office of Emergency Management	• Responsible for overseeing incidents caused by natural and or man-made disasters or emergencies. • Provide departmental and community education and assistance in conjunction with Emergency Response Organizations in providing services to governmental offices, the community at large and surrounding areas.
Health Department	• Control of disease and outbreak incidents. • Dispensing of medication and anti-viral vaccines through points of distribution and points of dispensing. • Public awareness and public service announcements in collaboration with the local radio station. • Conduct training for hazard related issues and incidents. • CERT Team leadership.
Facilities Department	• Maintain and operate heavy equipment for response to disaster related needs. • Maintain electricians on staff. • Responsibility for emergency shut-off of water mains. • Maintain a 24/7 on-call capability.
Procurement Department	• Emergency and other purchases. • Maintenance of emergency generators.
Indian Health Services – Office of Engineering & Environmental Health	• Emergency response and post-disaster needs assessments for mitigation and recovery.
BIA	• Mutual aid cooperative agreement with PYT for fire response and financial assistance.
Other(s)	• Tribal Public Safety personnel trained in NIMS and ICS, outside consultants

The Pascua Yaqui Tribe has several programs and policies in-place to include a newly established Office of Emergency Management to provide for effective hazard mitigation, as is summarized in the applicable tables. For the 2022 Plan, the Tribe pulled together a Local Planning Team consisting of its Facilities, Housing, Enrollment, Health, Law Enforcement, Procurement, and Land Departments. The Tribal Local Planning Team performed an evaluation/assessment of the information summarized, and noted the following regarding successes, gaps, opportunities and changes over the last planning cycle:

- Regarding pre- and post-disaster hazard management policies, programs, and capabilities, the Tribal Local Planning Team:
    - Identified the ongoing maintenance of its Emergency Operations Plan.
    - Identified processes and practices for coordinated and collaborative capability building to respond to a human-caused event at the AVA entertainment facility and casino.
    - The Tribe's ability to establish and maintain mutual aid agreements and partnerships were proving effective for expanding the response capacity for event taking place within tribal lands.
- Due to the COVID-19 Pandemic there has been no significant change in the Tribe's policies related to development in hazard prone areas over the 2022 planning cycle other than to regulate to the 100-year floodplain using the data and recommendations of the Pascua Yaqui Tribe Flood Control Project.
- Specific hazard management capabilities of the Tribe that have changed since approval of the previous plan include:
    - New BIA, Pima Fire Chiefs Association, PCCWPP, Arizona Mutual Aid Compact and SWAT cooperative/mutual aid agreements have been developed.
    - The Pascua Yaqui Tribe Flood Control Project Plan became available for flood management use. The plan is delivered in phases with completion of phase 2 concluding in October 2016 and activities will continue.
    - Community Emergency Response Team (CERT) collaboration.

Upon receipt of a presidential disaster declaration, the Tribe will work with FEMA to develop two (2) post-disaster hazard management tools:

1) Public Assistance Administration Plan; and
2) Hazard Mitigation Grant Program Administration Plan. Both plans will be used by the Tribe to identify the roles and responsibilities of the Tribe in administering the FEMA Public Assistance (PA) and Hazard Mitigation Grant Programs (HMGP), and to outline staffing requirements and the policies and procedures to be used. As result of developing these plans and revising this Plan, Tribal resources will improve hazard management and mitigation planning.

Table 5-17: Town of Sahuarita Programs & Policies		
2020-2025 Strategic Plan	Purpose	The 2020-2025 Strategic Plan is the Town's strategy of capitalizing on its financial position, organizational effectiveness, community involvement, and geographical location through innovative and managed risk.
	Responsible Agency	Town of Sahuarita – Mayor and Council
	Hazards	All
	Effect on Mitigation Efforts	The Strategic Plan foster an inclusive community with a unique identity where the residents can start, grow, and enjoy life.
	Opportunities for Enhancement	The Strategic Plan is a well-thought out process that will create various opportunities during the different phases as well as within different areas. The Strategic Plan can be improved through the inclusion of multi-hazard mitigation improvements, or multi-hazard mitigation techniques, within any planned Town capital improvement project.

Table 5-18: Town of Sahuarita Codes & Regulations		
Sahuarita Town Code, as amended	Purpose	To provide support and guidance to the present and future growth of the Town of Sahuarita in order to maximize the comfort and sustainability of both health and convenience of the community.
	Responsible Agency	Town of Sahuarita (Planning & Building Safety, Police, Public Works, Green Valley Fire District, Rural/Metro Fire District)
	Hazards	All
	Effect on Mitigation Efforts	Since the Town of Sahuarita is a fairly new community, the code helps minimize and possibly eliminate the potential dangers of hazards.
	Opportunities for Enhancement	Adding to the code as new laws and regulations are adopted and clarifying some of the standards such as those for construction and building will improve the process.
2018 Series of International Codes (Chapter 15.05of the Town Code), as amended 2017 National Electric Code, as amended	Purpose	To provide guidance for safe and acceptable standards for building.
	Responsible Agency	Planning & Building
	Hazards	All
	Effect on Mitigation Efforts	Since the Town of Sahuarita is a fairly new community, the code helps minimize and possibly eliminate the potential dangers of hazards.
	Opportunities for Enhancement	Adding to the code as new laws and regulations are adopted and clarifying some of the standards such as those for construction and building will improve the process.
Floodplain Management Ordinance, as amended Aquifer Protection permit #103602	Purpose	To promote and protect the health, peace, safety, comfort, convenience, and general welfare of the community; to minimize public and private losses due to flooding.
	Responsible Agency	Public Works; Water Reclamation
	Hazards	Flood
	Effect on Mitigation Efforts	The code was recently updated to help with the development along local washes outside of the FEMA Flood Zones.
	Opportunities for Enhancement	Mapping of Local Washes to determine Flood and Erosion Hazard Setback limits can possibly improve planning resources for development along local washes.

Table 5-19: Town of Sahuarita Financial Resources		
Capital Improvement Project Funding	Purpose	To improve upon existing civil infrastructures as well as the construction of new ones to not only promote safety but also meet and exceed national standards.
	Responsible Agency	Public Works
	Hazards	All
	Effect on Mitigation Efforts	Minimizes and possibly eliminates potential hazards by building per standards.
Development Fees	Purpose	To improve upon development around the community by making sure that builders adhere to adopted standards.
	Responsible Agency	Public Works, Planning & Building, Mayor & Council
	Hazards	All
	Effect on Mitigation Efforts	Minimizes and possibly eliminates potential hazards by building per standards.

Table 5-20: Town of Sahuarita Staff/Personnel Resources	
Department/Agency	**Involvement**
Town of Sahuarita Council	The Town of Sahuarita is responsible for developing the Town's Ordinance, Land Use Plan, Master Plan, and Subdivision regulations.
Department Heads	Responsible for planning and development of policies to support hazard mitigation programs and projects.
Town Engineer	Point of Contact to initiate flooding emergency. Reviews plans for flooding mitigation and develops project recommendations to mitigate flooding.
Public Works Department (CIP)	Project design and construction management of infrastructure to minimize flooding
Code Enforcement	Responsible for the enforcement and regulation of the Town's Ordinance, Code, Standards, and Guidelines.
Police and Fire	Expertise relating to overall life and public safety considerations.

Table 5-21: City of Tucson Programs & Policies		
Tucson Floodplain Management Plan (TSMS Phase Va)	Purpose	Tucson Floodplain Management Plan (FMP) identifies unique hazard conditions in the Tucson area and prioritizes action tasks to: a) lower flood and erosion hazard associated costs and b) reduce risks within City of Tucson.
	Responsible Agency	City of Tucson Floodplain Board (Mayor & Council), Floodplain Administration housed in Department of Transportation and Mobility (DTM)
	Hazards	All
	Effect on Mitigation Efforts	High, since it prioritizes action plan tasks and projects, and helps educate and emphasize importance of flood and erosion hazard management, regulating development in regulatory 100-year flood conditions and erosion hazard areas, as well as critical infrastructure in 500-year floodplain.
	Opportunities for Enhancement	Annual updates for the Tucson FMP provide opportunity to assess how action items are being achieved and prioritize action items for that year. Tucson FMP is important to be referenced and utilized when applying for FEMA hazard mitigation grants – projects identified in this adopted plan are given more weight for FEMA grant approval. Floodplain management staff is about 25% of what it used to be about 15 years ago; more certified floodplain managers would increase effectiveness of floodplain management at the City of Tucson and for

Table 5-21: City of Tucson Programs & Policies		
		applying for and managing grant projects. Annual FMP updates occur to reflect current identified needs to address flood and erosion related hazards.
Tucson Levee Manual	Purpose	Provides oversight for levee breach response for the levees impacting the City of Tucson and provides requirements for development of levees, as well as itemized maintenance for classic levees and levee floodwalls.
	Responsible Agency	Tucson PDSD, Tucson Floodplain Administration
	Hazards	Flood
	Effect on Mitigation Efforts	Having a City of Tucson levee manual assists floodplain administration develop specific emergency response plans for impacted areas next to levee and dams.
	Opportunities for Enhancement	Emergency response plans will be customized for each dam and levee during breach conditions that can assist with warning system planning and implementation.
Tucson Green Streets Active Practice Guidelines	Purpose	City of Tucson Green Streets Active Practice Guidelines provides guidance for public right-of-way improvements to incorporate green infrastructure features into Tucson roadways wherever possible.
	Responsible Agency	Tucson DTM Landscaping, Tucson Floodplain Administration, Tucson's City Engineer.
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Water harvesting provides efficient opportunities to capture storm runoff to irrigate onsite vegetation; and with more trees, less heat island effect.
	Opportunities for Enhancement	The current version needs to be updated to reflect other transportation planning documents and water harvesting regulations.
Drought Preparedness and Response Plan	Purpose	The Plan recognizes that drought impacts do not occur suddenly or without warning and acknowledges that with proper planning and review it is unlikely the community will find itself in an emergency caused solely by drought. It also ensures that Tucson Water staff will implement drought response measures early enough to avoid crisis-mode decision making and to help the community anticipate what measures will come next if drought impacts become more severe.
	Responsible Agency	City of Tucson Water Department – Tucson Water
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Medium: Diversifying water supplies and increasing water savings has made the Utility more drought resilient, not just now but well into the future. Integrating climate change adaptation into both long range and drought planning will be a key aspect of maintaining our drought resilience. The 2020 update of Tucson Water's drought plan also makes the thresholds for each drought level consistent with the Lake Mead water elevations used for each tier in the DCP.
	Opportunities for Enhancement	Annual review of Plan provides the opportunity to update and align the Plan with changing state and federal policy.
Tucson Water Emergency Response Plan	Purpose	The purpose of the Tucson Water (TW) Emergency Response Plan (ERP) is to protect the health of employees and the public, limit the impact of a crisis on services and resources, and ensure a quick recovery following an emergency. This ERP addresses emergencies that will be managed primarily by TW and describes situations where TW will provide support and cooperation with other agencies (the City of Tucson, Pima County, state, federal, and/or private sector supporting agencies) during large-scale emergencies.
	Responsible Agency	City of Tucson Water Department – Tucson Water

Table 5-21: City of Tucson Programs & Policies		
	Hazards	All
	Effect on Mitigation Efforts	High: The Emergency Response Plan provides Emergency Action Plans or Checklists that serve as procedures to follow for emergency response to individual incidents.
	Opportunities for Enhancement	Conduct risk and resilience assessment of potable distribution system infrastructure, annual review and updating of the Emergency Response Plan, annual tabletop emergency response exercise, EPA certification every five (5) years.
Tucson One Water 2100 Master Plan	Purpose	The Tucson One Water 2100 Master Plan is an integrated planning and implementation approach to managing finite water resources for long-term resilience and reliability, meeting both community and ecosystem needs.
	Responsible Agency	City of Tucson Water Department – Tucson Water
	Hazards	All
	Effect on Mitigation Efforts	High: The Tucson One Water 2100 Master Plan provides strategic planning and technical guidance that encompasses all water sources in long term mitigation planning.
	Opportunities for Enhancement	Technical memorandums provide direction on improving mitigation strategies to protect water sources from hazards that affect the water system.
Heat advisory protocol	Purpose	Parks and Recreation has numerous employees who spend a significant amount of time working outdoors all day. To ensure the safety of employees, a heat advisory protocol has been developed to define when employees will be restricted from working outdoors.
	Responsible Agency	Tucson Parks and Recreation
	Hazards	Extreme heat
	Effect on Mitigation Efforts	High. When the defined heat index elements are met, employees are moved to indoor activities.
	Opportunities for Enhancement	The City of Tucson Parks and Recreation will review the protocol on an annual basis to evaluate the effectiveness.
Heat advisory	Purpose	To open up recreation centers as cooling stations for citizens during periods of excess heat conditions.
	Responsible Agency	Tucson Parks and Recreation
	Hazards	Extreme heat
	Effect on Mitigation Efforts	High. Actions allow citizens access to cool indoor spaces.
	Opportunities for Enhancement	The City of Tucson Parks and Recreation will review the protocol on an annual basis to evaluate the effectiveness.
Cold weather protocols	Purpose	To protect park property and assets from freezing conditions. When freezing conditions are forecast, staff cover back flow valves and shut off drinking fountains to prevent freezing and broken pipes.
	Responsible Agency	Tucson Parks and Recreation
	Hazards	Extreme cold
	Effect on Mitigation Efforts	High. Actions prevent broken water pipes and preserve property.
	Opportunities for Enhancement	The City of Tucson Parks and Recreation will review the protocol on an annual basis to evaluate the effectiveness.
Plan Tucson	Purpose	Plan Tucson provides the Mayor and Council's expected focus and goals as the City of Tucson General & Sustainability Plan.
	Responsible Agency	All Tucson departments
	Hazards	All
	Effect on Mitigation Efforts	Provides City projects consistency in following Mayor and Council directives and ensures projects consider sustainable approaches, such

Table 5-21: City of Tucson Programs & Policies		
		as: reduces potential harm to life and property in natural hazard areas and from hazards resulting from human activities and development through preventive measures; rehabilitates and enhances natural drainage systems, water detention and retention basins, and other infiltration areas for multiple benefits, such as recreation, wildlife habitat, and stormwater management; protects groundwater, surface water, and stormwater from contamination; and creates, preserves, and manages biologically rich, connected open space; wildlife and plant habitat; and wildlife corridors, including natural washes and pockets of native vegetation, while working to eradicate invasive species.
	Opportunities for Enhancement	Refresher training for staff and revisiting the plan periodically (every 5 years), and including Floodplain Administration input, helps to ensure the plan's goals are applied to City drainage improvement projects.
Tucson GSI Program	Purpose	Since May 1, 2020, a new Green Stormwater Infrastructure fee was included on utility services statements for residents and businesses within the City of Tucson, generating $3 million each year to build and maintain projects throughout the city that capture stormwater runoff from public streets and parking lots, and divert it into vegetated water harvesting areas. GSI Program: provides a funding source for existing GSI maintenance and growing more trees and plants on streets, and in parks and public areas using stormwater runoff as a primary water source; reduces stormwater pollution; shade and cool streets, sidewalks, bikeways, and parking areas; reduces costs for needed underground storm drain systems.
	Responsible Agency	Tucson Water, Tucson DTM (Stormwater)
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Green infrastructure projects that include water harvesting provides efficient opportunities to capture storm runoff to irrigate onsite vegetation; and with more trees, less heat island effect.
	Opportunities for Enhancement	Tucson Water is working with other Tucson departments including PDSD, DTM, Stormwater Management / Floodplain Administration to identify ways to ensure an efficient sub-program for drainage facility maintenance is utilized.
Tucson Stormwater Management Program	Purpose	Funded primarily by Tucson DTM, Stormwater Management Program is an oversight program that prepares the annual report to Arizona Department of Environmental Quality (ADEQ) and collects stormwater management data from all City departments regarding their department's stormwater activities and responsibilities. Prior to the GSI fee, a stormwater fee is being used to help fund City of Tucson Stormwater Management, providing approximately $190,000 per year to the program managed by staff in Tucson DTM. Stormwater Management Program complies with the Municipal Separate Stormwater Sewer System MS4 Phase 1 ADEQ permit and complies with EPA Clean Water Act.
	Responsible Agency	Tucson DTM oversight for all departments.
	Hazards	Flood
	Effect on Mitigation Efforts	With the high density of potable wells (both private and public) within the City of Tucson area, the Tucson Stormwater Management program helps to protect the surface water quality, thereby also protecting Tucson's groundwater quality. The program covers illicit discharge inspections and resolution, industrial/commercial

Table 5-21: City of Tucson Programs & Policies		
		inspections, first flush sampling, annual reporting, and other tasks that support clean surface runoff.
	Opportunities for Enhancement	Standardized stormwater pollution prevention plan boiler plate for the City of Tucson could be created to help facilitate private and public development project grading plan submittals. The ordinance readability could be improved; ordinance enforcement could be clarified/enhanced and written to correlate with associated ADEQ issued MS4 permit. The use of Corrective Action Plans for addressing stormwater issues could be written under technical standards for better implementation of stormwater compliance request/response.
Tucson Stormwater Management Study	Purpose	Tucson Stormwater Management Study (TSMS) is the adopted original highly comprehensive floodplain management plan for the City of Tucson. Tucson reports annually and every five years to FEMA and ADWR on flood and erosion hazard mitigation and regulatory compliance to the City's adopted flood and erosion hazard management regulations. In 2016, TSMS Phase V was adopted after public input in 5 stakeholder meetings as the updated Tucson Floodplain Management Plan. The latest Tucson FMP was adopted in 2020, as TSMS Phase Va. Annual public meetings occur for annual updates.
	Responsible Agency	Tucson DTM Floodplain Administration oversees floodplain and erosion hazard management code compliance for all departments. Planning and Development Services Department (PDSD) applies TSMS regulations for private development review. DTM applies TSMS regulations for public stormdrain system, public properties and right-of-way.
	Hazards	Flood and Erosion
	Effect on Mitigation Efforts	Reduce flood and erosion hazard risk and reduction of flood insurance costs to the City of Tucson property owners that have a flood insurance policy. Also, this plan provides oversight to NFIP activities by annual and 5-year certification processes.
	Opportunities for Enhancement	The flood warning & response activity is identified for additional work for flood warning systems as it pertains to: upgrading/maintaining automated wash crossing systems; dam and levee breach hazards as well as obtaining additional rain gauges and stream sensors for flood stage data that can assist with warning systems. There is an opportunity for increased funding for flood and erosion hazard projects throughout the City. Floodplain management planning activities have additional effort opportunities that include: when reviewing annual FMP action items – with more staff and funding, more action items can be addressed

Table 5-22: City of Tucson Codes & Regulations		
Tucson Unified Development Code – Environmental Resource Zone (ERZ Overlay)	Purpose	ERZ Overlay code restricts disturbance within the 100-year flood limits to only necessary access, necessary utilities (that cross perpendicular to flow and are set below scour depth, protected against scour), bike paths and trails. The remaining 100-year floodplain is to be kept undisturbed (other than under modification request for up to 5% additional disturbance).
	Responsible Agency	Tucson Floodplain Administration, PDSD, Tucson DTM (for project review, inspections)
	Hazards	Flood

Table 5-22: City of Tucson Codes & Regulations		
	Effect on Mitigation Efforts	Natural function floodplain lowers flood and erosion hazard risks.
	Opportunities for Enhancement	City staff may benefit from periodic refresher training assuring all reviewers are familiar with existing code and understand how to apply codes.
Tucson Watercourse Amenities, Safety Habitat (W.A.S.H. Ordinance: Tucson Code Chapter 29 Article VIII)	Purpose	W.A.S.H. Ordinance protects the riparian floodplain within the area fifty feet from top of back on designated watercourses. Purpose per code: (a) Maximize opportunities for groundwater recharge through the preservation of specific washes with earthen channels and banks; (b) Protect existing vegetation found within and near specific washes; (c) Provide for the restoration of vegetation disturbed as a result of development in and adjacent to specific washes. (d) Assist in the reduction of the urban heat island effect by retaining existing vegetation and minimizing structural improvement of urban washes.
	Responsible Agency	Tucson Floodplain Administration, PDSD.
	Hazards	Extreme Heat and flood
	Effect on Mitigation Efforts	By protecting the riparian floodplain, flood risks are reduced and all or portion of required erosion hazard setbacks are provided using natural floodplain function of the riparian area. Increased natural vegetation helps reduce heat island effect.
	Opportunities for Enhancement	Currently, development projects are asked to have the riparian floodplain within the W.A.S.H. Study Area to remain as is, even when there is opportunity to add additional trees / vegetation. Since one of the intents of the W.A.S.H. Ordinance is to provide for the restoration of vegetation disturbed as a result of development in and adjacent to specific washes, additional guidelines or technical standards could be provided to clarify specifically how enhancement of 50-foot study area can be augmented with additional trees and vegetation to increase erosion protection potential as well as increase potential to lessen heat island effect.
Tucson Technical Standards Section 4-01	Purpose	Technical Standards 4-01: Commercial Rainwater Harvesting standards reduce dependency on potable and reclaimed water sources by providing regulations for development water harvesting requirements.
	Responsible Agency	Tucson PDSD, Tucson Water, Tucson Floodplain Administration
	Hazards	Extreme Heat
	Effect on Mitigation Efforts	Water harvesting provides efficient opportunities to capture storm runoff to irrigate onsite vegetation; and with more trees, less heat island effect.
	Opportunities for Enhancement	Periodic training for staff reviewers and providing training to development consultants could improve the ease of use of these standards. Water harvesting requirements for site plans can be more comprehensive than standard retention/detention basin volume requirements; an easier procedure for preparing water harvesting plans would benefit the development community.
Tucson Technical Standards Section 4-02	Purpose	Technical Standards 4-02 provides development review procedures for projects that have requirements under Tucson Code Article 1, Division 1, Floodplain and Hazard Area Regulations, Chapter 26, Tucson Code; Article VIII, Watercourse Amenities, Safety and Habitat (WASH), Chapter 29, Tucson Code; and Section 5.7, Environmental Resource Zone (ERZ), Unified Development Code (UDC), Chapter 23, all of the Tucson Code.
	Responsible Agency	Tucson PDSD, Tucson Floodplain Administration

Table 5-22: City of Tucson Codes & Regulations		
	Hazards	Flood
	Effect on Mitigation Efforts	Helps reviewers and development community apply the ERZ code and W.A.S.H Ordinance so that all designated W.A.S.H. and ERZ watercourses (Proposed, TSMS and Regulated designations) meet mitigation efforts by protecting riparian floodplain to lessen flood and erosion hazard risks and heat island effect.
	Opportunities for Enhancement	Refresher training for review staff to become more familiar with existing regulations and better understand how to apply codes.
Tucson Technical Standards Section 4-03	Purpose	Technical Standards 4-03: Detention and retention standards
	Responsible Agency	Tucson PDSD, Tucson Floodplain Administration
	Hazards	Flood
	Effect on Mitigation Efforts	Within the critical watershed management areas, a minimum 15% reduction in runoff flowrates from pre-developed conditions for 2-year, 10-year and 100-year storm events shall be achieved for development projects. In balanced watershed management areas, pre-developed conditions shall be achieved. In no case shall adverse impacts occur and post-developed flowrates shall be at or less than pre-developed conditions. These requirements which have been in place for several decades lessen the impact of flooding from new development.
	Opportunities for Enhancement	Considerations need to be identified for pumps and dry wells as these features have not been effective forms for infiltration in the City due to the unique soils in the City limits. Further education of staff and the public about the sustainable approach of detention is needed.
Tucson Technical Standards Section 4-04	Purpose	Technical Standards 4-04: City of Tucson Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona is a comprehensive drainage manual used by other jurisdictions. The manual covers flood peak calculations, drainage maintenance, erosion hazard setbacks, conduit and open channel design, bridge and scour depth requirements, and other drainage standards for preparing drainage reporting documents for public and private development.
	Responsible Agency	Tucson PDSD, Tucson Floodplain Administration
	Hazards	Flood
	Effect on Mitigation Efforts	High. Due to the comprehensive coverage of regulations, the manual is effective at covering all types of development requirements.
	Opportunities for Enhancement	Refresher training for review staff is needed.
Tucson Code Chapter 11 (Sections 58-63)	Purpose	Like Tucson's flood and erosion hazard management code (Chapter 26, Article I), this section of the Tucson Code (Section 11-58) provides restriction for storm drain systems making it illegal to deposit offensive matter, soapy water, sewerage, clothing washing wastewater, etc., or cause diversions or obstructions to rainwater runoff. Tucson Code Section 11-59 through 63 augments section 58 by explaining the duty to clean watercourses by property owner, issuing notices of violations and defines penalties.
	Responsible Agency	Tucson departments: Code Enforcement, DTM, PDSD, Tucson Floodplain Administration
	Hazards	Flood
	Effect on Mitigation Efforts	Provide legal reference for enforcing regulations that protect watercourses from illegal dumping, obstructions, diversions, and other adverse impacts. Enforcement of this code helps to improve surface and groundwater quality thereby improving water quality of public and private potable water wells.

Table 5-22: City of Tucson Codes & Regulations		
	Opportunities for Enhancement	Opportunities include: more staff and refresher training for Code Enforcement, Stormwater Management (Illicit Discharge and Elimination subprogram) by Floodplain Administration
Tucson Code Chapter 26 Article II	Purpose	City if Tucson has its own Stormwater Ordinance that provides regulations pertaining to surface water quality and complies with ADEQ, EPA Clean Water Act regulations.
	Responsible Agency	Tucson DTM, Engineering Division, Stormwater Management
	Hazards	Flood
	Effect on Mitigation Efforts	With the high density of potable wells (both private and public) within the City of Tucson area, the Tucson Stormwater Ordinance helps to protect the surface water quality, thereby also protecting Tucson's groundwater quality.
	Opportunities for Enhancement	Standardized stormwater pollution prevention plan boiler plate for the City of Tucson could be created to help facilitate private and public development project grading plan submittals. The ordinance readability could be improved; ordinance enforcement could be clarified/enhanced and written to correlate with associated ADEQ issued MS4 permit. The use of Corrective Action Plans for addressing stormwater issues could be written under technical standards for better implementation of stormwater compliance request/response.
Tucson Flood and Erosion Hazard Management Ordinance (Tucson Code Chapter 26 Article I)	Purpose	City of Tucson's floodplain ordinance provides regulations for the safe conveyance of floodwaters, to promote and protect the health, peace, safety, comfort, convenience, and general welfare of the residents within the jurisdictional area of City of Tucson, Arizona; to minimize public and private losses due to flooding and erosion hazards; and to enable its residents to participate in the National Flood Insurance Program (NFIP), receive federal disaster assistance, obtain flood insurance, and reduce the cost of flood insurance.
	Responsible Agency	City of Tucson Floodplain Board (Mayor & Council), Tucson Floodplain Administrator
	Hazards	Flood
	Effect on Mitigation Efforts	High. This code was recently updated January 2021, to reflect the changes of development within the City that are increasingly using more erosion and flood prone properties for development; updated code lessens development risk in the erosion hazard setback at top of bank of regional watercourses in the City limits. This code also assists in regulating utility work, building construction, and grading within flood prone areas, as well as defines requirements for Critical Facilities.
	Opportunities for Enhancement	City of Tucson continues to review and update the ordinance, last time being ins 2020. The City of Tucson intends to continue to update the ordinance to provide a higher standards for flood and erosion hazard management to ensure the ordinances is within guidelines of the NFIP updates.
Community Water System Planning and Reporting Requirements: A.R.S. §45-342	Purpose	Community Water Systems are required to complete annual water-use reports and system water plans. These requirements are part of a larger set of recommendations made by the Governor's Drought Task Force in 2005. The reports and plans are intended to reduce Community Water Systems' vulnerability to drought and ensure that water providers are prepared to respond to drought or water shortage conditions.
	Responsible Agency	Arizona Department of Water Resources
	Hazards	Extreme Heat

Table 5-22: City of Tucson Codes & Regulations		
	Effect on Mitigation Efforts	High: Reduction of Community Water Systems' vulnerability to drought and ensures that water providers are prepared to respond to drought or water shortage conditions.
	Opportunities for Enhancement	Mayor and Council review and approve updates to the Drought Plan Preparedness and Response Plan annually. The reviews are utilized to further increase mitigation efforts by rolling the drought plan up into the One Water 2100 master plan. All of the response measure/mitigation actions listed in the drought plan will go through a public engagement process and M&C review as the One Water 2100 master plan is developed.
America's Water Infrastructure Act of 2018 (AWIA) Section 2013	Purpose	Section 2013 of America's Water Infrastructure Act of 2018 (AWIA) requires community water systems1 that serve more than 3,300 people to complete a risk and resilience assessment and develop an emergency response plan.
	Responsible Agency	Environmental Protection Agency (EPA)
	Hazards	All
	Effect on Mitigation Efforts	High: AWIA provides specific emergency response guidance for all hazards
	Opportunities for Enhancement	Incorporating updates from EPA to the Emergency Response Plan and the Risk and Resiliency Assessment tool.

Table 5-23: City of Tucson Financial Resources		
FEMA grants	Purpose	To support the flood & erosion hazard mitigation projects.
	Responsible Agency	Tucson's Department of Transportation & Mobility (DTM) Floodplain Administration working with City Emergency Management staff in Tucson Fire Department (TFD), Business Services, and other City staff.
	Hazards	Flood, Drought, Extreme Heat, Severe Wind, and Wildfire
	Effect on Mitigation Efforts	Grants are the only resource at this time for funding the construction of flood / erosion hazard mitigation projects, aside from using limited other resources such as City's general fund, Army Corps of Engineer projects, and county flood control district projects. If DEMA/ FEMA awards the grant, then projects can improve safety and lower risks and costs associated with flood and erosion hazards.
Water Conservation Fund	Purpose	To offer Tucson Water customers high-quality conservation and education programs and robust efficiency incentives.
	Responsible Agency	City of Tucson Water Department – Tucson Water
	Hazards	Drought
	Effect on Mitigation Efforts	Medium: Conservation of potable water through multiple incentive and educational program.
Impact fees for homebuyers or new development/homes	Purpose	For new developments inside impact fee area-zones only. The impact fees are charged to new developments.
	Responsible Agency	Planning and Development
	Hazards	Flood and Erosion
	Effect on Mitigation Efforts	To support the flood & erosion hazard mitigation projects.
Capital Improvement Project Funding	Purpose	A Capital Improvement Plan (CIP) is a community planning and fiscal management tool used to coordinate the location, timing, and financing of capital improvements over a five-year period. Capital improvements refer to major, non-recurring physical expenditures such as land, buildings, public infrastructure, and equipment, all with a cost of $100,000 or more. The CIP is necessary to improve public facilities

Table 5-23: City of Tucson Financial Resources		
		and infrastructure assets for the economic, aesthetic, and functional viability to our City. The plan identifies our City's specific capital needs based on various long-range plans, goals, and policies and also provides analysis for decision making for City officials and strategic capital planning efforts with City departments.
	Responsible Agency	City of Tucson, Office of Budget
	Hazards	Flood
	Effect on Mitigation Efforts	To support the flood & erosion hazard mitigation projects.

Table 5-24: City of Tucson Staff/Personnel Resources	
Department/Agency	**Involvement**
City of Tucson Engineering Division staff (PDSD & DTM)	City of Tucson Floodplain Administration is responsible for: FEMA map revision review/approval; Flood/Erosion data management and map updates; Customer service/floodplain information; Drainage complaints and enforcement; Notices of Violations and variances; Public drainage infrastructure inspection; Public drainage infrastructure maintenance; Public outreach (on floodplain issues); CRS Coordinator activities; Grant writing and management. PDSD staff is responsible for the following floodplain management tasks: Development Review in flood and erosion hazard areas (subdivisions, commercial development, etc.); Managing and processing single-lot floodplain permits; FEMA map review for private development; Customer service/floodplain information; Drainage complaints and enforcement for private property; and Private drainage infrastructure inspections. City of Tucson Floodplain Administrator (also performing responsibilities of City Engineer and Engineering Administrator) and Community Rating System (CRS) Coordinator (Civil Engineer for floodplain and stormwater management) are positions located in DTM. Currently, two Planning and Development Services Department (PDSD) engineering division reviewers (used to be 8 reviewers about 15 years ago), and three DTM engineering division reviewers (with one of those as the primary reviewer, there used to be over 4 civil engineers in transportation department providing floodplain management about 15 years ago as well as several stormwater management engineers. Of those 3 engineers, there are two Certified Floodplain Managers in the City of Tucson (in DTM). The city floodplain management is understaffed; more certified floodplain managers would increase effectiveness of floodplain management plan action items and CRS tasks at the City of Tucson and increase effectiveness for applying for and managing grant projects.
Project Manager	Update the Hazard Mitigation Plan, Capability Assessment and Mitigation Strategies forms.
Lead Planner	Complete the One Water 2100 Master Plan
Water Conservation Staff	Fund, manage, and promote the water efficiency rebate programs, and the Zanjero residential water audit program; Participate, promote, and sponsor the SmartScape program in partnership with the University of Arizona Cooperative Extension; Review and update the City of Tucson Department Drought Preparedness and Response Plan.
Incident Management Team	Emergency response management to all hazardous incidents following the Emergency Response Plan's Emergency Action Plans/Checklists
Water Maintenance and Water Quality & Operations Staff	Emergency response in the field to all hazardous incidents following the Emergency Response Plan's Emergency Action Plans.
City of Tucson Park and Recreation Staff	Positions most likely impacted by hazard mitigation are: • Project managers while designing parks • Park supervisors during events • Recreation center supervisors during events • All management/leadership staff while drafting new policies and procedures

Table 5-24: City of Tucson Staff/Personnel Resources	
Department/Agency	**Involvement**
City of Tucson, City Council	City of Tucson in effort to address climate change has declared a climate action plan in efforts to be carbon neutral by 2030. The climate emergency actions plan will work with other departments in efforts to address different natural hazards, which are result of carbon emission to include extreme heat, which is reflected in Tucson City Policy and Codes.

5.4 Mitigation Measures

The process for defining the list of mitigation measures for the Plan was accomplished in three steps. First, an assessment of the actions and projects specified in the 2017 plan was performed. Second, a new list of measures for was developed by combining the carry forward results from the assessment with new measures. Third, an implementation strategy for the combined list of measures was formulated.

Previous Mitigation Measures/Projects Assessment

The Planning Team and Local Planning Team for each jurisdiction reviewed and assessed the actions and projects listed in the Mitigation Strategy section of the 2017 Plan. Any measure with a disposition classification of "Keep" or "Revise" was carried forward to become part of the measure list for the 2022 Plan. All measures identified as "Delete" were removed and are not carried forward in this Plan. The results of the assessment for each of the 2017 Plan measures is summarized by jurisdiction in Appendix A.

New Mitigation Measures

Upon completion of the assessment, each jurisdiction's LPT developed new measures using the 2022 goals and objectives, results of the vulnerability analysis and capability assessment, and the planning team's institutional knowledge of hazard mitigation needs in the community.

For each measure, the following elements were identified:

- **Description**
- **Hazard(s) Mitigated**
- **Estimated Cost**
- **Anticipated Completion Date**
- **Lead Agency**
- **Potential Funding Source**
- **Priority Ranking** – each measures was assigned a priority ranking of either "High", "Medium", or "Low". The assignments were subjectively made using a simple process that assessed how well the measure satisfied the following considerations:
    - A favorable benefit versus cost evaluation, wherein the perceived direct and indirect benefits outweighed the project cost.
    - A direct beneficial impact on the ability to protect life and property from natural hazards.
    - A mitigation solution with long-term effectiveness

  Tables 5-20 through 5-25 summarize the current mitigation activities and implementation strategy for each participating Plan jurisdiction

Table 5-25: Mitigation Measures for Unincorporated Pima County						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Continue to identify vulnerable populations for heat related illness, provide education targeted toward recreational activities, visitors/travelers, hospitality industry, homeless populations, and build cooling center capacity.	Extreme Heat	$100,000	Ongoing	PCHD, PCOEM, PCOSC	Mitigation Grants, Public Health Emergency Preparedness, BRACE	High
Building Resilience Against Climate Effects (BRACE) with support from the Arizona Department of Health Services ADHS to help prevent HRI	Extreme Heat	$10,000	Ongoing	PCHD	PCHD, Parks and Rec, University of Arizona, ADHS	High
Enforce Flood & Erosion Hazard Ordinance in accordance with the NFIP.	Flood	$1.2M	Ongoing	PCRFCD	Flood Control Tax Levy	High
Implement NFIP tasks such as LOMR submittals, maintaining a countywide map repository, performing master drainage studies, and coordinating to ensure the digital map is correct. Also included is post fire inundation area mapping studies including land and vegetation cover change and hydrology studies.	Flood	$600,000	Ongoing	PCRFCD	Flood Control Tax Levy	High
Provide flood risk mitigation through Capital Improvement Projects (CIP). Also included is maintenance and structural improvements to address post fire flood future conditions.	Flood	$8.0M	Ongoing	PCRDFD	Flood Control Tax Levy, USACOE, & FEMA PF-HGMP	High
Participate in Community Rating System to reduce insurance premiums.	Flood	$50,000	Ongoing	PCRFCD	Flood Control Tax Levy	
Cañada del Oro Levee Augmentation	Flood Wildfire	$2,308,604	2023	PCRFCD	PF-HGMP and Levy	High
Finger Rock Wash Critical Infrastructure Protection	Flood Wildfire	$2,630,000	2023	PCRFCD/PCDOT	PF-HGMP and Levy	High
Post Fire Flood Studies	Flood Wildfire	$350,000	2022	PCRFCD/NFS	PF-HGMP and Levy	High
Participate in coordination of water resiliency efforts through regional coordination of retention, recharge and beneficial use of stormwater.	Flood Drought	$4B	2025	PCRFCD	Water Recharge District	High
Implement the Drought Management Plan. If drought conditions worsen, the Board of Supervisors may consider increasing the drought stage that will trigger drought conservation measures.	Drought	Staff Time	Ongoing	OSC-Water Resources Unit	General Fund and RWRD Enterprise Fund	Medium

Table 5-25: Mitigation Measures for Unincorporated Pima County						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Identify and mitigate the risk of loss of treatment functionality due to All-hazards loss of power from the main utility grid at Tres Rios WRF through the creation of an internal, non-exporting facility microgrid utilizing existing solar resources and implementation of a back-up generator system.	All	$3M	Ongoing	RWRD	DOD-USACE	High
Mitigate effects of local area flooding due to monsoonal rain at the Avra Valley WRF facility, which prevents entry/exit to the facility.	Flooding	$3M	Ongoing	DOT, RFCD, RWRD	DOD-USACE	Medium
Mitigate bank protection breach resulting from local flash erosion event at the Schulte Pit Bank.	Flash Erosion	$750,000	Ongoing	RWRD	TBD	High
Treat soil surfaces with appropriate stabilization materials and vegetation control to reduce blowing dust.	Severe Wind	$2,000,000	Ongoing	PCDOT	Highway User Revenue Funds, Local Regional Transportation Authority Funds	Medium
Provide links on the Pima County Office of Emergency Management Website to sources of hazard mitigation educational materials encouraging private citizens to be prepared for hazard emergencies.	All	Staff Time	Ongoing	PCOEM	General Fund	Low
Promote wildfire awareness and education in the community through the use of website, social media, and printed materials. Awareness combined with education helps to reduce the risk of accidental human ignitions.	Wildfire	Staff Time	Ongoing	PCOEM	General Fund Grants	Low
Educate public officials on the need of the mitigation plan.	All	Staff Time	Ongoing	PCOEM	General Fund Grants	Medium
Work with jurisdictions, fire department/districts to update the Community Wildfire Protection Plan (CWPP). The CWPP identifies actions that will reduce the risk of wildfires tocommunities within wildland-urban interface zones.	Wildfire	60K Staff Time	2023-2024	PCOEM	General Fund Grants	Medium
South Houghton Road Widening Project - Widen from 2 lanes to 4 lanes with drainage improvements.	Flood	$30M	2022	PCDOT	Impact Fees	High
Kolb Road, Sabino Canyon to Sunrise Drive - Widen from 2 lanes to 3 lanes with drainage improvements.	Flood	$19.5M	2022	PCDOT	1997 HURF Bonds	High

Table 5-25: Mitigation Measures for Unincorporated Pima County						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Sahuarita Road and Wilmot Road Intersection - Traffic signal, turn lanes and drainage improvements.	Flood	$3M	2022	PCDOT	Pima County	High
Sunset Road, I-10 to River Road - New road and bridge over the Rillito River connecting Sunset Road west of I-10 to River Road.	Flood	$34.9M	2024	PCDOT	RTA	High
Buffelgrass and other Fire-Prone Invasive Species Mitigation – identify public outreach opportunities including pamphlets, community event participation, media outreach.	Wildfire	$5,000 Staff Time	Ongoing	PCOEM, PCNRPR	General Fund Grants	High
Buffelgrass and other Fire-Prone Invasive Species Mitigation – locate county areas for mitigation of fire-prone invasive species and administer grant funding for ongoing activities related to wildfire reduction through removal and reduction.	Wildfire, Flood	3M	Ongoing	PCNRPR, PCRFCD, PCDOT	Grants including BRIC, PF-HMGP and AZ-DFFM	High
Post-Fire Mitigation on Pima County Parks, Ranches, and Open Space - allows for livestock management ensuring rest/recovery for burned areas; replacing important watershed vegetation cover, mitigating floods, and dust impacts from high winds	Wildfire, Flood	$1M	Ongoing	PCNRPR	Grants including AZ-DFFM and FEMA Grants	High

Table 5-26: Mitigation Measures for Marana

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
LPR – update to Town floodplain code, implementing higher standards than FEMA requirements	Flood	No cost	4/2022	Keith Brann/ Town Engineering	Not required	High
SIP-reconstruction of phase 1 of Tangerine Road	Flood	$60.6M	Completed in 2019	Tom Houle/ Town Engineering	Town construction sales tax, impact fees, RTA, HURF, partner jurisdictions	Low
SIP-reconstruction of phase 2A of Tangerine Road	Flood	$25M	Winter 2024	Tom Houle/ Town Engineering	Town construction sales tax, impact fees, RTA, State AZ general funding	High
SIP-reconstruction of Twin Peaks Road over Rattlesnake Pass	Flood	$20M	Summer 2023	Tom Houle/ Town Engineering	Town construction sales tax, impact fees, developer funding	High
SIP-Adonis Road extension	Flood	$5M	Completed in 2020	Tom Houle/ Town Engineering	Town construction sales tax, developer funding	Low
SIP – De Anza subdivision interception channel improvements/LOMR	Flood	$304,298	Completed in 2021	Developer	Developer funded	Low
EAP-floodplain outreach information pamphlets to citizens living in the FEMA floodplain	Flood	$500	Completed fall 2021	Gus Myers/ Town Engineering	Town General funding	Low
NSP-Invasive Vegetation Pulls in the Tortolita Mountain Range	Wildfire	Employee time	Ongoing & Seasonal	Mary Grodman/ Parks and Recreation	Town General Funding	Low
NSP-Invasive vegetation removal along I-10	Wildfire	Employee time	Ongoing and Seasonal	Parks and Recreation	Town General Funding	Low

Table 5-26: Mitigation Measures for Marana

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
LPR) The Town of Marana Public Works Department has prepared a Storm Preparedness Plan and designated staff to certain areas throughout the Town for response and recovery following extreme flood events. The plan contains many elements and functions that are designated to work cohesively and seamlessly during flood events. Crews patrol the major streets and drainage channels to identify possible trouble conditions and make the necessary corrections in the shortest time possible. The Public Works Director is contacted directly for the inspection and possible closure of Town bridge structures during storm events.	Flood	Employee and equipment time	Ongoing and Seasonal	Public Works Team	Town General and HURF Funds	High
(SIP) Orange Grove Underpass Sump Pump Station Alert System. The sump pump is inspected periodically to ensure effective operations during storm events. The sump pump contains an alert system where malfunctions are reported to Streets and Traffic staff for quick response and barricading.	Flood	$10,000 Annual Contractor Services	Ongoing Annual	Public Works Supervisors	Town HURF Funds	Medium
(SIP) Annual Culvert Maintenance Program. Streets staff and contractor forces remove silt and debris from culverts and washes to improve storm water carrying capacity.	Flood	$50,000 Annual Contractor Services	Ongoing Annual	Public Works Team	Town HURF Funds	Medium
SIP) National Bridge Inspection Program. Every Town bridge is inspected by ADOT once every two years to ensure the bridges are structurally sound and to identify any flaws, defects, or potential problem areas that may require maintenance. The overall goal is to identify issues early, before they develop into problems. Streets staff follow up and schedule the required maintenance.	Flood	$10,000 Annual In-house / Contractor Services	Ongoing Annual	Public Works	Town HURF Funds	Low

Table 5-27: Mitigation Measures for Town of Oro Valley

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
Install generator auto transfer switch to provide backup power to countryside service area in the event of power outage caused by any hazard.	All	$50,000	June 30, 2022	Oro Valley Water Utility	Oro Valley Water Utility Enterprise Fund	Medium
Develop and implement stormwater harvesting criteria design standards.	All	Staff Time	June 30, 2025	Stormwater Utility	Stormwater Utility	Medium
Incorporate hazard mitigation strategies into the General Plan and prioritized in the Strategic Leadership Plan.	All	$150,000	November 2026	Community and Economic Development	Community and Economic Development Department Budget	Low
Continue to update zoning codes as needed to provide the town with modern and needed regulatory tools to mitigate exposure to the impacts of future hazards.	All	Staff Time	December 2027	Community and Economic Development	Community and Economic Development Department Budget	Low
Identify and implement mitigation projects to reduce, minimize, and manage invasive vegetation found in parks, trails, and golf courses.	Wildfire	Staff and Volunteer Time	June 30, 2027	Parks and Recreation	Parks and Recreation Department Budget	Low
Mitigate and stabilize areas damaged by storm related activity in the Gravel Pit Wash Channel downstream of Lambert Lane by reconstructing 500 linear feet of channel bottom, and mitigate side slope to protect public and private property, public infrastructure and utilities from additional damage. Outlet improvements to the wash will be put in place to mitigate long term channel scour.	Flood	$800,000	July 30, 2023	Stormwater Utility	Pima County Regional Flood Control District and Town CIP	High
Identifying regulatory floodplain boundaries to help mitigate potential impacts from flooding.	Flood	Staff Time	June 30, 2027	Stormwater Utility	Stormwater Utility	Medium
Analyze NFIP CRS program for potential adoption and develop plan for future implementation.	Flood	Staff Time	June 30, 2024	Stormwater Utility	Stormwater Utility	Low
Partner with Pima County Regional Flood Control District and US Forest Service to identify, design, and construct any post-Bighorn fire flood mitigation projects	Flood	Staff Time	June 2026	Stormwater Utility	Stormwater Utility, Pima County Regional Flood Control District, US Forest Service	High

Table 5-27: Mitigation Measures for Town of Oro Valley

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
identified in post-fire analysis and/or high precipitation incidents.						
Implement updated water wasting code articles to support water conservation amid ongoing drought conditions fueled by more extreme heat days.	Extreme Heat, Drought	$20,000 (Staff Time and Printing)	June 30, 2027	Oro Valley Water Utility	Oro Valley Water Utility Enterprise Fund	Medium
Annual purchase of full Town CAP allocation and store unused CAP water in underground storage facilities for future use.	Drought	$11 M	June 30, 2027	Oro Valley Water Utility	Oro Valley Water Utility Enterprise Fund (Annual approved budget)	Medium
Identified in the General Plan and prioritized within the Strategic Leadership Plan, develop new design standards, technical bulletins, and educational programs to support best practices in plant transplant and replanting, vegetation and erosion management, energy conservation, and drought tolerant landscapes.	All	Staff time	December 2027	Community and Economic Development	Community and Economic Development Department (Annual approved budget)	Medium
Addition of fire breaks in critical locations identified in the wildland urban interface and locations identified for post-Bighorn Fire mitigation efforts within a constantly changing wildland fire risk and threat environment.	Wildfire	GRFD (Wildland division staff hours)	December 2023	Golder Ranch Fire District and US Forest Service	Golder Ranch Fire District, US Forest Service, Grants	High
Provide annual, public awareness and public outreach on local hazards, mitigation, prevention, plans, and other activities through presentations to homeowners and HOAs, newsletters, and website.	All	Staff Time	June 30, 2027	Emergency Management	Innovation and Technology Department, Stormwater Utility, Water Utility, Community Economic Development, Golder Ranch Fire District (Annual approved budgets)	Low

Table 5-27: Mitigation Measures for Town of Oro Valley

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
Mitigate and stabilize areas damaged by storm related activity in the Catalina Ridge Drainage Channel by reconstructing 3,400 linear feet of channel bottom, improve wash degradation, and mitigate side slope to protect public and private property, public infrastructure and utilities from additional damage.	Flood	$1.9 M	June 30, 2025	Stormwater Utility	Stormwater Utility, Pima County Regional Flood Control District, FEMA Mitigation Grant Program	Low
Mitigate and stabilize areas damaged by storm related activity by: Designing and constructing of wash stabilization components to protect damaged areas from scour and deposition of sediment that is causing damage to existing properties. This includes three projects: 3 known projects: Sierra Wash/Naranja Ranch at Glover Road, Sierra Wash/Naranja Ranch at Via Mandarina, Highlands Wash/Highlands subdivision.	Flood	$4 M	July 30, 2025	Stormwater Utility	Pima County Regional Flood Control District and Town CIP	High

Table 5-28: Mitigation Measures for Pascua Yaqui Tribe

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
Tetakusim Drainage Improvement Project at Calle Tetakusim	Flood	$14,000,000	Tentative completion of Dec. 2024	Land Department Facilities Department Tribal Council	BIA appropriated funds	High
Drainage Improvement Project - East of the Education Building. Continued Implementation of Pascua Yaqui Reservation Flood Control Project	Flood	$130,000	Tentative completion of Sep. 2022	Land Department Facilities Department Tribal Council	EPA appropriated funds	High

Table 5-28: Mitigation Measures for Pascua Yaqui Tribe

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
Cemetery Bridge Project - Continued Implementation of Pascua Yaqui Reservation Flood Control Project. Project requires minor design for CMP's.	Flood	$350,000	February 2023	Land Department, Facilities Department, Tribal Council	FMD Capital Funds	High
Ignacio Baumea Improvement Project – Continued Implementation of Pascua Yaqui Reservation Road Improvement Project. Design has been completed. Sent to BIA for reviews but schedule impacted by COVID pandemic.	Flood	$5,000,000	Tentative completion date of Dec. 2023	Land Department, Facilities Department, Tribal Council	BIA appropriated funds	High
Black Mountain Hydrology study with Pima County, San Xavier District - Tohono O'odham Nation: Divert water from Black Mountain water shed to west San Xavier District initiated planning discussions and invited PYT departments. Next planned meeting will include Pima County Flood Control District	Flood	$800,000	Tentative completion date of Dec. 2027	Land Department, Facilities Department, Tribal Council, Fire Department	Based on eligibility of federal grant programs and or appropriated federal funds.	High
The Pascua Yaqui Tribes Master Drainage Report will be implemented within phases and serves as a guide for decision makers to minimize incompatible land use. It provides a balance of land uses that preserves and enhances the neighborhood, support in-fill strategies, promote economic development, and protect environmentally and culturally significant resources. - Oversee floodplain modeling - Review floodplain map revision - Assessments of flooding runoff in public gathering areas	Flood	Facilities Department Staff time	On-Going and Continuous	Facilities Management	General Fund	Medium
IGA between PYT and State Forestry Department - update and resume. Conduct Annual maintenance on established and identified critical fire break locations in the	Wildfire	Staff-time	Continuous	Fire Department.	General Fund	High

Table 5-28: Mitigation Measures for Pascua Yaqui Tribe

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
urban/wildland interface around all housing, neighborhoods projects and commercial buildings on the Pascua Yaqui Reservation. IGA is still intact. Current fire break locations are intact and identified for new housing projects. 2. Radio communication upgrades for improved regional interoperability and response. -Creating buffers around residential and non-residential structures through the removal or reduction of flammable vegetation, including vertical clearance of tree branches. -Creating defensible zones around power lines, oil and gas lines, and other infrastructure systems. -Performing arson prevention cleanup activities in areas of abandoned or collapsed structures, and accumulated trash or debris -Developing partnerships with neighborhood community groups, and others to conduct outreach activities.				Office of Emergency Management. Attorney General Office. Tribal Council		
Modify and continue to evaluate existing building codes to help mitigate hazards. Fire Code Enforcement Program passed through Tribal Council Resolution. PYT Attorney General Office is working on a Fire Code Enforcement Ordinance that enforces IFC and IBC Codes for any new and existing residential and commercial buildings and projects. Educate community on hazard via website, department brochures Evaluate material and installation of equipment to buildings and residence.	Extreme Heat	Staff-time	Continuous	Tribal Council. Fire Department. Land Department. Housing Department. Facilities Department. Office of Emergency Management	General Fund	High

Table 5-29: Mitigation Measures for Town of Sahuarita

Description	Hazard(s) Mitigated	Estimated Cost	Anticipated Completion Date	Project Lead	Potential Funding Source(s)	Priority Ranking
Review, update and modify NFIP requirements and make appropriate modifications to Floodplain Ordinance.	Flood	Staff Time	Ongoing	Public Works	None	Low
Review, update and modify NFIP requirements and make appropriate modifications to Floodplain Ordinance.	Flood	Staff Time	Ongoing	Public Works	None	Low
Educate the public to increase awareness of hazards, and potential opportunities for mitigation actions. Make Pima County's public information material sheets, websites, mitigation brochures, and media outlets available.	Extreme Heat; Flood	Staff Time	Ongoing	Public Works	Grant Funding	Low
Conduct pre-storm season inspections and debris removal for Town-owned roads and drainage crossings.	Flood	Staff Time	Ongoing	Public Works	HURF	High
Complete construction of the Quail Crossing Boulevard Extension Phase 2 Bridge at the Santa Cruz River.	Flood	$6M	December 31, 2022	Public Works	HURF	High
Partner with the Upper Santa Cruz Provider User Group (USCPUG) to educate the public to increase awareness of drought, and potential opportunities for mitigation actions. Provide outreach communications to increase community awareness of drought by providing updates on local water resources and new regulations.	Drought	Staff Time	Ongoing	Public Works	Grant Funding	Low
Complete Multi-Sector General Permit (Sahuarita Water Reclamation Facility) inspections and perform maintenance and repairs of control measures as identified during inspections.	Flood	Staff Time	Ongoing	Public Works	Enterprise	High

Table 5-30: Mitigation Measures for City of Tucson						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Christmas Watershed Flood Mitigation (NSP & SIP) - feasibility study and subsequent potential construction project for storm drain system and GI to reduce SFHA, and regional basins to help mitigate flood.	Flood / Erosion	FEMA funded 100% for feasibility study and $3,737,059 for construction costs	2024	Department of Transportation & Mobility / Director	DEMA grant, PCRFCD, plus potential partnership with gas company	High
Cushing Street Bridge Levee Extension – Feasibility study and subsequent potential construction project (SIP) for floodwall levee extension along Santa Cruz River, to include protection to hotel and electric substation (Critical Facility) servicing downtown area.	Flood / Erosion	$650,000 total ($162,500 – partners and City share)	Grant awarded for feasibility study May 2020, Project to be completed in 2025 if grant obtained	Department of Transportation & Mobility / Director	FEMA Region IX Reallocated Budget, Partnerships with hotel and utility	High
LOMR for removing parcels out of incorrectly mapped floodplain (including 6020 E LEE ST)	Flood	$50,000	2022	Department of Transportation & Mobility / Director	City of Tucson DTM Stormwater Management	High
Dip Crossing SIP Flood Mitigation Projects – including Neosha Project - safety improvements for residential access, including erosion, bank protection and guard rail, and dip crossing locations.	Erosion	$80,000 (Neosha)	2025	Department of Transportation & Mobility / Director	DEMA grant, plus $20,000 City	High
Downtown Links (SIP) - Roadway and drainage improvements for last phase of the Tucson Arroyo - Arroyo Chico master drainage project. (St Mary's Road storm drain phase completed already by City of Tucson, and Cherry Field & Park Avenue detention systems completed by PCRFCD in 2016.)	Flood	$53M	2023	Department of Transportation & Mobility / Director	RTA	Medium

Table 5-30: Mitigation Measures for City of Tucson						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Silvercroft Watershed SIP report – watershed study to determine base flood elevations and flowrates. Subsequent channel improvements to assure all weather access to vulnerable residential properties.	Flood / Erosion	$120,000	2027	Department of Transportation & Mobility / Director	DEMA grant, PCRFCD, plus potential partnership with gas company	High
Alamo Gabion NSP Project – design and construction of gabion infrastructure for erosion protection in W.A.S.H. Ordinance watercourse (riparian floodplain protected watercourse). Includes repetitive loss property protection.	Flood / Erosion / RLP Mitigation	$2M	2027	Department of Transportation & Mobility / Director	DEMA Grant (75% Federally funded, 25% City/PCRFCD funded)	High
Mojave - Aztec Flood mitigation project (NSP) along Silvercroft Wash downstream of new El Rio City Golf Course detention basin, lessening residential flood conditions downstream	Flood	$50,000	2025	Department of Transportation & Mobility / Director	PCRFCD / City of Tucson	Low
Gardner Lane Improvements Drainage infrastructure SIP improvements to provide relief for flood prone area east of UPRR railroad/I10.	Flood	$18,600	2022	Department of Transportation & Mobility Director	RTA / HURF	Medium
Grant Road Phased Road Project (SIP) - Road improvements with drainage features – box culvert/siphon structures, catch basins, and green infrastructure.	Flood	$1M	2023	Department of Transportation & Mobility / Director	PAG, HURF	High
Broadway Boulevard Corridor (Euclid to Country Club) SIP – Also known as SR3A / Broadway West, this phase includes six travel lanes and large diameter underground storm drain system will be installed throughout the project limits.	Flood	Cost just under $26.5M Drainage just over $8M	2022	Department of Transportation & Mobility / Director	RTA / HURF	Medium
Ponding Mitigation SIP Projects – including Euclid and 35th Street and other right-of-way projects to improve runoff.	Flood	$20,000	2022	Department of Transportation & Mobility / Director	City of Tucson DTM Stormwater Management	High

Table 5-30: Mitigation Measures for City of Tucson						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
Houghton Road, Valencia Road to Mary Ann Cleveland Way SIP - Roadway Widening - Drainage improvements with all-weather six lane divided roadway, multi-use lanes, median, multi-use paths, and drainage improvements improving cross town mobility, reducing congestion and improving safety.	Flood	Drainage Project Total Costs: $1,717,164	2022	Department of Transportation & Mobility / Director	PC Impact Fees, PC Bonds, PAG HURF, SE District Prior to 2012, & RTA	Medium
The Drought Preparedness and Response Plan recognizes that drought impacts do not occur suddenly or without warning and acknowledges that with proper planning and review it is unlikely the community will find itself in an emergency caused solely by drought. It also ensures that Tucson Water staff will implement drought response measures early enough to avoid crisis-mode decision making and to help the community anticipate what measures will come next if drought impacts become more severe.	Drought	$3,036,034	Annual/ On-going	Tucson Water Department	Water Conservation Fund	Medium
Develop water use reduction policy to implement during various levels of drought	Drought	Staff cost	Annual/ On-going	Parks and Recreation	Parks and Recreation Operating Budget	High
Develop park development standards for flood mitigation	Flood	Staff cost	Annual/On-going	Parks and Recreation	Parks and Recreation Operating Budget	Medium
Develop preventative tree maintenance program for implementation prior to monsoon season	Severe Wind	Staff cost	Annual/On-going	Parks and Recreation	Parks and Recreation Operating Budget	High
Develop park closing procedures for implementation during severe flooding incidents	Flood	Staff cost	Annual/On-going	Parks and Recreation	Parks and Recreation Operating Budget	Medium
Develop a wildland fire preparedness and response plan, which includes community educational component. The City of Tucson is an urban based community, and recognizes that wildland fires mainly impacts areas, which are outside the City limits. However, wildland fires outside the City limits has the potential to still influence the impacts on the residents of the City of Tucson. Tucson Fire is operating	Wildfire	$800,000	2024	Tucson Fire Department/ Wildland Fire Unit	Prop 101, COT Budget, State and Federal Deployment Reimbursement	High

Table 5-30: Mitigation Measures for City of Tucson						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
in an Auto-Aid response with Northwest Fire Department and Golder Ranch Fire Department. With the addition of the agreement, TFD could be called upon to assist in mitigation efforts within Pima County. In addition, the City of Tucson has wildland urban interface areas that would be considered high-risk within the City limits. These areas are densely populated and are surround by mature old growth vegetation and limited access, with traditional fire equipment. With proper wildland program implementation, proper equipment, crews, and planning response to wildland fires within the City limits will lessen the impact of such events. The City of Tucson is in the process of increasing the size of wildland fire response both by vehicles (Water Tender, Type 3 and Type 6) and manpower (doubling the response wildland crews)						
Identifying specific at-risk populations (homeless), which are vulnerable to periods of extreme heat and extreme cold to organize outreach efforts including establishing and promoting heating and cooling center in the community.	Extreme Heat, Extreme Cold	Staff Time	2024	Tucson Police Department/ Homeless Outreach Program	Community Partners, and COT Budget	High
Assess inventory, and map vulnerability within Tucson to seismic hazards. Conduct outreach efforts to property owners in high-seismic risk zones, or who own building at especially high ricks for seismic damage such as historic adobe homes, about retrofits that can be made to their structures to reduce seismic impact. Use vulnerability data gathered to perform analysis of current building codes and propose changes, as appropriate, to reduce seismic risk community wide.	Earthquakes	Staff Time	2024	Planning and Development Services	Department Budget	Medium
Assess the vulnerability of critical facilities to flooding from runoff and encourage reducing runoff and means for mitigating critical facilities when runoff cannot be reduced	Flood	Staff Time	Annual/On-going	Planning and Development Services	Department Budget	High
In compliance with the NFIP, the City will continue to require the preparation and submittal of a CLOMR or CLOMR-F for all proposed developments within FEMA delineated Special Flood Hazard Areas. The City will also	Flood	Staff Time	Annual/ On-going	Planning and Development Services	Department Budget and Fees for Developers	High

Table 5-30: Mitigation Measures for City of Tucson						
Description	**Hazard(s) Mitigated**	**Estimated Cost**	**Anticipated Completion Date**	**Project Lead**	**Potential Funding Source(s)**	**Priority Ranking**
continue to prepare record drawings and submit LOMR's per NFIP requirements						
Maintain compliance with NFIP regulations by enforcement of the current flood and erosion hazard management codes through review of new development located in the regulatory flood prone and erosion hazard setback areas and with the issuance of floodplain use permits	Flood/ Erosion	Staff Time	Annual/ On-going	Planning and Development Services	Department Budget	High
City of Tucson is in partnership with the University of Arizona in a pilot project to collect and review data on the application of PlusTi from Pavement Technology Inc. on a section of roadway in the City of Tucson. The pilot project area is located on South Country Club Rd from Broadway Blvd to Aviation Hwy. The data collected will determine the effectiveness of PlusTi application in reducing surface temperature, ambient air temperatures, wind speeds and weather conditions.	Extreme Heat	$190,000	February 2021	Department of Transportation/ Sustainability Coordinator	Prop 101	High
Green Storm water Infrastructure Program. The program is designed to build and maintain projects throughout the City that capture storm water runoff from public streets and parking lots, and divert it into vegetated water harvesting area.	Flood	$3,000,000	2023	Water Department-Green Storm water Infrastructure Program	Green Storm water Infrastructure fee	High
The planting of 1 million trees is an initiative within the City of Tucson to increase tree canopy, which will decrease and mitigate both day and night the heat island effect. This is a result of the Arizona summer temperatures. The tree canopy and root system will assist with the increase of water retention, and water conservation within the City. With the increase tree density in the City of Tucson there will be a greater ground structural foundation, resulting in a reduction in the top soil erosion due to flooding.	Extreme Heat/ Flood	$10M	2030	Urban Forest Program Manager for the City of Tucson	Private donors and grant foundations	High

SECTION 6: PLAN MAINTENANCE PROCEDURES

Elements of this plan maintenance section include:

Monitoring, Evaluating, and Updating

Monitoring of Mitigation Measures

Incorporation into Other Planning Mechanisms

The participating jurisdictions in this Plan that reviewed this section recognized that it is intended to be a "living" document with regularly scheduled monitoring, evaluation, and updating. The 2017 Plan outlined specific steps in the Plan Maintenance; however, the 2022 MJPT found that few, if any, formal reviews occurred over the past five years. Reasons for the lack of formal review were discussed by the MJPT, and included:

- Staff turnover;
- Lack of funding for consultant plan reviews annually;
- Misunderstanding of the relationship between mitigation plans to anything other than grants eligibility;
- Lack of promotion of the Plan to the county departments, jurisdictions and the general public; and
- Inability of first responder agencies to understand the significance of mitigation planning to response priorities.

In an effort to avoid these issues again, the MJPT discussed ways to make sure that the Plan is active and treated as a living document which are listed in Section 6.1.

6.1 Monitoring, Evaluating and Updating

The Planning Team has established the following monitoring and evaluation procedures revised for this Plan:

- **Schedule** – The Plan shall be reviewed on at least an annual basis or following a major disaster. PCOEM will take the lead to reconvene the Planning Team annually near the anniversary of the official FEMA approval date. Participating jurisdictions have committed to providing resources to this effort annually. The PCOEM Planner and Operations Manager will be responsible for reconvening annually and initiation the next review cycle.
- **Review Content** – One month prior to the MJPT review meeting, a reminder questionnaire will be distributed to each jurisdictions' point of contact by the PCOEM Planner and will be returned by each jurisdiction within a minimum of three weeks. The approximate date of this review will be calendar year 2nd quarter in 2023, 2024, 2025 and 2026. The questionnaire will be comprised of the following questions:
    - **Hazard Identification:** Have the risks and hazards changed? Is there new information to include regarding the risks/hazards?
    - **Goals and objectives:** Are the goals and objectives still able to address current and expected conditions?
    - **Mitigation Projects and Actions:** What is the status of the mitigation measures in the current Plan?
    - **Capability Assessment:** Have there been any changes in capabilities in the past review year?
    - **FEMA HMP Programmatic Updates**: Have there been any changes to the FEMA HMP program that have occurred in the past review year?
    - **Incidents:** Have any incidents occurred in the past review year?

The PYT-OEM will coordinate with PCOEM. Prior to the updating requirements, the PYT-OEM will coordinate and work with the Tribal Local Planning Team before annual update and will provide report on information developed by the Tribal Local Planning Team.

The PYT-OEM is the lead agency for the Pascua Yaqui Tribe to track progress and send out meeting requests. Representatives of the Tribal Local Planning Team will report on the progress made by their respective departments or entities. Other PYT departments, programs and entities will be invited, as necessary to report or present data relative to the Plan or mitigation measures implemented by their departments. The implementation of mitigation measures will be monitored by the PYT-OEM on an on-going basis until implementation is complete.

6.2 Monitoring of Mitigation Measures

During the annual meeting, each jurisdiction and tribe will have the opportunity to provide a report to the group summarizing its review of the Plan. The report will include their responses to the above questions and any other items specific to their community. Documentation of the annual meeting may include notes on the results of the meeting as well as specific information on the reasoning for proposed changes to the Plan for the next update. Copies of the annual review report will be kept with the Plan for review and consideration in future reviews and the five-year update.

The Plan requires updating and approval from FEMA every five years. The Plan updates will adhere to that set schedule using the following procedure:

- One year prior to the plan expiration date, the PCOEM Planner will reconvene the MJPT to review and assess the materials accumulated from annual reviews and other documents related to hazards, disasters and mitigation actions taken.
- The MJPT will update the appropriate or affected portions of the plan and produce a new Plan.
- The new plan will be submitted to DEMA and FEMA for review, comment, and approval.
- The new Plan will be presented before the respective councils and boards for an official concurrence/adoption of the changes.

For FEMA supported projects, progress reports will be submitted to FEMA on a quarterly basis, or as required throughout the project duration. The degree of quarterly reporting will be dependent upon the type of mitigation activities, its funding source, and the associated requirements. The quarterly report may include:

- Project Completion Status;
- Project Challenges or Issues (if any);
- Budgetary Considerations (Cost Overruns or Underruns); and
- Detailed Documentation of Expenditures.

Upon completion of projects, the project location will be visited, and results viewed and documented. Closed projects will then be monitored for effectiveness of the intended mitigation action. FEMA supported project closeouts will include an audit of the financials as well as other guidelines and requirements set forth under the funding or grant rules, and any attendant administrative plans developed by the Pascua Yaqui Tribe.

6.3 Incorporation into Other Planning Mechanisms

Incorporation of the Plan into other planning mechanisms, either by content or by reference, enhances a community's ability to perform hazard mitigation by expanding the scope of the Plan's influence. The jurisdictions acknowledge that incorporation of the Plan into other planning mechanisms has improved over the prior plan. Additional ways in which the 2017 Plan has been incorporated or referenced into other planning mechanisms for each jurisdiction are summarized below.

Past Activities

Pima County

- The 2017 Plan is cited in the Annual Recertification and 5-yr Cycle Verification of the Community Rating System for the NFIP.

- The plan was used as a resource during the 2021 Pima County Emergency Operations Plan revisions.
- The plan was used as reference material for mitigation grant funding opportunities.

Marana

- The plan was used as a resource during the 2017 and 2020 Town of Marana Emergency Operations Plan revisions.
- The plan was used for reference to identify hazards and mitigation strategies for the Towns General Plan in 2020.
- The plan was used to define mitigation AP's for Town of Marana capital improvement projects and programming during the past five-year cycle.

Oro Valley

- Used as reference material for other emergency plans, procedures, and hazard analysis.
- Identified mitigation actions and projects correlate to planned capital improvement projects; water conservation program; stormwater management program; goals, policies, and action items identified in the General Plan; and community outreach activities.

Pascua Yaqui Tribe

- The 2017 plan was referenced in the Pascua Yaqui Tribe Master Land Use Plan which serves as a guide for tribal leadership and stakeholders to minimize incompatible land use. It provides a balance of land uses that preserves and enhances the community, support in-fill strategies, promotes economic development, and protects environmentally and culturally significant resources. Mitigation strategies were addressed in the development of this plan.
- The master drainage study is a critical component to the Tribe's economic well-being, as well health, safety, and general welfare of the community. It was initially adopted in 2004 to minimize the flooding and drainage problems and will be updated within the next reporting period. It requires no development zones set aside for conveyances of floodwaters and the construction of regional storm water retention facilities
- As a part of National Flood Insurance Program requirements, the plan will be used as a reference.
- The 2017 plan was provided to FEMA when the Tribe submitted its declaration request for Public Assistance Grant Program for the COVID-19 Pandemic.

Sahuarita

- The plan was used when developing the General Plan mainly in reference to the hazards and risks.

Tucson

- The plan was used as reference material for the update of the Emergency Operations Plan.
- The plan was used as reference material for the Threat and Hazard Identification and Risk Assessments processes.
- The plan was used as reference in the development of Continuity of Operations Plans for the City Departments.
- The plan was used as a reference in the development in the Tucson Floodplain Management Plan.

Future Activities

The Plan will continue to function as a standalone document subject to its own review and revision schedule. The Plan will serve as a reference for other mitigation and land planning needs of the jurisdictions. Whenever possible, the jurisdictions will endeavor to incorporate the risk assessment results, mitigation actions and projects identified in the Plan into existing and future planning mechanisms as appropriate.

As is demonstrated above, the typical ways to use and incorporate the Plan include:

- Use of, or reference to, Plan elements in general and comprehensive planning update documents;
- Addition of defined mitigation measures to capital improvement programming;
- Inclusion of Plan elements into development planning and practices; and
- Resource for developing and updating emergency operations plans.

Specific incorporation of the Plan risk assessment elements into the natural resources and safety elements of each jurisdiction/tribe's general plans (county comprehensive plan) and development review processes, adding or revising building codes, adding or changing zoning and subdivision ordinances, and incorporating mitigation goals and strategies into general and comprehensive plans, may help to ensure hazard mitigated future development. In addition to continuing the past incorporation activities, below are the methods of incorporation the jurisdictions intend to implement over the next five-year period.

Pima County

- An annual review of the plan will be scheduled by the Office of Emergency Management including all 2022 plan participants. This will be held in November of each year and include a review of the hazards and risks and evaluation of mitigation measures.
- The plan revision planning process will begin in the second calendar quarter of 2024 for the 2025 plan revision. The Office of Emergency Management Planner will coordinate planning activities.
- The plan will be referenced annually when updating the Pima County Emergency Operations Plan.
- PCOEM will continue outreach to county departments and committees to make them aware of the Plan and advice on how it can be incorporated into other planning activities.
- PCOEM will continue working with the Pima County Grants & Innovation department on funding opportunities for mitigation activities.

Marana

- Continue to pursue past activities as listed in table 3-3 as appropriate.
- Continue to have representatives participate in annual mitigation meetings with other jurisdictional partners.
- Continue to incorporate plan elements into the Town's implementation of the 2040 General Plan, zoning activities and CIP programmed projects.

Oro Valley

- Participate in annual review of plan, as coordinated by the Pima County Office of Emergency Management.
- Use as reference material for other emergency plans, procedures, and hazard analysis.
- Staff awareness of plan to use as reference material when identifying future capital improvement projects; water conservation program; stormwater management program; code amendments; goals, policies, and action items in the General Plan; and community outreach activities.

Pascua Yaqui Tribe

- The Tribe will participate in the annual reviews of the plan with the other jurisdictional partners.
- The plan will be referenced when working with other tribal departments on grants and plans development.
- The hazards and risks will be used in development of exercises for the Tribe.
- The 2022 plan will be used as a reference in the ongoing revisions of the Pascua Yaqui Tribe Emergency Operations Plan.
- The 2022 plan will be referenced in the development of a tribal continuity of operations plans.

Sahuarita

- The Town will participate in the annual plan reviews with other jurisdictions.
- The plan will be used as a resource when the Emergency Operations Plan is revised.

Tucson

- The Plan will be used as reference in the ongoing revision of the City of Tucson Emergency Operations Plan.
- Participate in the annual review of the plan, as part of the Pima County Multi-Jurisdiction Hazard Mitigation Planning Committee.
- The inclusion and reference of the plan in the review and revision of the City general and sustainability plan adopted in 2013.
- The Plan will be used as a reference in the development and revision of the City's improvement projects and programming.

Continued Public/Stakeholder Involvement

The jurisdictions were successful during the past five years in outreach to the public and jurisdictional stakeholders by keeping them informed and involved with activities related to the 2017 Plan. The jurisdictions are committed to continuing that effort and intend to implement the following activities during the next five-year period, whenever possible:

Table 6-1: Continued Public and Stakeholder Involvement	
Jurisdiction	**Activity or Opportunity**
Pima County	• Continue working with the Regional Flood Control District on the Community Rating System (CRS) Program for Public Information, Notification and Exercise requirements. • Schedule annual mitigation review meetings with jurisdictional partners. • Enhance public outreach on mitigation issues through the county's mass notification tool. • Maintain the Hazard Mitigation Plan accessible to the public on the website. • Assist jurisdictions and county departments with mitigation grant funding opportunities.
City of Tucson	• City of Tucson Office of Emergency Management webpages was dedicated to preparedness and mitigation topics. • Preformed annual "Operation Splash" outreach efforts to raise awareness of the dangers of driving through flooded washes and roadways. • Preformed annual "Operational Freeze" outreach effort to raised awareness of the dangers of cold and freezing weather. • Use to "Don't Get Swept Away, Find a Safer Place to Play" campaign to encourage people to avoid flooded washes and other storm water infrastructure during the monsoon season. • The Tucson Office of Emergency Management regularly used social media sites to share preparedness and mitigation information to the public. • Declaration signed by the Mayor and Council of September Preparedness Month, with public preparedness outreach at public events, via social media, on television etc. • Regular water conservation outreach efforts from Tucson Water Department via bill inserts, social media, television etc. • Monthly preparedness and safety tips via the Tucson Fire Department posted online and aired on television. • Provided preparedness and mitigation orientation for Council staff on the mission of emergency management including mitigation efforts. • Monthly safety tips via the Tucson Police Department posted on social media. • Outreach effort by Tucson Fire Department Reference Urban Interface Wildland education program. The outreach campaign encourages people to take proactive efforts to clear high dense brush and bushes from around residence and businesses in order to provide natural fire break.
Town of Marana	• Promote the Marana Citizens Water Academy program to increase customer awareness about water conservation. • Provide public alternate water conservation sources via links on Town website. • Providing drought response through Marana's Drought Preparedness Plan. • Provide Heat Index awareness information via newsletter, and email blasts. • Provide hazard awareness and preparedness information to the community through articles, social media, website, videos, meetings, youth outreach and education through the schools, and community presentations. • Continue collaboration with Pima County Regional Flood Control District and other regional partners on post fire flood risks, potential mitigation projects, annual sandbag program, and outreach activities. • Provide staff support and technical guidance to homeowners, businesses, and HOAs about flood mitigation projects on private property. Marana Water will work with regional partners and the Citizens' Water Academy to recommend updates to its Drought Preparedness Plan.

Table 6-1: Continued Public and Stakeholder Involvement	
Jurisdiction	**Activity or Opportunity**
Town of Oro Valley	• Provide hazard awareness and preparedness information to the community through articles, social media, PSAs, podcasts, website, newsletters, public surveys, videos, meetings, youth outreach and education through the schools, and community presentations. • Expand use of web-based tools and discussion forums. • Continue to implement General Plan public involvement components, as prioritized in the Strategic Leadership Plan. • Expand collaboration with regional partners on opportunities to engage the public through different methods. • Use of new technologies to increase customer awareness about water conservation. • Continue collaboration with Pima County Regional Flood Control District and other regional partners on post fire flood risks, potential mitigation projects, annual sandbag program, and outreach activities. • Provide staff support and technical guidance to homeowners, businesses, and HOAs about flood mitigation projects on private property.
Pascua Yaqui	• Development of a Training and Exercise program that will provide continued education, awareness of mitigation measures. • Interface and collaborate with Pima County Flood Control to include exercises and training opportunities. • Develop and cultivate a social media presence using relevant platforms and applications that focus on mitigations strategies and measures that individuals/families can use before fire season, monsoon, winter preparedness etc. • Attend and participate in community-based events and engage with the public on mitigation and preparation activities for all Yaqui communities. • Develop an internal working group/committee of stakeholders to address mitigation strategies. • Continue mitigation activities in correlation to the Pascua Yaqui Tribe Improvement Projects program. • Develop a Communication Plan for mass/targeted messaging before, during, and after emergencies. • Development of an annual preparedness/mitigation conference that includes the whole community.
Town of Sahuarita	• Town of Sahuarita website (https://sahuaritaaz.gov). • Town of Sahuarita Resident/Citizen Portal. • Town of Sahuarita Facebook.

APPENDIX A: ASSESSMENT OF PREVIOUS ACTION ITEMS

2017 Plan Mitigation Measures Assessment for Unincorporated Pima County								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Lead Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Enforce Flood & Erosion Hazard Ordinance in accordance with the NFIP.	Flood	Both	$1.2M Ongoing	High	PCRFCD / Floodplain Mgmt. Division	Flood Control Tax Levy	Keep	This activity is on-going. Since the last report, counter visits, permits and complaints were received by the District. Violations were resolved. Staff also processed site construction permits, development concept plans, tentative plats, habitat mitigation plans, and rezoning and comprehensive plan amendment cases.
Implement NFIP tasks such as LOMR submittals, maintaining a countywide map repository, performing master drainage studies, and coordinating to ensure the digital map is correct.	Flood	Both	$600,000 Ongoing	High	PCRFCD / Planning & Development Division	Flood Control Tax Levy	Keep	During FY2019/2020 "TDN" studies were completed for the Alamo Wash, Black Mountain, Bronx Wash, Carmack Wash, Christmas Wash, City of South Tucson, Lee Moore Wash, Navajo/Wilson Wash, North Ranch, Pistol Hill Watershed and the West Branch of the Santa Cruz River. The District continues to validate post Big Horn fire flood flow rates for notification purposes, maintenance and infrastructure improvement needs.
Provide flood risk mitigation through Capital Improvement Projects (CIP).	Flood	Both	$8M Ongoing	High	PCRDFD / Planning & Development Division	Flood Control Tax Levy & USACOE	Keep	FY2020/2021 CIP expenditures included acquisition, regional detention basins, bank protection, grade control structures, a railroad culvert, channel improvements, and

2017 Plan Mitigation Measures Assessment for Unincorporated Pima County								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Lead Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
								habitat restoration. An equivalent sum was expended on maintenance needs of existing improvements. This includes significant sediment management in major rivers which in part is due to fires in mountainous headwaters on federal land, as well as desert soil conditions and geomorphology. Major future needs identified for potential DMA funding include Post Fire Hazard Mitigation Grants for Cañada del Oro Levee Augmentation and enlarging the Finger Rock wash culvert under Skyline Drive. While these capital projects have been identified, another significant need are urban drainage improvements on a neighborhood scale. This includes upgrades to current standards, retrofit to address projected future conditions, and new smaller projects utilizing dispersed measures sometimes referred to as Green Infrastructure.
Participate in Community Rating System to reduce insurance premiums.	Flood	Both	$50,000 Ongoing	Medium	PCRFCD / Planning & Development Division	Flood Control Tax Levy	Keep	During 2021 Pima County improved its CRS Rating from 5 to 3. Improvements included adoption of a Floodplain

2017 Plan Mitigation Measures Assessment for Unincorporated Pima County								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Lead Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
								Management Plan and expansion of response activities.
Buffelgrass Mitigation – identify public outreach opportunities including pamphlets, community event participation, media outreach.	Wildfire	Both	$5,000 Ongoing	High	PCOEM, PCNRPR, PCRFCD	Mitigation Grants, General Funds, Donation	Keep and revise	NRPR and RFCD participate in Save our Saguaro events annually with a focus on educating residents on fire risk from buffelgrass invasion and impacts to native cactus including Saguaros. For the past 20 years, thousands of Pima County residents and visitors have received buffelgrass education materials and programs.
Buffelgrass Mitigation – locate county areas for mitigation of buffelgrass and administer grant funding for ongoing activities related to wildfire reduction through removal and reduction in Buffelgrass.	Wildfire	Both	$3M Ongoing	Medium	PCOEM, PCNRPR, PCRFCD	Mitigation Grants	Ongoing, roll into update and revise	The mitigation activities under the initial $3M PDM grant (PDM-09-AZ-2011) were completed in 2017. NRPR and RFCD continue to apply for and receive various grants to support bufflegrass control to reduce wildfire risks. Over 3,000 volunteer hours are harnessed annually for buffelgrass treatment on thousands of acres in Tucson Mountain Park. Staff and youth crews spend several months annually controlling buffelgrass in other areas
Treat soil surfaces with appropriate stabilization materials and vegetation control to reduce blowing dust.	Severe Wind	Both	$2M Ongoing	Medium	PCDOT	Highway User Revenue Funds, Local Regional Transportation Authority Funds	Roll into update	Continuing to implement standard operating procedures to reduce dust during construction.

2017 Plan Mitigation Measures Assessment for Unincorporated Pima County								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Lead Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Continue to identify vulnerable populations for heat related illness, provide education targeted toward recreational activities, visitors/travelers, hospitality industry, homeless populations, and build cooling center capacity.	Extreme Heat	Both	$100,000 Ongoing	High	PCHD, PCOEM, Parks & Recreation	Mitigation Grants, Public Health Emergency Preparedness	Keep and revise	PCHD will expand collaborations through a task force of multiple community sector representatives involved in climate-ready planning, mitigation and response.
Implement the Drought Management Plan. If drought conditions worsen, the Board of Supervisors may consider increasing the drought stage that will trigger drought conservation measures.	Drought	Both	None Ongoing	Medium	OSC/Water Resources Unit	General fund and RWRD enterprise fund	Keep	Pima County's Local Drought Impact Group continues to meet to monitor the status of drought and identify drought impacts.
Pima County DOT in conjunction with the AZGS and the US Forest Service will work to identify vulnerable slide areas and begin developing mitigation approaches and monitoring protocols.	Landslide	Existing	Staff Time Ongoing	Medium	PCDOT	Highway User Revenue Funds, Mitigation Funds, Bond Fund, Aid to Federal Highways	Delete	Landslides are relatively low risk to Pima County roads. DOT lacks staff and funding to evaluate slide risk at this time.

2017 Plan Mitigation Measures Assessment for Marana								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Provide training to the applicable Marana departments on the adopted hazard mitigation plan and its requirements.	All	Both	$500 2021	High	EM Coordinator	General Fund	Keep and roll into update	Towns EOP Current as reviewed. COVID mitigation measures in place. Town wide COVID 19 vaccination clinic scheduling and support completed. Vaccine awareness education conducted town wide. Audit of impacted department required NIMS training completed.
Conduct public education campaigns to increase awareness of natural hazards (such as wildfire, flooding, extreme heat and cold, and severe winds and landslides) by distributing DEMA and Pima County hazard awareness flyers at community events and public gathering opportunities. Event opportunities include events such as the Town of Marana Founders Day (Mar), the 4th of July Celebration (Jul), the Cotton Festival (Oct) and the Holiday Tree Lighting (Dec) and at community meetings sponsored by the Community Services Department.	All	Both	$500 2021	High	Community Development Director	General Fund	Keep and roll into update	COVID mitigation measures greatly minimized ability to continue outreach meetings. Plans to resume during the final quarter of 2021.
Encourage bridge or culvert construction where roads are susceptible to flooding. This will be accomplished as part of the Planning Process when Developers apply to build in Marana.	Flood	Both	Staff Time ongoing	High	Development Services/ General Manager	General Fund	Keep and roll into update	This will be accomplished as part of the Planning Process when Developers apply to build in Marana.

2017 Plan Mitigation Measures Assessment for Marana								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Marana will continue to participate in the National Flood Insurance Program by reviewing applications for buildings, ensuring they are properly designed.	Flood	Both	Staff Time	High	Development Services/ General Manager	General Fund	Keep and roll into update	Outreach efforts are still relevent and on-going.
On Rattlesnake Pass, from Saguaro Bloom to Twin Peaks Road, the Public Works Department and Planning Departments are installing infrastructure, making roadway drainage improvements, and grading the storm water conveyance systems to mitigate flooding hazards in the area.	Flood	Both	$29.8M Ongoing	High	Public Works / Planning Dept	Transportation Fund, General Fund	Keep and roll into update	The project is currently at 60% design, which will address/ mitigate many of the hazards of the current roadway.
Barnett Linear Park and Flood Control – Construct a 3-mile channel along Barnett Road to mitigate the drainage and flood hazard from the Santa Cruz River	Flood	Both	$16.5M 2022	High	Public Works Director	General Fund, Future MMPC Bonds	Delete	The project isn't currently funded.
Ina Road Bridge – Remove and replace the Ina Road bridge that crosses the Santa Cruz River	Flood	New	$17.5M TBD	High	Development Services Director	Transportation Fund, HURF Bonds, General Fund	Delete	This project has been completed and is being monitored for effectiveness.
Ina Road Improvements from Silverbell Road to I-10 – widening of Ina Road to 4-lane section with raised median, sidewalks, and drainage improvements	Flood	Both	$16.5M 2022	High	Public Works Director	Transportation Fund, Federal Grants	Delete	This project has been completed and is being monitored for effectiveness.
Tangerine Road Corridor - provide a minimum of 4 lanes with raised medians, drainage improvements, sidewalks, ADA facilities, multi-use path and lanes, Traffic Signals, Right-of-Way acquisitions, Utility relocations, Marana Water line extensions, and sewer modifications and additions.	Flood	Both	$95.5M Ongoing	High	Public Works Director	RTA, Future Bond Money	Keep and roll into update	The project is ongoing with phase one complete.
Ina Road TI – lower I-10 and construct a new overpass that will span both I-10 and the UPRR tracks. Project will mitigate flood issues and also improve access that will reduce accidents and HazMat incidents	Flood	New	$65M 2018	High	Public Works Director in coordination with ADOT	ADOT, RTA	Delete	This project has been completed and is being monitored for effectiveness.

2017 Plan Mitigation Measures Assessment for Marana								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Marana will continue to participate in the Flood Prone Land Acquisition Program and acquire properties located in flood hazard areas.	Flood	Both	Staff Ongoing	High	Development Services Gen Mgr	Grants, Partnership w/ Pima County	Keep and roll into update	Outreach efforts are still relevant and on-going.

2017 Plan Mitigation Measures Assessment for Oro Valley								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Conduct Floodplain Mapping to mitigate flood risk by delineating floodplains boundaries within existing subdivisions that were not required at the time of subdivision or commercial property platting. This includes subdivisions and commercial properties constructed prior to 1984 and falls within some recently annexed areas of the Town. This includes three projects: Carmack Wash/Shadow Mountain Estates subdivision, Peglar Wash/Suffolk Hills Subdivision/Rancho Catalina Subdivision, Highlands Wash/Highlands subdivision.	Flood	Existing Homes / Subdivisions/ Commercial Properties	$200K 2018	High	Oro Valley Stormwater Utility	PCRFCD CIP	Delete	Completed 2020
Mitigate and stabilize areas damaged by storm related activity by: Designing and constructing of wash stabilization components to protect damaged areas from scour and deposition of sediment that is causing damage to existing properties. This includes three projects: 3 known projects: Carmack Wash/Shadow Mountain Estates subdivision, Peglar Wash/Suffolk Hills Subdivision/Rancho Catalina Subdivision, Highlands Wash/Highlands subdivision.	Flood	Existing Homes / Subdivisions/ Commercial properties	$1-2M 2019	High	Oro Valley Stormwater Utility	PCRFCD CIP	Delete	Studies were completed. No progress on construction due to lack of funding.

2017 Plan Mitigation Measures Assessment for Oro Valley								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Lambert Lane (Rancho Sonora to La Cañada). All weather crossing, lowering hill profile and adding soil nail walls. Upgrading signal at Lambert Lane. Adding secondary access point to fire station from Lambert, currently only accessible from La Cañada Dr.	Flood	Existing road improvement	$5.5M Road $730K Utility 2017	High	Oro Valley Stormwater Utility	RTA, Water Utility, Town of Oro Valley	Delete	Completed 2017
Tangerine Rd. (Oro Valley portion of project is Shannon to La Cañada). All weather crossings, multi-use path, raised medians, curb and gutters, traffic signal improvement at La Cholla and Tangerine.	Flood	Existing road improvement	$95.5M (Total Tangerine Project) 2018	High	Marana	RTA, Marana, Pima County, and Oro Valley	Delete	Completed 2018
La Cholla (Oro Valley portion of project is Lucero Rd. to Tangerine). 4 lane divided with a raised median, separated multi-use path, all weather crossings. Traffic signal improvement at Lambert, Naranja, and Glover.	Flood	Existing road improvement	$20M 2020	High	Oro Valley	RTA, Pima County, and Oro Valley	Delete	Completed 2020
Purchase 2,000 acre-ft. of groundwater extinguishment credits in the Tucson Active Management Area (TAMA) to bolster the Town's groundwater allowance account for future use.	Drought	New	$400,000 2017	Medium	Water Utility	Water Utility Fees	Keep and revise	Additional purchases and storage is planned in the next five years.
Remove regulatory barriers and develop programs that support sustainable designs, landscapes, green infrastructure, and development practices. Update and develop new building codes and design standards that help reduce urban heat island effect.	Extreme Heat	Both	Staff Time $3,750/year 2021	Low	CDPW	Oro Valley	Keep and revise	Building codes adopted in 2019. The development of design standards is underway and highlighted in the Strategic Leadership Plan.

2017 Plan Mitigation Measures Assessment for Oro Valley								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Installation of hydrants in urban interface area targeting areas where there is a higher risk for brush fire.	Wildfire	New	$21,000/year 2021	Medium	Mountain Vista Fire District	MVFD general fund	Keep and roll into update	Addition of hydrants in strategic locations is part of managing wildfire risk in the WUI interface.
Annual maintenance on established and identified as critical fire break locations in the urban/wildland interface (Catalina State Park, Sun City Oro Valley, etc.).	Wildfire	Both	$10,000/year 2021	Medium	Golder Ranch Fire District	Golder Ranch Fire District	Keep and roll into revise	Have completed some of the rehab of the break around Sun City.
Provide annual, public awareness and public outreach on local hazards, mitigation, prevention, plans, and other activities through presentations to homeowners and HOAs, newsletters, and website.	All	Both	$500/year 2021	Medium	EM & Golder Ranch Fire District	Oro Valley & Golder Ranch Fire District	Keep and roll into update	Public education and outreach is an ongoing effort.
Mitigate and stabilize areas damaged by storm related activity in the Catalina Ridge Drainage Channel by reconstructing 3,400 linear feet of channel bottom, improve wash degradation, and mitigate side slope to protect public and private property, public infrastructure, and utilities from additional damage.	Flood	Existing	$1.9M 2021	High	Oro Valley Stormwater Utility	PCRFCD CIP, TOV, FEMA	Keep and roll into update	Development of mitigation projects based on highest risk properties.

2017 Plan Mitigation Measures Assessment for Pascua Yaqui							
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
The Pascua Yaqui Tribes Master Drainage Report overseen by Facilities Management Division will be implemented within phases • Oversee floodplain modeling • Review floodplain map revision • Assessments of flooding runoff in public gathering areas	Flood	Existing	Staff time Ongoing	Tribal Council, Facilities Dept, Land Dept	General Fund	Keep and roll into update	Design completed and project put out to bid; however, no bids were received. Will be re-advertising.
Complete and implement Phase 2 finalization of Master Drainage Report.	Flood	Existing	Staff time 2017	Tribal Council, Land Dept	General Fund	Delete	Complete
Update and resume the existing intergovernmental agreement between the Tribe and the State Forestry Department. Conduct Annual maintenance on established and identified critical fire break locations in the urban/wildland interface around all housing, neighborhoods projects and commercial buildings on the Pascua Yaqui Reservation.	Wildfire	Existing	Staff time Continuing	Fire Dept, Attorney General's, Office, Tribal Council	General Fund	Keep and roll into update	In-Progress The current Intergovernmental Agreement (IGA) between the Tribe and State Forestry was reviewed internally, by tribal representatives within the last planning cycle. As a result of the impacts of the COVID-19 pandemic an update/revision to the IGA between the Tribe and State Forestry was not

2017 Plan Mitigation Measures Assessment for Pascua Yaqui							
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
							completed and will be rolled into the 2022 planning cycle.
Modify and continue to evaluate existing building codes to help mitigate hazards. • Evaluate material and installation of equipment to buildings and residence • Educate community on hazard via website, department brochures	Extreme Heat	Existing	Staff Time Ongoing	Tribal Council, Fire Dept, Land Dept, Housing/Facilities Dept	General Fund	Keep and roll into update	On-going and continuous During the last planning cycle the Tribal Housing Department with the support of Tribal Council implemented requirements for the use of energy efficient building materials for tribal facilities and low income housing developments within the community. The upgrade of building materials include the use of double pane windows as opposed to single pane, the use of high "R" rated materials that improve the energy costs. In

2017 Plan Mitigation Measures Assessment for Pascua Yaqui							
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							addition to the use of energy efficient materials, the Tribe has also implemented landscaping requirements for new developments that include native plants/vegetation that require less water. In the next planning cycle the Tribal Housing and Facilities Departments will be reviewing and updating the building codes/ordinance for the Tribe.

2017 Plan Mitigation Measures Assessment for Sahuarita								
Description	**Hazard(s) Mitigated**	**Assets Mitigated (Ex/New)**	**Estimated Cost Completion**	**Priority**	**Primary Agency Title**	**Potential Funding Source(s)**	**Status Disposition**	**Explanation**
Complete Multi-Sector General Permit (Wastewater facility) inspections and perform maintenance and repairs of control measures as identified during inspections.	Flood	Existing	Staff Time Quarterly	High	Public Works - Wastewater	Enterprise	Delete	Since the Town of Sahuarita does not discharge industrial stormwater off-site to a WOTUS (Santa Cruz River), an MSGP is not needed and the Town is covered under the No Discharge Certification (NDC). The NDC was issued on January 10, 2020.
Organize and host annual Southern Arizona Beat Back Buffelgrass community removal event.	Wildfire	Both	Staff Time Annually	Medium	Public Works, Planning and Zoning	None	Keep and revise	The risk of a wildfire in Sahuarita due to vegetation (buffelgrass in this case) is very low to minimal. Public Works will possibly partner with the Town of Sahuarita Parks and Recreation

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								Department for a Buffelgrass community event. Currently, no event has been scheduled.
Review, update and modify NFIP requirement and make appropriate modifications to Floodplain Ordinance.	Flood	Both	Staff Time 2017	High	Public Works	General Fund	Delete	The Town of Sahuarita Floodplain and Erosion Hazard Ordinance was updated March of 2020. The Santa Cruz River is the only FEMA mapped Floodplain. NFIP requirements are set per FEMA Flood Maps of the Santa Cruz River.
Educate the public to increase awareness of hazards, and potential opportunities for mitigation actions. Make Pima County's public information material sheets, websites, mitigation brochures, and media outlets available.	Extreme Heat, Flood	Both	Staff Time 2018	Low	Town Clerk	None	Keep and revise	The Town of Sahuarita Department of Public Works sent out letters to local HOAs as a courtesy reminder to maintain

2017 Plan Mitigation Measures Assessment for Sahuarita								
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								washes and basins to minimize flooding possibilities. A manual in conjunction with Pima County was also included on the how, why, when, what, who of the drainage maintenance guidelines.
Conduct pre-storm season inspections and debris removal for Town-owned roads and drainage crossings.	Flood	Existing	Staff Time Ongoing	High	Public Works	HURF	Keep and revise	The Town of Sahuarita Department of Public Works Streets Division maintained all Town owned roads and drainage crossings. The recent event of the monsoon 2021 presented a lot of maintenance actions for our Streets Division. Overall, roads

2017 Plan Mitigation Measures Assessment for Sahuarita								
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								and drainage crossings are well-kept.
Complete construction of Sahuarita Road: I-19 to Eastern Town Limits including drainage improvements and a new 2-lane bridge over the Santa Cruz River.	Flood	Both	$47.7M Planning began 2106	High	Public Works	RTA, HURF, private	Delete	The Sahuarita Road Project from I-19 to Country Club Road has been completed for over a few years now.
Complete construction of the Pima Mine Road Bridge Replacement at the Santa Cruz River, which corrects structural deficiencies of the existing bridge, provides additional roadway capacity at the bridge, and provides additional capacity for delivery of CAP water to Sahuarita.	Flood, Drought	Both	$7.2M Planning began 2016	High	Public Works	RTA, HURF, private	Delete	The Pima Mine Road Bridge Replacement has been completed for over a few years now.
Finalize License Agreements allowing installation of CAP pipelines in Town rights-of-way to facilitate the delivery of CAP water to Sahuarita.	Drought, Extreme Heat, Flood	Both	Staff Time 2017	High	Public Works	None	Delete	CAP pipelines have been installed within the Town's ROW - from I-19 along the north side of Pima Mine Road all the way east the Nogales Highway.

2017 Plan Mitigation Measures Assessment for City of Tucson								
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Identify funding source and construct two bridges and 50 box culverts with 380 back-up power units for signalized intersections at high flood hazard crossings in Tucson limits in accord with the Department of Transportation 5-yr plan. If a box culvert cannot be constructed an automated warning device, consisting of a barricade, signs and flashing lights would be installed.	Flood, Severe Wind	New	$100M Staff Time Ongoing	High	Transportation Dept Streets Administrator and Streets Chief Engineer	Grant Funds	Keep and Roll into update	The mitigation measures are still in progress and are being pursued based upon available funding.
Promote disaster-resistant water delivery system by constructing redundant water transmission lines (e.g., The Utility and the community will be less susceptible to loss of water delivery due to natural or human-caused disasters).	All	Both	$7.9M 2020	High	Water Dept Water Administrator Maintenance & Operations	Operations Budget	Keep and revise	Upgraded SCADA monitoring systems for water transmission lines
In compliance with the NFIP, Tucson will continue to require the preparation and submittal of a CLOMR or CLOMR-F for all proposed development within FEMA delineated Special Flood Hazard Areas.	Flood	Existing	Staff Time Annually	High	Planning and Development Services	Department Budget and Fees for Developers	Keep and roll into update	The City of Tucson requires CLOMR of CLOMR-F (as applicable) for all proposed development located within Special Flood Areas
Maintain compliance with NFIP regulations by enforcement of the current floodplain management ordinance through review of new development located in the floodplain and issuance of floodplain use permits.	Flood	Existing	Staff Time Annually	High	Planning and Development Services	Department Budget	Keep and roll into update	The City of Tucson requires a floodplain use permit for all proposed developments

2017 Plan Mitigation Measures Assessment for City of Tucson								
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								located within a floodplain
Improve floodplain administration under the NFIP program by sending inspectors into the field when we receive a flood warning from the NWS, to assess bridges, washes, and other critical infrastructures within Tucson.	Flood	Existing	Staff Time Annually	Medium	Transportation Dept	Department Budget	Keep, and roll into update	Staff worked with departments, committees, Ward offices, Developers, and Engineering Consultants to review and update the goals and changes to the Tucson Floodplain Management Plan (the Plan) in 2020. The updates to the Plan became effective December 2020 with a revised ordinance.
Continue to fund and promote the following rebate and incentive programs: residential and small commercial rainwater harvesting rebate program; residential high-efficiency clothes washer replacement rebate program; Single-family residential gray-water rebate program; Single-family residential high-efficiency toilet replacement; rainwater harvesting grant/loan	Drought	Existing	$1.4M Annually	Medium	Tucson Water	Conservation Utility Fee	Keep and roll into update	All of these programs continue as described

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program for low-to-moderate income customers; free toilet replacement program for low-to-moderate income homeowners; commercial or multi-family high-efficiency toilet replacement program; commercial and industrial high-efficiency urinal replacement program.								
Continue to fund and promote the Tucson Water Zanjero (water manager) residential water audit program.	Drought	Existing	$271K Annually	Medium	Tucson Water	Department Budget	Keep and roll into update	Zanjero program continues to be funded
Continue to participate in, promote and sponsor the Pima County SmartScape program in partnership with the University of Arizona Cooperative Extension.	Drought	Existing	$239K Annually	Medium	Tucson Water	Conservation Utility Fee	Keep and roll into update	Smartscape Program continues to be funded by Tucson Water under IGA with University of Arizona
Review and update the City of Tucson Water Department Drought Preparedness and Response Plan.	Drought	Both	Staff Time Ongoing	Medium	Tucson Water	Department Budget	Keep and roll into update	Drought Plan was updated in 2020
Assess, inventory, and map vulnerability within Tucson to seismic hazards. Conduct outreach efforts to property owners in high-seismic risk zones, or who own building at especially high risk for seismic damage such as historic adobe homes, about retrofits that can be made to their structures to reduce seismic impact. Use vulnerability data gathered to perform analysis of current building codes and propose changes, as appropriate, to reduce seismic risk community wide.	Earthquake	Both	Staff time 2019	High	Planning and Development Services	Department Budget	Keep and revise	The City of Tucson is working to identify existing structures that may be at risk of damage as a result of seismic event

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Perform feasibility study of a downtown District Energy model that would create greater energy and water resiliency in downtown Tucson.	Drought, Extreme Heat, Extreme Cold	Both	$75K 2017	High	Environmental and General Services	City operating funds with matching county contribution	Delete	No additional work has been completed on the study upon its completion Date in 2017
Assess the vulnerability of critical facilities to flooding from runoff and encourage reducing runoff and means for mitigating critical facilities when runoff cannot be reduced.	Flooding	Both	Staff time Annually	Medium	Planning and Development Services	Department Budget		The City of Tucson is assessing the vulnerability of critical facilities.
Implement a severe wind risk awareness program with information about shelter locations, education for homeowners about retrofits, and education for professionals about wind mitigation.	Severe Wind	New	Staff time 2018	Medium	OEM and Homeland Security	Department Budget	Keep and roll into update	Due to current budget funding, and staffing available this project is still pending
Implement a winter weather risk awareness program to educate the public on the risks of severe cold during winter storms.	Extreme Cold	New	Staff time 2017	Medium	OEM and Homeland Security	Department Budget	Keep and roll into update	Office of Emergency Management (Tucson Police Department and Tucson Fire Department), collaborates with local nation weather representatives providing consent communicatio

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								n and updates in order to insure programs such as "Operations Deep Freeze" and others similar programs.
Assess and identify specific at-risk populations vulnerable to long-term power outages and organize outreach efforts include establishing and promoting heating and cooling centers in the community.	Extreme Heat, Extreme Cold	Both	Staff time 2018	High	OEM and Homeland Security	Department Budget	Keep and roll into update	Colorations with NAOA, Tucson Fire Department, Voluntary Organization active in disasters.


PIMA COUNTY
ORO VALLEY ARIZONA
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TOWN OF
Sahuarita
CITY OF
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PASCUA YAQUI TRIBE
ARIZONA