Fresno County Multi-Hazard Mitigation Plan

Public Review Draft / April 2018





amec foster wheeler

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EXECUTIVE SUMMARY

The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards. Fresno County and the other participating jurisdictions developed this multi-hazard mitigation plan to make the County and its residents less vulnerable to future hazard events. This plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 so that Fresno County would be eligible for the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance Grants, including Pre-Disaster Mitigation and Hazard Mitigation Grant programs as well as lower flood insurance premiums (in jurisdictions that participate in the National Flood Insurance Program's Community Rating System).

The plan was originally developed in 2007-2008 and FEMA approved in 2009. The plan was comprehensively updated in 2017-2018. The County followed a planning process in alignment with FEMA guidance during its original development and update, which began with the formation of a hazard mitigation planning committee (HMPC) comprised of key county, city, and district representatives and other stakeholders. The HMPC conducted a risk assessment that identified and profiled hazards that pose a risk to Fresno County, assessed the County's vulnerability to these hazards, and examined the capabilities in place to mitigate them. The County is vulnerable to several hazards that are identified, profiled, and analyzed in this plan. Floods, wildfires, severe weather, drought, and agricultural hazards are among the hazards that can have a significant impact on the County.

Based on the risk assessment, the HMPC identified goals and objectives for reducing the County's vulnerability to hazards. To meet identified goals and objectives, the plan recommends a number of mitigation actions that include actions specific to each participating jurisdiction. This plan has been formally adopted by the County and the participating jurisdictions and will be updated every five years at a minimum.

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1 INTRODUCTION

1.1 Purpose

Fresno County, along with 17 participating jurisdictions, prepared this local multi-hazard mitigation plan to better protect the people and property of the County from the effects of hazard events. This plan underwent a comprehensive update in 2017-2018 building upon the plan that was originally developed in 2009. This plan demonstrates the community’s commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed to make Fresno County and participating jurisdictions eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency’s (FEMA) Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) program, and Flood Mitigation Assistance (FMA). This plan also meets the planning requirements of the National Flood Insurance Program’s Community Rating System (CRS), in order to earn points under CRS Activity 510, which could lower flood insurance premiums in CRS communities.

1.2 Background and Scope

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. 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 natural disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated through planned mitigation.

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 results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $4 in avoided future losses in addition to saving lives and preventing injuries (National Institute of Building Science Multi-Hazard Mitigation Council 2005). An update to this report in 2017 (Natural Hazard Mitigation Saves: 2017 Interim Report) indicates that mitigation grants funded through select federal government agencies, on average, can save the nation $6 in future disaster costs, for every $1 spent on hazard mitigation.

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are determined, prioritized, and implemented. This plan documents

Fresno County's hazard mitigation planning process, identifies relevant hazards and vulnerabilities, and provides strategies the County and participating jurisdictions will use to decrease vulnerability and increase resiliency and sustainability in Fresno County.

The Fresno County Multi-Hazard Mitigation Plan is a multi-jurisdictional plan that geographically covers everything within Fresno County's jurisdictional boundaries (hereinafter referred to as the planning area). Unincorporated Fresno County and the following communities and special districts participated in the planning process; an asterisk '*' indicates jurisdictions added to the plan during the 2017-2018 update:

- City of Clovis
- City of Coalinga
- City of Firebaugh*
- City of Fowler*
- City of Fresno
- City of Kerman
- City of Kingsburg
- City of Mendota
- City of Reedley*
- City of San Joaquin*
- City of Sanger
- City of Selma
- Fresno Metropolitan Flood Control District
- Lower San Joaquin Levee District
- Sierra Resource Conservation District/Highway 168 Fire Safe Council
- Kings River Conservation District*
- Westlands Water District*

This plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the *Federal Register* on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act.) While the act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288). Because the Fresno County planning area is subject to many kinds of hazards, access to these programs is vital.

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and their residents by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. The Fresno County planning area has been affected by hazards in the past and is thus committed to reducing future impacts from hazard events and becoming eligible for mitigation-related federal funding.

1.3 Plan Organization

The Fresno County Multi-Hazard Mitigation Plan is organized as follows:

- Chapter 2: Community Profile
- Chapter 3: Planning Process
- Chapter 4: Risk Assessment
- Chapter 5: Mitigation Strategy
- Chapter 6: Plan Adoption
- Chapter 7: Plan Implementation and Maintenance
- Jurisdictional Annexes
- Appendices

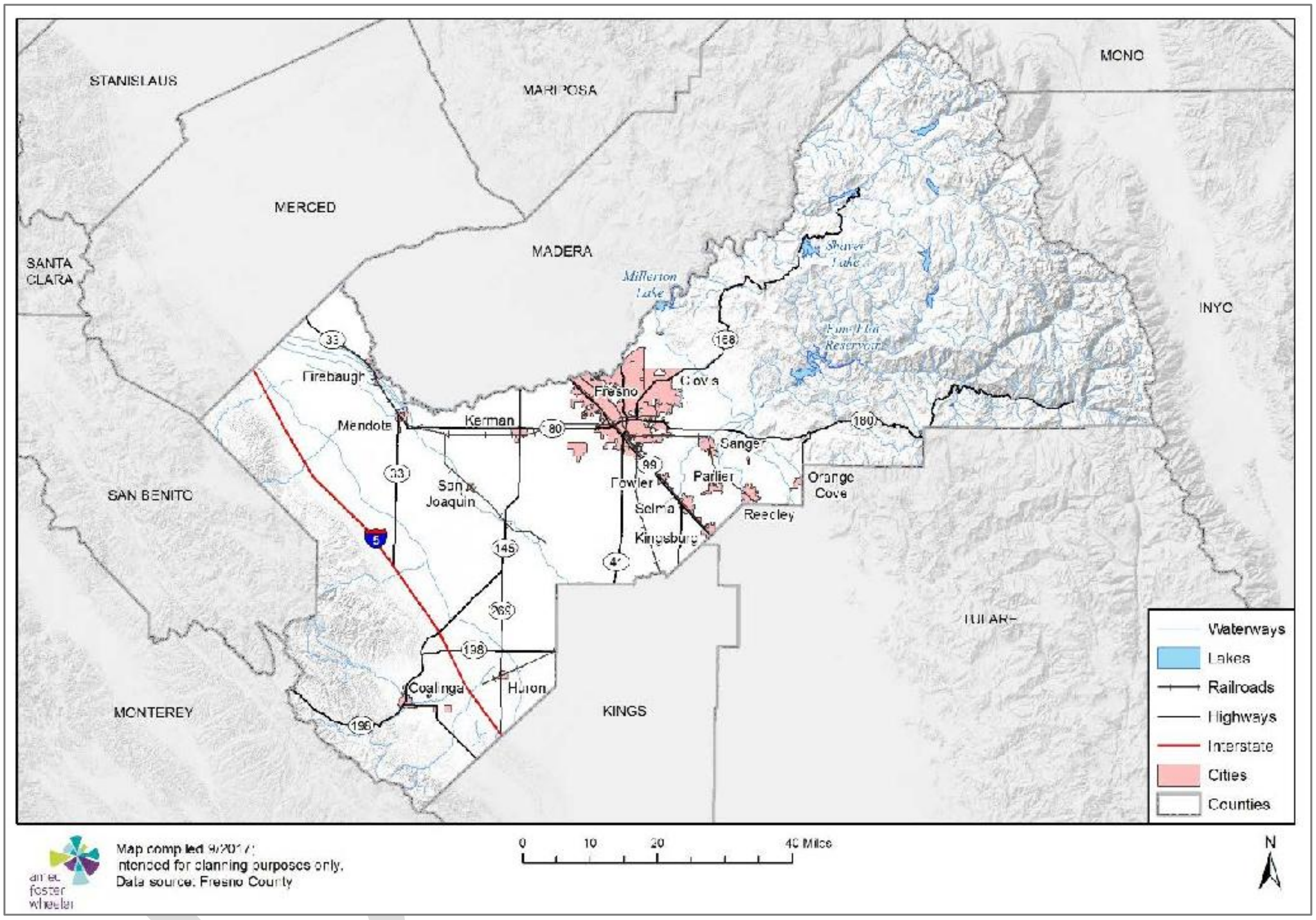
1.3.1 Jurisdictional Annexes

Each jurisdiction participating in this plan developed its own annex, which provides a more detailed assessment of the jurisdiction's unique risks as well as their mitigation strategy to reduce long-term losses. Each jurisdictional annex contains the following:

- Community profile summarizing geography and climate, history, economy, and population;
- Hazard risk information for geographically specific hazards or unique vulnerabilities;
- Hazard map(s) at an appropriate scale for the jurisdiction, if available;
- Number and value of buildings, critical facilities, and other community assets located in hazard areas, if available;
- Vulnerability information in terms of future growth and development in hazard areas;
- A capability assessment describing existing regulatory, administrative, technical, and fiscal resources and tools as well as outreach efforts and partnerships and past mitigation projects; and
- Mitigation actions specific to the jurisdiction.

Fresno County is illustrated in Figure 2.1.

Figure 2.1 Fresno County Base Map



2.1 History

When the first European settlers came to the Fresno area in the early 1800s, the Yokuts tribe was living on the valley floor and in the foothills along the San Joaquin and the Kings Rivers. The Monache tribe lived further up the rivers. After the initial Spanish explorers came, others began to arrive, including trappers, hunters, and miners. Kit Carson, the famous mountain man, explored the area during the 1840s. Named for the Spanish word for ash or ash tree, Fresno County was created in 1856, yet its present day boundaries were not established until 1909.

The County was a part of the mining boom of California from its early years until the mid-1860s. Once gold fever subsided, the County turned to livestock and general farming, which received its impetus from the arrival of the Central Pacific Railroad in 1872. As more water became available, the County shifted from general farming to orchards and vineyards.

2.2 Geography and Climate

California's 10th largest county, Fresno County covers an area of over 6,000 square miles in central California. It is approximately 200 miles north-northwest of Los Angeles and approximately 160 miles southeast of San Francisco.

The County is located near the center of California's San Joaquin Valley and is part of the Great Central Valley, one of the state's distinct physical regions. The County's topography is characterized by broad, flat valley floors that generally slope from southeast to northwest; foothills and moderately high mountains (Coast Ranges) in the west; and foothills and high mountains (Sierra Nevada) in the east. Approximately 55 percent of the County is mountainous, and 45 percent is valley land. Elevations range from 100 to 400 feet on the valley floor to 4,000 feet in the Coast Ranges and more than 14,000 feet in the Sierra Nevada. There are two major rivers in Fresno County, both which originate in the Sierra Nevada: the San Joaquin and Kings rivers.

The climate varies among the County's three regions. Summers are long, hot, and dry in the valley; moderate to hot in the Coast Ranges; and relatively cool in the high elevations of the Sierra Nevada. There is little precipitation in the County during the summer. Winters in the valley and Coast Ranges are short and mild with light rain in the valley and moderate rainfall in the Coast Ranges. In the Sierra Nevada, winters vary from short and mild with frequent rain and some snow to moderately severe with frequent snow. Most of the seasonal precipitation occurs between October and April. More specific information about Fresno County's climate can be found in Chapter 4 Risk Assessment.

2.3 Economy

Agriculture is Fresno County's primary industry and is a driving force in the County's economy. Fresno County is the third largest agricultural county in the state, with a total gross production value of over $7 billion. The county leads the State in tomato processing, accounting for over 30 percent of the State's total production, and chickens, with nearly 50 percent of the State's total production, followed by Merced with 26 percent. Fresno County ranks second in production of almonds, with 17 percent of the State's total production, grapes, with 13 percent, cattle and calves, with 13 percent, pistachios, with 23 percent, and tangerines, with 32 percent. The ten leading crops, in order of dollar value, were grapes, cotton, almonds, tomatoes, turkeys, cattle, milk, plums, oranges, peaches, and nectarines.

The 2014 Fresno County Agricultural Commissioner's Report includes a comparison of gross production value of crops by year. The Agricultural Commissioner's Report shows that field crops and fruit and nut crops experienced the most dramatic change in the percentage of total profits between 1994 and 2014. From 1994 to 2014, field crops dropped from 21.4 to 4.6 percent of the total gross production value of crops harvested, and during that same period fruit and nut crops grew from 32.2 to 49.0 percent.

Agriculture accounts for the largest portion of jobs in Fresno County; However, since 1990, the percentage of agriculture-related jobs has continuously fallen. In 1990 agriculture-related jobs accounted for over 50 percent of the total jobs within the top ten raking industries. By 2000, there was a decrease, with agriculture-related jobs falling to approximately 47 percent of those total jobs. By 2013, the percentage had decreased to approximately 36 percent. The 2006 Fresno County Agricultural Crop and Livestock Report states that while the agricultural economy is improving, the industry struggles with labor shortages during peak harvest periods, increased production expenses, and hazard-related losses (drought, frost, hail, rain, and excessive heat).

Fresno County farm employment represents 13.2 percent of the total countywide employment, compared to 2.5 percent of statewide employment. Within the Valley, San Joaquin County had the lowest unemployment rate (8.8 percent) and Tulare County had the highest (12.2 percent), with Fresno County falling in between (10.3 percent). Fresno County has slightly more service-related employment than the rest of the San Joaquin Valley. The total goods-producing employment (e.g., mining, construction, and manufacturing) represented 12.3 percent of the total nonfarm employment, which is just slightly lower than the state and also lower than that of the San Joaquin Valley, at 12.7 and 13.8 percent, respectively

Beyond agriculture and farming, the healthcare field has shown robust growth in Fresno County. Between 1990 and 2013, employment in ambulatory health services more than doubled, with an average annual growth rate of 3.4 percent. The hospital sector has also grown, with an annual growth rate of 1.4 percent from 1990 to 2013. Additionally, employment in the administrative and support services sector increased at an average annual rate of 3.9 percent between 1990 to 2013.

When looking at total employment within the entire Valley, Fresno County ranked highest, with 33 percent of total employment, followed by Kern and San Joaquin counties with 30 and 23 percent, respectively. Though Fresno County has the highest percentage of jobs, the number of jobs grew much faster in other counties, at 1.6 percent average annual growth rate between 2010 and 2014, in comparison to Kern, Madera, and Merced counties which during the same period grew at rates of 3.0 percent, 2.3 percent and 2.0 percent, respectively.

While Fresno County's total employment was the highest among San Joaquin Valley counties, the unemployment rate fell in the middle. San Joaquin County had the lowest unemployment rate in December 2015 (8.8 percent) and Tulare County had the highest (12.2 percent), with Fresno County at 10.3 percent, a rate very similar to other counties in the Valley. All counties in the San Joaquin Valley had unemployment rates significantly higher than that of the state average of 5.8 percent. Figure 2-5 shows the difference between the Fresno County and state unemployment rate between 1995 and 2015.

In relation to the state and neighboring counties, Fresno County has a lower population to jobs ratio, which may indicate a lack of available jobs to match the skills of the county's residents or reflect the number of residents who work outside the county but who can afford the cost of housing in the County as opposed to the higher cost housing in the Bay Area. Education levels are also lower; approximately 20 percent of the county population with a bachelor's degree or higher, compared to over 30 percent of the statewide population.

Comprehensive economic data available for Fresno County comes from the U.S. Census Bureau by way of the American Community Survey. Select estimates of economic characteristics for Fresno County are shown in Table 2.1.

Table 2.1 Fresno County Economic Characteristics

Characteristic	Fresno County
In civilian labor force, total, percent of population age 16 years+	60.9
In civilian labor force, female, percent of population age 16 years+	54.6
Total accommodation and food services sales, 2012 ($1,000)	1,226,169
Total health care and social assistance receipts/revenue, 2012 ($1,000)	5,325,615
Total retail sales, 2012 ($1,000) (c)	9,117,752
Median household income (in 2015 dollars), 2010-2014	45,233
Per capita income in past 12 months (in 2015 dollars), 2010-2014	20,408
Persons in poverty, percent	26.8
Total employer establishments, 2015	16,350
Total employment 2015	374,564
Total annual payroll ($1,000), 2015	10,056,124
Total employment, percent change 2014-2015	2.0

Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

The median household income for Fresno County has increased over the past nine years, from about $41,900 in 2005 to $45,233 in 2015. In comparison with other San Joaquin Valley counties, the median household income is somewhat low. The County falls significantly short of the state median household income ($61,900), as well as other counties in the San Joaquin Valley ($52,000 in San Joaquin County and $51,000 in Stanislaus County).

More recent data from the California Employment Development Department indicates that, in 2015, there were 432,146 people in the Fresno County labor force. Of these, 374,564 were employed; 57,137 were not. The unemployment rate was 13.2 percent. Areas with seasonal economies, such as the County's agriculture industry, tend to have higher unemployment.

Table 2.2 illustrates the breakdown of employment by industry in Fresno County in 2016, and Table 2.3 compares the distribution of employment in Fresno County to the San Joaquin Valley and State of California. The best available data on industry is compiled by Fresno County Economic Development Corporation using US Economic Census information from 2012. This information is also included in the 2040 Fresno County General Plan.

Table 2.2 Fresno County's Employment by Industry, 2016

Industry	# Employed	% Employed
Educational Services, and Health Care, and Social Assistance	89,768	23.6
Retail Trade	40,404	10.6
Agriculture, Forestry, Fishing and Hunting, and Mining	38,340	10.1
Arts, Entertainment, and Recreation, and Accommodation, and Food Services	33,510	8.8
Professional, Scientific, and Management, and Administrative and Waste Management Services	31,818	8.4
Manufacturing	28,025	7.4
Public Administration	23,284	6.1
Construction	20,259	5.3
Other Services, Except Public Administration	19,208	5.0
Transportation and Warehousing, and Utilities	18,381	4.8
Finance and Insurance, and Real Estate and Rental and Leasing	18,293	4.8
Wholesale Trade	14,526	3.8
Information	4,805	1.3
Totals	380,621	100.0

Source: U.S. Census Bureau American Community Survey, 2012-2016 5-Year Estimates, www.census.gov/

Table 2.3 Annual Employment by Industry*-- California, Fresno, and San Joaquin Valley*

Sector/Industry	California		Fresno		San Joaquin Valley	
	Avg Emp	% of Total	Avg Emp	% of Total	Avg Emp	% of Total
Total Farm	399,100	2.5%	48,900	13.2%	196,400	13.7%
Total Nonfarm	14,706,300	90.3%	292,600	79.2%	1,124,100	78.6%
Goods Producing						
Mining and Logging***	30,500	0.2%	300	0.1%	51,800	4.6%
Construction	589,900	4.0%	12,200	4.2%		
Manufacturing	1,252,100	8.5%	23,600	8.1%	103,300	9.2%
Subtotal Goods Producing	1,872,500	12.7%	36,100	12.3%	155,100	13.8%
Trade, Transportation, and Utilities						
Wholesale Trade	675,700	4.6%	12,800	4.4%	44,900	4.0%
Retail Trade	1,572,300	10.7%	33,800	11.6%	137,900	12.3%
Transportation, Warehousing, Utilities	487,300	3.3%	11,600	4.0%	52,500	4.7%
Subtotal Trade, Transportation, Utilities	2,735,300	18.6%	58,200	19.9%	235,300	20.9%
Service Providing						
Information	435,100	3.0%	3,800	1.3%	11,500	1.0%
Financial Activities	773,500	5.3%	12,800	4.4%	41,600	3.7%
Professional and Business Services	2,238,200	15.2%	28,000	9.6%	102,000	9.1%
Education Services (Private), Health Care, Social Assistance	2,172,100	14.8%	51,100	17.5%	174,000	15.5%
Leisure and Hospitality	1,598,700	10.9%	28,000	9.6%	101,200	9.0%
Other (excluding Private Household Workers)	504,700	3.4%	10,600	3.6%	35,100	3.1%
Government	2,376,300	16.2%	64,100	21.9%	256100	22.8%
Subtotal Service Producing	10,098,600	68.7%	198,400	67.8%	721,500	64.2%
Total Employment	16,281,000	100.0%	369,300	100.0%	1,430,500	100.0%

*Employment reflects number of jobs. Data is not seasonally adjusted.

**Includes Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties.

***The total number and percentage for San Joaquin Valley is higher than the actual estimate; numbers for Kern, Fresno, and San Joaquin County included construction numbers separately from Mining and Logging but the other five counties did not. Therefore, the total for Mining and Logging jobs in San Joaquin Valley also includes construction jobs.
Source: California Employment Development Department, 2012.

2.4 Population

Fresno County is one of the largest, fastest growing, and most diverse counties in California. It is the state's 10th most populous county according to the California Department of Finance. Fresno County's population is projected to grow by 606,200 over the 45-year period, an increase of 61.8 percent overall and an average annual rate of 1.1 percent. The county's rate falls between the San Joaquin Valley (76.1 percent overall and 1.4percent annually) and California (32.8percent overall and 0.6percent annually).

Overall, Fresno County has a younger population than the rest of California. Minors (under 18) account for 29.3 percent of the population, while seniors (age 65 and above) account for 10.6 percent of the population. Approximately 30.6 percent of the population in Fresno County cities is under 18, compared with 26.2 percent in unincorporated areas (U.S. Census Bureau, 2014 American Community Survey).

Fresno County residents have completed less formal education than residents of California as a whole, with 50.6 percent of the population in Fresno County attaining education levels beyond a high school diploma, compared with 60.8 percent of the population in California (U.S. Census Bureau, 2014 American Community Survey).

Population estimates for the years 2010-2016 for each of the incorporated towns and the unincorporated County are provided in Table 2.5.

Table 2.4 Fresno County Population 2010-2016*

	2010	2011*	2012*	2013*	2014*	2015*	2016*
County Total	932,463	940,496	946,844	953,762	963,151	972,130	979,915
City of Clovis	96,210	97,452	98,560	99,656	101,980	103,926	106,583
City of Coalinga	18,067	18,047	16,812	16,736	16,412	16,521	16,598
City of Firebaugh	7,373	7,474	7,639	7,773	7,935	8,084	8,176
City of Fowler	5,305	5,434	5,655	5,785	5,908	6,006	6,083
City of Fresno	496,879	500,897	505,261	508,971	514,376	518,503	522,053
City of Huron	6,755	6,754	6,763	6,777	6,789	6,812	6,941
City of Kerman	13,641	13,894	14,314	14,338	14,376	14,463	14,594
City of Kingsburg	11,411	11,512	11,601	11,668	11,702	11,774	11,807
City of Mendota	11,179	11,356	11,382	11,381	11,377	11,398	11,418
City of Reedley	23,669	23,968	24,304	24,562	24,858	25,092	25,273
City of Sanger	24,303	24,467	24,542	24,625	24,716	24,857	25,007
City of San Joaquin	3,927	3,965	3,974	3,991	4,010	4,008	4,011
City of Selma	23,317	23,445	23,775	24,160	24,2345	24,349	24,597

Source: U.S Census Bureau American Community Survey 5-Year Estimates http://factfinder.census.gov/
*Estimate

Select demographic and social characteristics for Fresno County from the 2012-2016 American Community Survey are shown in Table 2.6.

Table 2.5 Fresno County Demographic and Social Characteristics, 2016

Fresno County	
Population	
Population estimates, 2016	963,160
Population, percent change- 2010 (estimates base) to 2016	3.5
Population, Census, 2010	930,450
Age and Sex	
Persons under 5 years, percent	8.2
Persons under 18 years, percent	28.9
Persons 65 years and over, percent	11.2
Female persons, percent	50.1
Race and Hispanic Origin	
White alone, percent	61.6
Black or African American alone, percent	5.0
American Indian and Alaska Native alone, percent	1.0
Asian alone, percent	9.9
Native Hawaiian and Other Pacific Islander alone, percent	0.2
Two or More Races, percent	3.9
Hispanic or Latino, percent	52.0
White alone, not Hispanic or Latino, percent	30.8
Education	
High school graduate or higher, percent of persons age 25 years+	73.8
Bachelor's degree or higher, percent of persons age 25 years+	19.7

Source: U.S. Census Bureau, 2010 Decennial Census, 2016 Population Estimates, American Community Survey 2012-2016 5-Year Estimates, http://factfinder2.census.gov/

2.5 Development Trends

The California Department of Finance (DOF) forecasts population growth from 2015 through 2060 for the eight counties in the San Joaquin Valley and for California overall. Fresno County's population is projected to grow by 606,200 over the 45-year period, an increase of 61.8 percent overall and an average annual rate of 1.1 percent. The growth rate is expected to be higher over the first few decades before tapering-off in the later decades. Fresno County's rate falls between the San Joaquin Valley (76.1percent overall and 1.4percent annually) and California (32.8 percent overall and 0.6 percent annually). Fresno County's growth rate through 2060 is expected to be lower than all other San Joaquin Valley counties, except Stanislaus County (59.0percent overall and 1.0 percent annually).

Since 1960, Fresno County's population has shifted from the county's unincorporated area to the county's cities, with the incorporated-unincorporated split changing from 50.2percent to 49.8percent in 1960 to 82.5percent to 17.5percent in 2015. Fresno County's population and anticipated growth is mostly concentrated in and around the county's cities. The Fresno metropolitan area has absorbed much of the county's population growth, either through annexations or new development. Over 53 percent of the county's population now resides in the City of Fresno and almost 11 percent resides in Clovis. Between 1960 and 2015, the population of unincorporated Fresno County decreased by 11,670 from 182,120 to 170,450, a reduction of 6.4 percent.

The FCOG projections indicate an increasing percentage of employment growth occurring in Fresno County's cities, compared with the unincorporated areas. Between 2015 and 2050, 91.8percent of the employment growth is projected to occur in city spheres of influence. This will result in 16.8 percent of the county's employees located in the unincorporated area by 2050. The fastest-growing sectors will be construction (3.8 percent annually), professional and business services (3.1 percent annually), and educational services, health care, and social assistance (3.2 percent annually).

3 PLANNING PROCESS

Requirements §201.6(b) and §201.6(c)(1): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1) **An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;**
2) **An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and**
3) **Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.**

[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

3.1 Background on Mitigation Planning in Fresno County

The primary purpose of the Fresno County Multi-Jurisdictional Hazard Mitigation Plan (LHMP) update is to reduce or eliminate long-term risk to people and property from natural hazards and their effects on the Fresno County, California planning area. Fresno County recognized the need and importance of a Local Hazard Mitigation Plan (LHMP) and initiated its development in 2007 after receiving a grant from the Federal Emergency Management Agency (FEMA), which served as the primary funding source for this plan. The original LHMP was developed in 2007-2008 and received FEMA approval in 2009. Additional details on the original planning effort can be referenced in the 2009 Plan.

The plan underwent a comprehensive update in 2017-2018. The planning process followed during the update was similar to that used in the original plan development utilizing the input from a multi-jurisdictional Hazard Mitigation Planning Committee (HMPC). Amec Foster Wheeler was procured to assist with the update in 2017. The process is described further in this section and documented in Appendix E.

3.2 What's New in the Plan Update

Requirements §201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

The updated LHMP complies with Federal Emergency Management Agency (FEMA) guidance and California Office of Emergency Services guidelines for Local Hazard Mitigation Plans. The update followed the requirements noted in the Disaster Mitigation Act (DMA) of 2000 and the 2013 Local Hazard Mitigation Planning Handbook.

This HMP update involved a comprehensive review and update of each section of the 2009 plan and includes an assessment of the progress of the participating communities in evaluating, monitoring and implementing the mitigation strategy outlined in the initial plan. Only the information and data still valid from the 2009 plan was carried forward as applicable into this HMP update.

Also to be noted, Section 7.0 Plan Implementation of this plan update identifies key requirements for updating future plans including:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Document hazard events and impacts that occurred within the five-year period;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate documentation of continued public involvement;
- Incorporate documentation to update the planning process that may include new or additional stakeholder involvement;
- Incorporate growth and development-related changes to building inventories;
- Incorporate new project recommendations or changes in project prioritization;
- Include a public involvement process to receive public comment on the updated plan prior to submitting the updated plan to Cal OES/FEMA; and
- Include re-adoption by all participating entities following FEMA approval.

These requirements and others as detailed throughout this plan were addressed during the 2017-2018 plan update process.

Plan Section Review and Analysis – 2018 Update

During the 2017-2018 plan update, the HMPC updated each of the sections of the previously approved plan to include new information. Amec Foster Wheeler developed a summary of each section in the plan and guided the HMPC through the elements that needed updating during the kickoff meeting in July 2017. This included analyzing each section using FEMA's local plan update guidance (2013) to ensure that the plan met the latest requirements. The HMPC and Amec Foster Wheeler determined that nearly every section of the plan would need revision to align the plan with the latest FEMA planning guidance and requirements. A summary of the changes in this plan update is highlighted in the table below

Table 3.1 Fresno County Hazard Mitigation Plan Update Highlights

Plan Section	Summary of Plan Review, Analysis, and Updates
1. Introduction	Updated language to describe purpose and requirements of the Fresno County Multi-Hazard Mitigation Plan update process. Identified new participating jurisdictions.
2. Community Profile	Updated with recent census data and current economy description
3. Planning Process	Described and document the planning process for the update, including coordination among agencies Described how 2009 plan was integrated with/into other planning efforts. Removes 2009 planning process info. Described any changes in participation in detail. Described 2017-2018 public participation process Described updates to the Hazard Mitigation Planning Committee
4. Risk Assessment	Revisited former hazards list for possible modifications. Reviewed the County and City of Fresno's CRS participation Updated list of disaster declarations to include recent data. Updated tables to include recent National Center for Environmental Information data. Updated past occurrences for each hazard to include recent data. Updated critical facilities identified from the 2009 plan. Updated growth and development trends to include recent Census and local data sources. Updated historic and cultural resources using local/state/national sources. Updated property values for vulnerability and exposure analysis, using updated building information based on assessor's data. Updated estimate flood losses using the latest Fresno County Digital Flood Insurance Rate Map (DFIRM) and assessor's data. Updated National Flood Insurance Program (NFIP) data and Repetitive Loss structure data from the previous plan. Incorporated new hazard loss estimates since 2009, as applicable. Used updated GIS inventory data to assess wildfire threat to the County Updated HAZUS-MH Level I earthquake vulnerability analysis data Updated information regarding specific vulnerabilities to hazards, including maps and tables of specific assets at risk, specific critical facilities at risk, and specific populations at risk. Updated maps in plan where appropriate. Reviewed mitigation capabilities and update to reflect current capabilities.
5. Mitigation Strategy	Indicated what projects have been implemented that may reduce previously identified vulnerabilities. Updated Chapter 5 based on the results of the updated risk assessment, completed mitigation actions, and implementation obstacles and opportunities since the completion of the 2009 plan. Reviewed and updated goals and objectives based on HMPC input. Revised to include more information on the Community Rating System (CRS) categories of mitigation measures (structural projects, natural resource protection, emergency services, etc.) and how they are reviewed when considering the options for mitigation. Included updated information on how actions are prioritized. Reviewed mitigation actions from the 2009 plan and develop a status report for each; identified if actions have been completed, deleted, or deferred/carried forward. Updated priorities on actions. Identified examples of successful implementation to highlight positive movement on actions identified in 2009 plan. Identified and detailed new mitigation actions proposed by the HMPC.

Plan Section	Summary of Plan Review, Analysis, and Updates
6. Plan Adoption	Plan will be re-adopted as part of the update process
7. Plan Maintenance	Reviewed and updated procedures for monitoring, evaluating, and updating the plan. Revised to reflect current methods. Updated the system for monitoring progress of mitigation activities by identifying additional criteria for plan monitoring and maintenance.
Jurisdictional Annexes	Developed annexes for new participating jurisdictions in 2017-2018. Updated previous participants' annexes with recent Census data. Updated past event history and hazard loss estimates. Added new maps and updated old maps as needed. Updated mitigation actions from 2009 and added new mitigation actions.
Appendices	Updated references. Updated planning process documentation. Updated mitigation alternatives analyzed in the process. Public participation plan updated Plan Adoption.

3.3 Local Government Participation

In the 2017-2018 plan update, the following jurisdictions participated in the planning process and will be adopting the updated plan following FEMA approval. Changes in participation during the 2017-2018 are denoted below by an asterisk '*' which indicates jurisdictions added to the plan during the update process. This included four municipalities and two special districts. Only one municipality (Huron) that participated in the 2009 plan did not participate in the update and no longer has an annex specific to them.

Lead Jurisdiction:

- Fresno County

Municipalities:

- City of Clovis
- City of Coalinga
- City of Firebaugh*
- City of Fowler*
- City of Fresno
- City of Kerman
- City of Kingsburg
- City of Mendota
- City of Reedley*
- City of San Joaquin*
- City of Sanger
- City of Selma

Special Districts:

- Fresno Metropolitan Flood Control District
- Lower San Joaquin Levee District
- Sierra Resource Conservation District/Highway 168 Fire Safe Council
- Kings River Conservation District*
- Westlands Water District*

**indicates new to plan in 2017-2018*

The DMA planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the HMPC
- Detail areas within the planning area where the risk differs from that facing the entire area
- Identify potential mitigation actions
- Formally adopt the plan

For the Fresno County planning area's HMPC, "participation" meant the following:

- Providing facilities for meetings
- Attending and participating in the HMPC meetings
- Completing and returning Amec Foster Wheeler Data Collection worksheets or reviewing and jurisdictional annexes
- Collecting and providing other requested data (as available)
- Identifying mitigation actions for the plan
- Reviewing and providing comments on plan drafts
- Informing the public, local officials, and other interested parties about the planning process and providing opportunity for them to comment on the plan
- Coordinating, and participating in the public input process
- Coordinating the formal adoption of the plan by the governing boards

The County and all jurisdictions with annexes to this plan and seeking FEMA approval met all of these participation requirements. In most cases one or more representatives for each jurisdiction attended the multi-jurisdictional meetings described in Table 3.2, Schedule of Planning Meetings, and also brought together a local planning team to help collect data, identify mitigation actions and implementation strategies, and review and provide data on annex drafts. In some cases, the jurisdictions had limited capacity to attend or had conflicts with HMPC meetings; in these cases, side-bar phone calls and emails were used to provide input into the process. Appendix E provides additional information and documentation of the planning process.

3.4 The 10-Step Planning Process

Amec Foster Wheeler established the planning process for the Fresno County Multi-Hazard Mitigation Plan using the DMA planning requirements and FEMA's associated guidance. The original FEMA planning guidance is structured around a four-phase process:

1) Organize Resources
2) Assess Risks
3) Develop the Mitigation Plan
4) Implement the Plan and Monitor Progress

Into this process, Amec Foster Wheeler integrated a more detailed 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the modified 10-step process used for this plan meets the requirements of major grant programs including: FEMA's Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, Flood Mitigation Assistance Program, and flood control projects authorized by the U.S. Army Corps of Engineers.

In 2013, FEMA released the Local Mitigation Planning Handbook that has become the official guide for local governments to develop, update and implement local mitigation plans. While the requirements under §201.6 have not changed, the Handbook provides guidance to local governments on developing or updating hazard mitigation plans to meet the requirements under the Code of Federal Regulations (CFR) Title 44 – Emergency Management and Assistance §201.6, Local Mitigation Plans for FEMA approval and eligibility to apply for FEMA Hazard Mitigation Assistance grant programs. It also offers practical approaches, tools, worksheets and local mitigation planning examples for how communities can engage in effective planning to reduce long-term risk from natural hazards and disasters. The Handbook complements and liberally references the Local Mitigation Plan Review Guide (October 1, 2011), which is the official guidance for Federal and State officials responsible for reviewing local mitigation plans in a fair and consistent manner.

Table 3.1 shows how the modified 10-step process fits into FEMA's four-phase process, and how these elements correspond to the tasks in the FEMA Mitigation Planning Handbook.

Table 3-1 Fresno County Hazard Mitigation Planning Process

FEMA's 4-Phase DMA Process	Modified 10-Step CRS Process	FEMA Local Mitigation Planning Handbook Tasks
1) Organize Resources		
201.6(c)(1)	1) Organize the Planning Effort	1: Determine the planning area and resources
201.6(b)(1)	2) Involve the Public	2: Build the planning team - 44 CFR 201.6 (C)(1)
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies	3: Create an outreach strategy - 44 CFR 201.6(b)(1)
		4: Review community capabilities - 44 CFR 201.6 (b)(2)&(3)
2) Assess Risks		
201.6(c)(2)(i)	4) Identify the Hazards	5: Conduct a risk assessment - 44 CFR 201.6 (C)(2)(i) 44 CFR 201.6(C)(2)(ii)&(iii)
201.6(c)(2)(ii)	5) Assess the Risks	
3) Develop the Mitigation Plan		
201.6(c)(3)(i)	6) Set Goals	6: Develop a mitigation strategy - 44 CFR 201.6(c)(3)(i); 44 CFR 201(c)(3)(ii) and 44 CFR 201.6(c)(3)(iii)
201.6(c)(3)(ii)	7) Review Possible Activities	
201.6(c)(3)(iii)	8) Draft an Action Plan	
4) Implement the Plan and Monitor Progress		
201.6(c)(5)	9) Adopt the Plan	7: Review and adopt the plan
201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan	8: Keep the plan current
		9: Create a safe and resilient community - 44 CFR 201.6(c)(4)

3.4.1 Phase 1: Organize Resources

Planning Step 1: Organize the Planning Effort

The 2017-2018 planning process and update of the LHMP was formally initiated in April and May of 2017 under the coordination of the Fresno County Office of Emergency Services (OES) as the lead entity. Amec Foster Wheeler worked with the OES staff to establish the framework and organization for development of the plan. Amec Foster Wheeler assisted OES with coordination with other governmental agencies and public process elements to develop the updated LHMP for the Fresno County Operational Area. Organizational efforts were initiated with a series emails to inform and educate jurisdictions within the County of the purpose and need for an update to the countywide hazard mitigation plan. Representatives from participating jurisdictions and HMPC members to the 2009 plan were used as a starting point for the invite list, with additional invitations extended as appropriate throughout the planning process. The list of initial invitees is included in Appendix B. Email invitations were sent to all city managers (15) and fire chiefs, county departments; and all special districts in the County. The HMPC was re-established as a result of this effort.

Hazard Mitigation Planning Committee

The HMPC, which included key County, city, and other local government and stakeholder representatives, updated the plan with leadership from the County's emergency services manager and facilitation by Amec Foster Wheeler. The following participated on the HMPC:

Fresno County

- Agriculture Department
- CAO
- Public Health Department
- Public Health -Environmental Health and Safety
- Fresno County Fire Protection District
- Internal Services Department
- Information Technology Services Department
- Office of Emergency Services (Lead)
- Public Works - Development Services
- Public Works and Planning Department
- Public Works - Roads
- Sheriff's Department

Participating Jurisdictions

- City of Clovis
  - Fire
- City of Coalinga
  - Fire
- City of Fresno
  - Office of Emergency Services
- City of Firebaugh
- City of Fowler
- City of Kerman
  - Police
  - Public Works
- City of Kingsburg
  - Fire
- City of Mendota
- City of Reedley
- City of San Joaquin
- City of Sanger
  - Fire
- City of San Joaquin
- City of Selma

- Fresno Metropolitan Flood Control District
- Lower San Joaquin Levee District
- Sierra Resource Conservation District – in cooperation with Oak to Timberline Fire Safe and Highway 168 Fire Safe Council
- Westlands Water District

Other Government and Stakeholder Representatives:

- California Department of Water Resources
- California Department of Forestry and Fire (CAL FIRE: Fresno County)
- Fresno Irrigation District*
- Fresno Mosquito District
- Kings River Conservation District*
- San Joaquin Valley Resource Conservation Development
- U.S. Army Corps of Engineers Pine Flat
- U.S. Forest Service – Sierra National Forest*
- U.S. Bureau of Reclamation*

A list of the primary HMPC representatives for each jurisdiction and a complete list of participating HMPC members are included in Appendix B. Each jurisdiction also utilized the support of many other support staff in order to collect and provide requested data and conduct timely reviews of the draft documents. Note that the above list of HMPC members also includes several other government and stakeholder representatives that contributed to the planning process. Specific participants from these other agencies are also identified in Appendix B.

Planning Meetings

The planning process officially began with a kick-off meeting on July 12, 2017. The meeting covered the scope of work and an introduction to the DMA requirements. Participants were provided with a Local Hazard Mitigation Plan Update Guide, which included worksheets to facilitate the collection of information necessary to support update of the plan. Using FEMA guidance, Amec Foster Wheeler designed these worksheets to capture information on past hazard events, identify hazards of concern to each of the participating jurisdictions, quantify values at risk to identified hazards, inventory existing capabilities, and record possible mitigation actions. A copy of Amec Foster Wheeler's Local Hazard Mitigation Plan Update Guide for this project is included in Appendix E. The County and each jurisdiction seeking FEMA approval of their plan completed and returned the worksheets in either the Local Hazard Mitigation Plan Update Guide, or the Jurisdictional Annex Template (described further below) to Amec Foster Wheeler for incorporation into the plan document.

During the planning process, the HMPC communicated through face-to-face meetings, email, telephone conversations, and a project-based website. Draft documents were posted on this website so that the HMPC members could easily access and review them. The HMPC formally met three times during the planning period (July 12, 2017 – November 16, 2017). The purposes of these meetings are described in Table 3.2. In addition to these meetings some jurisdictions held meetings with subcommittees to discuss the needed input for the plan update. An example is a meeting with County OES and other department representatives on August 15, 2017.

Table 3-2 Schedule of Planning Meetings

Meeting Type	Meeting Topic	Meeting Date(s)	Meeting Location(s)
HMPC #1	Kick-off meeting: introduction to DMA, the planning process, and hazard identification	July 12, 2017	Clovis
HMPC #2	Hazard Identification, Risk Assessment, and Mitigation Goals/Strategy	October 6, 2107	Clovis
HMPC #3	Development and prioritization of mitigation action recommendations	November 16, 2017	Clovis

During the kickoff meeting, a template for the jurisdictional annexes was distributed. Similar to the Local Hazard Mitigation Plan Update Guide described above, this template included blank tables and other directional information to facilitate the collection of key jurisdictional information for jurisdictions that would be new to the plan in 2017-2018. A copy of the Jurisdictional Annex Template is included in Appendix E. A project Google drive was used to coordinate the population of the templates and receive edits to existing jurisdictional annexes. Each jurisdiction with an annex in this plan provided data as requested in the annex template and reviewed and commented on the draft annexes throughout the development of the plan.

Agendas for each of the meetings and lists of attendees are included in Appendix E.

Planning Step 2: Involve the Public

Involving the public assures support from the community at large and is a part of the planning process. Early discussions with the Fresno County OES established the initial plan for public involvement in the plan update. Public outreach began early in the process with a public survey and a meeting held in November 2017 to inform the public of the purpose of the DMA and the hazard mitigation planning process for the Fresno County planning area.

At the kick-off meeting, the HMPC discussed additional options for public involvement and agreed to an approach using established public information mechanisms and resources within the community. Public involvement activities included press releases, website postings, flyer development and distribution, public meetings, and the collection of public comments on the draft plan. The Fresno County Multi-Hazard Mitigation Plan was also discussed on the local radio during interview with the County OES manager.

A public involvement 'backgrounder' document (see Appendix E) was prepared and presented to the HMPC at the kickoff meeting. The document outlines the FEMA definition of hazard mitigation, explains why hazard mitigation is important, gives some background on hazard mitigation plans and the process of updating the plans, and finally offers information on how the public can become involved in the process. This backgrounder was used as handout at various public meetings and events as a mechanism to outreach and engage the public in the planning process for the update. An example of a public meeting where the flyer was distributed was a commissioner's meeting on personal disaster preparedness held November 13, 2017. Hardcopy versions of a public survey discussed below were also distributed.

During the plan update's drafting stage, an online public survey was developed as a tool to gather public input. A hardcopy version was also developed. The survey was for the public to provide feedback to the Fresno County multi-jurisdictional Hazard Mitigation Planning Committee on reducing hazard impacts. The survey provided an opportunity for public input during the planning process, prior to finalization of the plan update. The survey gathered public feedback on concerns about hazards and input on strategies to reduce their impacts. The survey was released in November and closed on December 31st. The HMPC provided links to a public survey by distributing it using social media, email, and posting the link on websites.

One hundred eighty four (184) people filled out the survey online and in hardcopy (which was faxed or scanned and emailed). Results showed that the public perceives the most significant hazards to be drought, tree mortality and wildfire. Wildfire fuels treatment projects, evacuation route development and hazardous tree removal were cited as the most popular mitigation actions. A summary of the survey data can be found in **Appendix G.**

Figure 3.1 Example of Public Survey Response

Public meetings were held during the draft-plan development and prior to finalizing the plan as further described in Table 3.3. Example press releases and sign in sheets are located in Appendix E. Prior to finalizing the plan the draft was available online on the Fresno County OES website. An electronic comment form was provided with the draft plan. X comments were received. Where appropriate, stakeholder and public comments were incorporated into the final plan, including the sections that address mitigation goals and strategies. The public outreach activities described here were conducted with participation from and on behalf of all jurisdictions participating in this plan.

Table 3-3 Schedule of Public Meetings

Meeting Topic	Meeting Date	Meeting Locations
Public education and feedback Meeting: risk assessment overview, mitigation project options overview, an update on planning process, and public survey	November 16, 2017	Clovis

Planning Step 3: Coordinate with Other Departments and Agencies

Early in the planning process, state, federal, and local agencies and organizations were invited to participate as stakeholders in the process. Stakeholders could participate in various ways, either by contributing input at HMPC meetings, being aware of planning activities through an email group, providing information to support the effort, or reviewing and commenting on the draft plan. Based on their involvement in other hazard mitigation planning efforts, status in the County, and interest as a neighboring jurisdiction, representatives from the following agencies were invited to participate as stakeholders in the process:

- California Department of Forestry and Fire Protection (CAL FIRE: Fresno County)*
- California Department of Water Resources
- California Governor's Office of Emergency Services*
- California Department of Transportation CAL Trans
- Fresno Irrigation District*
- Fresno Metropolitan Flood Control District*
- Fresno Mosquito District
- Highway 168 Fire Safe Council
- Lower San Joaquin Levee District*
- Madera County Office of Emergency Services
- Table Mountain Rancheria
- U.S. Army Corps of Engineers Pine Flat
- U.S. Bureau of Reclamation*
- Westlands Water District*

* Participated on HMPC

The HMPC also used technical data, reports, and studies from the following agencies and groups in the development and update of this plan:

- Bureau of Land Management
- California Department of Forestry and Fire Protection*
- California Department of Parks and Recreation Office of Historic Preservation
- California Department of Transportation
- California Geological Survey
- Fresno County Agricultural Department*
- Fresno County Health Department*
- Fresno County Information Technology/Geographic Information Systems Department*
- Fresno County Internal Services Department*
- Fresno County Land Use Department
- Fresno County Public Works and Planning Department*
- National Oceanic and Atmospheric Administration National Climatic Data Center
- National Register of Historic Places
- Natural Resource Conservation Service
- National Weather Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- US Sierra National Forest*
- Western Regional Climate Center

* Participated on HMPC

The majority of the listed stakeholders were invited to participate in the planning process, which included an invitation to the kickoff meeting. Several opportunities were provided for the above groups to participate in the planning process. At the beginning of the planning process, invitations were extended to these groups to actively participate on the HMPC.

Coordination with key agencies, organizations, and advisory groups throughout the planning process allowed the HMPC to review common problems, development policies, and mitigation strategies as well as identifying any conflicts or inconsistencies with regional mitigation policies, plans, programs and regulations. Phone calls and emails were used during plan development to directly coordinate with key individuals representing other regional programs.

As noted by the asterisks next to the above names, many of these groups found it beneficial to participate on the HMPC. Others assisted in the process by providing data directly as requested in the Local Hazard Mitigation Plan Update Guide or through data contained on their websites. Further as part of the both HMPC and public outreach processes, all groups were invited to review and comment on the plan prior to submittal to CA-OES and FEMA.

As part of the public review and comment period for the draft plan, key agencies were again specifically solicited to provide any final input to the draft plan document. This input was solicited both through membership on the HMPC and by direct emails to key groups and associations to review and comment on the plan. As part of this targeted outreach, these key stakeholders were also specifically invited to attend the HMPC and public meeting to discuss any outstanding issues and to provide input on the draft document and final mitigation strategies.

Appendix D References provides a detailed list of general references used in the preparation of this plan update. Specific references relied on in the development of this plan are also sourced throughout the document as appropriate.

In summary, several opportunities were provided for the groups listed above to participate in the planning process. At the beginning of the planning process, invitations were extended to these groups to actively participate on the HMPC. Specific participants from these groups are detailed in Appendix B. Others assisted in the process by providing data directly as requested or through data contained on their websites or as maintained by their offices. Further as part of the public outreach process, all groups were invited to attend the public meetings and to review and comment on the plan prior to submittal to Cal OES and FEMA. In addition, as part of the review of the draft plan, key agency stakeholders were contacted and their comments specifically solicited.

This process accomplished as part of planning steps two and three in the FEMA Local Mitigation Planning Handbook.

Other Community Planning Efforts and Hazard Mitigation Activities

The coordination and synchronization with other community planning mechanisms and efforts are vital to the success of this plan. To have a thorough evaluation of hazard mitigation practices already in place, appropriate planning procedures should also involve identifying and reviewing existing plans, policies, regulations, codes, tools, and other actions are designed to reduce a community's risk and vulnerability from natural hazards. Fresno County uses a variety of mechanisms to guide growth and development. Integrating existing planning efforts, mitigation policies, and action strategies into this plan establishes a credible, comprehensive document that weaves the common threads of a community's values together. The development and update of this plan involved a comprehensive review of existing plans, studies, reports, and initiatives from Fresno County and each participating municipality.

- Fresno County General Plan Safety Element and Background Report (revised 2016)
- Fresno County Operational Area Master Emergency Services Plan
- Fresno County Flood Insurance Study
- Highway 168, Community Wildfire Protection Plan
- State of California Multi-Hazard Mitigation Plan

Other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment.

During the 2017-2018 update this LHMP update was coordinated with the following planning efforts ongoing at the time:

- Fresno County General Plan Update - The HMP utilized information from the ongoing update of the General Plan that is anticipated to be approved in 2018. This included referencing information from the 2016 Revised Background Report and Safety Element. Members of the Amec Foster Wheeler consulting team included Mintier Harnish which was the consultant updating the General Plan. The references to the General Plan policies in Section 4.4 of this plan were reviewed by Mintier Harnish and Department of Public Works staff to reflect recent changes that will be in the updated General Plan. The HMP will be again be incorporated by reference into the Safety Element in accordance with Assembly Bill (AB) 2140.
- 2017 update of Fresno County Operational Area Master Emergency Services Plan
- The Central California Irrigation District (CCID) Hazard Mitigation Plan is a plan that was developed in 2017 in an adjacent jurisdiction and included participation of staff from Fresno County OES in a planning meeting.

2009 Mitigation Plan Inclusion in Other Planning Mechanisms

Chapter 7 Plan Implementation and Maintenance in the 2009 Plan recommended the incorporation of the hazard mitigation plan recommendations and their underlying principles into other County and City plans and mechanisms. The following is a list of plans that the 2009 LHMP was integrated into, or cross referenced. In some cases communities have deferred this for future planning mechanisms, as discussed in the Chapter 7 Plan Implementation and Maintenance.

Table 3-4: 2009 Mitigation Plan Inclusion in Other Planning Mechanisms

Jurisdiction	Planning Mechanism
Fresno County	Fresno County Operational Area, Master Emergency Services Plan- used to inform Hazard Vulnerability Assessment
	Incorporated by reference into the Safety Element in accordance with Assembly Bill (AB) 2140.
Clovis	Incorporated by reference into the Safety Element in accordance with Assembly Bill (AB) 2140.
Coalinga	Deferred for incorporation by reference in future planning mechanisms, where applicable
Fresno	Deferred for incorporation by reference in future planning mechanisms, where applicable
Huron	Deferred for incorporation by reference in future planning mechanisms, where applicable
Kerman	Deferred for incorporation by reference in future planning mechanisms, where applicable
Kingsburg	Deferred for incorporation by reference in future planning mechanisms, where applicable
Mendota	Deferred for incorporation by reference in future planning mechanisms, where applicable

Jurisdiction	Planning Mechanism
Sanger	Deferred for incorporation by reference in future planning mechanisms, where applicable
Selma	Deferred for incorporation by reference in future planning mechanisms, where applicable
Fresno Metropolitan Flood Control District	Deferred for incorporation by reference in future planning mechanisms, where applicable
Lower San Joaquin Levee District	Deferred for incorporation by reference in future planning mechanisms, where applicable
Sierra Resource Conservation District	Highway 168 Fire Safe Council CWPP - Cross references the LHMP and mitigation projects

3.4.2 Phase 2: Assess Risks

Planning Step 4: Identify the Hazards

Amec Foster Wheeler led the HMPC in an effort to review the list of hazards identified in the 2009 plan and document all the hazards that have, or could, impact the planning area, including documenting recent drought, flood, wildfire and winter storm events. Data collection worksheets were used in this effort to aid in determining hazards and vulnerabilities and where risk varies across the planning area. The profile of each of these hazards was then updated in 2017 with information from the HMPC and additional sources. Web resources, existing reports and plans, and existing GIS layers were used to compile information about past hazard events and determine the location, previous occurrences, probability of future occurrences, and magnitude/severity of each hazard. Geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities where data permitted. A more detailed description of the hazard identification and risk assessment process and the results are included in Chapter 4 Risk Assessment.

Planning Step 5: Assess the Risks

After updating the profiles of the hazards that could affect the County, the HMPC collected information to describe the likely impacts of future hazard events on the participating jurisdictions. This step included two parts: a vulnerability assessment and a capability assessment.

Vulnerability Assessment—Participating jurisdictions updated their assets at risk to natural hazards—overall and in identified hazard areas. These assets included total number and value of structures; critical facilities and infrastructure; natural, historic, and cultural assets; and economic assets. The HMPC also analyzed development trends in hazard areas. The latest DFIRM was used to refine the estimate flood losses during the update, where available for the NFIP participating communities.

Capability Assessment— The HMPC also conducted a capability assessment update to review and document the planning area's current capabilities to mitigate risk and vulnerability from natural hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC can assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. This information for the County is included in Section 4.5 and in the respective jurisdictional annexes. This addressed FEMA planning task 4: Review community capabilities - 44 CFR 201.6 (b)(2)&(3).

Results of the risk assessment were presented and comments discussed at the second meeting of the HMPC in November 2017.

A more detailed description of the risk assessment process and the results are included in Chapter 4 Risk Assessment.

3.4.3 Phase 3: Develop the Mitigation Plan

Planning Step 6: Set Goals

Amec Foster Wheeler facilitated a discussion session with the HMPC to review the 2009 plan's goals and objectives. The HMPC discussed definitions and examples of goals, objectives, and actions and considered the goals of the state hazard mitigation plan and other relevant local plans when reviewing and revising the goals and objectives. The resulting updated goals and objectives are presented in Chapter 5 Mitigation Strategy.

Planning Step 7: Review Possible Activities

Amec Foster Wheeler facilitated a discussion at an HMPC meeting to review the alternatives for mitigating hazards. This included a brainstorming session with the HMPC to identify a comprehensive range of mitigation actions for each identified hazard, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. More specifics on the process and the results of this collaborative process are captured in Chapter 5 Mitigation Strategy.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, Amec Foster Wheeler produced a complete first draft of the plan. This complete was shared electronically with the HMPC for review and comment. Other agencies were invited to comment on this draft as well. HMPC and agency comments were integrated into the second draft, which was advertised and distributed to collect public input and comments. Amec Foster Wheeler integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the California Office of Emergency Services and FEMA Region IX to review and approve, contingent upon final adoption by the governing boards of each participating jurisdiction.

3.4.4 Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was adopted by the governing boards of each participating jurisdiction on the dates included in the adoption resolutions in Appendix A: Adoption Resolutions. The final plan will be included in the safety element of the County General Plan and result in the County's eligibility for Assembly Bill (AB) 2140. This adoption makes the jurisdiction eligible for consideration for part or all of its local costs on eligible public assistance to be provided by State share funding through the California Disaster Assistance Act.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. Up to this point in the plan update process, all of the HMPC's efforts have been directed at researching data, coordinating input from participating entities, and updating and developing appropriate mitigation actions. Each recommended action includes key descriptors, such as hazard(s) addressed, lead manager and priority, to help initiate implementation. An overall implementation strategy is described in Chapter 7 Plan Implementation and Maintenance.

Finally, there are numerous organizations within the Fresno County planning area whose goals and interests interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is paramount to the ongoing success of this plan and of mitigation in Fresno County, and is addressed further in Chapter 7. A plan update and maintenance schedule and a strategy for continued public involvement are also included in Chapter 7.

Implementation and Maintenance Process: 2009 Plan

The 2009 LHMP included a process for implementation and maintenance which was generally followed, with some variation. Implementation of the plan including the status of mitigation actions is captured in Chapter 5 and the jurisdictional annexes. In general the County and participating jurisdictions have made progress in the implementation of the plan. Successes of note are detailed in Chapter 5. An updated implementation and maintenance chapter can be referenced in Chapter 7.

4 Risk Assessment

Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. “It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.”

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction’s potential risk to hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

This risk assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (FEMA 386-2, 2002), which breaks the assessment into a four-step process:

1) Identify hazards
2) Profile hazard events
3) Inventory assets
4) Estimate losses

Data collected through this process has been incorporated into the following sections of this chapter:

- **Section 4.1 Hazard Identification: Natural Hazards** identifies the natural hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 4.2 Hazard Profiles** discusses the threat to the planning area and describes previous occurrences of hazard events and the likelihood of future occurrences.
- **Section 4.3 Vulnerability Assessment** assesses the County’s total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends.
- **Section 4.4 Human-Caused Hazards** identifies the areas most susceptible to potential human-caused hazard events by evaluating the locations of hazardous materials facilities and transportation routes.
- **Section 4.5 Capability Assessment** inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation and can affect net vulnerability.

This risk assessment covers the entire geographical extent of Fresno County. Since this plan is a multi-jurisdictional plan, the HMPC was required to evaluate how the hazards and risks vary from jurisdiction to jurisdiction. While these differences are noted in this chapter, they are expanded upon in the annexes of the participating jurisdictions. If no additional data is provided in an annex, it should be assumed that the risk and potential impacts to the affected jurisdiction are similar to those described here for the entire Fresno County planning area.

4.1 Hazard Identification: Natural Hazards

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

The Fresno County HMPC conducted a hazard identification study to determine the hazards that threaten the planning area.

4.1.1 Methodology and Results

Using existing natural hazards data and input gained through planning meetings during both the 2009 LHMP and 2017-2018 update, the HMPC agreed upon a list of natural hazards that could affect Fresno County. Hazards data from the California Governor's Office of Emergency Services (CA-OES), FEMA, the National Oceanic and Atmospheric Administration, and many other sources were examined to assess the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries and property and economic damage. The natural hazards evaluated as part of this plan include those that occurred in the past or have the potential to cause significant human and/or monetary losses in the future. The potential for loss and impacts from the hazards are analyzed further in Section 4.3 Vulnerability Assessment.

In alphabetical order, the natural hazards identified and investigated for the Fresno County Multi-Hazard Mitigation Plan include:

- Agricultural Hazards
- Avalanche
- Dam Failure
- Drought
  - Tree Mortality
- Earthquake
- Flood
- Human Health Hazards
  - Epidemic/Pandemic
  - West Nile Virus
- Landslide

- Severe Weather
  - Extreme Temperatures
    - Extreme Cold/Freeze
    - Extreme Heat
  - Fog
  - Heavy Rain/Thunderstorm/Hail/Lightning/Wind
  - Winter Storm
  - Tornado
- Soil Hazards
  - Erosion
  - Expansive Soils
  - Land Subsidence
- Volcano
- Wildfire

During the 2017-18 LHMP update the HMPC reviewed the list of hazards and confirmed that the original list identified in the 2009 plan was valid. Significant tree deaths have occurred in the Sierras and foothills due to long term drought and insect infestations since the 2009 LHMP. This issue is addressed in the plan update as a consequence and sub-hazard of the drought hazard. It is also noted in the wildfire hazard as it exacerbates the fuel loads. The widespread tree mortality also increases the potential for wind fall hazards.

The HMPC eliminated the natural hazards listed below from further consideration in this risk assessment because they occur rarely or not at all in Fresno County.

- Coastal Erosion
- Coastal Storm
- Hurricane
- Tsunami

Overall Hazard Significance Summary

Overall hazard significance was based on a combination of Geographic Extent, Probability and Potential Magnitude/Severity as defined below. The individual ratings are based on or interpolated from the analysis of the hazards in the sections that follow. During the 2017-18 Fresno County LHMP update the individual ratings and significance of the hazards was revisited and updated. Subsidence, as a subset of soil hazards, has become more of an issue due to heavy groundwater withdrawal during the severe multi-year drought 2012-2017. It may also be exacerbating flood hazards by lowering levee heights in some areas. This hazard's significance was changed from low to medium.

Table 4.1 Fresno County Hazard Significance

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	Significance
Agricultural Hazards	Limited	Highly Likely	Negligible	High
Avalanche	Limited	Likely	Limited	Low
Dam Failure	Extensive	Occasional	Critical	High
Drought	Significant	Likely	Limited	High
Earthquake	Significant	Occasional	Catastrophic	Medium
Flood/Levee Failure	Extensive	Likely	Critical	High
Human Health Hazards:				
Epidemic/Pandemic	Extensive	Occasional	Negligible	High
West Nile Virus	Limited	Highly Likely	Negligible	Low
Landslide	Limited	Occasional	Limited	Low
Severe Weather				
Extreme Cold/Freeze	Significant	Highly Likely	Negligible	Low
Extreme Heat	Extensive	Highly Likely	Limited	Low
Fog	Extensive	Likely	Limited	Medium
Heavy Rain/Thunderstorm/ Hail/Lightning	Extensive	Highly Likely	Limited	Low
Winter Storm	Limited	Highly Likely	Negligible	Medium
Tornado	Extensive	Occasional	Negligible	Low
Windstorm	Extensive	Likely	Limited	Medium
Soil Hazards:				
Erosion	No Data	Likely	No Data	Low
Expansive Soils	No Data	Occasional	No Data	Low
Land Subsidence	Significant	Likely	No Data	Medium
Volcano	Extensive	Unlikely	Negligible	Low
Wildfire	Extensive	Highly Likely	Critical	High
Hazardous Materials	Significant	Highly Likely	Limited	

Geographic Extent
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability

Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less. Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years. Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.	Limited—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid **Significance** Low: minimal potential impact Medium: moderate potential impact High: widespread potential impact

4.1.2 Disaster Declaration History

One method the HMPC used to identify hazards was the researching of past events that triggered federal and/or state emergency or disaster declarations in the planning area. Federal and/or state disaster declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and without the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors.

A USDA declaration will result in the implementation of the Emergency Loan Program through the Farm Services Agency. This program enables eligible farmers and ranchers in the affected county as well as contiguous counties to apply for low interest loans. A USDA declaration will automatically follow a major disaster declaration for counties designated major disaster areas and those that are contiguous to declared counties, including those that are across state lines. As part of an agreement with the USDA, the SBA offers low interest loans for eligible businesses that suffer economic losses in declared and contiguous counties that have been declared by the USDA. These loans are referred to as Economic Injury Disaster Loans.

Fresno is among the many counties in California that are susceptible to disaster. Details on federal and state disaster declarations were obtained by the HMPC, FEMA, and CA-OES and compiled in chronological order in Table 4.1. A review of state and federal declared disasters indicates that Fresno County received 23 state declarations between 1950 and July 2016, 14 of which also received federal disaster declarations. Of the 22 state declarations, 15 were associated with severe winter storms, heavy rains, or flooding; 4 were for freeze; 1 was for drought; 1 was for earthquake; and 2 were for wildfire. USDA declarations for the planning area are discussed in Section 4.2.1 Agricultural Hazards.

This disaster history (combined federal and state) suggests that Fresno County experiences a major event worthy of a disaster declaration every 2.7 years. The County has a 39 percent chance of receiving a disaster declaration in any given year. With the exception of the declarations for earthquake and wildfire, every declaration resulted directly or indirectly from severe weather. Similarly, most disaster-related injuries to people and damage to property and crops resulted from severe weather.

Table 4.2 Fresno County's State and Federal Disaster Declarations, 1950-2017

Hazard Type	Disaster #	Year	State Declaration	Federal Declaration	Location	Damage*
Floods	CDO 50-01	1950	11/21/50	--	Fresno County (statewide)	9 deaths; $32,183,000
Floods	DR-47	1955	12/22/55	12/23/55	Fresno County (statewide)	74 deaths; $200,000,000
Unseasonal and Heavy Rainfall	--	1957	5/20/57	--	Fresno County (other cherry producing areas)	2 injuries; $6,000,000
Storm & Flood Damage	--	1958	4/2/58	4/4/58	Fresno County (statewide)	13 deaths $24,000,000
Unseasonal and Heavy Rainfall	--	1959	9/17/59	--	Fresno County (other Tokay grape producing areas)	2 deaths $100,000
Abnormally Heavy and Continuous Rainfall	--	1963	2/14/64	--	Fresno County (and 50 other counties)	--
1969 Storms	OEP 253-DR-CA	1969	1/25/69	1/26/69	Fresno County (and 39 other counties)	47 deaths 161 injuries $300,000,000
Freeze and Severe Weather Conditions	--	1972	4/17/72	--	Fresno County (and 16 other counties)	$111,517,260
Drought	--	1976	2/9/76	--	Fresno County (and 30 other counties)	$2,664,000,000
Rains Causing Agricultural Losses	--	1982	10/26/82	--	Fresno County (and 10 other counties)	$345,195,974
Winter Storms	DR-682	1982/ 1983	3/15/83	2/9/83	Fresno County (and 43 other counties)	$523,617,032
Coalinga Earthquake	DR-682	1983	5/02/83	5/3/83	Fresno County	No deaths 47 injuries $31,076,300
Storms	DR-758	1986	2/26/86	2/18/86	Fresno County (and 38 other counties)	13 deaths 67 injuries $407,538,904
Wildland Fires	--	1987	9/03/87	--	Fresno County (and 23 other counties)	3 deaths 76 injuries $18,000,000
Freeze	DR-894	1990	1/11/91	2/11/91	Fresno County (and 32 other counties)	$856,329,675

Hazard Type	Disaster #	Year	State Declaration	Federal Declaration	Location	Damage*
Late Winter Storms	DR-979	1992	1/21/93	1/15/93	Fresno County (and 23 other counties)	20 deaths 10 injuries $600,000,000
Severe Winter Storms	DR-1044	1995	1/17/95	1/13/95	Fresno County (and 44 other counties)	11 deaths $741,400,000
Late Winter Storms	DR-1046	1995	--	1/10/95	Fresno County (and all other counties except Del Norte)	17 deaths $1,100,000,000
January 1997 Floods	DR-1155	1997	1/5/97	1/4/97	Fresno County (and 46 other counties)	8 deaths $1,800,000,000
Severe Winter Storms and Flooding	DR-1203	1998	--	2/9/98	Fresno County (and 39 other counties)	17 deaths $550,000,000
Freeze	DR-1267	1998-1999	--	2/7/99	Fresno County (and 7 other counties)	--
Severe Freeze	DR-1689	2007	--	3/14/07	Fresno County (and 11 other counties)	$1,400,000,000
Goose Fire	FM-5140	2016	7/30/16	8/8/16	Fresno County	--
Floods	CDO 50-01	1950	11/21/50	--	Fresno County (statewide)	9 deaths; $32,183,000
Floods	DR-47	1955	12/22/55	12/23/55	Fresno County (statewide)	74 deaths; $200,000,000
Unseasonal and Heavy Rainfall	--	1957	5/20/57	--	Fresno County (other cherry producing areas)	2 injuries; $6,000,000
Storm & Flood Damage	--	1958	4/2/58	4/4/58	Fresno County (statewide)	13 deaths $24,000,000
Unseasonal and Heavy Rainfall	--	1959	9/17/59	--	Fresno County (other Tokay grape producing areas)	2 deaths $100,000
Abnormally Heavy and Continuous Rainfall	--	1963	2/14/64	--	Fresno County (and 50 other counties)	--
1969 Storms	OEP 253-DR-CA	1969	1/25/69	1/26/69	Fresno County (and 39 other counties)	47 deaths 161 injuries $300,000,000
Freeze and Severe Weather Conditions	--	1972	4/17/72	--	Fresno County (and 16 other counties)	$111,517,260
Drought	--	1976	2/9/76	--	Fresno County (and 30 other counties)	$2,664,000,000
Rains Causing Agricultural Losses	--	1982	10/26/82	--	Fresno County (and 10 other counties)	$345,195,974

Hazard Type	Disaster #	Year	State Declaration	Federal Declaration	Location	Damage*
Winter Storms	DR-682	1982/ 1983	3/15/83	2/9/83	Fresno County (and 43 other counties)	$523,617,032
Coalinga Earthquake	DR-682	1983	5/02/83	5/3/83	Fresno County	No deaths 47 injuries $31,076,300
Storms	DR-758	1986	2/26/86	2/18/86	Fresno County (and 38 other counties)	13 deaths 67 injuries $407,538,904
Wildland Fires	--	1987	9/03/87	--	Fresno County (and 23 other counties)	3 deaths 76 injuries $18,000,000
Freeze	DR-894	1990	1/11/91	2/11/91	Fresno County (and 32 other counties)	$856,329,675
Late Winter Storms	DR-979	1992	1/21/93	1/15/93	Fresno County (and 23 other counties)	20 deaths 10 injuries $600,000,000
Severe Winter Storms	DR-1044	1995	1/17/95	1/13/95	Fresno County (and 44 other counties)	11 deaths $741,400,000
Late Winter Storms	DR-1046	1995	--	1/10/95	Fresno County (and all other counties except Del Norte)	17 deaths $1,100,000,000
January 1997 Floods	DR-1155	1997	1/5/97	1/4/97	Fresno County (and 46 other counties)	8 deaths $1,800,000,000
Severe Winter Storms and Flooding	DR-1203	1998	--	2/9/98	Fresno County (and 39 other counties)	17 deaths $550,000,000
Freeze	DR-1267	1998-1999	--	2/7/99	Fresno County (and 7 other counties)	--
Severe Freeze	DR-1689	2007	--	3/14/07	Fresno County (and 11 other counties)	$1,400,000,000
Goose Fire	FM-5140	2016	7/30/16	8/8/16	Fresno County	--

Source: California Governor's Office of Emergency Services, www.oes.ca.gov/
*Damage amount and deaths and injuries reflect totals for all impacted counties

4.2 Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

The hazards identified in Section 4.1 Hazard Identification: Natural Hazards are profiled individually in this section. In general, information provided by planning team members is integrated into this section with information from other data sources, such as those mentioned in

Section 4.1. These profiles set the stage for Section 4.3 Vulnerability Assessment, where the vulnerability is quantified, where possible, for each of the priority hazards.

Each hazard is profiled in the following format:

- **Hazard/Problem Description**—This section gives a description of the hazard and associated issues followed by details on the hazard specific to the Fresno County planning area. Where known, this includes information on the hazard extent, seasonal patterns, speed of onset/duration, and magnitude and/or secondary effects.
- **Extent –** This section gives a description of the potential strength or magnitude of the hazard as it pertains to Fresno County. The geographic extent or location of the hazard is also discussed.
- **Past Occurrences**—This section contains information on historical incidents, including impacts where known. The extent or location of the hazard within or near the Fresno County planning area is also included here. Historical incident worksheets were used to capture information from participating jurisdictions on past occurrences.
- **Likelihood of Future Occurrence**—The frequency of past events is used in this section to gauge the likelihood of future occurrences. Where possible, frequency was calculated based on existing data. It was determined by dividing the number of events observed by the number of years on record and multiplying by 100. This gives the percent chance of an event happening in any given year (e.g., three droughts over a 30-year period equates to a 10 percent chance of a drought in any given year). The likelihood of future occurrences is categorized into one of the following classifications:
  - **Highly Likely**—Near 100 percent chance of occurrence in next year or happens every year.
  - **Likely**—Between 10 and 100 percent chance of occurrence in next year or has a recurrence interval of 10 years or less.
  - **Occasional**—Between 1 and 10 percent chance of occurrence in the next year or has a recurrence interval of 11 to 100 years.
  - **Unlikely**—Less than 1 percent chance of occurrence in next 100 years or has a recurrence interval of greater than every 100 years.
- **Climate Change Considerations** - This describes the potential for climate change to affect the frequency and intensity of the hazard in the future

Section 4.3 Vulnerability Assessment has more detail on the County's total exposure to natural hazards, considering assets at risk, critical facilities, and future development trends. Where feasible the vulnerability of people, property, critical facilities, the natural environment and future development are considered for each hazard.

The following sections provide profiles of the natural hazards that the HMPC identified in Section 4.1 Identifying Hazards. The hazards follow alphabetically.

4.2.1 Agricultural Hazards

Hazard/Problem Description

Located in the Central San Joaquin Valley, Fresno County's farming and agricultural industry is ranked as the top agriculture-producing county in California and the country. Farming and agriculture-related businesses are a significant component of the local economy and are responsible for no less than one out of every three jobs. According to the Fresno County Agricultural Commissioner the County has approximately 678,103 acres of prime agricultural land, 404,083 acres of farmland of statewide importance, and 825,276 acres of grazing land (see table below).

Table 4.3 Fresno County's Farmland Inventory, 2012

Soil Category	Acres
Prime Farmland	678,103
Farmland of Statewide Importance	404,083
Unique Farmland	33,653
Farmland of Local Importance	131,341
Grazing Land	825,276
Urban and Built-Up Land	124,025
Water	4,915
Other Land	116,094

Source: Fresno County Agricultural Commissioner 2017

According to the 2015 Fresno County Agricultural Crop and Livestock Report, the total gross value of agricultural commodities in Fresno County in 2015 was $6.6 billion, exceeding the six billion dollar mark for the fifth consecutive year, though down from 2014's record of $7,069 billion. This value represents a 6.55 percent decrease from the 2014 production value of $7.069 billion. The County's leading agricultural products included almonds, grapes, tomatoes, poultry, cattle and calves, tomatoes, milk, peaches, garlic, mandarins and oranges. The report notes that the decrease from 2014 may be attributed to a number of factors, including no allocation of surface water in 2014 and 2015.

Fresno's top ten crops have seen a shift between 1995 and 2015; though the crops have mostly remained constant, their ranks in the county have changed in the intervening 20 years.

Table 4.4 Fresno County's Ten Leading Crops

Crop	2015 Rank	2015 Dollar Value	2014 Rank	2005 Rank	1995 Rank
Almonds	1	$1,205,730,000	1	2	7
Grapes	2	$896,295,000	2	1	2
Poultry	3	$561,146, 000	3	7	3
Cattle and Calves	4	$551,989,000	5	5	8
Tomatoes	5	$520,146,000	6	4	4

Crop	2015 Rank	2015 Dollar Value	2014 Rank	2005 Rank	1995 Rank
Milk	6	$436,765,000	4	3	5
Peaches	7	$223,597,000	9	8	12
Garlic	8	$198,800,000	8	14	11
Mandarins	9	$197,622,000	+		
Oranges	10	$153,811,000	11	10	10

*Includes turkey, chickens, ducks, geese and game birds
+Not previously combined for ranking purposes
Source: State of California Department of Conservation Farmland Mapping and Monitoring Program, www.conservation.ca.gov/

According to the HMPC, agricultural losses occur on an annual basis and are usually associated with severe weather events, including heavy rains, floods, hail, freeze, and drought. The State of California Multi-Hazard Mitigation Plan attributes most of the agricultural disasters statewide to drought, freeze, and insect infestations. Other agricultural hazards include fires, crop and livestock disease, noxious weeds, and contamination of animal food and water supplies.

Fresno County is threatened by a number of insects that, under the right circumstances, can cause severe economic and environmental harm to the agricultural industry. Insects of concern to plants and crops include the medfly, peach fruit fly, Mexican fruit fly, guava fruit fly, oriental fruit fly, melon fly, gypsy moth, Japanese beetle, glassy-winged sharpshooter, paper wasp, and Turkestan roach. Livestock disease can also cause large-scale economic losses in any area that raises large amounts of livestock.

Noxious weeds, which are any plant that is or is liable to be troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species and that is difficult to control or eradicate, are also of concern. Noxious weeds within the planning area include yellow starthistle, purple loosestrife, and Japanese dodder.

Noxious weeds have been introduced in the planning area by a variety of means, including through commercial nurseries. An absence of natural controls combined with the aggressive growth characteristics and unpalatability of many of these weeds allows these weeds to dominate and replace more desirable native vegetation. Negative effects of weeds include the following:

- Loss of wildlife habitat and reduced wildlife numbers
- Loss of native plant species
- Reduced livestock grazing capacity
- Increased soil erosion and topsoil loss
- Diminished water quality and fish habitat
- Reduced cropland and farmland production
- Reduced land value and sale potential

Another threat to the agricultural industry is the wild hogs that run free in the eastern and western foothills of the County. These wild hogs can cause extensive agricultural crop and property damage to farm and private land. Wild hogs are known to carry and transmit 30 different diseases both to humans and livestock. E. coli contamination of leafy vegetables has been linked to wild hogs foraging in vegetable fields.

In addition to issues associated with wild hogs, the proper management of other wildlife within the planning area is of significant concern to the County Department of Agriculture. Wildlife such as coyotes, ground squirrels, and others can cause extensive livestock, crop, and property damage. Such wildlife is also known to carry and transmit disease (e.g., bubonic plague and rabies) to livestock and domestic animals as well as to humans.

According to the Fresno County Operational Area Master Emergency Services Plan, the consequences of agricultural disasters to the planning area include ruined plant crops, dead livestock, ruined feed and agricultural equipment, monetary loss, job loss, and possible multi-year effects (i.e., trees might not produce if damaged, loss of markets, food shortages, increased prices, possible spread of disease to people, and loss or contamination of animal products). When these hazards cause a mass die-off of livestock, other issues arise that include the disposal of animals, depopulation of affected herds, decontamination, and resource problems. Those disasters related to severe weather may also require the evacuation and sheltering of animal populations. Overall, any type of severe agricultural disaster can have significant economic impacts on the agricultural community as well as the entire Fresno County planning area.

Extent

Historically, Fresno County has received disaster declarations from the USDA for a variety of incident types, including drought, hail, rain, cold and wind. Fresno County's agriculture industry is a multi-billion dollar enterprise; a long-term, widespread agricultural hazard could have impacts in the hundreds of millions of dollars, if not billions of dollars.

Past Occurrences

Based on information from the USDA, Fresno County received 16 USDA disaster declarations between 1991 and 2007 (see). All the declarations were associated with drought or severe weather events; none were related to agricultural disease.

Table 4.5 Fresno County's USDA Disaster Declarations

Incident Type	Incident Date	Damage ($)
Short Term Drought	2009	164,893,718
Severe Spring Storms: Rain, Hail, High Winds	6/4 & 5/2009	4,533,107
Lack of Chill Hours	2014	53,534,295
Severe Long-Term Drought	2012 through 2016	Not Quantified

Source: Fresno County Department of Agriculture

Between January and August of 2017, Fresno County had received one additional USDA Declaration in January for drought. Historical occurrences identified by the HMPC include the following:

Fresno County

- **1970s**—A local outbreak of scabies occurred.
- **1991**—There was an outbreak of bovine tuberculosis in Fresno County.
- **1997/1998**—One bird in downtown Fresno was discovered with exotic Newcastle disease, a contagious and fatal viral disease affecting all species of birds that does not affect humans. The bird and all chickens within a one-kilometer radius were destroyed.
- **1998**—Freeze resulted in almost $70 million in losses, including crop loss, broken water pipes and water damage, damaged water treatment plants, and damaged fire sprinkler systems. Other impacts included almost 18,000 applications for services and assistance and over 1,700 unemployment insurance claims filed.
- **1999**—Severe weather caused a crop loss of over $89 million.
- **2006**—Fresno County growers were impacted by adverse spring weather with $21 million in losses.
- **2006**—Twenty-one days of over 100 degrees, including three days over 113 degrees, caused crop, livestock, poultry, and milk production losses of $93 million.
- **2008**—A Fresno County dairy was quarantined after state and federal agriculture officials found bovine tuberculosis in five cows.
- 2009 -Short term drought with no or little allocation to the west side. Springtime hail brought damage to trees along the Kings River corridor.
- 2012 Through 2016 – Long-term western states drought. Billions in losses.
- 2014 – Warm winter and spring brought a lack of chill hours affecting fruit set in cherry crop.

Neighboring Counties

- **2002**—Merced County had an outbreak of avian influenza H5 (which is different from the severe variety found in Asia).
- **2002/2003**—After more than 10 years without a case of bovine tuberculosis in California, two dairy herds in Tulare County and one in Kings County were infected with bovine tuberculosis. All three herds were quarantined, 152,000 cattle were tested, 8,000 cattle destroyed, and the affected premises were cleaned and disinfected.
- **2002/2003**—There was an outbreak of exotic Newcastle disease in Southern California.

According to data provided by the USDA Risk Management Agency (RMA), $558,702,249 in indemnities were paid in Fresno County between 2008 and 2017, averaging $5,587,022 over the ten-year period.

Table 4.6 Top Ten RMA Indemnities in Fresno County 2008-2017

Year	Commodity	Damage Cause	Affected Acres	Indemnity Amount
2014	Cotton	Irrigation Supply Failure	40,958	$39,247,461
2015	Cotton	Irrigation Supply Failure	39,877	$36,446,882
2015	Pistachios	Heat	8,938	$33,815,833
2016	Cotton	Irrigation Supply Failure	31,659	$2,916,344

Year	Commodity	Damage Cause	Affected Acres	Indemnity Amount
2009	Cotton	Irrigation Supply Failure	18,032	$14,973,864
2015	Almonds	Excess Moisture/Precipitation/Rain	9,122	$14,721,498
2013	Cotton	Irrigation Supply Failure	14,033	$12,208,450
2009	Cotton	Irrigation Supply Failure	16,185	$10,543,189
2015	Almonds	Heat	6,417	$8,374,283
2016	Almonds	Excess Moisture/Precipitation/Rain	6,987	$7,906,123

Source: USDA Risk Management Agency

Of these payments, $2,755,872 were for damages caused by insects, with damages to cotton, dry beans, tomatoes, alfalfa seed and navel oranges; the average annual payment for indemnities related to insect damage is $145,046 per year.

Table 4.7 Indemnities Paid for Insect Damage in Fresno County 2008-2017

Year	Commodity	Damage Cause	Affected Acres	Indemnity Amount
2008	Cotton	Insects	308	$17,743
2008	Cotton	Insects	823	$199,777
2008	Dry Beans	Insects	153	$30,911
2008	Tomatoes	Insects	195	$42,254
2008	Tomatoes	Insects	313	$277,015
2010	Alfalfa Seed	Insects	201	$51,102
2011	Cotton	Insects	62	$53,030
2011	Alfalfa Seed	Insects	286	$220,726
2013	Tomatoes	Insects	745	$151,477
2013	Navel Oranges	Insects	15	$3,672
2014	Cotton	Insects	31	$16,250
2014	Dry Beans	Insects	141	$58,601
2014	Dry Beans	Insects	86	$47,924
2014	Tomatoes	Insects	1,443	$289,636
2014	Alfalfa Seed	Insects	17	$10,069
2015	Tomatoes	Insects	704	$371,869
2015	Alfalfa Seed	Insects	297	$389,272
2016	Tomatoes	Insects	396	$452,035

Source: USDA Risk Management Agency

In the same timeframe, $3,729,991 in indemnities were paid for damages caused by plant disease, with damages to tomatoes, cotton, onions and grapes; the average annual payment for indemnities related to plant disease between 2008 and 2017 was $177,619 per year.

Table 4.8 Indemnities for Plant Disease in Fresno County 2008-2017

Year	Commodity	Damage Cause	Affected Acres	Indemnity Amount
2008	Fresh Market Tomatoes	Plant Disease	215	$109,429
2010	Tomatoes	Plant Disease	765	$382,840
2012	Cotton	Plant Disease	56	$11,508

Year	Commodity	Damage Cause	Affected Acres	Indemnity Amount
2012	Tomatoes	Plant Disease	300	$158,964
2013	Tomatoes	Plant Disease	153	$223,531
2013	Tomatoes	Plant Disease	2,854	$1,450,955
2013	Tomatoes	Plant Disease	137	$227,479
2014	Onions	Plant Disease	90	$100,193
2014	Dry Beans	Plant Disease	149	$54,061
2014	All Other Crops	Plant Disease	35	$10,120
2015	Onions	Plant Disease	37	$32,667
2015	Fresh Market Tomatoes	Plant Disease	112	$81,769
2015	Tomatoes	Plant Disease	270	$420,489
2016	Onions	Plant Disease	130	$200,706
2016	Table Grapes	Plant Disease	30	$92,066
2016	Table Grapes	Plant Disease	33	$274,862
2016	Grapes	Plant Disease	19	$7,024
2016	Tomatoes	Plant Disease	197	$54,312
2017	Table Grapes	Plant Disease	12	$12,956
2017	Table Grapes	Plant Disease	1	$3,352
2017	Grapes	Plant Disease	6	$4,840

Source: USDA Risk Management Agency

Likelihood of Future Occurrences

Highly Likely—As long as the hazards discussed in this section continue to be an ongoing concern to the Fresno County planning area, the potential for agricultural losses remains.

Climate Change Considerations

As climate change has progressed, noticeable changes have occurred with the climate and weather patterns across the globe. Weather events have become more numerous and more severe. Changes in weather patterns can have dramatic impacts on the ecosystem, including agriculture systems; more severe impacts can be expected into the future.

4.2.2 Avalanche

Hazard/Problem Description

Avalanches occur when loading of new snow on a slope increases stress at a rate faster than strength develops, and the slope fails. Critical stresses develop more quickly on steeper slopes and where deposition of wind-transported snow is common. The vast majority of avalanches occur during and shortly after storms. This hazard generally affects a small number of people, such as snowboarders, skiers, and hikers, who venture into backcountry areas during or after winter storms. Roads and highway closures, damaged structures, and destruction of forests are also a direct result of avalanches. Avalanches typically occur above 8,000 feet and on slopes ranging between 25 and 50 degrees incline. The eastern portion of Fresno County is in the Sierra National Forest in a high alpine environment and has potential for areas above 8,000 on slopes ranging between 25 and 50 degrees incline. The combination of steep slopes, abundant snow, weather, snowpack, and an impetus to cause movement creates avalanches. Areas prone to avalanche hazards include hard to access areas deep in the backcountry. Avalanche hazards exist in eastern Fresno County in the Sierras, where combinations of the above criteria occur.

Extent

Based on this information, the geographic extent rating for avalanches in Fresno County is **limited**. Occasional death and injury might occur to persons in the backcountry.

Past Occurrences

Historically, avalanches occur within the County between the months of December and April, following snowstorms. According to the HMPC, there has been some historical avalanche activity involving people, but specific details are unknown.

Likelihood of Future Occurrences

Likely—Injuries and loss of life from an avalanche are usually due to people recreating in remote areas at the wrong time. Given the topography and amount of snow falling on an annual basis in eastern Fresno County, avalanches will continue to occur, but damage from avalanches should continue to be limited.

Climate Change Considerations

In the future the likelihood and nature of avalanches may be affected by climate change. As winter is taking longer to descend, weaker snow accumulates at the very bottom of the snow pack. As more snow piles on top of the weak layer, and temperatures remain warm, the upper, moisture-laden layers became vulnerable to sliding, and create a delicate situation. More extreme precipitation events that deposit large amounts of snow in a short period of time could also periodically increase the potential for large avalanches.

4.2.3 Dam Failure

Hazard/Problem Description

Dams are manmade structures built for a variety of uses, including flood protection, power generation, agriculture, water supply, and recreation. When dams are constructed for flood protection, they usually are engineered to withstand a flood with a computed risk of occurrence. For example, a dam may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year. If prolonged periods of rainfall and flooding occur that exceed the design requirements, that structure may be overtopped and fail. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can also result from any one or a combination of the following causes:

- Earthquake
- Inadequate spillway capacity resulting in excess overtopping flows
- Internal erosion caused by embankment or foundation leakage or piping or rodent activity
- Improper design
- Improper maintenance
- Negligent operation
- Failure of upstream dams on the same waterway

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result as well as potentially catastrophic effects to roads, bridges, and homes. Associated water quality and health concerns could also be issues. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

In general, there are three types of dams: concrete arch or hydraulic fill, earth-rockfill, and concrete gravity. Each type of dam has different failure characteristics. A concrete arch or hydraulic fill dam can fail almost instantaneously: the flood wave builds up rapidly to a peak then gradually declines. An earth-rockfill dam fails gradually due to erosion of the breach: a flood wave will build gradually to a peak and then decline until the reservoir is empty. And, a concrete gravity dam can fail instantaneously or gradually with a corresponding buildup and decline of the flood wave.

Extent

According to the Fresno County Operational Area Master Emergency Services Plan, there are several hundred dams in Fresno County constructed for flood control, irrigation storage, electrical generation, recreation, and stock watering purposes. There are 36 dams of concern, of which 31 are considered high hazard and five are significant hazard. Crane Valley and Mazanita Diversion dams are located in Madera County; however, they pose a threat to Fresno County based on the topography and hydrological flow characteristics of the area. Table 4.9 details the dams effecting Fresno County, with significant hazard dams denoted by "**". The majority of these dams are in the San Joaquin River or Kings River watersheds in the eastern part of the county. Both incorporated and unincorporated areas are at risk of damage from flooding in the event of a dam failure, however, the City of Fresno, Clovis, Sanger and the eastern unincorporated county are at greater risk. Generally, the areas at risk are large urban and rural areas downstream and below the dams on the valley floor. There have not been any failures of major dams in Fresno County; future failures are more likely to occur with smaller dams, with minimal or no damage potential.

Based on this information, the geographic extent rating for dam failure in Fresno County is **Extensive**.

Table 4.9 Fresno County Dam Characteristics

Dam Name	Downstream City	Owner Name	Dam Type	Capacity (Acre-Feet)
Fancher Creek	Clovis	Fresno Metropolitan Flood Control District	Earth	24,300
Big Creek Dam No. 7	Auberry	Southern California Edison Company	Gravity	35,000
Crane Valley	North Fork	Pacific Gas and Electric Company		45,410
Sand Creek	Orange Cove	Tulare Co Resources Mgmt Agency	Earth	1,500
Giffen Reservoir	Centerville	Harris Farms Inc	Earth	1,244
Silt Pond	Coalinga	Granite Construction	Earth	25
Big Creek Dam No. 6	Big Creek	Southern California Edison Company	Variable Radius Arch	1,726
Fresh Water Pond		Avenal Aggregates	Earth	4
Florence Lake	Mono Hot Springs	Southern California Edison Company	Multiple Arch	68,000
Mendota Diversion	Firebaugh	Central Calif Irr Dist		3,000
Mammoth Pool	Big Creek	Southern California Edison Company	Earth	122,175
Little Panoche Detention	Oro Loma	Doi Br	Earth	13,240
Redbank Creek Detention Basin	Fresno	Fresno Metropolitan Flood Control District	Earth	-
Sequoia Lake	Miramonte	Y M C A Inc	Earth	2,370
Pine Flat Dam	Sanger	Cespk	Gravity	1,000,000
Fancher Creek Detention	Fresno	Fresno Metropolitan Flood Control District	Earth	2,959
Manzanita Diversion	North Fork	Pacific Gas and Electric Company	Variable Radius Arch	168
Vermilion	Mono Hot Springs	Southern California Edison Company	Earth	140,000
Big Dry Creek	Clovis	Fresno Metropolitan Flood Control District	Earth	49,661
Courtright	Balch Camp	Pacific Gas and Electric Company	Rockfill	134,342
Wishon Main	Wishon Village	Pacific Gas and Electric Company	Rockfill	133,600
Shaver Lake	Shaver Lake	Southern California Edison Company	Gravity	135,568
Big Creek Dam No. 1	Big Creek	Southern California Edison Company	Gravity	89,800
Shaver Dike	Shaver Lake	Southern California Edison Company	Rockfill	135,568
Friant Millerton Road Embankment A	Fresno	Doi Br	Earth	555,500
Alluvial Drain Detention	Clovis	Fresno Metropolitan Flood Control District	Earth	1,152
Balsam Meadow Forebay Main	Big Creek	Southern California Edison Company	Rockfill	1,960
Redbank	Fresno	Fresno Metropolitan Flood Control District	Earth	2,975

Big Creek Dam No. 3	Big Creek	Southern California Edison Company	Gravity	89,800
Big Creek Dam No. 2	Big Creek	Southern California Edison Company	Gravity	89,800
Friant Dike 3	Fresno	Doi Br	Rockfill	555,500
Balch Diversion**	Balch Camp	Pacific Gas and Electric Company	Variable Radius Arch	1,295
Balch Afterbay**	Balch Camp	Pacific Gas and Electric Company	Variable Radius Arch	325
Mud*	San Joaquin	James Irrigation District	Rockfill	304
Big Creek Dam No. 5	Big Creek	Southern California Edison Company	Variable Radius Arch	74
Wishon Auxiliary No. 1**	Wishon Village	Pacific Gas and Electric Company	Rockfill	133,600
Fancher Creek	Clovis	Fresno Metropolitan Flood Control District	Earth	24,300

Source: HSIP Freedom- National Dam Inventory, 2015
*One acre-foot=326,000 gallons
** Denotes significant hazard dams

Both unincorporated and incorporated areas of the County are identified on dam failure inundation maps included in the County's dam failure evacuation plan. The inundation areas for each of the dams are generally downstream and include large rural and urban areas on the valley floor below the dams. Adjacent jurisdictions could also be affected by a dam failure in Fresno County. These include, depending on the dam involved, the Counties of Tulare, Kings, Madera, and Merced.

Figure 4.1 illustrates the locations of identified dams of concern within Fresno County, and illustrates their water routes.

Figure 4.1 Fresno County's Dams of Concern and Capacity

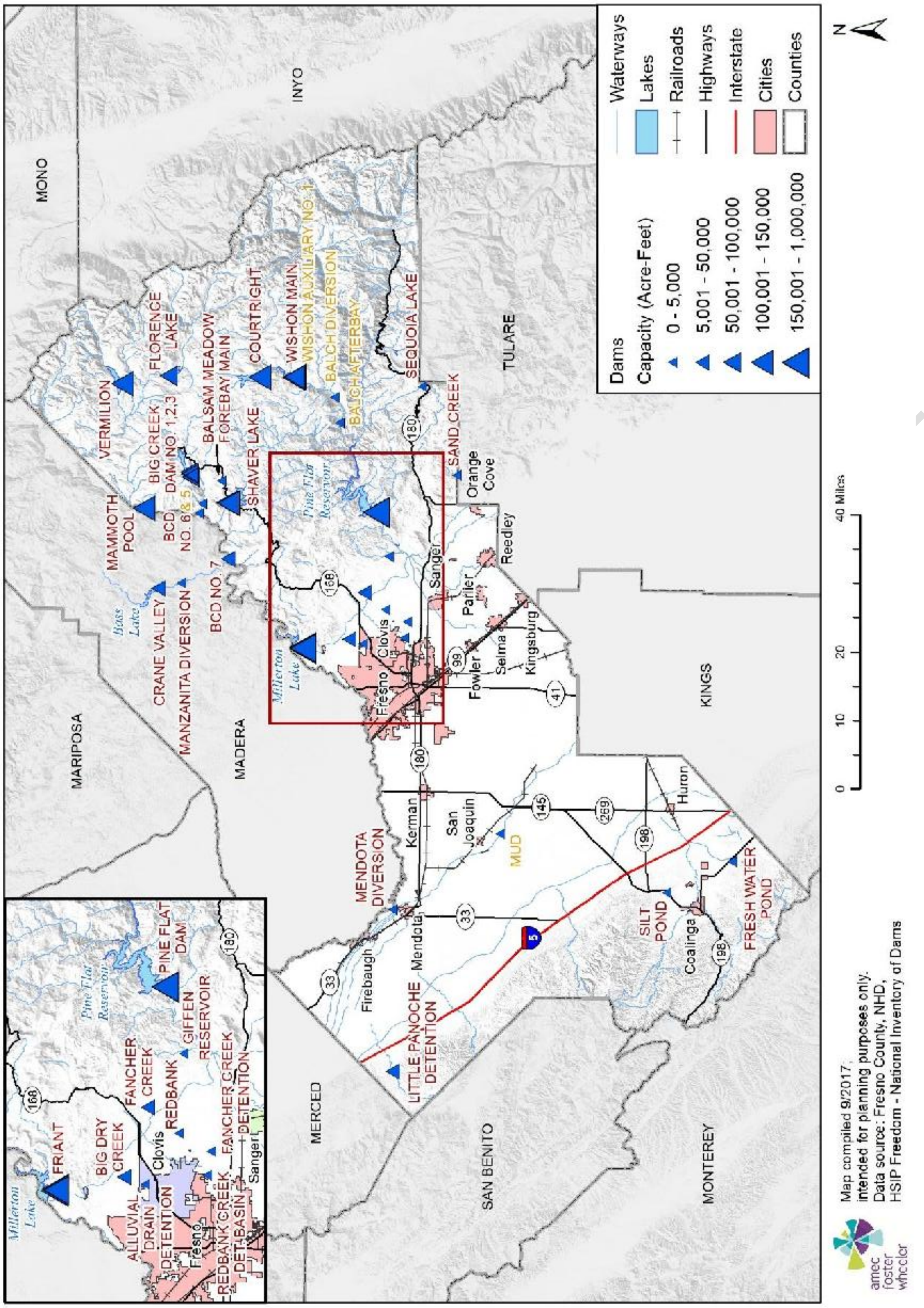


Figure 4.2 Fresno County Dams by Hazard Class

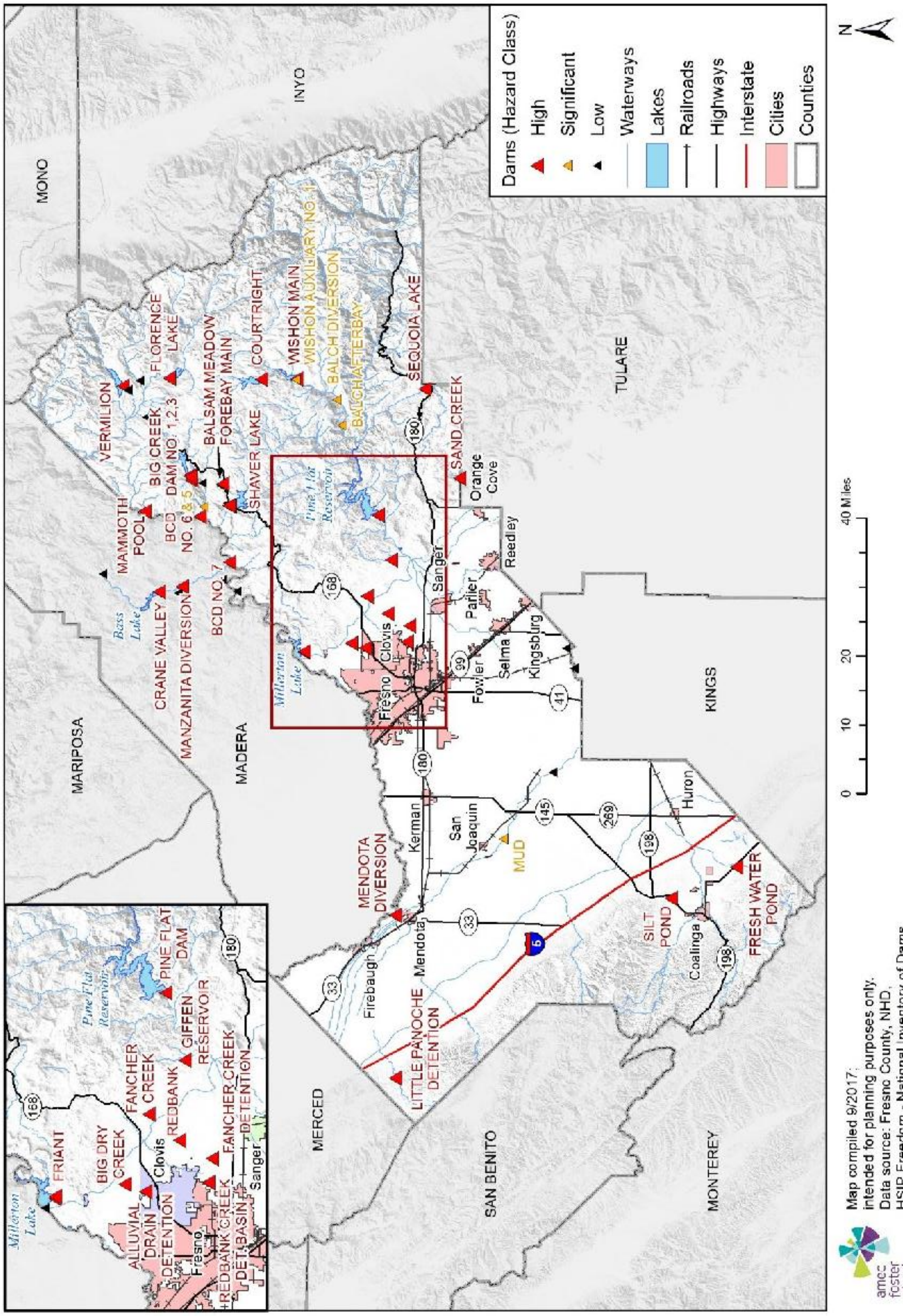
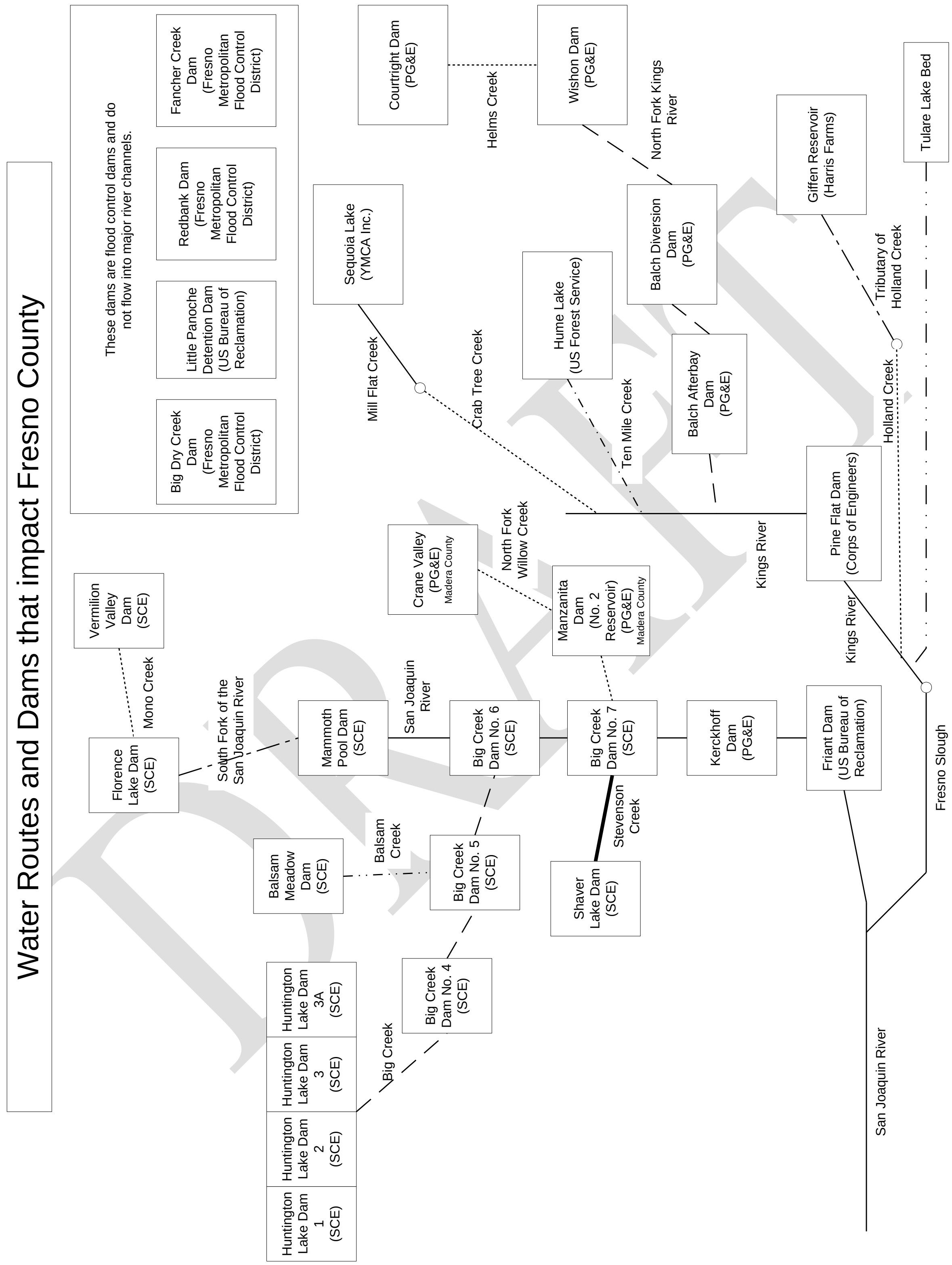


Figure 4.3 Water Routes and Dams that Impact Fresno County



Source: Fresno County Operational Area Dam Failure Evacuation Plan, 2003

Past Occurrences

According to the Fresno County Operational Area Master Emergency Services Plan, there were 14 dam failures in Fresno County between 1976 and 1983, but all were earthen dams on private property. None of the County's 23 major dams were involved. The failures were due to inadequate rodent and vegetation control, unauthorized and inadequate construction, and failure to consult an engineer. The main impacts from these failures were silting of downstream waters, properties, and dams; flooded or undermined roadways; and eroded embankments. Main losses were flooding of a residence and construction lumber washed downstream. In 1986, Friant Dam experienced a small, uncontrolled release. The lock on a drum gate opened, releasing 3,000 cubic feet per second. No major flooding resulted.

Likelihood of Future Occurrences

Occasional—The County remains at risk to dam failures from numerous dams under a variety of ownership and control and of varying ages and conditions. Given the high number of dams in the County and the history of past dam failures, the potential exists for future dam failures in the Fresno County planning area, but the likelihood of this is low. Nonetheless, it should be noted that there have not been any failures of major dams in the County. Uncontrolled or controlled release flooding below dams due to excessive rain or runoff are more likely to occur than failures.

Climate Change Considerations

The potential for climate change to affect the likelihood of dam failure is not fully understood at this point in time. With a potential for more extreme precipitation events a result of climate change, this could result in large inflows to reservoirs. However, this could be offset by generally lower reservoir levels if storage water resources become more limited or stretched in the future due to climate change, drought and/or population growth.

4.2.4 Drought

Hazard/Problem Description

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multi-year period, and it is often not obvious or easy to quantify when a drought begins and ends.

Drought is a complex issue involving many factors—it occurs when a normal amount of moisture is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects:

- **Meteorological** drought is defined by a period of substantially diminished precipitation duration and/or intensity. The commonly used definition of meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- **Agricultural** drought occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry-land agricultural operations.
- **Hydrological** drought refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir, and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurements tend to lag behind other drought indicators.
- **Socio-economic** drought occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

The California Department of Water Resources (DWR) says the following about drought:

> *"One dry year does not normally constitute a drought in California. California's extensive system of water supply infrastructure—its reservoirs, groundwater basins, and inter-regional conveyance facilities—mitigates the effect of short-term dry periods for most water users. Defining when a drought begins is a function of drought impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users elsewhere, or for water users having a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, or expected supply from a water wholesaler to define their water supply conditions."*

The drought issue in California is further compounded by water-rights. Water is a commodity possessed under a variety of legal doctrines. The prioritization of water rights between farming and federally protected fish habitats in California is part of this issue.

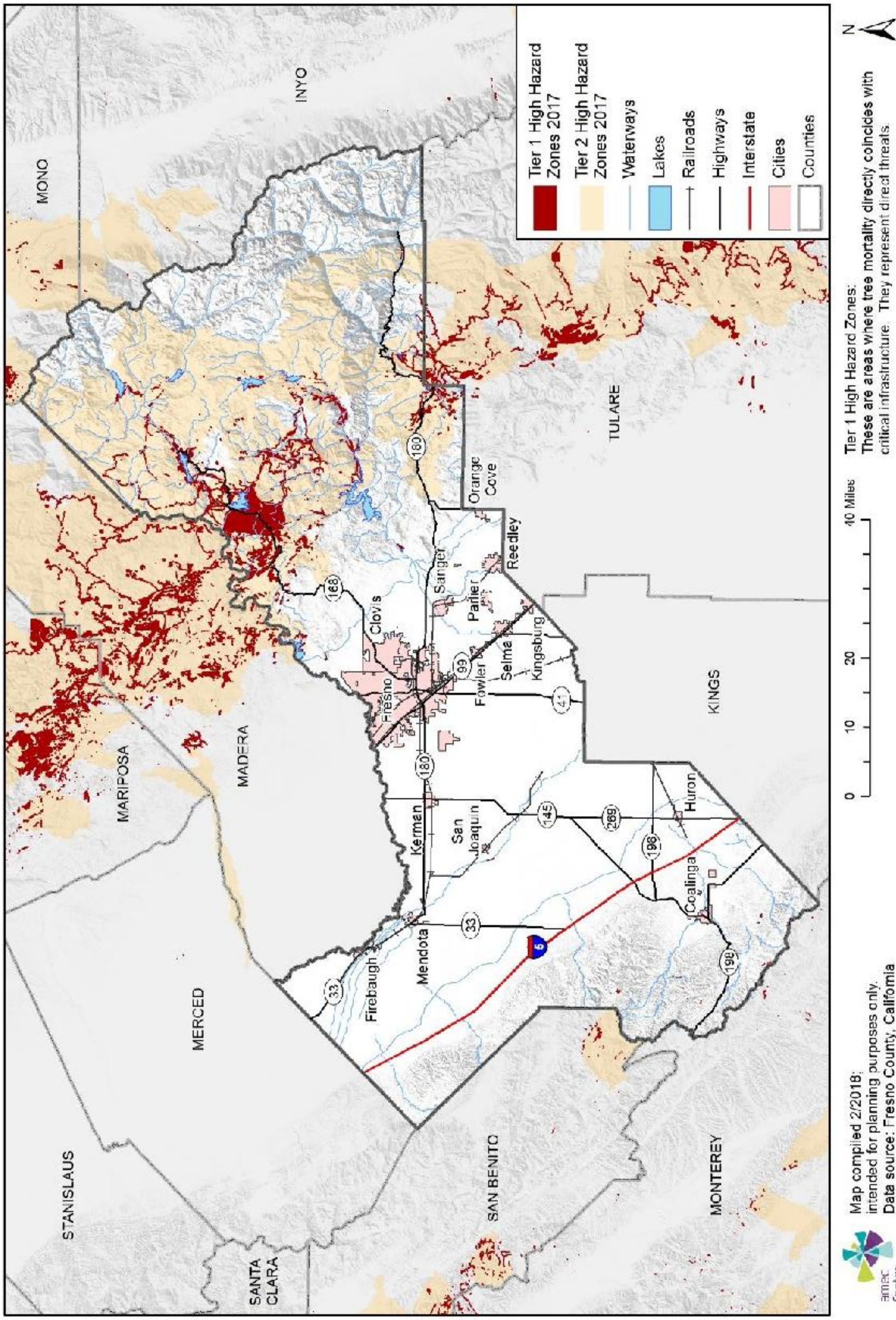
Drought impacts are wide-reaching and may be economic, environmental, and/or societal. The most significant impacts associated with drought in the planning area are those related to water intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. Also, during a drought, allocations go down, which results in reduced water availability. Voluntary water conservation measures are typically implemented during extended droughts. A reduction of electric power generation and water quality deterioration are also potential problems. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

Tree Mortality

The HMPC identified tree mortality as an additional drought impact of significance to Fresno County during the 2018 update. In recent years, due to the multi-year drought throughout the planning area and state-wide, a vast number of trees have been (and continue to be) impacted within Fresno County foothill and mountain communities and beyond. Standing dead trees could fall and pose a risk to people, buildings, power lines, roads and other infrastructure. In addition, drought-impacted trees become susceptible to diseases and insect infestations (bark beetle) further adding to the risk of tree mortality and related potential impacts.

The location, extent, and probability of occurrence for tree mortality can be viewed as sub-set to the drought hazard. Those areas of the natural environment susceptible to drought comprise a larger area, since tree mortality is related to other sub-factors specific to the species impacted such as tree age and soil composition. Figure 4.4 illustrates the extent of impact of drought and tree mortality in Fresno County. The Tier 1 High Hazard Zones (as indicated in red) depict areas where tree mortality directly coincides with critical infrastructure.

Figure 4.4 Fresno County Drought Related Tree Mortality Hazards



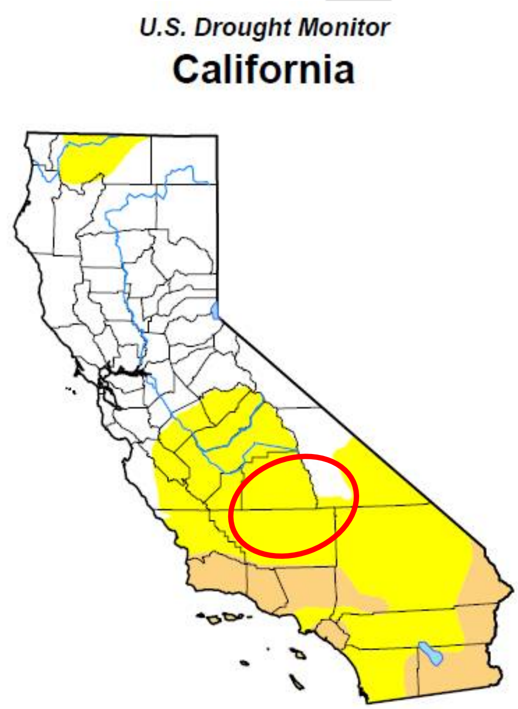
Extent

Given the historical occurrence of severe drought impacts throughout Fresno County and across the state, the HMPC understands that drought will continue to pose a high degree of risk to the entire planning area, potentially impacting crops, livestock, water resources, the natural environment at large, buildings and infrastructure (from land subsidence), and local economies. In addition, although drought affects the entire planning equally, the potential impacts may be variable and specific to each jurisdiction, depending on contextual factors such as the degree of assets and activities historically impacted by drought within each jurisdiction, such as the agricultural and parks and tourism industries.

Figure 4.5 and Figure 4.6 provide "snapshots in time" of the drought conditions in California in January 2018 and August 2015 (during the period of the last drought in Fresno County from 2013 - 2017). The snapshots selected are instrumental in depicting both the historic and potential change in drought's geographic range and severity in Fresno County (circled in red and yellow respectively).

Note: The Drought Monitor maps integrate data from several sources including the Palmer Drought Index, Soil Moisture Models, U.S. Geological Survey Weekly Stream flows, Standardized Precipitation Index, and Satellite Vegetation Health Index.

Figure 4.5 U.S. Drought Monitor for California: January 23, 2018



January 23, 2018
(Released Thursday, Jan. 25, 2018)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	45.48	54.52	12.69	0.00	0.00	0.00
Last Week 01-16-2018	53.21	46.79	12.69	0.00	0.00	0.00
3 Months Ago 10-24-2017	77.90	22.10	8.24	0.00	0.00	0.00
Start of Calendar Year 01-02-2018	55.70	44.30	12.69	0.00	0.00	0.00
Start of Water Year 09-26-2017	77.88	22.12	8.24	0.00	0.00	0.00
One Year Ago 01-24-2017	38.73	61.27	51.40	26.46	2.16	0.00

Intensity:
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Richard Heim
NCEI/NOAA

http://droughtmonitor.unl.edu/

Figure 4.6 U.S. Drought Monitor for California: August 4, 2015

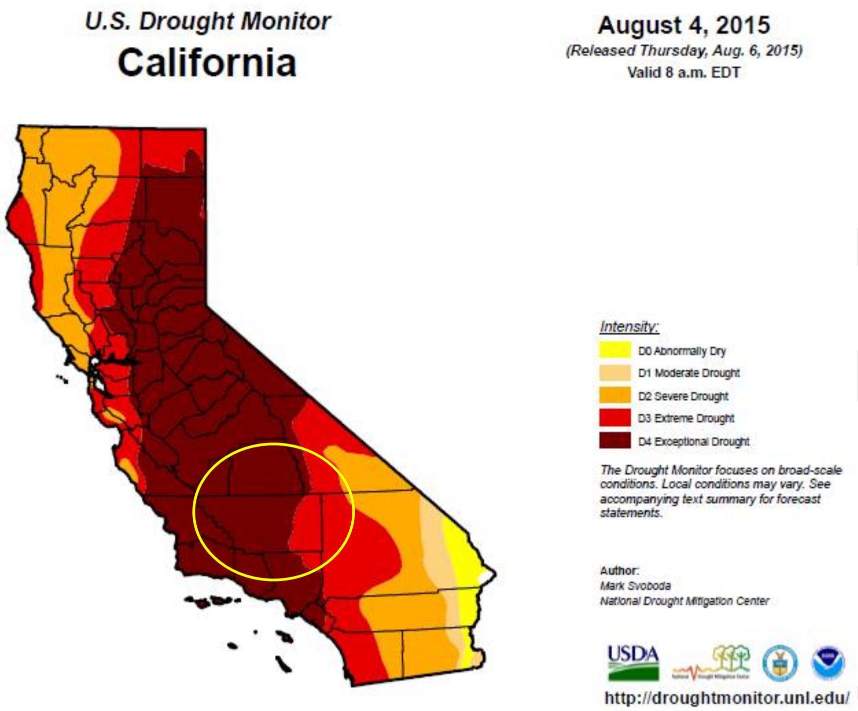
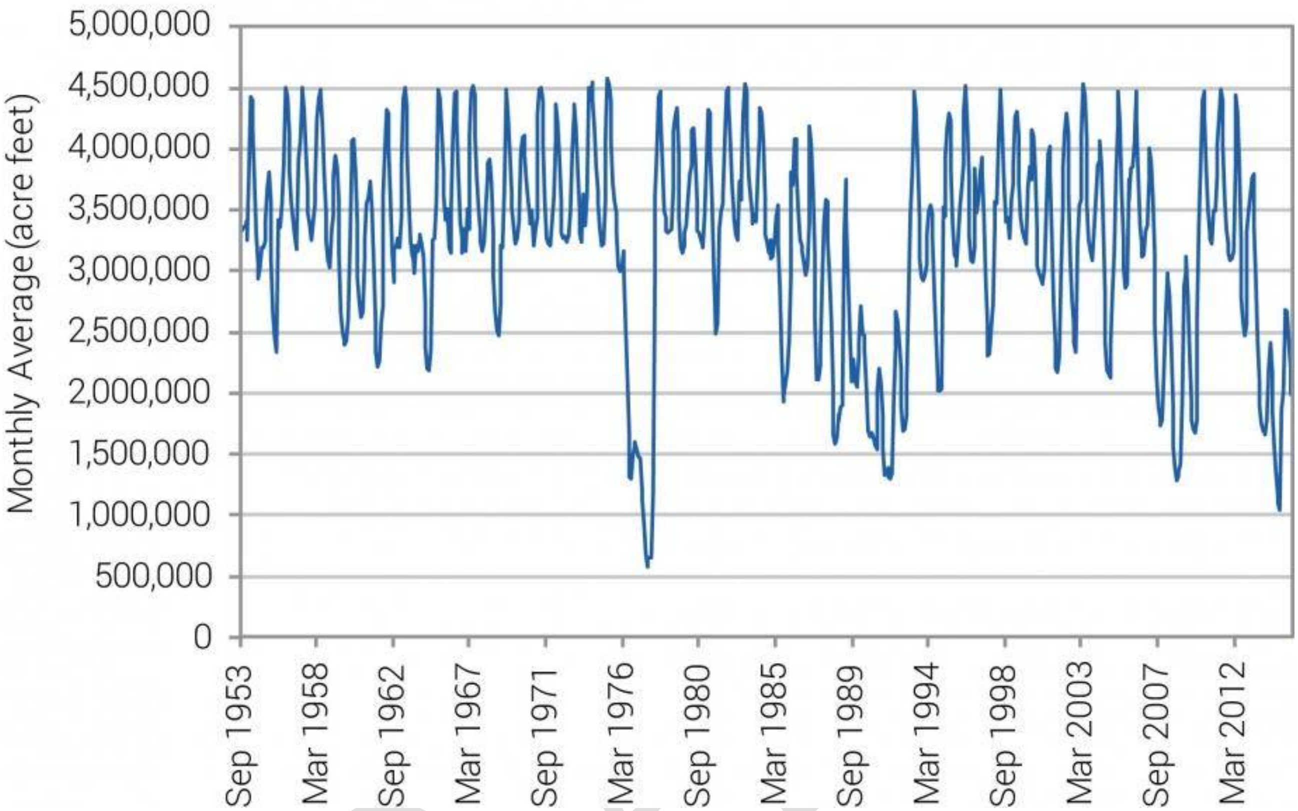


Figure 4.7 below identifies the reductions in water storage levels in the Shasta Dam Reservoir, a key water supply resource for drought management in Fresno County and beyond. Long-term monthly time series of the average water levels in the Shasta Dam Reservoir. The Shasta Dam Reservoir generally experiences similar seasonal cycles in water levels from year to year. However, water levels have dropped significantly several times over the past 60 years. In 2014, the reservoir reached its second lowest levels, surpassed only by extremely low levels during the 1977 drought.

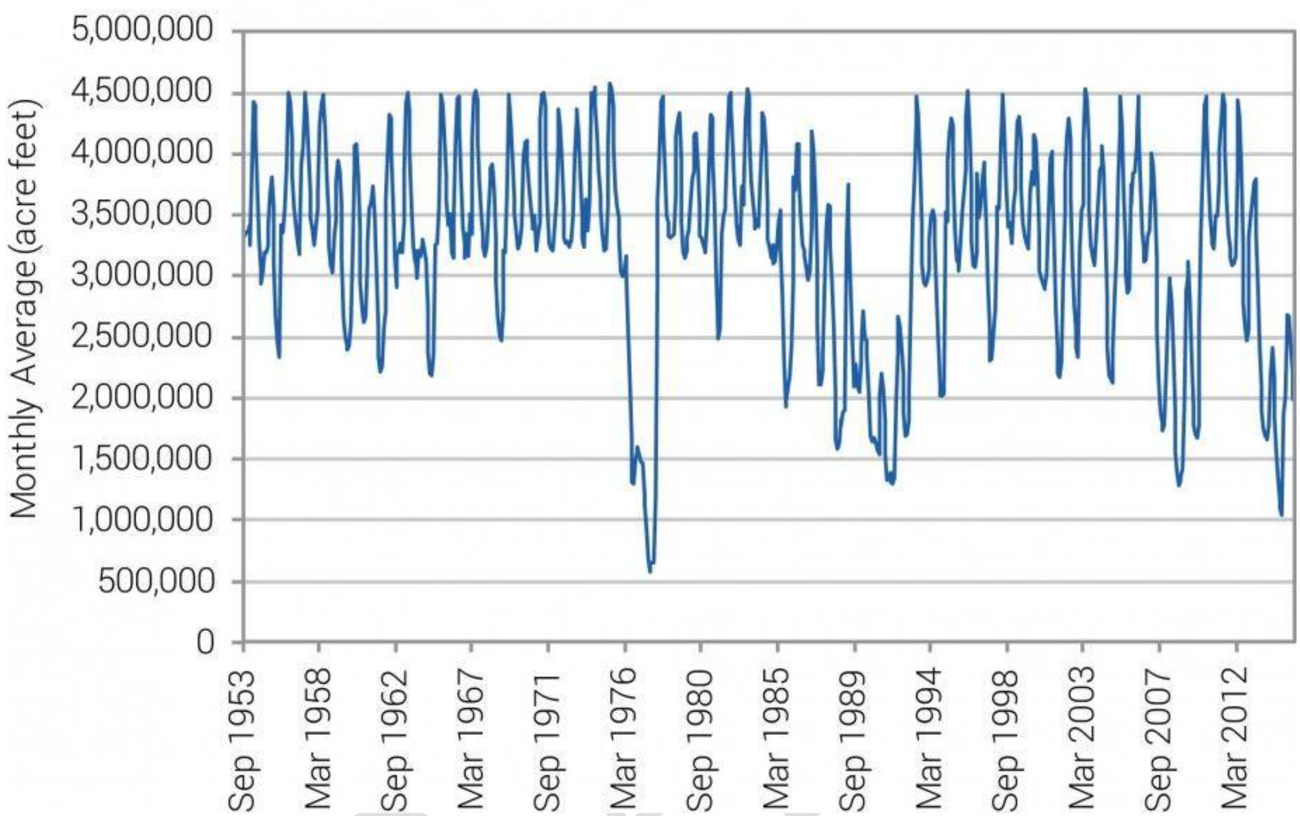
Figure 4.7 Storage Levels in the Shasta Dam Reservoir



Source: California Data Exchange Center. https://statesummaries.ncics.org/c

Figure 4.8 below identifies the reductions in water storage levels in the Shasta Dam Reservoir, a key water supply resource for drought management in Fresno County and beyond. Long-term monthly time series of the average water levels in the Shasta Dam Reservoir. The Shasta Dam Reservoir generally experiences similar seasonal cycles in water levels from year to year. However, water levels have dropped significantly several times over the past 60 years. In 2014, the reservoir reached its second lowest levels, surpassed only by extremely low levels during the 1977 drought.

Figure 4.8 Storage Levels in the Shasta Dam Reservoir



Source: California Data Exchange Center. https://statesummaries.ncics.org/c

Tree Mortality Extent

According to the CA Department of Forestry and Fire Protection (FRAP), the California Tree Mortality Task Force (TMTF), and the US Forest Service's Aerial Detection Survey mapping project, over 100 million trees have died throughout the state (2012-2016), with significant losses taking place within Fresno County with an ongoing high probability of occurrence. The Tree Mortality Task Force mapping effort (see previous map) identifies Tier 1 and Tier 2 risk zones in order to fully capture the extent of tree mortality risk to populations, buildings, infrastructure, and natural resources. Ti er 1 are those areas that directly coincide with critical infrastructure, and which pose a direct threat to people and assets operating in these areas. Tier 2 are areas defined by watersheds (HUC 12, average of 24,000 acres) and which have a significant degree of tree mortality coinciding with significant community and natural resource assets. (Source: http://calfire.ca.gov)

Based on the mapping as well as input from the LHMPC, the extent of the risk in Fresno County comprises approximately 15% - 20% of the total planning area, with areas of greatest risk being located roughly within the eastern third of the county within and around both foothill and mountain communities at elevations between 3,000 and 7,500 feet, with greatest impact to pine tree species. In addition, the mapping project identifies vulnerable populations, buildings, and infrastructure, and (Tier 2) broader fire risk areas, as well as numerous other supporting information layers to assist public and private land owners in preparing for, and mitigating the causes of, and risks associated with tree mortality.

Past Occurrences

Historically, California has experienced multiple severe droughts. According to the DWR, droughts exceeding three years are relatively rare in Northern California, and the region is the geographic source of much of the state's developed water supply. The 1929-34 drought established the criteria commonly used in designing storage capacity and yield of large Northern California reservoirs. The table below compares the 1929-34 drought in the Sacramento and San Joaquin Valleys to drought periods in 1976-77, and 1987-92. It does not include the 2012-2017 (California's most recent multi-year drought). The driest single year of California's measured hydrologic record was 1977.

Table 4.10 Severity of Extreme Droughts in the Sacramento and San Joaquin Valleys

Drought Period	Sacramento Valley Runoff		San Joaquin Valley Runoff	
	(maf*/yr)	(% Average1901-96)	(maf*/yr)	(% Average 1906-96)
1929-34	9.8	55	3.3	57
1976-77	6.6	37	1.5	26
1987-92	10.0	56	2.8	47

Source: California Department of Water Resources, www.water.ca.gov/
*Million acre-feet

The HMPC identified the following droughts as having significant impacts on the planning area:

- **1976**—A federal disaster declaration was declared as a result of a drought affecting Fresno County and much of California.
- **1987-1992**—Fresno County also suffered adverse effects resulting from this statewide drought.
- **2002**—Abnormally dry to moderate drought conditions lingering from 2001 into 2002 reduced rangeland grasses and feed for cattle. Losses to rangeland and loss of feed were estimated at $2.5 million. An estimated 850,000 acres were affected in both the east and west side of the valley. A USDA disaster declaration on November 22 made low interest loans available to family-size operations.
- **2008** – Drought impacted Fresno County of most of the Central valley, resulting in significant crop damage. In addition, the drought not only impacted agriculture, but the economy of the planning area in general, where small towns were especially hard hit, including job loss and the need for food-supply assistance provided by the state.
- **2012 – 2017** – Drought produced severe impacts to water wells throughout the planning area, with a high number of wells running dry. Land subsidence due to increased groundwater pumping also occurred in areas of the San Joaquin Valley including Fresno County. Crop damage was widespread as well. Water allotments were drastically reduced in many towns and

water agencies, with extremely high costs for procuring water. In addition, job loss occurred with many families requiring food supply assistance, and water supply assistance provided to home owners with dry wells. According to a report released by UC Davis Center for Watershed Sciences, the 2014 California drought cost the state's agriculture industry about $1 billion in lost revenue, with a total statewide economic cost of the drought calculated to be $2.2 billion. The 2014 drought, the report says, is responsible for the greatest water loss ever seen in California agriculture - about one third less than normal. The report calls the groundwater situation in California "a slow-moving train wreck." Spring snowpack at Donner Summit reached record low levels in 2014, exceeded in 2015 by a remarkable April 1 snow-water-equivalent value of only 5% of average. Decreased precipitation since contributed to near-record low levels in the Shasta Reservoir. The ongoing drought has contributed to declines in Fresno County crop values, based on information from an article in the Fresno Bee. Fresno County's overall gross value fell 2.2 percent to $6.4 billion in 2013, and with the reduction lost its status as the number one agricultural county in California. The Fresno County Agricultural Commissioner noted the drought -- one of the worst in state history -- has pinched the production of several west side field crops including cotton, corn silage and barley. The field crop category fell by 42 percent (Source: https://statesummaries.ncics.org/ca).

Likelihood of Drought Occurrences

Likely —Historical drought data for the Fresno County planning area and the Central Valley region indicate there have been five significant droughts in the last 79 years. This equates to a drought every 15.8 years on average or a 6.3 percent chance of a drought in any given year. Based on this data, droughts will likely affect the planning area.

Likelihood of Tree Mortality Occurrence

Based on information from the LHMPC, Cal Fire, and the Governor's Tree Mortality Task Force, established in 2015, it is a certainty that tree mortality resulting from drought and insect infestation will continue in the future, though the degree to which it occurs depends on future rainfall levels and other factors. Some of the current challenges include how to eradicate the bark beetle, dead tree removal strategies, how to utilize the wood once it is removed, and how to restore the forests to a sustainable ecosystem (http://frap.fire.ca.gov/projects/projects_drought).

Climate Change Considerations

In California, rising temperatures are projected to increase the average lowest elevation at which snow falls, reducing water storage in the snowpack, particularly at those lower mountain elevations which are now on the margins of reliable snowpack accumulation. Higher spring temperatures will also result in earlier melting of the snowpack. The shift in snow melt to earlier in the season is critical for California's water supply because flood control rules require that water be allowed to flow downstream and that water cannot be stored in reservoirs for use in the dry season.

Climate change will likely adversely impact the ability of watersheds and ecosystems to deliver important ecosystem services. There is a broad range of climate change impacts that affect water resources in California. These changes may limit the natural capacity of healthy forests to capture water and regulate stream flows. Peterson et al., (2008) report that Sierra Nevada mountain winters and springs are warming, and on average, precipitation as snowfall relative to rain is decreasing. A warming climate with reduced snowpack will result in earlier snowmelt and will subsequently reduce downstream water availability during summer and early fall.

Source: http://frap.fire.ca.gov/data/assessment2010/pdfs/3.1water.pdf; p. 139

As such, Fresno County potentially has less capacity to address future drought (and wildfire) risk related to climate change due to projected temperature increases and shortages in water; ground-water withdrawals have been occurring at a deficit rate of one to two million acre feet per year, where the impacts of drought include decreased availability of water for agriculture and environmental uses. In forested and other vegetated areas, prolonged drought decreases the moisture content of forest fuels and increases the risk of high severity wildfires.

Source: http://frap.fire.ca.gov/data/assessment2010/pdfs/3.1water.pdf; p. 139

California is the single most productive agricultural state with Fresno County and the San Joaquin Valley being a key factor to such productivity. The agricultural industry relies heavily on reservoir water supplied by snowmelt and rainfall runoff. Yearly variations in snowpack depths have implications for water availability as snowmelt from the winter snowpack feeds a network of reservoirs. Spring snowpack at Donner Summit reached record low levels in 2014, exceeded in 2015 by a remarkable April 1 snow-water-equivalent value of only 5% of average. Decreased precipitation since 2011 has contributed to near-record low levels in the Shasta Reservoir.

Source: https://statesummaries.ncics.org/ca

As such, the HMPC understands that high degree of risk posed by drought will be exacerbated by greater climate variation in the future, which, in this case, means greater variation and uncertainty regarding the availability of water supplies which are already under tremendous stress. The HMPC will continue to explore solutions for mitigating the drought hazard by accessing the best available data and resources on climate change and its relationship to drought.

Table 4.11 Summary of Climate Change Impacts on Water Resources

Resource	Type of Impact	Description
Sea Level	Direct	Sea level is rising and will likely impact coastal areas
Soil Moisture	Direct	Prolonged dry seasons can lead to decreases in soil moisture; drier vegetation
Vegetation	Indirect	Longer and more intense fire season with increased extent of area burned
Stream Conditions	Direct	Increases in water temperature; potential effects on fish
Snowpack	Indirect	Increases in temperature will lead to decreases in snowpack

Resource	Type of Impact	Description
Runoff	Direct	Warmer temperatures are likely to lead to a shift in peak runoff from spring to winter and a likely decrease in summer baseflow
Hydropower	Indirect	Decreased summer flows resulting from earlier snowmelt and a shift in peak runoff could affect hydropower generation during summer months
Precipitation	Direct	Warmer winter temperatures will result in a greater percentage of precipitation falling as rain rather than as snow
Groundwater	Indirect	Reduction in snowpack and extended periods of drought are likely to increase dependency on groundwater

Source: http://frap.fire.ca.gov/data/assessment2010/pdfs/3.1water.pdf p. 140

4.2.5 Earthquake

Hazard/Problem Description

An earthquake is caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up, and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake. The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake as recorded on seismographs. Another measure of earthquake severity is intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface (see discussion in Extent section). Seismic shaking is typically the greatest cause of losses to structures during earthquakes.

Seismic Hazards

Earthquakes can cause structural damage, injury, and loss of life, as well as damage to infrastructure networks, such as water, power, gas, communication, and transportation. The degree of damage depends on many interrelated factors. Among these are the magnitude, focal depth, distance from the causative fault, source mechanism, duration of shaking, high rock accelerations, type of surface deposits or bedrock, degree of consolidation of surface deposits, presence of high groundwater, topography, and the design, type, and quality of building construction. The following analysis of seismic hazards from the Fresno County General Plan Background Report (2000) discusses some of these factors in more detail.

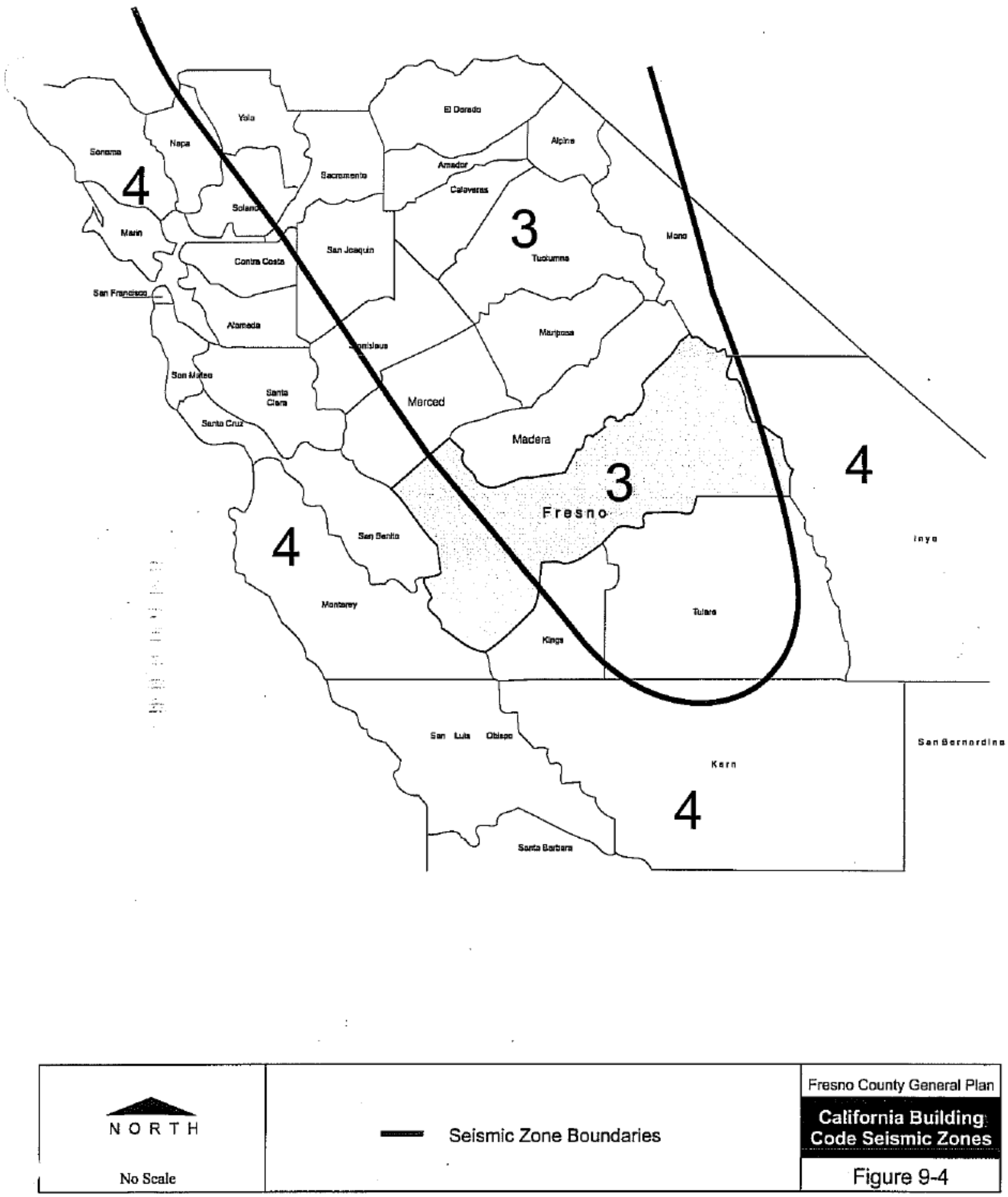
Ground Shaking

When movement occurs along a fault, the energy generated is released as waves, which cause ground shaking. Ground shaking intensity varies with the magnitude of the earthquake, the distance from the epicenter, and the type of rock or sediment through which the seismic waves move. The geological characteristics of an area thus can be a greater hazard than its distance to the earthquake epicenter.

Although most of Fresno County is situated within an area of relatively low seismic activity, the faults and fault systems that lie along the eastern and western boundaries of Fresno County, as well as other regional faults, have the potential to produce high-magnitude earthquakes throughout the County. A high-magnitude earthquake on one of these faults could cause moderate intensity ground shaking in Fresno County. The valley portion of Fresno County is located on alluvial deposits, which tend to experience greater ground shaking intensities than areas located on hard rock. Therefore, structures in the valley areas would tend to suffer greater damage from ground shaking than those located in the foothill and mountain areas.

Most of Fresno County, from approximately Interstate 5 east, is located in Seismic Zone 3, as defined by the most recent California Uniform Building Code. Areas in the Coast Range and foothills and a small area along the Fresno County-Inyo County boundary are located in Seismic Zone 4 (Figure 4.9).

Figure 4.9 California Building Code Seismic Zones



SOURCE: California Code of Regulations, Title 24, Figure 23-2, 1991; Structural Engineers Association of California, Seismology Committee, Recommended Lateral Force Requirements and Tentative Commentary, 1988, Figure 1A and p. 5-C; EIP Associates, March 1997.

Source: Fresno County General Plan, 2000

Seismic Structural Safety

Older buildings constructed before building codes were established, and even newer buildings constructed before earthquake-resistance provisions were included in the codes, are the most likely to be damaged during an earthquake. Buildings one or two stories high of wood-frame construction are considered to be the most structurally resistant to earthquake damage. Older masonry buildings without seismic reinforcement (unreinforced masonry) are the most susceptible to the type of structural failure that causes injury or death.

The susceptibility of a structure to damage from ground shaking is also related to the underlying foundation material. A foundation of rock or very firm material can intensify short-period motions, which affect low-rise buildings more than tall, flexible ones. A deep layer of water-logged soft alluvium can cushion low-rise buildings, but it can also accentuate the motion in tall buildings. The amplified motion resulting from softer alluvial soils can also severely damage older masonry buildings.

Other potentially dangerous conditions include, but are not limited to, building architectural features that are not firmly anchored, such as parapets and cornices; roadways, including column and pile bents and abutments for bridges and overcrossings; and above-ground storage tanks and their mounting devices. Such features could be damaged or destroyed during strong or sustained ground shaking.

Liquefaction Potential

Liquefaction is a process whereby soil is temporarily transformed to a fluid form during intense and prolonged ground shaking. Areas most prone to liquefaction are those that are water saturated (e.g., where the water table is less than 30 feet below the surface) and consist of relatively uniform sands that are loose to medium density. In addition to necessary soil conditions, the ground acceleration and duration of the earthquake must be of sufficient energy to induce liquefaction. Scientific studies have shown that the ground acceleration must approach 0.3g before liquefaction occurs in a sandy soil with relative densities typical of the San Joaquin alluvial deposits.

Liquefaction during major earthquakes has caused severe damage to structures on level ground as a result of settling, titling, or floating. Such damage occurred in San Francisco on bay-filled areas during the 1989 Loma Prieta earthquake, even though the epicenter was several miles away. If liquefaction occurs in or under a sloping soil mass, the entire mass may flow toward a lower elevation. Also of particular concern in terms of developed and newly developing areas are fill areas that have been poorly compacted.

No specific countywide assessments to identify liquefaction hazards have been performed. Areas where groundwater is less than 30 feet below the surface are primarily in the valley. However, soil types in the area are not conducive to liquefaction, because they are either too coarse or too high in clay content. Areas subject to 0.3g acceleration or greater are located in a small section of the Sierra Nevada along the Fresno-Inyo border and along the Coast Range foothills in western Fresno County. However, the depth to groundwater in such areas is greater than in the valley, which would minimize liquefaction potential as well. Detailed geotechnical engineering investigations would be necessary to more accurately evaluate liquefaction potential in specific areas and to identify and map the areal extent of locations subject to liquefaction.

Settlement

Settlement can occur in poorly consolidated soils during ground shaking. During settlement, the soil materials are physically rearranged by the shaking to result in a less stable alignment of the individual minerals. Settlement of sufficient magnitude to cause significant structural damage is normally associated with rapidly deposited alluvial soils or improperly founded or poorly compacted fill. These areas are known to undergo extensive settling with the addition of irrigation water, but evidence is not available. The only urban area directly affected by settlement is the City of Coalinga. Fluctuating groundwater levels may have changed the local soil characteristics. Sufficient subsurface data is lacking to conclude that settlement would occur during a large earthquake; however, the data is sufficient to indicate that the potential exists.

Other Hazards

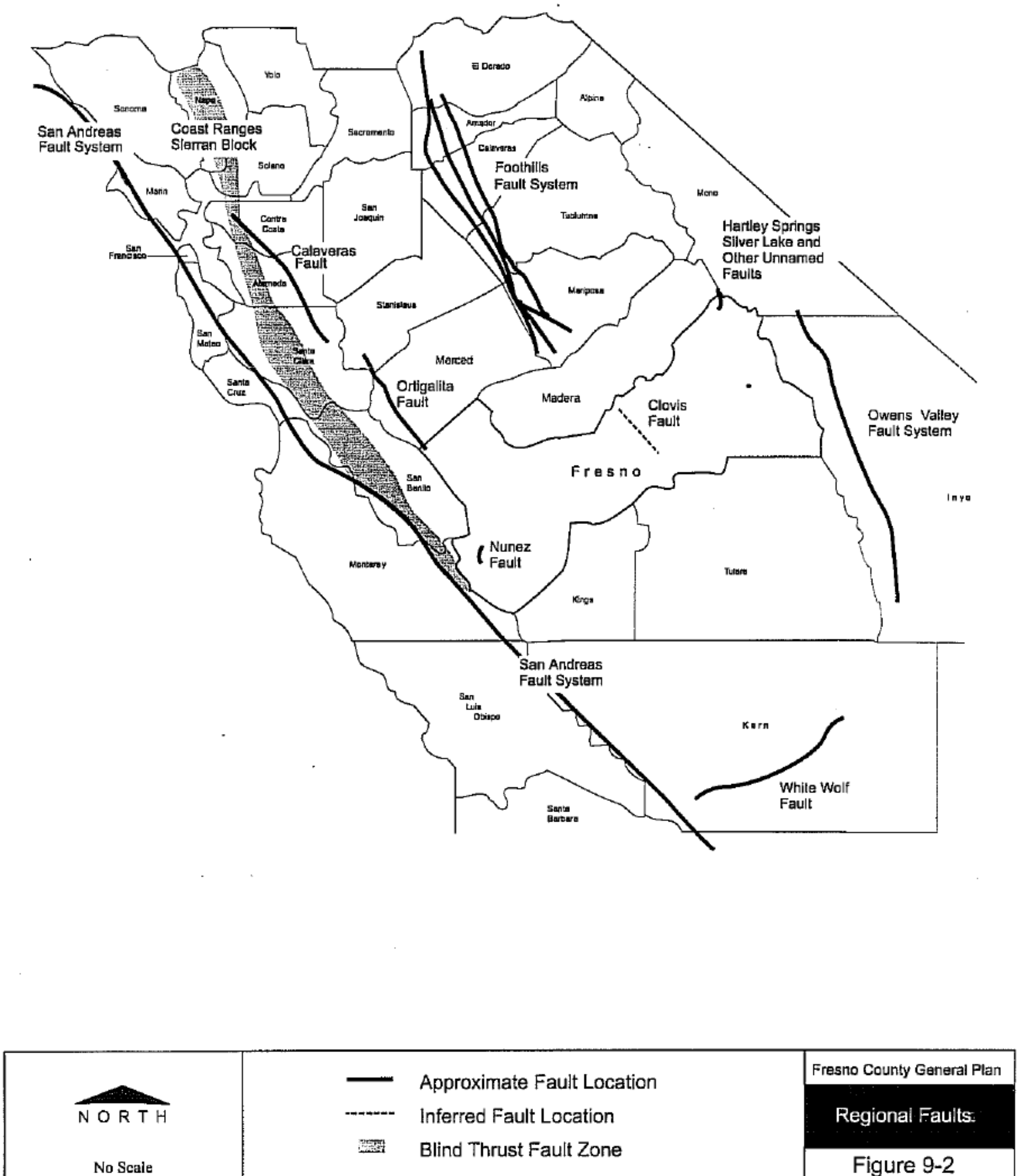
Earthquakes can also cause seiches, landslides, and dam failures. A seiche is a periodic oscillation of a body of water resulting from seismic shaking or other causes that can cause flooding. Earthquake-induced seiches are not considered a risk in Fresno County. Earthquakes may cause landslides, particularly during the wet season, in areas of high water or saturated soils. The most likely areas for earthquake-induced landslides are the same areas of high landslide potential discussed in Section 4.2.9 Landslide. Finally, earthquakes can cause dams to fail (see Section 4.2.3 Dam Failure).

Faults

An active fault is defined by the California Geological Survey as one that has had surface displacement within the last 11,000 years (Holocene). This does not mean, however, that faults having no evidence of surface displacement within the last 11,000 years are necessarily inactive. For example, the 1975 Oroville earthquake, the 1983 Coalinga earthquake, and the 1987 Whittier Narrows earthquake occurred on faults not previously recognized as active. Potentially active faults are those that have shown displacement within the last 1.6 million years (Quaternary). An inactive fault shows no evidence of movement in historic (last 200 years) or geologic time, suggesting that these faults are dormant.

There are a number of active and potentially active faults within and adjacent to Fresno County. Faults within Fresno County and major active and potentially active faults in the region are illustrated in Figure 4.10 and Figure 4.11.

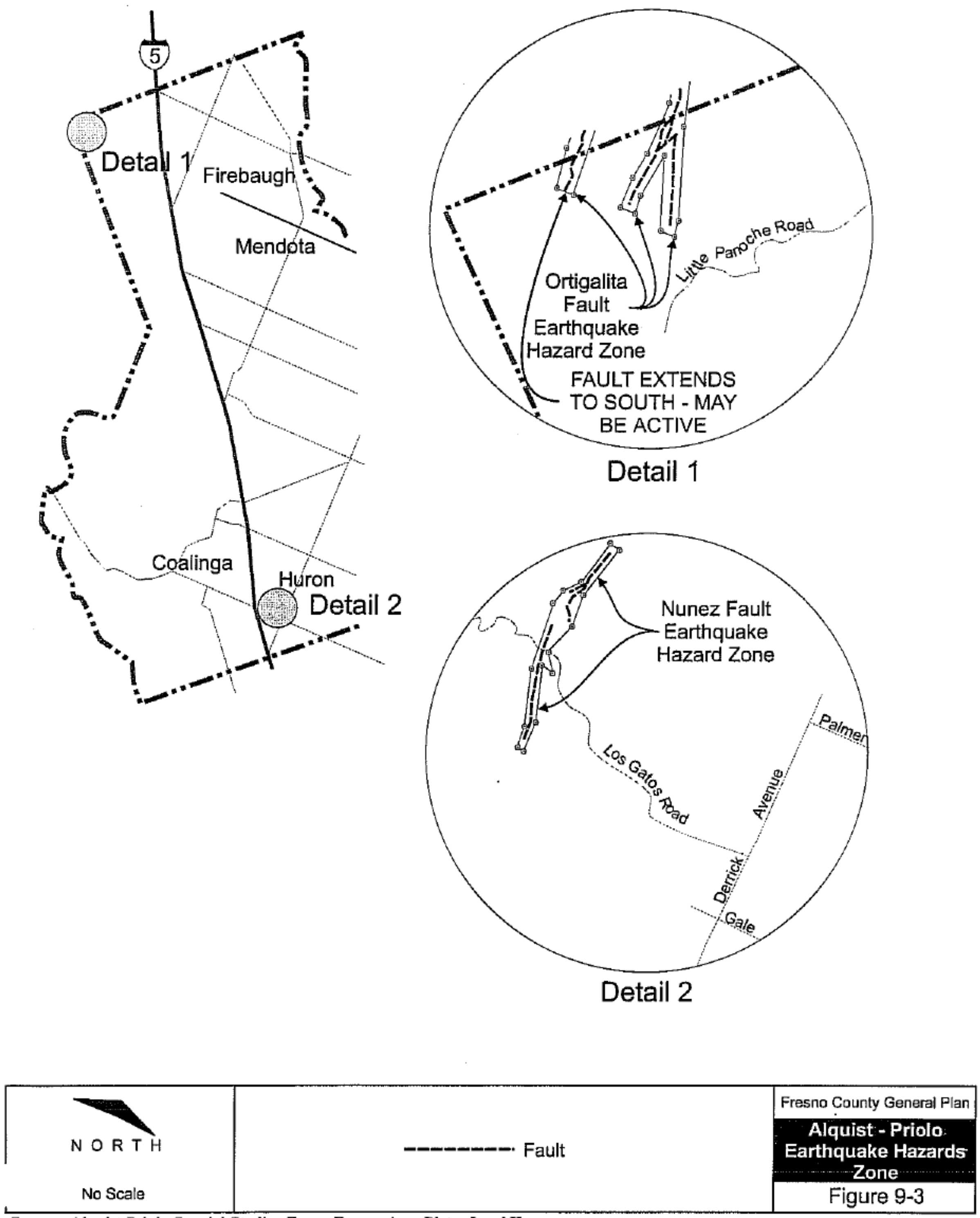
Figure 4.10 Fresno County Regional Faults



SOURCE: California Division of Mines and Geology, Fault
ctivity Map of California and Adjacent Areas, Scale
.750,000 Geologic Data Map No. 6, 1994; EIP Associates,
March 1997.

Source: Fresno County General Plan, 2017

Figure 4.11 Alquist-Priolo Earthquake Fault (Hazards) Zones



Source: Alquist Priolo Special Studies Zones Fresno Area Plates I and II

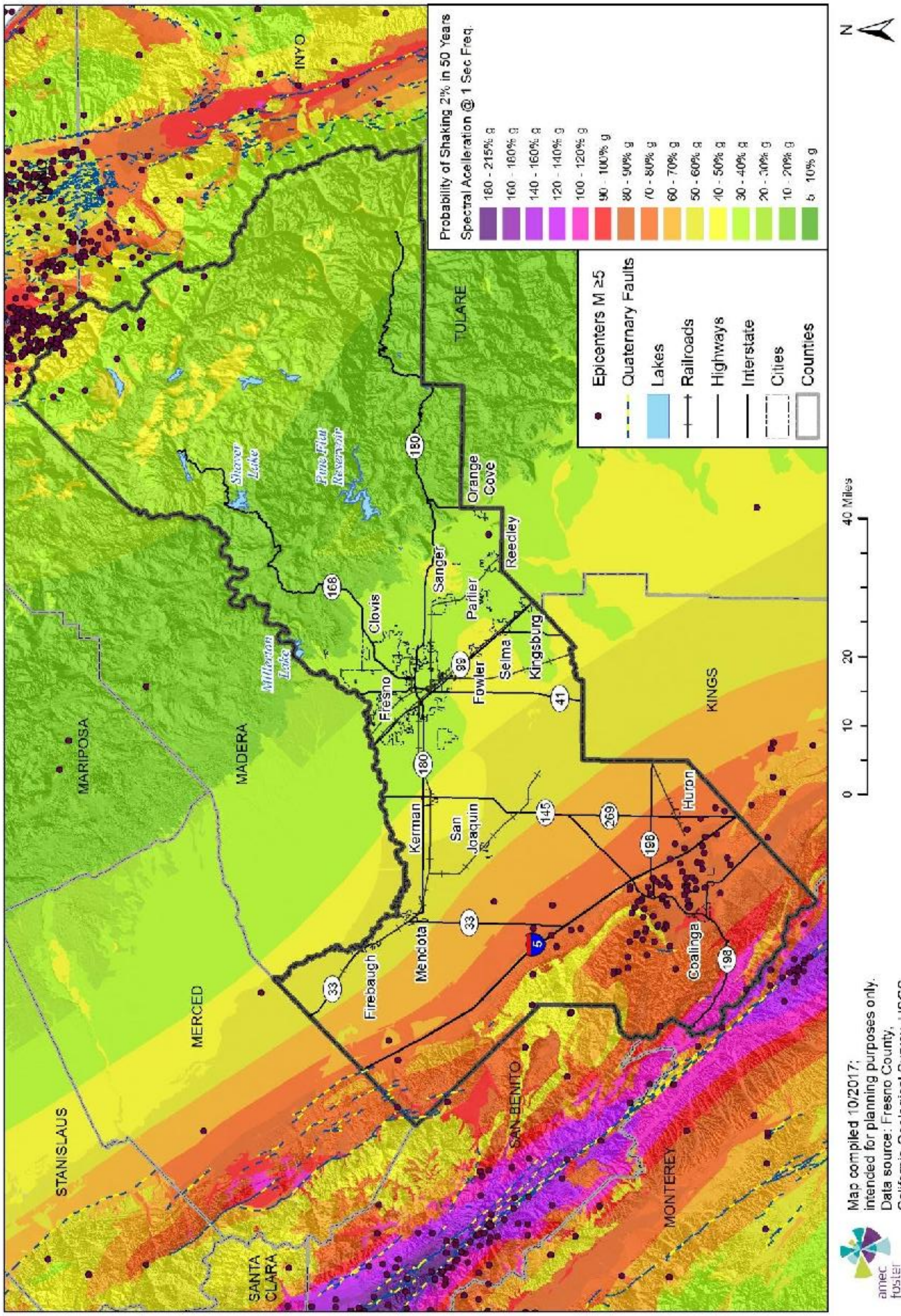
Source: Fresno County General Plan, 2017

- **Clovis Fault**—The northwest-trending Clovis fault is believed to be approximately five to six miles east of the City of Clovis, extending from an area just south of the San Joaquin River to a few miles south of Fancher Creek. The Clovis fault is considered a pre-Quaternary fault or fault without recognized Quaternary displacement. This fault is not necessarily inactive.
- **Hartley Springs Fault, Silver Lake Fault (Parker Lake Fault), Unnamed Faults**—Holocene and Quaternary faults are present in the vicinity of Duck Lake in the northeastern part of Fresno County, a few miles south of Mammoth Lakes.
- **Unnamed Inferred Faults**—Relative or apparent upward and downward displacement, which are interpreted as inferred faults, occur in an area located a few miles south of Helm, extending southeast to approximately Lanare (between Fresno Slough and Crescent Ditch). As with the Clovis fault, there is no apparent Quaternary displacement; however, the possibility for fault movement in this area cannot be completely eliminated.
- **Nuñez Fault**—The Nuñez fault is located approximately six to seven miles northwest of Coalinga. The Nuñez fault experienced surface rupture during the 1983 Coalinga earthquake and is designated an earthquake fault zone under the Alquist-Priolo Earthquake Fault Zoning Act of 1994. No structure for human occupancy may be built within an earthquake fault zone until geologic investigations demonstrate that the site is free of fault traces that are likely to rupture with surface displacement. Special development standards associated with Alquist-Priolo requirements would be necessary for development in this area.
- **Ortigalita Fault**—The Ortigalita fault zone is approximately 50 miles long, originating near Crow Creek in western Stanislaus County and extending southeast to a few miles north of Panoche in western Fresno County. Most of the fault is considered active due to displacement during Holocene time and is designated an earthquake fault zone under the Alquist-Priolo Earthquake Fault Zoning Act of 1994. The southernmost extension of the fault lies in Fresno County.
- **The San Andreas Fault**—The San Andreas fault lies to the west and southwest of Fresno County. In the southwestern part of the County, the fault is roughly parallel to and a few miles west of the County line. This fault is considered active and is of primary concern in evaluating seismic hazards throughout western Fresno County, although effects of earthquakes along the San Andreas fault could occur farther east as well.
- **Sierra Nevada Fault Zone (Owens Valley Fault Zone)**—Approximately 12 miles east of the eastern Fresno County boundary lies the Owens Valley fault zone. This northwest-trending fault zone is a lengthy and complex system containing active and potentially active faults. Historically, this fault has been the source of seismic activity in Madera County to the north.
- **Foothills Fault System**—The southern part of the Foothills Fault System, located approximately 70-80 miles north of the City of Fresno, includes the Bear Mountains fault and the Melones fault zone, as well as numerous smaller, but related faults. According to the California Geological Survey data, these faults have not shown any activity during the last 1.6 million years; however, geologic investigations of the seismic safety of the Auburn Dam site suggest these faults are potentially active. Therefore, the possibility exists that earthquakes could occur on these faults.

- **White Wolf Fault**—The White Wolf fault is located approximately 100 miles south of western Fresno County. The fault was not considered active until 1952, when movement along it generated a series of damaging earthquakes in the Bakersfield (Kern County) area.
- **Coast Range-Sierran Block Boundary**—Recent evidence suggests that faults along the western boundary of the Central Valley may be more active than once believed. According to the California Geological Survey, asymmetrical folds have recently been identified on the eastern slopes of the Coast Range, which includes western Fresno County. Such folds can hide faults that show no surface rupture. These faults and folds, which are part of a large system called the Coast Range-Sierran Block Boundary, are similar to the faults/folds identified as the cause of the 1983 Coalinga earthquake. Therefore, faults beneath the Central Valley once believed to be inactive are now believed to be active and capable of generating large magnitude earthquakes.

Figure 4.12 is an earthquake shaking map of Fresno County that is based on the 2% probability of occurrence in 50 years, based on analyses of these faults, soils, topography, groundwater, and the potential for earthquake shaking sufficiently strong to trigger landslide and liquefaction. It represents worst-case ground shaking and supports the conclusion that the Fresno County planning area is at risk to future damaging earthquake hazards, especially in the western and northeastern portions of the County.

Figure 4.12 Earthquake Shaking Potential for Fresno County

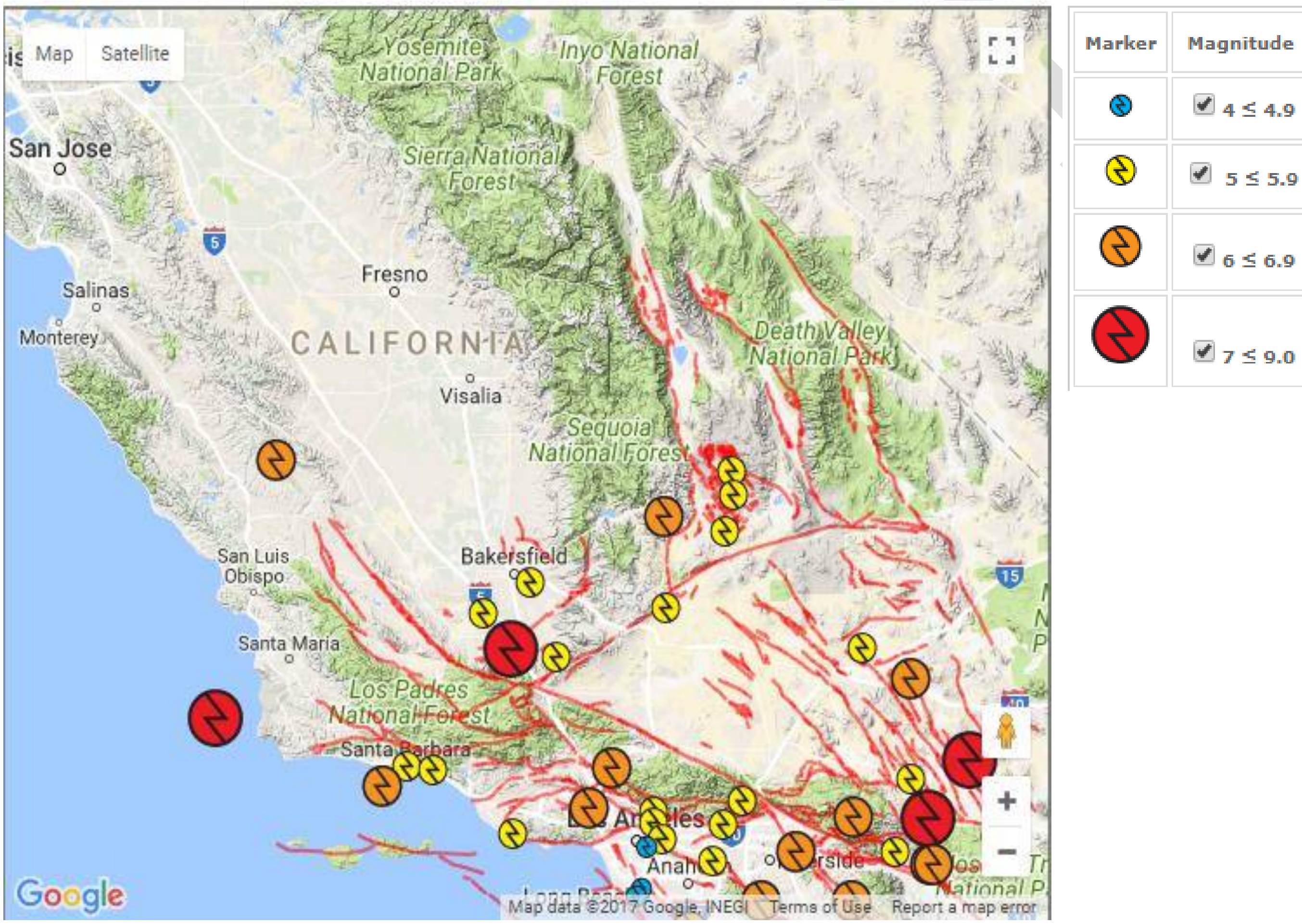


Seismic risk is not limited to identified faults. A significant fraction of small to moderately large earthquakes occur on faults not previously recognized. Such earthquakes are characterized as "background seismicity" or "floating earthquakes," which mean that the expected sources and locations of such earthquakes are unknown.

Extent

Figure 4.13 shows the location of faults and past earthquake epicenters in Southern California. Since earthquakes affect large areas the earthquake hazard extent within city limits is considered significant, potentially impacting 50-100% of the planning area.

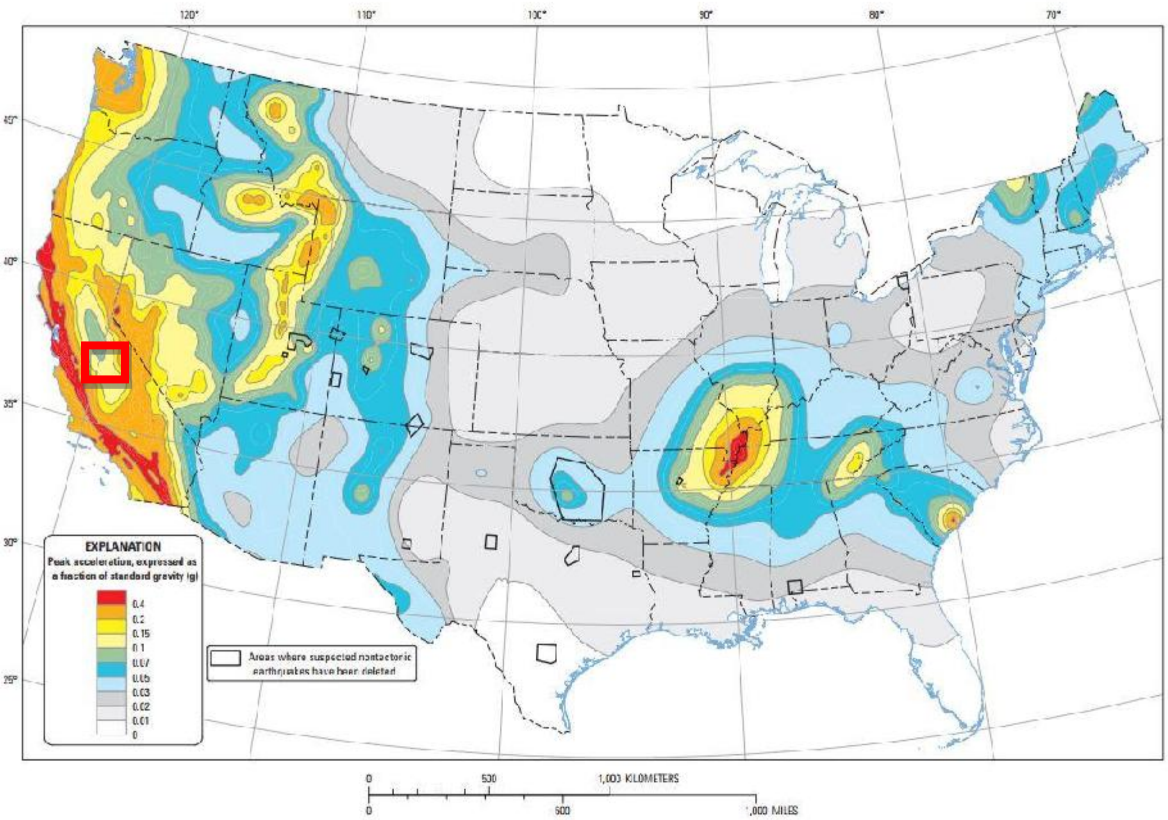
Figure 4.13 Southern California Earthquake and Fault Map



Source: California Institute of Technology, Southern California Earthquake Data Center, 2017

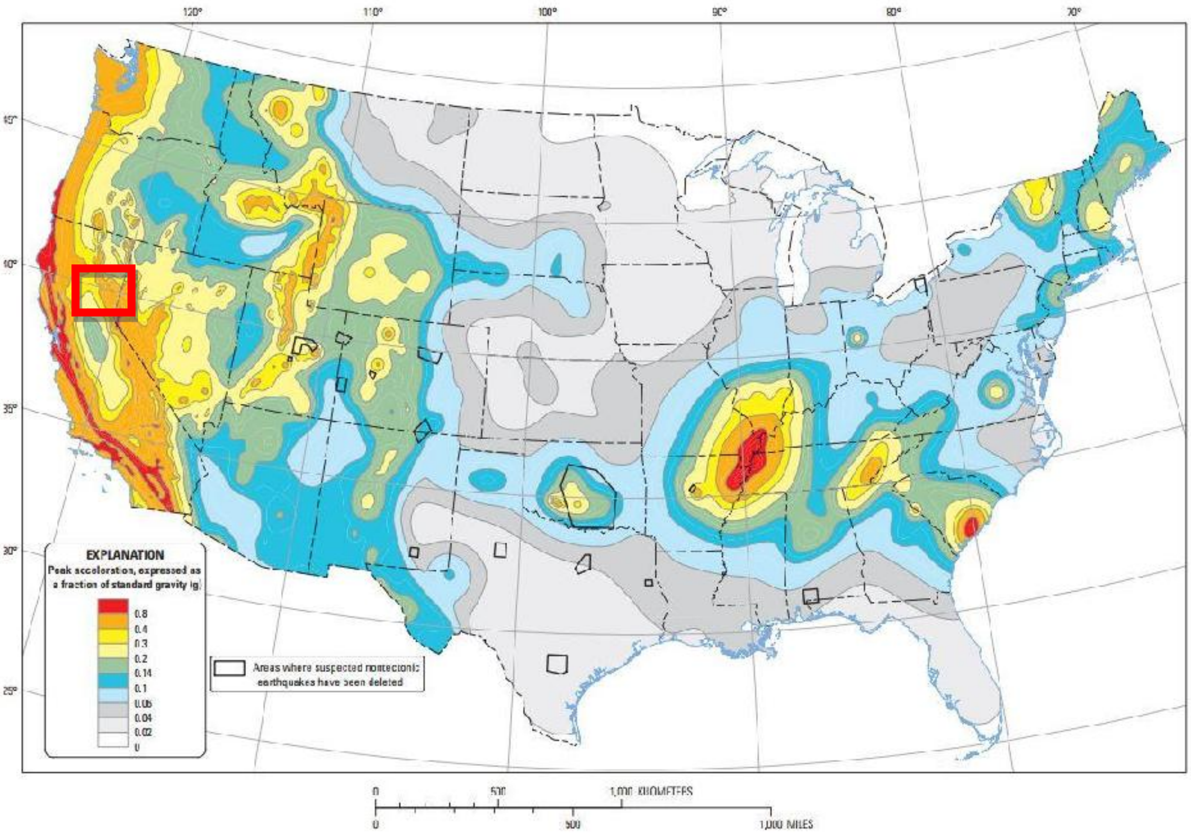
The U.S. Geological Survey (USGS) issues National Seismic Hazard Maps as reports every few years. These maps provide various acceleration and probabilities for time periods. Figure 4.14 depicts the peak horizontal acceleration (%g) with 10% probability of exceedance in 50 years for the planning region. The figure demonstrates that the city falls in the 3%g area. This data indicates that the expected severity of earthquakes in the region is fairly limited, as damage from earthquakes typically occurs at peak accelerations of 30%g or greater. However, as demonstrated by the HAZUS modeling documented earlier, the potential, though remote, does exist for damaging earthquakes.

Figure 4.14 Peak Horizontal Acceleration with 10% Probability of Occurrence in 50 Years



Source: USGS National Seismic Hazard Maps – 2014 Long-term Model.

Figure 4.15 Peak Horizontal Acceleration with 2% Probability of Occurrence in 50 Years



Source: USGS National Seismic Hazard Maps – 2014 Long-term Model.

The amount of energy released during an earthquake is usually expressed as a magnitude and is measured directly from the earthquake as recorded on seismographs. Seismologists have developed several magnitude scales; one of the first was the Richter Scale, developed in 1932 by the late Dr. Charles F. Richter of the California Institute of Technology. The Moment Magnitude Scale is used to quantify the magnitude or strength of the seismic energy released by an earthquake. Another measure of earthquake severity is Intensity. Intensity is an expression of the amount of shaking at any given location on the ground surface based on felt or observed effects. Seismic shaking is typically the greatest cause of losses to structures during earthquakes. Intensity is measured with the Modified Mercalli Intensity (MMI) scale. The table below compares Magnitude and the felt effects associated with the MMI scale. Damage typically occurs in MMI VII or above, and some areas of the County are susceptible to this level of shaking.

Table 4.12 Richter Scale Measurements and Associated Characteristics

Magnitude	Mercalli Intensity	Effects	Frequency
Less than 2.0	I	Microearthquakes, not felt or rarely felt; recorded by seismographs.	Continual
2.0-2.9	I to II	Felt slightly by some people; damages to buildings.	Over 1M per year
3.0-3.9	II to IV	Often felt by people; rarely causes damage; shaking of indoor objects noticeable.	Over 100,000 per year
4.0-4.9	IV to VI	Noticeable shaking of indoor objects and rattling noises; felt by most people in the affected area; slightly felt outside; generally, no to minimal damage.	10K to 15K per year
5.0-5.9	VI to VIII	Can cause damage of varying severity to poorly constructed buildings; at most, none to slight damage to all other buildings. Felt by everyone.	1K to 1,500 per year
6.0-6.9	VII to X	Damage to a moderate number of well-built structures in populated areas; earthquake-resistant structures survive with slight to moderate damage; poorly designed structures receive moderate to severe damage; felt in wider areas; up to hundreds of miles/kilometers from the epicenter; strong to violent shaking in epicentral area.	100 to 150 per year
7.0-7.9	VIII<	Causes damage to most buildings, some to partially or completely collapse or receive severe damage; well-designed structures are likely to receive damage; felt across great distances with major damage mostly limited to 250 km from epicenter.	10 to 20 per year
8.0-8.9	VIII<	Major damage to buildings, structures likely to be destroyed; will cause moderate to heavy damage to sturdy or earthquake-resistant buildings; damaging in large areas; felt in extremely large regions.	One per year
9.0 and Greater	VIII<	At or near total destruction - severe damage or collapse to all buildings; heavy damage and shaking extends to distant locations; permanent changes in ground topography.	One per 10-50 years

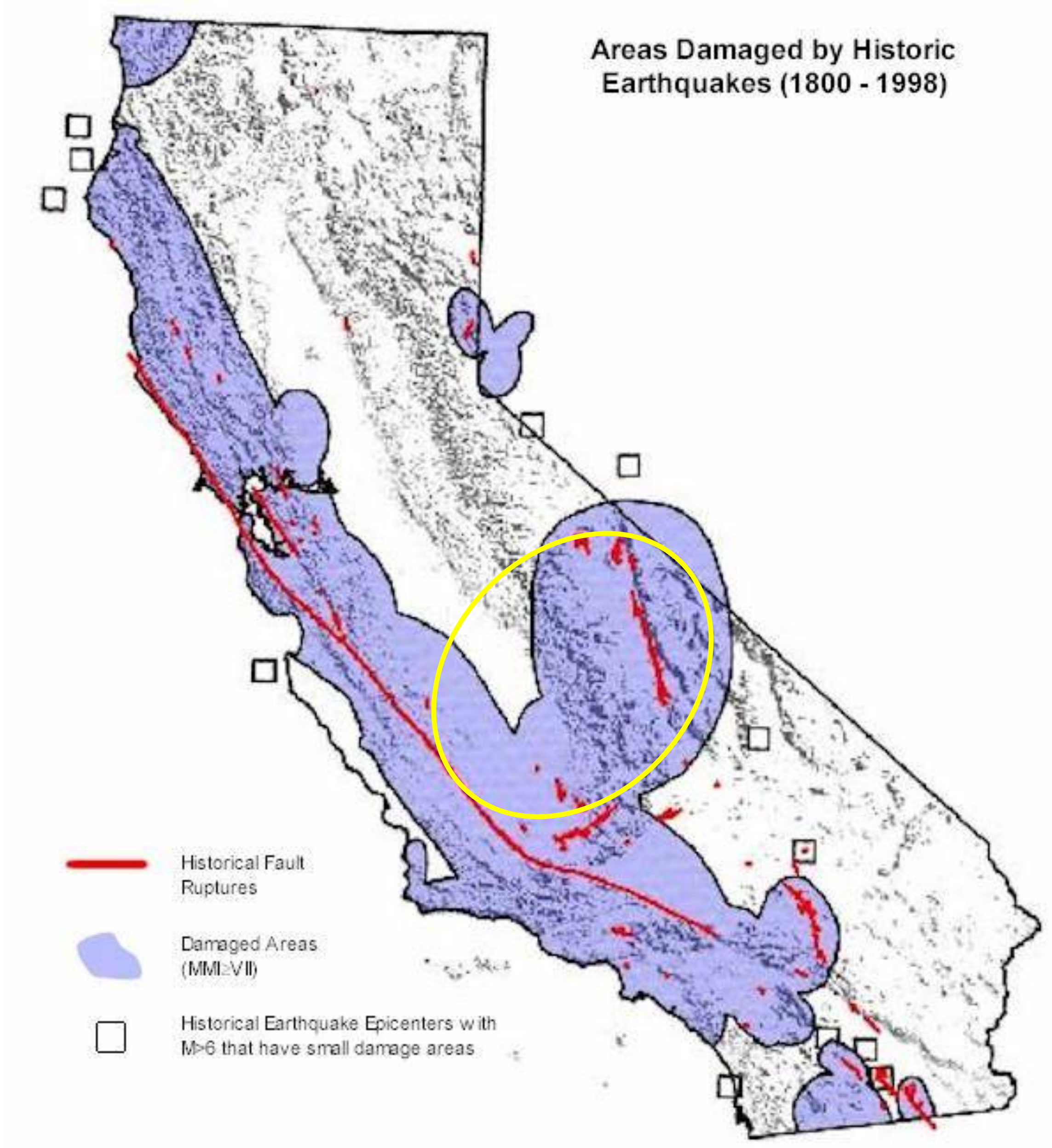
Past Occurrences

Earthquakes have occurred in Fresno County in the past. Figure 4.16 illustrates areas of California damaged by earthquakes between 1800 and 1998. According to the Fresno County Operational Area Master Emergency Services Plan, the California Geological Survey has identified a minimum of four magnitude 5.0 or greater earthquakes that caused damaging shaking in Fresno County between 1800 and 1999. Details on some of these events follow.

- **1983**—In Coalinga, a surface rupture occurred along the Nuñez fault. The main shock was 6.7 on the Richter scale. The surface rupture was determined not to be the cause of the main shock; instead, a blind thrust fault concealed deep within a complex fold-and-thrust belt at the western end of the San Joaquin Valley was identified as the cause. Approximately 800 buildings were destroyed, and 1,000 people were left homeless. No deaths resulted, but 47 people were injured. Private homeowner losses exceeded $25 million. Public agency losses were roughly $6 million. The commercial section of Coalinga was heavily damaged; however, most schools and the hospital received only slight damage. Local, state, and federal declarations resulted.
- **August 4, 1985**—A magnitude 6.0 earthquake occurred, centered about 10.5 kilometers east of Coalinga.

It is unknown to what extent earthquakes occurring outside of the planning area were felt by Fresno County residents.

Figure 4.16 Areas Damaged by Historical Earthquakes, 1800-1998



Source: California Geological Survey, www.consrv.ca.gov/CGS/rghm/psha/ofr9608/index.htm#Faults%20in%20California

Likelihood of Future Occurrences

Occasional—According to the Fresno County Operational Master Emergency Services Plan, the faults and fault systems that lie along the eastern and western boundaries of Fresno County, as well as other regional faults, have the potential to produce high magnitude earthquakes throughout the County. Based on the Alquist-Priolo Earthquake Fault Zone chart, Fresno County would be affected by earthquake activity in the Alcalde Hills and Ortigalita Peak faults. There are also several faults in the vicinity of Coalinga that could cause problems in the future. These include the Nuñez fault, about ten kilometers northwest of Coalinga, the Coalinga fault, 5 kilometers northeast of Coalinga; and the New Idria fault, approximately 21 kilometers northwest of Coalinga. In addition, there are many faults in neighboring counties that could potentially affect Fresno County. Specifically, the U.S. Geological Survey is predicting an earthquake at the community of Parkfield in Monterey County, approximately 15 miles southwest of Coalinga.

Climate Change Considerations

While climate change is not expected to directly affect earthquake frequency or intensity; it could exacerbate indirect impacts of earthquakes (e.g., climate change will increase the frequency and intensity of extreme precipitation events, increasing the probability of landslides and liquefaction events during an earthquake).

4.2.6 Flood

Hazard/Problem Description

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss and are usually caused by weather events. Floods can cause substantial damage to structures, landscapes, and utilities as well as life safety issues. Certain health hazards are also common to flood events. Standing water and wet materials in structures can become breeding grounds for microorganisms such as bacteria, mold, and viruses. This can cause disease, trigger allergic reactions, and damage materials long after the flood. When floodwaters contain sewage or decaying animal carcasses, infectious disease becomes a concern. Direct impacts, such as drowning, can be limited with adequate warning and public education about what to do during floods. Where flooding occurs in populated areas, warning and evacuation will be of critical importance to reduce life and safety impacts.

The area adjacent to a channel is the floodplain. Floodplains are illustrated on inundation maps, which show areas of potential flooding and water depths. In its common usage, the floodplain most often refers to the area that is inundated by the 100-year flood, the flood that has a one percent chance in any given year of being equaled or exceeded. The 100-year flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program. The 500-year flood is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. In addition to the standard 100-year and 500-year flood maps, the California Department of Water Resources (CA DWR) has initiated a program that covers areas at risk of a 200-year flood. After propositions IE and 84 were passed in 2006, funding became available to support the Central Valley Floodplain Evaluation and Delineation (CVFED) program. To assist DWR with fulfilling new California code requirements, the CVFED Program provides new maps delineating the 100-year, 200-year and 500-year floodplains for areas receiving protection from the State federal flood protection system in the Central Valley.

The potential for flooding can change and increase through various land use changes and changes to land surface, which can result in a change to the floodplain. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

The Fresno County planning area is susceptible primarily to three types of flooding: localized, riverine, and dam failure flooding.

- **Localized flooding—**Localized flooding problems are often caused by flash flooding, severe weather, or an unusual amount of rainfall. Flooding from these intense weather events usually occurs in areas experiencing an increase in runoff from impervious surfaces associated with development and urbanization as well as inadequate storm drainage systems. The term “flash flood” describes localized floods of great volume and short duration. This type of flood usually results from a heavy rainfall on a relatively small drainage area. Precipitation of this sort usually occurs in the winter and spring. Flash floods often require immediate evacuation within the hour.
- **Riverine flooding—**Riverine flooding, defined as when a watercourse exceeds its “bank-full” capacity, generally occurs as a result of prolonged rainfall, or rainfall that is combined with already saturated soils from previous rain events. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include one or more independent river basins. The onset and duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface due to urbanization. In the Fresno County planning area, riverine flooding is largely caused by heavy and continued rains, sometimes combined with snowmelt, increased outflows from upstream dams, and heavy flow from tributary streams. These intense storms can overwhelm the local waterways as well as the integrity of flood control structures. The warning time associated with slow rise floods assists in life and property protection.
- **Dam failure flooding**—Flooding from failure of one or more upstream dams is also a concern to the Fresno County planning area. A catastrophic dam failure could easily overwhelm local response capabilities and require mass evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major loss of life could result, and there could be associated health concerns as well as problems with the identification and burial of the deceased. Dam failure is further addressed in Section 4.2.3 Dam Failure.

Eastern and Central Fresno County

Eastern Fresno County extends from the Sierra Nevada foothills to the Great Western Divide. It is located primarily in the Sierra Nevada, where precipitation falls mainly as snow. The region is characterized by small local watersheds and draining to the reservoirs upstream of Millerton and

Pine Flat reservoirs. Flows originating in the mountains and foothills contribute to the drainage and flooding problems on the valley floor.

Central Fresno County includes the area between the valley floor around Fresno Slough and eastward to the Sierra Nevada foothills, including Millerton Reservoir to Pine Flat Reservoir. The geographic area of central Fresno County runs along the Sierra Nevada foothills at elevations around 500 feet, and slopes down to the Fresno Slough on the valley floor, and drains gently to the north. This area is the population center of the County; thus, most storm drainage and flood control systems are largely designed to protect urban development. Average annual precipitation in the central Fresno County area varies from 6 inches near Mendota to about 70 inches upstream.

The western slope of the Sierra Nevada drains into central Fresno County via the San Joaquin and Kings rivers and small creeks and stream systems. The Fresno Slough, also known as the North Fork of the Kings River, is connected to the San Joaquin River by the James Bypass, a manmade canal. It directs floodwater from the Kings River to the San Joaquin River. Three dams have been constructed to control flows on the rivers. These dams are Friant and Mendota dams on the San Joaquin River and Pine Flat Dam on the Kings River. Pine Flat Dam is operated primarily for flood control purposes. Friant Dam was constructed and is managed by the U.S. Bureau of Reclamation as part of the Central Valley Project. Although Friant Dam does serve to reduce release volumes in the main San Joaquin River channel, it was not sited, designed, or engineered for the purpose of flood control. Mendota Dam is operated primarily for irrigation.

In addition to the flood control facilities on the San Joaquin and Kings rivers, a number of reservoirs and detention basins have been constructed on streams east of the Fresno-Clovis area to prevent urban flooding. These facilities include Redbank Dam and the Redbank-Fancher Creeks Flood Control Project. The Redbank-Fancher Creeks Flood Control Project consists of two dams (Big Dry Creek Dam and Fancher Creek Dam), three detention basins (Redbank Creek, Pup Creek, and Alluvial Drain detention basins), and various canals to convey discharges around developed areas. The Friant-Kern Canal draws water from Millerton Reservoir at Friant Dam and flows south along the foothills toward Bakersfield.

The rivers, streams, and flood control systems of eastern and central Fresno County are described in further detail below. Table 4.13 summarizes the location, capacity, and managing agency for each steam system and flood control facility in eastern and central Fresno County.

San Joaquin River

The San Joaquin River forms the boundary between Fresno and Madera counties. It flows from the Great Western Divide in the Sierra Nevada southwest along the northern border of Fresno County where it is joined by flows from the North Fork of the Kings River. From there, the river flows northwest up the San Joaquin Valley toward the Delta. Friant Dam, which serves to regulate river flows, is the most significant of the dams on the San Joaquin River. Several dams are located upstream of Friant Dam.

The storage capacity of Millerton Reservoir (formed by Friant Dam) is 520,500 acre-feet. The Central Valley Project Friant Unit consists of Friant Dam and Millerton Reservoir; the Friant-Kern Canal, which runs south to Kern County; and the Madera Canal, which runs northwesterly to Madera County. Releases from Friant Dam to the San Joaquin River and the Friant-Kern Canal provide service to water users within Fresno County.

This storage capacity of Millerton Reservoir is inadequate for full flood protection during wet years, and emergency releases may result in flooding problems downstream. The U.S. Army Corps of Engineers (the Corps) has evaluated the operational plans for all the dams in the San Joaquin River system to determine the possibility of coordinated releases to reduce the likelihood of coincident peak flows downstream with some success. However, in 1997, emergency releases from Friant Dam combined with large storm events and several levee breaks contributed to flooding along the San Joaquin River. Not designed for purposes of flood control, any flood control capability of the Friant Unit is incidental to its function as a diversion facility. The Madera Canal, also part of this unit, also serves to release runoff volumes from the San Joaquin River.

The Friant-Kern Canal carries irrigation water from Millerton Reservoir southeast to Kern County. The average annual delivery from the canal is about one million acre-feet with a design capacity of 5,000 cubic feet per second (cfs). There is a spillway into the Kings River just upstream of a double barrel 24 ½-foot diameter siphon under the river. Although the canal was constructed by the Bureau of Reclamation and is normally managed by the Friant-Kern Water Users Authority, floodwater in the canal is managed by the Corps. During times of flooding, water from the Friant-Kern Canal may not be releasable to the Kings River since the Corps may not want additional flows on the river.

Mendota Pool is a 5,000-acre-foot reservoir created by Mendota Dam located just outside City of Mendota on the San Joaquin River. The primary function of the dam is storage of irrigation water for agriculture; however, the water level in the pool also functions to maintain water levels in the Mendota Wildlife Management Area. Mendota Pool provides little or no flood protection. Mendota Dam contains flow from the San Joaquin River as well as discharge and releases from the Kings River via the Fresno Slough and James Bypass. The Delta-Mendota Canal conveys Delta water to Mendota Pool from the north, and several irrigation channels divert flows from it. The Bureau of Reclamation, in coordination with the Central California Irrigation District, manages this system, which is part of the Central Valley Project, and they have proposed replacing the existing dam with a new dam, which may raise the water level in the pool.

Southern California Edison and Pacific Gas and Electric own and operate a number of dams and reservoirs on the San Joaquin River and its tributaries upstream of Friant Dam. The most notable of these are Edison Lake and Florence Lake. These upstream storage facilities are operated for the production of electric energy and have a combined capacity of about 609,530 acre-feet. Their operation does affect the flow of water into Millerton Reservoir and subsequently the timing and availability of releases to Friant Unit contractors. None of these storage facilities are designed or operated for flood control, and the Corps currently has no jurisdiction over releases from these structures. Cumulative flood releases from the upper San Joaquin River dams could overwhelm Friant Dam.

From Friant to Gravelly Ford, the San Joaquin River is part of the Designated Floodway Program administered by the State Reclamation Board. Land use restrictions and river management practices allow the river to meander, flood the overbanks, and remain in a relatively natural state. Downstream of Gravelly Ford, the river is confined by levees. The design capacity of the San Joaquin River from Friant Dam to Chowchilla Bypass is in excess of 8,000 cfs, while the channel capacity downstream is reduced. The major San Joaquin River "choke point" in Fresno County is the reach near Mendota and Firebaugh, which has a channel capacity of 8,000 cfs. Beyond that point, San Joaquin River channel capacity continues to decrease for some distance due to lack of annual flooding and natural channel clearing since Friant Dam was constructed. Further downstream, the river channel has been deepened and widened by historical flows of the Merced and Tuolumne rivers and other tributaries.

In addition to releases from Friant Dam, two uncontrolled streams, Cottonwood Creek and Little Dry Creek, add significantly to the river flows below Friant during heavy precipitation. Historically, large areas within the Central Valley were within the river's floodplain. Development has encroached on the floodplain and the flow is now confined to a relatively narrow channel constrained by levees, which reduce the carrying capacity of the river. Most of the flow from Friant Dam is diverted to the Chowchilla Bypass, which branches off the San Joaquin River about 11 river miles upstream from Mendota Dam. Over time, encroachment of vegetation, substantial sedimentation, and land subsidence has considerably reduced channel capacity. Erosion, seepage, and prolonged high water compromise levee integrity. Downstream of the Chowchilla Bypass, the river is not confined by levees (within Fresno County) and generally carries no more than 2,500 cfs.

Flood control measures constructed along the main stem of the river have impacted riparian and wetland wildlife habitat areas. Levee construction and sediment and vegetation removal can damage streamside vegetation, divert floodwater from wetlands and riparian areas, and reclaim natural wetlands for other uses.

Kings River

The Kings River originates high in the Sierra Nevada Mountains near the Inyo County line and flows southwest through the central part of Fresno County and into Tulare County at Reedley. It has a large drainage basin, which includes most of Kings Canyon National Park and most of the area between Shaver and Florence lakes in the north to the Fresno/Tulare County border in the south. North of Hanford, the river branches, and the south fork flows southward to the Tulare Lakebed. The north fork joins Fresno Slough, which conveys flows north to the San Joaquin River at Mendota Pool. Several sloughs and canals branch off the river and are used for water storage and to convey irrigation water.

The Kings River flows are regulated by Pine Flat Dam, completed in 1954 for flood control purposes. Pine Flat Reservoir has a storage capacity of approximately one million acre-feet. The flood control functions of the facility are managed by the Corps while the releases for irrigation diversion are managed by the Kings River Water Association. There are additional reservoirs upstream of Pine Flat that are owned and operated by Pacific Gas and Electric for the purpose of hydroelectric power generation. These facilities have a combined storage capacity of about 252,000 acre-feet. Two uncontrolled creeks, Hughes Creek and Mill Creek, flow into the Kings River below Pine Flat Dam. Pine Flat Reservoir has adequate storage capacity to avoid emergency releases in most storm events, but these downstream creeks can add significant flow to the river.

Downstream of Pine Flat Dam, the Kings River is managed for flood control by the Kings River Conservation District in cooperation with the Corps, the California Department of Water Resources (DWR), and local irrigation districts. Releases from Pine Flat Dam and flows from Hughes Creek and Mill Creek provide the majority of the river's flow. Numerous sloughs and irrigation canals branch off the Kings River. The capacity of the river is more than 13,000 cfs. The Kings River flood control facilities include many miles of levees in central Fresno County.

There are three weirs on the river: Army Weir, Crescent Weir, and Stinson Weir. Army Weir is located where the north and south forks branch off the natural river just upstream from State Route 41. Crescent Weir is located at the Crescent Bypass southwest of 22nd and Excelsior Avenues. The Crescent Bypass flows to Fresno Slough. Stinson Weir is located near the confluence of Murphy Slough and Fresno Slough at Elkhorn Avenue. Normal flows are held by these weirs in the main channel. During storm events, as much as 4,750 cfs is diverted to the North Fork and the San Joaquin River. As much as 3,200 cfs can then be diverted to the Crescent Bypass. Any flow above approximately 10,000 cfs is divided equally between the north and south forks.

In practice, the flow of the Kings River is carefully managed using analysis of anticipated weather, upstream flows, and ability of downstream users to receive the water. Significant adjustment may be necessary, and a variety of operations options are considered, including storing or routing water through alternate sloughs or requesting users to accept additional water. Fresno Slough and the James Bypass are normally dry except for groundwater seepage and irrigation returns. Flow is diverted to the South Fork only in very wet years.

Sand and gravel extraction has occurred along both the San Joaquin River and the Kings River in Fresno County, although most of this aggregate mining has occurred outside of the main river channels. The hydrologic effect of the mining and subsequent reclamation activity has generally been to increase the overall hydraulic capacity of the rivers to accommodate major flood events.

Eastern County Streams

There are many creeks and lakes in the high Sierra Nevada within Fresno County, all of which eventually feed into either the Kings River or the San Joaquin River. In addition, several creeks drain the foothill areas and flow into developed areas in central Fresno County. Most of these streams (i.e., Redbank, Fancher, Dry, and Dog creeks) have been controlled by efforts of the Corps and the Fresno Metropolitan Flood Control District to protect the City of Fresno from damage of flooding from a 200-year storm. Other creeks, such as Wahtoke Creek, are uncontrolled. Some streams in foothill areas of southeastern Fresno County are tributaries to the Orange Cove Stream Group and to Sand Creek, which is a tributary to the Kaweah River.

Flood control efforts along some of these eastern Fresno County streams include the following:

- **Redbank Reservoir**—Redbank Reservoir, formed by Redbank Dam, is located on Redbank Creek north of Shaw Avenue. The reservoir has a gross pool capacity of 1,030 acre-feet, and receives water from the Redbank Creek watershed. The reservoir is operated for flood control by the Fresno Metropolitan Flood Control District.
- **Redbank-Fancher Creeks Flood Control Project**—This project consists of a system of two dams, three detention basins, and canals to protect developed areas in and around the City of Fresno from a 200-year storm. The project was built by the Corps and is managed and operated by the Fresno Metropolitan Flood Control District. Fancher Creek Reservoir has a capacity of 9,712 acre-feet and retains water from Fancher and Hog creeks and some flows from Redbank Creek. Fancher Dam diverts flows via canals around Fresno. Redbank Creek Detention Basin (940 acre-feet) contains local flows from Redbank Creek downstream from Redbank Dam. The Alluvial Drain and Pup Creek detention basins have capacities of 305 and 559 acre-feet, respectively, and can each regulate discharges into Dry Creek at 25 cfs.
- **Big Dry Creek Reservoir**—Big Dry Creek Reservoir, with a capacity of 30,200 acre-feet, retains flows from Big Dry Creek and Dog Creek and diverts flows via Little Dry Creek to the San Joaquin River at a rate of up to 700 cfs. During a flood event, water is not typically released from Big Dry Creek Dam; however, during a severe flood event, it may be necessary to do so.

Table 4.13 Major Flood Control Facilities and Stream Systems in Eastern and Central Fresno County

Facility/Water Body	Location	Capacity	Managing Agency
Millerton Reservoir*	17 miles northeast of SR 99 on the San Joaquin River in the north central part of the county	520,500 acre-ft[1]	U.S. Bureau of Reclamation
Pine Flat Reservoir	16 miles northeast of Sanger on the Kings River in the east central part of the county	1,000,000 acre-ft[1]	U.S. Army Corps of Engineers
Mendota Pool	On the San Joaquin River at Mendota where the river turns north and Fresno Slough joins the river in the northwestern part of the country	5,000 acre-ft[2]	U.S. Bureau of Reclamation
Big Dry Creek Reservoir	West of Friant-Kern Canal and north of Tollhouse Road on Big Dry Creek	30,200 acre-ft[1]	Fresno Metropolitan Flood Control District
Redbank Reservoir	7 miles east of Clovis, 3 miles southwest of the Friant-Kern Canal between Dog Creek and Fancher Creek in the central part of the county	1,030 acre-ft	Fresno Metropolitan Flood Control District
Fancher Creek Reservoir	East of the Friant-Kern Canal at the confluence of Fancher and Hog creeks	9,712 acre-ft[1]	Fresno Metropolitan Flood Control District
Redbank Creek Detention Basin	On Redbank Creek north of McKinley Avenue and west of DeWolf Avenue	940 acre-ft[1]	Fresno Metropolitan Flood Control District
Pup Creek Detention Basin	On Pup Creek south of Herndon Avenue and east of Temperance Avenue	559 acre-ft[1]	Fresno Metropolitan Flood Control District
Alluvial Drain Detention Basin	On Alluvial Drain west of Temperance Avenue and north of Nees Avenue	305 acre-ft[1]	Fresno Metropolitan Flood Control District
Eastern and Central Fresno County 1997	Flows from the Sierra Nevada southwest along the northern border of the county to Mendota where it turns to flow to the northwest. Forms the border between Fresno and Madera counties	8,000 cfs[1**] (Friant Dam to Chowchilla) 2,500 cfs[1,4] (to Mendota) 4,500 cfs[1,4] (Mendota Dam to Sand Slough)	U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and Local Irrigation Districts
Kings River	Flows from the Sierra Nevada to Sanger and Reedley and into Kings County boundary to Army Weir above Hwy 41 where the normal flow is diverted to the North Fork. Excess flows are diverted to Tulare Lakebed	13,000 cfs[3**]	Kings River Conservation District
Fresno Slough & James Bypass	A seasonal waterway system which connects the Kings River near Laton and Lemoore NAS to the San Joaquin River at Mendota Pool during flood events	4,750 cfs[1]	U.S. Army Corps of Engineers
Friant-Kern Canal	Flows southeasterly from Millerton Lake through Orange Cove continuing on to Bakersfield. Crosses five feet below Kings River via a 24.5 ft diameter 3,000 ft siphon	5,000 cfs[1]	Friant-Kern Water Users' Authority, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers
Millerton Reservoir*	17 miles northeast of SR 99 on the San Joaquin River in the north central part of the county	520,000 acre-ft[1]	U.S. Bureau of Reclamation

Source: Fresno County General Plan, 2017

Note: The numbers provided in this table are design capacity and actual river capacity may vary significantly

*Friant Dam/Millerton Reservoir is not sited, designed, or operated to function as a flood control facility, and any such capability is incidental to its function as a diversion facility
[1]U.S. Army Corps of Engineers
[2]Central California Irrigation District
[3]Kings River Conservation District
[4]River channel capacity is difficult to define due to significant changes in the river conditions over time, variance in channel conditions and geometry along a given river reach, and assumptions made in developing hydraulic models

Western County Streams

Western Fresno County consists of the Coast Range within which lies the County's western boundary with San Benito and Monterey counties and the San Joaquin Valley area between the Range and the Fresno Slough. Interstate 5 and the California Aqueduct pass in a north-south direction through western Fresno County. A complex system of streams drains the eastern slope of the Coast Range into the valley and the Fresno Slough. Western Fresno County is significantly different from the rest of the County in climate and character.

Western Fresno County is largely unpopulated. The major land uses are agriculture and grazing. The region is quite dry, with an average annual rainfall of only six to eight inches, yet the stream systems are prone to high flows and flooding because they drain very large watersheds. The soils in the Coast Range are subject to erosion. As a result, stormwater runoff typically carries large volumes of sediment and naturally occurring minerals, such as selenium, arsenic, boron, and asbestos, which is undesirable to downstream users.

Western Fresno County contains five major stream systems that flow from the Coast Range as described further below. The location, capacity, and managing agency for each stream system and associated flood control facility is summarized in Table 4.13.

- **Little Panoche Creek**—Little Panoche Creek, located in the northwestern corner of Fresno County, is managed for flood control purposes by the DWR. The DWR operates and maintains a detention dam and reservoir (Little Panoche Reservoir) on the creek. The facility was constructed by the Bureau of Reclamation to provide flood protection for the California Aqueduct. It was designed for a 100-year storm and has a storage capacity of 820 acre-feet. When storage levels in the reservoir exceed 820 acre-feet, the dam's uncontrolled spillway releases water. The creek flows under Interstate 5 and the California Aqueduct. Little Panoche Creek ends at a retention basin on the eastside of the aqueduct. When the retention basin fills with stormwater during high flows, stormwater is pumped into the aqueduct. The reservoir also serves as a wildlife preserve.
- **Panoche Creek**—Panoche Creek is located just south of Little Panoche Creek in northwestern Fresno County. It flows under Interstate 5and across the California Aqueduct. The estimated 100-year peak flow for Panoche Creek is 22,000 cfs. On the east side of the aqueduct, the water is not channelized and flows overland. During high creek flows, stormwater floods vast tracks of agricultural land and portions of the City of Mendota.
- **Tumey Gulch and Arroyo Ciervo**—Tumey Gulch and Arroyo Ciervo are located in central western Fresno County and flow easterly from Ciervo Mountain. The estimated 100-year peak flow is 3,600 cfs for Tumey Gulch and is 900 cfs Arroyo Ciervo. No flood control facilities

exist on the streams; however, the California Aqueduct obstructs their eastward flow. During periods of high stream flow, sediment laden floodwater may form ponds on the west side of the aqueduct. These ponds may spill stormwater and sediment into the aqueduct during storm events.

- **Cantua Creek System**—This creek system includes Arroyo Hondo, Cantua Creek, Salt Creek, Martinez Creek, and Domegine Creek in central western Fresno County. These creeks drain the east side of Joaquin Ridge, crossing Interstate 5 between Kamm Road and Fresno-Coalinga Road. The estimated 100-year peak flow from the Cantua Creek system is 8,300 cfs. As with Tumey Gulch and Arroyo Ciervo, stormwater from the Cantua Creek system ponds on the east side of the California Aqueduct during periods of high flow, dumping large quantities of sediment and storm runoff into the aqueduct. Cantua Creek has inundated Interstate 5 during large storm events.
- **Arroyo Pasajero Stream System**—The Arroyo Pasajero stream system encompasses the largest drainage area in the western San Joaquin Valley. The major creeks in the system are Los Gatos, Warthan, Jacalitos, and Zapato-Chino creeks. They flow through the City of Coalinga and under Interstate 5 to a small ponding basin on the west side of the California Aqueduct. Arroyo Pasajero carries large quantities of sediment containing naturally occurring asbestos. During flood events, the system may damage the aqueduct and Interstate 5. Floodwater may also wash asbestos fibers into the aqueduct.

Major Sources of Flooding/Problem Areas

Flooding is a natural occurrence in the Central Valley because it is a natural drainage basin for thousands of watershed acres of Sierra Nevada and Coast Range foothills and mountains. FEMA's Flood Insurance Study for the County, effective January 20, 2016, describes several types of primary flood problems.

General rainfall floods can occur in Fresno County during winter and spring months. This type of flood results from prolonged heavy rainfall over tributary areas and is characterized by high peak flows of moderate duration. Flooding is more severe when antecedent rain has resulted in saturated ground conditions; when the ground is frozen and infiltration is minimal; or when rain on snow in the high elevations on the east side adds snowmelt to rain flood runoff.

Snowmelt floods on the San Joaquin and Kings rivers and their higher elevation tributaries can be expected to occur any time from April through June. Although snowmelt flooding is of much larger volume and longer duration than rain flooding, it does not have the high peak flows characteristic of rain floods. Snowmelt flood runoff is sometimes augmented by late spring rains on the snowfields or lower elevation tributary watersheds.

Cloudburst storms sometimes lasting as long as three hours can occur any time from late spring to early fall and may occur as an extremely severe sequence within a general rainstorm. Cloudbursts are high-intensity storms that can produce floods characterized by high peak flows, short duration of flood flows, and small volume of runoff. In some areas, especially where drainage basins are small, cloudbursts can produce peak flows substantially larger than those of general rainstorms.

Cloudburst storms usually cover small areas and would not generally affect flood flows or flood stages on the San Joaquin or Kings rivers. Generally, only the upper reaches of the smaller streams are affected by cloudbursts.

In urban areas, flood problems intensify because open land available to absorb rainfall and runoff is being used for new development, which increases the amount of paved areas (i.e., impervious surfaces). The decrease in the amount of open land increases the volume of water that must be carried away by waterways. Urban development in some areas of Fresno County has been substantial in recent years and is expected to continue.

Eastern and Central Fresno County Flood Problem Areas

Most flood issues in eastern and central Fresno County are associated with the San Joaquin River, Kings River, and several other stream systems.

San Joaquin River System

The San Joaquin River from Gravelly Ford to the Chowchilla Bypass outside Fresno County is confined by a levee system. The design capacity of the river is 5,000 cfs, which is considered a safe carrying capacity with three feet of allowable freeboard. Over time, encroachment of vegetation, substantial sedimentation, and land subsidence has considerably reduced channel capacity. Erosion, seepage, and prolonged high water compromise levee integrity. Levee maintenance is generally under the jurisdiction of local reclamation districts. Uncontrolled flooding from the San Joaquin River between the Chowchilla Bypass and Dos Palos tends to flow into Madera County north of Mendota.

The Mendota Pool area has shown evidence of significant subsidence, possibly affecting levee height, river invert (i.e., bottom of low-flow channel), as well as the pool depth. The flooding hazards in the region are from Panoche Creek to the west into Madera County downstream from Mendota Pool. It was reported in 1997 (Fresno County General Plan Background Report) that the Mendota Dam is of limited usefulness for flood control purposes. Construction of a new dam at Mendota has been contemplated to improve flood control capabilities of the lower reaches of the San Joaquin.

The flooding potential from creeks and streams between the San Joaquin and Kings Rivers in the east has been substantially eliminated within the last few years by the completion of the Redbank-Fancher Creeks Flood Control Project. This has resulted in a decrease in the areas designated in the 100-year floodplain. However, as noted in the Fresno County General Plan Background Report, the 100-year storm event flows have increased from 18,000 cfs to 24,500 cfs in the San Joaquin River over last few decades (due to increasing intensity of storms and statistical analysis of the meteorologic/hydrologic database for the San Joaquin River).

Kings River System

Uncontrolled creeks within the Kings River system, notably Mill Creek, continue to challenge management of Pine Flat Dam and Kings River flood control during consecutive large storm events. In 1997, water was not released form Pine Flat due to large flows in Mill Creek, which pushed the limits of the system. If another large event had occurred before Pine Flat Reservoir releases could provide adequate storage space and the Mill creek watershed was still saturated, rapid runoff in Mill Creek and an emergency spill at Pine Flat would have overwhelmed the system. In the event of a major release from Pine Flat Dam, downstream flooding would occur over agricultural lands near the riverbanks and possibly within the Cities of Reedley and Kingsburg.

Western Fresno County Flood Problem Areas

Flood issues in western Fresno County are varied in scope and unique in nature. Many creeks prone to high flows and significant erosion are found in the area, but most of the region is unpopulated, so flooding in many areas poses little threat to life or personal property. Major facilities that are subject to flooding include Interstate 5 and the California Aqueduct. Urban areas subject to flooding include the communities of Coalinga, Huron, and Mendota. Important wetland habitat in the Mendota Wildlife Management Area is also subject to flooding and may be impacted by sediments carried by flood flows from these creeks.

During large storm events, the California Aqueduct is flooded by high flows from Arroyo Pasajero. Consequently, the Bureau of Reclamation, the Corps, and the DWR are coordinating efforts to relieve the threat of flooding from this stream system. Other stream systems obstructed by the aqueduct may pose a flooding hazard during periods of high flow when ponds form on the west side of the aqueduct. The streams carry large amounts of sediment. When ponds fill with sediment, water and sediment spill into the aqueduct.

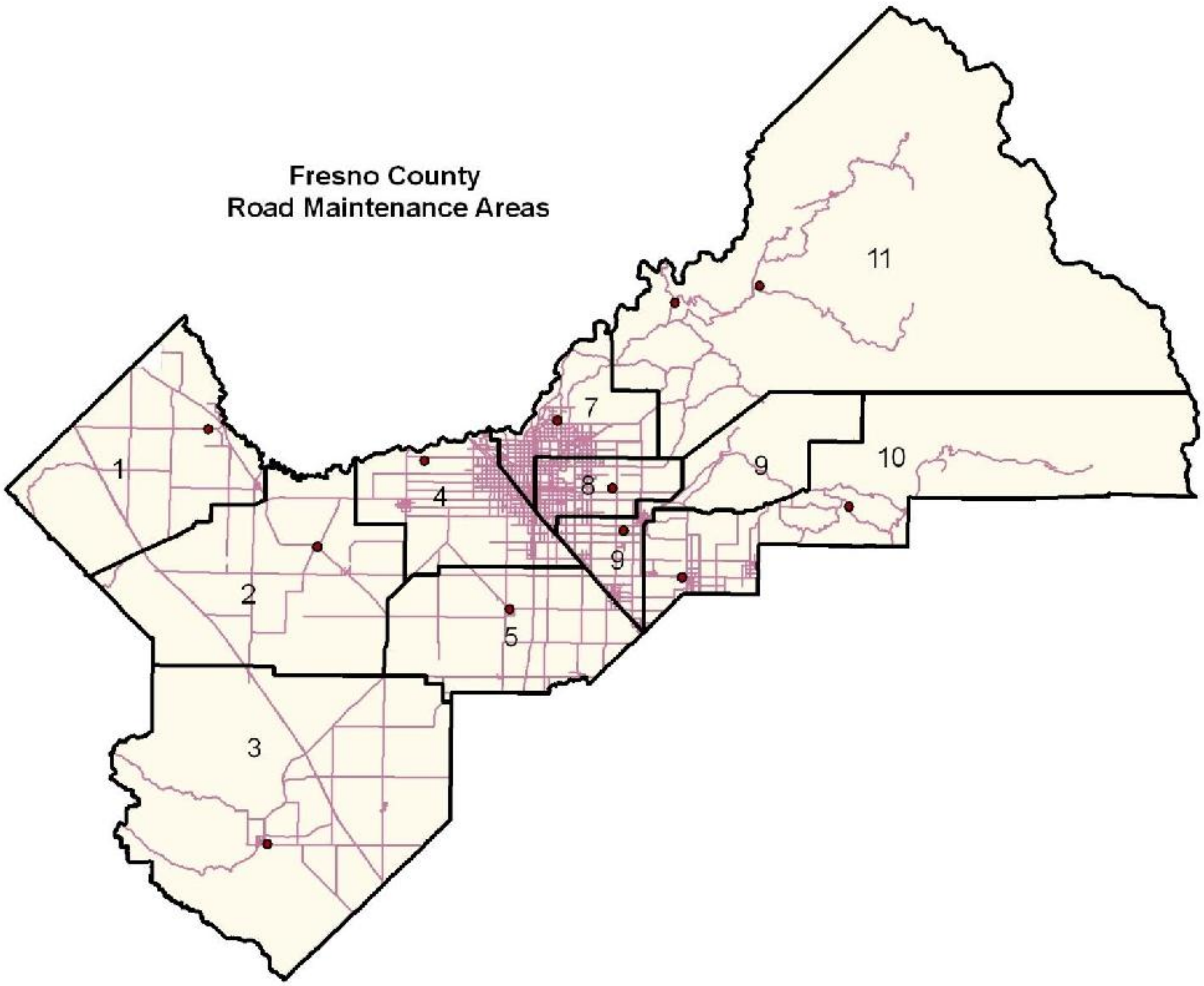
Various stream systems also flood developed areas in western Fresno County during storm events. Creeks that feed into Arroyo Pasajero flow through the City of Coalinga, creating flood hazards and preventing development in impacted areas. Downstream, Arroyo Pasajero is prone to flooding the road into the City of Huron. After crossing the California Aqueduct, Panoche Creek flows overland and floods both agricultural land and portions of the City of Mendota.

The Mendota Wildlife Management Area receives water from Panoche Creek, which drains into Mendota Pool. During storm events, the sediments carried in Panoche Creek contain high levels of selenium and arsenic, which may degrade the water quality in the Mendota Wildlife Management Area.

Localized Flooding Problem Areas

Localized flooding also occurs throughout the County with several areas of primary concern. According to the Fresno County Department of Public Works, numerous roads throughout the County are subject to flooding in heavy rains. In addition to flooding, damage to these areas during heavy storms includes pavement deterioration, washouts, landslides/mudslides, debris areas, and downed trees. The amount and type of damage or flooding that occurs varies from year to year, depending on the quantity of runoff. Flooding problems are tracked by road maintenance area (see Figure 4.17) and noted below.

Figure 4.17 Fresno County's Road Maintenance Areas



Source: Fresno County Public Works and Planning

A-1 Firebaugh Area

The following roads in Area #1 are subject to flooding in heavy rains and flooding signs are required.

- Washoe at Delta Mendota Canal southeast of Bridge
- Herndon at Russell
- Belmont from San Diego to Fairfax

- Shaw between Milux and Russell
- Washoe .01 miles north of California
- Shields at Fairfax southwest corner
- Russell 1.9 miles south of Shields
- Little Panoche, numerous areas 1.3 miles west of Interstate 5 to C/L
- Milux at Bullard, west side
- Bullard east of Milux numerous areas to Fairfax
- Althea 1 mile west of Russell
- Hudson at Merrill northeast corner
- Fairfax at Valeria southwest corner
- Fairfax .02 miles south of Valeria
- Oxalis .04 miles west of Ormsby

A-2 Tranquility

Areas that flood east of James Road:

- Butte, American to North
- American, Denver to El Dorado
- El Dorado, American to Colorado
- Marin, Adams South .2 miles
- Sumner, Colorado to Placer
- Yuba, Manning to Colorado
- Parilier, Placer to Yuba
- Springfield, Colorado to Plumas
- Springfield, Colusa to Sutter
- Huntsman, Colorado to El Dorado
- Floral, Colorado to Graham
- Rose, Colorado to Trinity
- Napa, at drain ditch crossing (Nebraska)?
- Kamm, Placer to Yuba

Areas that flood west of James Road:

- San Mateo north of State Route 180
- Sante Fe at San Benteo
- Jefferson Amador to Tuolumne
- Lincoln James Rd. to Calaveras
- Mt. View San Mateo to Monterey
- Clarkson San Mateo to Amador
- Amador Clarkson to Elkhorn
- Elkhorn Amador to Sonoma
- Sonoma Elkhorn to Mt. Whitney
- Kamm State Route 33 to Interstate 5
- Manning Aqua Duct to Interstate 5
- Douglas south of Manning .1 mile
- Douglas north of Manning 1 mile
- San Diego Adams to American
- Jensen San Diego to Washoe

A-3 Coalinga

- Mt. Whitney
- Coalinga-Mendota Road
- Parkfield
- Collwell east and west
- Boone
- Alcalde Road

A-4 Biola

- Dickenson Avenue, Herndon to Barstow
- Dickenson Avenue, south of North Avenue, east side
- Belmont Avenue, Grantland to Howard Avenue, various locations
- Shields Avenue, Westlawn to Bishop Avenue, various locations
- Shields Avenue west of State Route 145, various locations
- Shaw Avenue west of State Route 145, various locations
- Dower Avenue, Shields Avenue to Shaw Avenue, various locations
- Henderson north of South Avenue, east side
- Brawley south of Lincoln
- Elm Avenue between Morton and Clayton Avenue.
- Adams-Clovis Avenue to State Route 99
- Central at Blyth to Cornelia
- Grantland south of Shaw, east side
- Grantland south of Belmont to RXR tracks, east side

A-5 Caruthers

- Floral west of Temperance
- Fowler at Davis
- McCall south of Clarkson
- Fowler north of Elkhorn
- Temperance south of Conejo
- Dewolf north of Mt. View
- Clovis north of Nebraska
- Harlan between Maple and Chestnut

A-7 Fresno-Clovis

- Copper between Minnewawa and Fowler
- Copper near Armstrong
- Armstrong between Copper and International
- International between Flower and Armstrong
- Fowler between International and Shepherd
- Behymer between Willow and Minnewawa
- Behymer between Minnewawa and Fowler
- Sunnyside between Teague and Nees
- Teague between Fowler and Armstrong
- Marion between Teague and Nees
- Shaw between McCall and Leonard
- Academy between Herndon and Shaw
- Sierra between Academy and Del Rey

- Herndon between Academy and Madsen
- Madsen between Herndon and Shepherd
- Shepherd between SH 168 and Academy
- Shepherd between Fowler and Armstrong
- Gettysburg between Van Ness and Wishon
- Sierra between Forkner and Van Ness Extension
- College between Swift and Santa Ana

A-8 Fresno-Sanger

This is not a complete list as there are many locations that pool at the shoulder or just onto the road. Large or back to back storms can change all.

- Jensen at Sierra Vista
- Shields/Locan
- National east of Minnewawa
- Monticeto/Rogers
- Fowler at Princeton
- Butler east of Locan
- Gettysburg/Greenwood
- McKinley west of Bethel
- McKinley at Leonard
- Indianola south of Highway 180
- Dewolf/Church
- Bond/Mayfair Drive North
- Griffith east of Clovis
- Dakota east of Highland
- Fowler at Olive
- Walling north of Kings Canyon
- Olive east of Hornet
- Temperance north of Church
- Temperance north of Jensen
- Locan north of Church
- Highland north of Jensen
- Zediker south of Belmont
- Tulare west of Zediker
- Newmark north of Belmont
- Macdonough north of Belmont
- Newmark north of Highway 180
- California east of Dockery
- McCall/Tulare
- Tulare east of McCall
- Indianola at Jensen
- Olive/Zediker
- Thompson north of Dakota
- Rancho at Butler
- Illinois west of Villa
- Madison west of Clovis
- Grant west of Clovis
- Washington west of Clovis
- Easterby Drive South west of Minnewawa
- Easterby Drive North west of Minnewawa
- Brown at Jackson

A-9 Sanger-Del Rey

- American between Academy and Armstrong
- Central between McCall and Willow
- Bethel south of Adams 100-500 feet
- Bethel between Manning and Rose
- Willow between North and Jensen

- Nebraska from Academy to city limits and at intersection of Bethel

A-10 Reedley-Dunlap

- Aita at Manning
- Zediker south of Caruthers
- South at Zediker
- Reed at Floral
- Reed at South
- Adams between Zediker and Smith
- Smith at Dinuba
- Hill between Sumner and Adams
- Monson south of Parlier (this might be the City of Orange Cove)

Levee Failure

A levee is a raised area that runs along the banks of a river or canal. Levees reinforce the banks and help prevent flooding. By confining the flow, levees can also increase the speed of the water. Levees can be natural or man-made. A natural levee is formed when sediment settles on the river bank, raising the level of the land around the river. To construct a man-made levee, workers pile dirt or concrete along the river banks, creating an embankment. This embankment is flat at the top, and slopes at an angle down to the water. For added strength, sandbags are sometimes placed over dirt embankments.

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce, not eliminate, the risk to individuals and structure behind them. A levee system failure or overtopping can create severe flooding and high water velocities. It's important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

There are three primary risks to levee integrity in Fresno County:

- Earthquake failure
- High water failure
- Dry weather failure.

Earthquake Failure

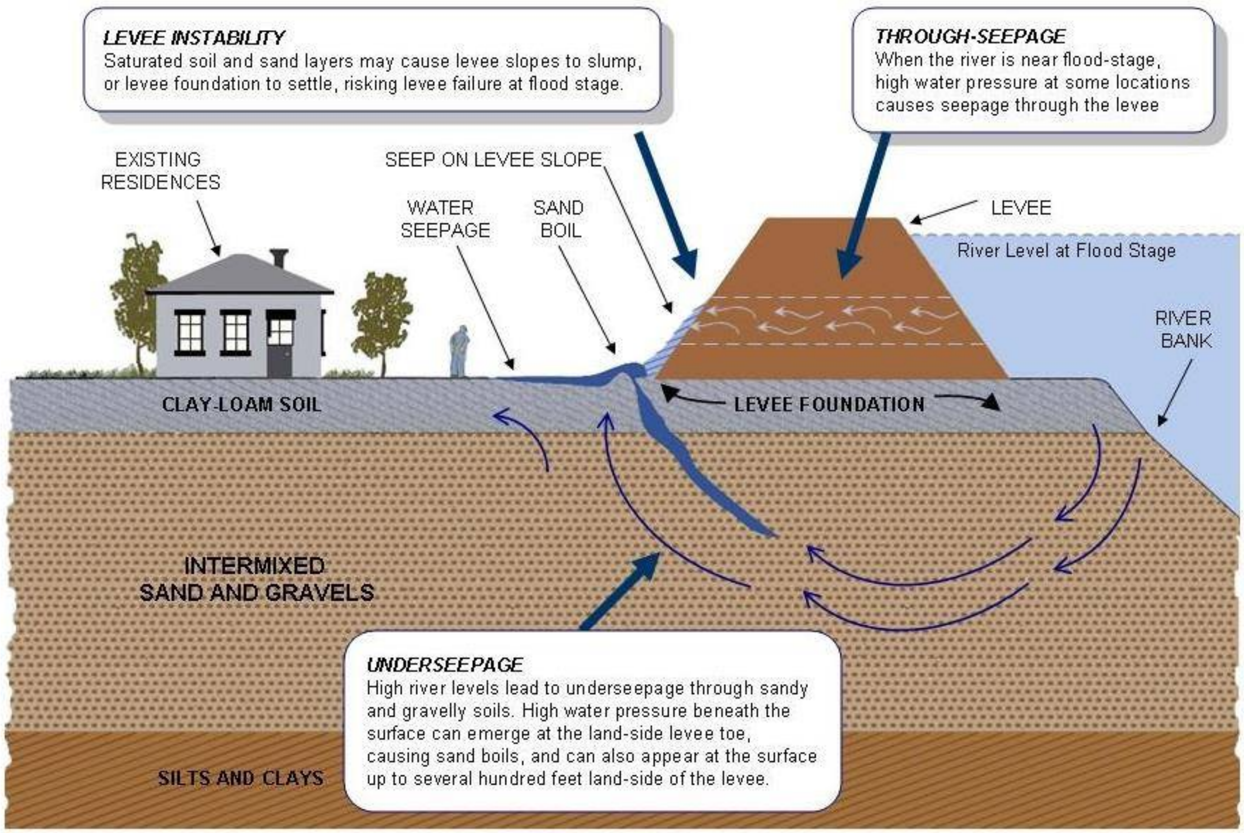
Seismic risk in the Fresno area is characterized as moderate-to-high because of many active faults in the area. Figure 4.13 in Section 4.2.5 Earthquake, illustrates the locations of faults in and surrounding Fresno County. Seismic risk to levees stems from the risk of liquefaction, ground settlement, and cracking.

High Water Failure

High water in the County can overtop levees. High water also increases the hydrostatic pressure on levees and their foundations, causing instability. The risk of through-levee and under-levee seepage failures increases as well.

Under-seepage refers to water flowing under the levee through the foundation materials, often emanating from the bottom of the landside slope and ground surface and extending landward from the landside toe of the levee. Through-seepage refers to water flowing through the levee prism directly, often emanating from the landside slope of the levee. Both conditions can lead to failure by several mechanisms, including excessive water pressures causing foundation heave and slope instabilities, slow progressing internal erosion, and piping leading to levee slumping.

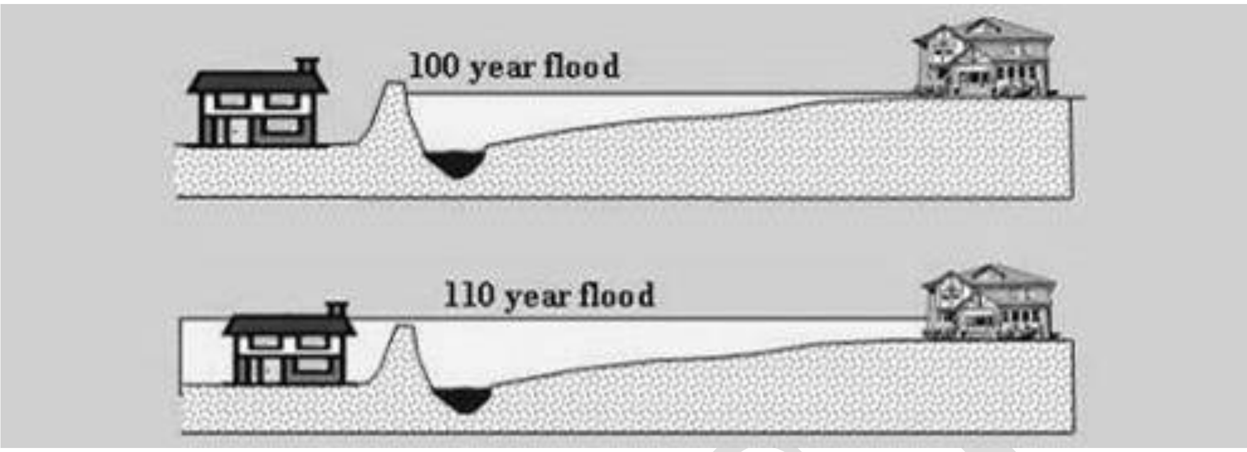
Figure 4.18 Through-Seepage and Under-Seepage During High Water Conditions



Source: USACE

Overtopping failure occurs when the flood water level rises above the crest of a levee. The representation of the failure modes and the evaluation of the probability of levee failures for each mode are discussed in the remaining sections.

Figure 4.19 Flooding from Levee Overtopping



Source: Levees In History: The Levee Challenge. Dr. Gerald E. Galloway, Jr., P.E., Ph.D., Water Policy Collaborative, University of Maryland, Visiting Scholar, USACE, IWR.
http://www.floods.org/ace-files/leveesafety/lss_levee_history_galloway.ppt

Dry Weather Failures

Dry weather, or sunny-day, failures are levee breaches that are not flood or seismic related. These failures typically occur between the end of the late snowmelt from the Sierras, in late May, and the beginning of the rainy season, in early October. Sunny-day failures are addressed separately from flood-induced failures to differentiate between winter and summer events. Aside from seismic events, factors that can cause levee failures in the County in the summer period are different than the factors that can cause winter failures.

Burrowing animal activities and pre-existing weaknesses in the levees and foundation are the key weak links leading to levee failures. This is the case whether or not the failures occur during a high-tide condition. Burrowing animals can cause undue weaknesses by creating a maze of internal and interconnected galleries of tunnels. Tree growth on levees may cause weakness as well.

Under-seepage and through-levee seepage are slow processes that tend to work through time by removing fines from levee and foundation material during episodes of high river levels. Cumulative deterioration through the years can lead to foundations ultimately failing in dry weather by means of uncontrollable internal erosion that leads to slumping and cracking of levees.

Floodplain Mapping

FEMA established standards for floodplain mapping studies as part of the National Flood Insurance Program (NFIP). The NFIP makes flood insurance available to property owners in participating communities adopting FEMA-approved local floodplain studies, maps, and regulations. Floodplain studies that may be approved by FEMA include federally funded studies; studies developed by state, city, and regional public agencies; and technical studies generated by private interests as part of property annexation and land development efforts. Such studies may include entire stream reaches or limited stream sections depending on the nature and scope of a study. A general overview of floodplain mapping is provided in the following paragraphs. Details on the NFIP and mapping specific to participating jurisdictions are in the jurisdictional annexes.

Flood Insurance Study (FIS)

The FIS develops flood-risk data for various areas of a community that is used to establish flood insurance rates and to assist the community in its efforts to promote sound floodplain management. The current Fresno County FIS is dated January 20, 2016. This study covers both the unincorporated and incorporated areas of the County.

Flood Insurance Rate Map (FIRM)

The FIRM is designed for flood insurance and floodplain management applications. For flood insurance, the FIRM designates flood insurance rate zones to assign premium rates for flood insurance policies. For floodplain management, the FIRM delineates 100- and 500-year floodplains, floodways, and the locations of selected cross sections used in the hydraulic analysis and local floodplain regulation. The County FIRMs are in the process of being replaced by new digital flood insurance rate maps as part of FEMA's Map Modernization program, which is discussed further below.

Letter of Map Revision (LOMR) and Map Amendment (LOMA)

LOMRs and LOMAs represent separate floodplain studies dealing with individual properties or limited stream segments that update the FIS and FIRM data between periodic FEMA publications of the FIS and FIRM.

Digital Flood Insurance Rate Maps (DFIRM)

As part of their Map Modernization program, FEMA is converting paper FIRMS to digital FIRMs (DFIRMS). These digital maps:

- Incorporate the latest updates (LOMRs and LOMAs),
- Utilize community supplied data,
- Verify the currency of the floodplains and refit them to community supplied base maps,
- Upgrade the FIRMs to a GIS database format to set the stage for future updates and to enable support for GIS analyses and other digital applications, and
- Solicit community participation.

Levee Mapping

Also as part of FEMA's Map Modernization program, FEMA is mapping levees within communities, with a primary focus on maps determined to provide a 100-year level of flood protection. Most of the levees are privately owned, maintained, and operated. Because of the ownership and lack of enforcement for maintenance, most of the levee systems do not meet the current standards for flood protection and are mapped as such.

In August of 2005, FEMA Headquarters' issued Memo 34 *Interim Guidance for Studies Including Levees*. This memo recognizes the risk and vulnerability of communities with levees. The memo mandates the inclusion of levee evaluations for those communities that are undergoing map changes such as the conversion to DFIRMs. No maps can become effective without an evaluation of all levees within a community against the criteria set forth in 44 CFR 65.10 *Mapping of Areas Protected by Levee Systems*. Generally, these levee certification requirements include evaluations of freeboard, geotechnical stability and seepage, bank erosion potential due to currents and waves, closure structures, operations and maintenance, and wind wet and wave run-up. In short, these guidelines require certification of levees before crediting any levee with providing protection from the 1 percent annual event (e.g., the 100-year flood).

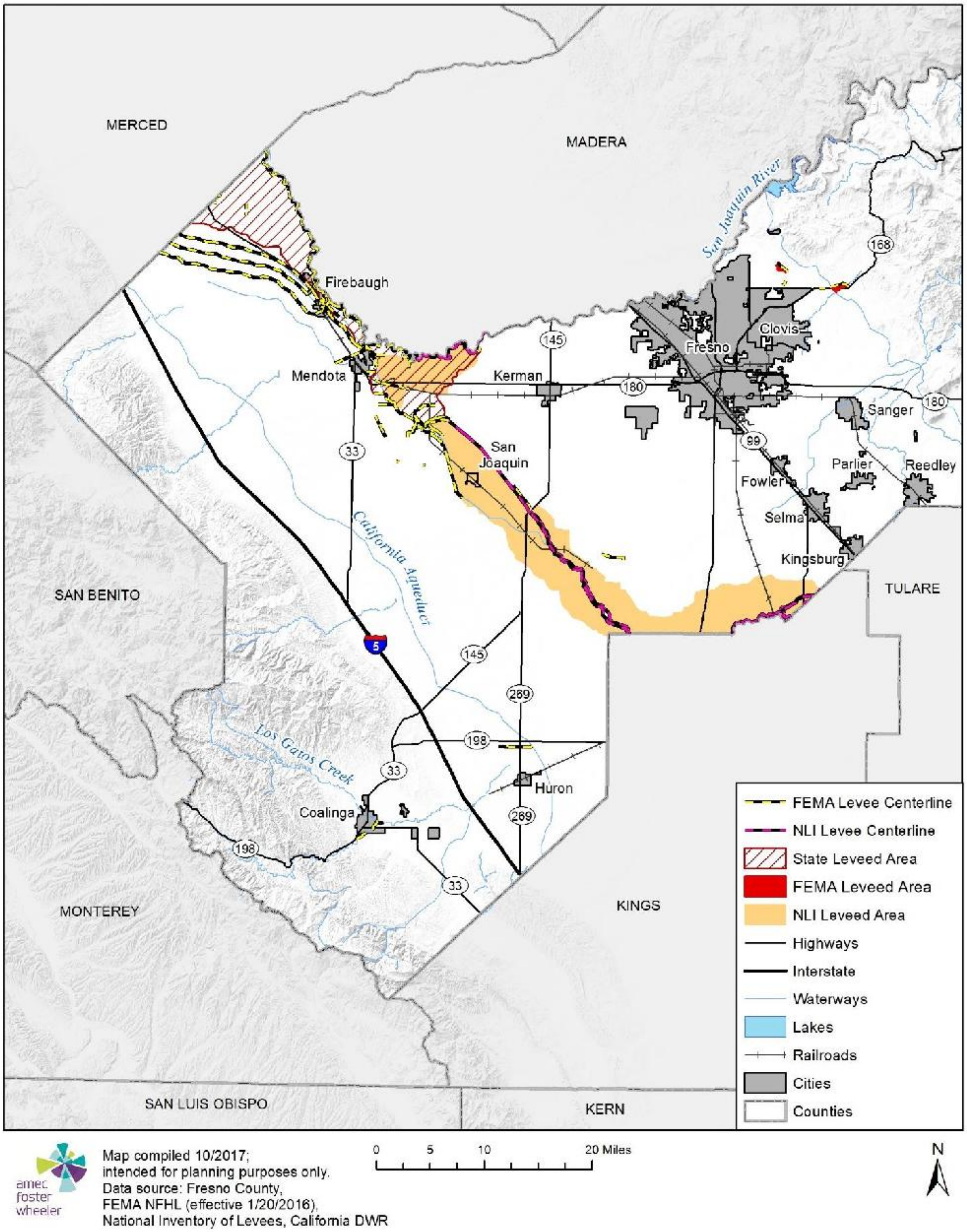
In Fresno County, similar to other locations in California, levees and flood control facilities have been built and are maintained variously by public and private entities, including water, irrigation and flood control districts, other state and local agencies, and private interests. To best address the issue of levees in the DFIRM process, FEMA provided guidance for the issuance of PAL (provisionally accredited levee) agreements that would allow for identified levees to be provisionally accredited for purposes of mapping while communities/levee owners compile and submit data and documentation necessary for full accreditation. Communities have two years from the date of FEMA's initial coordination to submit to FEMA final accreditation data for all PALs. Levees for which such agreements were signed are shown on the final effective FIRM as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year and labeled as a PAL. Following receipt of final accreditation data, FEMA will revise the FIS and FIRM as warranted.

FEMA-designated 100-year and 500-year floodplains in Fresno County that were updated under the Map Modernization Program and became effective on January 20, 2016. The State of California (DWR) completed levee flood protection zone (LFPZ) maps in December 2008 of areas that may be inundated if a project levee fails (from water surface elevations at the top of the levee, which may be from a storm event even larger than the levee's design storm). The LFPZ map of the San Joaquin River shows a considerable area within Fresno County that may be inundated if the project levees fail. For more information, refer to the 2017 Fresno County General Plan (Draft) for a comprehensive series of inundation maps.

A relatively broad levee flood protection zone (LFPZ) is identified along the San Joaquin River, with depths less than three feet indicated west of the river, but greater than three feet all along the east side of the river. Several areas protected by project levees in the east county would also have inundation areas that are primarily less than three feet, but include some deeper areas.

Fresno County's levee system can be seen in Figure 4.20

Figure 4.20 Fresno County Levee System



Flood Hazard Extent

Fresno County is large and geographically diverse. Water resources in the Fresno County planning area include a number of rivers and streams, artificial waterways, and groundwater sources located throughout the County. The mountainous eastern portion of Fresno County, located primarily in the Sierra Nevada, contains many small mountain lakes and streams that are tributaries to the San Joaquin and Kings rivers, which flow into the Central Valley. The arid western portion of Fresno County is characterized by larger watersheds in the Coast Range that drain stormwater eastward into the valley and the Fresno Slough. Flash floods with depths of several feet can occur in the valleys of the Sierras, while large areas of relatively shallow inundation can occur in the Central Valley.

During winter and spring months, river systems in Fresno County swell with heavy rainfall and snowmelt runoff. To prevent flooding, a wide variety of storm drainage and flood control measures are used throughout the County. These include flood control reservoirs, levee systems, and watershed treatments. In rural areas, the management of reservoir releases, canals, and levee systems reduces the likelihood of flooding and reroutes stormwater around urban areas. In developed areas, storm drainage systems composed of street gutters, inlets, underground storm drains, ponds, pumping stations, and open channels are used to collect and control stormwater runoff. The storm drainage and flood control systems are discussed further in the sections that follow.

Figure 4.21 illustrates natural and manmade waterways in the County. Information on the County's more notable waterways and associated flood control facilities extracted from the Fresno County General Plan Background Report (2017) is included below by region.

Figure 4.21 Waterways in Fresno County

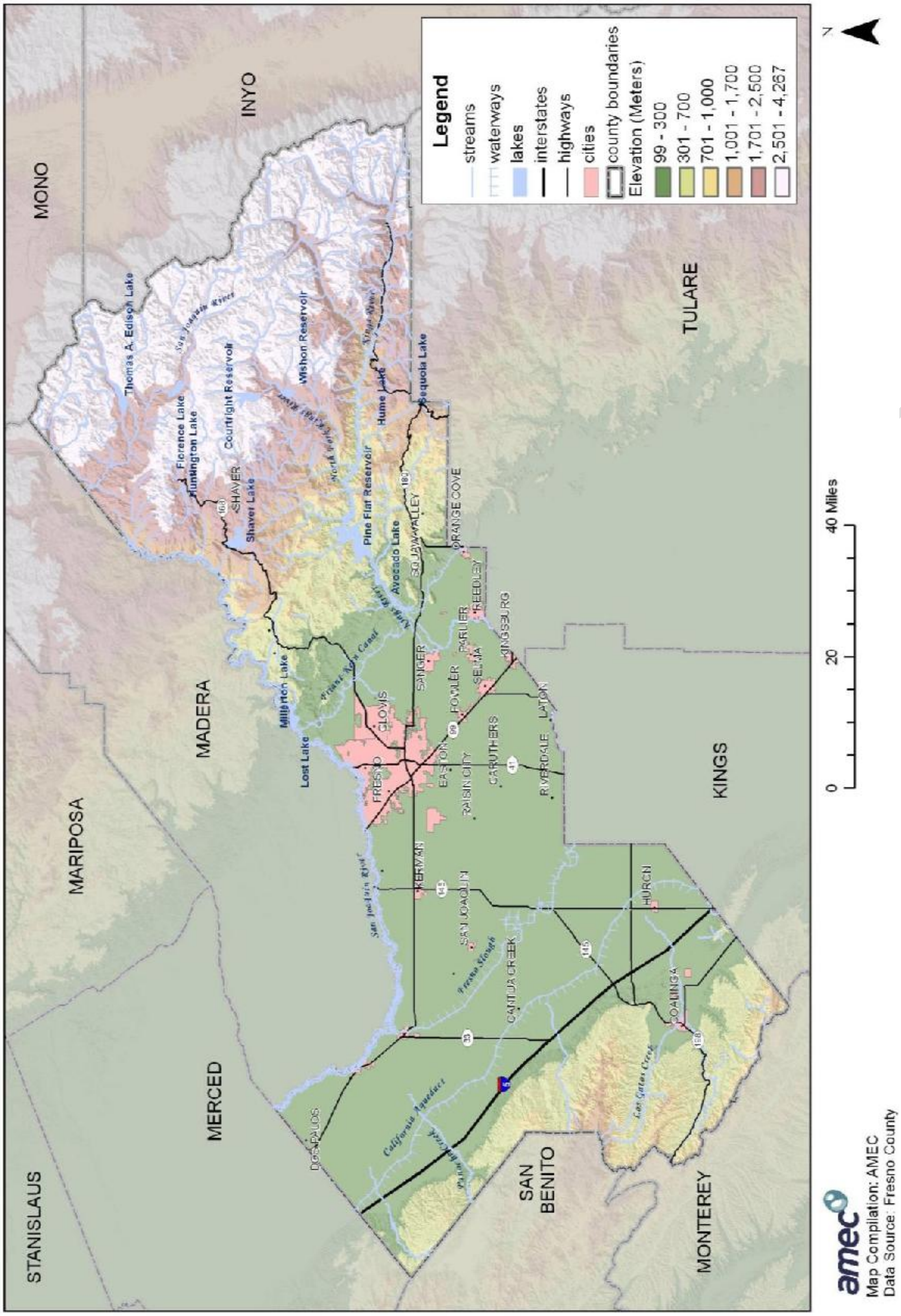
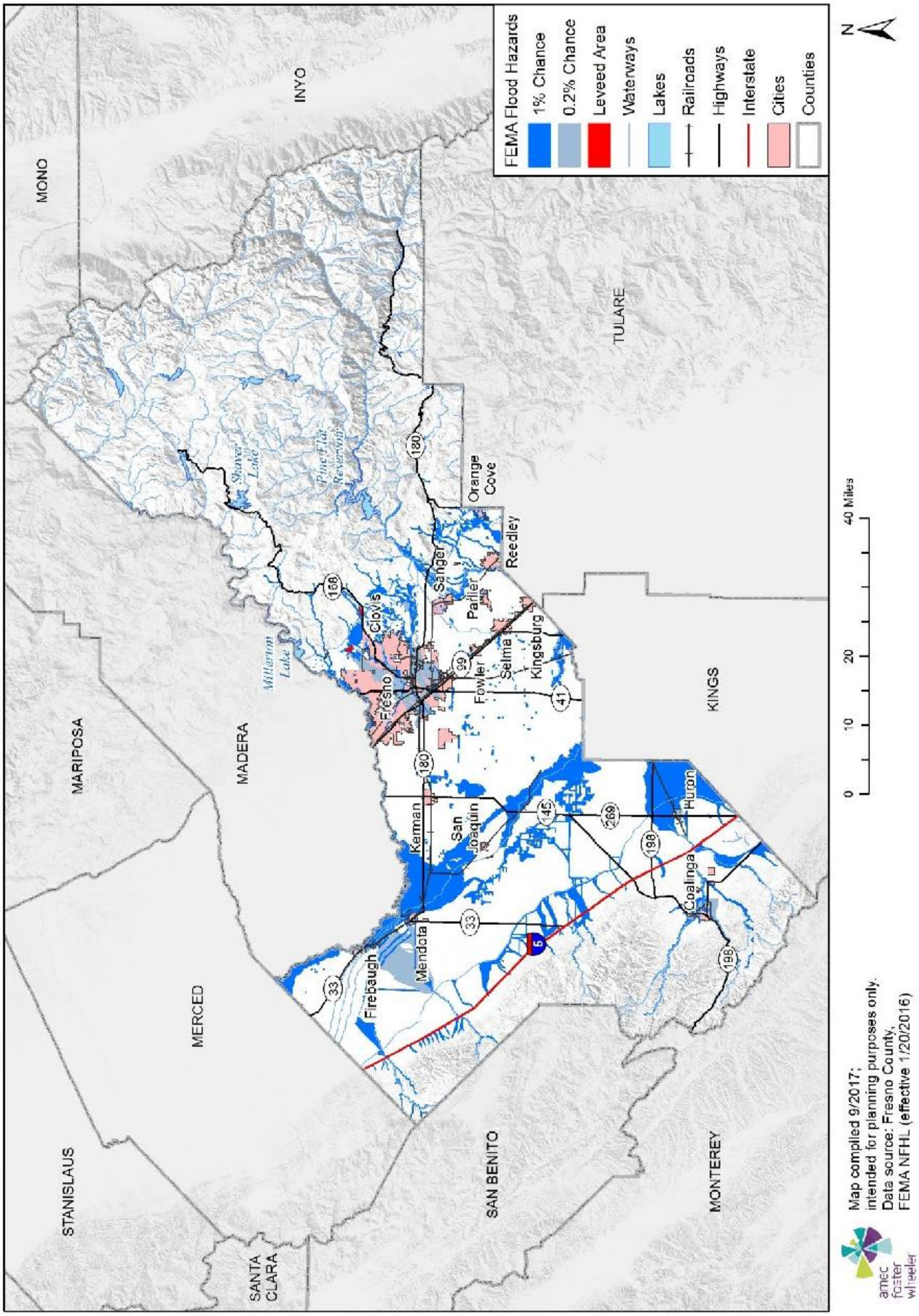


Figure 4.22 illustrates the city's mapped flood hazard areas. Flood hazard areas periodically change to reflect improved and updated mapping techniques as well as areas that may have been altered by flood mitigation projects, typically reflected in the development of Conditional Letters of Map Revision (CLOMR) or Letters of Map Revision (LOMR). More detailed flood hazard maps are included later in this Chapter, in Section 4.3.2.

Figure 4.22 Fresno County Flood Hazards



Levee Failure Extent

The geographic extent of the levee hazard is shown in Figure 4.20 and explained further in the Vulnerability portion of this plan.

Past Occurrences

Fresno County has a long history of flooding, but according to the Fresno County General Plan Background Report, little definitive data is available for specific floods, particularly on the smaller streams. Historical records indicate that nine significant flood events occurred in Fresno County between the 1840s and 1900. A series of river floods during the 1980s and 1990s prompted FEMA to drastically revise its estimate of the 100-year flood flows in the San Joaquin River channel and to develop a new FIRM for the area. Construction of major detention structures in the eastern part of the County along the Fresno County Stream Group enabled FIRMs to be revised in the early 1990s to show a reduced 100-year flood risk from the San Joaquin River to the metropolitan area. The HMPC provided information on more recent flood events, which are detailed below.

- **December 1955**—A rain on snow event caused local and downstream flooding in eastern Fresno County, ultimately affecting the entire valley region. Homes were lost and roads and bridges were damaged or destroyed. Damage to some dam facilities also resulted.
- **1995**—Beginning in January and continuing through the end of March 1995, a series of strong storms caused flooding that resulted in multiple road closures, destroyed a bridge on Interstate 5, displaced 300 to 400 people, damaged crops, and caused the deaths of seven people. Most flooding occurred in the western portion of the County. A local, state, and federal disaster was declared for the County. Twenty homes were damaged; 150 acres submerged. Losses to public facilities were estimated at $5 million. Agricultural damage and crop losses exceeded $8.6 million. There was an estimated $9 million in economic and other damage to businesses. Additionally, Huntington Lake Road and Highway 168 were closed due to snowfall, Highway 180 was closed due to a rock slide, an Interstate 5 bridge over Arroyo Pasajero drainage was washed out (causing the seven deaths), 15 to 20 other County roads were closed at least temporarily, 20 to 40 water systems were unable to serve potable water for various periods of time, and an estimated 300 to 400 people were displaced by flooding (the American Red Cross shelter was open from March 11-18, providing shelter for 57 to 70 people).
- **1997**—A regionwide rain on snow event in high elevations caused local flooding and flooding downstream in the valley. Homes, bridges, roads, and other infrastructure near waterways were damaged. A bridge on Interstate 5 over the Kings River was washed out. Losses to infrastructure were estimated in the hundreds of millions. Other impacts included damage to fisheries and wildlife.
- **1998 (El Niño rain event)**—Starting February 1, 1998, and continuing until June of 1998, Fresno County experienced extreme amounts of rain, resulting in local, state, and federal emergency declarations. Thirty-three days within a 42-day period experienced significant rainfall. Flooding damaged buildings and crops in the area. Property damage included major

damage to five buildings and minor damage to six buildings for a cost of $378,000 and $80,000 in damage to public facilities. There was an estimated loss of $17 million to the farming industry. The primary damage was to tree fruit and row crops. Estimated economic impacts to the community were $38-48 million. An estimated 15,000 to 20,000 agricultural workers were out of work or on limited work schedules.

- **April 28, 2005 (Parlier Flood)**—A cell of severe weather passed over the City of Parlier dropping up to three inches of rain in 20 minutes. The drainage system could not handle the flow, and approximately 25 homes and businesses were flooded. The City of Parlier declared a local disaster, as did Fresno County. Damage was estimated at $700,000. Home owners had little or no insurance coverage. In addition, J Street was closed for one day.
- **2005-2006**—Above average rainfall occurred between December 19, 2005, and January 1, 2006. This resulted in flooding of low lying areas throughout the County. Flood control basins were overflowing in several areas, including the Cities of Fresno and Clovis. Property damage included damage to approximately 180 businesses and homes estimated at $1.4 million within the unincorporated County. Damage to other jurisdictions was estimated at $611,307. Damage to crops was minimal due to the time of year. Flooding further resulted in a number of road closures, which were one to two weeks in duration.
- **April 5, 2006**—Above average rainfall and snowmelt created excessive run off into the San Joaquin and Kings river drainages on the west side of the County. Levees and river channels were in jeopardy of failing, but held. The DWR sent a flood fight team to coordinate the effort to shore up the system. Construction crews and hand crews were used to shore up the system, make sandbags, and repair leaks. Property and crop damage was minimal due to limited flooding. The most notable damage to cropland was to 200 acres affected by a levee break in the Tranquillity Irrigation District. There was, however, extensive damage to the levee system, canal system, and river channel. Local and state disasters were declared for the County based on the potential damage if the levees, canals, or river channel failed. Extensive work was done on the system during the event by locals and the DWR.
- **July 2006**—Flash floods from thunderstorms in drainages above the north end of Huntington Lake resulted in a variety of damage. This included an estimated $250,000 in damage to private boats and an estimated $200,000 in damage to local infrastructure (roads, boat docks, etc.). Other impacts included loss of power for three weeks in some areas, closure of a primary summer road for one week, and closure of Huntington Lake to recreational use for one week. Cleanup costs exceeded $150,000, and search and rescue costs were estimated at $25,000.
- **October 29, 2007**-- Newspapers and broadcast meteorologists reported a number of roadways flooded in Northwest Fresno. Numerous vehicles were stranded and water rescues occurred. Heavy rain caused a roof to collapse at an industrial plant on the northwest side of the city. Damages were estimated at 250,000 to the roof structure alone. Total property damage associated with the event amounted to over $500,000.
- **December 2007**—Heavy rain and snow storms ravaged central California, including the San Juaquin Valley and Fresno metropolitan area. The combination of locally heavy rains and poor drainage areas within the urban and suburban land lead to over $175,000 in property damage between December 18th and 19th.

- **December 29, 2010**-- On the morning of the 29th, heavy rain across the San Joaquin Valley caused widespread urban and poor drainage flooding. Especially hard hit were the metro areas of Fresno, Visalia, and Bakersfield, and the adjacent foothills. Fresno had a record rainfall of 0.92 inch on the 28th, breaking the old record of 0.72 inch, set in 2004. The two-day total at Fresno-Yosemite International Airport was 1.54 inch, which pushed the December rainfall to 5.92 inches for the second wettest December on record for Fresno; the wettest December was in 1955, with 6.73 inches. It was also the coldest low of the year for Fresno, with temperatures dropping below 32 degrees. Property damaged amounted to $125,000.
- **November 30, 2011**-- Fresno set record high minimum temperatures on the last day of the month, establishing the total record for the sixth warmest November. This was also the fourth consecutive month that Fresno ranked in the top 10 warmest months. Fresno had a record rainfall on November 30th of 0.62 inch; the old record was 0.50 inch. As a result of the heavy rainfall, some rock and mud slides occurred as the moisture weakened the soil. Law enforcement reported a rock and mud slide on Highway 168 about 15 miles northeast of Clovis, which closed the road for several hours while authorities cleaned up the debris.
- **February 7, 2017--** Atmospheric river system brought heavy rainfall, flooding, debris flows, and high elevation snowfall to the central California region. Damages were over $100,000 and the California Highway Patrol reported road closure due to a bridge collapse from heavy rainfall near Sugarloaf Road and Auberry Road just northeast of Meadow Lakes.

Localized Flooding

In addition to the major historical flood events described above, as previously described, the Fresno County planning area remains at risk to annual localized flooding.

Levee Failure Past Occurrence

February 18, 2017—Dry weather debilitated a levee located in the Fresno Slough, where the San Joaquin River and Kings River meet. The levee experienced several small breaks for a few days, posing a danger to nearly 80 homes in the vicinity, forcing hundreds of people to evacuate. Repairs and monitoring lead by Fresno County Public Works and Emergency Management stopped the levee breach.

June 22, 2017—A 15-foot wide breach opened along the Kings River, leading to mandatory evacuations. The Kings River began to flood 25 miles north of Fresno. The levee failure occurred after a prolonged period of warmer-than-average temperatures led to a surge in snowmelt from the nearby Sierra Nevada Mountains.

Likelihood of Future Occurrences

100-Year Flood

Occasional—The 100-year flood is the flood that has a one percent chance in any given year of being equaled or exceeded.

<100-Year Flood/Outside the 100-Year Floodplain

Highly Likely—Based on historical data, flooding events less severe than a 100-year flood and those outside of the 100-year floodplain occur frequently during periods of heavy rains.

Climate Change Considerations

Heavy precipitation events that lead to flooding occur at the short-term time scales of weather, rather than the multi-year time scales of climate that most climate models examine. However, extreme events are, by their very nature, uncommon. Quantifying trends at a given location is quite difficult, and no trends in the historical record of extreme climate events have been definitively detected in Fresno County. Globally, precipitation extremes and their hydrological impacts (e.g., the magnitude of 100-year floods) are expected to get larger because in most places, higher temperatures will result in increased atmospheric water vapor available to form precipitation. The 100-year flood of today might become a more frequent event in the future (i.e., a 50-year event), meaning that current design levels and regulatory practices might be less adequate in the future.

4.2.7 Human Health Hazards: Epidemic/Pandemic

Hazard/Problem Description

Epidemics occur when an infectious disease spreads beyond a local population, lasting longer and reaching people in a wider geographical area. When that disease reaches global proportions, it is considered a pandemic. Several factors determine whether an outbreak will explode into an epidemic or pandemic: the ease with which a microbe moves from person-to-person and the behavior of individuals and societies.

A pandemic flu occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine. This disease spreads easily person-to-person, causes serious illness, and can sweep across the country and around the world in a very short time. The U.S. Centers for Disease Control and Prevention has been working closely with other countries and the World Health Organization to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

Most recently, health professionals are concerned by the possibility of an avian (or bird) flu pandemic associated with a highly pathogenic avian H5N1 virus. Since 2003, avian influenza has been spreading through Asia. A growing number of human H5N1 cases contracted directly from handling infected poultry have been reported in Asia, Europe, and Africa, and more than half the infected people have died. There has been no sustained human-to-human transmission of the disease, but the concern is that H5N1 will evolve into a virus capable of human-to-human transmission.

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Extent

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines. Since the hazard can affect 50-100% of the planning area it was given an extensive geographic extent rating.

Past Occurrences

There were three acknowledged pandemics in the twentieth century:

- **1918-19 Spanish flu (H1N1)**—This flu is estimated to have sickened 20-40 percent of the world's population. Over 20 million people lost their lives. Between September 1918 and April 1919, 500,000 Americans died. The flu spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old; the reasons for this are uncertain. By late September 1918, over 35,000 people throughout California had contracted influenza. According to state officials, influenza was most prevalent in the southern part of California, but the death toll was high across the state.
- **1957-58 Asian flu (H2N2)**—This virus was quickly identified due to advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults, and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between 1 and 2 million.
- **1968-69 Hong Kong flu (H3N2)**—This strain caused approximately 34,000 deaths in the United States and more than 700,000 deaths worldwide. It was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to die. This virus returned in 1970 and 1972 and still circulates today.

The 21st century has seen four major global disease outbreaks, with Severe Acute Respiratory System (SARS) in 2003, H1N1 in 2009, Middle East Respiratory Syndrome (MERS) in 2012, and Ebola in 2014-2016.

Likelihood of Future Occurrences

Occasional—According to historical data, three influenza pandemics have occurred between 1918 and 2017. This averages out to a pandemic every 33 years or a 3.33 percent chance of a pandemic outbreak in any given year. Although scientists cannot predict when the next influenza or other type of pandemic will occur or how severe it will be, wherever and whenever it starts, everyone around the world will be at risk.

Climate Change Considerations

Research into the impacts of climate change indicates that the greatest impact would be increased spread of disease vectors, especially mosquitoes and other insects. Drawing definitive conclusions about public health risk changes associated with vector-borne illnesses as a result of climate change are complicated by the need to also account for any associated changes in human behavior that would accompany the associated impacts to seasonal and daily weather conditions. For example, increased temperatures could result in more time spent indoors during extreme heat days, which could potentially reduce exposure to disease carrying vectors.

4.2.8 Human Health Hazards: West Nile Virus

Hazard/Problem Description

The impact to human health that wildlife, and more notably, insects, can have on an area can be substantial. Mosquitoes transmit the potentially deadly West Nile virus to livestock and humans alike. West Nile virus first struck the western hemisphere in Queens, New York, in 1999 and killed four people. Since then, the disease has spread across the United States. In 2003, West Nile virus activity occurred in 46 states and caused illness in over 9,800 people. According to the CDC, 2012 was the worst year for West Nile Virus nationally, with 286 fatalities in 48 states attributed to the disease.

Most humans infected by the virus have no symptoms. A small proportion develops mild symptoms that include fever, headache, body aches, skin rash, and swollen lymph glands. Less than 1 percent of those infected develop more severe illness such as meningitis or encephalitis, symptoms of which include headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis. Of the few people who develop encephalitis, fewer than 1 out of 1,000 infected die as a result. People over 50 and those with compromised immune systems are the most vulnerable to the virus.

There is no specific treatment for the infection or a vaccine to prevent it. Treatment of severe illness includes hospitalization, use of intravenous fluids and nutrition, respiratory support, prevention of secondary infections, and good nursing care. Medical care should be sought as soon as possible for persons who have symptoms suggesting severe illness. People over 50 years of age appear to be at high risk for the severe aspects of the disease.

West Nile virus is a concern in the Fresno County planning area in part because of the agricultural nature of the County and the large areas of standing water created through farming operations. Excess standing water provides a breeding area for mosquitoes. Also contributing to the mosquito population in the County are the beaver dams and ponds, which are large pools of standing water.

Within the Fresno County planning area, several mosquito abatement and control districts operate to prevent the spread of the virus through focused efforts on reducing the mosquito population and educating the public. Several types of preventive methods lower mosquito populations to levels that reduce chances for the spread of disease. The County also has an active surveillance program and maintains records for all identified cases of the virus.

Extent

An especially severe mosquito-borne illness outbreak could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines. Since the hazard can affect 50-100% of the planning area it was given an extensive geographic extent rating.

Past Occurrences

The virus first appeared in California in 2002 with the identification of one human case. In 2003, three human cases occurred in California, and the virus was detected in six southern California counties. By 2004, the virus was in all 58 counties in California; 830 human infections were identified. According to the California West Nile Virus Surveillance Information Center sponsored by the California Department of Health Services, 28 California residents died from the virus in 2004. Most of these deaths were in Southern California.

In 2005, 54 of the 58 California counties reported some West Nile virus activity and 935 human cases were reported, which included 19 deaths from 12 counties (at least 1 death was in Fresno County). In 2006, the number of human cases in California was 278, including 7 deaths (1 in Fresno County), which was significantly down from 2005. In 2007, there were 380 human cases in California, including 18 deaths (at least 1 in Fresno County). Table 4.14 summarizes reported West Nile virus cases in Fresno County for the years 2004 through 2017. While West Nile numbers in Fresno County (especially human infections) spiked in 2014, they have since settled back into recorded norms.

Table 4.14 Summary of West Nile Virus in California and Fresno County, 2004-2017*

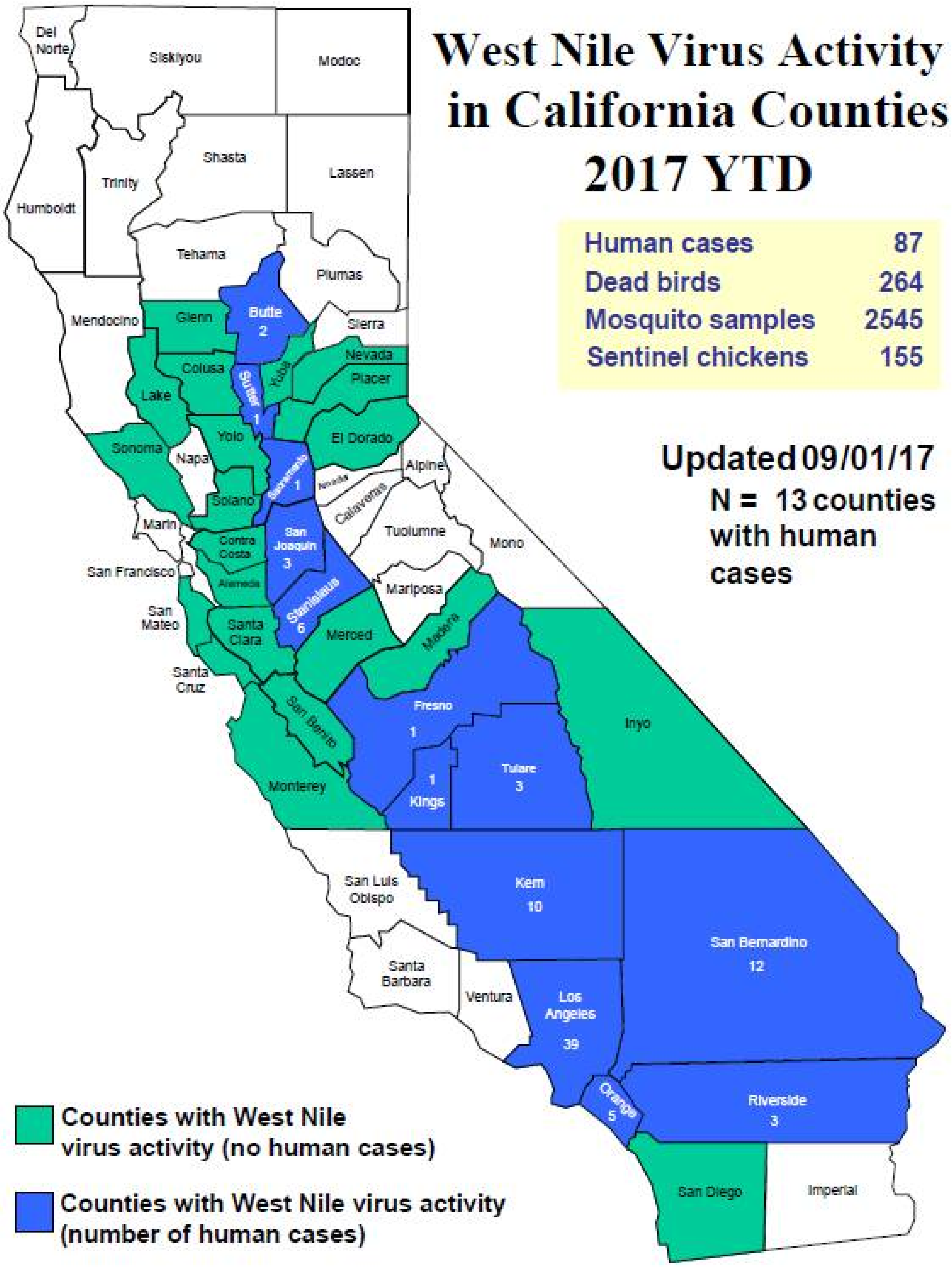
Year	Humans		Birds		Mosquitoes		Horses		Sentinel Flock	
	CA	Fresno County	CA	Fresno County	CA	Fresno County	CA	Fresno County	CA	Fresno County
2004	830	15	3,232	116	1,136	14	540	21	805	25
2005	935	68	3,046	97	1,242	71	456	33	1,053	85
2006	278	11	1,446	2	832	40	58	5	640	37
2007*	380	17	1,395	114	1,007	61	28	1	510	46
2008	445	3	2569	44	2,003	53			585	24
2009	112	13	515	62	1,063	132			443	17
2010	111	23	416	22	1,305	130			281	7
2011	158	9	688	15	2,087	123			391	0
2012	479	24	1,644	25	2,849	147			540	0
2013	379	7	1,251	12	2,528	66			485	0
2014	801	43	2,442	9	3,340	138			443	0
2015	782	8	1,349	3	3,329	108			449	0

Year	Humans		Birds		Mosquitoes		Horses		Sentinel Flock	
	CA	Fresno County	CA	Fresno County	CA	Fresno County	CA	Fresno County	CA	Fresno County
2016	442	14	1,352	6	3,528	185			343	0
2017*	87	1	264	3	2,545	136			155	0

Source: California West Nile Virus Web Site, www.westnile.ca.gov/
*As of September 1, 2017

West Nile virus activity in California (and Fresno County) for 2017 is illustrated in Figure 4.23.

Figure 4.23 West Nile Virus Activity in California Counties, 2017



Source: California Department of Public Health, www.westnile.ca.gov/

In response to the increased activity of the virus in California, in August of 2007, Governor Schwarzenegger signed an emergency proclamation and commitment of more than $10 million in emergency funding to fight the virus.

Likelihood of Future Occurrences

Highly Likely—Based on historical data, the Fresno County planning area has experienced 255 human cases of West Nile virus between its discovery in California in 2003, and the end of 2016. This is an average of 20 cases per year. The agricultural nature of much of the planning area combined with the great potential for standing water to be present throughout the County puts the planning area at future risk of West Nile virus.

Climate Change Considerations

Milder weather in the current "cold" seasons and warmer weather in the summer could make the county a more suitable habitat for new mosquito species, increasing the potential for additional cases of some mosquito-borne diseases that are already established in the county. At the same time, increases in the precipitation associated with extreme events could increase the habitat suitable for supporting mosquitoes. Drawing definitive conclusions about public health risk changes associated with vector-borne illnesses as a result of climate change are complicated by the need to also account for any associated changes in human behavior that would accompany the associated impacts to seasonal and daily weather conditions. For example, increased temperatures could result in more time spent indoors during extreme heat days, which could potentially reduce exposure to disease carrying vectors.

4.2.9 Landslide

Hazard/Problem Description

Landslides refer to a wide variety of processes that result in the perceptible downward and outward movement of soil, rock, and vegetation under gravitational influence. Common names for landslide types include slump, rockslide, debris slide, lateral spreading, debris avalanche, earth flow, and soil creep. Landslides may be triggered by both natural and human-induced changes in the environment that result in slope instability.

The susceptibility of an area to landslides depends on many variables, including steepness of slope, type of slope material, structure and physical properties of materials, water content, amount of vegetation, and proximity to areas undergoing rapid erosion or changes caused by human activities. These activities include mining, construction, and changes to surface drainage areas.

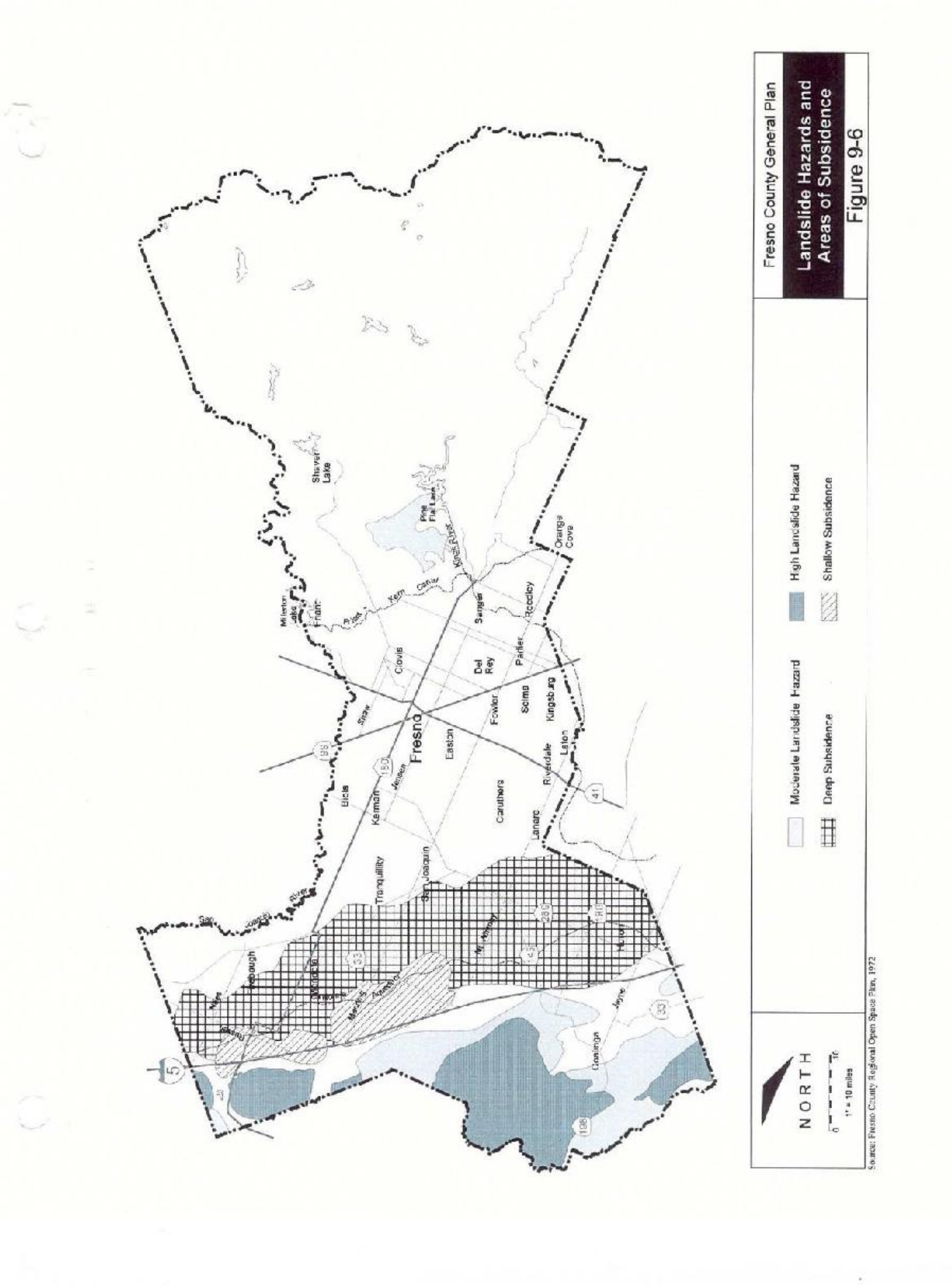
Landslides often accompany other natural hazard events, such as floods, wildfires, or earthquakes. Landslides can occur slowly or very suddenly and can damage and destroy structures, roads, utilities, and forested areas and cause injuries and death.

Extent

The Fresno County General Plan Background Report describes areas in Fresno County that are particularly prone to landslides. Landslide hazard areas include foothill and mountain areas where fractured and steep slopes are present (i.e., the Sierra Nevada), areas where less consolidated or weathered soils overlie bedrock (e.g., the Coast Range), and areas where inadequate ground cover accelerates erosion (e.g., along the San Joaquin River). According to the background report, areas where steep slopes are present are not generally heavily populated and most are located in federal or state lands. The report further identified State Route 168 in eastern Fresno County and State Route 198 in western Fresno County as areas that could be affected by landslides caused by earthquakes or heavy rains. It also concludes that there is no risk of large landslides in the valley area of the County due to its relatively flat topography. However, there is the potential for small slides and slumping along the steep banks of rivers and creeks.

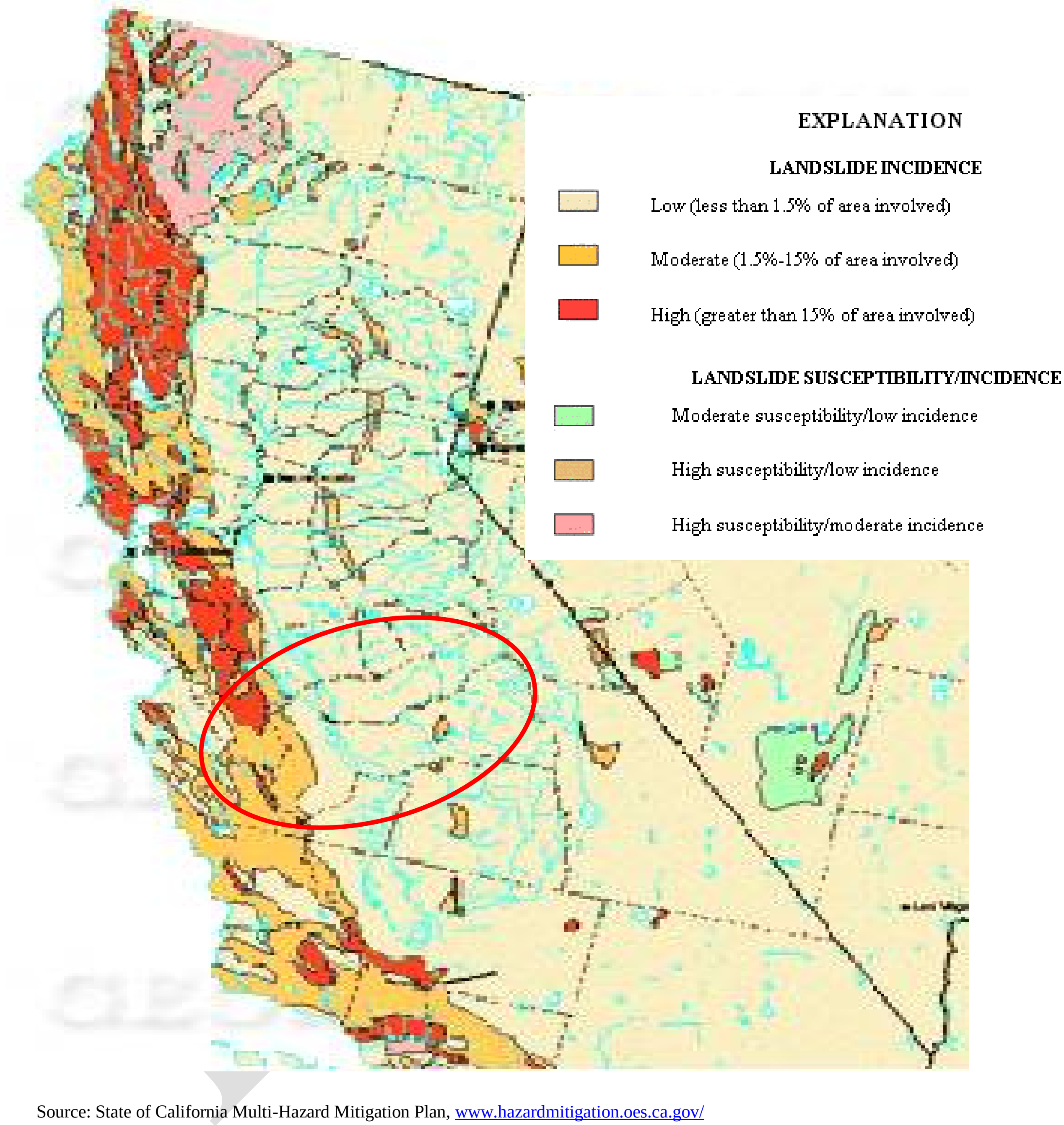
Figure 4.24 is a landslide hazard map from the background report. Figure 4.25 was developed for the State of California Multi-Hazard Mitigation Plan. It indicates that the central and eastern portions of Fresno County are at low risk for landslides and the far west side of the County along the Coast Range is at moderate risk for landslides.

Figure 4.24 Landslide Hazards and Areas of Subsidence in Fresno County



Source: Fresno County General Plan, 2000

Figure 4.25 California's Landslide Risk Zones



Source: State of California Multi-Hazard Mitigation Plan, www.hazardmitigation.oes.ca.gov/
Red oval indicates Fresno County

Past Occurrences

There have been no disaster declarations associated with landslides in Fresno County. Notable landslides of record include the following:

- **1995**—Following a large storm event, a fairly large landslide occurred on Los Gatos Road, a significant local access road west of Coalinga. State geologists determined that catastrophic failure was unlikely, but long-term road maintenance could be compromised due to undercutting of the slope by the creek below the road.

Likelihood of Future Occurrences

Occasional—Based on data provided by the HMPC, minor landslides have occurred in the past, probably over the last several hundred years, as evidenced both by past deposits exposed in erosion gullies and recent landslide events. With significant rainfall, additional failures are likely within the identified landslide hazard areas. Given the nature of localized problems identified within the County, minor landslides will likely continue to impact the area when heavy precipitation occurs, as they have in the past.

Climate Change Considerations

Climate change projections for more intense precipitation events has the potential to increase landslide incidence.

4.2.10 Soil Hazards: Erosion

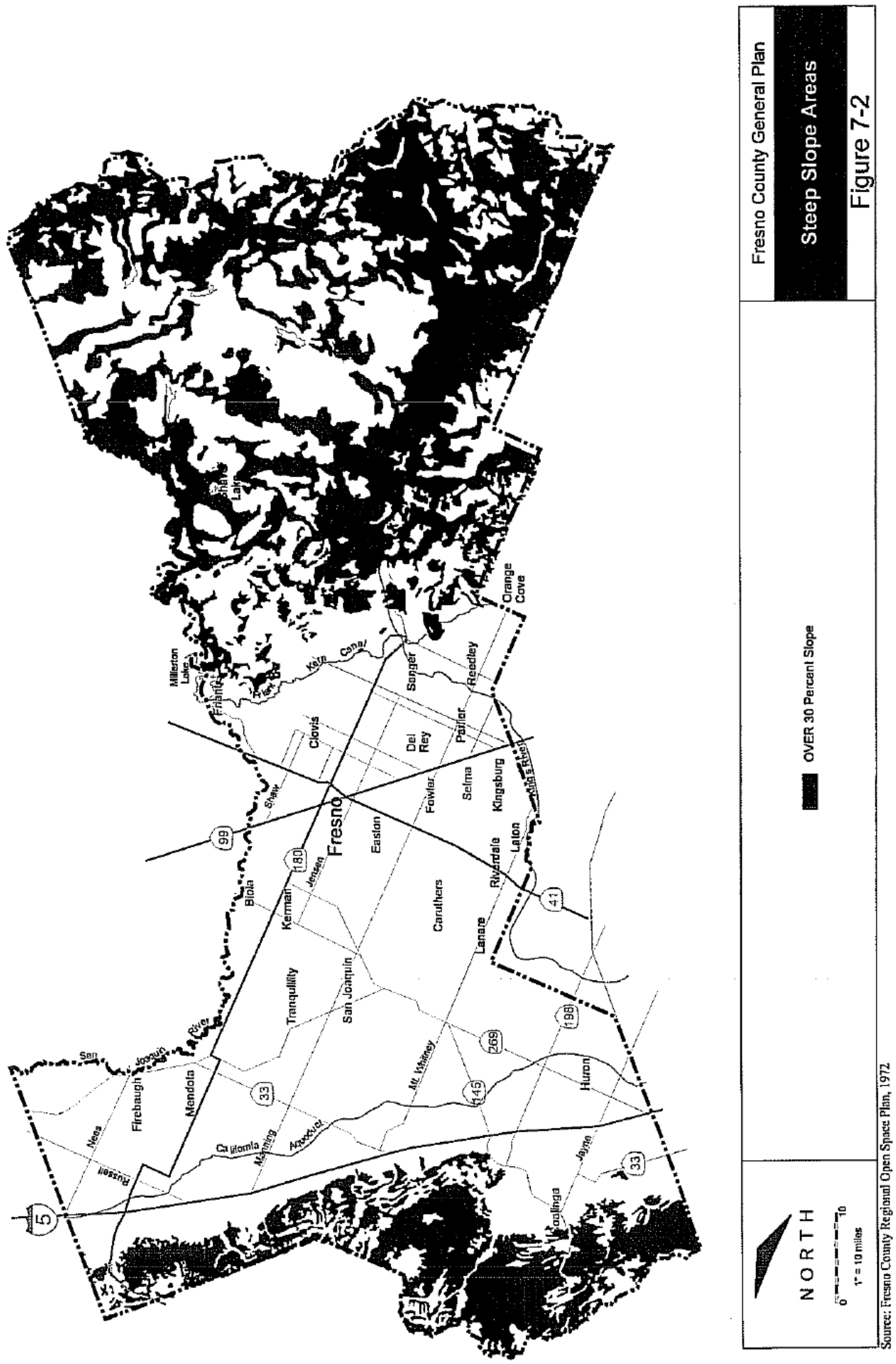
Hazard/Problem Description

Erosion is the general process whereby rocks and soils are broken down, removed by weathering, or fragmented and then deposited in other places by water or air. The rate of erosion depends on many variables, including the soil or rock texture and composition, soil permeability, slope, extent of vegetative cover, and precipitation amounts and patterns. Erosion increases with increasing slope and precipitation and with decreasing vegetative cover, which includes areas where protective vegetation has been removed by fire, construction, or cultivation. Significant erosion can cause degradation and loss of agricultural land, degradation of streams and other water habitats, and rapid silting of reservoirs.

Extent

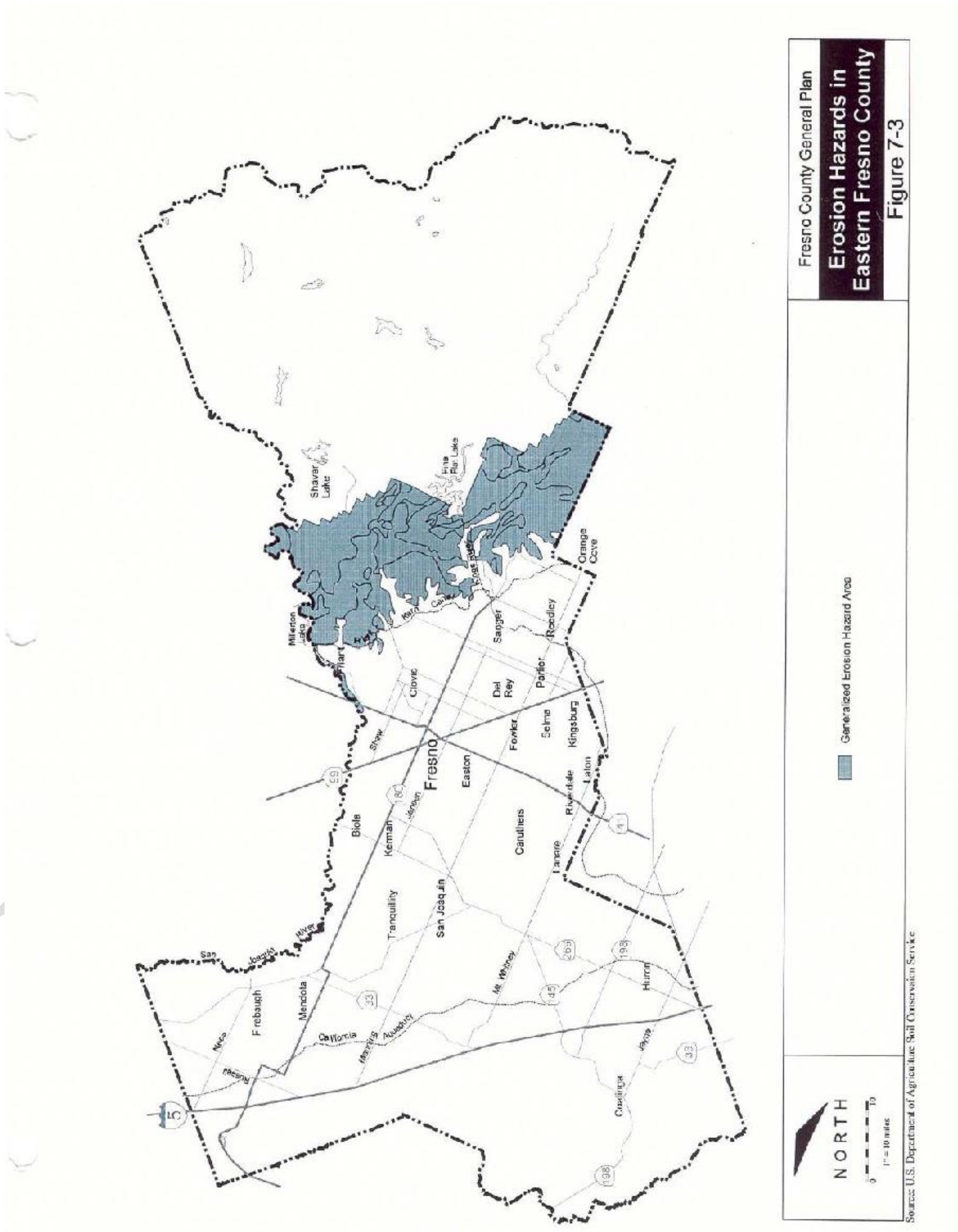
The Fresno County General Plan Background Report identifies those areas with moderately high to high erosion potential. These include areas of certain soil types in the Sierra Nevada and the foothills that generally coincide with slopes that exceed 30 percent (see Figure 4.26 and Figure 4.27). However, many of these identified areas are located within the boundaries of the Sierra National Forest, Sequoia National Forest, or Kings Canyon National Park, which limits their availability for intensive development.

Figure 4.26 Steep Slope Areas in Fresno County



Source: Fresno County General Plan, 2000

Figure 4.27 Erosion Hazards in Eastern Fresno County

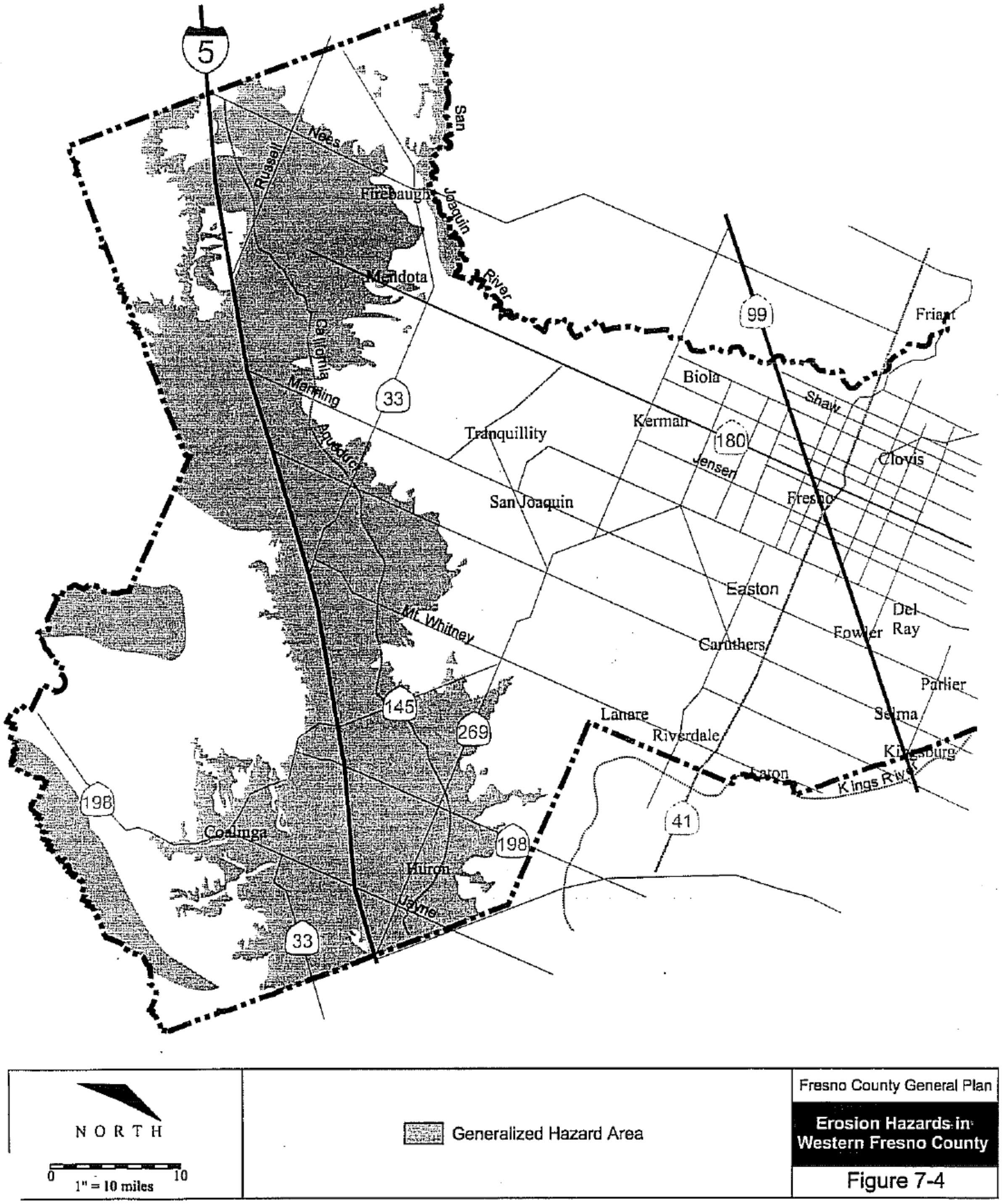


Source: Fresno County General Plan, 2000

Erosion within the valley area is generally not problematic, with the exception of areas containing Rossi soil east of the Fresno Slough from approximately Mendota to Fish Slough near Helm. Severe erosion potential has also been identified along the San Joaquin River Bluff. Also, along the main bypass floodway of the Fresno Slough, widely spaced gullies in a trellis pattern have eroded the soils where subsiding floodwaters drain back into the deeper main flood channel.

In western Fresno County, most soils associated with the Kettleman series appear to be subject to moderate to severe sheet and gully erosion potential. These include areas located primarily west of Interstate 5 in the Coast Range foothills. Also in the western portion of the County, Panoche and Panhill soils, which under natural conditions do not exhibit erosion potential, are susceptible to erosion as a result of human activity. These soils are located extensively throughout the western part of the County and are prevalent in areas on recent alluvial fans in the central part of the region (see Figure 4.28).

Figure 4.28 Erosion Hazards in Western Fresno County

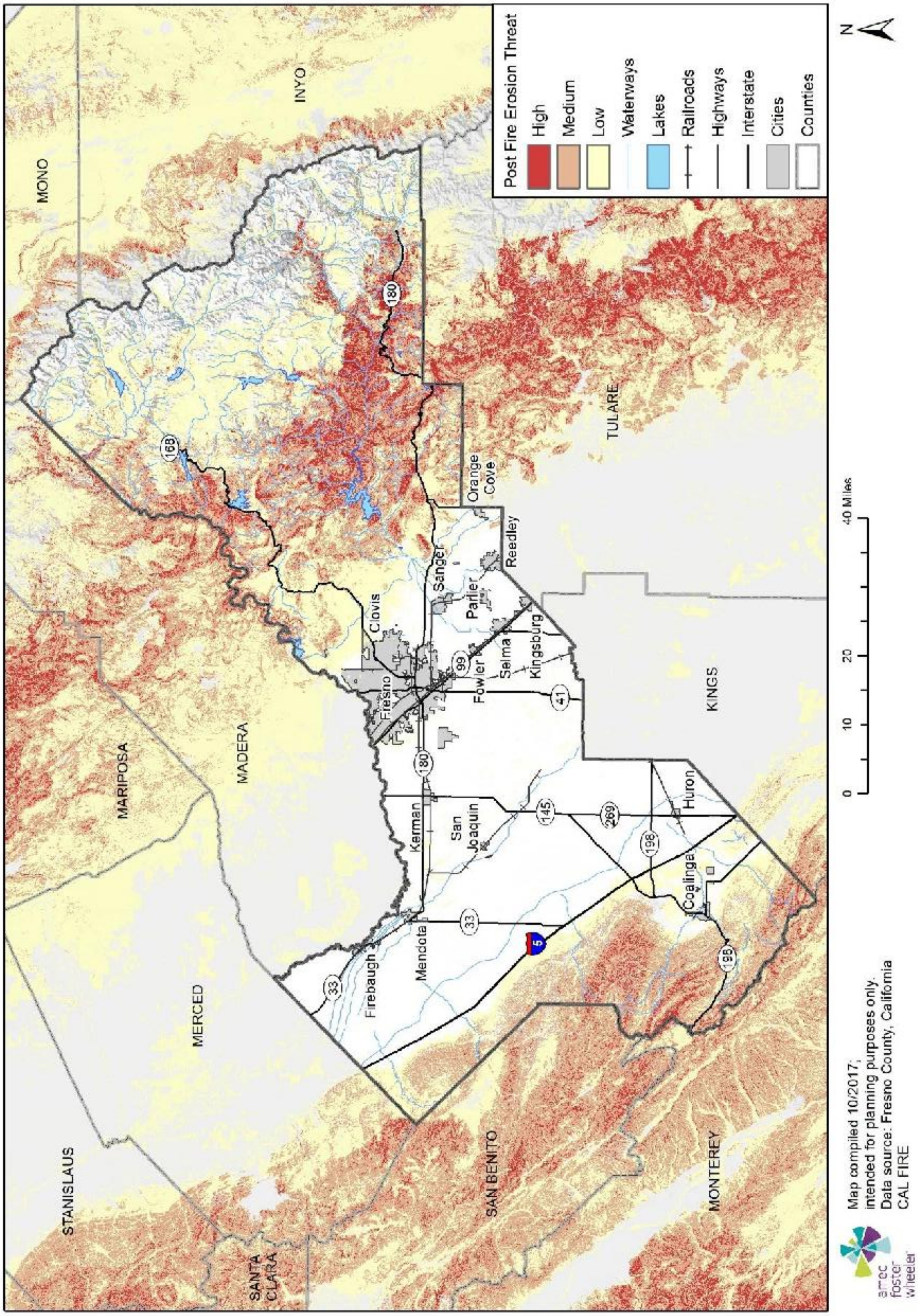


Source: U.S. Department of Agricultrue, Soil Conservation Service, *Soil Survey Western Fresno Area, California*, 1950

Source: Fresno County General Plan, 2000

One of the main concerns associated with erosion is related to wildfire; as a fire burns it destroys plant material. Plants such as shrubs, grasses, and trees provide roots that stabilize the soil. Fires destroy the soil protection, leading to increased vulnerability to erosion, in addition to increased risk of flood hazard. The amount of erosion after a burn is determined by the severity of the burn, the slope, soil type and condition of the watershed before the burn. Using information provided by Cal Fire, Figure 4.30 outlines the post fire erosion threat for Fresno County.

Figure 4.29 Fresno County Post Fire Erosion Threat



Past Occurrences

According to the HMPC and the County geologist, there have been no significant erosion events within the County.

Likelihood of Future Occurrences

Likely—Based on input from the HMPC, erosion does occur in the planning area. Given the nature of erosion problems identified within the County, erosion will continue to be an issue.

Climate Change Considerations

Global warming is expected to lead to a more vigorous hydrological cycle, including more total rainfall and more frequent high intensity rainfall events. Rainfall amounts and intensities increased on average in the United States during the 20th century, and according to climate change models they are expected to continue to increase during the 21st century. These rainfall changes, along with expected changes in temperature, solar radiation, and atmospheric C02 concentrations, will have significant impacts on soil erosion rates. The processes involved in the impact of climate change on soil erosion by water are complex, involving changes in rainfall amounts and intensities, number of days of precipitation, ratio of rain to snow, plant biomass production, plant residue decomposition rates, soil microbial activity, evapo-transpiration rates, and shifts in land use necessary to accommodate a new climatic regime.

4.2.11 Soil Hazards: Expansive Soils

Hazard/Problem Description

Expansive (swelling) soils or soft bedrock are those that increase in volume as they get wet and shrink as they dry. They are known as shrink-swell, bentonite, expansive, or montmorillinitic soils. Swelling soils contain high percentages of certain kinds of clay particles that are capable of absorbing large quantities of water, expanding up to 10 percent or more as the clay becomes wet. The force of expansion is capable of exerting pressures of 20,000 pounds per square foot or greater on foundations, slabs, and other confining structures. Soils composed only of sand and gravel have no potential for volume changes. Soils are generally classified into three expansive soils classes with low, moderate, and high potential for volume changes:

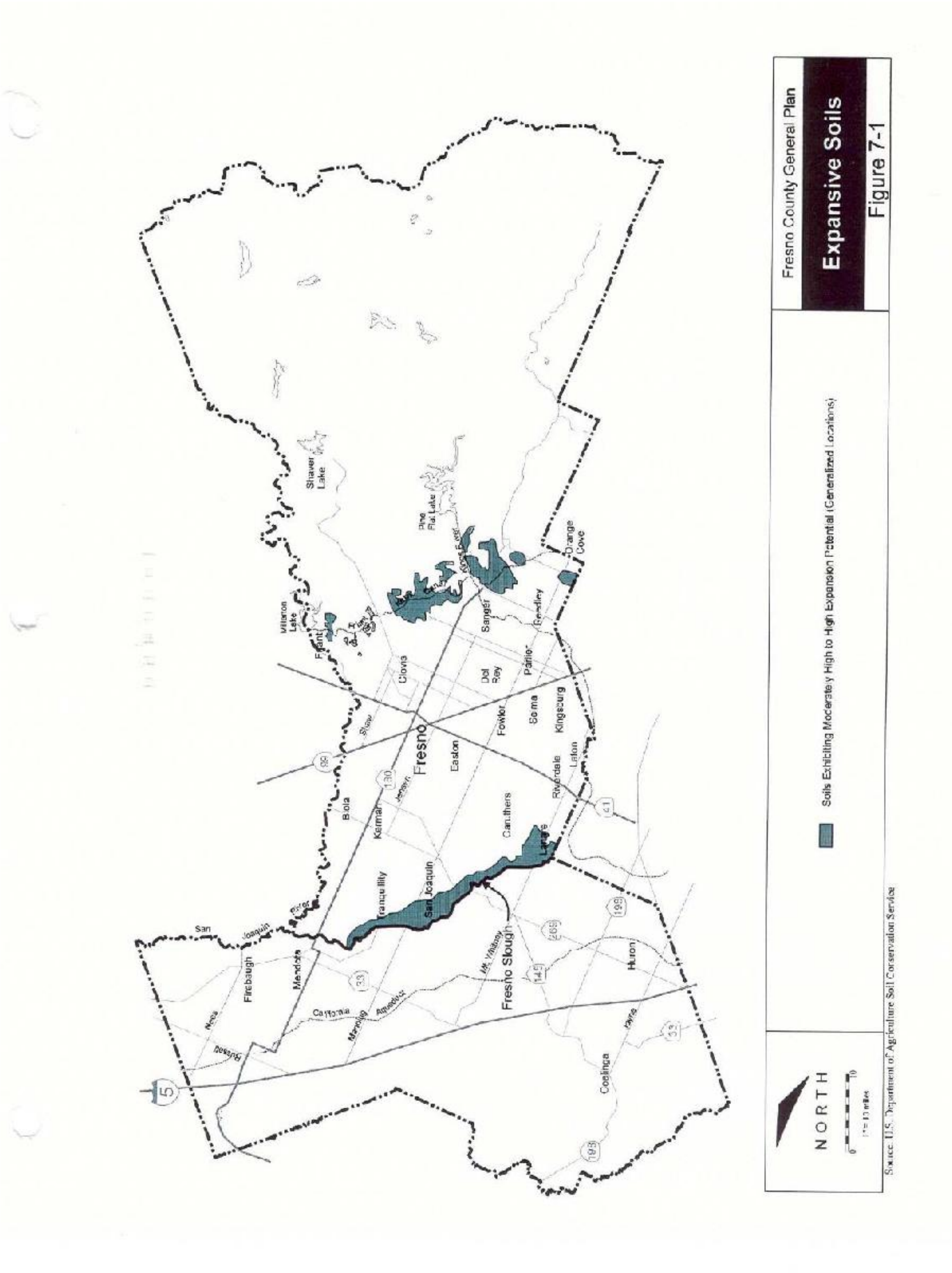
- **Low**—This soils class includes sands and silts with relatively low amounts of clay minerals. Sandy clays may also have low expansion potential, if the clay is kaolinite. Kaolinite is a common clay mineral.
- **Moderate**—This class includes silty clay and clay textured soils, if the clay is kaolinite, and includes heavy silts, light sandy clays, and silty clays with mixed clay minerals.
- **High**—This class includes clays and clay with mixed montmorillonite, a clay mineral which expands and contracts more than kaolinite.

Damage can include severe structural damage, cracked driveways and sidewalks, heaving of roads and highway structures, and disruption of pipelines and other utilities. Destructive forces may be upward, horizontal, or both. Building in and on swelling soils can be done successfully, although more expensively, as long as appropriate construction design and mitigation measures are followed.

Extent

According to the Fresno County General Plan Background Report, expansive soils within Fresno County generally occur in a northwest-trending belt approximately parallel to the Friant-Kern Canal foothills in Kings Canyon National Park in the Sierra Nevada, along the Fresno Slough from Madera County to Kings County, and roughly parallel to the San Luis Drain west of Tranquility and San Joaquin. Figure 4.30 from the Fresno County General Plan Background Report illustrates the areas most susceptible to expansive soils.

Figure 4.30 Expansive Soils in Fresno County



Source: Fresno County General Plan, 2000

Past Occurrences

Expansive soils are present in the County. However, due to the ability to successfully mitigate the hazard by adhering to sound design and construction practices, the HMPC was unable to find examples of historical expansive soil problems in the planning area.

Likelihood of Future Occurrences

Occasional—Based on the soil types found in Fresno County, the potential exists for expansive soils to be a future issue in the Fresno County planning area.

Climate Change Considerations

There is potential for more severe wet and dry cycles in future climate, which may have an effect on the frequency and intensity of expansive soils in Fresno County.

4.2.12 Soil Hazards: Land Subsidence

Hazard/Problem Description

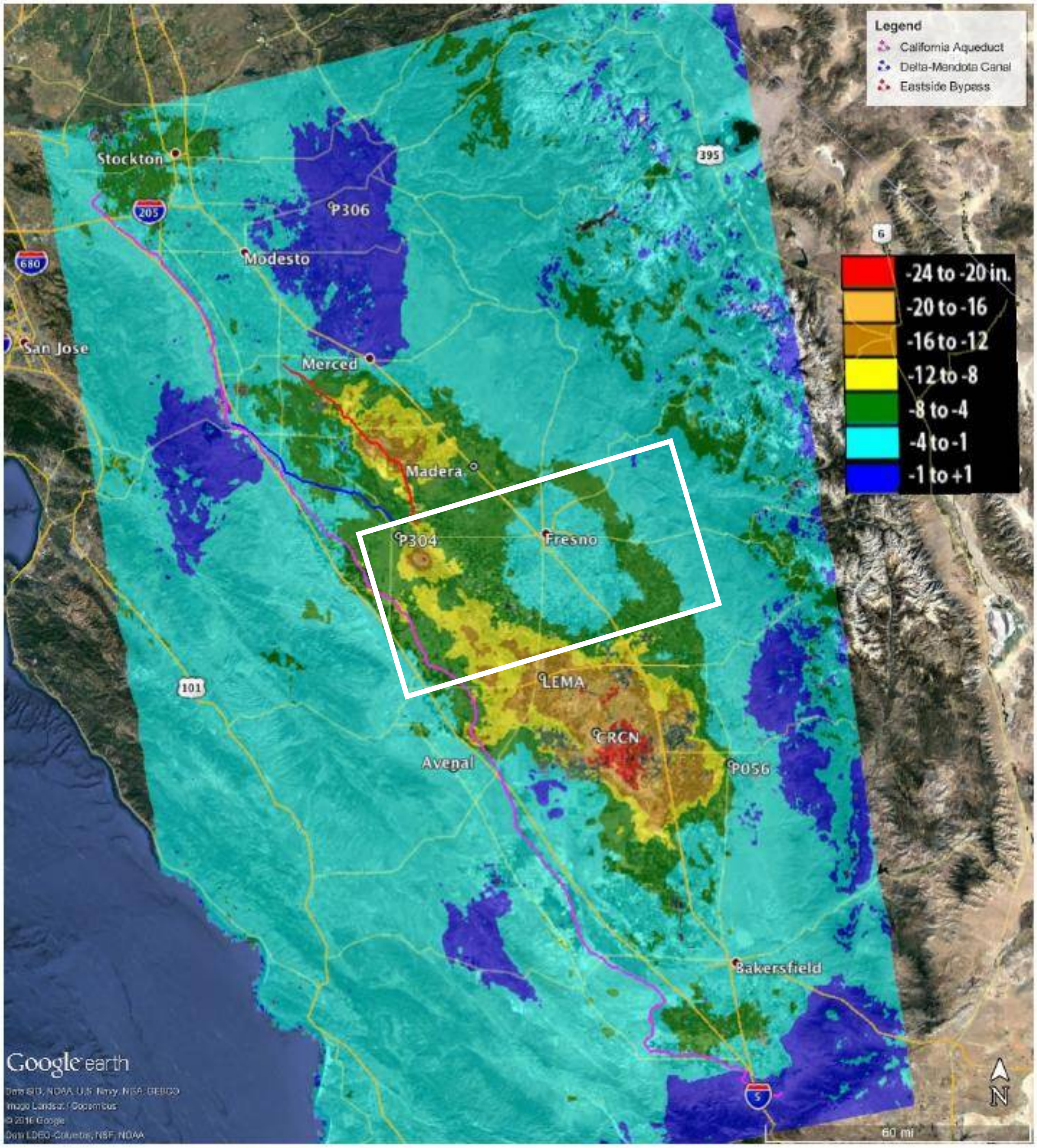
Land subsidence is defined as the vertical sinking of the land over manmade or natural underground voids. Subsidence, usually as a direct result of groundwater withdrawal or oil and gas withdrawal is common in several areas of California, including parts of the Central Valley. Weight, including surface developments such as roads, reservoirs, and buildings, and manmade vibrations from such activities as blasting and heavy truck or train traffic can accelerate the natural processes of subsidence. According to the Fresno County General Plan Background Report, some areas of the Central Valley have subsided more than 20 feet during the past 50 years.

Subsidence can result in serious structural damage to buildings, roads, irrigation ditches, canals, streams, underground utilities, and pipelines. It can disrupt and alter the flow of surface or underground water. Improper use of land subject to subsidence can result in excessive economic losses: direct economic losses as well as indirect losses (e.g., increased taxes and decreased property values).

Extent

According to the background report, in some areas along the valley trough and in parts of western Fresno County, groundwater pumping has caused subsidence of the land surface. Historically, this has occurred in areas where the groundwater basin has been subject to overdraft and long-term recharge is inadequate to maintain the water table elevation, leaving underground voids. There are two main subsidence bowls covering hundreds of square miles that grew wider and deeper between spring 2015 and fall 2016. The geographic extent and magnitude of subsidence in the san Joaquin Valley is displayed below in Figure 4.31.

Figure 4.31 Subsidence in the San Joaquin Valley, May 7, 2015 – September 10, 2016



Source: NASA, ESA's Sentinel-1A and processed at JPL

* Approximate Fresno County planning area denoted by white square

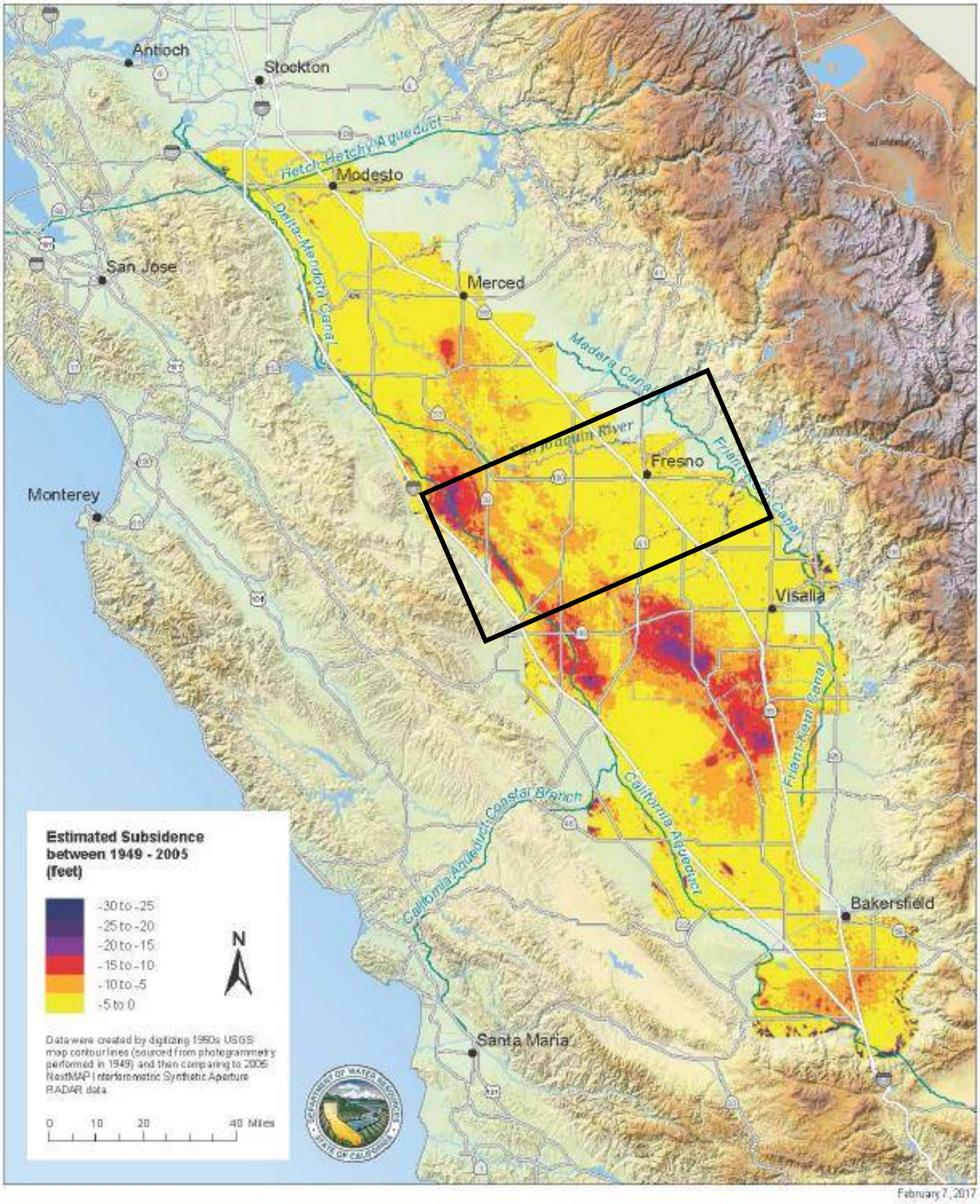
Geospatial analysis indicates that subsidence risk is concentrated in the western portion of the County. While subsidence rates fall in the -4 to -1-inch range in the east, NASA's survey technology shows subsidence reaching up to -16 inches in some pockets along the San Joaquin Valley corridor. Effected jurisdictions include Firebaugh, Mendota, Coalinga, and Huron.

Additionally, a significant area of concern is the Eastside Bypass, a system designed to carry flood flow off the San Joaquin River. Subsidence also intensified at a third area, near Tranquility, where the land surface has settled up to 20 inches in an area that extends seven miles. Specific areas where subsidence has been a problem include the Westlands Water District and the Pleasant Valley Water District. The increased subsidence rates have the potential to damage levees, bridges, and roads. Over time, subsidence can permanently reduce the underground aquifer's water storage capacity.

Past Occurrences

Subsidence caused by groundwater pumping in the Central Valley has been a problem for decades. Long-term subsidence already has destroyed thousands of public and private groundwater well casings in the San Joaquin Valley. NASA has been using radar satellite maps to document rates of subsidence in the San Joaquin Valley since 2014. The NASA analysis evaluated the Eastside Bypass system and found that the land surface had fallen between 16 inches and 20 inches since May 2015 – on top of several feet of subsidence measured between 2008 and 2012. Though recent technology and resources has brought this problem to light, the San Joaquin Valley subsidence due to groundwater extraction was observed as early as the 1920s. Extensive monitoring and research related to subsidence in the Valley was carried out in the 1950s through the 1970s because of concerns about subsidence-related damage to the state and federal water projects. Figure 4.31 below documents 50-years of estimated subsidence rates in the San Joaquin Valley. Similar to Figure 4.31, the eastern portion of the County has historically seen the most subsidence, potentially reaching up to 30-feet in the north-east.

Figure 4.32 Estimated Subsidence in the San Joaquin Valley, 1949 – 2005



Source: USGS
* Fresno County planning area denoted by black square

In 1963, DWR initiated construction of the State Water Project's 444-mile-long California Aqueduct. Subsidence mitigation was integrated into the project design; however, subsidence has required repairs such as the raising of canal linings, bridges, and water control structures on the Aqueduct and on the Central Valley Project's Delta-Mendota and Friant-Kern canals. In recent years, a five-mile reach of the Eastside Bypass was raised in 2000 because of subsidence, and DWR estimates that it may cost in the range of $250 million to acquire flowage easements and levee improvements to restore the design capacity of the subsided area.

Likelihood of Future Occurrences

Occasional—Land subsidence has been a constant issue effecting Fresno County for decades. This hazard is ongoing and is certain to continue in the future. However, legislation passed in 2014 requires local governments to regulate pumping and recharge to better manage groundwater supplies. Groundwater-dependent regions are required to halt overdraft and bring basins into sustainable levels of pumping and recharge by the early 2040s. Though occurrence may be inevitable, the magnitude of subsidence rates is dependent on the mitigation actions and pumping regulations initiated by Fresno County. Excess groundwater pumping is more likely to occur during times of drought.

Climate Change Considerations

The most likely impact that climate change will have on land subsidence risk is the potential for extended and severe drought, which could likely result in more groundwater pumping and human-induced subsidence. During periods of drought, water levels may be drawn too low, which results in an irreversible compaction of aquitards. The water cannot recharge the layers, causing permanent subsidence and diminishment of groundwater storage capacity

4.2.13 Severe Weather: General

Severe weather is generally any destructive weather event, but usually occurs in the Fresno County planning area as localized thunderstorms that bring heavy rain, hail, lightning, and strong winds.

The National Oceanic and Atmospheric Administration's National Center for Environmental Information (NCEI) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to 2017 (except from 6/1993-7/1993); and additional data from the Storm Prediction Center, which includes tornadoes (1950-1992), thunderstorm winds (1955-1992), and hail (1955-1992). This database contains 6,024 severe weather events that occurred in Fresno County between January 1, 1950, and September 30, 2017. The table below summarizes these events.

Table 4.15 NCEI Hazard Event Reports for Fresno County, 1950-2017*

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Dense Fog*	1,135	21,350,000	0	24	72
Flash Floods	17	65,000	0	0	0
Floods	323	582,061,000	124,190,000	8	8
Funnel Clouds	36	0	0	0	0
Hail	69	1,020,000	100,500	0	4
Heavy Rain	127	2,079,000	65,690,000	0	0
High Winds**	30	2,470,000	30,000	1	0
Lightning	34	1,768,000	300,000	0	3
Severe Thunderstorms/Wind	57	3,586,500	43,035,000	2	15
Tornado**	26	5,440,050	26,000	0	3
Wildfires*	645	1,847,706,500	119,918,000	32	0
Totals	**2,499**	**2,467,546,050**	**353,289,500**	**67**	**105**

Source: National Center for Environmental Information Storm Events Database, www.ncdc.noaa.gov/stormevents/
*Hazards with wide extents have losses which reflect larger zones that extend beyond Fresno County
**Source is NOAA Storm Events Database GIS data

The HMPC supplemented NCEI data with data from SHELDUS (Spatial Hazard Events and Losses Database for the United States) when the plan was originally developed. SHELDUS is a county-level data set for the United States that tracks 18 types of natural hazard events along with associated property and crop losses, injuries, and fatalities for the period 1960-2005. Produced by the Hazards Research Lab at the University of South Carolina, this database combines information from several sources (including the NCEI). From 1960 to 1995, only those events that generated more than $50,000 in damage were included in SHELDUS. For events that covered multiple counties, the dollar losses, deaths, and injuries were equally divided among the affected counties (e.g., if four counties were affected, then a quarter of the dollar losses, injuries, and deaths were attributed to each county). From 1995 to 2005, all events that were reported by the NCEI with a specific dollar amount are included in SHELDUS. SHELDUS became a fee-for service database circa 2013, thus was NCEI data was used as the primary source for the update of this plan

SHELDUS contains information on 201 severe weather events that occurred in Fresno County between 1960 and 2005. Table 4.16 summarizes these events.

Table 4.16 SHELDUS Hazard Event Reports for Fresno County, 1960-2005*

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Drought	1	86,207	8,620,690	.05	0
Earthquake	1	50,000	0	2	32
Flooding	13	33,296,405	189,605,958	23.38	226.14
Flooding, Severe Storm, Thunderstorm	2	66,250	13,000,000	0	0
Flooding, Wind	1	0	11,241,379	0	0
Flooding, Wind, Winter Weather	1	0	21,000,000	0	0

Type	# of Events	Property Loss ($)	Crop Loss ($)	Deaths	Injuries
Flooding, Winter Weather	2	96,166,667	5,000,000	0.5	0
Fog	16	1,102,500	0	6.17	98.86
Hail	17	2,437,084	86,454,282	0.78	5.17
Hail, Severe Storm/ Thunderstorm	1	50,000	0	0	0
Hail, Wind	1	5,000	0	0	0
Heat	4	1,316	7,700,000	0.18	0
Landslide	2	0	22,100,000	0	0
Lightning	8	169,404	28,676	1.06	1.33
Lightning, Wind, Winter Weather	1	20,000	0	0	0
Severe Storm, Thunderstorm	23	6,883,517	2,492,779	2.48	2.32
Severe Storm, Thunderstorm, Wind	21	1,103,636	58,892,468	0.02	20.1
Severe Storm, Thunderstorm, Winter Weather	1	5,000	0	0	0
Tornado	9	2,536,086	20,862	0.2	0
Wildfire	9	1,531,730	438	0.16	0.34
Wind	41	38,736,053	188,412	1.91	27.82
Winter Weather	26	73,000	26,311,400	0	3.86
Totals	**201**	**184,372,355**	**452,767,760**	**32.89**	**328.08**

Source: SHELDUS, Hazards Research Lab, University of South Carolina, www.sheldus.org/
*Events may have occurred over multiple counties, so damage may represent only a fraction of the total event damage and may not be specific to Fresno County

The NCEI and SHELDUS tables above summarize severe weather events that occurred in Fresno County. Only a few of the events actually resulted in state and federal disaster declarations. It is further interesting to note that different data sources capture different events during the same time period, and often different information specific to the same events. While the HMPC recognizes these inconsistencies, they see the value this data provides in depicting the County's "big picture" hazard environment.

As previously mentioned, all of Fresno County's state and federal disaster declarations have been a result of severe weather. For this plan, severe weather is broken down as follows:

- Extreme Temperatures (Extreme Cold/Freeze and Extreme Heat)
- Fog
- Heavy Rain/Thunderstorm/Hail/Lightning/Wind
- Winter Storm
- Tornado

Due to size of the County and changes in elevation and climate, weather conditions can vary greatly across the County. The profiles that follow provide information, where possible, from three weather stations in different parts of the County: Huntington Lake (elevation: 7,000 feet) in east Fresno County, Fresno WSO AP (elevation: 33 feet) in central Fresno County, and Coalinga (elevation: 66 feet), in west Fresno County.

4.2.14 Severe Weather: Extreme Temperatures

Hazard/Problem Description

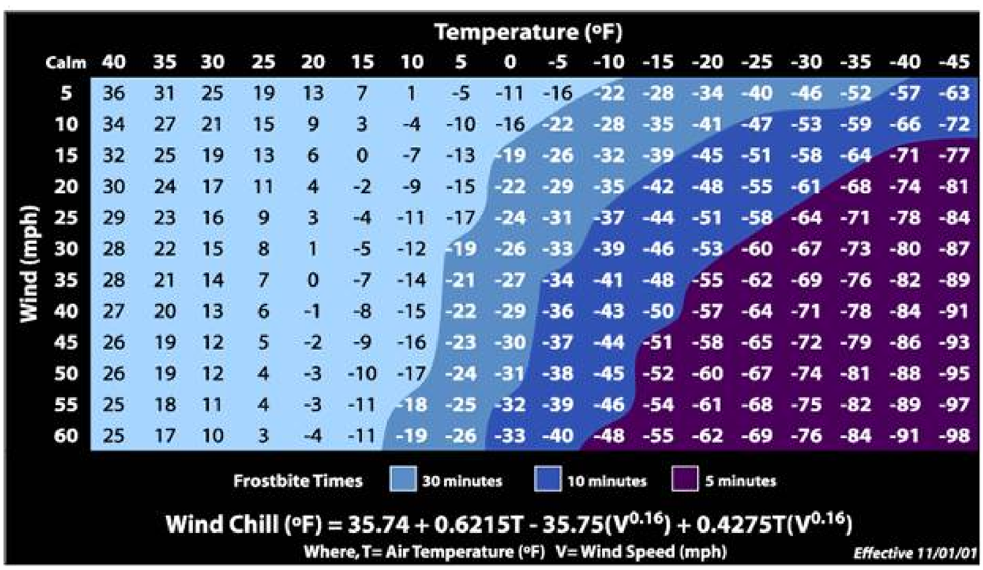
Extreme temperature events, both cold and hot, can have severe impacts on human health and mortality, natural ecosystems, and agriculture and other economic sectors.

Extreme Cold/Freeze

Extreme cold often accompanies a winter storm or is left in its wake. Prolonged exposure to cold can cause frostbite or hypothermia and can be life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Freezing temperatures can cause significant damage to the agricultural industry. The effects of freezing temperatures on agriculture in Fresno County are discussed further in Section 4.2.1 Agricultural Hazards.

In 2001, the National Weather Service implemented an updated Wind Chill Temperature index (see Figure 4.33 National Weather Service Wind Chill Chart). 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 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.

Figure 4.33 National Weather Service Wind Chill Chart



Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: National Weather Service Forecast Office, San Joaquin Valley/Hanford, California, www.wrh.noaa.gov/hnx/

Extreme Heat

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the NWS, among natural hazards, only the cold of winter—not lightning, hurricanes, tornadoes, floods, or earthquakes—takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died. Extreme heat can also affect the agricultural industry. Extreme heat, as it affects agriculture in Fresno County, is discussed further in the section on agricultural hazards.

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating or a chemical (salt) imbalance caused by too much sweating. When heat gain exceeds the level the body can remove, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illness may develop. The elderly, small children, chronic invalids, those on certain medications or drugs, and people with weight and alcohol problems are particularly susceptible to heat reactions.

Extent

According to the Fresno County Heat Emergency Contingency Plan, the average high and low temperatures for Fresno County in July are 98.6°F and 65.1°F, respectively. Temperatures that are 10 degrees above normal are considered excessive. The NWS has in place a system to initiate alert procedures (advisories, watches, and warnings) when high temperatures are expected to have a significant impact on public safety. The expected severity of the heat determines which type of alert is issued. A common guideline for the issuance of excessive heat alerts in Fresno County is when the maximum daytime high is expected to equal or exceed 110°F and a nighttime minimum high of 80°F or above is expected for two or more consecutive days.

Fresno County begins to experience hot weather in May or June of each year, and the heat continues throughout the summer months. The Fresno County Heat Emergency Contingency Plan provides a two-phase approach to mitigate and reduce the effects of extreme heat. Phase I calls for a heat awareness campaign to be initiated at the beginning of the heat season. Phase II calls for an operational area response to be activated once the County health officer declares a heat emergency. The following factors help the health officer determine if the threat to public health and safety is significant enough to declare a heat emergency:

- The NWS has issued an excessive heat watch or warning.
- Heat-related illnesses and deaths are above average.
- Heat-related animal deaths are above average.

- There are successive days when daytime temperatures exceed normal ranges, and nighttime temperatures do not drop low enough to allow for three-four hours of cooling (temperatures dropping below 80°F).
- The California Independent System Operator has issued a stage 3 electrical emergency.
- High heat is accompanied by electrical blackouts or rotating power outages.
- Two or more jurisdictions within the County have declared heat emergencies.
- The state has declared a heat emergency.

Overall, extreme temperature impacts would likely be limited in the planning area, with 10 to 25 percent of the planning area affected. 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. Extreme cold and extreme heat can also impact livestock and even crops if the event occurs during certain times of the year.

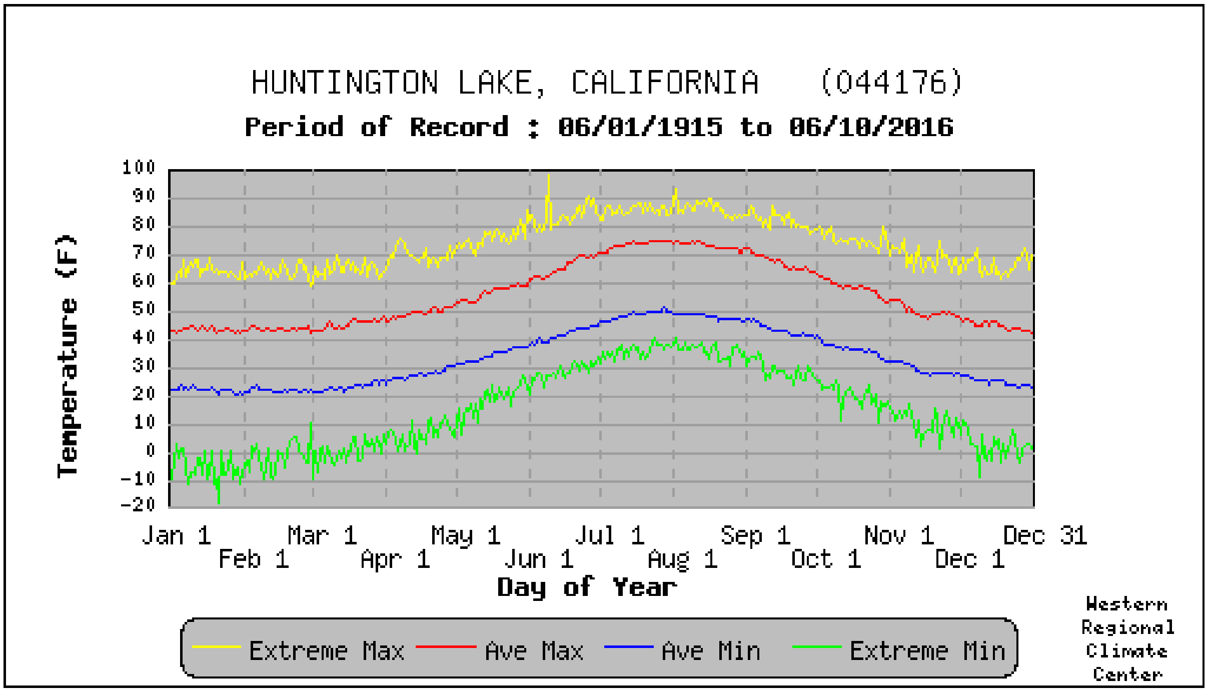
Past Occurrences

Information from the three representative weather stations introduced in Section 4.2.13 Severe Weather: General is summarized below and in Figure 4.34 through Figure 4.36

Fresno County—East (Huntington Lake Weather Station, Period of Record 1948 to 2007)

In the eastern portion of Fresno County, monthly average maximum temperatures in the warmest months (May through October) range from the mid-50s to the mid-70s. Monthly average minimum temperatures from November through April range from the low to high 20s. The highest recorded daily extreme was 88°F on September 3, 1955, August 7, 1981, and July 18, 1988. The lowest recorded daily extreme was -10°F on February 13, 1949, and January 27, 1957. In a typical year, maximum temperatures do not exceed 90°F and may be less than 32°F on 16.2 days, and minimum temperatures fall below 32°F on 169.3 days and below 0°F on .8 days.

Figure 4.34 Fresno County—East Daily Temperature Averages and Extremes

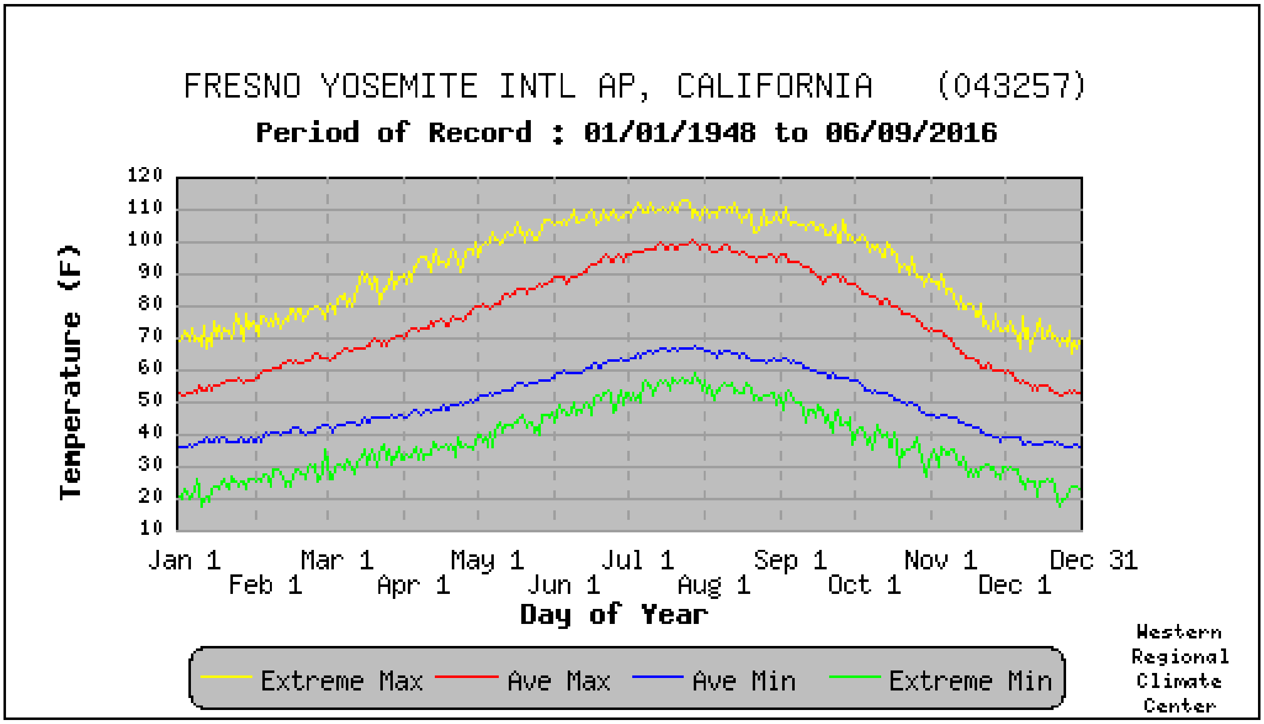


Source: Western Regional Climate Center, www.wrcc.dri.edu/

Fresno County—Central (Fresno WSO AP Weather Station, Period of Record 1948 to 2007)

In the central portion of Fresno County, monthly average maximum temperatures in the warmest months (May through October) range from the high 70s to the high 90s. Monthly average minimum temperatures from November through April range from the high 30s to the high 40s. The highest recorded daily extreme was 113°F on July 23, 2006. The lowest recorded daily extreme was 18°F on January 10, 1949, and December 23, 1990. In a typical year, maximum temperatures exceed 90°F on 106.3 days and are less than 32°F on 21.3 days, and minimum temperatures fall below 32°F on 169.4 days.

Figure 4.35 Fresno County—Central Daily Temperature Averages and Extremes

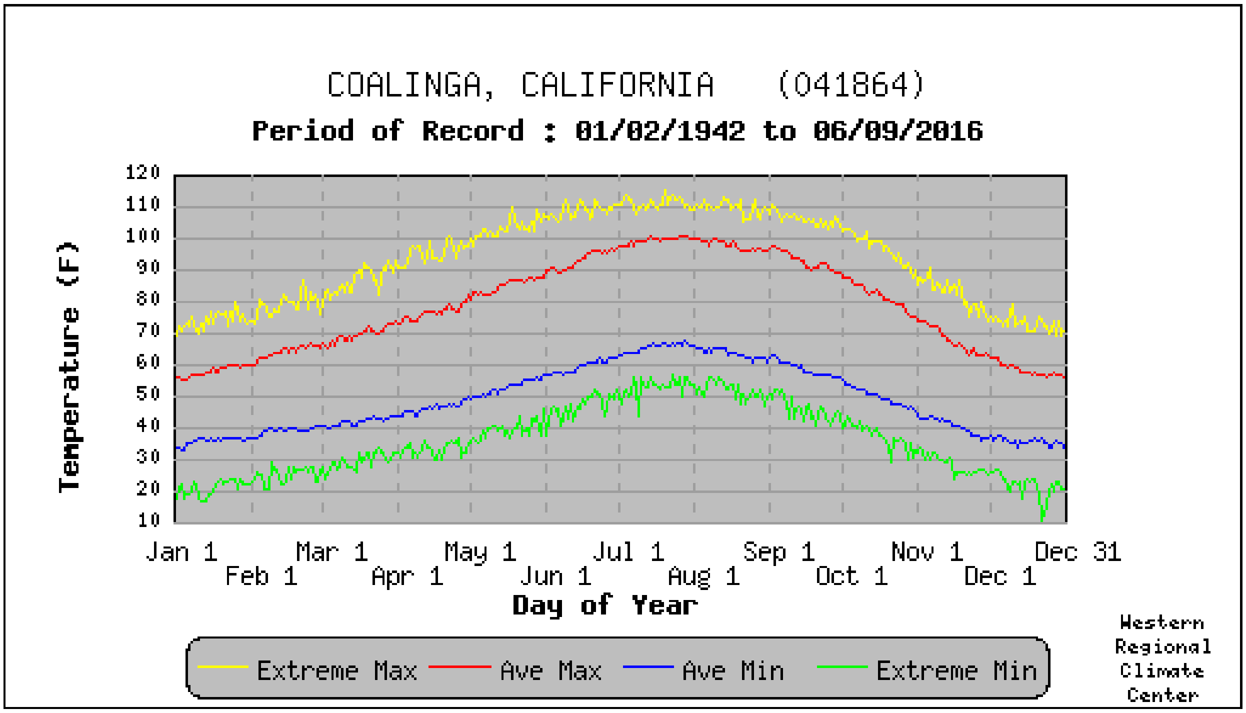


Source: Western Regional Climate Center, www.wrcc.dri.edu/

Fresno County—West (Coalinga Weather Station, Period of Record 1942 to 2007)

In the western portion of Fresno County, monthly average maximum temperatures in the warmest months (May through October) range from the low 80s to the high 90s. Monthly average minimum temperatures from November through April range from the mid-30s to the high 40s. The highest recorded daily extreme was 114°F on July 4, 1991. The lowest recorded daily extreme was 11°F on December 22, 1990. In a typical year, maximum temperatures exceed 90°F on 115.5 days and do not fall below 32°F, and minimum temperatures fall below 32°F on 32.8 days.

Figure 4.36 Fresno County—West Daily Temperature Averages and Extremes



Source: Western Regional Climate Center, www.wrcc.dri.edu/

The HMPC identified the following events related to extreme temperatures in the Fresno County planning area:

Events of Note

Extreme Cold/Freeze

- **1990**—This freeze event is on record as the most economically devastating freeze event to date due to the loss of production citrus trees, not just the loss of the fruit crop.
- **December 20-28, 1998**—Extreme low temperatures adversely affected agricultural crops in the County. Citrus crops were impacted the most, but winter vegetables were also damaged. Total crop damage was estimated at $74 million. The loss to crops also resulted in unemployment and loss of income to small towns and industry throughout the planning area. An estimated 14,000 or more agricultural workers were out of work. Estimated economic impacts to the community were $220 million. This freeze resulted in local, state, and federal declarations (2/9/99). The County also incurred $223,700 in damage to government facilities and roads. Statewide, $2.5 million was paid out in claims.
- **January 2007**—Freezing temperatures destroyed citrus crops and put a large number of people out of work. Within the agricultural citrus belts, temperatures ranged from 19-24°F during the morning. Damage to County facilities was estimated at $15,000. Crop damage was estimated at roughly $128 million. Residual effects from loss of sales and resulting unemployment were considered to be three times the cost of the crop damage ($383 million). Local, state, and

federal disasters were declared. The state provided monies for mortgage and rental assistance. Federal and state donations to local food banks were increased. Unemployment insurance benefits were also increased. Central and South Valley estimated combined property damage was $250,000, and agricultural damage was $710 million.

Extreme Heat

- **July 16-22, 2006**—The planning area experienced six days of triple digit temperatures. The state declared a heat emergency for Fresno County. Cooling centers were opened by the state and some local jurisdictions. 24 people died between July 14 and August 1. 16,500-25,000 dairy cattle died in the Central Valley, and up to 700,000 poultry died. Milk production was down 30 percent, with dairy losses estimated to exceed $80 million. Residual effects from loss of sales and resulting unemployment were considered to be three times the cost to the livestock industry. A local declaration was also declared to dispose of dead livestock at the County landfill. Federal/state disaster relief included $16 million for lost milk production. Federal loans were made available to farmers.
- **July 2007**—Extreme, prolonged heat caused a mass die-off of farm animals such as dairy cattle and poultry. An estimated 50,000 turkeys, weighing up to 40 pounds each, died, which created a disposal issue. Zacky Farms was hit hardest, but other losses were incurred at various locations throughout the County. A local emergency was declared to legally dispose of these animals at the local landfill.
- **July 2008-** An extreme heat event developed on July 8 across Interior Central CA as a strong ridge of high pressure setup across the region. This weather pattern promoted progressively increasing temperatures for several days with excessive heat warning criteria met in some locations beginning the night of July 8, and continuing in most locations through July 11. Maximum temperatures on the 9th and 10th were generally between 105-112 degrees. Unusually humid conditions resulted in heat index values of 110 degrees or higher in many locations. Nighttime relief was very limited, especially in cities, where minimum heat index values failed to drop below 80 degrees. In addition, very poor air quality occurred coincident with the heat event due to wildfires across CA. The San Joaquin Valley Air Pollution Control District, in cooperation with NWS Hanford, issued several Air Quality Alerts, Health Advisories, and other air quality statements, in response to the poor air quality. NWS Hanford has a well-developed agreement to assist the Air District with air quality information dissemination.

  Temperature records have been broken at several locations. The low temperature at Bakersfield on July 10th was 86 degrees. This breaks the record highest minimum temperature at Bakersfield for the date of 82 degrees, set in 2002. The low temperature at Fresno on July 10th was 82 degrees. This breaks the record for the highest minimum temperature at Fresno for the date of 80 degrees, set in 1896. The low temperature at Bakersfield on July 9th was 84 degrees. This was 7 degrees warmer than the record high minimum temperature at Bakersfield for the date of 77 degrees, set in 1975. The low temperature at Fresno on July 9th was 81 degrees.

This was 2 degrees warmer than the record high minimum temperature at Fresno for the date of 79 degrees, set in 1896.

Two fatalities occurred during this extreme heat event. Both fatalities were in Kern County near Maricopa. The victims were both farm workers working during the heat event. The first fatality occurred of a 42-year-old male vineyard worker in Kern County. He was found in his truck along a highway and vineyard. The second fatality was a man of unknown age, also working in the vineyard near Maricopa.

The combination of very hot weather of very poor air quality created a situation very dangerous for those individuals sensitive to poor conditions, such as the elderly, young, and those with chronic health problems.

Kings County Government reported extensive poultry losses on July 10, dollar estimates were unavailable. An estimated 150 tons of dead poultry came into a local rendering plant. Kings County declared a local state of emergency.

- **August 2011**- Strong high pressure developed over southeast California during late August, and led to excessive heat across Joshua Tree National Park beginning on Monday August 22nd. High temperatures across the east end of the park climbed well in excess of 100 degrees Monday, and peaked above 110 Tuesday through Saturday. The excessive heat led to the deaths of a 44-year-old Dutch man and a 38-year-old German woman on Monday afternoon. According to Lt. Tingle of the Sheriff's Indio station, the bodies were found near Black Eagle Mine road. The dead man was found on the edge of the road, about a mile and a half east of Pinto Basin Road, north of the Cottonwood Visitor's Center. The dead woman was found about one mile east of the man's body. Captain Raymond Gregory of the Sheriff's Indio station reported that the pair entered the park shortly before noon, and that they abandoned their vehicle in an area deemed impassable to passenger vehicles. Evidence indicated that they both succumbed to exposure to the elements.
- **July 2013**- A record-setting ridge of high pressure (600 dm over northern New Mexico) built in over the Great Basin and desert Southwest, beginning around June 29th, lasting through approximately July 7, when it hit another peak in temperatures. This resulted in extreme high temperatures, well above normal across the region during this period. The hottest days in July were the 1st through the 3rd, during which several record high minimums were set, as well as highs well over 100 degrees. Prolonged heat in the higher terrain was a significant impact, like in San Diego County.
- **June 2016**- Strong high pressure over the four corners region retrograded westward over southern and central California bringing a period of high temperatures over the 110-degree mark to locations in the Kern County Desert.
- **June 2017**- A strong ridge of high pressure and a dry airmass helped temperatures soar in inland areas from the 16th through the 27th. The heat was most intense in the deserts on the 20th, 24th, and 25th with Palm Springs reaching 122 degrees on all three days. Temperatures

peaked in the 100-110 degree range over the San Diego County Valleys and Inland Empire on the 20th, 24th and 25th. Flex Alerts were issued asking customers to conserve power.

- **August 2017-** Upper level high pressure brought record heat to the area. A plume of subtropical moisture promoted the growth of isolated afternoon thunderstorms with large hail. A 13-year-old was hospitalized Tuesday after suffering heat stroke during tryouts for the freshman football team at Lincoln High School on August 1. Temperatures at Lincoln Airport reached 100 degrees between 4 and 7 pm PDT.
- **September 2017** - A persistent large upper ridge centered over the Great Basin provided the area with an extended period of much warmer than normal temperatures between August 26 and September 3. High temperatures ranged mainly from 106 to 112 degrees at many locations each day between August 26 and September 3 across the San Joaquin Valley, the southern Sierra foothills and the Kern County Deserts while morning lows ranged from the mid 70's to the lower 80's.

Likelihood of Future Occurrences

Highly Likely—Temperature extremes are likely to continue to occur annually in the Fresno County planning area.

Climate Change Considerations

Although heat waves will likely become more frequent, there is also the potential for continued cold outbreaks in winter, even in an overall warmer climate. This could have direct impacts on human health in terms of heat related illness. With the general trend of increased warming of average temperatures, extreme high temperatures will likely increase as well. Cascading impacts include increased stress on water quantity and quality, degraded air quality, and increased potential for more severe or catastrophic natural events such as heavy rain, droughts, and wildfire. Another cascading impact includes increased duration and intensity of wildfires with warmer temperatures.

4.2.15 Severe Weather: Fog

Hazard/Problem Description

Fog results from air being cooled to the point where it can no longer hold all of the water vapor it contains. For example, rain can cool and moisten the air near the surface until fog forms. A cloud-free, humid air mass at night can lead to fog formation, where land and water surfaces that have warmed up during the summer are still evaporating water into the atmosphere. This is called radiation fog. A warm moist air mass blowing over a cold surface also can cause fog to form, which is called advection fog.

The interior California valleys have a unique fog problem called the tule fogs. The tule fog is a radiation fog, which condenses when there is a high relative humidity, typically after a heavy rain, calm winds, and rapid cooling during the night. The longer nights during the winter months create this rapid ground cooling and results in a pronounced temperature inversion at a low altitude, creating a thick ground fog. Above the cold, foggy layer, the air is typically warm and dry. Once the fog has formed, turbulent air is necessary to break through the inversion. Daytime heating can also work to evaporate the fog in some areas. The tule fogs get their name from the tule reeds, which grew around the swamps and deltas of the great Tulare Lake that once covered the southern end of the San Joaquin Valley.

The tule fog season in Fresno County is typically in the late fall and winter (November through March) but can occur as late as May. Fog typically forms rapidly in the early morning hours. Tule fogs can last for days, sometimes weeks. Fog can have devastating effects on transportation corridors in the County. Nighttime driving in the fog is dangerous and multi-car pileups have resulted from drivers using excessive speed for the conditions and visibility.

The San Joaquin Valley is hemmed in on three sides by mountain ranges, with resulting inversion layers trapping cooler air on the valley floor. This predisposes the Fresno area to severe episodes of fog in winter months, when barometric pressures are high, humidity is increased, and ambient temperatures are low. The table below notes the average number of days with dense fog by month.

Table 4.17 Average Number of Days in Fresno with Dense Fog

Month	Number of Days
January	12
February	6
March	2
April	≤.5
May	≤.5
June	0
July	0
August	≤.5
September	≤.5
October	1
November	6
December	12
Annual	**41.0**

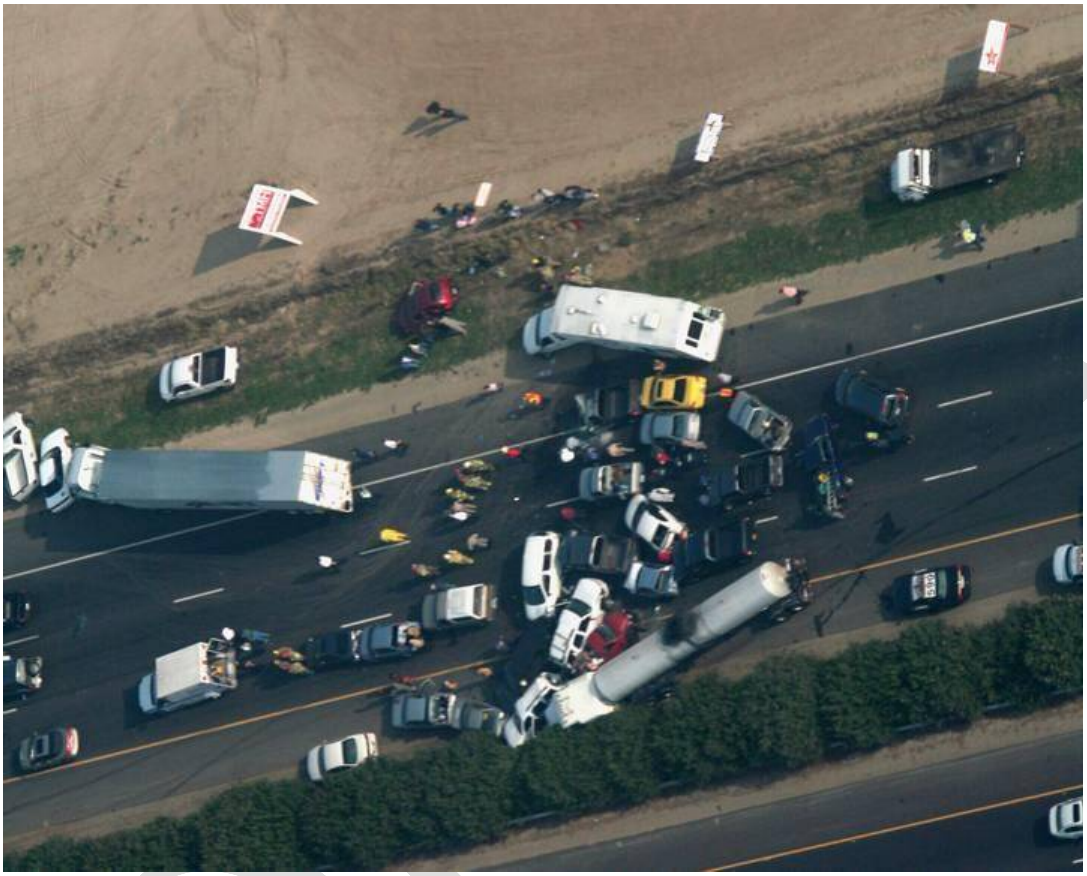
Source: Western Regional Climate Center

Fog contributes to transportation accidents and is a significant life safety hazard. These accidents can cause multiple injuries and deaths and could have serious implications for human health and the environment if a hazardous or nuclear waste shipment were involved. Other disruptions from fog include delayed emergency response vehicles and school closures.

Extent

Tule fog forms on clear nights when the ground is moist and the wind is near calm. On nights like this, the ground cools rapidly. In turn, the moist air above it cools and causes water vapor to condense. Once it has formed, the air must be heated enough to either evaporate the fog or lift it above the surface so that visibilities improve. Common areas for tule fog to form include foothills and valleys. Visibility in tule fog is usually less than an eighth of a mile (about 600 ft or 200 m), but can be much lower. Visibility can vary rapidly; in only a few feet, visibility can go from 10 feet (3.0 m) to near zero.

Figure 4.37 Traffic Accident Caused by Fog, November 2007



Source: Donavan, California Highway Patrol

Most of these notable fog-related accidents occurred on Highway 99. In addition to these events, other, less notable collisions occurred on other roads during foggy conditions. Records provided by the HMPC indicated that from January 1, 1999, through December 31, 2006, 22 collisions occurred during foggy weather on multiple roads, resulting in five injuries. The only fatal accident due to fog noted previously. It is unclear the extent that fog played in many of these accidents as there were other contributing factors, such as driver negligence.

Past Occurrences

According to the HMPC, severe fog is a recurring problem within the planning area, and most damage results from automobile accidents. Most of these incidents occurred between November and March; one was in October. Notable fog incidents reported by the HMPC include the following:

- **February 1991**—A series of accidents involving 74 vehicles occurred along a three-mile, fog-shrouded stretch of Highway 99 south of Fresno. Three people were killed and 30 were injured.
- **January 16, 1994**—Dense fog caused a 56-vehicle pileup on Highway 99 near Selma, killing two people and injuring 42 others.
- **November 1998**—Dense fog caused a chain-reaction accident involving 74 vehicles along a one-mile stretch on Highway 99 near Kingsburg. Two people were killed, 51 others injured.
- **February 2002**—Fog was a factor in a string of crashes on Highway 99 near Selma that killed two people. More than 30 others were injured in the accident, which involved 87 cars, trucks, and big rigs over a four-mile stretch.
- **November 20, 2002**—Fog was a major factor in a 50-vehicle collision on Highway 99 near Merced that resulted in 32 injuries.
- **February 7, 2006**—Fog was a factor in a 20-vehicle collision on Highway 99 near Tulare that resulted in one death and multiple injuries.
- **November 3, 2007**—Dense fog contributed to the worst traffic accident in Fresno County on Highway 99 just south of Fresno. At least two people were killed in the 108-car chain-reaction crash, which involved 18 big rigs, and 39 individuals were sent to local hospitals. Drunk driving was also cited as a contributing factor.
- **February 2008**- Two nights of dense fog resulted in a 10-15 car pileup on the morning of the 11th near Kerman west of Fresno, where there were no injuries, and newspaper accounts of only minor property damages. However, the fog was a major factor in a series of chain-reaction accidents on Highway 99 near Kingsburg during the morning of February 12th. At least four separate accidents occurred, involving at least 40 vehicles and resulting in at an estimated 10 people being injured.
- **November 2012**-Despite the lack of rainfall from the storm on November 20th-21st on the San Joaquin Valley floor, patchy dense fog developed during the morning of the 22nd. Initially the fog formed in the Los Banos area, but this patch of fog eroded from the north. Later, a larger patch of fog developed in the Reedley-Visalia area, and then spread northward and westward, lingering through much of the morning. At the same time, clouds banked up over the San Joaquin Valley. This narrow band of fog drifted over the Valley floor, causing visibilities at most airports to fluctuate from near zero to a couple of miles. Widespread dense fog continued through November 27th across most of the San Joaquin Valley. On the morning of the 27th, dense fog contributed to a chain reaction crash involving two big rigs and one vehicle. Three people were killed in this crash. The crash occurred on Highway 152 about two miles south of Chowchilla in adjacent Madera County.
- **January 2013**-January began with the central and southern San Joaquin Valley under a cold, dry airmass that moved into the region. Dense fog continued its reputation as the main winter weather hazard for the central and southern San Joaquin Valley, as a fatal collision occurred 3 miles southeast of Chowchilla in dense fog during the morning of January 4th. These conditions continued through the morning of the 5th, and then a strong upper-level low brought the first precipitation of the year that evening.
- **January 2017**-High pressure with clearing skies over the region coupled with recent heavy precipitation created ideal conditions for dense nighttime and morning radiational fog to

develop. Fresno police and California Highway Patrol reported a 2-vehicle accident during dense fog causing one fatality at Jensen Avenue and Chateau Fresno Avenue in the city of Fresno in Fresno County. It also appeared alcohol was a factor.

Likelihood of Future Occurrences

Likely—Based on the NCEI and SHELDUS data, 21 major fog incidents over a 58-year period equates to a major fog event every 2.8 years and a 36.2 percent chance of a major fog event in any given year. Based on input from the HMPC, it is likely that minor fog events will continue to occur annually in the Fresno County planning area.

Climate Change Considerations

California’s winter tule fog has declined dramatically over the past three decades, raising a red flag for the state’s multibillion dollar agricultural industry, according to researchers at UC Berkeley. Crops such as almonds, pistachios, cherries, apricots and peaches go through a necessary winter dormant period brought on and maintained by colder temperatures. Tule fog, a thick ground fog that descends upon the state’s Central Valley between late fall and early spring, helps contribute to this winter chill. “The trees need this dormant time to rest so that they can later develop buds, flowers and fruit during the growing season,” said biometeorologist and study lead author Dennis Baldocchi. “An insufficient rest period impairs the ability of farmers to achieve high quality fruit yields.” The findings have implications for the entire country since many of these California crops account for 95 percent of U.S. production, the authors noted. The researchers paired NASA and National Oceanic and Atmospheric Administration satellite records with data from a network of University of California weather stations, covering 32 consecutive winters. There was a great deal of variability from year to year, but on average, the researchers found a 46 percent drop in the number of fog days between the first of November and the end of February. Climate forecasts suggest that the accumulation of winter chill will continue to decrease in the Central Valley. Tule fog was also less prevalent in recent years in part due to the multi-year drought.

4.2.16 Severe Weather: Heavy Rain/Thunderstorm/Hail/Lightning/Wind

Hazard/Problem Description

Storms in the Fresno County planning area are generally characterized by heavy rain often accompanied by strong winds and sometimes lightning and hail. Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is three-quarters of an inch or greater, winds in excess of 50 knots (57.5 mph), or a tornado.

Hail is formed when water droplets freeze and thaw as they are thrown high into the upper atmosphere by the violent internal forces of thunderstorms. Hail is usually associated with severe storms within the Fresno County planning area. Hailstones are usually less than two inches in diameter and can fall at speeds of 120 miles per hour (mph). Severe hailstorms can be quite destructive, causing damage to roofs, buildings, automobiles, vegetation, and crops.

Lightning is defined as any and all of the various forms of visible electrical discharge caused by thunderstorms. Thunderstorms and lightning are usually (but not always) accompanied by rain. Cloud-to-ground lightning can kill or injure people by direct or indirect means. Objects can be struck directly, which may result in an explosion, burn, or total destruction. Or, damage may be indirect, when the current passes through or near an object, which generally results in less damage.

High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss. Windstorms in Fresno County are typically straight-line winds. Straight-line winds are generally any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 mph, that represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. These winds can overturn mobile homes, tear roofs off houses, topple trees, snap power lines, shatter windows, and sandblast paint from cars. Other associated hazards include utility outages, arcing power lines, debris blocking streets, dust storms, and an occasional structure fire. Tornadoes (see Section 4.2.18 Tornado) and funnel clouds can also occur during these types of storms.

Downslope Winds occur when warm/dry air descends rapidly down a mountain side. These types of winds may commonly occur just west of the Sierras. These winds can blow over 40 mph, and can occur in sudden gusts that are even stronger, which can make driving hazardous. In addition, their dry conditions increase the risk of wildfires in the area.

Santa Ana Winds occur when air from a region of high pressure over the dry, desert region of the southwestern U.S. flows westward towards low pressure located off the California coast. This creates dry winds that flow east to west through the mountain passages in Southern California closer to Los Angeles and San Diego, but may occasionally influence Fresno County. These winds are most common during the cooler months of the year, occurring from September through May. Santa Ana winds typically feel warm (or even hot) because as the cool desert air moves down the side of the mountain, it is compressed, which causes the temperature of the air to rise. These strong winds can cause major property damage. They also increase wildfire risk because of the dryness of the winds and the speed at which they can spread a flame across the landscape.

Extent

The National Weather Service classifies hail by diameter size, and corresponding everyday objects to help relay scope and severity to the population. Table 4.18 indicates the hailstone measurements utilized by the National Weather Service.

Table 4.18 Hail Measurements

Average Diameter	Corresponding Household Object
.25 inch	Pea
.5 inch	Marble/Mothball
.75 inch	Dime/Penny
.875 inch	Nickel
1.0 inch	Quarter
1.5 inch	Ping-pong ball
1.75 inch	Golf-Ball
2.0 inch	Hen Egg
2.5 inch	Tennis Ball
2.75 inch	Baseball
3.00 inch	Teacup
4.00 inch	Grapefruit
4.5 inch	Softball

Source: National Weather Service

The largest hailstones recorded in Fresno County had a diameter of 1.75 inches in 1957.

Lightning is measured by the Lightning Activity Level (LAL) scale, created by the National Weather Service to define lightning activity into a specific categorical scale. The LAL is a common parameter that is part of fire weather forecasts nationwide. The LAL is reproduced in Table 4.19.

Table 4.19 Lightning Activity Level Scale *

LIGHTNING ACTIVITY LEVEL	
LAL 1	No thunderstorms
LAL 2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period
LAL 3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.
LAL 4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent, 11 to 15 cloud to ground strikes in a five-minute period.
LAL 5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a five-minute period.
LAL 6	Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag warning.

Source: National Weather Service

Table 4.20 outlines the Beaufort scale, describing the damaging effects of wind speed.

Table 4.20 Beaufort Wind Scale

Wind Speed (mph)	Description—Visible Condition
0	Calm; smoke rises vertically
1-4	Light air; direction of wind shown by smoke but not by wind vanes
4-7	Light breeze; wind felt on face; leaves rustle; ordinary wind vane moved by wind
8-12	Gentle breeze; leaves and small twigs in constant motion; wind extends light flag
13-18	Moderate breeze; raises dust and loose paper; small branches are moved
19-24	Fresh breeze; small trees in leaf begin to sway; crested wavelets form on inland water
25-31	Strong breeze; large branches in motion; telephone wires whistle; umbrellas used with difficulty
32-38	Moderate gale whole trees in motion; inconvenience in walking against wind
39-46	Fresh gale breaks twigs off trees; generally, impedes progress
47-54	Strong gale slight structural damage occurs; chimney pots and slates removed
55-63	Whole gale trees uprooted; considerable structural damage occurs
64-72	Storm very rarely experienced; accompanied by widespread damage
73+	Hurricane devastation occurs

Source: NOAA

Fresno County is at risk to experience lightning in any of these categories.

Past Occurrences

Heavy rains and severe storms occur in the Fresno County planning area primarily during the late fall, winter, and spring, but have been documented in every month of the year. According to the Fresno County General Plan Background Report, the majority of precipitation is produced by storms during the winter months. Precipitation during the summer months is in the form of convective rain showers and is rare. Fresno County receives about 10 inches of rain per year. Snowstorms, hailstorms, and ice storms occur infrequently in the San Joaquin Valley and severe occurrences of any of these are very rare. Damaging winds often accompany winter storm systems moving through the area. Although summer winds are a frequent occurrence, with afternoon winds of 10 to 20 mph being common, it is the winds experienced during the winter storms that result in the most wind-related damage.

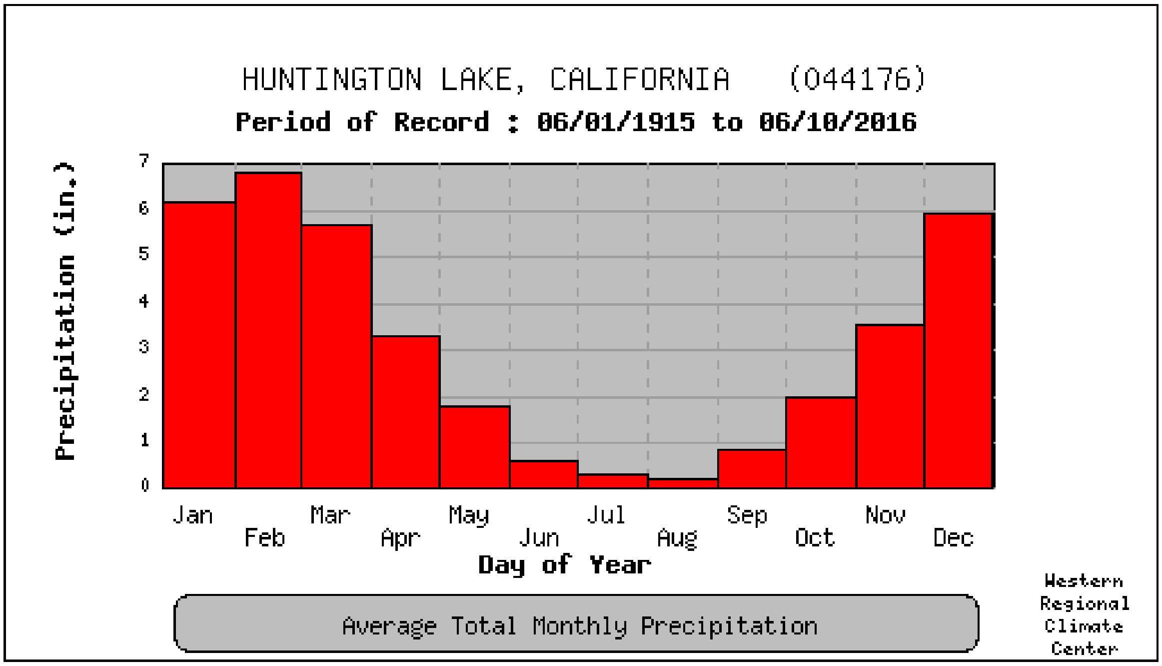
According to the HMPC, short-term, heavy storms can cause both widespread flooding as well as extensive localized drainage issues. With the increased growth of the area, the lack of adequate drainage systems has become more of an issue. In addition to the flooding that often occurs during these storms, strong winds, when combined with saturated ground conditions, can down very mature trees.

Information from the three representative weather stations introduced in Section 4.2.13 Severe Weather: General is summarized below and in Figure 4.38 through Figure 4.43.

Fresno County—East (Huntington Lake Weather Station, Period of Record 1948 to 2017)

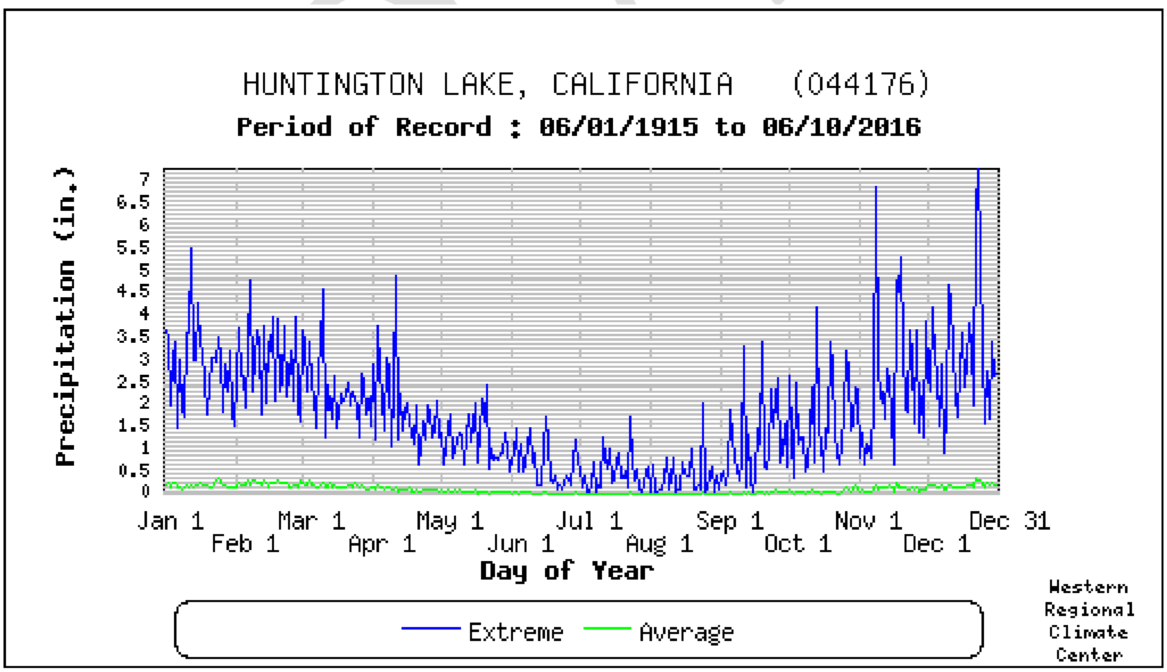
Average annual precipitation in the eastern portion of Fresno County is 41.35 inches per year. The highest recorded annual precipitation is 82.90 inches in 1982; the highest recorded precipitation for a 24-hour period is 7.28 inches on December 23, 1955. The lowest recorded annual precipitation is 19.38 inches in 1953.

Figure 4.38 Fresno County—East's Monthly Average Total Precipitation



Source: Western Regional Climate Center, www.wrcc.dri.edu/

Figure 4.39 Fresno County—East's Daily Precipitation Average and Extreme

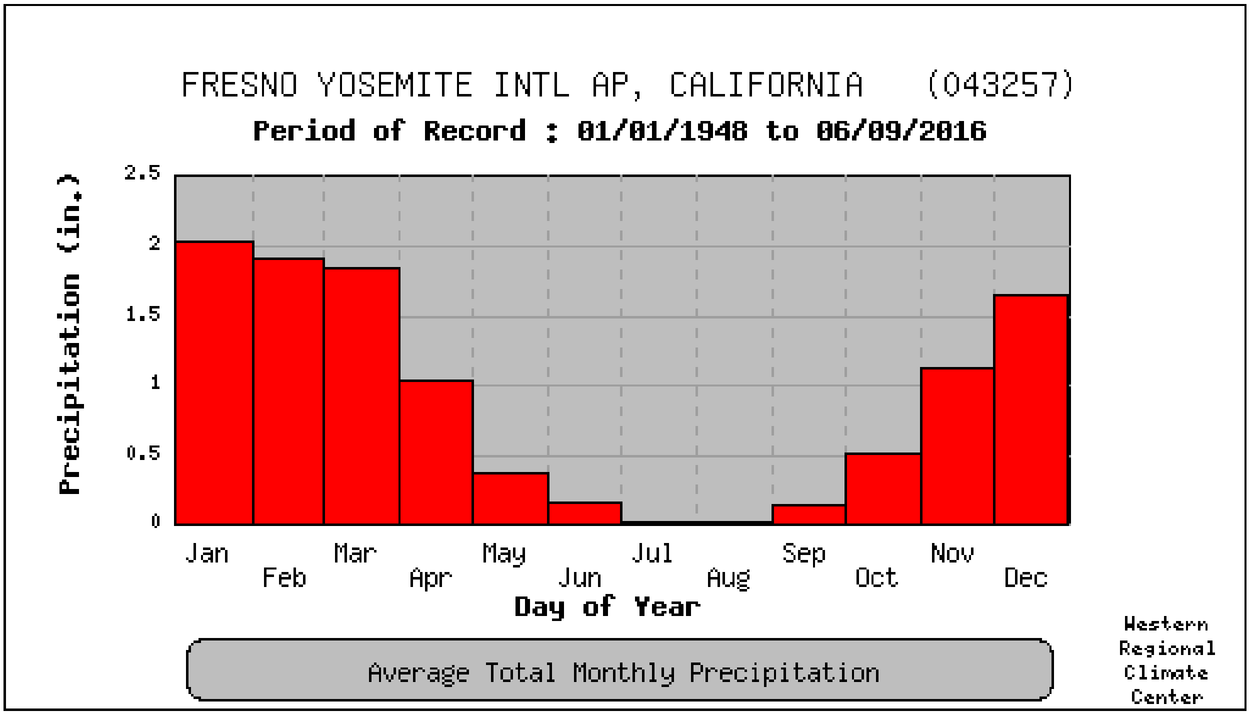


Source: Western Regional Climate Center, www.wrcc.dri.edu/

Fresno County—Central (Fresno WSO AP Weather Station, Period of Record 1948 to 2017)

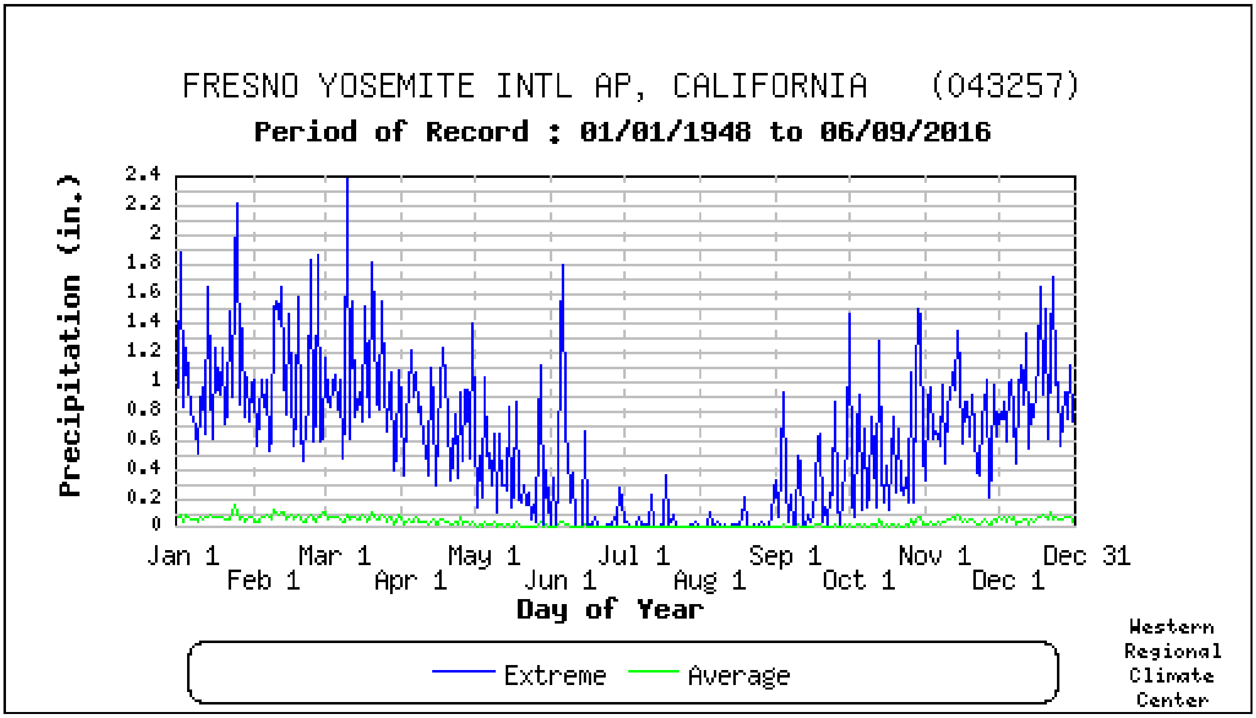
Average annual precipitation in the central portion of Fresno County is 10.90 inches per year. The highest recorded annual precipitation is 21.61 inches in 1983; the highest recorded precipitation for a 24-hour period is 2.38 inches on March 10, 1995. The lowest recorded annual precipitation is 6.07 inches in 1966.

Figure 4.40 Fresno County—Central's Monthly Average Total Precipitation



Source: Western Regional Climate Center, www.wrcc.dri.edu/

Figure 4.41 **Fresno County—Central's Daily Precipitation Average and Extreme**

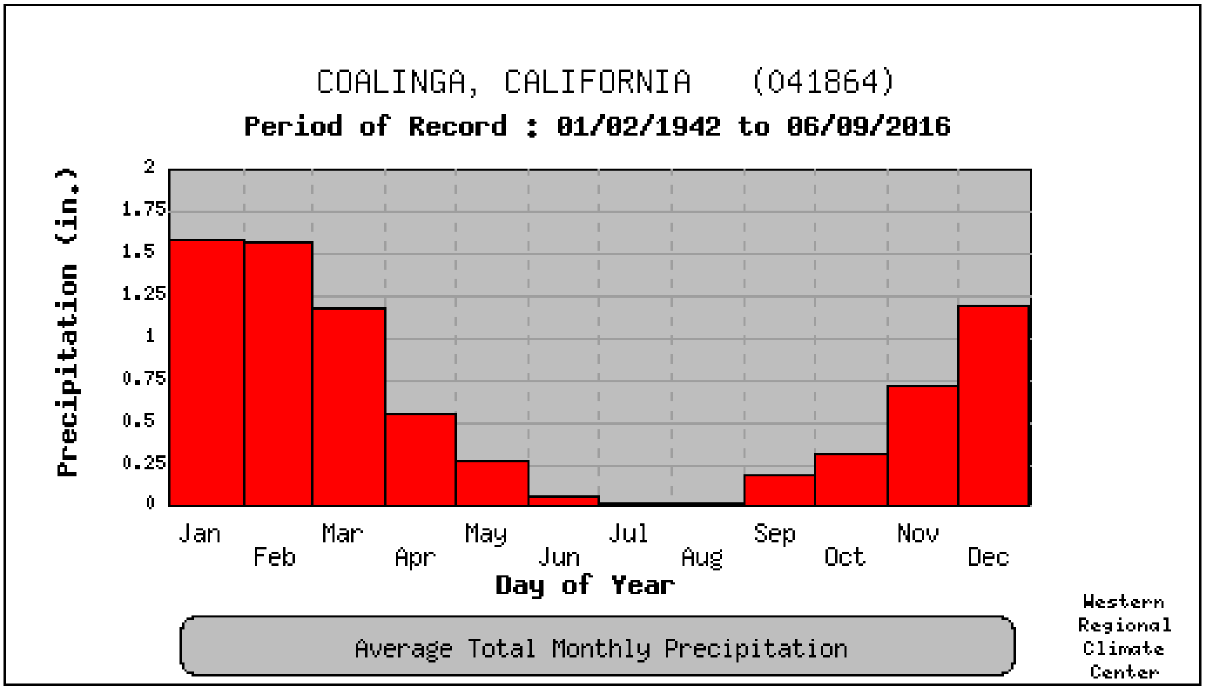


Source: Western Regional Climate Center, www.wrcc.dri.edu/

Fresno County—West (Coalinga Weather Station, Period of Record 1942 to 2017)

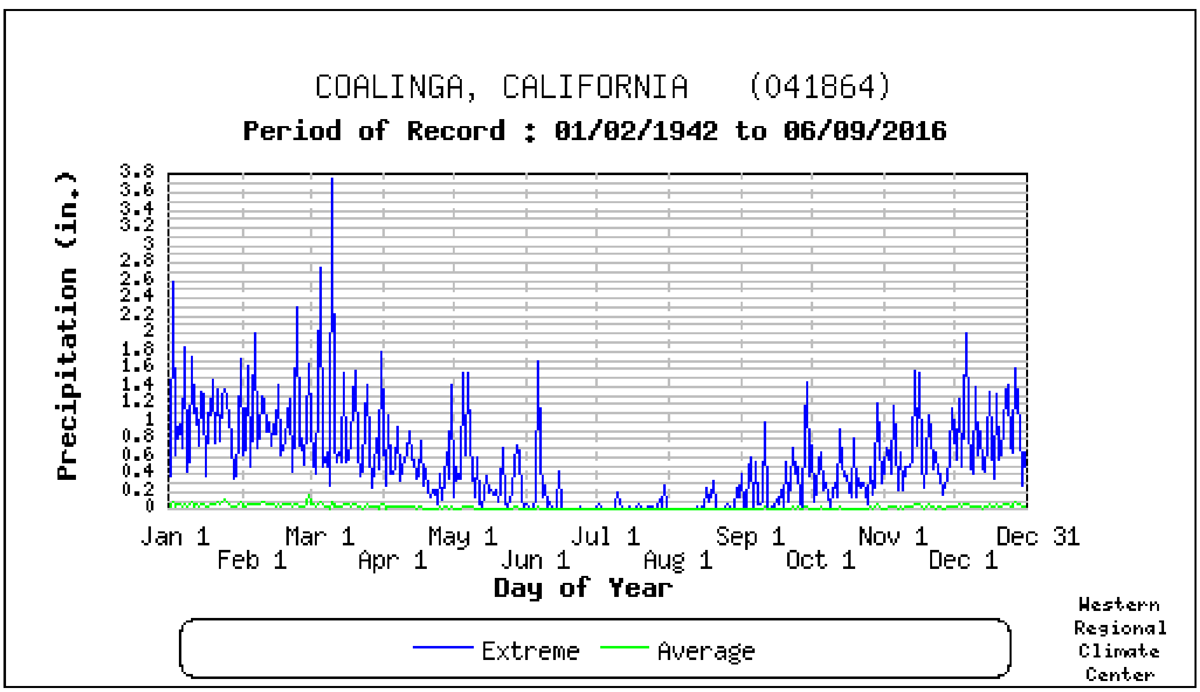
Average annual precipitation in the western portion of Fresno County is 7.69 inches per year. The highest recorded annual precipitation is 16.03 inches in 1998; the highest recorded precipitation for a 24-hour period is 3.74 inches on March 10, 1995. The lowest recorded annual precipitation is 1.98 inches in 1947.

Figure 4.42 Fresno County—West's Monthly Average Total Precipitation



Source: Western Regional Climate Center, www.wrcc.dri.edu/

Figure 4.43 Fresno County—West's Daily Precipitation Average and Extreme



Source: Western Regional Climate Center, www.wrcc.dri.edu/

High Wind Events

Also related to severe weather is the issue of dust storms caused by blowing dust during high wind events. Similar to fog conditions, blowing dust can cause extreme visibility problems resulting in traffic accidents. Given the agricultural nature of much of the planning area, recently plowed fields can create the potential for blowing dust and debris. The HMPC provided the following information on a deadly dust-related traffic accident:

- **November 29, 1991**—The day after Thanksgiving, furious winds stoked a huge dust storm on Interstate 5 in western Fresno County, reducing visibility to zero and causing multiple traffic collisions. At least 164 vehicles were involved in 33 collisions clustered along a two- mile segment of the highway. A total of 349 people were involved in the collisions; 17 were killed and 151 were injured.
- **April 14, 2009**-- Another short-lived upper-level ridge built into California on April 11th-12th, then gave way to a mostly dry system that reached California on the 13th. This cold front brought strong winds to the west side of the San Joaquin Valley on April 14th, with dust storms occurring near Coalinga and Avenal. Both dust storms produced areas of near-zero visibility. Winds gusted to 41 mph at Meadows Field Bakersfield and to 35 mph at Fresno-Yosemite International Airport. The gusts at Meadows Field were only 4 mph less than the ASOS-era record for April of 45 mph, set on April 3rd, 1999. (Because the ASOS measures winds in a different manner than older anemometers, wind records for ASOS sites only go back to the date the ASOS was commissioned).

  On the 14th at 1425 PDT, the California Highway Patrol reported blowing dust at Avenal cutoff on I-5 with near-zero visibility. The CHP determined it caused a traffic collision along Interstate 5. No fatalities were reported although several people were injured. Winds continued to gust to 35 mph through the morning of April 15th, and spread across the central Valley to the cities of Merced and Atwater. The winds then abated a bit, but increased again the next day. A gust to 40 mph was measured at Fresno-Yosemite International Airport on April 16th, only 1 mph less than the ASOS-era record gust for April of 41 mph on April 14th, 2002.

  The storm brought only a trace of rain to Fresno and Bakersfield. The highest reported rainfall was only 0.06 inch at Mariposa Grove in the Southern Sierra Nevada southeast of Wawona.
- **June 4, 2012--** Wind gusted up to 40 mph on the San Joaquin Valley floor, and to around 50 mph in the Kern County mountains and deserts. The strongest gust at Fresno-Yosemite International Airport 40 mph tied the record for the strongest gust for the month of June, last set on June 10th, 2008. Blowing dust reduced visibilities to a quarter mile or less at times, and occasionally to near zero, on the Valley floor. A haboob (significant dust storm) accompanying a cold front occurred across the eastern side of the San Joaquin Valley causing near-zero visibility and reports of power outages (6000 customers without power in Fresno county) and downed trees in Fresno, Hanford, and Visalia. A 10-car pileup occurred on CA-99 near Delano (Kern County) at 1700 PDT.

The storm moved east of the central California interior on June 5th. Behind the upper-level trough, northwest winds aloft aligned with the passes and canyons of the Kern County mountain to generate strong wind gusts during the afternoon of June 5th. Winds gusted to 61 mph at the mouth of Jawbone Canyon and to 51 mph on the desert floor north of Mojave. The strongest winds occurred at Bird Springs Pass (elevation 7400 feet) about 10 miles southeast of Weldon in the Tehachapi Mountains. Here winds gusted up to 85 mph between 2 and 3 am on the 5th.

- **April 14, 2015**-- An upper level trough of low pressure moved onshore on April 14th resulting in wind gusts of 45-60 MPH. An area of dust and dirt was lifted into the atmosphere, reducing visibility to near zero across Highway 180 near Fresno. The reduced visibility lead to a seven-car crash causing minor injuries and a closure of the roadway for a few hours. Blowing dust reduced visibility to nearly zero along Highway 180, near Fresno, causing two multi-car accidents.

Figure 4.44 Fresno County Wind Events Map

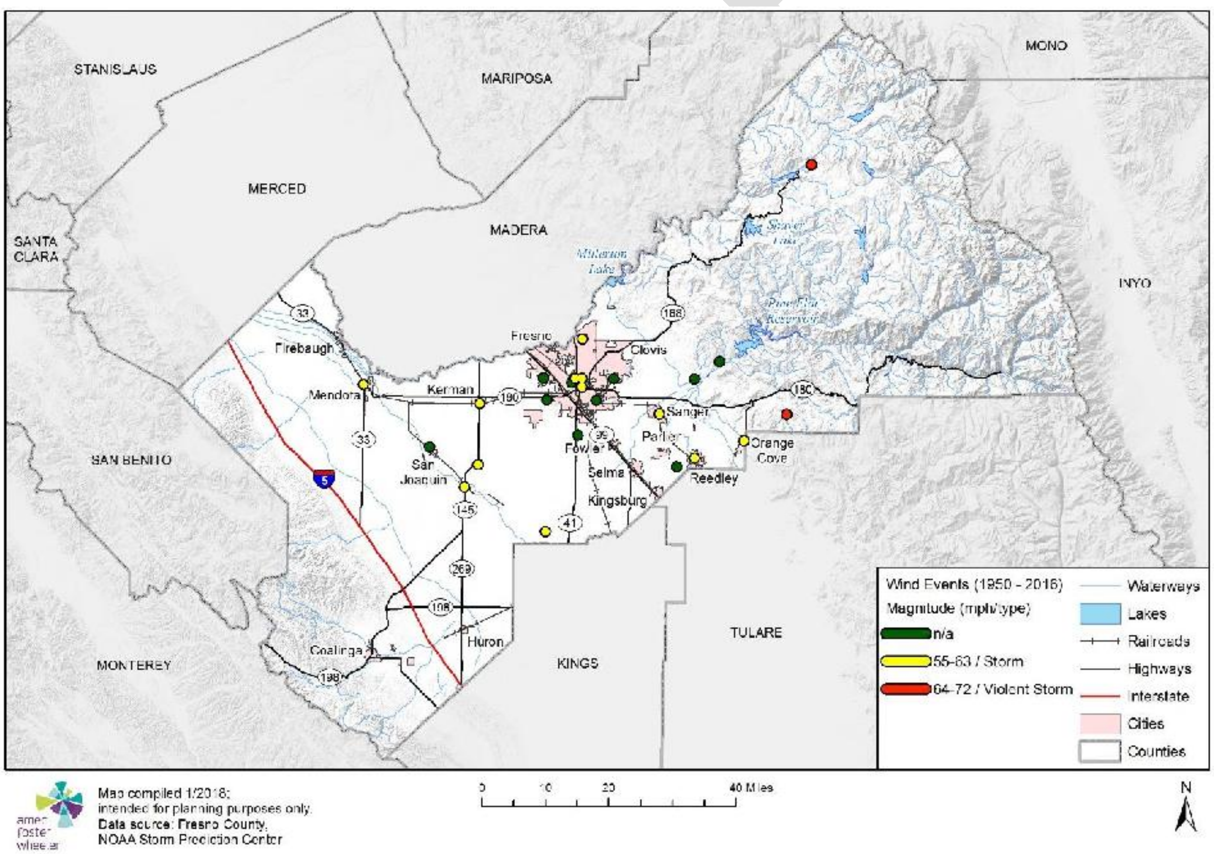


Table 4.21 Fresno County Wind Events Table

Date	Jurisdiction	Magnitude (mph)	Fatality	Injury	Property Loss	Crop Loss
1958-04-03	Fresno	0	0	0	$0	$0
1958-07-28	Fresno	0	0	0	$0	$0
1958-07-28	Unincorporated	0	0	0	$0	$0
1984-05-29	Fresno	0	0	0	$0	$0
1994-05-30	Fresno	0	1	0	$0	$0
1995-05-01	Unincorporated	0	0	0	$500,000	$0
1995-05-01	Unincorporated	0	0	0	$500,000	$0
1995-05-13	Unincorporated	0	0	0	$0	$0
1995-06-15	Unincorporated	0	0	0	$500,000	$0
1996-10-30	Unincorporated	0	0	0	$10,000	$0
1998-02-14	Fresno	57.5	0	0	$0	$0
1998-02-23	Fresno	0	0	0	$100,000	$0
2001-04-20	Fresno	57.5	0	0	$0	$0
2002-05-31	Unincorporated	0	0	0	$50,000	$0
2002-05-31	Unincorporated	0	0	0	$50,000	$0
2006-07-21	Unincorporated	69	0	0	$0	$0
2007-10-29	Fresno	57.5	0	0	$30,000	$0
2007-10-29	Fresno	57.5	0	0	$50,000	$0
2007-10-29	Fresno	57.5	0	0	$10,000	$0
2008-01-27	Unincorporated	64.4	0	0	$50,000	$0
2008-03-15	Mendota	57.5	0	0	$10,000	$0
2009-05-28	Fresno	57.5	0	0	$0	$0
2009-05-28	Reedley	57.5	0	0	$0	$0
2009-05-28	Sanger	57.5	0	0	$0	$0
2009-05-28	Unincorporated	57.5	0	0	$60,000	$0
2009-05-28	Unincorporated	57.5	0	0	$0	$0
2009-06-05	Unincorporated	59.8	0	0	$0	$0
2009-06-05	Unincorporated	59.8	0	0	$0	$0
2012-04-13	Kerman	57.5	0	0	$50,000	$30,000
2014-02-28	Unincorporated	64.4	0	0	$500,000	$0
		Total	**1**	**0**	**$2,470,000**	**$30,000**

Likelihood of Future Occurrences

Highly Likely—Heavy rain, thunderstorms, hail, lightning, and wind are well-documented seasonal occurrences that will continue to occur annually in the Fresno County planning area.

Climate Change Considerations

Pacific Northwest National Laboratory researchers found that atmospheric rivers will reach the West Coast more frequently if greenhouse gas pollution continues to rise sharply. Currently, the West receives rain or snow from these atmospheric rivers between 25 and 40 days each year. By the end of this century, days on which the atmospheric rivers reach the coast could increase by a third this century, between 35 and 55 days a year. Meanwhile, the number of days each year on which the atmospheric rivers bring "extreme" amounts of rain and snow to the region could increase by more than a quarter.

4.2.17 Severe Weather: Winter Storm

Hazard/Problem Description

Winter snow storms can include heavy snow, ice, and blizzard conditions. Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse roofs and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. The cost of snow removal, damage repair, and business losses can have a tremendous impact on cities and towns.

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days until damage can be repaired. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

Some winter storms are accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chills. Strong winds with these intense storms and cold fronts can knock down trees, utility poles, and power lines. Blowing snow can reduce visibilities to only a few feet in areas where there are no trees or buildings. Serious vehicle accidents can result and cause injuries and deaths.

The central and western portions of the Fresno County planning area generally do not experience snowfall on a seasonal basis; however, the higher elevations in the eastern portion of the County receive an abundance of snow, mostly between the months of November through April. Winter snow storms in this part of the County, including strong winds and blizzard conditions, can result in localized power and phone outages and closures of streets, highways, schools, business, and nonessential government operations. People can also become isolated from essential services in their homes and vehicles. Snow removal costs can impact budgets significantly. Heavy snowfall during winter can also lead to flooding or landslides during the spring if the area snowpack melts too quickly.

Extent

The extent of winter storms and cold that cause issues in Fresno County includes storms forecasted to be Winter Storm Warnings, Wind Chill Warnings or Blizzard Warnings. These storms would be confined to the Sierra Mountains within Fresno County. Heavy snows, or a combination of snow, freezing rain or extreme wind chill due to strong wind, may bring widespread or lengthy road closures and hazardous travel conditions, plus threaten temporary loss of community services such as power and water. Deep snow and additional strong wind chill or frostbite may be a threat to even the appropriately dressed individual or to even the strongest person exposed to the frigid weather for only a short period.

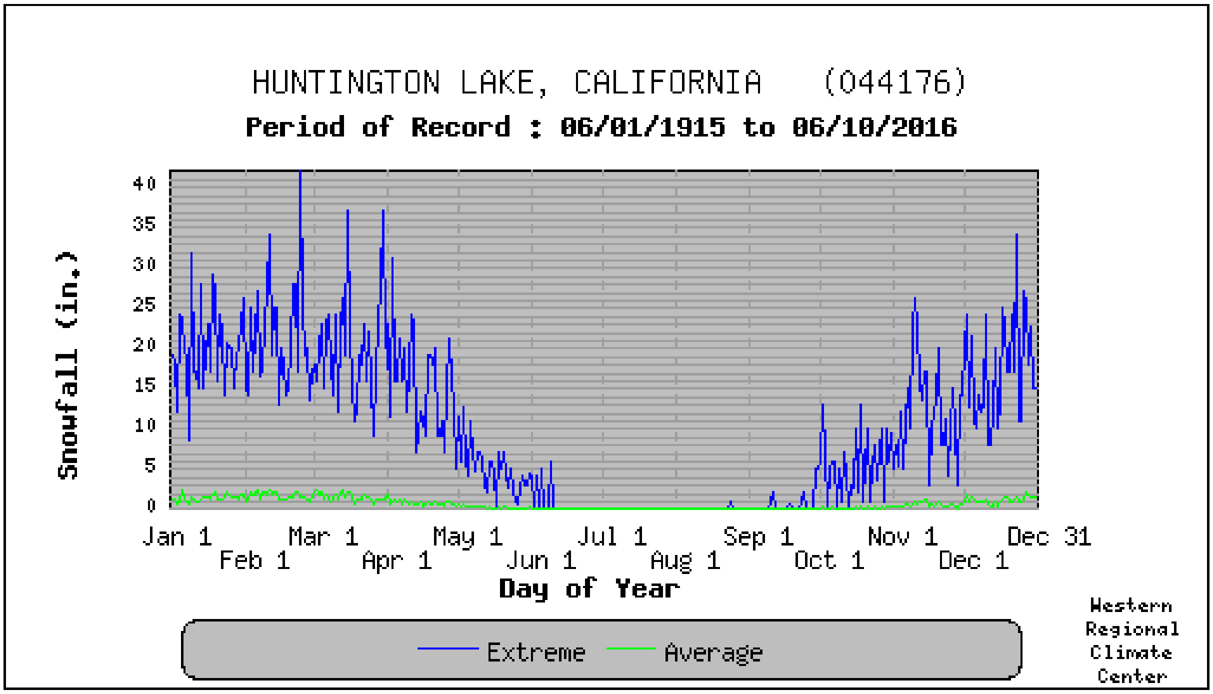
Past Occurrences

Information from the three representative weather stations introduced in Section 4.2.13 Severe Weather: General is summarized below.

Fresno County—East (Huntington Lake Weather Station, Period of Record 1948 to 2007)

Average annual total snowfall for the eastern portion of Fresno County is 183.2 inches. The snowiest months include December, January, February, and March, with 29.4, 35.2, 36.9, and 38.6 average inches of snow, respectively. April follows close behind with an average snowfall of 23.2 inches. The highest annual snowfall on record was 488 inches in 1968-69. The highest recorded monthly snowfall for the period of record was 191 inches in February 1969. The average snow depth ranges from 3 inches in November and May to 40 inches in February. Figure 4.45 illustrates the Daily Snowfall Average and Extreme for the Huntington Lake Weather Station in eastern Fresno County.

Figure 4.45 Fresno County—East's Daily Snowfall Average and Extreme



Source: Western Regional Climate Center, www.wrcc.dri.edu/

Fresno County—Central (Fresno WSO AP Weather Station, Period of Record 1948 to 2007)

Snow in central Fresno County is quite rare. During the period of record, snow fell only four times: 0.10 inches in January 1957, 2.2 inches in January 1962, 1.2 inches in December 1968, and 0.5 inches in December 1998.

Fresno County—West (Coalinga Weather Station, Period of Record 1942 to 2007)

Snow in western Fresno County is even rarer than in central Fresno County. During the period of record, snow fell only once: five inches were recorded in January of 1957.

The Fresno County Office of Emergency Services is not aware of any incidents where snow caused enough damage to declare a countywide emergency. According to the HMPC, the following winter snow event impacted the eastern portion of the Fresno County planning area:

- **January 2005**—Heavy wet snow fell in eastern Fresno County above 4,000 feet resulting in a regionwide closure of roads and loss of power for up to three weeks in three communities. Eight injuries were reported due to vehicle accidents from poor road conditions. Property damage was estimated at $3.5 million from trees falling on homes, cabins, and out buildings. Infrastructure damage was estimated at $2.5 million to the power distribution grid and $250,000 to the road system. An estimated 10-15,000 merchantable trees were damaged or destroyed. Most roads in the area were closed for three weeks; schools were closed for two weeks.

- **March 2011-** The last major storm of the month arrived on March 24th. This storm brought gusts to 45 mph to the west side of the San Joaquin Valley, and gusts to 65 mph in the Kern County mountains and deserts. Convective activity was limited to near Merced, with several reports of road flooding due to the already saturated ground. Thunderstorms and showers moved east into the foothills of Madera and Mariposa Counties, where the heavy rains triggered rock and mud slides. Mainly light showers occurred southward. The trough moved east of the region on the 25th, with residual light showers in its wake. Additional light snow fell in the Southern Sierra Nevada measuring around 5 inches or less. Local media reported that the roof of a vacant store at Shaver Lake collapsed on March 26th due to 6 feet of snow accumulation on the roof.
- **April 2012-** An upper-level short-wave moved into California on April 10th, flattening the ridge. This set the stage for back-to-back strong storms to move through the central California interior on the 11th, 12th, and 13th. Each storm triggered severe thunderstorms over the central and southern San Joaquin Valley with hail up to 1.75 inches in diameter. Tallies of agricultural and crop loss approached 100 million dollars due to the extensive hail damage across Kings, Tulare, Fresno, and Merced counties. Funnel clouds were observed, although none touched down. The first storm brought up to a foot of snow to the Southern Sierra Nevada, and the second colder storm dropped up to 30 inches of snow at Lodgepole in Sequoia National Park.

Likelihood of Future Occurrences

Highly Likely—Snow in the eastern region of the County is a well-documented seasonal occurrence that will continue to occur annually.

Climate Change Considerations

Climate change has the potential to exacerbate the severity and intensity of winter storms, including potential heavy and intense amounts of snow. A warming climate may also result in warmer winters, the benefits of which may include lower winter heating demand, less cold stress on humans and animals, and a longer growing season. However, these benefits are expected to be offset by the negative consequences of warmer summer temperatures.

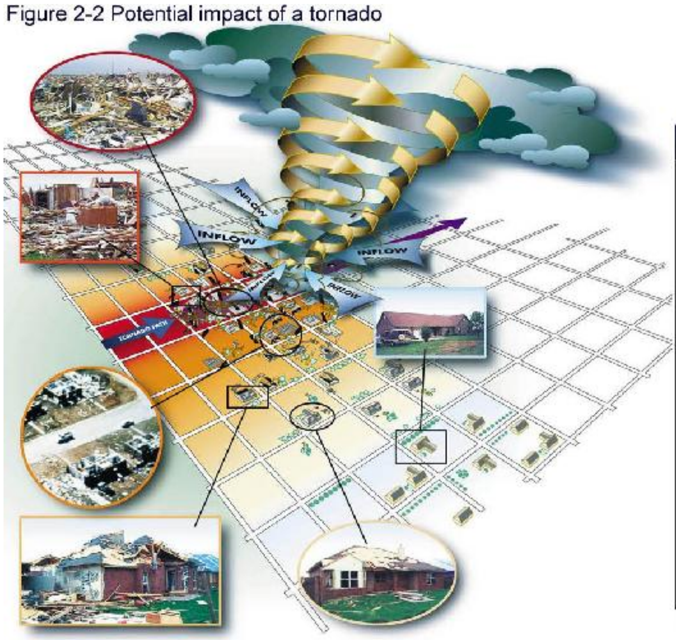
4.2.18 Severe Weather: Tornado

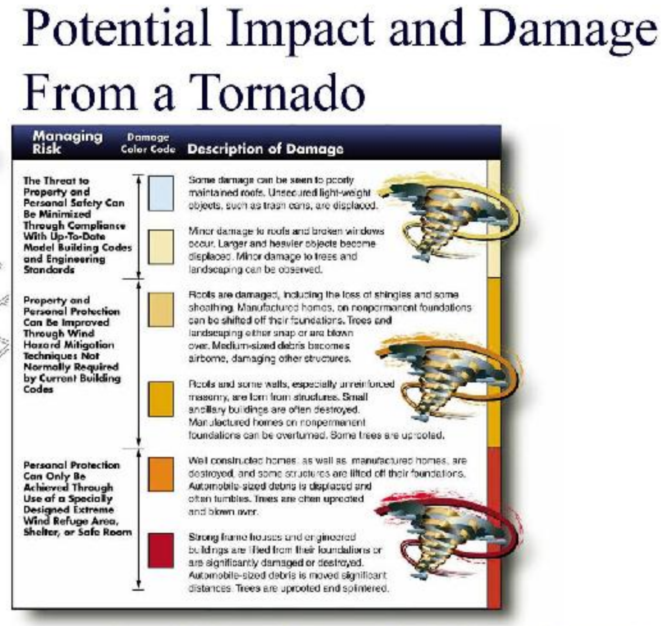
Hazard/Problem Description

Tornadoes are another severe weather hazard that can affect the Fresno County planning area, primarily during the rainy season. Tornadoes form when cool, dry air sits on top of warm, moist air. Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes are the most powerful storms that exist. They can have the same pressure differential that fuels 300-mile-wide hurricanes across a path only 300-yards wide or less. Figure 4.46 illustrates the potential impact and damage from a tornado. With additional heat in the atmosphere storms are projected to become more severe in the future, and thus lightning may become more prevalent.

Figure 4.46 Potential Impact and Damage from a Tornado

Figure 2-2 Potential impact of a tornado





Potential Impact and Damage From a Tornado

Managing Risk	Damage Color Code	Description of Damage
The Threat to Property and Personal Safety Can Be Minimized Through Compliance With Up-To-Date Model Building Codes and Engineering Standards		Some damage can be seen to poorly maintained roofs. Unsecured light-weight objects, such as trash cans, are displaced.
		Minor damage to roofs and broken windows occur. Larger and heavier objects become displaced. Minor damage to trees and landscaping can be observed.
Property and Personal Protection Can Be Improved Through Wind Hazard Mitigation Techniques Not Normally Required by Current Building Codes		Roofs are damaged, including the loss of shingles and some sheathing. Manufactured homes, on nonpermanent foundations can be shifted off their foundations. Trees and landscaping either snap or are blown over. Medium-sized debris becomes airborne, damaging other structures.
		Roofs and some walls, especially unreinforced masonry, are torn from structures. Small ancillary buildings are often destroyed. Manufactured homes on nonpermanent foundations can be overturned. Some trees are uprooted.
Personal Protection Can Only Be Achieved Through Use of a Specially Designed Extreme Wind Refuge Area, Shelter, or Safe Room		Well constructed homes, as well as manufactured homes, are destroyed, and some structures are lifted off their foundations. Automobile-sized debris is displaced and often tumbles. Trees are often uprooted and blown over.
		Strong frame houses and engineered buildings are lifted from their foundations or are significantly damaged or destroyed. Automobile-sized debris is moved significant distances. Trees are uprooted and splintered.

Figure 2-2 Potential damage table for impact of a tornado

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 4.22 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity. Table 4.23 shows the wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 4.22 Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 4.23 Enhanced Fujita Scale

Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Tornadoes can cause damage to property and loss of life. While most tornado damage is caused by violent winds, most injuries and deaths result from flying debris. Property damage can include damage to buildings, fallen trees and power lines, broken gas lines, broken sewer and water mains, and the outbreak of fires. Agricultural crops and industries may also be damaged or destroyed. Access roads and streets may be blocked by debris, delaying necessary emergency response.

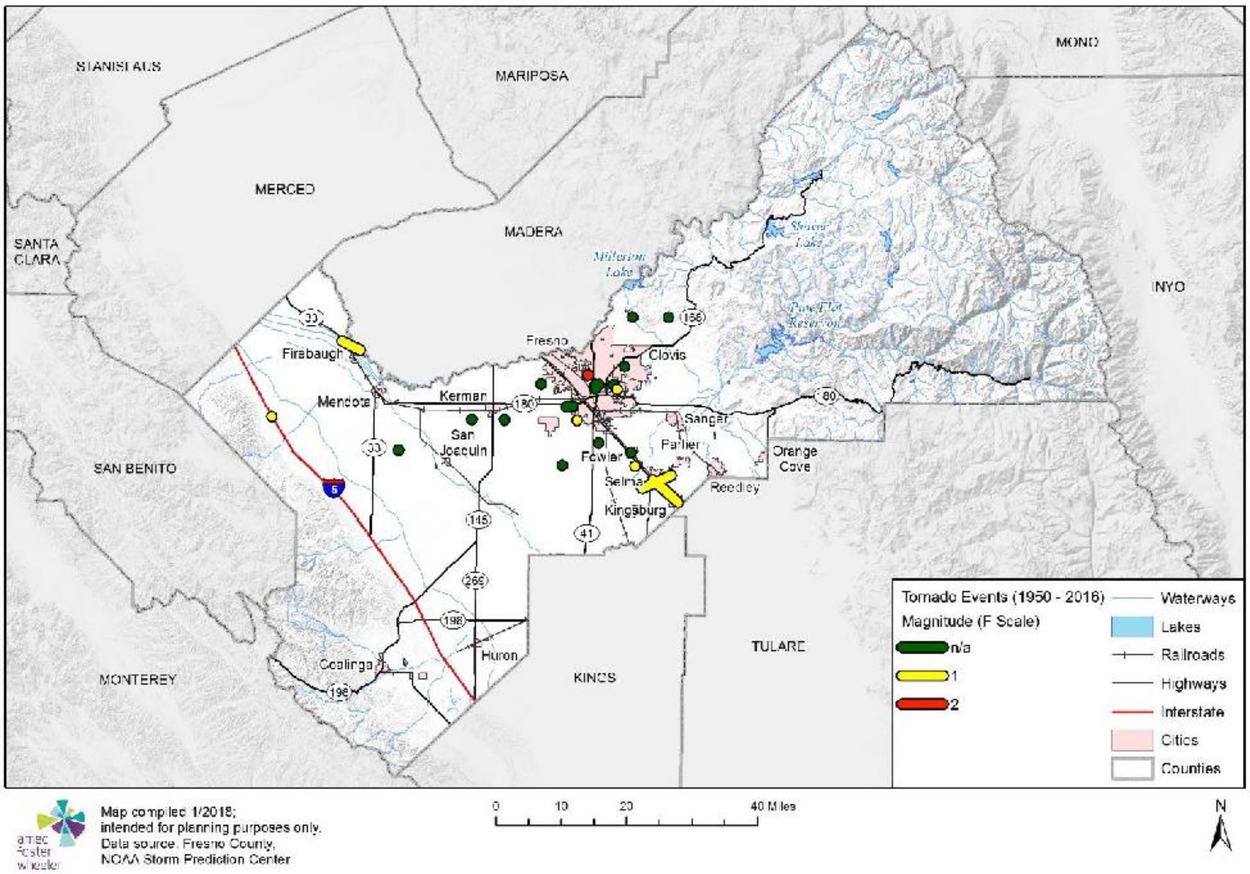
Extent

The majority of tornadoes in the past in Fresno County have been F0 and F1. Large tornadoes are possible, however. Should the County be hit by an EF-4 or EF-5 tornado, it can be extrapolated that because of its relative size and the potential size and length of a tornado's path a significant portion of the County could be impacted, resulting in property and crop damage and loss of life.

Past Occurrences

Based on data from 1950 to1995, California ranks 32nd among the 50 states for frequency of tornadoes, 36th for injuries, and 31st for cost of damage. When compared to other states by the frequency per square mile, California ranks 44th for frequency and injuries per area and 40th for cost of damage per area. Figure 4.47 shows tornados that have affected the County using NOAA data from 1950 to 2016.

Figure 4.47 Fresno County Tornadoes, 1950-2016



According to the HMPC, during the rainy season, the Fresno County planning area is prone to relatively strong thunderstorms, sometimes accompanied by funnel clouds and tornadoes. While tornadoes do occur occasionally, most often they are of F0 or F1 intensity. Documented incidents of tornadoes in the Fresno County planning area from the NCEI Storm Events Database are listed in Table 4.24.

Table 4.24 Fresno County's Tornadoes, 1950-2017

Type	# of Events	Property Loss ($)	Deaths	Injuries
Tornado: F0	18	230,000	0	0
Tornado: F1	7	5,205,050	0	3
Tornado: F2	1	5,000	0	0
Totals	**26**	**5,440,050**	**0**	**0**

Source: National Center for Environmental Information Storm Events Database

Likelihood of Future Occurrences

Occasional—Twenty-six tornadoes occurred in Fresno County over 68 years of record keeping, which equates to one tornado every 2.6 years, on average, and a 38.2 percent chance of a tornado occurring in any given year. Historical tornadic activity within the planning area indicates that the area will likely continue to experience the formation of funnel clouds and low intensity tornadoes during adverse weather conditions. The actual risk to the County is dependent on the nature and location of any given tornado.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of change that climate change may have related to tornado frequency and intensity. NASA's Earth Observatory has conducted studies which aim to understand the interaction between climate change and tornadoes. Based on these studies meteorologists are unsure why some thunderstorms generate tornadoes and others don't, beyond knowing that they require a certain type of wind shear. Tornadoes spawn from approximately one percent of thunderstorms, usually supercell thunderstorms that are in a wind shear environment that promotes rotation. Some studies show a potential for a decrease in wind shear in mid-latitude areas. Because of uncertainty with the influence of climate change on tornadoes, future updates to the mitigation plan should include the latest research on how the tornado hazard frequency and severity could change. The level of significance of this hazard should be revisited over time.

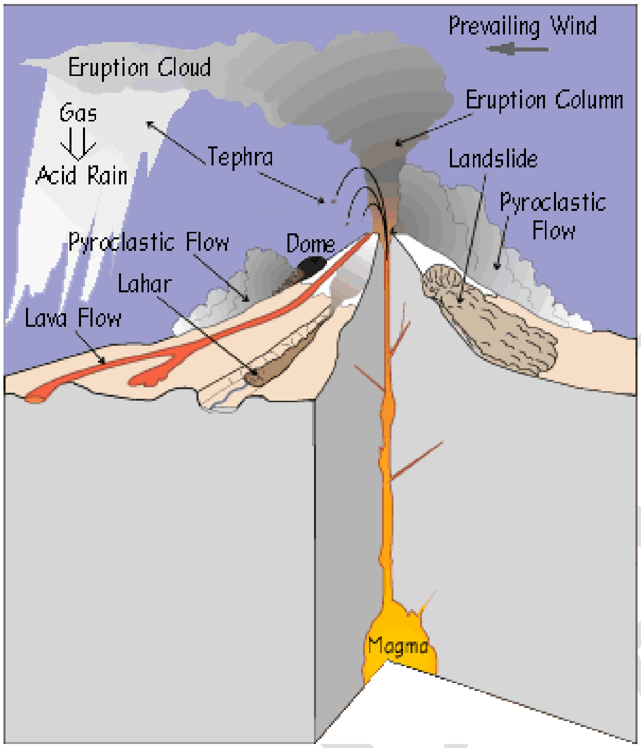
4.2.19 Volcano

Hazard/Problem Description

Of the almost 70 active and potentially active volcanoes in the United States, more than 50 have erupted one or more times in the past 200 years. Volcano hazards are the greatest in five western states: Alaska, Hawaii, California, Oregon, and Washington. Volcanoes create a wide variety of hazards that can kill people and destroy property.

Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows; although, large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Volcanic ash can also travel and affect populations many miles away. The ash from the 1980 eruption of Mount St. Helens in Washington fell over a large area of the western United States. Heavy ash fall can collapse buildings, and even minor ash fall can damage crops, electronics, and machinery. Some volcanic hazards, such as landslides, can occur even when a volcano is not erupting. Figure 4.48 depicts a volcano typical of those found in the western United States.

Figure 4.48 Typical Wester U.S. Volcano



Source: http://pubs.usgs.gov/fs/fs002-97/

The State of California Multi-Hazard Mitigation Plan identifies volcanoes as one of the hazards that can adversely impact the state. However, there have been few losses in California from volcanic eruptions. Of the approximately 20 volcanoes in the state, only a few are active and pose a threat.

Extent

The Fresno County General Plan Background Report identifies the Mono Lake-Long Valley area located adjacent to the north and east of the northernmost areas of Fresno County as the only known volcanic hazard to Fresno County. The Long Valley area is considered to be an active volcanic region of California and includes features such as the Mono-Inyo Craters, Long Valley Caldera, and numerous active and potential faults. Figure 4.49 shows volcanoes in or near California and the location of the Long Valley area relative to the Fresno County planning area.

Figure 4.49 Volcanoes In or Near California

Populations living near volcanoes are most vulnerable to volcanic eruptions and lava flows, although volcanic ash can travel and affect populations many miles away and cause problems for aviation. Based on information in the background report, the Fresno County planning area is susceptible to various hazards associated with its proximity to the Long Valley area as further described below.

Volcanic Flows

Two mildly explosive volcanic vents are located three to four miles from northernmost Fresno County, northwest of Duck Lake. In the event of an eruption, flows or debris from the vents would likely flow predominantly southwest approximately parallel to the North Fork of the San Joaquin River in Madera County. Lava flows, steam blasts, or base surges could occur in the northernmost tip of Fresno County. The northern portions of the Silver Divide (including Duck Lake and Fish Creek) could be subject to lava flows. However, this area of the County is mostly unpopulated and not easily developable as it is situated in the high peaks of the Sierra Nevada. Thus, potential safety hazards would be limited to backcountry visitors.

Ash

With most volcanic eruptions, a significant amount of ash is released into the atmosphere. The location and thickness of ash in any given area is generally a function of the volume erupted and wind speed and direction. Based on historical wind directions and wind speeds, most volcanic ash from a volcanic eruption of Long Valley would be deposited east of the volcano. Looking at historical data from past ash falls, the majority of ash beds from volcanic eruptions in California lie east of their source vents. Other studies of Mount Rainier and Mount St. Helens show that more than 90 percent of the ash beds deposited from volcanic eruptions during the last 10,000 years lie to the east of those volcanoes. This data suggests that most ashfall from future eruptions, including those from Long Valley, would also be deposited to the east of the source.

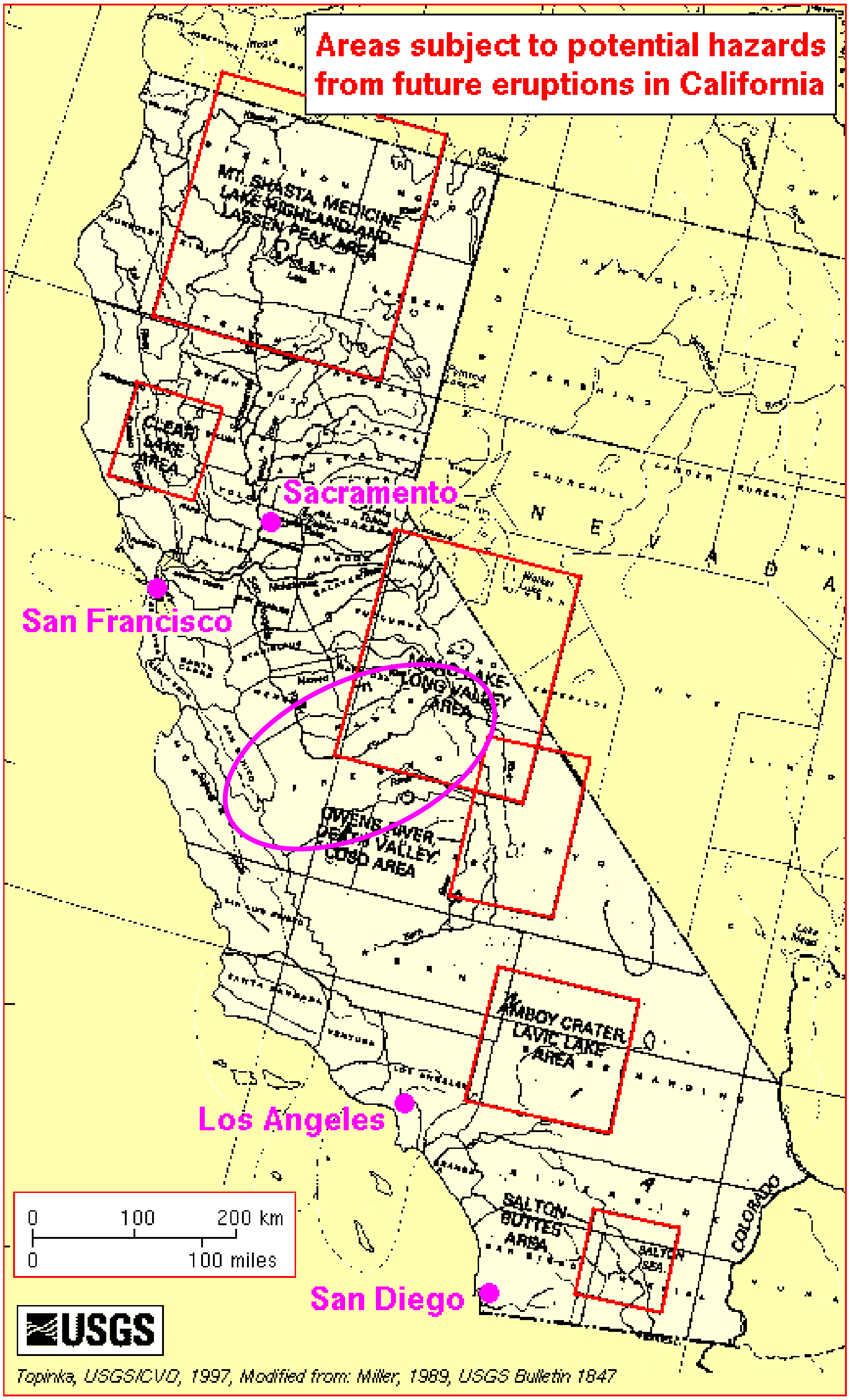
According to a worst-case scenario provided in the background report, geologists estimate that the South Fork of the San Joaquin River, Mono Creek, Margaret Lakes, Duck Lake, Fish Creek, Lake Thomas A. Edison, Bear Creek, Lake Italy, and the town of Mono Hot Springs could be subject to eight inches or more of compacted ash from an eruption at Long Valley. It only takes up to five inches of ash to stop an automobile engine. These areas, in addition to Kaiser Creek and Three Island Lake, could also be affected by hot pyroclastic flows. It is further estimated that up to two inches of ash could fall within a 50-mile radius of the eruption, potentially affecting the areas of Auberry, Prather, Meadow Lakes, Pine Ridge, Tollhouse, Dinkey Creek, Humphreys Station, Courtright Reservoir, Pine Flat Reservoir, and numerous small lakes, creeks, and streams.

Resulting Floods and Mudflows

An eruption on the western slope of Mammoth Mountain (on the rim of the Long Valley Caldera) in the winter could also cause hot mudflows to mix with melting snow and rock debris, creating the possibility of severe flood conditions in the San Joaquin River drainage system, endangering people, dams, and other property as it moves downstream.

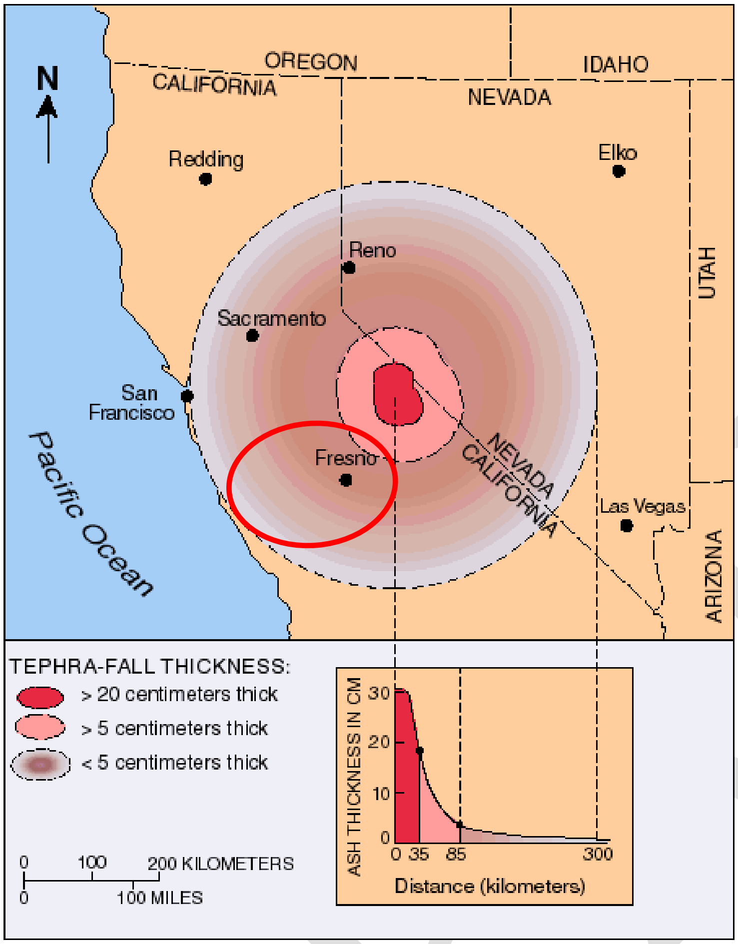
Figure 4.50 illustrates areas subject to potential volcanic hazards from future eruptions in California and supports the conclusion that the planning area is potentially at risk to volcanic activity from the Long Valley area. The ash dispersion map that follows (Figure 4.51) also illustrates the extent to which the planning area may be affected by ash fallout in the event of renewed volcanic activity in the area.

Figure 4.50 Areas Subject to Potential Volcanic Hazards from Future Eruptions in California



Source: U.S. Geological Survey, Cascades Volcano Observatory, http://vulcan.wr.usgs.gov/Volcanoes/California/

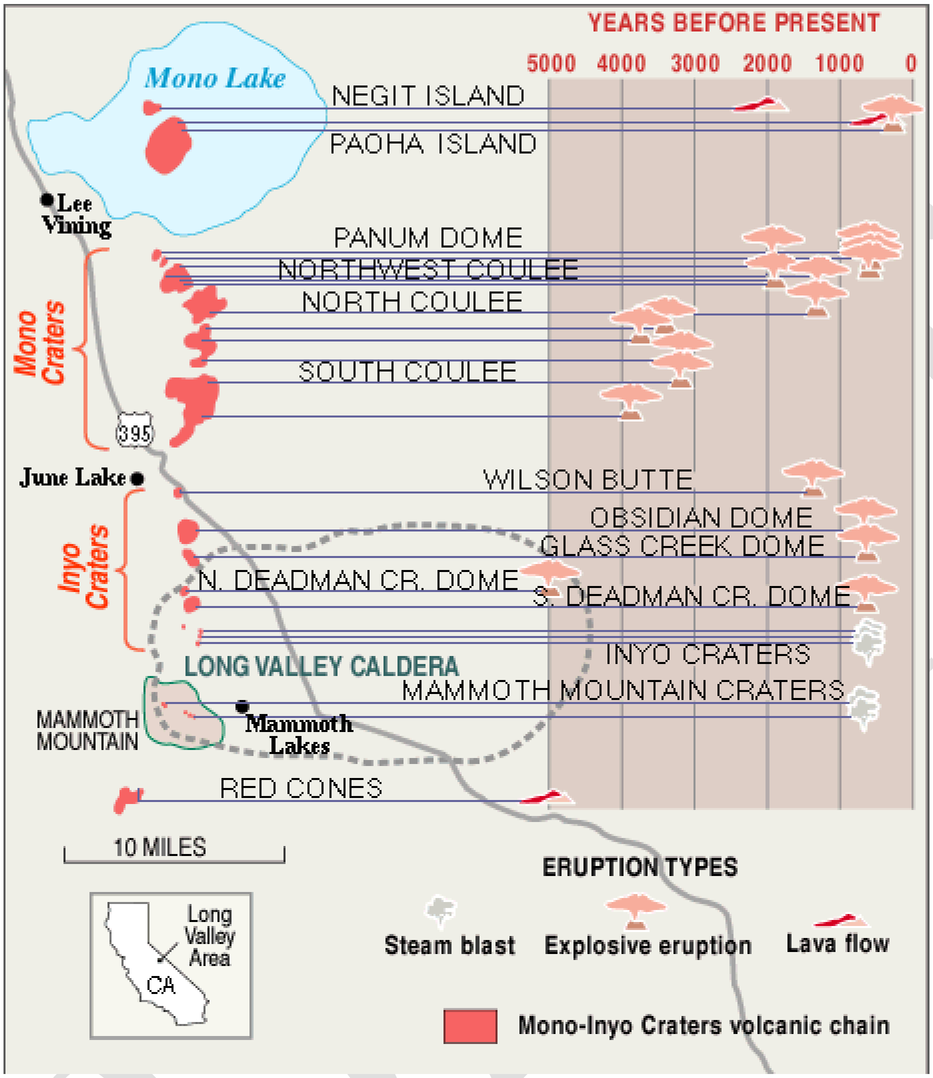
Figure 4.51 Volcanic Hazards Ash Dispersion Map for the Long Valley Caldera



Past Occurrences

During the past 1,000 years there have been at least 12 volcanic eruptions in the Long Valley area. Volcanoes in the Mono-Inyo Craters volcanic chain, which extends from just south of Mammoth Mountain to the north shore of Mono Lake, have erupted often over the past 40,000 years. Over the past 5,000 years, small to moderate eruptions have occurred at various sites along the Mono-Inyo Craters volcanic chain at intervals ranging from 250 to 700 years (see Figure 4.52).

Figure 4.52 Volcanic Activity in the Mono-Inyo Craters Volcanic Chain of the Past 5,000 Years



Source: U.S. Geological Survey, http://pubs.usgs.gov/fs/fs073-97/eruptions.html

In 1980, four large earthquakes (greater than magnitude 6 on the Richter Scale) and numerous relatively shallow earthquakes occurred in the area. Since then, earthquakes and associated uplift and deformation in the Mammoth Lakes Caldera have continued. Because such activities are common precursors of volcanic eruptions, the U.S. Geological Survey closely monitors the unrest in the region.

Likelihood of Future Occurrences

Unlikely—According to the U.S. Geological Survey, the pattern of volcanic activity over the past 5,000 years suggests that the next eruption in the Long Valley area will most likely happen somewhere along the Mono-Inyo volcanic chain. However, the probability of such an eruption occurring in any given year is less than 1 percent. Most likely, the next eruption will be small and similar to previous eruptions along the Mono-Inyo volcanic chain during the past 5,000 years (see Figure 4.52 above). Based on available data and the location of the County relative to the Long Valley area, there is a remote potential for volcanic activity of sufficient magnitude to adversely impact the Fresno County planning area.

Climate Change Considerations

There presently is not enough data or research to quantify the magnitude of potential change that climate change may have on volcanic activity.

4.2.20 Wildfire

Hazard/Problem Description

Three classes of fires exist in the planning area: understory fires, crown fires, and ground fires. Naturally-induced wildfires burn at relatively low intensities, consuming grasses, woody shrubs, and dead trees. These understory fires often play an important role in plant reproduction and wildlife habitat renewal and self-extinguish by low fuel loads or precipitation. Crown fires, which consist of fires consuming whole living tress, are low probability but high consequence type events. Crown fires typically match perceptions of wildfires. In areas with high concentrations of organic materials in the soil, ground fires may burn, sometimes persisting undetected for long periods until the surface is ignited.

Wildfire is an ongoing concern for the Fresno County planning area. Historically, the fire season extends from June through October of each year during the hot, dry months. Since 2010 the fire season throughout California and Fresno County has been getting longer, typically starting in May and extending into November, but wildfires can occur any time of year. Fire conditions arise from a combination of high temperatures, intense sunlight, low rainfall and humidity, dry vegetation, and high winds. Down slope winds, such as the Santa Ana winds of southern California which can gust to 80 mph, are often associated with the most destructive wildfires. Since they usually occur in the fall and winter after the summer dry season when there is ample dry vegetation for fuel, they can cause small fires to quickly burn out of control. These Santa Ana winds have been associated with some of the state's largest fires, including in October 2003 and October 2007, when more than 800,000 and 1,000,000 acres burned, respectively (Source: https://statesummaries.ncics.org/ca). In December 2017 and January 2018, the Thomas Fire northwest of Los Angeles became one of the largest fires in the State's history at 291,893 acres which was also exacerbated by Santa Ana winds.

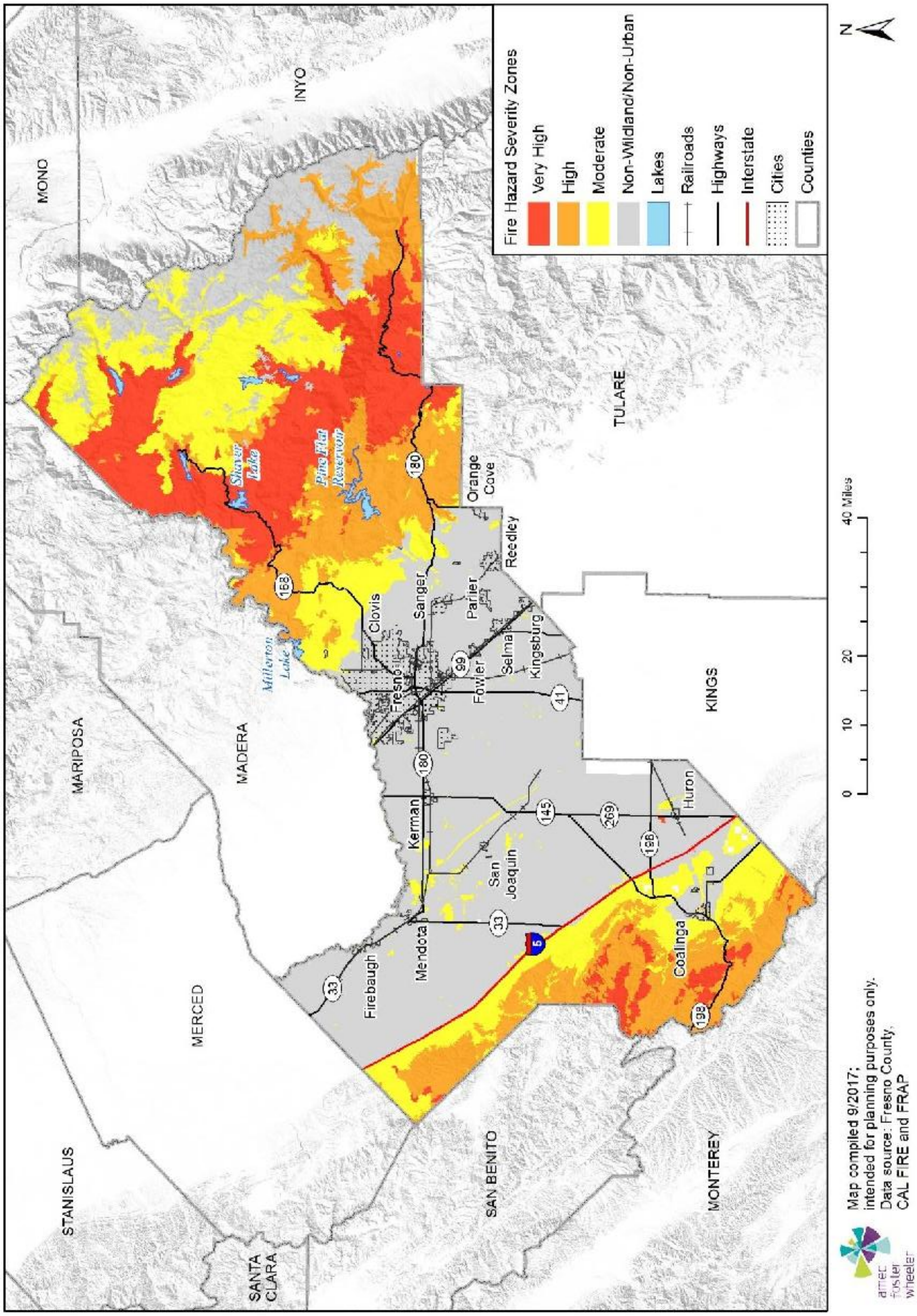
Throughout California, communities are increasingly concerned about wildfire safety as increased development in the foothills and mountain areas and subsequent fire control practices have affected the natural cycle of the ecosystem. While wildfire risk is predominantly associated with wildland-urban interface (WUI) areas, significant wildfires can also occur in heavily populated areas and across non WUI landscapes in the forest. The wildland-urban interface is a general term that applies to development adjacent to or within large watershed landscapes that support wildfire. Wildfires affect grass, forest, and brush lands, as well as any structures located within them. Where there is human access to wildland areas, such as the Sierra Nevada and Coast Range foothills, the risk of fire increases due to a greater chance for human carelessness as 90% of wildland fires are human caused.

Within the County there are three principal areas that have large damaging fire history: West of Interstate 5, the San Joaquin River Watershed and the Kings River Watershed. Each of these areas have unique vegetation and topography types, fire weather and communities. West of Interstate 5 is best described as an area with low rainfall (average of less than 10 inches) and a vegetation type consisting of annual grass, oak woodlands and brush. This area is predominantly used as rangeland for livestock grazing, mining, oil and gas production and underground transportation.

The San Joaquin River and the Kings River Watersheds have a diverse vegetation type ranging from annual grasslands, oak woodlands, brush and timber. These vegetation types transition from the valley floor to the Sierra Nevada's. The topography ranges from rolling foothills, steep river canyons to high sierra mountains. This area has numerus communities and homes on small parcels intermixed within the larger landscape. The San Joaquin river and Kings River have numerous hydroelectric facilities and critical power infrastructure located from the foothills to the high sierra. Recreation in the Sierra and Sequoia National Forests areas along with group camps increases the population and ignition potential during fire season. The drought that started in 2012 has left an abundance of dead brush, oaks and timber in the upper elevations of these watersheds. The impacts to the vegetation will carry on for many years into the future making fire suppression more difficult and increasing the chance for large catastrophic fires across the landscape.

Figure 4.53 illustrates Fresno County's wildfire threat.

Figure 4.53 Fresno County's Wildfire Severity Zones



Potential losses from wildfire include human life, structures, critical infrastructure, natural and cultural resources, quality and quantity of water supplies, cropland, timber, and recreational opportunities. Economic losses could also result due to damages to natural resources, grazing lands, tourism and local businesses not mention the loss of revenue to businesses during a wildfire event. Smoke and air pollution from wildfires can be a severe health hazard to local communities and the greater San Joaquin Valley air basin. In addition, catastrophic wildfire can create favorable conditions for other hazards such as flooding, landslides, and erosion during the rainy season impacting communities and downstream reservoirs.

Generally, there are three major factors that sustain wildfires and predict a given area's potential to burn. These factors are fuel, topography, and weather.

- **Fuel—**Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and include everything from dead tree leaves, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Also, to be considered as a fuel source are manmade structures, such as homes and other associated combustibles. The type of prevalent fuel directly influences the behavior of wildfire. Fuel is the only factor that is under human control. Fuel types within the Fresno County planning area include annual grasses, deciduous oaks, and heavy brush in the Coast Range of western Fresno County; seasonal grasses, deciduous and evergreen oaks, brush and grass in the lower and mid-elevations of central and eastern Fresno County, and conifers in the higher elevations of eastern Fresno County.
- **Topography—**An area's terrain and slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement and types of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- **Weather**—Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will more readily ignite and burn more intensely. Thus, during periods of drought, the threat of wildfire increases. Wind is the most influential weather factor of the three and its influence can increase rates of spread regardless of temperature and relative humidity. The Fresno County planning area has a diverse normal wind pattern. The western side of the planning area is influenced more by the coastal range and weather patterns along the coast. The east side of the valley is more influenced by the normal heating and cooling of the valley floor and the influence along the river drainages, this area is also susceptible to foehn winds from the high sierra. Lightning during the summer monsoonal moisture season also ignites wildfires, often in difficult-terrain with limited access for firefighters.

Extent

In terms of geographic extent, the wildfire hazard potentially impacts the entire planning area, but the most intense fires will be in the forested areas of the county. While the wildfire threat map

(4.39) depicts variable risk across the planning area, the history of occurrence map (4.40) indicates that even moderate and low risk areas have experienced wildfires, and potentially will continue to do so. However, with regard to the severity or potential impact of the wildfire hazard two facts should be considered: first, both maps demonstrate that the areas of greatest risk correspond to the locations with the greatest number of historical events; second, the Medium, High, and Very High hazard areas correspond to heavily forested areas and urban wildland interface areas, where fuel loads for wildfire are highest, are periodically exacerbated by drought conditions, and further complicated by a widespread incidence of tree mortality adding additional fuel load risk (see Section 4.2.4 for discussion of drought and tree mortality). Finally, in order to understand the extent of wildfire severity, the variable risk (Low, Medium, High, Very High) across the planning area identified on the wildfire risk map (Figure 4.55) must be viewed in relation to the location of each jurisdiction participating in the plan. The majority of the risk is in the unincorporated areas and on the fringes of municipalities that include Coalinga, Fresno, and Firebaugh. The Sierra Resource Conservation District has considerable area at risk to wildfires. For additional information on each jurisdiction's wildfire risk, please consult the jurisdictional Annexes and the Vulnerability Section 4.3.2.

The Fire Rating System defined in Table 4.25 describes the characteristics and potential intensity of fires, including the effect on the ability to manage and suppress fires. Such characteristics should be understood in light of the wildfire risks and history of occurrence in Fresno County, as identified on Figure 4.55 through Figure 4.56, and in the narrative descriptions of wildfire history previously discussed. Fire conditions up through Class 5 are possible in Fresno County, primarily in the unincorporated areas.

Table 4.25 Fire Danger Rating System

rating	basic description	detailed description
CLASS 1: Low Danger (L) COLOR CODE: **Green**	fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: **Blue**	fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: **Yellow**	fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: **Orange**	fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.

CLASS 5: Extreme (E) COLOR CODE: **Red**	fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Source: http://www.wfas.net

Past Occurrences

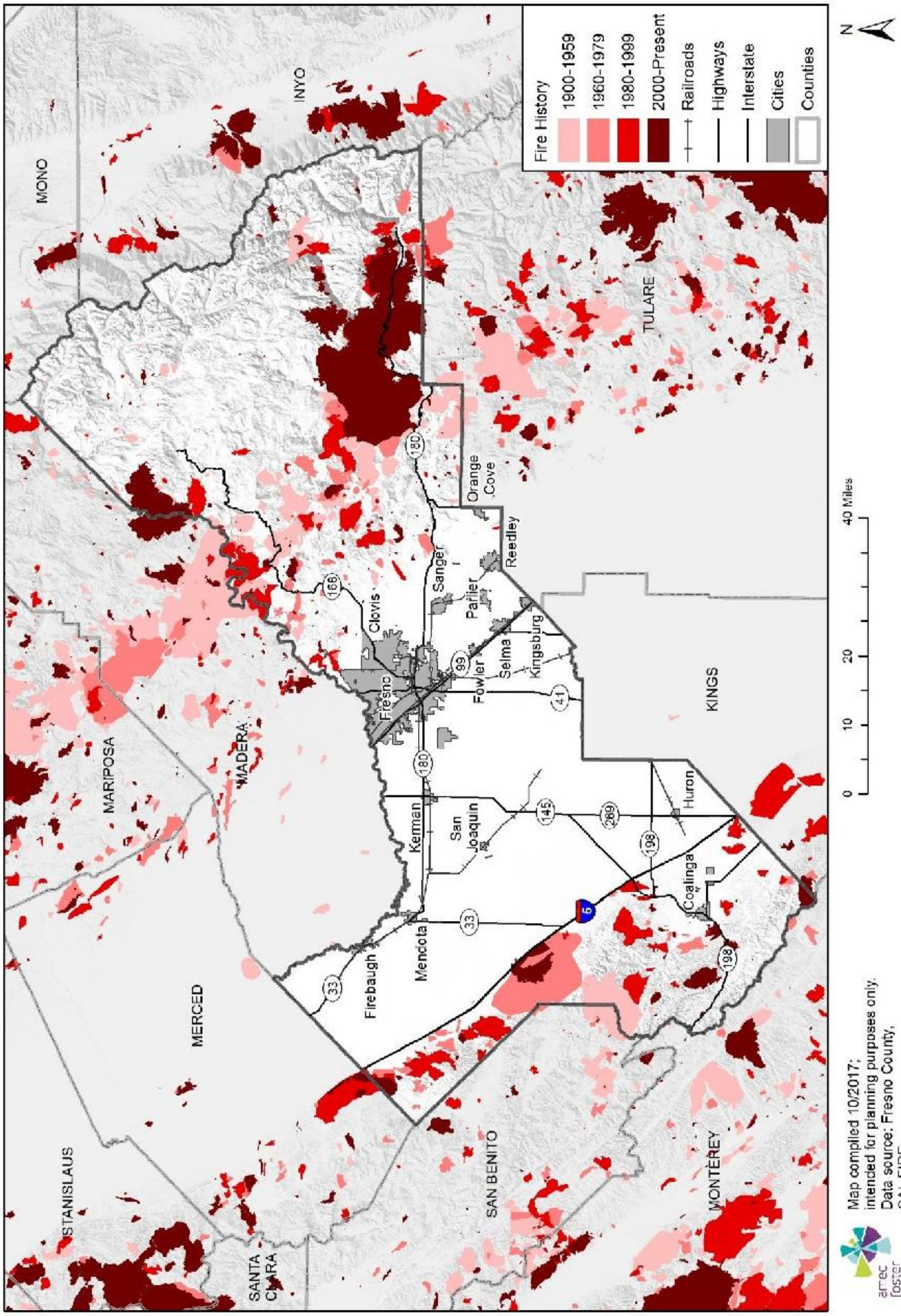
Wildfires are of significant concern throughout California. According to the California Department of Forestry and Fire Protection (CAL FIRE), vegetation fires occur within their jurisdiction on a regular basis; most are controlled and contained early with limited damage. For those ignitions that are not readily contained and become major incidents, damage can be extensive. There are many causes of wildfire, from naturally caused lightning fires to human-caused fires linked to activities such as smoking, campfires, debris burning, equipment use, and arson. Recent studies conclude that the greater the population density in an area, the greater the chance of an ignition. With population continuing to grow throughout California and the Fresno County planning area, the risk posed by wildfire also continues to grow.

According to the 2005 Prefire Management Plan for CAL FIRE's Fresno-Kings Unit, an ignition analysis for 2004 was determined to be very similar to that of years past. The four primary ignition sources continue to be other and undetermined (535 fires), arson (311 fires), equipment use (315 fires), and debris burning (158 fires). The remaining causes, which are almost insignificant in number, are lightning, campfires, smoking, vehicles, electrical power, and playing with fire. The unit, which encompasses all of Fresno and Kings counties, experiences 120 to 200 fires a year in the state responsibility area and 1,400 to 1,600 fires in the local responsibility area is a fire history map for the Fresno-Kings Unit.

During the drafting of the 2009 Fresno County HMP, the Unit, which encompasses all of Fresno and Kings counties, experienced 120 to 200 fires a year in the state responsibility area and 1,400 to 1,600 fires in the LRA. Figure 4.54 is a fire history map for the Fresno-Kings Unit, which depicts the majority of occurrences as being located within the Very High risk area as identified on the Fresno County Fire Risk Map (Figure 4.55). Additionally, Figure 4.54 details the extent of previous fire incidents occurring between 1900 and 2017.

However, in 2017, the Fresno County Fire Protection District reports a dramatic increase in fire incidents, with 1,283 reported as of July 31, 2017. (Source: https://www.fresnocountyfire.org/wp-content/uploads/2017/08/incident-summary.pdf). That said, of the total number, 470 were categorized as Vegetation fires (wildfires), while the remaining fires related to vehicles (221), structures (197), refuse (331), industrial (33), improvement/controlled burns (21), and agricultural products (10). However, as has been noted previously, wildfires occur from both natural and human-made causes. Therefore, given the recent frequency increase in vegetation fires, and the fact that other types of fires have the potential to spread into a wildfire scenario, the wildfire hazard risk seems to be growing, and the LHMPC will remain vigilant in its efforts to mitigate the risks, although an increase in frequency does not necessarily translate to an increase in the extent (range) of wildfires or their severity.

Figure 4.54 Fresno County Fire History



The HMPC identified the following as notable wildfires in the Fresno County planning area:

- **1933**: **The Tollhouse Fire** started when a local resident was burning brush in late August. The fire got out of hand and burned across fields and grazing lands and encircled the Town of Tollhouse, a large hub for the timber industry in eastern Fresno County. It burned portions of the flume that carried logs and boards from Shaver Lake to the valley floor. The fire raced up the hill and burned into Jose Basin and over Burrough Mountain into Blue Canyon. The fire burned very hot, destroying conifers in the area, which never grew back. Tollhouse was evacuated for safety, but no losses were incurred.
- **1987**: The state declared a disaster for Fresno County and 32 other counties during the 1987 wildfires. Collectively, the fires resulted in 3 deaths, 76 injuries, and $18 million in damage. The eastern side of Fresno County was primarily affected. Property damage was estimated at $1 million. Damage to roads, bridges, and power distribution also occurred. Timber production in the area was also impacted.
- **August 2-21, 1989: The Powerhouse Fire** started near the Fresno and Madera county line on the Fresno side of the San Joaquin River. Arson was suspected as the cause. The fire raced up the canyon skirting Powerhouse road in Auberry, traveling mid-slope behind the settlement of Jose Basin. Fingers of the fire touched New Auberry and Auberry. It burned across the front of Bald Mountain in to Mile High and it threatened Meadow Lakes and all homes in its path. An assault by air and ground stopped the fire at Sugarloaf Road at the 3,800-foot elevation. It took a multi-agency effort to put out the fire, which burned an estimated 21,000 acres. No deaths were reported, and only minor injuries were experienced by firefighters. No homes were burned, but several out buildings were lost. Other losses included damage to power poles, fences, and automobiles. Overall, the fire was devastating to the watershed, wildlife, and residents.
- **August 24, 1994: The Big Creek Wildland Fire** occurred in eastern Fresno County in the area of Big Creek, between Shaver and Huntington Lakes, which is used extensively for recreation and has numerous summer homes. The Big Creek area is part of an extensive hydroelectric project (Southern California Edison) that produces electricity for the area. 9,000 acres of national forest land burned. Although 300-500 homes were threatened, no structures burned. Highway 168 and Huntington Lake Road were temporarily closed. The local school closed and the community of Big Creek was evacuated for 1 ½ weeks. Estimated cost of infrastructure damage included $2 million to roads and miscellaneous improvements on national forest land and $500,000 to power distribution. An estimated cost to recover forest land was $2 million. Twelve firefighters were injured. Fighting the fire cost more than $50 million. A post-fire mudslide caused an estimated $50,000 in damage.
- **September 21, 2000**: **The Millwood Fire** burned 283 acres; 363 personnel responded. Highway 180 was closed until 8:00 p.m. that evening. A shelter was prepared in the City of Orange Cove, but was not used.
- **August 17, 2001**: **The Highway fir**e located near the community of Dunlap, burned 4,152 acres and destroyed five out buildings, a cabin, two travel trailers, and a miscellaneous number of cars.

- **August 17, 2001**: **The Musick Fire**, located between Shaver Lake and Big Creek, burned 193 acres. No structures were damaged in this fire caused by downed power lines. The cost was estimated at $800,000.
- **July 2013: The Aspen Fire** took place in the Kaiser Wilderness area of the Sierra National Forest, North of Huntington Lake. The fire burned over 150,000 acres with a suppression cost of $22.8 million dollars. The fire posed imminent danger to people within the National Forest, resulting in the evacuation of multiple campsites.
- **July 27, 2014: The French Fire** was a major wildland fire that burned 13,832 acres in Fresno County. No crop, property or infrastructure damage or injuries were reported.
- **July 30, 2015: The Rough Fire** was ignited by a lightning strike in the Sierra National Forest, North of Hume Lake, and then spread to Sequoia National Forest, Kings Canyon National Park, as well as state and private-owned lands. The fire consumed approximately 151,000 acres with significant impacts including a significant decrease in air quality, damage to one commercial building, three outbuildings, the temporary closure of 2 schools, several summer camps, and parts of the Sequoia – Kings Canyon National Forest, and the evacuation of multiple communities and campgrounds. Secondary impacts included a drastic drop in revenue from tourism and other visitors to the communities and park lands in the affected area, and a cost of $119 million dollars to suppress the fire.
- **July 1, 2016: The Curry Fire** was a major wildland fire that burned 2,944 acres in Coalinga, CA. Though no crop, property or infrastructure damage or personal injury occurred, it did result in several road closures.
- **July 2016: The Goose Fire** began at or around the intersection of Gooseberry Lane and Morgan Canyon Road, South of the town of Prather. The fire consumed 2,241 acres, and destroyed 4 residences and 5 outbuildings. The fire posed an imminent threat to 400 homes, and residents were issued evacuation orders.
- **August 8, 2016: The Mineral Fire** was a major wildland fire which burned 7,05 acres in Coalinga, CA. Though no crop, property or infrastructure damage or personal injury occurred, it did result in several road closures.
- **July 9, 2017: The Garza Fire** was a major wildland fire igniting in Monterey County (Coalinga, CA), and spreading to Kings and Fresno Counties. Although the fire burned 48,888 acres, no personal injuries or damage to crops, buildings or infrastructure were reported. However, it did result in several road closures.
- The Sacata Fire and Turkey Fire, burning 2,099 and 2,530 acres respectively, both occurred in Fresno County.

Likelihood of Future Occurrences

Highly Likely—Within the Fresno-Kings Unit, fire occurrences range from 120 to 200 fires a year in the SRA and 1,400 to 1,600 fires in the LRAs. Fires will continue to occur on an annual basis in the Fresno County planning area.

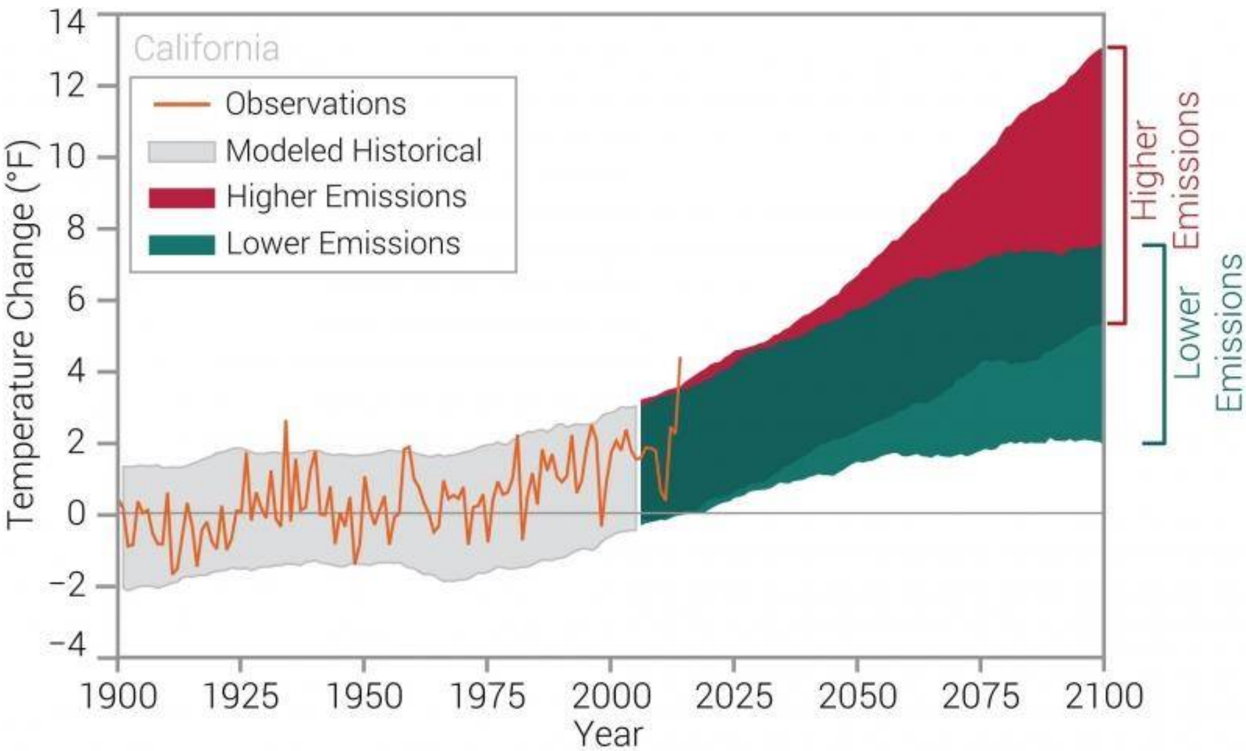
Other statistical measures to be considered in assessing the extent of the wildfire hazard include data on frequency (and severity): According to the Fire and Resource Assessment Program (FRAP), having compiled and analyzed a variety of measures for fire activity, such as the influence of time and fuel types, although fire activity across the state varies from year to year, the annual average since 2000 is 598,000 acres, or almost twice that of the preceding 50-year period from 1950-2000 (264,000 acres).

It should be noted that many ecosystems in the state that previously adapted to frequent low to moderate severity fires have seen shifts in reduced fire frequency (missed fire cycles), associated fuel build-up, and subsequent increases in fire severity when wildfires eventually occur. That said, other ecosystems appear to be burning too frequently – a situation facilitated by exotic invasive species that cause fundamental changes to post-fire fuel dynamics. These changes facilitate early seral phases to re-burn within a matter of only a couple years, and may reduce or eliminate native species that require time to develop to maturity and assure regeneration. And, in areas such as Fresno County, where ecosystems are commingled across various regimes, there is more uniformity of mixed-and high-severity effects that are not as clearly linked to basic ecosystem function. Therefore, in many mixed conifer systems, while the modern trend indicates an increase in fire rates, the type of fire and its typical interval are still significantly departed from the frequent low and mixed-severity fires that dominated low and mid-elevation confer forests throughout California (Source: 2010 Assessment Chapter 2.1: Wildfire Threat to Ecosystem Health and Community Safety, p.102;(http://frap.fire.ca.gov/data/assessment2010)).

Climate Change

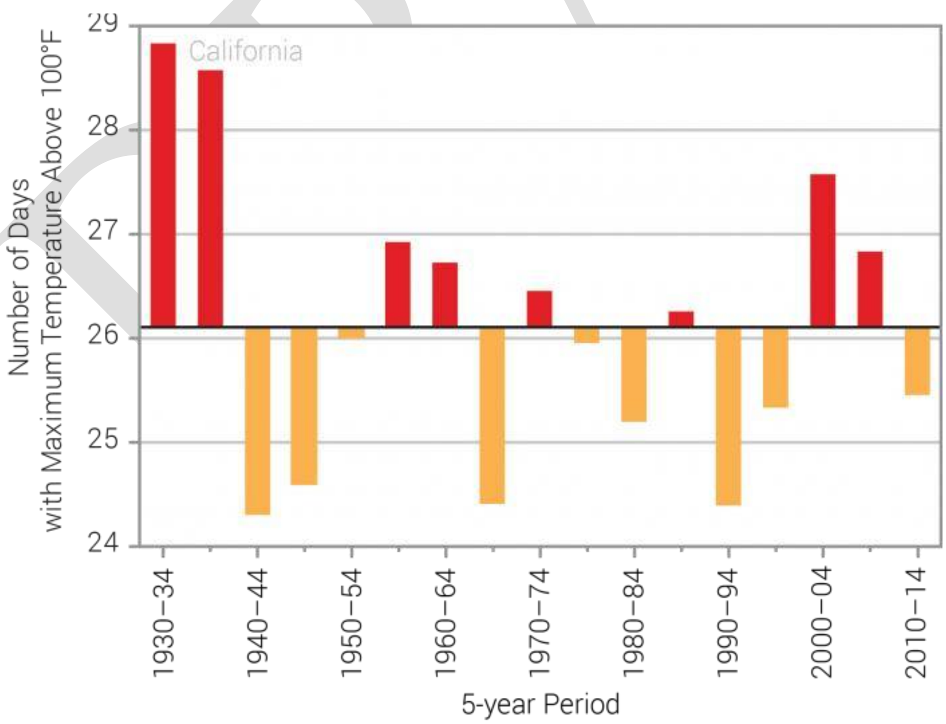
Due to higher emissions, historically unprecedented warming is projected by the end of the 21st century (See Figure 4.55 below), and in 2015 and 2016, California has experienced the highest number of days over 100 degrees since the 1930's. Even under a pathway of lower greenhouse gas emissions, average annual temperatures are projected to most likely exceed historical record levels by the middle of the 21st century. Overall, warming will lead to increased heat wave intensity but decreased cold wave intensity. Future heat waves signify a potential increase in the wildfire hazard intensity and severity in Fresno County, as well as a year-long fire season

Figure 4.55 California Observed and Projected Temperature Change



Source: https://statesummaries.ncics.org/ca

Figure 4.56 California Observed Number of Extremely Hot Days



Source: https://statesummaries.ncics.org/ca

Finally, it should be noted that Fresno County potentially has less capacity to address future wildfire risk related to climate change due to shortages in water, vital to combating wildfires. In California, rising temperatures are projected to increase the average lowest elevation at which snow falls, reducing water storage in the snowpack.

4.3 Vulnerability Assessment

Requirement §201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

With Fresno County's hazards identified and profiled, the HMPC conducted a vulnerability assessment to describe the impact that each hazard would have on the County. The vulnerability assessment quantifies, to the extent feasible using best available data, assets at risk to natural hazards and estimates potential losses. This section focuses on the risks to the County as a whole. Data from the individual participating jurisdictions was also evaluated and is integrated here and in the jurisdictional annexes and noted where the risk differs for a particular jurisdiction within the planning area.

This vulnerability assessment followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses*, as well as Tasks 5 and 6 of the 2013 *FEMA Local Mitigation Planning Handbook*. The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard.

Data used to support this assessment included the following:

- County GIS data (hazards, base layers, and assessor's data)
- Statewide GIS datasets compiled by the California Governor's Office of Emergency Services to support mitigation planning

- California Department of Forestry and Fire Protection GIS datasets including tree mortality data
- FEMA's HAZUS-MH for earthquake modelling
- Written descriptions of inventory and risks provided by participating jurisdictions
- A refined flood loss estimation by jurisdiction with the use of geospatial analysis 1% and 0.2% annual chance flooding as well as the 200-year floodplain.
- Existing plans and studies
- Personal interviews with planning team members and staff from the County and participating jurisdictions

4.3.1 Fresno County Vulnerability and Assets at Risk

As a starting point for analyzing the planning area's vulnerability to identified hazards, the HMPC used a variety of data to define a baseline against which all disaster impacts could be compared. This section describes significant assets at risk in the planning area. Data used in this baseline assessment included:

- Total values at risk
- Critical facility inventory
- Historic, cultural, and natural resources
- Growth and development trends
- Social vulnerability

Total Values at Risk

The following data from the Fresno County Assessor's Office is based on the certified roll values for 2017. This data should only be used as a guideline to overall values in the County, as the information has some limitations. The most significant limitation is created by Proposition 13. Instead of adjusting property values annually, the values are not adjusted or assessed at fair market value until a property transfer occurs. As a result, overall value information is likely low and does not reflect current market value of properties within the County. It is also important to note, in regard to a disaster, it is generally the value of the infrastructure or improvements to the land that is of concern or at risk. Generally, the land itself is not a loss. Table 4.26 shows the building values for the entire Fresno County planning area (e.g., the total values at risk) by jurisdiction. The values for unincorporated Fresno County are provided in Table 4.27 by property type. For more information on building exposure for each jurisdiction, see the appropriate annex.

Table 4.26 Fresno County Exposure by Jurisdiction

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Clovis	31,568	41,565	$7,130,096,545	$4,158,423,181	$11,288,519,726
Coalinga	3,271	3,797	$393,744,248	$232,224,345	$625,968,593
Firebaugh	1,559	2,024	$190,892,252	$145,901,471	$336,793,723
Fowler	1,802	2,003	$331,505,557	$240,388,754	$571,894,311
Fresno	129,037	203,846	$24,434,591,987	$16,375,186,070	$40,809,778,057
Huron	805	1,085	$83,013,224	$50,216,784	$133,230,008
Kerman	3,167	4,520	$512,764,662	$318,872,167	$831,636,829
Kingsburg	3,626	4,003	$636,380,099	$425,477,080	$1,061,857,179
Mendota	1,764	2,400	$186,949,712	$113,187,887	$300,137,599
Orange Cove	1,534	1,816	$156,857,250	$87,111,922	$243,969,172
Parlier	2,474	2,938	$289,602,563	$177,506,477	$467,109,040
Reedley	5,678	9,894	$865,266,269	$550,731,018	$1,415,997,287
San Joaquin	687	1,246	$60,346,713	$40,082,400	$100,429,113
Sanger	6,343	8,354	$817,023,618	$491,412,710	$1,308,436,328
Selma	5,789	7,449	$770,773,863	$491,867,089	$1,262,640,952
Unincorporated	60,371	68,147	$11,373,573,733	$8,721,106,775	$20,094,680,508
Total	**259,475**	**365,087**	**$48,233,382,295**	**$32,619,696,128**	**$80,853,078,423**

Source: Amec Foster Wheeler based on information from Fresno County Assessor 2017

Table 4.27 Building Exposure for Unincorporated County, by Property Type

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Agricultural	7,151	7,143	$1,244,142,066	$1,244,142,066	$2,488,284,132
Commercial	936	1,873	$330,979,055	$330,979,055	$661,958,110
Exempt	383	763	$0	$0	$0
Industrial	810	1,112	$685,043,441	$1,027,565,162	$1,712,608,603
Multi-Residential	358	875	$73,852,860	$36,926,430	$110,779,290
Open Space	10,498	8,263	$3,120,718,551	$3,120,718,551	$6,241,437,102
Residential	40,224	48,105	$5,916,124,497	$2,958,062,249	$8,874,186,746
Unknown	11	13	$2,713,263	$2,713,263	$5,426,526
Total	**60,371**	**68,147**	**$11,373,573,733**	**$8,721,106,775**	**$20,094,680,508**

Source: Amec Foster Wheeler based on information from Fresno County Assessor 2017

Critical Facility Inventory

Of significant concern with respect to any disaster event is the location of critical facilities in the planning area. Critical facilities are often defined as those services and facilities essential during a major emergency and that, if damaged, would result in severe consequences to public health and safety or facilities that, if unusable or unreachable because of a major emergency, would seriously and adversely affect the health, safety, and welfare of the public. Critical facilities include, but are not limited to:

- Schools and other publicly owned facilities;
- Hospitals, nursing homes, and housing likely to have occupants who may not be sufficiently mobile to avoid injury or death during a major disaster;
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for response activities before, during, and after an event;
- Public and private utility facilities that are vital to maintaining or restoring normal services to damaged areas before, during, and after an event; and
- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials.

An updated inventory of critical facilities in the planning area based on data from a combination of Fresno County GIS and the Homeland Infrastructure Foundation-Level Data (HIFLD 2017) is provided in Table 4.28. A noted limitation is the lack of facilities for water and power which was not available in the County or HIFLD datasets. Critical facilities in the County are illustrated in Figure 4.57, with more detail shown in Figure 4.58, Figure 4.59, and Figure 4.60. More information on critical facilities in the participating jurisdictions can be found in the jurisdictional annexes.

Table 4.28 Fresno County Planning Area's Critical Facilities

Critical Facilities Type	Unincorporated	All Cities	County Totals
Airport	8	7	15
Behavioral Health		6	6
CalARP	87	69	156
Colleges & Universities*		24	24
Communications		4	4
County Government		4	4
Courthouse		3	3
Daycare		155	155
Department of Agriculture	1	3	4
Department of Public Health	1	4	5
Department of Public Works	11	2	13
Department of Social Services		11	11
Detention Center		4	4
District Attorney		2	2
Fire Station*	36	42	78
General Services		3	3
Health Care		18	18
Nursing Home*	3	36	39
Police*		24	24
School	127	334	461
Sheriff	2	5	7

Critical Facilities Type	Unincorporated	All Cities	County Totals
Supplemental College*		4	4
Urgent Care*		7	7
Wastewater Treatment Plant*	2		2
Total	278	771	1,049

Source: Fresno County GIS and *HIFLD 2017
Power and water utilities are not mapped

Figure 4.57 Critical Facilities in Fresno County

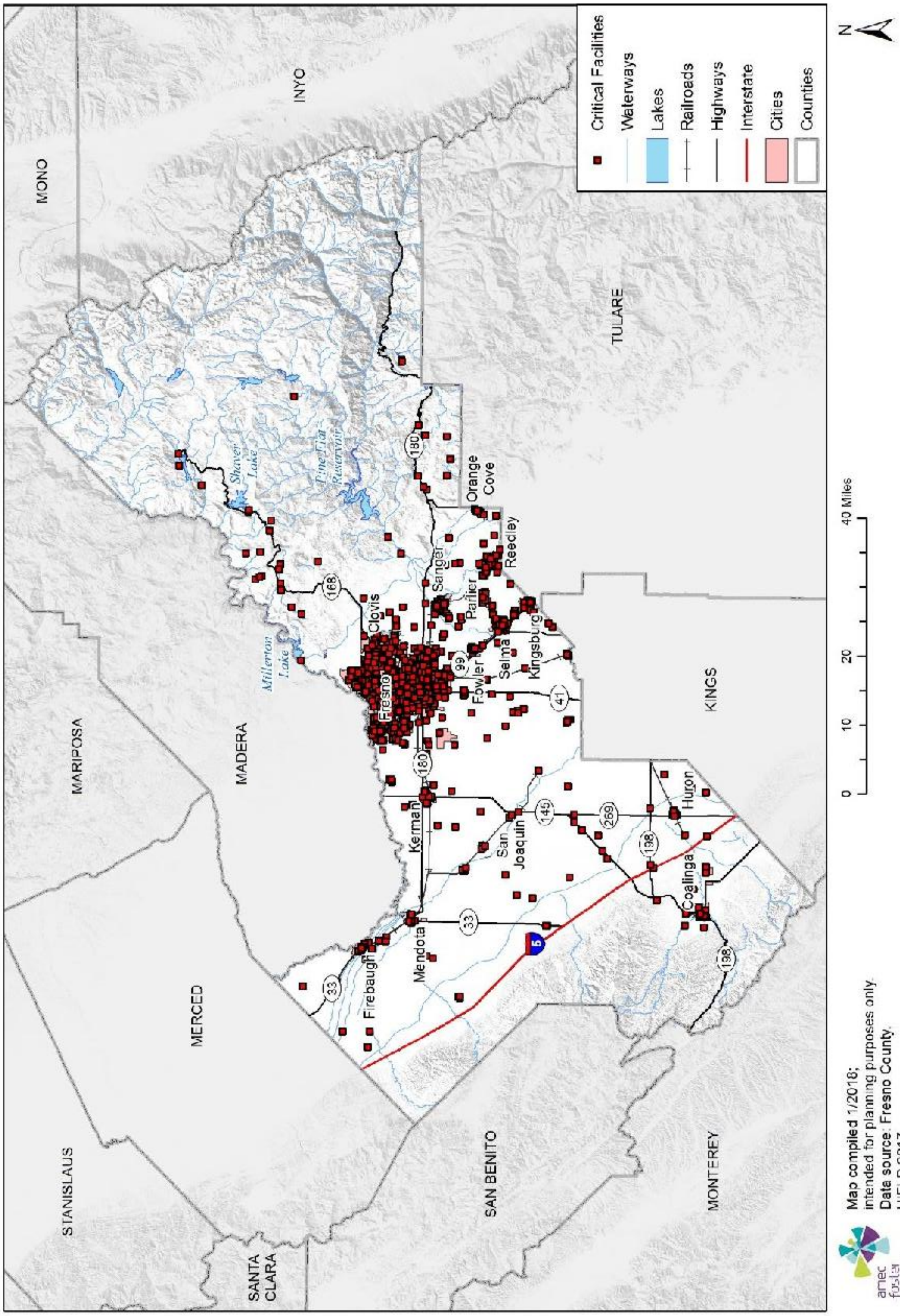


Figure 4.58 Critical Facilities in Western Fresno County

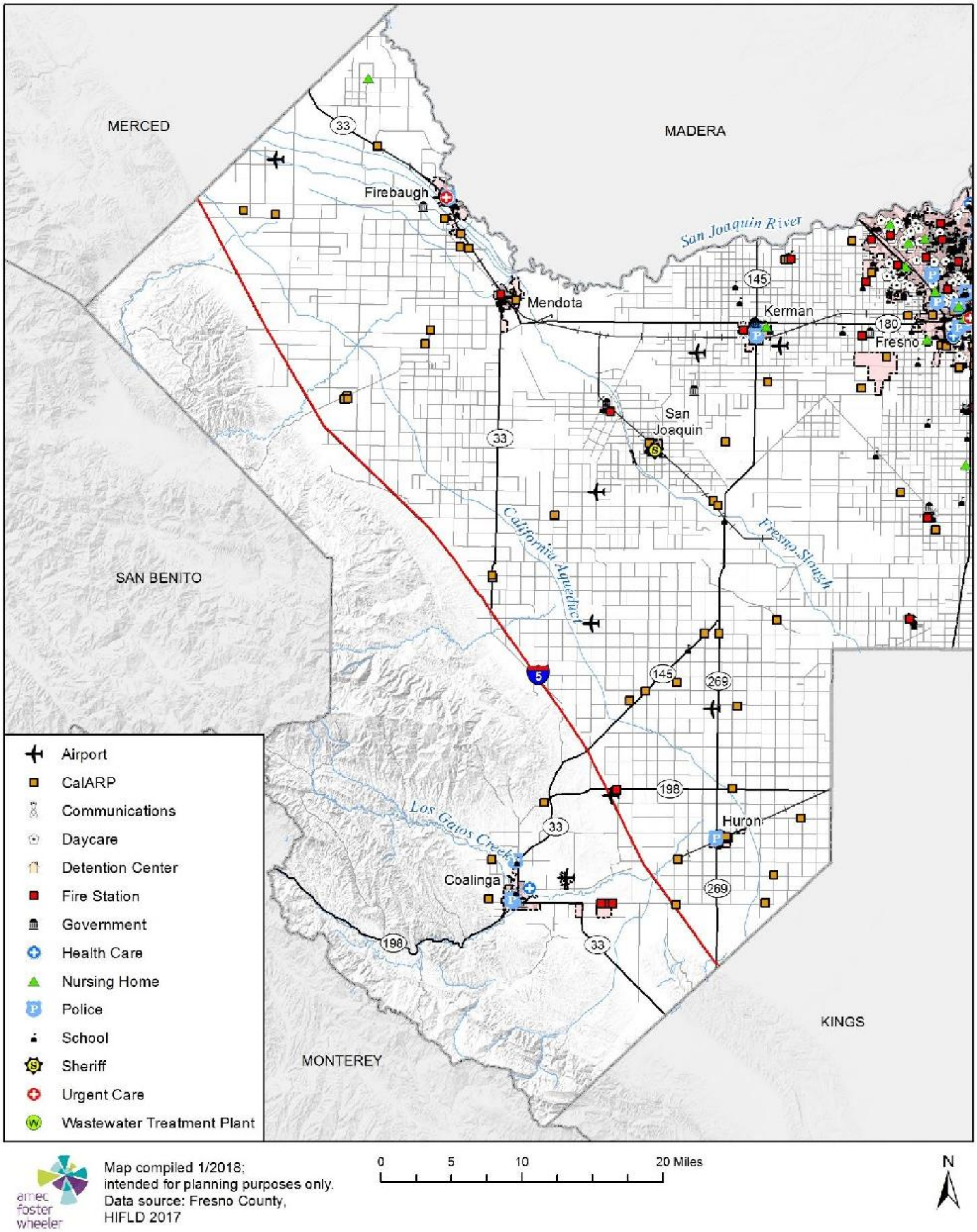


Figure 4.59 Critical Facilities in Central Fresno County

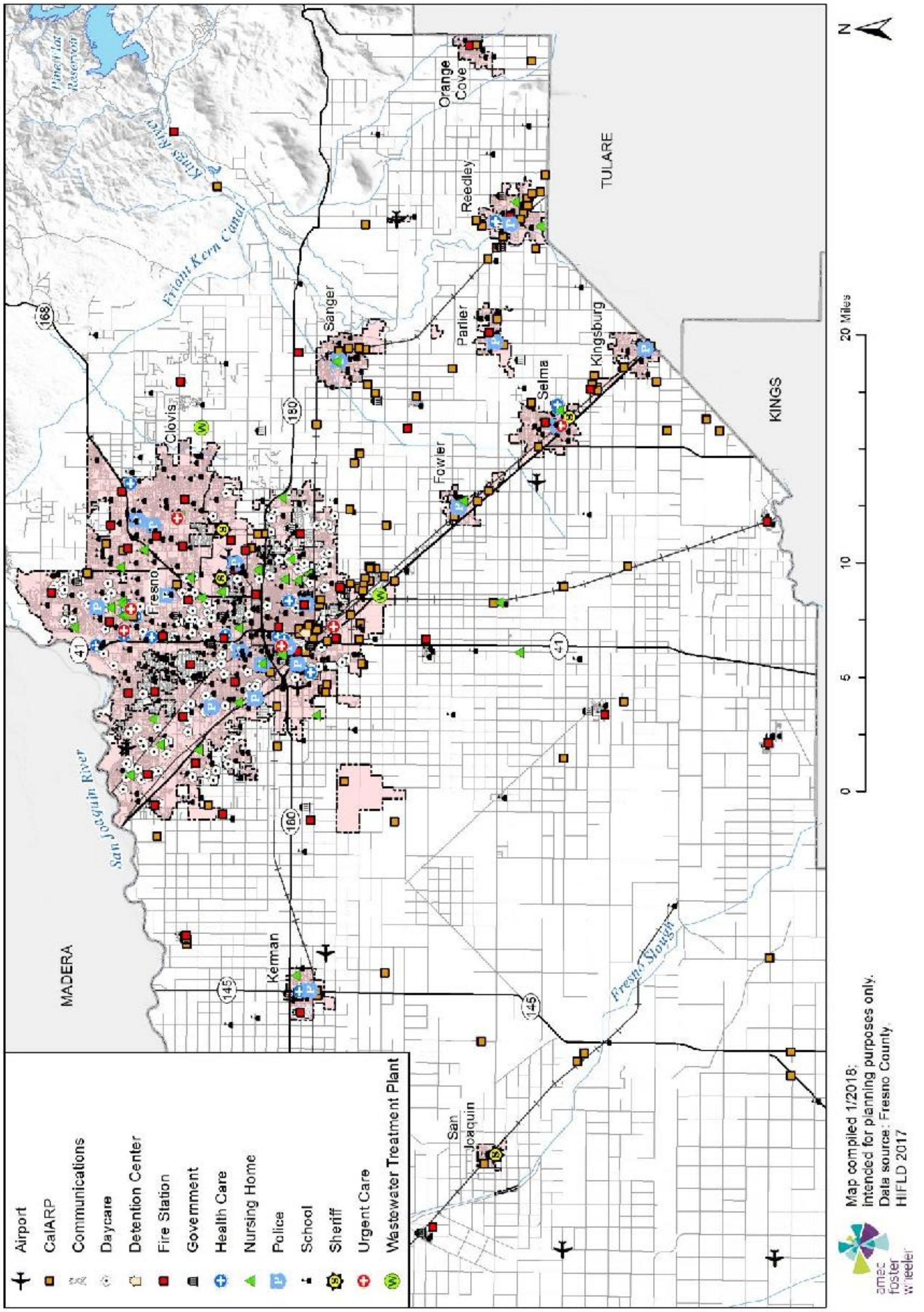
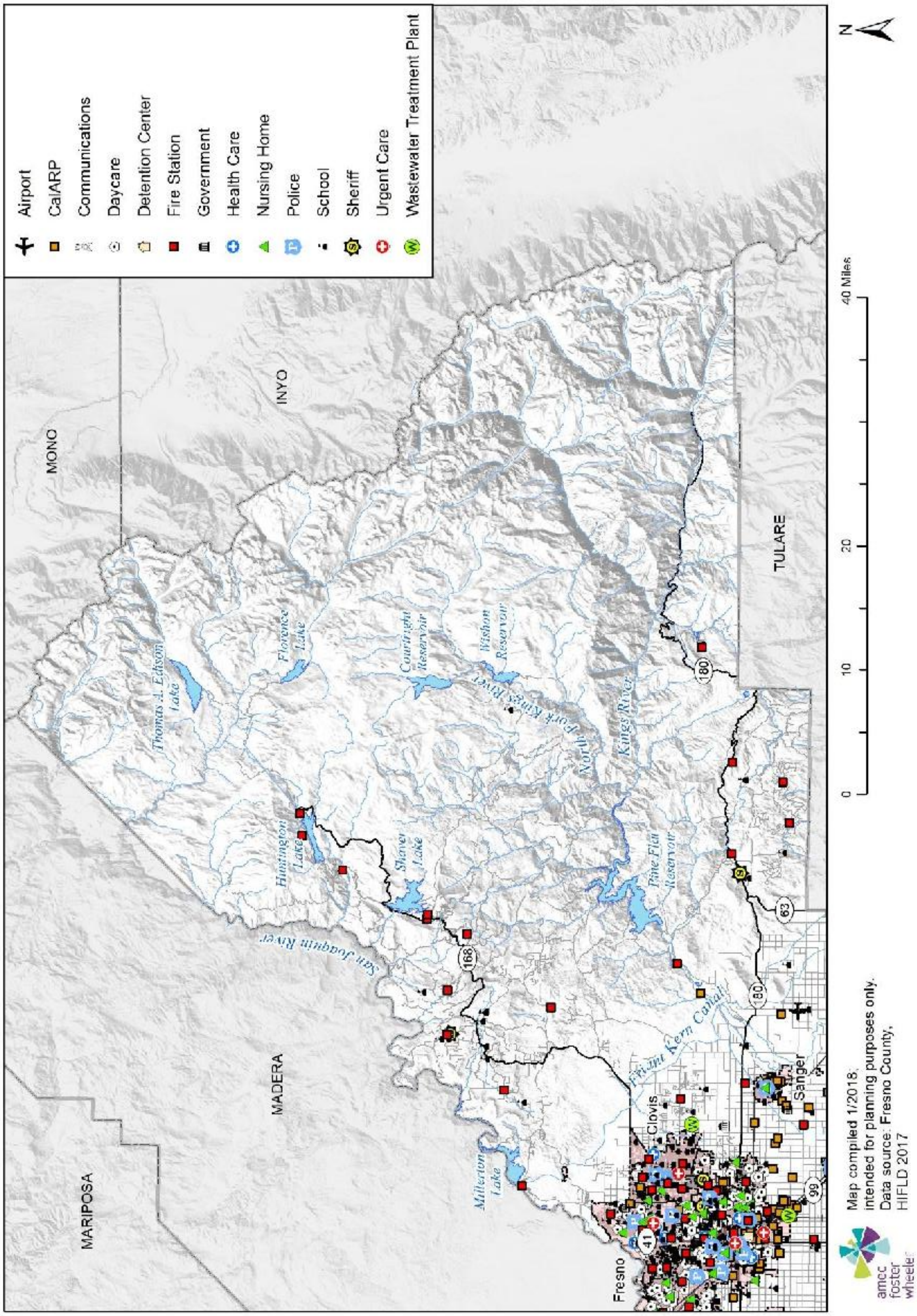


Figure 4.60 Critical Facilities in Eastern Fresno County



Historic, Cultural, and Natural Resources

Assessing the vulnerability of Fresno County to disaster also involves inventorying the historic, cultural, and natural assets of the area. This step is important for the following reasons:

- The community may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing so ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts are higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, for example, wetlands and riparian habitat help absorb and attenuate floodwaters.

Historic and Cultural Resources

Fresno County has a large stock of historically significant homes, public buildings, and landmarks. To inventory these resources, the HMPC collected information from a number of sources. The California Department of Parks and Recreation Office of Historic Preservation (OHP) was the primary source of information. The OHP is responsible for the administration of federally and state mandated historic preservation programs to further the identification, evaluation, registration, and protection of California’s irreplaceable archaeological, and historical resources. OHP administers the National Register of Historic Places, the California Register of Historical Resources, the California Historical Landmarks, and the California Points of Historical Interest programs. Each program has different eligibility criteria and procedural requirements.

- The **National Register of Historic Places** is the Nation’s official list of cultural resources worthy of preservation. The National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Properties listed include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.
- The **California Register of Historical Resources** program encourages public recognition and protection of resources of architectural, historical, archeological and cultural significance; identifies historical resources for state and local planning purposes; determines eligibility for state historic preservation grant funding; and affords certain protections under the California Environmental Quality Act. The register is the authoritative guide to the state’s significant historical and archeological resources.
- **California Historical Landmarks** are sites, buildings, features, or events that are of **statewide** significance and have anthropological, cultural, military, political, architectural, economic, scientific, technical, religious, experimental, or other value. Landmarks #770 and above are automatically listed in the California Register of Historical Resources.

- **California Points of Historical Interest** are sites, buildings, features, or events that are of **local (city or county)** significance and have anthropological, cultural, military, political, architectural, economic, scientific, technical, religious, experimental, or other value. Points designated after December 1997 and recommended by the State Historical Resources Commission are also listed in the California Register.

Historical resources included in the programs above are identified in Table 4.29.

Table 4.29 Fresno County's Historical Resources

Name (Landmark Plaque Number)	National Register	State Landmark	Point of Intere st	Date Listed	City
Arroyo De Cantua (344)		X		8/8/1939	Coalinga
Bank of Italy (N1140)	X			10/29/1982	Fresno
Birdwell Rock Petroglyph Site (N2193)	X			3/12/2003	Coalinga
Brix, H.H., Mansion (N1235, P438)	X		X	9/15/1983 (N) 10/1/1975 (P)	Fresno
Coaling Station A (P7)			X	12/16/1966	Coalinga
Coalinga Polk Street School (N1099)	X			5/6/1982	Coalinga
Dinkey Creek Bridge (N1957)	X			9/5/1996	Dinkey Creek
Einstein House (N554, P440)	X		X	1/31/1978 (N) 10/1/1975 (P)	Fresno
Fig Garden Woman's Club (P799)			X	7/18/1994	Fresno
Forestiere Underground Gardens (N524, 916)	X	X		10/28/1977 (N) 1/31/1978	Fresno
Fort Miller (584)		X		5/22/1957	Friant
Fowler's Switch (P299)			X	5/2/1973	Fowler
Fresno Bee Building (N1158)	X			11/1/1982	Fresno
Fresno Brewing Company Office and Warehouse (N1260)	X			1/5/1984	Fresno
Fresno City (488)		X		8/7/1951	Tranquillity
Fresno Memorial Auditorium (N1867)	X			5/10/1994	Fresno
Fresno Republican Printery Building (N738)	X			1/2/1979	Fresno
Fresno Sanitary Landfill (N2140)	X			8/7/2001	Fresno
Gamlin Cabin (N471)	X			3/8/1977	Wilsonia
Holy Trinity Armenian Apostolic Church (N1450)	X			7/31/1986	Fresno
Hotel Californian (N2235)	X			4/21/2004	Fresno
Kearney, M. Theo, Park and Mansion (N335, P5)	X		X	3/13/1975 (N) 8/5/1966 (P)	Fresno
Kindler, Paul, House (N1141)	X			10/29/1982	Fresno
Kingsburg Railroad Depot (P694)			X	3/30/1988	Kingsburg
Knapp Cabin (N727)	X			12/20/1978	Cedar Grove
Maulbridge Apartments (N1100)	X			5/6/1982	Fresno
Meux House (N324, P437)	X		X	1/13/1975 (N) 10/1/1975 (P)	Fresno
Milwood Townsite (P4)			X	8/5/1966	Miramonte

Name (Landmark Plaque Number)	National Register	State Landmark	Point of Intere st	Date Listed	City
Old Administration Building, Fresno City College (N282)	X			5/1/1974	Fresno
Old Fresno Water Tower (N114)	X			10/14/1971	Fresno
Orange Cove Santa Fe Railway Depot (N658)	X			8/29/1978	Orange Cove
Pantages, Alexander, Theater (N559)	X			2/23/1978	Fresno
Physicians Building (N701)	X			11/20/1978	Fresno
Reedley National Bank (N1344)	X			2/28/1985	Reedley
Reedley Opera House Complex (N1276)	X			4/5/1984	Reedley
Rehorn House (N982)	X			1/8/1982	Fresno
Romain, Frank, House (N986)	X			1/11/1982	Fresno
San Joaquin Light & Power Corporation Building (N2310)	X			1/3/2006	Fresno
Santa Fe Hotel (N1673)	X			3/14/1991	Fresno
Santa Fe Passenger Depot (N443)	X			11/7/1976	Fresno
Settlement of Academy (P45)			X	9/22/1967	Toll House
Shorty Lovelace Historic District (N555)*	X			1/31/1978	Pinehurst
Site of First Junior College in California (803)		X		6/28/1965	Fresno
Site of the Fresno Free Speech Fight of the Industrial Workers of the World (873)		X		7/19/1974	Fresno
Southern Pacific Passenger Depot (N561)	X			3/21/1978	Fresno
Stoner House (N1390)	X			10/17/1985	Sanger
Sycamore Point (P226)			X	10/5/1971	Friant
Temporary Detention Camps for Japanese Americans-Fresno Assembly Center (934)		X		5/13/1980	Fresno
Temporary Detention Camps for Japanese Americans-Pinedale Assembly Center (934)		X		5/13/1980	Pinedale
Tollhouse (P145)			X	11/3/1969	Toll House
Tower Theatre (N1795)	X			9/24/1992	Fresno
Twining Laboratories (N1681)	X			3/26/1991	Fresno
Warehouse Row (N564)*	X			3/24/1978	Fresno
YWCA Building (N673, P439)	X		X	9/21/1978(N) 10/1/1975 (P)	Fresno

Source: California Department of Parks and Recreation Office of Historic Preservation, http://ohp.parks.ca.gov/
*Historic district

The National Park Service administers two programs that recognize the importance of historic resources, specifically those pertaining to architecture and engineering. While inclusion in these programs does not give these structures any sort of protection, they are valuable historic assets. Note: Since these structures are not protected, it is possible that they no longer exist.

- The **Historic American Buildings Survey** (HABS) documents America's architectural heritage. The following are the HABS structures in Fresno County:
  - Burnett Nurse's Home, 120 North Howard Street, Fresno
  - Camp Barbour Blockhouse, Millerton vicinity
  - Fort Miller Bakery, Lake Millerton, Millerton
  - Fort Miller Ford, Lake Millerton, Millerton

- Fort Miller Hospital, Lake Millerton, Millerton
- Fort Miller Mess Hall, Lake Millerton, Millerton
- Fort Miller Officer’s Quarters, Lake Millerton, Millerton
- Fort Miller, Lake Millerton, Millerton
- Ira H. Brooks House, 350 North Fulton Avenue, Fresno
- Shelter Cabin, Muir Pass, Big Pine vicinity

- The **Historic American Engineering Record** documents historic sites and structures related to engineering and industry. The following are the HAER structures in Fresno County:
  - Big Creek Hydroelectric System, Big Creek Town, Operator House Garage, Orchard Avenue south of Huntington Lake Road, Big Creek vicinity
  - Big Creek Hydroelectric System, Big Creek Town, Operator House, Orchard Avenue south of Huntington Lake Road, Big Creek vicinity
  - Big Creek Hydroelectric System, Powerhouse 3 Penstock Standpipes, Big Creek, Big Creek vicinity
  - Big Creek Hydroelectric System, Powerhouse 8, Operator Cottage, Big Creek, Big Creek vicinity
  - Hume Lake Dam, Sequoia National Forest, Hume

The Fresno County General Plan Background Report identifies the following, some of which are already mentioned above, as historic properties in Fresno County:

1.O.O.F. Hall
Academy
Alamo/Helm House
Alexander Home
American Self Storage (denied by city)
Anderson Home
Arioto, Thomas; Home
Armenian Presbyterian Church (demolished)
Arroyo De Cantua
Aten Residence
Back (Beck) Home
Baker Valley Historic District
Bank of America Building
Bank of Italy (Fresno)
Bank of Italy (Reedley)
Barkdale Home
Barton Opera House (non extent)
Basque Hotel
Bauder Home
Bean Home
Beeler/Thorton Shop (denied by City)
Bekins Van & Storage
Bernhauer House
Berry Home
Berven Rug Mills
Besaw Home
Bethel Lutheran Church
Bing Kong Tong Asso. Building
Black Market (denied by city)
Bonsel/Rush/Hunt Home (relocated)
Booker House
Boole Tree
Bow On Ton Asso. Building
Brix Apartments (removed from city list)
Brix Home
Burks, Drs.; Home
Caldwell Home
California Products Company
Camp Barbour Blockhouse
Campbell’s Store
Cardwell Home
Carlson Home
Carmel Saddlery
Carnegie Library
Centennial Stump
Centerville
Central Packaging/Supply
Chicago Stump
Chorbajian Home (demolished)
City Fire Alarm Station
City Fire Alarm Station
Clements Service Station
Clovis Carnegie Library
Clovis Cole Home
Cobb Home
Collins Residence
Converse Basin Grove
Converse Hoist Site
Cowdrey Home
Craycroft Home
Davidson Home
Einstein Home
El Camino Viejo
Elkhorn Springs

Euless Home (denied by city)
Evinger Home
Ewing Home (denied by city)
Eymann, A.C. Home
Eymann, J.J. Home
Farr Residence
Fassett Home (demolished)
Fig Garden Women’s Club
Firebaugh’s Ferry
First Church of Christian Science
First Congressional Church
First Fresno Store
First Mexican Baptist Church
First Presbyterian Church (proposed)
First Store in Fresno
First Store, James Pager 1872
First United Methodist Church (proposed)
Forestiere Underground Gardens
Forkner Home
Fort Miller Blockhouse
Fort Miller Site
Fort Washington Site
Forthcamp Home
Fowler’s Switch
Frank Dusy Home Site
Frankenau Home (proposed)
Free Speech Fight Site
Freemont, John C.; Kearney Park
Fresno Bee Building
Fresno Brewery Company
Fresno Buddhist Temple
Fresno City College Library
Fresno City Hall
Fresno Copper Mine
Fresno County Hall of Records
Fresno County Seat
Fresno Fire Alarm Station
Fresno Irrigation District/Moses J. Church
Fresno Junior College
Fresno Memorial Auditorium
Fresno Planning Mill
Fresno Republican/Print Building
Fresno Temple Church of God
Fresno Traction Company
Fresno Trolley Cars
Gamlin Cabin
Gemer Home
Gerlitz Home
Gibbs Home
Giffen Home (denied by city)
Gilbert Residence (denied by city)
Goodman Residence
Graff Home
Grant House
Grant Tree/Nations Christmas Tree
Green Bush Spring Plaque
Gregory Home
Griffen Home; Blackstone Ave
Groundwater Irrigation Plaque
Guarantee Savings Building
Gundelfinger, Henry, Home
Gundelfinger, Herbert, Home
Gundelfinger, Louis, Home
Hanger Home
Hansen House
Hansen, Jens; House
Hare, Drs., Home
Hayhurst Home
Hays Home
Helm Building
Hero Home
Hewitt Residence
Hines Home
Hines Home; Blackstone Ave
Hobbs Parsons Produce Co.
Holt Lumber Company
Holy Trinity Armenian Apostolic Church
Hoover Residence
Hotel California
Hotel Fresno
Hotel Virginia
Howard, Dr. Oliver, Home
Hughes Home
Hume Lake Dam
Hunt/Bonsel Home (relocated)
Huntington/Douglas Stump
Ingmire, Ovid; Home
J.C. Penny Store
Jamieson Home
Japanese American Detention Site
Jensen Home
Johnson Home
Johnson Home; Illinois Ave
Johnson, N.M., Home
Kearney Boulevard
Kearney Mansion
Kerman Union High School
Kern Kay Hotel
Kindler, Paul House
King Solomon Lodge
Kings River Irrigation Plaque
Kingsburg Railroad Depot
Knapp Cabin; Cedar Grove
Kutner Home
La Libertad
Laguna de Tache Land Office (burned)
Laton Library Building
Legler Residence
Leslie House
Letcher
Liberty Theatre/Hardys
Long/Black Home
Main Home
Main Post Office
Maracci, Joseph, Home
Mason Building
Masonic Hall
Mattel Building
Maubridge Apartments
McAlpine Home
McCollum Home
McKay Home
McIndoo/Phillips Home
Meux Home, Museum
Meux, John, Home (burned)
Mill Ditch
Miller Home
Millerton Site
Millwood Site
Mink Home
Mosgrove Home
Mundroff Home
National Warehouse
Nestel Home
Neverman Home

Newman Home
Nye, Judge, Home
Ohannesian Home
Oil City
Okamoto’s Dept. Store
Okonogi Home
Old Administration Building
Old Barn "M" Street
Old Clovis Courthouse
Old Fresno City Site
Old Fresno Unified School Building
Old Fresno Water Tower
Old St. Agnes Hospital
Orangedale Odd Fellow’s Lodge 211 (proposed)
Owen Home
P.G.kE. Building
Pantages, Alexander; Theater
Parret Home
Patterson, T.W., Building
Pattison House
Peden Home
Peterson Home
Phelan, James, Building
Physicians Building
Pine Flat Dann Plaque
Pinedale Elementary Plaque
Pollasky Railroad
Poole’s Ferry
Porteous Home
Posa de China Site
Post Office Substation; Inyo
Prescott, F.K. Home
Post Office; Tulare
Prescott, F.K. Home
Pueblo de las Juntas
Radin-Kamp Dept. Store
Railroad Anniversary Plaque; 100 Anniversary
Rainbow Ballroom
Ramona Apartments (demolished)
Reedley National Bank
Reedley Opera House
Rehorn Residence
Reyburn Home
Rheingans Home
Riverview Ranch House
Robinson Home
Roessler Home
Roessler Winery
Romain Home
Rowell Building
Rowell Home
Rustigan Building
Rutherford Home (not extant)
Saddler Office Supply
San Joaquin Grocers Wholesale
San Joaquin Valley Coal Mine
San Joaquin Valley Railroad
Sanger Depot Museum
Sanger Lodge #316 (proposed)
Sanger Womens Club
Santa Fe Depot, Fresno
Santa Fe Depot; Orange Cove
Santa Fe Motel
Saroyan Home; El Monte Way
Saroyan Home; Griffith Way
Schmidt Home
Schutz Residence (non extant)
Scottish Rite Temple
Scottsburg Site
Security Bank Building
Selma Flouring Mill
Selma, Townsite
Sharer Home
Shipp Home
Shorty Lovelace Hist. District
Shuttera Home
Solorio Residence
Southern Pacific Depot
Spencer Home
Squaw Leap Archeological Dit.
St. Alphonsus Catholic Church
St. Ansgar’s Lutheran Church
St. Genevieve’s Catholic
St. John’s Cathedral
St. John’s Hall School
St. John’s Rectory
St. Paul’s Armenian Church
Staley House
Station “A” Postal Service
Steinwand Home
Stone Home
Stoner House
Sun Maid Raisin Growers (demolished)
Sun Stereo Warehouse
Swedish Methodist Church
Swift Home
Sycamore Bend
Teilrnan Home
Temple Beth Israel
Theatre 3
Thomas, Montgomery; Home
Thompson Residence
Tinkler Mission Chapel
Tollhouse Grade
Towne Apartments
Tranquillity Site
Traveler’s Hotel
Turner Building
Turpin Home
Twin Sisters/McVey House
Twining Laboratories
Van Ness Gate
Van Volkenburgh Home
Vartanian Home
Vincent Home
Vincent Home; San Pablo Ave
Warehouse Row
Warehouse Row Packing
Warehouse Row Storehouse
Warrior’s/Pantages Theater
Water Works Assoc.
Webb House
Weems House
Welsh Home
Wilson Theater Building
Wishon Home
Wishon, A.G.; Home
Wishon, A.G.; Home, Fulton St
Woolfolk Home
YWCA Residence Hall
Yost & Webb Mortuary
Yost Sr Webb Mortuary/Martin
Young Home
Zacky Farm Grain Elevator

A 1988 publication from the state’s Office of Historical Preservation identified 16 “ethnic historic sites” in Fresno County. *Five Views: An Ethnic Historic Site Survey for California* was originally conceived to broaden the spectrum of ethnic community participation in historic preservation activities and to provide better information on ethnic history and associated sites. The 16 sites are as follows:

- Burr Ranch/Smith Brothers Ranch (Black American)
- Fowler City Park (Black American)
- Gabriel Moore Ranch (Black American)
- Young’s Place (Black American)
- First Mexican Baptist Church (Mexican American)
- Fresno Buddhist Church (Japanese American)
- Fresno Nihonmachi (Japanese American)
- H. Sumida Company (Japanese American)
- Iseki Labor Camp (Japanese American)
- Kamikawa Brothers (Japanese American)
- Nihin Byoin-Hashiba Sanitarium (Japanese American)
- Okonogi Hospital Site (Japanese American)
- Reedley Kyogi-Kai Hall (Japanese American)
- Bowles (Japanese American)
- Selma Japanese Mission Church (Japanese American)
- KGST (Mexican American)

The Fresno County General Plan Background Report also identifies 13 museums in Fresno County, most of which are located in the City of Fresno. They are all privately owned and operated nonprofit organizations.

- African-American Museum, Fresno (city)
- Centro Bellas Artes, Fresno (city)
- Clovis-Big Creek Historical Museum, Clovis
- Discovery Center, Fresno (city)
- Forestiere Underground Gardens, Fresno (city)
- Fresno Art Museum, Fresno (city)
- Fresno Metropolitan Museum, Fresno (city)
- German Museum, Fresno (city)
- Kearney Mansion Museum, Fresno (city)
- Meux Home Museum, Fresno (city)
- R.C. Baker Memorial Museum, Coalinga
- Reedley Museum, Reedley
- Sanger Depot Museum, Sanger

It should be noted that these lists may not be complete, as they may not include those properties currently in the nomination process and not yet listed. Additionally, as defined by the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), any property over 50 years of age is considered a historic resource and is potentially eligible for the National Register. Thus, in the event that the property is to be altered, or has been altered, as the result of a major federal action, the property must be evaluated under the guidelines set forth by CEQA and NEPA. Structural mitigation projects are considered alterations for the purpose of this regulation.

Natural Resources

Natural resources are important to include in benefit-cost analyses for future projects and may be used to leverage additional funding for mitigation projects that also contribute to community goals for protecting sensitive natural resources. Awareness of natural assets can lead to opportunities for meeting multiple objectives. For instance, protecting wetlands areas protects sensitive habitat as well as stores and reduces the force of floodwaters.

Central Coast Range Region

Only a small portion of the far western edge of Fresno County lies in the central Coast Range region. This area supports a mosaic of summer dry grassland, blue oak and blue oak-foothill pine woodland, and chaparral habitat types. Western Fresno County transitions from the grasslands and agriculture of the Central Valley to the inner coast region. Mostly intermittent streams flow from the inner Coast Range to the valley floor. Some can support riparian habitat that provides additional value to both resident and migratory wildlife.

San Joaquin Valley Floor Region

More than 50 percent of Fresno County lies in the southern San Joaquin Valley subregion of the Central Valley. This southern subregion is generally hotter and drier than the subregion to the north and supports some desert elements. The valley floor region has undergone extensive conversion of native habitats that existed before European settlement of the state. Presently, this region supports extensive amounts of agriculture and urban development around the Fresno, Clovis, and Sanger areas.

In the few remaining areas not converted to urban or agriculture use, unique biological features persist. Mixed in with areas of grassland habitat are freshwater and alkaline vernal pools that support unique native flora and fauna. A few small isolated areas of sodic vernal pools occur in the northwestern part of the County, primarily at the Kerman reserve. Concentrations of freshwater vernal pools occur in a belt along the northeast edge of the valley floor region north of the Kings River. In the highly modified Central Valley, vernal pool areas are often grazed but remain a unique biological relic of native California species in the natural landscape.

The rivers and streams that flow from the mountains in the east historically meandered through broad floodplain. Because of urbanization and agriculture, these broad floodplains have been restricted to narrower belts along the rivers and streams or otherwise modified for flood control. In the upper San Joaquin River, the floodplains are naturally constrained by high bluffs bordering the river. Within this modified landscape, the remaining riparian habitat provides corridors and linkages to and from the biotic regions of the County and is of great value to resident and migratory wildlife. The San Joaquin and Kings river systems and the Fresno Slough are the major waterways in the County.

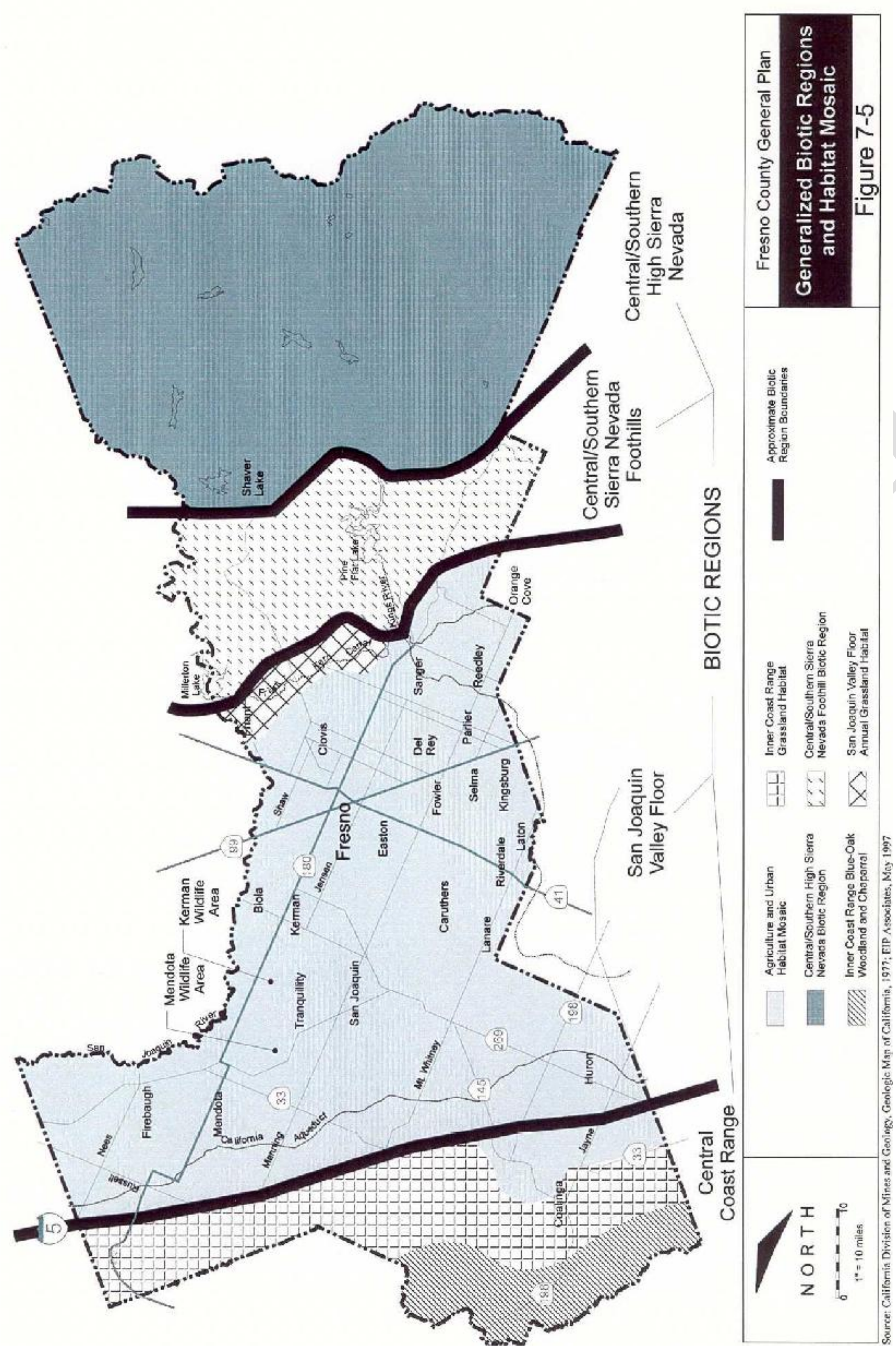
Central Southern Sierra Nevada Foothills

Fresno County includes a portion of the central and southern subregions of the Sierra Nevada Mountains that can be further divided into a central/southern Sierra Nevada foothill and central/southern high Sierra Nevada district. The foothill district is best differentiated from the high Sierra and the San Joaquin Valley areas by habitat types that change with topography. The foothills that are the transition from the valley floor to the high Sierra can be characterized by blue oak and blue oak-foothill pine woodlands and chaparral habitats dotted with areas of serpentine soils. Density and canopy coverage of tree species is highly variable depending on natural conditions such as soils, topography, slope and aspect, and human influences from grazing, hardwood harvesting, and other land clearing activities. Moderate gradient perennial and intermittent streams and rivers support a varied amount of riparian habitat that provide valuable habitat for wildlife.

Central/Southern High Sierra Nevada

The transition from the foothills to the high Sierra Nevada can be characterized by the addition of ponderosa pine at the low elevations into the dominant plant species composition (from around 2,000 feet). The foothills to high Sierra biotic regions make a transition through a mixed hardwood conifer habitat to those habitats dominated by conifers, such as ponderosa pine, white fir, and giant sequoia. In the higher elevations, Jeffrey pine, lodgepole pine, and treeless alpine communities dominate. Rivers and streams are at a higher gradient than their foothill or valley floor reaches and support a montane riparian habitat that, like the others, provides valuable habitat for resident and migratory wildlife. The majority of the high Sierra region in Fresno County is included in the Sequoia and Sierra National Forests and Kings Canyon National Park and managed by their respective federal agencies for recreational, timber, tourism, and wilderness values.

Figure 4.61 Fresno County's Generalized Biotic Regions and Habitat Mosaic



Source: Fresno County General Plan, 2000

Each region hosts specific habitats that together support a wide variety of vegetation and wildlife (see Table 4.30), and each region has different susceptibilities to hazards such as wildfire, flood, and drought. Fresno County recognizes the importance of protecting, preserving, conserving, and restoring this biodiversity.

Table 4.30 Fresno County Habitat Types by Biotic Region

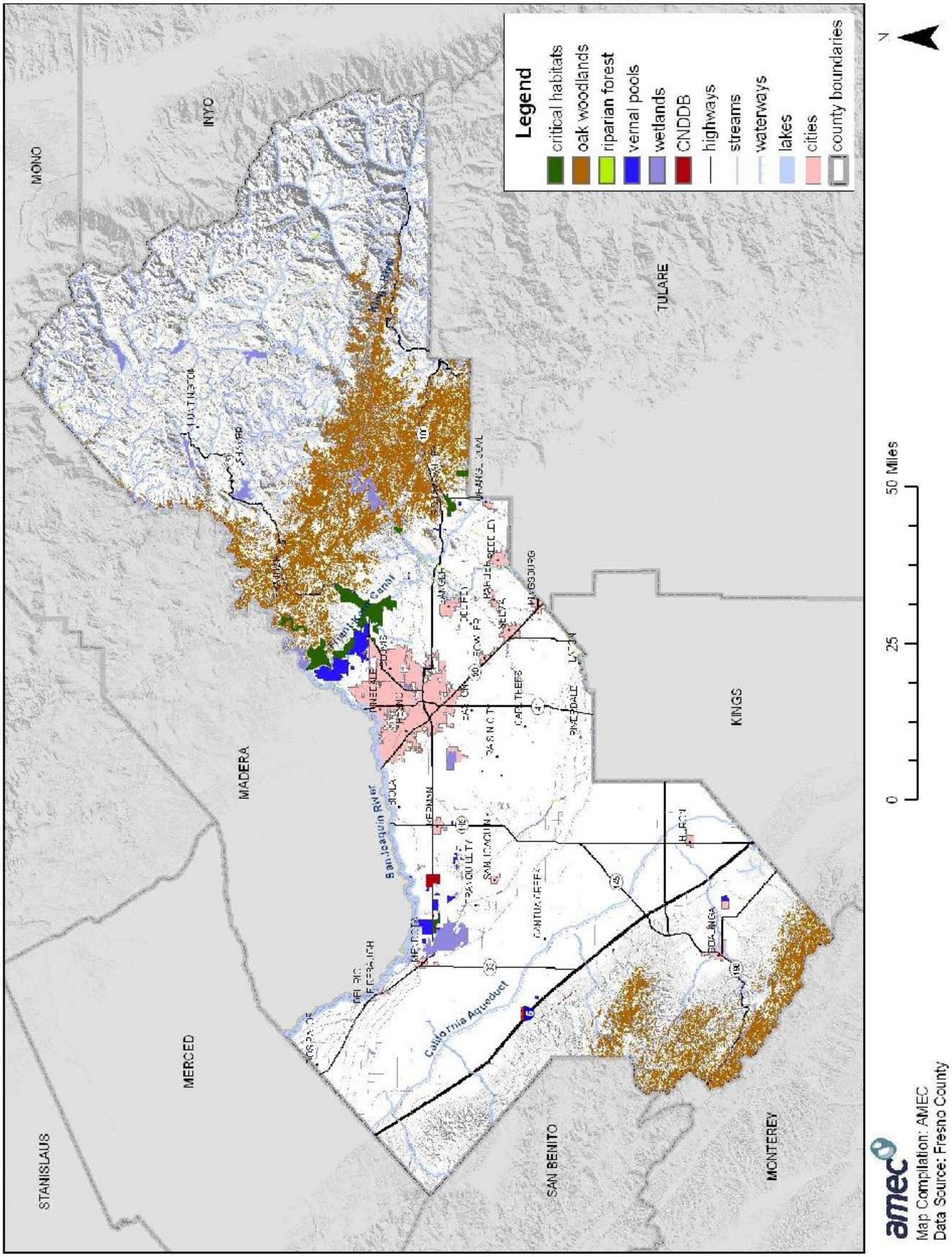
Central Coast Range	San Joaquin Valley Floor	Central/Southern Sierra Nevada Foothills	Central/Southern High Sierra Nevada
• Annual/Ruderal Grassland • Valley Oak Woodland • Pasture • Cropland • Valley-Foothill Riparian/Riverine • Fresh Emergent Wetland • Larustrine • Blue Oak Woodland • Blue Oak-Foothill Pine Woodland • Mixed Chaparral • Chamise-Redshank Chaparral	• Annual/Ruderal Grassland • Vernal Pool • Alkali Scrub • Pasture • Cropland • Orchard-Vineyard • Urban • Valley-Foothill Riparian • Fresh Emergent Wetland • Lacustrine	• Annual/Ruderal Grassland • Pasture • Cropland • Orchard-Vineyard • Urban • Valley-Foothill Riparian • Fresh Emergent Wetland • Larustrine • Blue Oak Woodland • Blue Oak Foothill Fine Woodland • Mixed Chaparral • Chamise-Redshank Chaparral	• Montane Chaparal • Montane Hardwood-Conifer • Montane Riparian • Sierran Mixed Conifer • Ponderosa Pine • Jeffrey Pine • White Fir • Red Fir • Lodgepole Pine • Subalpine Conifer • Alpine Dwarf Scrub • Wet Meadow • Bitterbrush • Juniper

Source: Fresno County General Plan, 2000

Approximately one third of the County lies within land under federal jurisdiction. The USDA Forest Service and National Parks Service manage these lands for recreation, biology, wilderness, tourism, timber, and mining under federal guidelines, policies, and laws. The biotic regions that are outside of federal ownership and, therefore, most subject to development are the Central Coast Range, San Joaquin Valley Floor, and the lower Sierra Nevada foothills.

For purposes of this plan, natural resources include special-status species, sensitive habitats, wetlands, and other natural resources identified by the HMPC. Figure 4.62 further illustrates Fresno County’s environmental features.

Figure 4.62 Fresno County's Environmental Features



Special-Status Species

To further understand natural resources that may be particularly vulnerable to a hazard event, as well as those that need consideration when implementing mitigation activities, it is important to identify at-risk species (i.e., endangered species) in the planning area. An endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Both endangered and threatened species are protected by law and any future hazard mitigation projects are subject to these laws. Candidate species are plants and animals that have been proposed as endangered or threatened but are not currently listed.

Information from the U.S. Fish and Wildlife Service and the California Natural Diversity Data Base, a program that inventories the status and locations of rare plants and animals in California, was combined to create an inventory of special-status species in Fresno County. The full inventory, along with information about habitat requirements and distribution where available from the Fresno County General Plan Background Report, is available in Appendix B: Special-Status Species in Fresno County. Table 4.31 lists national and state endangered, threatened, rare, and candidate species in Fresno County by species type.

Table 4.31 Endangered, Threatened, Rare, and Candidate Species in Fresno County

Common Name	Scientific Name	Federal Status	California Status
Amphibians			
California red-legged frog	*Rana aurora draytonii*	Threatened	None
California tiger salamander*	*Ambystoma californiense*	Threatened	None
Sierra Madre (=mountain) yellow-legged frog	*Rana muscosa*	Endangered	None
Sierra Nevada yellow-legged frog	*Rana sierrae*	Candidate	None
Yosemite toad	*Bufo canorus*	Candidate	None
Birds			
Bald eagle	*Haliaeetus leucocephalus*	Delisted	Endangered
Bank swallow	*Riparia*	None	Threatened
California condor	*Gymnogyps californianus*	Endangered	Endangered
Great gray owl	*Strix nebulosa*	None	Endangered
Swainson's hawk	*Buteo swainsoni*	None	Threatened
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Candidate	Endangered
Willow flycatcher	*Empidonax traillii*	None	Endangered
Fish			
Central Valley steelhead	*Oncorhynchus mykiss*	Threatened	None
Lahontan cutthroat trout	*Oncorhynchus (=Salmo) clarkii henshawi*	Threatened	None
Paiute cutthroat trout	*Oncorhynchus (=Salmo) clarkii seleniris*	Threatened	None
Invertebrates			
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Threatened	None
Vernal pool fairy shrimp*	*Branchinecta lynchi*	Threatened	None

Common Name	Scientific Name	Federal Status	California Status
Vernal pool tadpole shrimp*	*Lepidurus packardi*	Endangered	None
Mammals			
California wolverine	*Gulo*	None	Threatened
Fresno kangaroo rat*	*Dipodomys nitratoides exilis*	Endangered	Endangered
Giant kangaroo rat	*Dipodomys ingens*	Endangered	Endangered
Nelson's antelope squirrel	*Ammospermophilus nelsoni*	None	Threatened
Pacific fisher	*Martes pennanti (pacifica) DPS*	Candidate	None
San Joaquin kit fox	*Vulpes macrotis mutica*	Endangered	Threatened
Sierra Nevada (=California) bighorn sheep	*Ovis canadensis sierrae (=californiana)*	Endangered	Endangered
Sierra Nevada red fox	*Vulpes necator*	None	Threatened
Tipton kangaroo rat	*Dipodomys nitratoides*	Endangered	Endangered
Plants			
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	None	Endangered
California jewel-flower	*Caulanthus californicus*	Endangered	Endangered
Congdon's lewisia	*Lewisia congdonii*	None	Rare
Greene's tuctoria	*Tuctoria greenei*	Endangered	Rare
Hairy Orcutt grass*	*Orcuttia pilosa*	Endangered	Endangered
Hartweg's golden sunburst	*Pseudobahia bahiifolia*	Endangered	Endangered
Hoover's eriastrum	*Eriastrum hooveri*	Delisted	None
Keck's checkerbloom (=checker-mallow)*	*Sidalcea keckii*	Endangered	None
Mariposa pussypaws	*Calyptridium pulchellum*	Threatened	None
Palmate-bracted bird's-beak	*Cordylanthus palmatus*	Endangered	Endangered
San Benito evening-primrose	*Camissonia benitensis*	Threatened	None
San Joaquin adobe sunburst	*Pseudobahia peirsonii*	Threatened	Endangered
San Joaquin Valley Orcutt grass*	*Orcuttia inaequalis*	Threatened	Endangered
San Joaquin woollythreads	*Monolopia congdonii (=Lembertia congdonii)*	Endangered	None
Slender moonwort	*Botrychium lineare*	Candidate	None
Succulent (=fleshy) owl's-clover	*Castilleja campestris ssp. succulenta*	Threatened	Endangered
Tompkins' sedge	*Carex tompkinsii*	None	Rare
Tree-anemone	*Carpenteria californica*	None	Threatened
Reptiles			
Blunt-nosed leopard lizard	*Gambelia (=Croataphytus) sila*	Endangered	Endangered
Giant garter snake	*Thamnophis gigas*	Threatened	Threatened

Sources: U.S. Fish and Wildlife Service Sacramento Office, www.fws.gov/sacramento/; California Natural Diversity Data Base, www.dfg.ca.gov/biogeodata/cnddb/

*According to the U.S. Fish and Wildlife Service, critical habitat is designated for this species

Sensitive Habitats

The California Department of Fish and Game Natural Diversity Data Base identifies 12 sensitive habitat types in Fresno County:

- Big tree forest
- Coastal and valley freshwater marsh
- Great Valley mesquite scrub

- Great valley mixed riparian forest
- Monvero residual dunes
- Northern basalt flow vernal pool
- Northern claypan vernal pool
- Northern hardpan vernal pool
- Northern vernal pool
- Sycamore alluvial woodland
- Valley needlegrass grassland
- Valley sink scrub

Wetlands

Wetlands are habitats in which soils are intermittently or permanently saturated or inundated. Wetland habitats vary from rivers to seasonal ponding of alkaline flats and include swamps, bogs, marshes, vernal pools, and riparian woodlands. Wetlands are considered to be waters of the United States and are subject to the jurisdiction of the U.S. Army Corps of Engineers as well as the California Department of Fish and Game (CDF&G). Where the waters provide habitat for federally endangered species, the U.S. Fish and Wildlife Service may also have authority.

Wetlands are a valuable natural resource for communities due to their benefits to water quality, wildlife protection, recreation, and education and play an important role in hazard mitigation. Wetlands provide drought relief in water-scarce areas where the relationship between water storage and streamflow regulation are vital and reduce flood peaks and slowly release floodwaters to downstream areas. When surface runoff is dampened, the erosive powers of the water are greatly diminished. Furthermore, the reduction in the velocity of inflowing water as it passes through a wetland helps remove sediment being transported by the water.

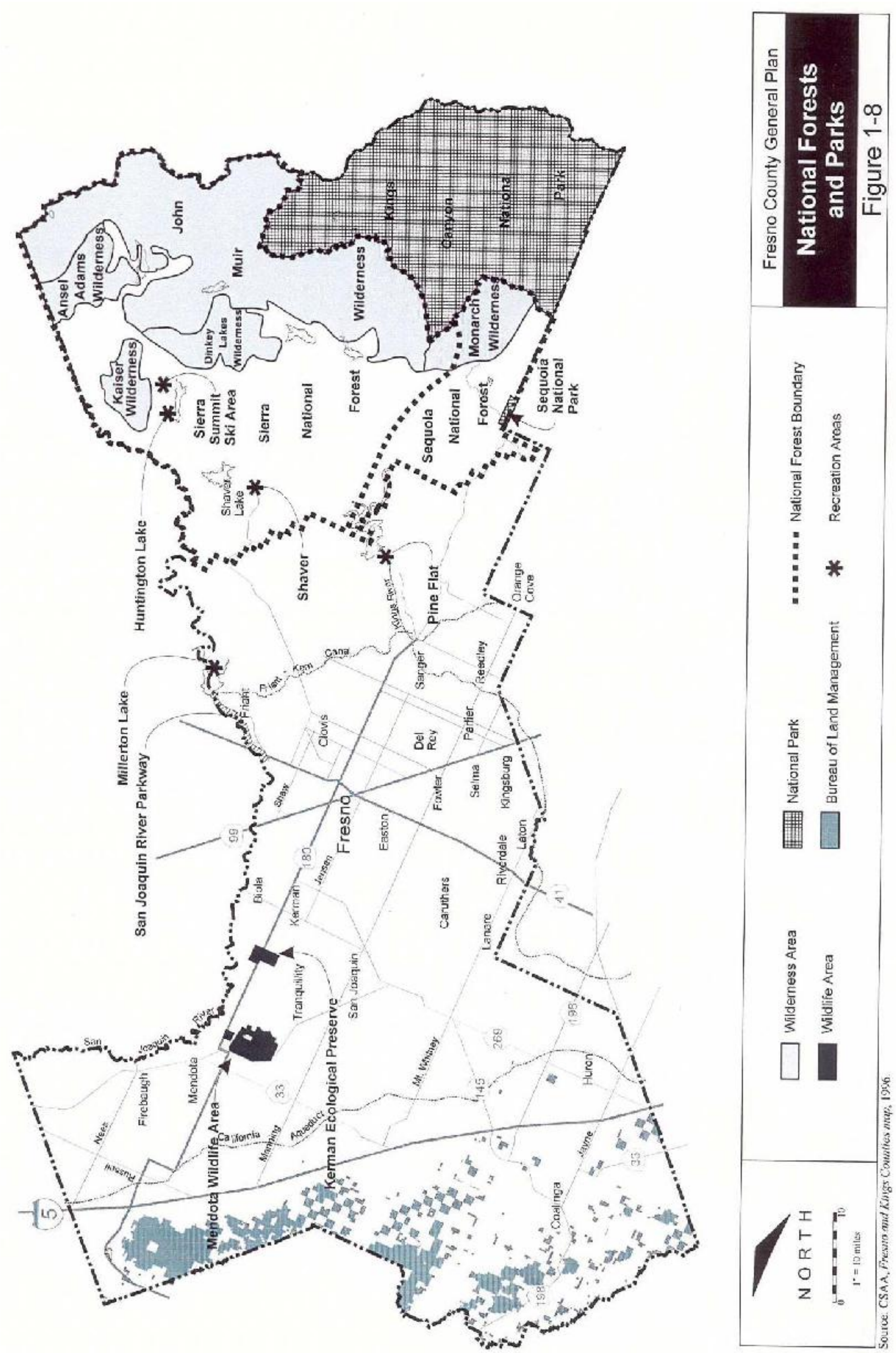
Notable categories of wetlands found in Fresno County include wet meadows in the mountainous region, vernal pools in the foothills, marshes in the valley trough, and reclaimed agricultural lands in western Fresno County. The CDF&G manages several of the major identified wetlands in Fresno County, including the Mendota Wildlife Management Area, Kerman Ecological Reserve, Alkali Sink Ecological Reserve, and smaller wetlands management units along the San Joaquin River. While these lands are currently being adequately protected, environmental concern is primarily focused on wetlands that are not yet identified and protection of remaining vernal pools. Several vernal pool complexes are located near Friant between Friant Road and the Friant-Kern Canal and in the area south of Academy and east of Red Mountain. A large concentration of very high quality vernal pools is found in these areas, and they are considered to be some of the best examples of vernal pools in the state. The County's vernal pools are threatened by urban development and conversion to intensive agriculture.

Other Natural Resources

While some of these resources are not owned or managed by the County, they are important assets for the County (see Figure 4.63).

- **Sierra National Forest**—Managed by the USDA Forest Service, makes up much of the eastern portion of the County north of the Kings River
- **Sequoia National Forest**—Managed by the USDA Forest Service, makes up a small portion of the County south of the Kings River
- **Kings Canyon National Park**—Managed by the National Park Service, encompasses a portion of southeastern Fresno County
- **John Muir, Ansel Adams, Monarch, Kaiser, and Dinkey Lake Wilderness Areas**—Managed by the Bureau of Land Management, located in the eastern portion of the County
- **Mendota Wildlife Area**—Operated by the California Department of Fish and Game, located three miles south of Mendota
- **Kerman Ecological Preserve**—Operated by the California Department of Fish and Game
- **Alkali Sink Ecological Reserve**—Operated by the California Department of Fish and Game
- **Allen Ranch**—640 acres operated by the California Department of Fish and Game
- **Millerton Lake State Recreational Area**—Administered by the California Department of Parks and Recreation

Figure 4.63 National Forests and Parks in Fresno County



Source: Fresno County General Plan, 2000

Growth and Development Trends

As part of the planning process, the HMPC looked at changes in growth and development, both past and future, and examined these changes in the context of hazard-prone areas, and how the changes in growth and development affect loss estimates and vulnerability. Information from the Fresno County General Plan Housing Element, the draft 2007 Fresno County Regional Housing Needs Allocation Plan, and the California Department of Finance form the basis of this discussion.

More specific information on growth and development for each participating jurisdiction can be found in the jurisdictional annexes.

Current Status and Past Development

The 2016 estimated population of Fresno County was 979,915. This was an increase of 5.09 percent from the 2010 census population of 932,450. In terms of population, Fresno County is the 10th largest county in California (and the 53rd largest in the United States). Table 4.32 through Table 4.35 illustrate past growth in Fresno County in terms of population, housing units, and density.

Table 4.32 Fresno County's Population Growth 1960-2016

	1960's	1970	1980	1990	2000	2010	2016*
Total	365,945	413,329	514,621	667,490	799,407	932,450	979,915
Change	--	47,384	101,292	152,869	131,917	133,043	47,465
Percent Change (%)	--	12.95	24.51	29.71	19.76	16.64	5.09

Sources: Social Science Data Analysis Network, www.censusscope.org/; California Department of Finance, www.dof.ca.gov/Research/
*Estimate

Table 4.33 Population Growth for Jurisdictions in Fresno County, 2010-2016

Jurisdiction	2010	2016*	% Change	# Change	% of County	% of Total Growth
Clovis	93,631	106,583	13.83%	12,952	10.88%	27.29%
Coalinga	13,380	16,598	24.05%	3,218	1.69%	6.78%
Firebaugh	7,549	8,311	10.09%	762	0.85%	1.61%
Fowler	5,682	6,348	11.72%	666	0.65%	1.40%
Fresno	494,665	522,053	5.54%	27,388	53.28%	57.70%
Huron	6,754	6,941	2.77%	187	0.71%	0.39%
Kerman	13,544	14,594	7.75%	1,050	1.49%	2.21%
Kingsburg	11,382	11,807	3.73%	425	1.20%	0.90%
Mendota	11,014	11,418	3.67%	404	1.17%	0.85%
Orange Cove	9,078	9,586	5.60%	508	0.98%	1.07%
Parlier	14,494	15,179	4.73%	685	1.55%	1.44%
Reedley	24,194	25,582	5.74%	1,388	2.61%	2.92%
San Joaquin	4,001	4,024	0.57%	23	0.41%	0.05%
Sanger	24,270	25,007	3.04%	737	2.55%	1.55%
Selma	23,219	24,597	5.93%	1,378	2.51%	2.90%
All Cities	758,867	808,628	6.56%	49,761	82.52%	105%
Unincorporated	173,583	171,287	-1.32%	-2,296	17.48%	-4.84%
County Totals	**932,450**	**979,915**	**5.09%**	**47,465**	**100%**	**100%**

Source: US Census Bureau. http://factfinder.census.gov/ *Estimate based on 2010 Census

Table 4.34 Growth in Housing Units for Jurisdictions in Fresno County, 2010-2016

Jurisdiction	2010	2016	% Change	# Change	% of County	% of Total Growth
Clovis	35,306	36,704	4%	1,398	11%	17%
Coalinga	4,344	4,453	3%	109	1%	1%
Firebaugh	2,096	2,189	4%	93	1%	1%
Fowler	1,842	1,803	-2%	-39	1%	0%
Fresno	171,288	175,978	3%	4,690	54%	56%
Huron	1,602	1,815	13%	213	1%	3%
Kerman	3,908	4,025	3%	117	1%	1%
Kingsburg	4,069	3,938	-3%	-131	1%	-2%
Mendota	2,556	2,872	12%	316	1%	4%
Orange Cove	2,231	2,407	8%	176	1%	2%
Parlier	3,494	3,845	10%	351	1%	4%
Reedley	6,867	7,484	9%	617	2%	7%
San Joaquin	934	1085	16%	151	0%	2%
Sanger	7,104	7,079	0%	-25	2%	0%
Selma	6,813	7,014	3%	201	2%	2%
All Cities	254,454	262,691	3%	8,237	81%	99%
Unincorporated	61,077	61,166	0.1%	89	19%	1%
County Totals	**315,531**	**323,857**	3%	8,326	100%	100%

Source: US Census Bureau. http://factfinder.census.gov/ *Estimate based on 2010 Census

Table 4.35 Population and Housing Unit Density for Jurisdictions in Fresno County, 2010-2016

Jurisdiction	Area in Square Miles	2010 Population Density	2010 Housing Unit Density	2016 Population Density*	2016 Housing Unit Density*
Clovis	17.12	5,469	2,062	6,226	2,144
Coalinga	5.96	2,245	729	2,785	747
Firebaugh	2.91	2,594	720	2,856	752
Fowler	2.03	2,799	907	3,127	888
Fresno	104.8	4,720	1,634	4,981	1,679
Huron	1.34	5,040	1,196	5,180	1,354
Kerman	2.16	6,270	1,809	6,756	1,863
Kingsburg	2.34	4,864	1,739	5,046	1,683
Mendota	1.87	5,890	1,367	6,106	1,536
Orange Cove	1.54	5,895	1,449	6,225	1,563
Parlier	1.62	8,947	2,157	9,370	2,373
Reedley	4.49	5,388	1,529	5,698	1,667
San Joaquin	0.99	4,041	943	4,065	1,096
Sanger	4.75	5,109	1,496	5,265	1,490
Selma	4.34	5,350	1,570	5,668	1,616
All Cities	158.26	4,795	1,608	5,109	1,660
Unincorporated	5,859.16	30	10	29	10
County Totals	**6,017.42**	155	52	163	54

Source: US Census Bureau. http://factfinder.census.gov/ *Estimate based on 2010 Census

Current Status and Past Development Summary

- 171,287 individuals, 17.48 percent of Fresno County's residents live in the unincorporated portion of the County.
- 808,628 individuals, 82.52 percent, of Fresno County's residents live within the County's incorporated areas.
- Population growth between 2010 and 2016 was greatest in the incorporated areas of Coalinga (24.05%), Clovis (13.83%), Fower (11.72%) and Firebaugh (10.09%).
- Numerically, the greatest population growth occurred in the Cities of Fresno (27,388) and Clovis (12,952). The combined population of the contiguous cities is 628,636, 64.15 percent of the County's total population.
- Population between 2010 and 2016 decreased by 1.32% (2,296 individuals) in the unincorporated county. Among the incorporated areas, growth was slowest in the City of San Joaquin (0.57%), Huron (2.77%), Sanger (3.04%), and Mendota (3.67%).
- Population growth in the City of Fresno was 57.7 percent of the County's total population growth. The City's housing unit growth was 56.3 percent of the County's total housing unit growth.

- Fresno County's population growth outstripped the increase in housing units by 2.5 percent, suggesting an increasing unmet housing need, larger household sizes (with potential overcrowding), or both.
- With 9,370 people per square mile, Parlier has the highest population density in the County, followed by Kerman (6,756), and Clovis (6,225). Clovis and Kerman displaced Orange Cove since the 2012 update of this plan.
- With 2,373 housing units per square mile, Parlier has the highest housing unit density in the County, followed by Clovis (2,143) and Kerman (1,863).

Future Development

As indicated in the previous section, Fresno County has been steadily growing over the last four decades, and this growth is projected to continue through the middle of the century. Table 4.36 shows the population projections for the County as a whole through 2050.

Table 4.36 Population Projections for Fresno County, 2000-2050

	2000	2010	2020	2030	2040	2050
Population	804,508	983,478	1,201,792	1,429,228	1,670,542	1,928,411
Percent Change (%)		22.25	22.20	18.92	16.88	15.44

Source: California Department of Finance, www.dof.ca.gov/Research/

Table 4.37 shows the population projections for each jurisdiction and the unincorporated area through 2050.

Table 4.37 Detailed Population Projections for Fresno County, 2015-2050

Jurisdiction	2015	2020	2025	2030	2035	2040	2045	2050
Clovis	114,770	123,780	132,830	141,110	149,150	156,860	164,130	171,740
Coalinga	16,530	17,350	18,170	18,920	19,650	20,350	21,010	21,700
Firebaugh	7,780	8,600	9,430	10,180	10,920	11,620	12,280	12,980
Fowler	6,580	7,240	7,890	8,490	9,070	9,630	10,160	10,710
Fresno	574,590	627,190	679,970	728,280	775,190	820,140	862,570	906,950
Huron	6,820	6,990	7,160	7,310	7,460	7,610	7,740	7,890
Kerman	14,880	15,900	16,930	17,860	18,770	19,650	20,470	21,330
Kingsburg	12,750	13,670	14,590	15,440	16,260	17,050	17,790	18,570
Mendota	11,210	12,030	12,850	13,610	14,340	15,040	15,700	16,390
Orange Cove	9,360	9,540	9,710	9,880	10,030	10,190	10,330	10,480
Parlier	15,100	16,100	17,110	18,040	18,940	19,800	20,610	21,460
Reedley	25,570	26,700	27,830	28,870	29,880	30,850	31,760	32,720
Sanger	26,310	27,990	29,680	31,230	32,730	34,170	35,520	36,940
San Joaquin	4,040	4,310	4,580	4,830	5,070	5,310	5,520	5,750
Selma	26,680	28,280	29,870	31,330	32,750	34,110	35,400	36,740
Subtotal Cities	**872,970**	**945,670**	**1,018,600**	**1,085,380**	**1,150,210**	**1,212,380**	**1,270,990**	**1,332,350**
Unincorporated	99,330	101,770	104,220	106,460	108,630	110,720	112,680	114,740
Total County	**972,300**	**1,047,440**	**1,122,820**	**1,191,840**	**1,258,840**	**1,323,100**	**1,383,670**	**1,447,090**

Future Development Summary

- According to the projections in Table 4.37, all areas of the County will continue to grow, but the percentage of growth will decrease over time, through 2050.
- The Fresno County General Plan assumes that 92.6 percent of the population growth experienced in Fresno County through the year 2020 will be directed to incorporated cities and 7.4 percent will be absorbed in the unincorporated area.
- In evaluating the residential growth potential based on development on vacant sites in the unincorporated areas, Fresno County recognizes the governmental, environmental, and economic influences that may impact the provision of new housing or maintenance of existing housing.
- The Land Resources Inventory verifies that there is no shortage of potentially developable land in Fresno County. Consistent with the County's urban development policy, intensive housing development will be directed to residentially zoned urban areas and established communities where infrastructure and services are available. This policy reflects the commitment to conserve natural and managed resources and to minimize the loss of valuable agriculture land and open space.

Social Vulnerability

Certain demographic and housing characteristics may amplify or reduce overall vulnerability to hazards. These characteristics, such as age, race/ethnicity, income levels, gender, building quality, and public infrastructure, all contribute to social vulnerability.

A Social Vulnerability Index compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina measures the social vulnerability of U.S. counties to environmental hazards for the purpose of examining the differences in social vulnerability among counties. Based on national data sources, primarily the 2000 census, it synthesizes 42 socioeconomic and built environment variables that research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards (i.e., social vulnerability). Eleven composite factors were identified that differentiate counties according to their relative level of social vulnerability: personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race (African American and Asian), ethnicity (Hispanic and Native American), occupation, and infrastructure dependence. Fresno County ranks in the top 20 percent in the nation and in the state on the vulnerability index, which indicates highest social vulnerability.

Fresno County is the 8th most socially vulnerable County (out of 58 counties) in California. To better understand the characteristics behind this ranking, the HMPC researched information from the 2000 census on four factors of social vulnerability: gender, age, language spoken in home, and wealth/poverty. These factors were analyzed for Fresno County as a whole and individually for each of the incorporated and unincorporated communities. One characteristic of social vulnerability is differential access to resources and greater susceptibility to hazards. All factors considered here are related to this characteristic. Table 4.38 displays these variables and compares them to the same variables for California and the United States. These factors of social vulnerability hold many implications for disaster response and recovery and are important considerations when identifying and prioritizing mitigation actions and overall goals and objectives of the plan.

Gender

Women may have a more difficult time recovering from disaster than men because of sector-specific employment, lower wages, and family care responsibilities. The percentage of men and women in the County is approximately equal: Fresno County is 50.1 percent female. This is generally true for the incorporated and unincorporated areas; however, Coalinga has a higher proportion of men to women, with 56.3 percent men, as well as Firebaugh (52.5%), and Fowler (51.1%). Some jurisdictions have higher proportions of women, including Huron (52.3%) and Sanger (52.2%).

Age

Age can affect the ability of individuals to move out of harm's way and take care of themselves. The HMPC analyzed two variables for age, percentage of population age 65 and over and percentage under age 18.

According to the Fresno County General Plan, the percentage of children in Fresno County decreased from 30.2 percent in 2010 to 29.3 percent in 2014. Fresno County as a whole has higher percentage of children than the state average, 29.3 percent and 24.2 percent respectively. Some cities have between 35 and 45 percent of their population under the age of 18 (San Joaquin, Orange Cove, Huron, Parlier). Fresno County's children population grew at an average annual rate of 0.3 percent while the statewide population of children declined at an average annual rate of -0.3 percent. The incorporated areas of the county, especially Coalinga, Fowler, and Kerman, the population of children grew rapidly over the period. The unincorporated county had a slight increase in the population of children between 2010 and 2014, an average annual growth rate of 0.4 percent. Although the low proportion of elderly residents in many areas lowers vulnerability; some of these areas have a high percentage of children, which heightens vulnerability

Fresno County has a slightly smaller percentage of seniors (10.6 percent) than California (12.1 percent). Fresno County's senior population grew at an average annual rate of 2.9 percent, compared to 3.3 percent for California. Unincorporated Fresno County has a higher percentage of seniors (14.9 percent) than the whole of Fresno County (10.6 percent), and higher than any of the individual incorporated cities. Huron experienced the highest average annual growth in the senior population, at a rate of 27.3 percent. The incorporated cities of Kerman, Reedley, and San Joaquin were the only cities to experience a negative average annual growth rate among the senior population. The percent of the population age 65 and over is particularly high in Kingsburg (10.4%), and Reedley (13.2%).

Language Spoken at Home

Language barriers can affect communication of warning information and access to post-disaster funding. In California, 39.5 percent of the population speaks a language other than English in the home. This is much higher than for the United States as a whole, which is 17.9 percent. Fresno County has a slightly higher percentage than the state: 40.8 percent. In more than half of Fresno County's cities and census-designated places, more than half of the populations speak languages other than English at home. In a number of communities, this percentage exceeds 75 percent: San Joaquin (89.8 percent), Huron (86.9 percent), Cantua Creek (83.3 percent), Parlier (82.9 percent), Mendota (82 percent), Calwa (81.8 percent), Orange Cove (77.9 percent), Firebaugh (77.1 percent), and Biola (76.8 percent). While this does not mean these populations do not speak English (20.7 percent of the County's population speaks English less than "very well"), these figures are indicative of cultural differences that may affect receipt of and response to disaster information.

Wealth and Poverty

Wealth and poverty are also indicators of social vulnerability. Low income and impoverished populations have fewer resources available for recovery and are more likely to live in structures of greater physical vulnerability. Wealthier communities often have greater capabilities to mitigate hazards and greater access to funds for recovery.

To compare wealth and poverty, the HMPC analyzed the percentage of individuals below the poverty level and the median home value in each city and census-designated place in Fresno County. Fresno County overall has a higher percentage of people living below the poverty level, 22.9 percent, than California (14.2 percent) or the nation (12.4 percent). Poverty is highest in the unincorporated areas of Orange Cove (44.5 percent) and Mendota (41.9 percent). The median value of single-family, owner-occupied homes in Fresno County in 2000 was $104,900 compared to $211,500 in California. Home values are lowest (below $80,000) in Cantua Creek, Lanare, Biola, Del Rey, Calwa, Tranquillity, Huron, and Laton.

Table 4.38 Measures of Fresno County's Social Vulnerability

	Total Population	Total Housing Units	% Females	% Under Age 18	% Age 65 and Over	% Speak Language Other than English in Home**	% Individuals Below Poverty Level**	Median Value ($), Single-Family Owner-Occupied Homes**
United States	308,745,538	133,351,840	50.9	24.0	13	17.9	15.5	178,600
California	37,253,956	13,845,790	50.3	28.1	12.5	39.5	16.3	385,500
Fresno County	930,450	321,955	49.9	28.2	6.1	40.8	26.8	194,600
Clovis	95,630	36,270	51.6	25.4	5.7	17.1	13.8	247,700
Coalinga*	13,380	4,472	43.7	33.0	5.9	42.2	23.2	154,600
Firebaugh	7,550	2,248	47.5	32.3	9.0	77.1	33.5	121,600
Fowler	5,570	154,600	48.9	29.6	9.0	53.7	25.3	204,500
Fresno	494,670	174,593	50.8	37.9	2.4	39.5	29.8	177,500
Huron	6,750	1,861	52.3	36.0	9.4	86.9	35.8	122,900
Kerman	13,540	3,975	50.5	26.4	10.4	62.4	25.6	174,300
Kingsburg	11,380	3,900	51.5	33.5	4.2	23.7	17.9	223,000
Mendota	11,010	2,951	47.	38.1	6.1	82	46.5	108,100
Orange Cove	9,080	2,460	51.6	35.4	5.7	77.9	53.0	116,300
Parlier	14,490	3,844	49.2	30.1	13.2	82.9	42.3	113,300
Reedley	24,190	7,240	49.7	30.8	9.2	58.8	26.7	164,200
San Joaquin	4,000	1,044	52.2	42.5	5.6	89.8	54.2	103,100
Sanger	24,270	7,350	50.7	29.9	9.4	65	23.0	161,800
Selma	23,220	6,984	49.8	28.2	6.1	55.6	24.3	164,100

Source: U.S. Census Bureau, 2010, American Community Survey 2015 estimates, www.census.gov
*Population count revised
**Based on sample data

4.3.2 Vulnerability of Fresno County to Specific Hazards

The Disaster Mitigation Act regulations require the HMPC to evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies, where data permits, the County's vulnerability to each of the hazards. Where specific hazards vary across the County vulnerability is broken out by jurisdiction where feasible; additional information can be found in the jurisdictional annexes. The hazards evaluated further as part of this vulnerability assessment include, in alphabetical order:

- Agricultural Hazards
- Avalanche
- Dam Failure
- Drought
  - Tree Mortality
- Earthquake
- Flood
  - Levee Failure
- Human Health Hazards
  - Epidemic/Pandemic
  - West Nile Virus
- Landslide
- Soil Hazards
  - Erosion
  - Expansive Soil
  - Land Subsidence
- Severe Weather
  - Extreme Temperatures
    - Extreme Cold/Freeze
    - Extreme Heat
  - Fog
  - Heavy Rain/Thunderstorm/Hail/Lightning
  - Windstorm
  - Snowstorm
  - Tornado
- Volcano
- Wildfire

A summary of the vulnerability of the County to each identified hazard is provided in each of the hazard-specific sections that follow. Vulnerability generally reflects the hazard significance rating which is also summarized in Section 4.1.1 Table 4.1. Vulnerability/Significance is measured in is a summary of the potential impact based on past occurrences, spatial extent, likelihood of future occurrences and impacts (damage and casualty potential). It is categorized into the following classifications:

- **Low**—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. The potential damage is more isolated and less costly than a more widespread disaster.
- **High**—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.

Vulnerability to Avalanches (Low)

People

Although future avalanches are likely to occur, the spatial extent is limited and the magnitude is low. Therefore, avalanches are a low significance hazard in the County. No known critical facilities or cultural resources were located in avalanche paths at the time this plan was written. It is public safety that is most threatened by this hazard. Outdoor recreationalists who travel into backcountry areas are most at risk. Additionally, while road closures help to mitigate impacts to travelers in avalanche-prone areas, snowplow drivers can still be exposed while clearing roads of snow or avalanche debris.

Property

In general, structures located below an area at high risk to avalanches are likely to be exposed to the impacts of an avalanche, but no instances of this were known based on available data.

Critical Facilities

There are not any known critical facility likely to be exposed to the impacts of an avalanche.

Natural Environment

Avalanches can erode topsoil, cover the environment with debris, and damage surrounding vegetation. For the most part the environment is resilient and would be able to rebound from whatever damages occurred, though this process could take years.

Future Development

Avalanche vulnerability could increase somewhat with future development and population growth as there will be a higher number of people driving on roadways and taking part in backcountry recreation. It is unlikely that risk to structures will increase as long as future development is planned outside of mapped or suspected avalanche hazard zones.

Vulnerability to Agricultural Hazards (High)

Given the importance of agriculture to Fresno County, agricultural hazards continue to be an ongoing concern. The primary causes of agricultural losses are severe weather events, such as drought and freeze and, to a limited extent, insect infestations and livestock disease. According to the HMPC, agricultural losses occur on an annual basis throughout the County and are usually associated with these severe weather events.

People

The largest impact to people from a widespread crop loss is pressure on the food supply. Some animal diseases can be transmitted to people which could pose a public health concern.

Property

The greatest impact to property from an agricultural hazard is crop damage and loss. Loss of livestock and poultry can also be significant. The economic value of total damaged or lost crops could range in the hundreds of millions of dollars.

Natural Environment

Critical Facilities

Agricultural hazards would most likely not have an impact on critical facilities. Mass mortality of animals could stress local rendering plants.

Future Development

Vulnerability to Dam Failure (High)

A dam failure can range from a small, uncontrolled release to a catastrophic failure. Vulnerability to dam failures is confined to the areas subject to inundation downstream of the facility. Secondary losses would include loss of the multi-use functions of the dam itself and associated revenues that accompany those functions.

People

Persons located underneath or downstream of a dam are at risk of a dam failure, though the level of risk can be tempered by topography, amount of water in the reservoir and time of day of the breach. Injuries and fatalities can occur from debris, bodily injury and drowning. Once the dam has breached, standing water presents all the same hazards to people as floodwater from other sources. People in the inundation area may need to be evacuated, cared for, and possibly permanently relocated. Specific population impacts are noted in the following section.

Property

In general, communities located below a dam and along a waterway are potentially exposed to the impacts of a dam failure. Specific inundation maps and risk information are included in the dam-specific emergency action plans. Due to the sensitive nature of this information, it is not included in this plan. Inundation maps that identify anticipated flooded areas (which may not coincide with known floodplains) are produced for all high hazard dams and are contained in the Emergency Action Plan (EAP) required for each dam. However, the information contained in those plans is considered sensitive and is not widely distributed. For reference, high hazard dams threaten lives and property, significant hazard dams threaten property only.

The potential impacts from a dam failure in the County and its municipalities are largely dependent on the specific dam or area in question. Generally, any buildings or other infrastructure located in a dam inundation area is vulnerable to the impacts from rising waters.

Dam failure flooding can occur as the result of partial or complete collapse of an impoundment. Dam failures often result from prolonged rainfall and flooding causing overtopping of the structure. The primary danger associated with dam failure is the high velocity flooding of those properties downstream of the dam.

According to the Fresno County Operational Area Dam Failure Evacuation Plan, of the 23 dams with a potential to impact the planning area four of them pose the greatest threat should a failure occur: Big Dry, Fancher Creek, Friant, and Pine Flat. According to the plan, a catastrophic failure of any of these dams could have a significant impact on Fresno County. Some jurisdictions are more at risk to dam failure than others. The City of Clovis and the City of Fresno are the most vulnerable, with three and five high hazard dams respectively. Centerville, Firebaugh, Friant, and Sanger also have a high hazard dam located within their boundaries. The failure of any of these dams would cause downstream flooding and would likely result in loss of life and property. The potential magnitude of a dam failure depends on the time of year and the base flow of the river when the failure occurs. During the winter months, when the river flows are higher, the impact to the area would be much greater and evacuation times much less.

Table 4.39 Major Dams with Potential to Impact the Fresno County Planning Area

Dam	Stream	Capacity (Acre-Feet)	Population Threatened
Balch Afterbay	North Fork Kings River	318	20
Balch Diversion	North Fork Kings River	1,295	20
Balsam Meadow	West Fork Balsam Creek	2,040	319
Big Creek No. 4	Big Creek	100	244
Big Creek No. 6	San Joaquin River	993	104

Dam	Stream	Capacity (Acre-Feet)	Population Threatened
Big Creek No. 7	San Joaquin River	35,000	713
Big Dry 1017	Big Dry Creek/ Dog Creek	30,200	266,502
Courtright	Helms Creek	123,300	20
Crane Valley	North Fork Willow Creek	45,410	142
Fancher Creek	Fancher Creek & Hog Creek	9,600	134,775
Florence Lake	South Fork San Joaquin River	64,406	822
Friant	San Joaquin River	520,500	75,184
Giffen Reservoir	Tributary Holland Creek	900	98
Hume Lake	Ten Mile Creek	1,410	57
Huntington Lake	Big Creek	88,834	1,018
Little Panoche	Little Panoche Creek	5,580	459
Mammoth Pool	San Joaquin River	123,000	817
Pine Flat	Kings River	1,000,000	143,678
Redbank	Redbank Creek	1,100	947
Sequoia Lake	Mill Flat Creek	1,370	27
Shaver Lake	Stevenson Creek	135,283	863
Vermilion Valley	Mono Creek	125,000	822
Wishon	North Fork Kings River	118,000	20

Source: Fresno County Operational Area Dam Failure Evacuation Plan, 2003

Dam failure flooding would vary by community depending on which dam fails and the nature and extent of the dam failure and associated flooding. Based on the risk assessment, it is apparent that a major dam failure could have a devastating impact on the planning area. Dam failure flooding presents a threat to life and property, including buildings, their contents, and their use. Large flood events can affect crops and livestock as well as lifeline utilities (e.g., water, sewerage, and power), transportation, jobs, tourism, the environment, and the local and regional economies.

Natural Environment

Dam failure effects on the environment would be similar to those caused by flooding from other causes. Water could erode stream channels and topsoil and cover the environment with debris. For the most part the environment is resilient and would be able to rebound from whatever damages occurred, though this process could take years.

Critical Facilities

A total dam failure can cause catastrophic impacts to areas downstream of the water body, including critical infrastructure. Any critical asset located under the dam in an inundation area would be susceptible to the impacts of a dam failure. Of particular risk would be roads and bridges that could be vulnerable to washouts, further complicating response and recovery by cutting off impacted areas. Risk to specific facilities is considered sensitive information but is detailed in the Fresno County Operational Area Dam Failure Evacuation Plan.

Future Development

Areas slated for future development should take into consideration potential impacts from dam failure risk upstream. In the case of a dam failure, inundation would likely follow some existing FEMA mapped floodplains, which contains development restrictions for areas in the 1% annual chance floodplain, but it could exceed those floodplains and affect areas that are not regulated for flood hazards. Also of note is that development below a low hazard dam could increase its hazard rating, though there are not any low hazard dams in the County.

Vulnerability to Drought (High)

People

The historical and potential impacts of drought on populations include agricultural sector job loss, secondary economic losses to local businesses and public recreational resources, increased cost to local and state government for large-scale water acquisition and delivery, and water rationing and water wells running dry for individuals and families. As drought is often accompanied by prolonged periods of extreme heat, negative health impacts such as dehydration can also occur, where children and elderly are most susceptible. Air quality often declines in times of drought which can affect those with respiratory ailments.

In particular, Fresno County's tree mortality risk and fallen tree occurrences has resulted in the closure of numerous roads most notably in parks, forest land, and outdoor recreation areas: In 2016, 20 to 30 campgrounds were closed as well as Kings Canyon National Park due to tree mortality risks to public safety. The risk is especially high between May and October, due to a dramatic influx of campers and other outdoor enthusiasts.

Property

The historical and potential impacts of drought on property include crop loss, injury and death of livestock and pets, and damage to infrastructure, homes and other buildings resulting from the secondary drought impact of land subsidence. As a related drought impact, tree mortality has resulted in potentially vulnerable critical infrastructure property as these trees become more susceptible to falling with time. Table 4.40 through Table 4.43 show the results of analysis for tree mortality related to property exposure. As depicted in Table 4.40, in both the incorporated and unincorporated parts of the county, there are 4,819 structures, valued at close to $657 million, with $337 million in contents located within the Tier I tree mortality hazard area. Most of the exposed buildings (90%) are residential and located in the unincorporated area, with total exposure (improved value and contents) for residentially zoned parcels equal to over $957 million. Tier II tree mortality only effects the unincorporated parts of Fresno County, with $8,688 buildings and $1.1billion in exposure.

Table 4.40 Tier I Tree Mortality Hazard by Property Type

Jurisdiction	Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Coalinga	Commercial	4	2	$177,515	$177,515	$355,030
	Exempt	1	1	$0	$0	$0
	Multi-Residential	1	1	$122,400	$61,200	$183,600
	Residential	5	6	$479,443	$239,722	$719,165
	Total	**11**	**10**	**$779,358**	**$478,437**	**$1,257,795**
Unincorporated	Agricultural	34	43	$2,642,571	$2,642,571	$5,285,142
	Commercial	67	124	$12,989,552	$12,989,552	$25,979,104
	Exempt	28	71	$0	$0	$0
	Multi-Residential	1	2	$121,255	$60,628	$181,883
	Open Space	17	18	$2,064,361	$2,064,361	$4,128,722
	Residential	3,365	4,551	$638,314,167	$319,157,084	$957,471,251
	Total	**3,512**	**4,809**	**$656,131,906**	**$336,914,195**	**$993,046,101**
	Grand Total	3,523	4,819	656,911,264	337,392,632	994,303,896

Table 4.41 Tier I Tree Mortality Hazard Summary

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Coalinga	11	10	$779,358	$478,437	$1,257,795
Unincorporated	3,512	4,809	$656,131,906	$336,914,195	$993,046,101
Total	**3,523**	**4,819**	**$656,911,264**	**$337,392,632**	**$994,303,896**

Table 4.42 Tier II Tree Mortality Hazard by Property Type

Jurisdiction	Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Unincorporated	Agricultural	172	219	$21,474,268	$21,474,268	$42,948,536
	Commercial	147	297	$59,402,148	$59,402,148	$118,804,296
	Exempt	55	166	$0	$0	$0
	Industrial	10	16	$1,772,934	$2,659,401	$4,432,335
	Multi-Residential	2	3	$159,849	$886,467	$1,046,316
	Open Space	215	237	$24,307,614	$159,849	$24,467,463
	Residential	5,923	7,750	$943,017,235	$12,153,807	$955,171,042
	Total	**6,524**	**8,688**	**$1,050,134,048**	**$96,735,940**	**$1,146,869,988**

Table 4.43 Tier II Tree Mortality Hazard Summary

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Unincorporated	6,524	8,688	$1,050,134,048	$96,735,940	$1,146,869,988
Total	**6,524**	**8,688**	**$1,050,134,048**	**$96,735,940**	**$1,146,869,988**

In addition to tree mortality hazards, several examples of agricultural impacts shape drought vulnerability and potential losses. When it comes to farm-gate values, Fresno County used to lead the nation in farm-gate crop values, but this has not been the case since 2012; reductions in the water supply being the primary factor.

The value of the nearly 400 different crops produced in Fresno County has continued to fall since it peaked at just over $7 billion in 2014. The 2016 figure of $6.18 billion provided by the County Agricultural Commissioner was not only lower than the previous year's figure by over 7.2 percent, it is off more than 12.5 percent from its 2014 record.

In raw numbers, Fresno County farmers and ranchers received $885 million fewer dollars in 2016 than they did in 2014. These producers also had 10 percent fewer acres of land in 2016 for the production of food and fiber compared to 2012. In 2016, the county had nearly 973,000 acres of irrigated farmland, a reduction of 12 percent over the same period.

Overall, water availability and prices, along with general commodity prices, account for the slump in the county's overall farm value. At no time since at least 1997 has the farm gate value fallen as steep in Fresno County as it has since 2014. Additionally, for West side growers, this included a third straight year of no surface water allocation. Moreover, for those jurisdictions where allocations were available, during the most recent drought some municipalities in Fresno County had to pay more for their surface water allocations. This impacted the smaller water districts and cities of Huron, Coalinga and Orange Cove that mostly rely on surface water. Officials also noted that a number of wells went dry, and drilling deeper was expensive and cost prohibitive. Together, such constraints on surface water allocations and groundwater supplies greatly impacts agricultural commodity growth, health, farm values and drought recovery efforts throughout the planning area.

Natural Environment

The historical and potential impacts of drought on the natural environment are widespread throughout public and private lands within the County, including tree mortality, impacts to all flora and fauna, and destabilization (erosion, subsidence) of land along streams and rivers, and within watersheds.

One of the core issue shaping the impact of drought in Fresno County and throughout California is water supply and demand. Several factors play into the issue including groundwater basins, surface water run-off, public and agricultural demand, and surface water storage water sheds. As such, an analysis was conducted through the 2010 Forest and Rangeland Assessment to identify threats and assets in order to select Priority Landscapes (PL) where water supply would benefit from forest management designed to protect or enhance water resources, the key effort which, in part, both defines and mitigates the severity of drought risk and vulnerabilities.

With regard to overall threat and asset findings shaping the potential severity of drought for Fresno County, the analysis determined that the Sierra bioregion (where Fresno County contains portions of the southern Sierra) has the greatest concentration of high priority landscape. The watersheds in this region contribute greatly to the state's water supply. They are under threat from climate change, wildfire and development. In addition, groundwater basins in the San Joaquin Valley and Sacramento Valley bioregions are an abundant resource that is heavily threatened by over pumping.

Given that the extent of the drought hazard is, in part, determined by the extent of ground and surface water over-pumping in Fresno County, it should also be pointed out that such over-pumping is part of a broader context of water supply and demand trends with related impacts to agriculture: (and the secondary hazard impacts from land subsidence resulting from groundwater withdrawal).

See also the discussion and maps showing Fresno County Wildfire Priority Landscapes based on threats to water supply and water quality in the wildfire vulnerability section. Trends in landscape characteristics indicate high threats to water quality and supply in the eastern portion of the County, in the Sierra Nevada region.

Critical Facilities

Drought impacts to critical facilities include water shortfalls for facility operations and critical functions, and potential structural destabilization and damage resulting from land subsidence. As a related drought impact, tree mortality has resulted in potentially vulnerable critical infrastructure as these trees become more susceptible to falling with time. The unincorporated county is the only area with critical facilities at risk to tree mortality. Table 4.44 below summarizes the types of facilities at-risk while Table 4.45 provides more details. In addition to the schools and fire stations in Tier I, there is one public works facility and two buildings of the Sheriff's Office located in the Tier II hazard areas.

Table 4.44 Critical Facilities within the Tree Mortality Tier I Summary

Jurisdiction	Facility Type	Counts
Unincorporated	Fire Station	8
	School	7
	Total	**15**

Table 4.45 Critical Facilities within the Tree Mortality Tier I in the Unincorporated County

Jurisdiction	Facility Type	Name
Unincorporated	Fire Station	Bald Mountain Volunteer Fire Department
	Fire Station	Big Creek Volunteer Fire Department
	Fire Station	Fresno County Fire Protection District - Shaver Lake
	Fire Station	Hume Lake Volunteer Fire and Rescue Company
	Fire Station	Huntington Lake Volunteer Fire Department
	Fire Station	Huntington Lake Volunteer Fire Department Station 2
	Fire Station	Pine Ridge Volunteer Fire Department
	Fire Station	Shaver Lake Volunteer Fire Department
	School	Big Creek Elementary
	School	Hammer Mountain School
	School	Hume Lake Charter
	School	Pine Ridge Elementary
	School	Pole Corral Elementary School

Table 4.46 Critical Facilities within the Tree Mortality Tier II Summary

Jurisdiction	Facility Type	Counts
Unincorporated	School	19
	Fire Station	13
	Department of Public Works	1
	Sheriff	2
	Total	**35**

Future Development

Because future development encompasses all forms of property, buildings, infrastructure, critical facilities and all related populations and their functions, drought impacts to future development align with the historical and potential impacts to populations, property, natural environment, and critical facilities discussed (above).

Vulnerability to Earthquake (Medium)

People and Property

Earthquake vulnerability is primarily based on population and the built environment. Urban areas in high seismic hazard zones are the most vulnerable, while uninhabited areas are less vulnerable.

The California Geological Survey and U.S. Geological Survey have done considerable work using GIS to identify populations in high seismic hazard zones in every California County.

Ground shaking is the primary earthquake hazard. Many factors affect the survivability of structures and systems from earthquake-caused ground motions. These factors include proximity to the fault, direction of rupture, epicentral location and depth, magnitude, local geologic and soils conditions, types and quality of construction, building configurations and heights, and comparable factors that relate to utility, transportation, and other network systems. Ground motions become structurally damaging when average peak accelerations reach 10 to 15 percent of gravity, average peak velocities reach 8 to 12 centimeters per second, and when the Modified Mercalli Intensity Scale is about VII (18-34 percent peak ground acceleration), which is considered to be very strong (general alarm; walls crack; plaster falls).

Fault rupture itself contributes very little to damage unless the structure or system element crosses the active fault. In general, newer construction is more earthquake resistant than older construction because of improved building codes and their enforcement. Manufactured housing is very susceptible to damage because rarely are their foundation systems braced for earthquake motions. Locally generated earthquake motions, even from very moderate events, tend to be more damaging to smaller buildings, especially those constructed of unreinforced masonry, as was seen in the Oroville, Coalinga, Santa Cruz, and Paso Robles earthquakes.

Common impacts from earthquakes include damage to infrastructure and buildings (e.g., crumbling of unreinforced masonry, failure of architectural facades, rupturing of underground utilities, and road closures). Earthquakes also frequently trigger secondary hazards, such as dam failures, landslides and rock falls, explosions, and fires that can become disasters themselves.

Estimating Potential Losses

Earthquake losses will vary across the Fresno County planning area depending on the source and magnitude of the event. The Coalinga earthquake provides a good estimate of loss to the planning area based on a realistic earthquake scenario. To further evaluate potential losses associated with earthquake activity in the planning area, a HAZUS-MH probabilistic earthquake scenario was run with the latest version of HAZUS-MH.

The methodology used probabilistic seismic hazard contour maps developed by the U.S. Geological Survey (USGS) for the 2014 update of the National Seismic Hazard Maps that are included with HAZUS-MH. The USGS maps provide estimates of potential ground acceleration and spectral acceleration at periods of 0.3 second and 1.0 second, respectively. The 2,500-year return period analyzes ground shaking estimates from the various seismic sources in the area with a 2 percent probability of being exceeded in 50 years. The International Building Code uses this level of ground shaking for building design in seismic areas and is more of a worst-case scenario.

The results of the scenario are captured in Table 4.47. Key losses included the following:

- Total economic loss estimated for the earthquake was $7.3 billion, which includes building losses and lifeline losses based on the HAZUS-MH inventory.
- Building-related losses, including direct building losses and business interruption losses, totaled $6.7 billion.
- 49,107 buildings (18% of total) were at least moderately damaged. 2,858 buildings were completely destroyed.
- Over 57 percent of the building- and income-related losses were residential structures.
- 15 percent of the estimated losses were related to business interruptions.
- The mid-day earthquake caused the most casualties: 2,205.
- 62,906 households experienced a loss of potable water the first day after the earthquake.

Table 4.47 HAZUS-MH Earthquake Loss Estimation: 2,500-Year Scenario Results

Type of Impact	Impacts to County
Total Buildings Damaged	Slight: 93,173 Moderate: 37,607 Extensive: 8,642 Complete: 2,858
Building and Income Related Losses	$6.74 billion 57 percent of damage related to residential structures 15 percent of loss due to business interruption
Total Economic Losses (Includes building, income and lifeline losses)	$7.3 billion
Casualties (Based on 2 a.m. time of occurrence)	Without requiring hospitalization: 1,212 Requiring hospitalization: 216 Life threatening: 19 Fatalities: 36
Casualties (Based on 2 p.m. time of occurrence)	Without requiring hospitalization: 2,205 Requiring hospitalization: 521 Life threatening: 77 Fatalities: 144
Casualties (Based on 5 p.m. time of occurrence)	Without requiring hospitalization: 1,498 Requiring hospitalization: 351 Life threatening: 80 Fatalities: 91
Damage to Transportation Systems	0 highway bridges, complete damage 61 highway bridges, moderate damage 2 airport facilities, moderate damage 2 bus facility, moderate damage
Damage to Essential Facilities	0 schools, 0 police stations, 0 fire station at least moderately damaged
Damage to Utility Systems	4 wastewater systems, moderate damage 1 oil system, moderate damage 10 electrical power systems, moderate damage 36 communication systems, moderate damage Potable water breaks: 1,863 Waste water breaks: 1,335 Natural gas breaks: 383
Households without Power/Water Service (Based on 289,391 total households)	Power loss, Day 1: 21,540 Power loss, Day 3: 13,819 Power loss, Day 7: 6,195 Power loss, Day 30: 1,375

Type of Impact	Impacts to County
	Power loss, Day 90: 30 Water loss, Day 1: 62,906 Water loss, Day 3: 60,182 Water loss, Day 7: 54,726 Water loss, Day 30: 24,665 Water loss, Day 90: 0
Displaced Households	3,985
Shelter Requirements	3,828
Debris Generation	1.41 million tons

Source: HAZUS-MH

A map showing the peak ground accelerations by census tract is shown in Figure 4.12, with warm color tones indicate damaging levels of shaking. The western portion of the County would experience the greatest shaking levels and damage due to its proximity to the San Andreas fault and other faults.

Natural Environment

An earthquake could cause cascading effects, including dam failure or rockslide that would impact the natural environment in different ways, depending on the scope of the cascading hazard. Other types of ground deformation could result as well.

Critical Facilities

An earthquake could have major impacts on critical infrastructure. HAZUS estimates impacts to critical facilities including hospitals, schools, Emergency Operations Centers (EOCs), police stations and fire stations. The following table shows the estimates for 2500-year scenario.

Table 4.48 Expected Damage to Critical Facilities

Classification	Total	Number of Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on Day 1
Hospitals	13	0	0	13
Schools	367	0	0	222
EOCs	2	0	0	2
Police Stations	28	0	0	23
Fire Stations	29	0	0	22
Total	439	0	0	282

Source: HAZUS-MH

In addition to the exposure analysis generated through Hazus, information provided by the California Geological Survey, and USGS was utilized to generate estimates of critical facilities within the 55% g or greater ground shaking potential area.

Table 4.49 Critical Facilities in Earthquake Hazard Areas

Jurisdiction	Facility Type	County
Coalinga	Airport	1
	Colleges & Universities	2
	Communications	1
	Department of Public Works	1
	Fire Station	3
	Health Care	1
	Police	3
	School	10
	Total	**22**
Firebaugh	Airport	1
	CalARP	2
	Fire Station	1
	Police	1
	School	9
	Urgent Care	1
	Total	**15**
Huron	CalARP	7
	Fire Station	1
	Police	1
	School	3
	Total	**12**
Mendota	Airport	1
	CalARP	1
	Fire Station	1
	School	7
	Total	**10**
San Joaquin	CalARP	1
	School	2
	Sheriff	1
	Total	**4**
Unincorporated County	Airport	5
	CalARP	35
	Department of Agriculture	1
	Department of Public Works	2
	Fire Station	5
	Nursing Home	1
	School	17
	Total	**66**
	Grand Total	**129**

Source: California Geological Survey, USGS

Future Development

Future development in the county is not anticipated to significantly affect vulnerability to earthquakes, but will result in a slight increase in exposure of the population and building stock

Vulnerability to Flood/Levee Failure (High)

People

The total number of residential properties in each floodplain was multiplied by the average household size of 3.17 persons for the County (2010 census), and that total was multiplied by the County Occupancy Factor (95%) to estimate resident population. Based on this analysis, which accounts for residents only and not workers, there are 6,662 residents living in the 100-year flood zone throughout Fresno County. Of all study areas, the unincorporated county has the most residents living in the 1% annual chance flood area, followed by the City of Firebaugh. Table 4.50 below details population estimates by jurisdiction, followed by similar tables for the 200-year and 500-year floodplains.

Table 4.50 Population Living in 1% Annual Chance Flood Hazard Zone

Jurisdiction	Population
Clovis	409
Coalinga	330
Firebaugh	1,385
Fowler	152
Fresno	342
Huron	3
Kerman	-
Kingsburg	-
Mendota	165
Orange Cove	583
Parlier	101
Reedley	-
San Joaquin	-
Sanger	346
Selma	51
Unincorporated	2,796
Total	**6,662**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA, US Census Bureau

The same analysis was conducted for the 500-year floodplain, indicating that there are 143,481 residents living in the 500-year flood zone throughout Fresno County. The majority of people living in this floodplain are residents of the City of Fresno, with 107,400 people representing 75% of the total. This population distribution is shown in Table 4.51.

Table 4.51 Population Living in 0.2% Annual Chance Flood Hazard Zone

Jurisdiction	Population
Clovis	18,741
Coalinga	1,797
Firebaugh	2,143
Fowler	51
Fresno	107,400
Huron	1,880
Kerman	-
Kingsburg	-
Mendota	38
Orange Cove	127
Parlier	-
Reedley	428
San Joaquin	-
Sanger	155
Selma	-
Unincorporated	10,721
Total	**143,481**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA, US Census Bureau

Population estimates were also generated for the 200-year floodplain using data provided by the USACE Comprehensive Study and the CA DWR. This flood hazard area does not cover as many jurisdictions as the 1% or 0.2% annual chance flood zones, with 3,294 residents at-risk. Table 4.52 shows the communities and number of residents effected, with a large concentration located in the City of Firebaugh.

Table 4.52 Population Living in 200-Year Flood Hazard Zone

Jurisdiction	Population
Clovis	-
Coalinga	-
Firebaugh	2,729
Fowler	-
Fresno	57
Huron	-
Kerman	-
Kingsburg	-
Mendota	222
Orange Cove	-
Parlier	-
Reedley	-
San Joaquin	-
Sanger	-

Jurisdiction	Population
Selma	-
Unincorporated	285
Total	**3,294**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; USACE Comprehensive Study

Property

Flooding is a natural occurrence in the Central Valley because it is a natural drainage basin for thousands of watershed acres of Sierra Nevada and Coast Range foothills and mountains. Historically, the Fresno County planning area has been at risk to flooding primarily during the winter and spring months when river systems in the County swell with heavy rainfall and snowmelt runoff. Normally, storm floodwaters are kept within defined limits by a variety of storm drainage and flood control measures. But, occasionally, extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage.

Flooding has occurred in the past: within the 100-year floodplain and in other localized areas. Recent draft digital flood insurance rate maps (DFIRMs) dated January 2016 placed additional areas within the 100-year or greater floodplain. This is primarily due to the inability of the old and inadequate levees to be certified in accordance with current FEMA standards. As such, these levees no longer provide protection from the 100-year flood. It should be noted, however, that all levees, whether certified or not, provide some level of protection to the planning area and remain a critical factor in floodplain management for the communities.

The continued need to rely on these flood control structures is an ongoing concern. The history of the area, beginning with hydraulic gold mining techniques and through the continuing conversion of agricultural lands to commercial and residential uses, makes it impossible to reverse the planning area's dependence on structural flood control protection. Levee maintenance is a continuous effort due to erosion and scour brought on by the channelization itself.

Additional improvements to strengthen the levees and make them less susceptible to seepage induced failures are a priority of local and state agencies. Once these improvements are made, certification may be possible. Nevertheless, while these improvements may mitigate the impacts of flooding due to levee failure, the levees will remain subject to overtopping by flood events larger than their design capacity.

The likelihood of flooding increases with the heavy rains that occur annually between November and May. In addition to damage to area infrastructure, other problems associated with flooding include erosion, sedimentation, degradation of water quality, loss of environmental resources, and certain health hazards.

Methodology

A flood vulnerability assessment was performed for Fresno County using GIS. The county's parcel layer and associated assessor's building improvement valuation data were provided by the county and were used as the basis for the inventory. Fresno County's effective DFIRM was used as the hazard layer. DFIRM is FEMA's flood risk data that depicts the 1% annual chance (100-year) and the 0.2% annual chance (500-year) flood events. Fresno County's effective FEMA DFIRM, dated January 20, 2016, was determined to be the best available floodplain data. Table 4.53 summarizes the flood zones included on these maps.

Table 4.53 Fresno County's Flood Zones

Flood Zone	Definition
Special Flood Hazard Areas (SFHA) Subject to Inundation by 100-Year Flood	
Zone A	No base flood elevations determined
Zone AE	Base flood elevations determined
Zone AH	Flood depths of 1-3 feet (usually areas of ponding); base flood elevations determined
Zone AO	Flood depths of 1-3 feet (usually sheet flow on sloping terrain); average depths determined; for areas of alluvial fan flooding, velocities also determined
Zone AR	SFHA formerly protected from the 1 percent annual chance flood by a flood control system that was subsequently decertified; zone AR indicates that the former flood control system is being restored to provide protection from the 1 percent annual chance or greater flood
Zone A99	Area to be protected from 1 percent annual chance flood by a federal flood protection system under construction; no base flood elevations determined
Other Flood Areas	
Zone X (with color coding)	Areas of 0.2 percent annual chance flood (i.e., 500-year flood); areas of 1 percent annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1 percent annual chance flood
Other Areas	
Zone X (with no shading)	Areas determined to be outside the 0.2 percent annual chance floodplain
Zone D	Areas in which flood hazards are undetermined, but possible

Source: 2016 Draft Digital Flood Insurance Rate Maps, Fresno County

GIS was used to intersect the parcel boundaries with a master address point layer to obtain number of buildings per parcel. The parcel layer was then converted into a centroid, or point, representing the center of each parcel polygon.

Only parcels with improvement values greater than zero and address points were used in the analysis, this method assumes that improved parcels have a structure of some type. The DFIRM flood zones were overlaid in GIS on the address points and parcel centroid data to identify structures that would likely be inundated during a 1% annual chance and 0.2% annual chance flood event. These overlays can be seen graphically in the regional maps in Figure 4.64, Figure 4.65, and Figure 4.66, and in more detail in the jurisdictional annexes.

Figure 4.64 Eastern Fresno County Flood Hazards

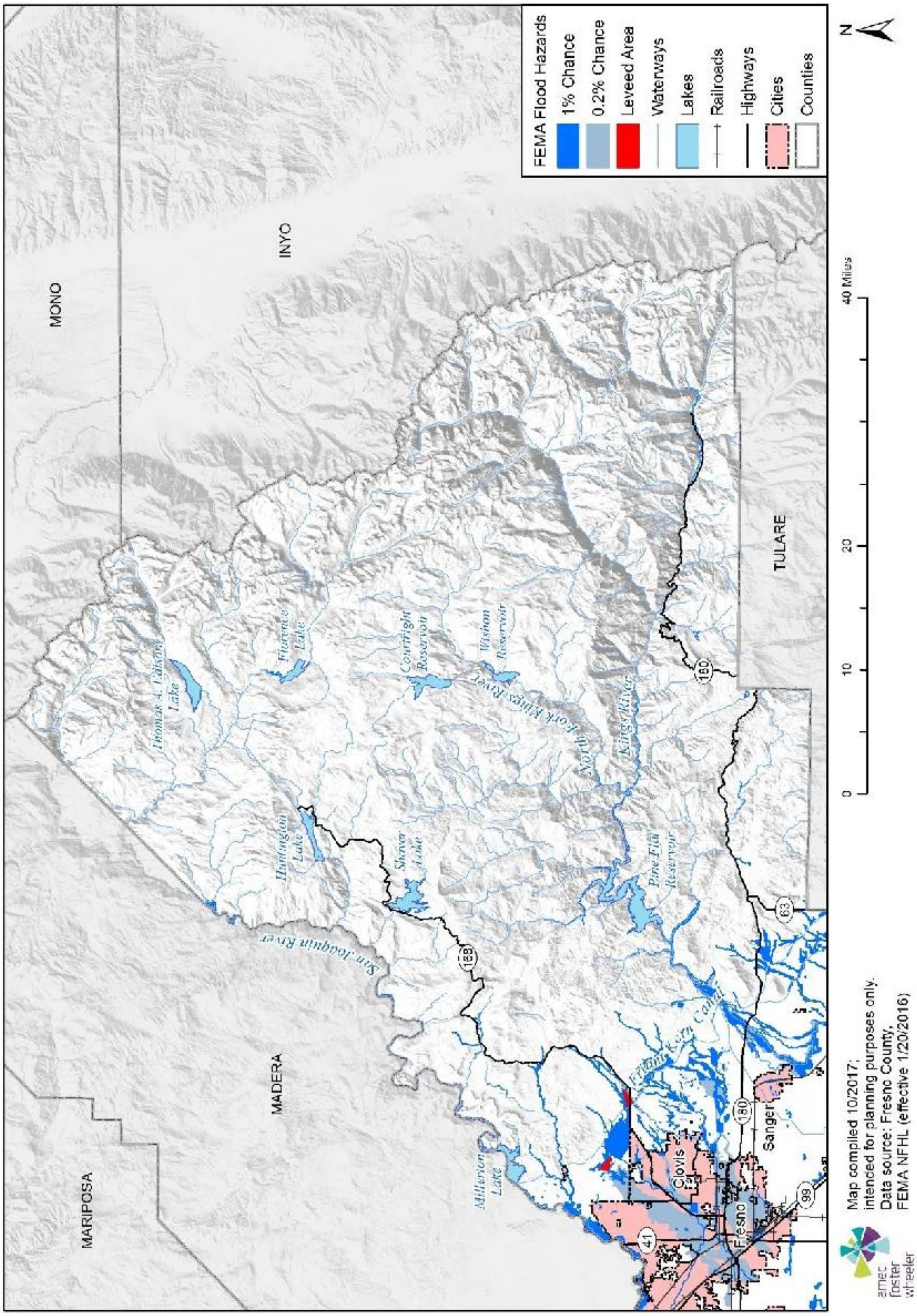


Figure 4.65 Central Fresno County Flood Hazards

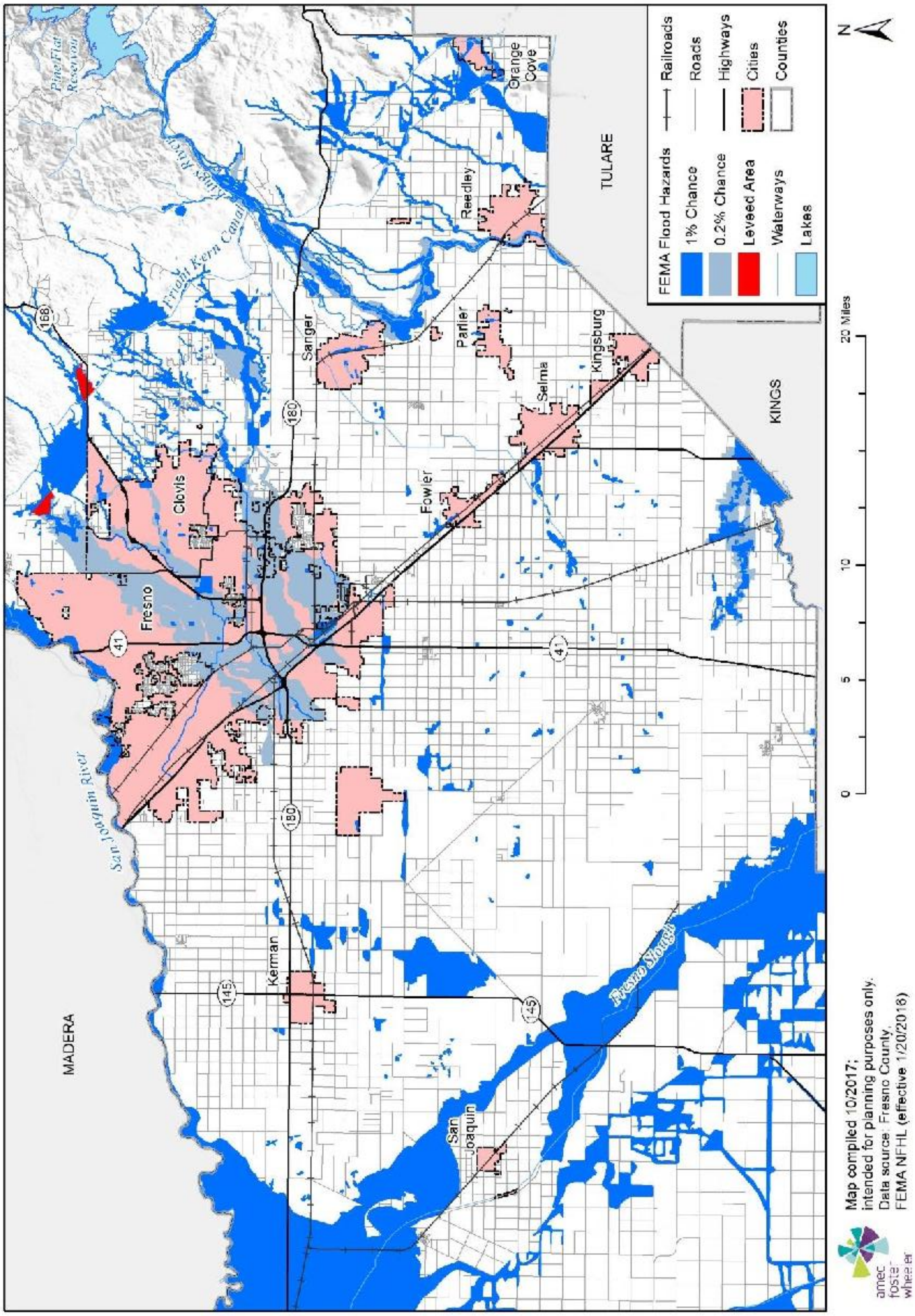


Figure 4.66 Western Fresno County Flood Hazards

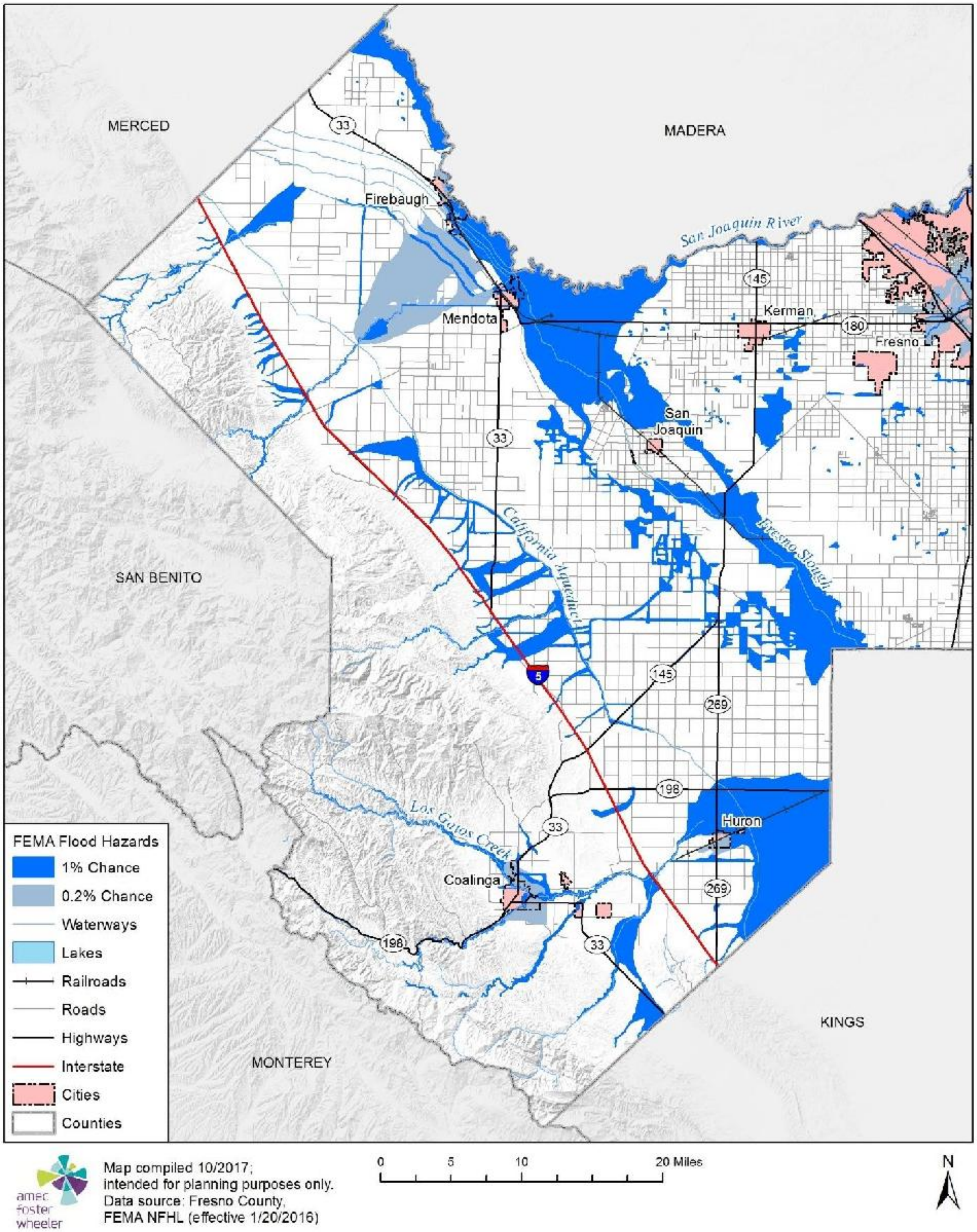
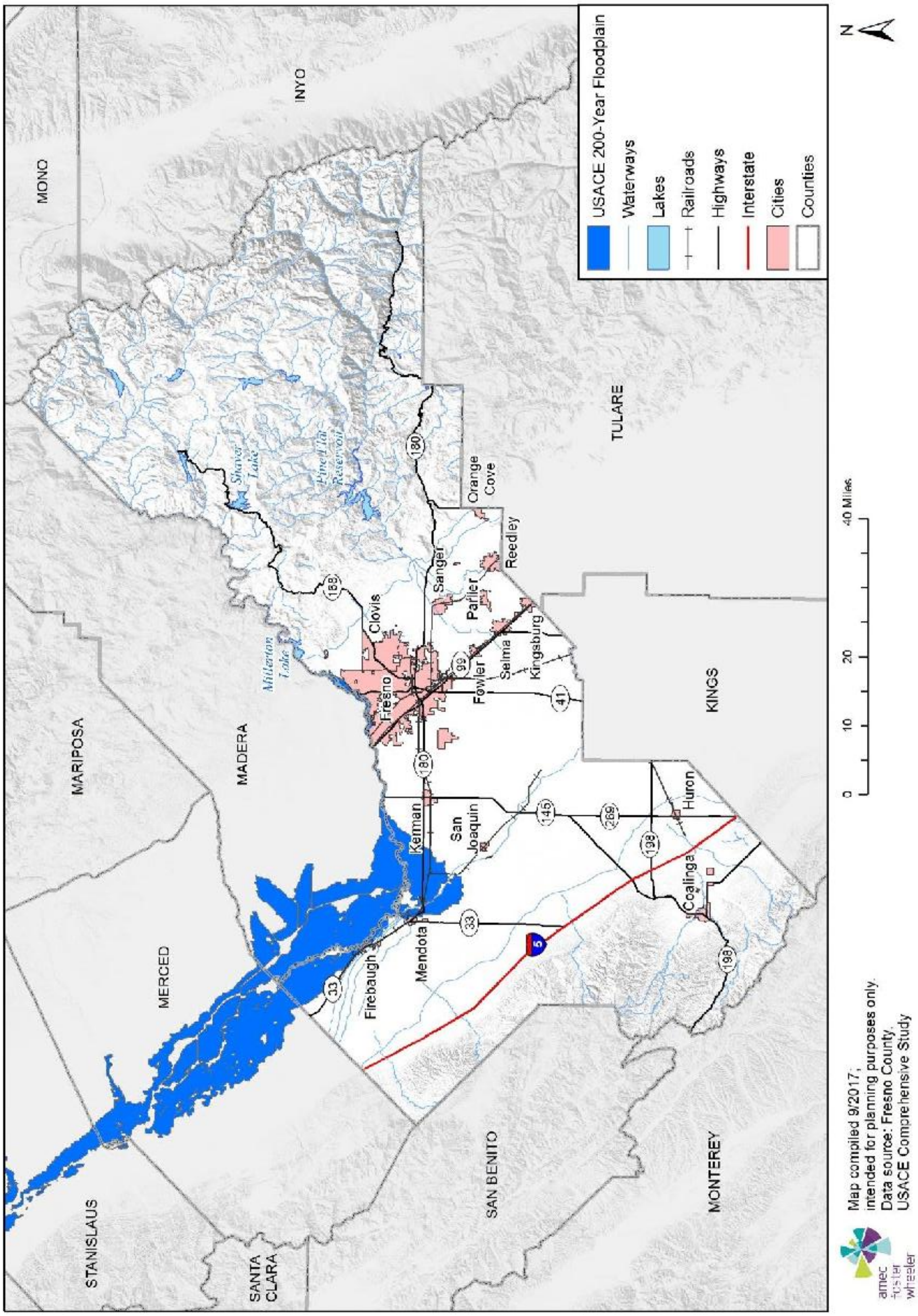


Figure 4.67 Fresno County USACE Comprehensive Study 200-Year Floodplain



Building improvement values and counts for those points were then extracted from the parcel/assessor's data and summed for the unincorporated county and jurisdictions. Results of the overlay analysis area shown in Table 4.54 for the 1% annual chance flood and Table 4.55 for 0.2% annual chance flood. The jurisdictional annexes provide more detailed information based on property type. Property type refers to the land use of the parcel and includes agricultural, commercial, exempt, industrial, multi-residential, open space and residential. Building loss is the number of impacted structures divided by the total number of structures in the jurisdiction.

A loss estimate analysis was also performed based on depth damage functions developed by the Corp of Engineers and applied in FEMA's BCA software. The loss curves depict the expected flood losses associated with the depth of flooding at a structure. Contents values were estimated as a percentage of building value based on their occupancy type, using FEMA/HAZUS estimated content replacement values. This includes 100% of the structure value for agricultural, commercial, exempt, and open space structures, 50% for multi-residential and residential structures and 150% for industrial structures. Building and contents values were totaled to obtain total exposure.

There are different curves for structure and content losses. For the purposes of this planning level analysis, an average flood depth of 2 feet is assumed. A depth damage ratio of 25% was used for structural loss, based on the FEMA damage curves for a 2-foot flood. The results are shown in the loss estimate columns in Table 4.54 for the 1% annual chance flood, Table 4.55 for the 0.2% annual chance flood and Table 4.56 for areas protected by levee.

It is important to note that there could be more than one structure or building on an improved parcel (i.e., condo complex occupies one parcel but might have several structures). Parcel and structure count were separated in the analysis to help better identify this issue. The end result is an inventory of the number and types of parcels and buildings subject to the hazards. Results are presented by unincorporated county and incorporated jurisdictions. Detailed tables show counts of parcels by jurisdictions and land use type (agricultural, commercial, exempt, industrial, multi-residential, open space and residential) within each flood zone. This flood loss analysis does not account for business disruption, emergency services, environmental damages, or displacement costs, thus actual losses could exceed the estimate shown.

Table 4.54 Count and Improved Value of Parcels in 1% Annual Chance Floodplain by Jurisdiction

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Clovis	170	232	$46,561,472	$30,660,891	$77,222,363	$19,305,591
Coalinga	109	221	$10,100,954	$5,627,905	$15,728,859	$3,932,215
Firebaugh	464	542	$54,041,713	$41,117,441	$95,159,154	$23,789,789
Fowler	53	57	$6,251,558	$4,204,757	$10,456,315	$2,614,079
Fresno	231	556	$62,764,109	$65,204,716	$127,968,825	$31,992,206
Huron	1	0	$4,125,000	$2,062,500	$6,187,500	$1,546,875
Kerman	-	-	-	-	-	-
Kingsburg	-	-	-	-	-	-
Mendota	54	46	$10,235,064	$5,257,341	$15,492,405	$3,873,101
Orange Cove	251	313	$22,644,434	$13,891,997	$36,536,431	$9,134,108
Parlier	43	53	$2,846,336	$2,038,897	$4,885,233	$1,221,308
Reedley	3	3	$0	$0	$0	$0
San Joaquin	-	-	-	-	-	-
Sanger	134	351	$21,812,438	$19,633,372	$41,445,810	$10,361,453
Selma	16	18	$1,953,999	$977,000	$2,930,999	$732,750
Unincorporated	2,364	2,303	$665,119,669	$588,852,859	$1,253,972,528	$313,493,132
Total	**3,893**	**4,695**	**$908,456,746**	**$779,529,675**	**$1,687,986,421**	**$421,996,605**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA

Table 4.55 Count and Improved Value of Parcels in 0.2% Annual Chance Floodplain by Jurisdiction

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Clovis	6,129	9,544	$1,468,015,418	$850,310,253	$2,318,325,671	$579,581,418
Coalinga	583	666	$100,974,088	$98,146,277	$199,120,365	$49,780,091
Firebaugh	749	877	$78,569,006	$75,471,573	$154,040,579	$38,510,145
Fowler	16	5	$1,449,011	$1,449,011	$2,898,022	$724,506
Fresno	37,849	64,728	$5,358,755,572	$5,114,818,267	$10,473,573,839	$2,618,393,460
Huron	674	858	$61,211,332	$56,966,997	$118,178,329	$29,544,582
Kerman	-	-	-	-	-	-
Kingsburg	-	-	-	-	-	-
Mendota	13	24	$1,704,421	$1,704,421	$3,408,842	$852,211
Orange Cove	43	51	$10,402,925	$8,631,773	$19,034,698	$4,758,674
Parlier	-	-	-	-	-	-
Reedley	137	186	$29,706,099	$29,706,099	$59,412,198	$14,853,050
San Joaquin	-	-	-	-	-	-
Sanger	49	50	$7,767,763	$7,767,763	$15,535,526	$3,883,882
Selma	-	-	-	-	-	-

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Unincorporated	3,921	4,553	$566,971,666	$594,425,493	$1,161,397,159	$290,349,290
Total	**50,163**	**81,542**	**$7,685,527,301**	**$6,839,397,924**	**$14,524,925,225**	**$3,631,231,306**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA

Looking at the flood risk for the entire Fresno County planning area, in general, Clovis, Firebaugh, Coalinga, Fresno, and Reedley are predominantly inundated by the 500-year flood. Orange Cove, San Joaquin, and Sanger are predominantly inundated by the 100-year flood. Fowler, Huron, Mendota, Parlier, and Selma are just barely affected by the floodplain. Kerman and Kingsburg are not in floodplains. This analysis does not take localized flooding into account

Table 4.56 Fresno County Flood Loss Estimates—Fresno County Planning Area

Flood Hazard	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
1% Annual Chance	3,893	4,695	$908,456,746	$779,529,675	$1,687,986,421	$421,996,605
0.2% Annual Chance	50,163	81,542	$7,685,527,301	$6,839,397,924	$14,524,925,225	$3,631,231,306
Leveed Area	54	61	$8,644,969	$4,781,060	$13,426,029	$3,356,507
Total	**54,110**	**86,298**	**$8,602,629,016**	**$7,623,708,659**	**$16,226,337,675**	**$4,056,584,419**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA
*Includes 500-year and 100-year flood data

According to this information, the Fresno County planning area has 3,893 parcels valued at roughly $908.4 million in the 100-year floodplain. An additional 50,163 parcels valued at roughly $7.7 billion fall within the 500-year floodplain, plus the 54 parcels ($8.6million value) in the leveed areas. As a result, total structural exposure is approximately $8.6 billion. When factoring the content values within these areas in addition to the structures and contents in leveed areas the total combined value of exposure is $16.2 billion. The end of this section provides more discussion on vulnerability in leveed areas.

In addition to the analysis of the 100- and 500-year floodplains, Table 4.57 describes the property located in the 200-year floodplain. There are significantly fewer parcels and buildings located in this area, and only three related jurisdictions. The majority of parcels in the 200-year flood hazard layer are located in the City of Firebaugh, with 1,362 buildings representing over half of all at-risk structures. In total, there is $446 million in combined structural and content value in this floodplain throughout the Fresno County planning area.

Table 4.57 Count and Improved Value of Parcels in 200-Year Floodplain by Jurisdiction

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Clovis	-	-	-	-	-	-
Coalinga	-	-	-	-	-	-

Jurisdiction	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Firebaugh	985	1,362	$97,678,429	$57,792,254	$155,470,683	$38,867,671
Fowler	-	-	-	-	-	-
Fresno	27	163	$16,486,935	$10,435,182	$26,922,117	$6,730,529
Huron	-	-	-	-	-	-
Kerman	-	-	-	-	-	-
Kingsburg	-	-	-	-	-	-
Mendota	78	76	$8,931,543	$9,493,886	$18,425,429	$4,606,357
Orange Cove	-	-	-	-	-	-
Parlier	-	-	-	-	-	-
Reedley	-	-	-	-	-	-
San Joaquin	-	-	-	-	-	-
Sanger	-	-	-	-	-	-
Selma	-	-	-	-	-	-
Unincorporated	558	564	$124,258,595	$121,876,254	$246,134,849	$61,533,712
Total	**1,648**	**2,165**	**$247,355,502**	**$199,597,576**	**$446,953,078**	**$111,738,269**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; USACE Comprehensive Study

Table 4.58, Table 4.59, and Table 4.60 below provides a detailed analysis that shows the count and improved value of parcels that fall in a floodplain by property type for the 100- and 500-year annual chance flood zones. Additionally, these tables include information on loss estimates by flood based on guidance from FEMA. Based on this guidance, contents value is estimated at 50 percent of the improved value. Estimated losses assume that a flood is unlikely to cause total destruction. Losses are related to a variety of factors, including flood depth, flood velocity, building type, and construction. Using FEMA's recommendations, average damage is estimated to be 20 percent of the total building value. Refer to the annexes for these results specific to each jurisdiction.

While there are several limitations to this model, it does allow for potential loss estimation. It should be noted that the model may have included structures in the floodplains that are elevated at or above the level of the base-flood elevation, which will likely mitigate flood damage. Also, it is important to remember that the assessed values are well below the actual market values. Thus, the actual value of assets at risk may be significantly higher than those included herein.

Table 4.58 Count and Improved Value of Parcels in 1% Annual Chance Floodplain by Property Type—Unincorporated Fresno County

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Agricultural	448	381	$77,195,934	$77,195,934	$154,391,868	$38,597,967
Commercial	23	60	$8,486,419	$8,486,419	$16,972,838	$4,243,210
Exempt	20	30	$0	$0	$0	$0
Industrial	37	43	$22,608,533	$33,912,800	$56,521,333	$14,130,333

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Multi-Residential	1	1	$35,404	$17,702	$53,106	$13,277
Open Space	953	519	$380,879,678	$380,879,678	$761,759,356	$190,439,839
Residential	881	1,267	$175,106,750	$87,553,375	$262,660,125	$65,665,031
Unknown	1	2	$806,951	$806,951	$1,613,902	$403,476
Total	**2,364**	**2,303**	**$665,119,669**	**$588,852,859**	**$1,253,972,528**	**$313,493,132**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA
*Includes Zones A, AE, AH, and AO
**Includes Shaded Zone X (500-year) and all 100-year flood zones

Table 4.59 Count and Improved Value of Parcels in 0.2% Annual Chance Floodplain by Property Type—Unincorporated Fresno County

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Agricultural	167	123	$23,370,188	$23,370,188	$46,740,376	$11,685,094
Commercial	34	47	$11,634,321	$11,634,321	$23,268,642	$5,817,161
Exempt	18	20	$0	$0	$0	$0
Industrial	170	224	$71,751,039	$107,626,559	$179,377,598	$44,844,399
Multi-Residential	102	206	$16,843,386	$8,421,693	$25,265,079	$6,316,270
Open Space	150	104	$32,509,380	$32,509,380	$65,018,760	$16,254,690
Residential	3,280	3,829	$410,863,352	$410,863,352	$821,726,704	$205,431,676
Total	**3,921**	**4,553**	**$566,971,666**	**$594,425,493**	**$1,161,397,159**	**$290,349,290**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA
*Includes Zones A, AE, AH, and AO
**Includes Shaded Zone X (500-year) and all 100-year flood zones

Table 4.60 Count and Improved Value of Parcels in 200-Year Floodplain by Property Type—Unincorporated Fresno County

Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value	Loss Estimate
Agricultural	122	126	$13,927,928	$13,927,928	$27,855,856	$6,963,964
Commercial	6	13	$968,584	$968,584	$1,937,168	$484,292
Exempt	8	19	$0	$0	$0	$0
Industrial	3	6	$3,525,545	$5,288,318	$8,813,863	$2,203,466
Open Space	329	226	$97,546,311	$97,546,311	$195,092,622	$48,773,156
Residential	90	174	$8,290,227	$4,145,114	$12,435,341	$3,108,835
Total	**558**	**564**	**$124,258,595**	**$121,876,254**	**$246,134,849**	**$61,533,712**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; USACE Comprehensive Study

Insurance Coverage, Claims Paid, and Repetitive Losses

Unincorporated Fresno County joined the National Flood Insurance Program (NFIP) on December 12, 1982, and the Community Rating System (CRS) on October 1, 1991. According to the CRS listing of eligible communities dated October 1, 2007, the County is currently a Class 7, which is lower than the 2007 rating (8). Lower ratings are preferable and a Class 7 provides a 15 percent discount on flood insurance for those located within the special flood hazard area (SFHA) and a 5 percent discount for those located in non-SFHA areas.

In the unincorporated County, there are 840 policies in force, of which there are 746 single family units, 11 2-4 family, 4 all other residential, and 79 nonresidential. 423 policies were located in an A zone (80 in zone A01-30 & AE, 193 in zone A, 119 in AO, 31 AH). The remaining policies are split between standard B, C, & X zone (146) and preferred B, C, & X Zone (271). 462 policies are pre-FIRM, leaving 378 as post-FIRM structures. There are two repetitive loss buildings in the unincorporated County. On repetitive loss structure is located in A zone, with three total payments equaling $19,385. The other repetitive loss building is located in zone B,C, and X, with two payments totaling $36,570. There are 35 paid losses in the unincorporated county, equal to $529,973. Of these losses, 17 were parcels in A zones and 18 parcels were in the B, C, and X zones. Of the 35 claims, 28 claims were associated with pre-FIRM structures and 7 with post-FIRM structures.

NFIP data indicates that there are 1,709 insurance policies in Fresno County representing $435.053 million of insurance coverage in force. There have been 151 paid losses, totaling $1.55 million. Table 4.61 provides more details on NFIP participation for each individual jurisdiction.

Table 4.61 Fresno County NFIP Information

Jurisdiction	Policies	Insurance in Force	No. of Paid Losses	Total Losses Paid
Clovis	103	$31,999,500	14	$134,920
Coalinga	60	$12,902,300		
Firebaugh	159	$31,729,100		
Fowler	22	$5,787,700	1	$3,197.94
Fresno Unincorporated	840	$208,980,000	39	$537,282.62
Fresno City	323	$93,791,300	81	$765,183.27
Huron	9	$4,320,000		
Kerman	No SFHA/Not Participating/Not Required			
Kingsburg	10	$3,220,000		
Mendota	17	$4,630,900	3	$2,572.00
Orange Cove	96	$23,078,500	6	$78,052
Parlier	8	$1,337,000		
Reedley	8	$2,345,000		

Jurisdiction	Policies	Insurance in Force	No. of Paid Losses	Total Losses Paid
San Joaquin			3	$10,720.38
Sanger	54	$10,931,700	4	$16,288.44
Selma	Not Participating - Sanctioned			
Total	**1709**	**$435,053,000**	**151**	**$1,548,217**

Source: FEMA National Flood Insurance Program Community Information System

Historic, Cultural, and Natural Resources at Risk

The Fresno County planning area has significant historic, cultural, and natural resources located throughout the County as previously described. Risk analysis of these resources was not possible due to data limitations. However, natural areas within the floodplain often benefit from periodic flooding as a naturally recurring phenomenon. These natural areas often reduce flood impacts by allowing absorption and infiltration of floodwaters.

Overall Community Impact

Floods and their impacts will vary by location and severity and will likely only affect certain areas of the County at any one time. Based on the risk assessment, it is evident that floods will continue to have potentially devastating economic impacts to certain areas of the County. However, many of the floods in the County are minor, localized flood events that are more of a nuisance than a disaster. Impacts that are not quantified, but can be anticipated in large future events, include:

- Injury and loss of life;
- Commercial and residential structural damage;
- Disruption of and damage to public infrastructure;
- Health hazards associated with mold and mildew;
- Damage to roads/bridges resulting in loss of mobility;
- Significant economic impact (jobs, sales, tax revenue) upon the community;
- Negative impact on commercial and residential property values; and
- Significant disruption to students and teachers as temporary facilities and relocations would likely be needed.

Natural Environment

Natural resources are generally resistant to flooding except where natural landscapes and soil compositions have been altered for human development or after periods of previous disasters such as drought and fire. Wetlands, for example, exist because of natural flooding incidents. Areas that are no longer wetlands may suffer from oversaturation of water, as will areas that are particularly impacted by drought. Areas recently suffering from wildfire damage may erode because of flooding, which can permanently alter an ecological system.

Critical Facilities

Critical facilities are those community components that are most needed to withstand the impacts of disaster as previously described. An analysis was performed using GIS software to determine critical facilities in Fresno County's floodplain. The DFIRM flood layer previously discussed was used to identify the 100- and 500-year floodplains. For more information on the spatial distribution and location of critical facilities, see the Critical Facility overview. The impact to the community could be great if these critical facilities were damaged or destroyed during a flood event. Similar data is available for the other participating jurisdictions in the jurisdictional annexes.

As described earlier, critical facilities are located throughout Fresno County. Critical facilities in the floodplain are summarized in Table 4.62 and Table 4.63 for the 100 and 500-year flood zones. In total, there are 34 facilities in the 100-year flood zone, 209 facilities in the 500-year flood zone, and 9 critical facilities in the 200-year floodplain. Information regarding critical facilities in the floodplain for each jurisdiction is outlined in the jurisdictional annexes.

Table 4.62 Critical Facilities in the 100-Year Floodplain

Jurisdiction	Facility Type	Building Count
Coalinga	Colleges & Universities	1
	Department of Public Works	1
	Total	**2**
Firebaugh	CalARP	1
	School	7
	Total	**8**
Fresno	CalARP	1
	Total	**1**
Mendota	Fire Station	1
	Total	**1**
Orange Cove	Fire Station	1
	Total	**1**
Parlier	CalARP	1
	School	1
	Total	**2**
Sanger	CalARP	2
	School	1
	Total	**7**
Unincorporated	Airport	1
	CalARP	9
	Fire Station	1
	School	1
	Total	**12**
	Grand Total	**34**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA

Table 4.63 Critical Facilities in the 500-Year Floodplain

Jurisdiction	Facility Type	Building Count
Clovis	Colleges & Universities	1
	Nursing Home	1
	School	6
	Total	**8**
Coaling	Health Care	1
	Total	**1**
Firebaugh	Airport	1
	CalARP	1
	School	1
	Urgent Care	1
	Total	**4**
Fresno	Airport	1
	Behavioral Health	1
	CalARP	12
	Colleges & Universities	5
	Communications	1
	County Government	2
	Daycare	52
	Department of Agriculture	2
	Department of Public Health	2
	Department of Social Services	6
	District Attorney	1
	Fire Station	7
	General Services	3
	Health Care	1
	Nursing Home	12
	Police	5
	School	68
	Urgent Care	2
	Total	**183**
Huron	CalARP	4
	School	2
	Total	**6**
Unincorporated	CalARP	4
	Fire Station	1
	School	2
	Total	**7**
	Grand Total	**209**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; National Flood Hazard Layer Effective date 01/20/2016, FEMA

Table 4.64 Critical Facilities in the 200-Year Floodplain

Jurisdiction	Facility Type	Building Count

Firebaugh	Fire Station	1
	Police	1
	School	3
	Urgent Care	1
	Total	**6**
Mendota	Airport	1
	CalARP	1
	Total	**2**
Unincorporated	Nursing Home	1
	Total	**1**
	Grand Total	**9**

Source: 2017 Certified Roll Values, Fresno County Assessor's Office; USACE Comprehensive Study

Future Development

Flooding and floodplain management are significant issues for Fresno County. The potential or likelihood of a flood event in the city increases with the annual onset of heavy rains in April combined with snowmelt runoff from May through June. Much of the historical growth in the Problems connected with flooding and stormwater runoff include erosion, sedimentation, degradation of water quality, losses of environmental resources, and certain health hazards. Future annexations of unincorporated areas could significantly add to the number of flood-prone structures in Fresno County.

For NFIP participating communities, floodplain management practices implemented through local floodplain management ordinances should mitigate the flood risk to new development in floodplains.

The development trend in the Fresno County planning area is steady, significant growth. Much of this growth is occurring in the urban areas, which causes a significant increase in peak flow and stormwater runoff.

Census projections from the California Department of Finance expect the County's population to grow to 1,201,792 by 2020. This is an increase of 271,342 people from the 2010 census estimate of 930,450. Such growth will consume previously undeveloped acres, and the impacts may overwhelm existing drainage and flood control facilities.

The potential for flooding may increase as stormwater is channelized due to land development. Such changes can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. Floodplain modeling and master planning should be based on buildout land use to ensure that all new development remains safe from future flooding. While local floodplain management, stormwater management, and water quality regulations and policies address these changes on a site-by-site basis, their cumulative effects can have a negative impact on the floodplain.

Local floodplain management ordinances require that new construction be built with the lowest floor elevated a minimum of one foot above the base flood (100-year) elevation. New development that adheres to the elevation requirements in addition to other requirements for maintaining elevation certificates and implementing stormwater program elements and erosion or sediment controls for all new development in the floodplain should help protect development from 100-year floods.

The amount of growth in the County and nearby communities can also strain the limits of the entire water management system, which includes water supply in addition to water control. When flood control structures are overwhelmed, the result is not only severe flooding. Significant losses to the water supply system may also occur.

Vulnerability to Levee Failure

A levee failure can range from a small, uncontrolled release to a catastrophic failure. Vulnerability to levee failures is generally confined to the areas subject to inundation downstream of the facility. Secondary losses would include loss of the multi-use functions of the facility and associated revenues that accompany those functions.

Vulnerability to Human Health: Epidemic/Pandemic (Medium)

Based on historical occurrences, the risk to the Fresno County planning area is occasional, but the vulnerability is medium. According to the Centers for Disease Control and Prevention, the risk from avian influenza is generally low to most people, because the viruses do not usually affect humans. However, H5N1 is one of the few avian influenza viruses to have crossed the species barrier to infect humans, and it is the deadliest of those that have crossed the barrier. Most cases of H5N1 influenza infection in humans have resulted from contact with infected poultry. So far, the spread of H5N1 from person to person has been limited and has not continued beyond one person. Nonetheless, because all influenza viruses have the ability to change, scientists are concerned that the H5N1 virus, or another influenza virus, could one day be able to infect humans and spread easily from one person to another. If this were to happen, a pandemic could begin and everyone would be at risk. Other communicable diseases of this nature could result in a similar type of epidemic/pandemic and become a significant concern for the Fresno County planning area.

People

Disease spread and mortality is affected by a variety of factors, including virulence, ease of spread, aggressiveness of the virus and its symptoms, resistance to known antibiotics and environmental factors. While every pathogen is different, diseases normally have the highest mortality rate among the very young, the elderly or those with compromised immune systems. As an example, the unusually deadly 1918 H1N1 influenza pandemic had a mortality rate of 20%. If an influenza pandemic does occur, it is likely that many age groups would be seriously affected. The greatest risks of hospitalization and death—as seen during the last two pandemics in 1957 and 1968 as well as during annual outbreaks of influenza—will be to infants, the elderly, and those with underlying health conditions. However, in the 1918 pandemic, most deaths occurred in young adults. Few people, if any, would have immunity to a new virus.

Property

For the most part, property itself wouldn't be impacted by a human disease epidemic or pandemic. As concerns about contamination increase, property may be quarantined or destroyed as a precaution against spreading illness.

Natural Environment

A widespread pandemic would not have an impact on the natural environment unless the disease was transmissible between humans and animals.

Critical Facilities

Agricultural hazards would most likely not have an impact on critical facilities.

Future Development

Future development would not be impacted by a pandemic.

Vulnerability to Human Health: West Nile Virus (Low)

While the likelihood of occurrence of West Nile virus in the Fresno County planning area is likely, the County's vulnerability is low, based on the percentage of total population that actually comes down with the disease. Since the discovery of West Nile virus in California in 2003, Fresno County has had 255 confirmed human cases.

Although the potential for exposure does exist in Fresno County, the vulnerability should be considered in terms of adverse effects due to exposure. The County already has an active vector control program in place for mosquitoes, and protective measures to prevent exposure are relatively simple and cost-effective. Given the nature of protective measures, such as wearing long-sleeved clothing and using bug spray, the responsibility for protection can and should be an individual responsibility. Fresno County's current public education program should give the community the knowledge as well as access to resources to effectively counter the risk and impact from the virus.

People

Approximately twenty percent of people exposed to West Nile Virus through a mosquito bite develop symptoms related to the virus; it is not transmissible from one person to another. Preventive steps can be taken to reduce exposure to mosquitos carrying the virus; these include insect repellent, covering exposed skin with clothing and avoiding the outdoors during twilight periods of dawn and dusk, or in the evening when the mosquitos are most active.

Property

Property would not be affected by West Nile Virus.

Natural Environment

While birds are the species primarily affected by West Nile Virus, bats, horses, cats, dogs, chipmunks, skunks, squirrels, domestic rabbits and alligators can all be infected with the virus.

Critical Facilities

Should a widespread outbreak of West Nile Virus occur, medical facilities could be stressed.

Future Development

Future development would not be impacted by West Nile Virus.

Vulnerability to Landslide (Low)

People

People are susceptible if they are caught in a landslide or rockfall; falling debris can cause injury or death. There is also a danger to drivers operating vehicles, as rocks and debris can strike vehicles passing through the hazard area or cause dangerous shifts in roadways.

Property

Landslide risk is minimal in the highly developed valley area of the County due to the relatively flat topography, and most structures concentrated in the central and eastern portion of the County are not at risk to landslides. However, the Fresno County General Plan identifies State Route 168 in eastern Fresno County and State Route 198 in western Fresno County as areas that could be affected by landslides caused by earthquakes or heavy rains. Current data is limited and future studies should evaluate the geologic conditions throughout the planning area.

Natural Environment

Landslides and rockfalls have minimal impacts to the natural environment; these impacts would be confined to a small area. There is a slight chance that a rockfall or landslide in the drainages above the City could cause blockage and water backup from temporary landslide dams.

Critical Facilities

There is not enough available data to determine whether or not there are any critical facilities located in landslide susceptible areas

Future Development

The severity of landslide problems is directly related to the extent of human activity in hazard areas. Human activities such as property development and road construction can also exacerbate the occurrence of landslides. Future development should be done carefully to prevent landslide damage to property or people. Adverse effects can be mitigated by early recognition and avoiding incompatible land uses in these areas or by corrective engineering. Improving mapping and information on landslide hazards and incorporating this information into the development review process could prevent siting of structures and infrastructure in identified hazard areas.

Vulnerability to Severe Weather: Extreme Temperatures (Extreme Cold/Freeze and Extreme Heat) (Low)

People

Traditionally, the very young and very old are considered at higher risk to the effects of extreme temperatures, but any populations outdoors in the weather are exposed, including otherwise young and healthy adults and homeless populations. While everyone is vulnerable to extreme temperature incidents, some populations are more vulnerable than others. Extreme temperatures pose the greatest danger to outdoor laborers, such as highway crews, police and fire personnel, and construction. The elderly, children, people in poor physical health, and the homeless are also vulnerable to exposure. Arguably, the young-and-otherwise-healthy demographic may experience a higher vulnerability of exposure, due to the increased likelihood that they will be out in the extreme temperatures, whether due to commuting for work or school, conducting property maintenance such as snow removal or lawn care, or for recreational reasons.

It is difficult to isolate the County's specific vulnerability to this hazard, as the impacts from extreme temperatures can be spread across an entire state or region. In general, all the population of the County can be considered at-risk to this hazard.

Property

Recent research indicates that the impact of extreme temperatures, particularly on populations, has been historically under-represented. The risks of extreme temperatures are often profiled as part of larger hazards, such as severe winter storms or drought. However, as temperature variances may occur outside of larger hazards or outside of the expected seasons but still incur large costs, it is important to examine them as stand-alone hazards. Extreme heat may overload demands for electricity to run air conditioners in homes and businesses during prolonged periods of exposure and presents health concerns to individuals outside in the temperatures. Extreme heat may also be a secondary effect of droughts, or may cause temporary drought-like conditions. For example, several weeks of extreme heat increases evapotranspiration and reduces moisture content in vegetation, leading to higher wildfire vulnerability for that time period even if the rest of the season is relatively moist. Extreme heat can cause infrastructure damage to roads. Extreme cold impacts structures when pipes or water mains freeze and burst, causing damage.

Extreme cold may also lead to higher electricity and natural gas demands to maintain appropriate indoor heating levels combined with damages caused to the delivery infrastructure such as frozen lines and pipes. Cold may impact transportation as well. Exposed populations may be at risk while waiting for public transportation, particularly when combined with wind-chill, and some vehicles may not start which impacts the commute of the workforce and, in worst case scenarios, the movement of emergency services personnel.

Natural Environment

Extreme heat may cause temporary drought-like conditions. For example, several weeks of extreme heat increases evapotranspiration and reduces moisture content in vegetation, leading to higher wildfire vulnerability for that time period even if the rest of the season is relatively moist. Extreme cold has the same impacts on exposed wildlife as it does on exposed people.

Changing heating and cooling patterns globally can have destructive secondary impacts, intensifying a variety of weather-related disasters that directly impact jurisdictions.

Critical Facilities

Extreme temperatures can impact pipe (extreme cold) and road infrastructure (extreme heat), but direct impacts to critical infrastructure is expected to be minimal. Critical infrastructure that relies on public utility systems that could be overloaded may see impacts during extreme temperature events.

Future Development

Since structures are not usually directly impacted by severe temperature fluctuations, continued development is less impacted by this hazard than others in the plan. However, pre-emptive cautions such as construction of green buildings that require less energy to heat and cool, use of good insulation on pipes and electric wirings, and smart construction of walkways, parking structures, and pedestrian zones that minimize exposures to severe temperatures may help increase the overall durability of the buildings and the community to the variations. Continued development also implies continued population growth, which raises the number of individuals potentially exposed to variations. Public 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 heat and cold.

Vulnerability to Severe Weather: Fog (Medium)

Fog issues are well documented in the Fresno County planning area. In recent years, there have been several large-scale accidents during periods of heavy fog. However, it should be noted that while fog is present, usually driver error is a significant contributory factor to these accidents. Fog is driven by weather patterns in the Central Valley that will continue to occur annually. As such, until people can learn to take appropriate precautions during fog events, fog-related accidents will also continue to occur.

People

Reduced visibility is the greatest risk to people when heavy fog is prevalent. Particularly when fog is dense, it can be hazardous to drivers, mariners and aviators and contributes to numerous accidents each year. To reduce injury and harm, people should avoid driving when dense fog is prevalent, if possible. If driving is pertinent, emergency services advise driving with lights on low beam, watching for CHP pace vehicles to guide through fog, avoiding stopping on highways, and avoiding crossing traffic lanes.

Property

Based on historic information, the primary effect of fog has not resulted in significant damages to property, or the losses are typically covered by insurance.

Natural Environment

As referred to in the Climate Change Considerations section of the Fog hazard profile, California's winter tule fog has declined dramatically over the past three decades, raising a red flag for the state's multibillion dollar agricultural industry. Crops such as almonds, pistachios, cherries, apricots and peaches go through a necessary winter dormant period brought on and maintained by colder temperatures. Tule fog, a thick ground fog that descends upon the state's Central Valley between late fall and early spring, helps contribute to this winter chill.

Critical Facilities

Fog can have devastating effects on transportation corridors in the County. Multi-car pileups have resulted from drivers using excessive speed for the conditions and visibility.

These accidents can cause multiple injuries and deaths and could have serious implications for human health and the environment if a hazardous or nuclear waste shipment were involved. Other disruptions from fog include delayed emergency response vehicles and school closures.

Future Development

Population and commercial growth in the County will increase the potential for complications with traffic accidents and commerce interruptions associated with dense fog.

Vulnerability to Severe Weather: Heavy Rain/Thunderstorm/Hail/Lightning/Wind (Low)

People

Exposure is the greatest danger to people from severe thunderstorms. People can be hit by lightning, pelted by hail, and caught in rising waters. Serious injury and loss of human life is rarely associated with hailstorms.

While national data shows that lightning causes more injuries and deaths than any other natural hazard except extreme heat, there doesn't seem to be any trend in the data to indicate that one segment of the population is at a disproportionately high risk of being directly affected. Anyone who is outside during a thunderstorm is at risk of being struck by lightning. Aspects of the population who rely on constant, uninterrupted electrical supplies may have a greater, indirect vulnerability to lightning. As a group, the elderly or disabled, especially those with home health care services relying on rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged. If they do not have a back-up power source, rural residents and agricultural operations reliant on electricity for heating, cooling, and water supplies are also especially vulnerable to power outages. Thunderstorms have the potential energy and strong winds to topple dead trees and injure people.

Property

Based on historic information, the primary effect of these storms has not resulted in significant injury or damages to people and property, or the losses are typically covered by insurance. It is the secondary hazards caused by weather, such as floods, that have had the greatest impact on the County.

Natural Environment

Severe thunderstorms are a natural environmental process. Environmental impacts include the sparking of potentially destructive wildfires by lightning and localized flattening of plants by hail. As a natural process, the impacts of most severe thunderstorms by themselves are part of the overall natural cycle and do not cause long-term consequential damage.

Critical Facilities

Because of the unpredictability of severe thunderstorm strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts. Due to the random nature of these hazards, a more specific risk assessment was not conducted for this plan.

Future Development

New critical facilities, such as communication towers should be built to withstand heavy rain, monsoon, and hail damage. Future development projects should consider severe weather hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability. Stormwater master planning and site review should be considered for all new development. Thus, development trends in the County are not expected to increase overall vulnerability to the hazard, but population growth will increase potential exposure to hazards such as lightning.

Vulnerability to Severe Weather: Winter Storm (Medium)

People

While virtually all aspects of the population are vulnerable to severe winter weather, there are segments of the population that are more vulnerable to the potential indirect impacts of a severe winter storm than others, particularly the loss of electrical power. If they do not have a back-up power source, rural residents reliant on electricity for heating and water supplies are also especially vulnerable to power outages. As a group, the elderly or disabled, especially those with home health care services that rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged.

Public education efforts may help minimize the risks to future populations by increasing knowledge of appropriate mitigation behaviors, clothing, sheltering capacities, and decision making regarding snow totals, icy roads, driving conditions, and outdoor activities (all of which are contributors to decreased public safety during severe winter storms.) New establishments or increased populations who are particularly vulnerable to severe winter storms (such as those with health concerns or those who live in communities that may be isolated for extended periods of time due to the hazard) should be encouraged to maintain at least a 72-hour self-sufficiency as recommended by FEMA. Encouraging contingency planning for businesses may help alleviate future economic losses caused by such hazards while simultaneously limiting the population exposed to the hazards during commuting or commerce-driven activities.

Property

While virtually all aspects of the population are vulnerable to severe winter weather, there are segments of the population that are more vulnerable to the potential indirect impacts of a severe winter storm than others, particularly the loss of electrical power. If they do not have a back-up power source, rural residents reliant on electricity for heating and water supplies are also especially vulnerable to power outages. As a group, the elderly or disabled, especially those with home health care services that rely heavily on an uninterrupted source of electricity. Resident populations in nursing homes, residential facilities, or other special needs housing may also be vulnerable if electrical outages are prolonged.

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Natural Environment

Natural resources may be damaged by the severe winter weather, including broken trees and death of wildlife. Unseasonable storms may damage or kill plant and wildlife, which may impact natural food chains until the next growing season. Most of these impacts would be short-term.

Critical Facilities

Because of the unpredictability of severe winter storm strength and path, most critical infrastructure that is above ground is equally exposed to the storm's impacts. Roads are especially susceptible to the effects of a winter storm. A more specific risk assessment was not conducted for this plan.

Future Development

Future residential or commercial buildings in locations that receive large amounts of snow each year should be built to be able to withstand snow loads from severe winter storms. Jurisdictions within Sierra National Forest like Lakeshore, Big Creek, Cedar Grover and Rock Haven may benefit from taking these precautions. Population growth in these areas and growth in visitors will increase problems with road, business, and school closures, and increase the need for snow removal and emergency services related to severe winter weather events. Development in the County will increase the number of vehicles and persons vulnerable to this hazard.

Vulnerability to Severe Weather: Tornadoes

People

Populations are the most vulnerable to tornados. The availability of sheltered locations such as basements, buildings constructed using tornado-resistant materials and methods, and public storm shelters, all reduce the exposure of the population. However, there are also segments of the population that are especially exposed to the indirect impacts of tornadoes, particularly the loss of electrical power. These populations include the elderly or disabled, especially those with medical needs and treatments dependent on electricity. Nursing homes, Community Based Residential Facilities, and other special needs housing facilities are also vulnerable if electrical outages are prolonged, since backup power generally operates only minimal functions for a short period of time.

Property

General damages are both direct (what the tornado physically destroys) and indirect, which focuses on additional costs, damages and losses attributed to secondary hazards spawned by the tornado, or due to the damages caused by the tornado. Depending on the size of the tornado and its path, a tornado is capable of damaging and eventually destroying almost anything. Construction practices and building codes can help maximize the resistance of the structures to damage.

Secondary impacts of tornado damage often result from damage to infrastructure. Downed power and communications transmission lines, coupled with disruptions to transportation, create difficulties in reporting and responding to emergencies. These indirect impacts of a tornado put tremendous strain on a community. In the immediate aftermath, the focus is on emergency services.

Natural Environment

Tornadoes can cause massive damage to the natural environment, uprooting trees and other debris. This is part of a natural process, however, and the environment will return to its original state in time.

Critical Facilities

Public gathering places including (but not limited to) schools, community centers, shelters, nursing homes and churches, may have increased impacts at certain times of day if struck by a tornado. Due to the random nature of these hazards, a more specific risk assessment was not conducted for this plan.

Future Development

As the County continues to add population, the number of people and housing developments exposed to the hazard increases. Proper education on building techniques and the use of sturdy building materials, basements, attached foundations, and other structural techniques may minimize the property vulnerabilities. Public shelters at parks and open spaces may help reduce the impacts of tornadoes on the recreational populations exposed to storms.

Vulnerability to Soil Hazards: Erosion (Low)

People

Erosion generally only damage structures, with no direct impacts on people.

Property

While impacts are slow to accumulate, costly damages to residences, facilities, roads, and other infrastructure could occur. Erosion occurs over a long period of time, though weather and other climatic factors can catalyze the magnitude of impact. Properties near construction sites are the most vulnerable to erosion, followed by structures on/near steep slopes, disturbed pits/quarries, and runoff channels.

Natural Environment

There are generally no significant impacts to the natural environment associated with erosion.

Critical Facilities

Roads, pipelines and facilities can be impacted but significant impacts are not anticipated.

Future Development

Erosion controls such as silt fences, netting, and vegetative coverage can be utilized to minimize soil erosion around at-risk properties. During construction, erosion risk can be reduced through the use of paved roads and runoff control features, while vegetation removal should be minimized and drainage ditches constructed only where necessary.

Vulnerability to Soil Hazards: Expansive Soils (Low)

People

No direct impacts on people are anticipated. Should an impact occur, it is anticipated to be localized.

Property

While impacts are slow to accumulate, costly damages property could occur. The majority of the hazard's significance is drawn from the exposure of existing development to this hazard. Older construction may not be resistant to the swelling soil conditions and, therefore, may experience expensive and potentially extensive damages. This includes heaving sidewalks, structural damage to walls and basements, the need to replace windows and doors, or dangers and damages caused by ruptured pipelines. Newer construction may have included mitigation techniques to avoid most damage from the hazard, but the dangers continue if mitigation actions are not supported by homeowners. For example, the maintenance of grading away from foundations and the use of appropriate landscaping near structures must be continued to prevent an overabundance of water in vulnerable soils near structures. While continued public education efforts may help increase compliance for landscaping and interior finishing mitigation actions, physical reconstruction of foundations is probably not feasible in all but the most heavily impacted of existing development. Therefore, damages may be expected into the future for existing structures.

Critical Facilities

Roads, pipelines and facilities can be impacted but significant impacts are not anticipated.

Natural Environment

No significant impacts are anticipated.

Future Development

The recognition of expansive soils typically allows it to be mitigated in future development.

Vulnerability to Soil Hazards: Land Subsidence (Medium)

People

Typically, this hazard results in property damage, not risk to human life.

Property

Subsidence may result in serious structural damage to buildings, roads, irrigation ditches, underground utilities, and pipelines. It can disrupt and alter the flow of surface or underground water. Weight, including surface developments such as roads, reservoirs, and buildings and manmade vibrations from such activities as blasting or heavy truck or train traffic can accelerate natural processes of subsidence, or incur subsidence over manmade voids. Fluctuations in the level of underground water caused by pumping or by injecting fluids into the earth can initiate sinking to fill the empty space previously occupied by water or soluble minerals. Available data prevented further estimation of loss potential.

Critical Facilities

Linear infrastructure (roads, buried pipelines) tends to have the most risk to land subsidence. Infrastructure at risk includes levees (which can lower their ability to contain flood flows), the California Aqueduct, and Interstate 5. Other buried infrastructure on the west side of the Valley could be at risk as well.

Natural Environment

Typically, there is little impacts to the natural environment from this hazard.

Future Development

The areas with the highest susceptibility to subsidence include the western edge of the Central Valley, where development trends have been slower than the more urbanized areas of the County. As such, vulnerability to this hazard is not anticipated to increase with new development, provided that land use planning and engineering practices are followed. Increased efforts to monitor and manage groundwater pumping, increased accuracy of mapping, and emphasis on appropriate grading and ground compaction during development will help alleviate vulnerability for future development in unknown areas of risk

Vulnerability to Volcanoes (Low)

The Mono Lake-Long Valley area located adjacent to the north and east of the northernmost areas of Fresno County is the only known volcanic hazard to Fresno County. Because of the limited area affected and remote potential of an eruption, the significance is rated low. A more likely scenario would involve ash from a regional event.

People

While a remote possibility for Fresno, volcanoes could have significant impacts on people. These include ash accumulation on the ground and in the air, that can affect the ability to breathe. More significant, though remote, could be the need to evacuate the area entirely, and a temporary or permanent relocation of large segments of the population.

Property

Volcanoes can cause two major types of impacts to the built environment. One type of impact has to do with the accumulation of ash and eruption debris on infrastructure, which needs to be removed. The other type of impact is direct impacts from lava flows and lahars, which can destroy buildings and infrastructure in their path. Due to the remote possibility of occurrence damage is not anticipated to be significant in the near future.

Natural Environment

Volcanoes can have significant impacts on the natural environment. The direct impacts of volcanoes can also destroy the landscape around the eruption – flattening trees, starting fires, moving debris and contaminating water sources. Volcanic eruptions can even affect the global climate. According to research conducted by NASA, after Mount Pinatubo in the Philippines erupted in 1991, strong winds spread the aerosol particles from the plume around the globe. The result was a measurable cooling of the Earth's surface for a period of almost two years.

Critical Facilities

Due to the low probability of this hazard, a more specific assessment of critical infrastructure risk was not conducted for this plan.

Future Development

The Mono Lake-Long Valley area located adjacent to the north and east of the northernmost areas of Fresno County is the only known volcanic hazard to Fresno County. Development in close proximity to the Valley is more at risk to volcanic flow hazards, however, the destructive impacts of a volcanic eruption cannot be easily mitigated by building codes or smart construction.

Vulnerability to Wildfire (High)

Fresno County planning area's wildfire risk and vulnerability is of significant concern, with some areas of the planning area being at greater risk than others as described further in this section. High fuel loads in the planning area, along with geographical and topographical features create the potential for both natural and human-caused fires that can result in loss of life and property. These factors, combined with natural weather conditions common to the area, including periods of drought, low relative humidity, and periodic winds, can result in frequent and sometimes catastrophic fires. Even the relatively flat and more urbanized area of central Fresno is not immune from fire. During the fire season, the dry vegetation and hot and sometimes windy weather combined with a denser population results in an increase in the number of ignitions.

Fresno County's wildfire vulnerability is the result of increased development encroaching into forested and annual grassland areas, typically referred to as the wildland-urban interface. As development continues throughout the planning area, especially in the interface, the risk and vulnerability to wildfires will likely increase. Two fire safe councils have been created to address this increased wildfire threat in the wildland-urban interface: Highway 168 and Oak to Timberline fire safe councils.

People

The historical and potential impacts of wildfire on populations include threat of injury or death, possible agricultural sector job loss, secondary economic losses to businesses located in the wildland-urban interface and within or near wildland resources like parks and national forests, and loss of public access to recreational resources. Fire suppression may also require increased cost to local and state government for water acquisition and delivery, especially during periods of drought when water resources are scarce.

The data and mapping demonstrates variations in vulnerability (population, population growth and density) across jurisdictions, and enables the analysis to identify the location of each jurisdiction relative to its risk zone on the wildfire risk map. Other at-risk populations include the location of the County's wildland recreational areas where persons might be located during a wildfire event, such as state and national parks and forests.

Wildfire risk is of greatest concern to populations residing in the moderate, high, and very high wildfire threat zones. GIS was used to estimate populations within the hazard zones, based on the residential parcels with improvements in the wildfire threat zones. Results are shown by jurisdiction in the table below.

Table 4.65 Populations at Risk to Wildfire: Fresno County Planning Area

Jurisdiction	Very High	High	Moderate	Nonwildland/ Nonurban	Urban Unzoned	Total
Clovis	0	0	0	17,968	77,713	95,680
Coalinga	0	751	1,756	431	6,464	9,402
Firebaugh	0	0	666	593	3,075	4,333
Fowler	0	0	0	1,407	3,775	5,183
Fresno	0	0	2,450	30,242	345,365	378,057
Huron	0	0	0	0	2,197	2,197
Kerman	0	0	0	2,295	7,180	9,475
Kingsburg	0	0	0	593	10,154	10,746
Mendota	0	0	0	894	4,232	5,126
Orange Cove	0	0	0	155	4,394	4,549

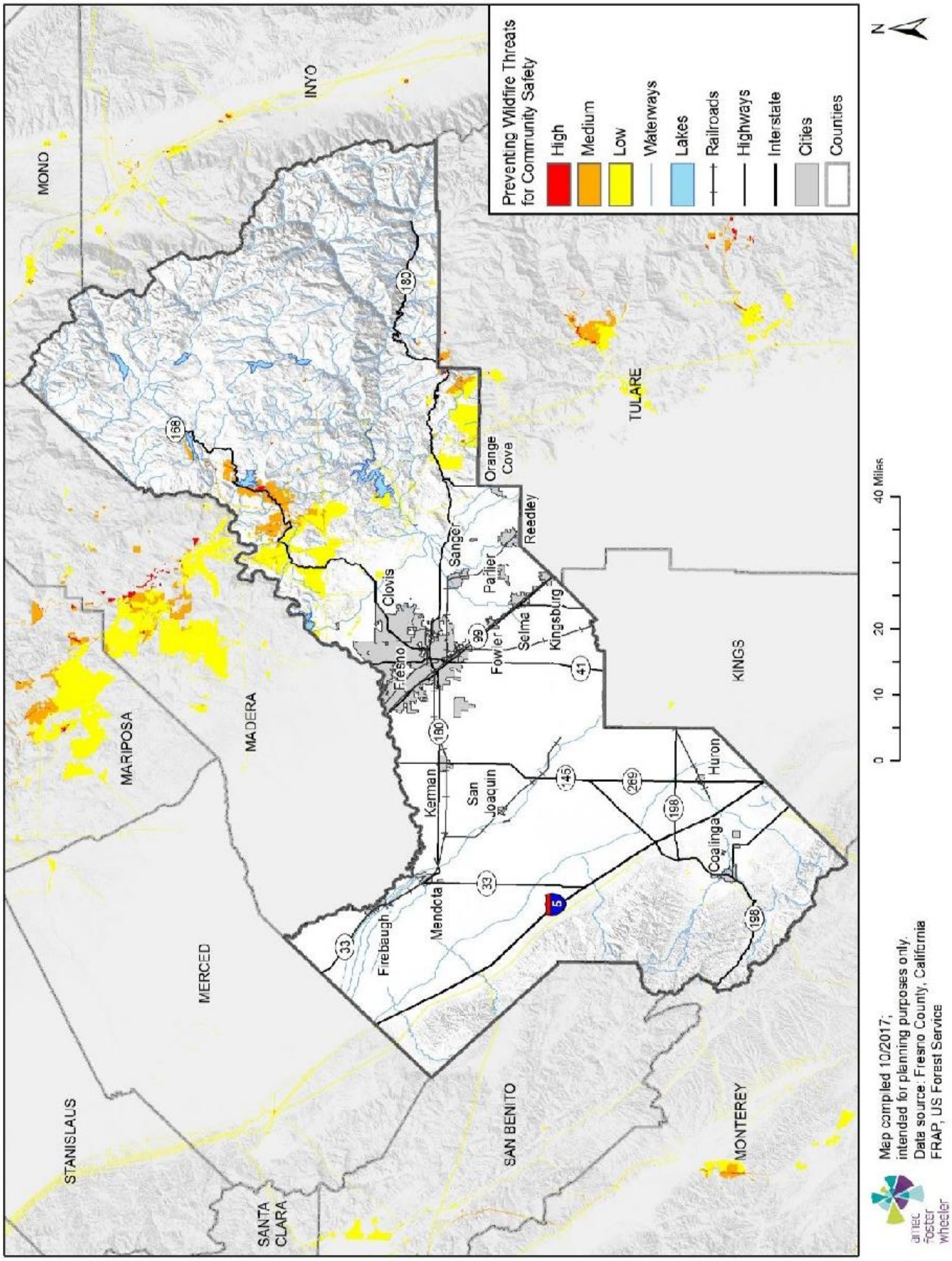
Jurisdiction	Very High	High	Moderate	Nonwildland/ Nonurban	Urban Unzoned	Total
Parlier	0	0	0	1,167	6,258	7,424
Reedley	0	0	0	1,480	15,096	16,576
San Joaquin	0	0	0	0	1,975	1,975
Sanger	0	0	0	3,119	15,701	18,820
Selma	0	0	0	973	15,860	16,833
All Cities	0	751	4,872	61,317	519,436	586,377
Unincorporated	10,981	12,325	8,033	19,502	77,804	128,645
County Totals	10,981	13,076	12,905	80,819	597,241	715,022

Sources: Amec Foster Wheeler analysis of California Department of Forestry and Fire Protection and Fresno County data

In another assessment of community vulnerability, the 2010 FRAP assessment utilized the Priority Landscape unit of analysis and defined it as the convergence of areas with high wildfire threat and human infrastructure assets. The analytical framework follows the same pattern of aligning threats with key assets to define the priority landscape. In this case, the threat is specific to the nature of fire that can cause significant losses to human infrastructure, personal property and pose a risk to public safety. These risk areas are shown on the map below. GIS Analysis of population within this area yielded the following estimates, all of which are in unincorporated areas.

- Population in High: 3,072
- Population in Medium: 8,125
- Population in Low: 11,041

Figure 4.68 Fresno County Preventing Wildfire Threats for Community Safety



Property

The historical and potential impacts of wildfire on property include crop loss, injury and death of livestock and pets, and damage to infrastructure, homes and other buildings located throughout the wildfire risk area, with greatest potential impact on property, buildings and infrastructure located within high and very high hazard zones including the urban-wildland interface, and buildings and infrastructure located within forested lands, including (but not limited to) national forests and parks.

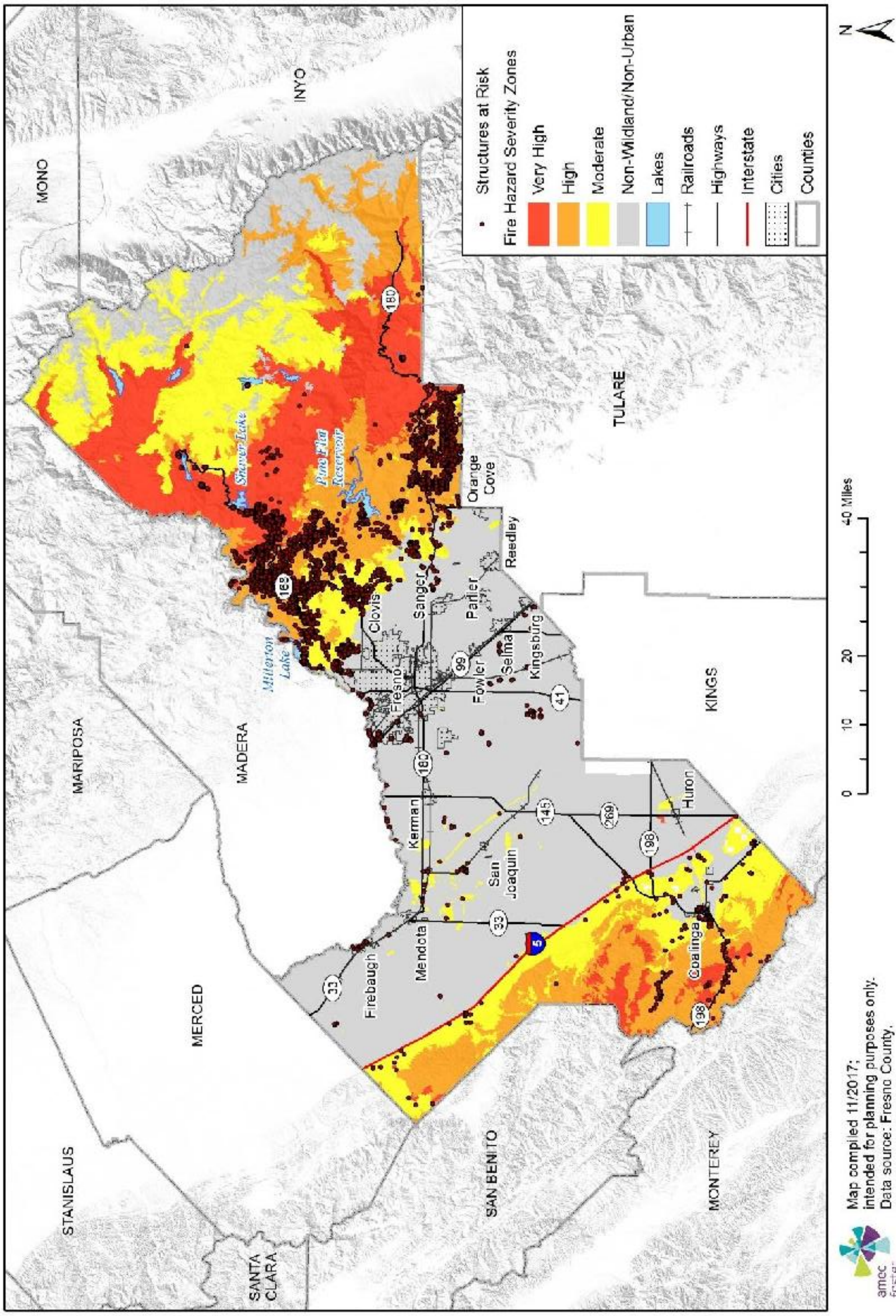
Methodology

Using CAL FIRE's Fire Hazard Severity Zones (FHSZ), an assessment of wildfire risk in the Fresno County planning area. GIS was used to create a centroid, or point, representing the center of each parcel polygon, which was overlaid on the wildfire layer. For the purposes of this analysis, the wildfire hazard zone that intersected the centroid was assigned as the hazard zone for the entire parcel. For purposes of this analysis, it was assumed that every parcel with an improved value greater than zero was developed in some way. Only improved parcels and the value of their improvements were analyzed. The wildfire data was acquired from the CAL FIRE Fire and Resource Assessment Program; the layer used was the Fire Hazard Severity Zones, Very High zones in LRA (Source: http://frap.fire.ca.gov/projects/wui/525_CA_wui_analysis.pdf and http://frap. fire.ca.gov/projects/hazard/fhz.html). The County's parcel layer was used as the basis for the inventory of developed parcels.

The results are summarized in the tables and maps that follow. The Community Wildfire Threat used in this analysis was derived from a new and unique spatial dataset, Fire Hazard Severity Zones (FHSZ). This dataset was explicitly built for adopting new ignition-resistant building code standards and adopted by the California Building Commission in 2007. It is constructed to describe the nature and probability of fire exposure to structures, including those lands that are highly urbanized, but in close proximity to open wildlands (WUI). Details of the FHSZ mapping project are available on the FRAP website (http://frap.fire.ca.gov/projects/hazard/fhz.html).

As the following illustrates, there is a significant fire hazard in the eastern and far western portions of the County. The majority of the structures in the WUI are in the Sierra foothills region.

Figure 4.69 Structures at Risk to Wildfire



Once the number of parcels and their values were determined, contents values were estimated (based on 50 percent of the assessed value) to determine total values at risk by hazard zone. Overlaying the fire hazard severity zone map with the County parcel layer, it is evident that the Fresno County planning area has significant assets at risk to wildfire as detailed in Table 4.66 through Table 4.68.

Table 4.66 Values at Risk from Wildfire Summary by Severity

Fire Severity Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Very High	3,659	4,999	$724,565,578	$386,663,834	$1,111,229,412
High	4,830	6,042	$552,079,230	$322,941,866	$875,021,096
Moderate	5,096	5,730	$1,189,769,652	$787,321,643	$1,977,091,295
Total	**13,585**	**16,771**	**$2,466,414,460**	**$1,496,927,342**	**$3,963,341,802**

Sources: 2017 Certified Roll Values, Fresno County Assessor's Office; California Department of Forestry and Fire Protection

Table 4.67 Values at Risk from Wildfire by Property Type—Unincorporated County

Fire Severity Type	Property Type	Parcels	Building Count	Improved Value ($)	Contents Value ($)	Total Value ($)
Moderate	Agricultural	353	324	$177,961,972	$177,961,972	$355,923,944
	Commercial	64	106	$21,887,626	$21,887,626	$43,775,252
	Exempt	29	80	$0	$0	$0
	Industrial	13	23	$1,516,713	$2,275,070	$3,791,783
	Multi-Residential	1	2	$40,189	$20,095	$60,284
	Open Space	509	319	$147,552,400	$147,552,400	$295,104,800
	Residential	2,533	3,128	$538,399,955	$269,199,978	$807,599,933
	Total	**3,502**	**3,982**	**$887,358,855**	**$618,897,140**	**$1,506,255,995**
High	Agricultural	236	298	$27,321,155	$27,321,155	$54,642,310
	Commercial	85	325	$28,173,191	$28,173,191	$56,346,382
	Exempt	29	55	$0	$0	$0
	Industrial	9	15	$1,703,010	$2,554,515	$4,257,525
	Multi-Residential	3	2	$345,207	$172,604	$517,811
	Open Space	341	355	$33,417,902	$33,417,902	$66,835,804
	Residential	3,885	4,624	$430,444,222	$215,222,111	$645,666,333
	Total	**4,588**	**5,674**	**$521,404,687**	**$306,861,478**	**$828,266,165**
Very High	Agricultural	54	65	$3,803,132	$3,803,132	$7,606,264
	Commercial	74	133	$41,254,672	$41,254,672	$82,509,344
	Exempt	28	95	$0	$0	$0
	Multi-Residential	1	2	$121,255	$60,628	$181,883
	Open Space	39	34	$3,704,286	$3,704,286	$7,408,572
	Residential	3,463	4,670	$675,682,233	$337,841,117	$1,013,523,350
	Total	**3,659**	**4,999**	**$724,565,578**	**$386,663,834**	**$1,111,229,412**

Sources: 2017 Certified Roll Values, Fresno County Assessor's Office; California Department of Forestry and Fire Protection

Table 4.68 Values at Risk from Wildfire—Fresno County Incorporated Cities

Fire Severity	Property Type	Parcel Count	Building Count	Improved Value	Content Value	Total Value
Moderate	Agriculture	3	17	$289,793	$289,793	$579,586
	Commercial	17	111	$26,502,121	$26,502,121	$53,004,242
	Exempt	18	18	0	0	0
	Industrial	20	20	$3,886,103	$5,829,155	$9,715,258
	Multi-Residential	16	37	$15,868,751	$7,934,376	$23,803,127
	Residential	1,521	1,561	$255,989,940	$127,994,970	$383,984,910
	Total	**1,595**	**1,764**	**$302,536,708**	**168,550,414**	**$471,087,122**
High	Agricultural	1	1	$66,463	$66,463	$132,926
	Commercial	4	118	$1,419,770	$1,419,770	$2,839,540
	Multi-Residential	3	5	$151,816	$75,908	$227,724
	Residential	234	244	$29,036,494	$14,518,247	$43,554,741
	Total	**242**	**368**	**$30,674,543**	**$16,080,388**	**$46,754,931**
	Grand Total	**1,837**	**2,132**	**$333,211,251**	**$184,630,802**	**$517,842,053**

Sources: 2017 Certified Roll Values, Fresno County Assessor's Office; California Department of Forestry and Fire Protection

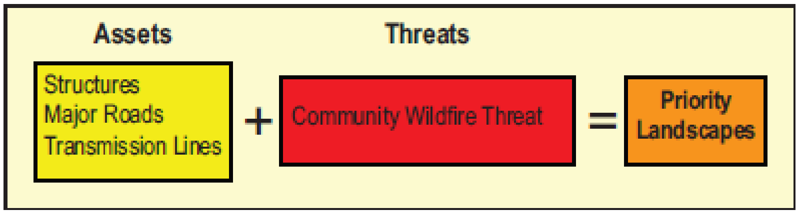
Natural Environment: Wildfire Potential Impact to Ecosystems

Natural resources are important to include in benefit-cost analyses for future projects and may be used to leverage additional funding for mitigation projects that also contribute to community goals for protecting natural resources. Awareness of natural assets can lead to opportunities for meeting multiple objectives. For instance, protecting watersheds will help maintain the quantity and quality of water, timber production and promote carbon sequestration.

Given the previous discussion on wildfire frequency and severity, research conducted as part of the 2010 FRAP Assessment brings to light the factors that shape the potential impact of wildfire events, namely the vulnerability characteristics of ecosystems, populations, buildings and infrastructure that lie within wildfire risk areas within the planning area and beyond. As such, the 2010 Assessment analyzed a variety of factors according to a set of criteria in order to identify what it terms, Priority Landscapes and Priority Communities most vulnerable to wildfire.

With regard to ecosystems, Figure 4.70 shows the analytical framework for identifying the Priority Landscape to assess the risk and feed the mitigation strategy for dealing with preventing damage to ecosystems as a result of wildfire.

Figure 4.70 Defining Wildfire Priority Landscapes



In analyzing the threats, the Assessment defined a particular small area as a Stand-Level threat and is derived from FRAP's fire threat data compiled in 2004. It is based on fuel conditions, observed fire frequency and expected fire weather conditions.

The Landscape-Level wildfire threat attempts to capture the threat of damage to ecosystems at the landscape scale. This is derived by calculating the percentage of each vegetation type in each unique tree seed zone that is "unhealthy", based on being in a condition class that indicates significant deviation from historical fire regimes–specifically the proportion of a given ecosystem that is in either condition class two or three. This approach recognizes that stand-level threats have elevated importance if cumulatively they have potential to damage broader landscape-level ecosystems. A detailed discussion of the metrics can be found on the FRAP website (http://frap.fire.ca.gov/assessment2003/Chapter3_Quality/wildfire.html).

Overall, results of the Assessment indicate that Priority Landscape identifies priority areas within ecosystems that have high levels of threat from future fires, and should be viewed as a basic assessment of need for strategies and adoption of tools to protect these key areas in the future. It is constructed by combining stand- and landscape-level threats to create a composite threat map, and classifying the final product into low, medium, and high priority landscapes. The following maps depict the Assessment findings, showing Fresno County Wildfire Priority Landscapes based on threats to water supply and water quality. Trends in landscape characteristics indicate high threats to water quality and supply in the eastern portion of the County, in the Sierra Nevada region.

Figure 4.71 Fresno Wildfire Priority Landscape- Water Supply

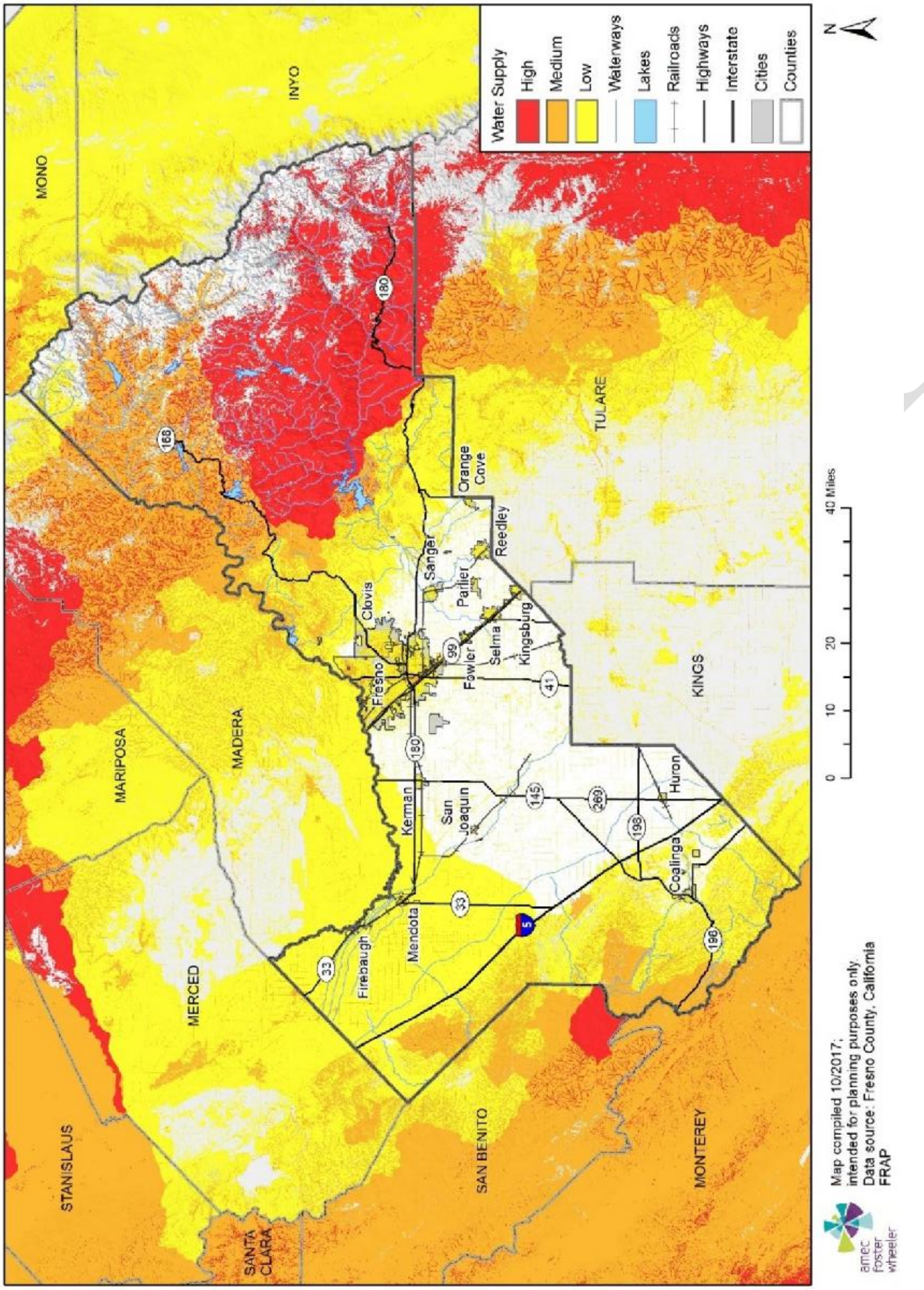


Figure 4.72 Fresno Wildfire Priority Landscape- Water Quality

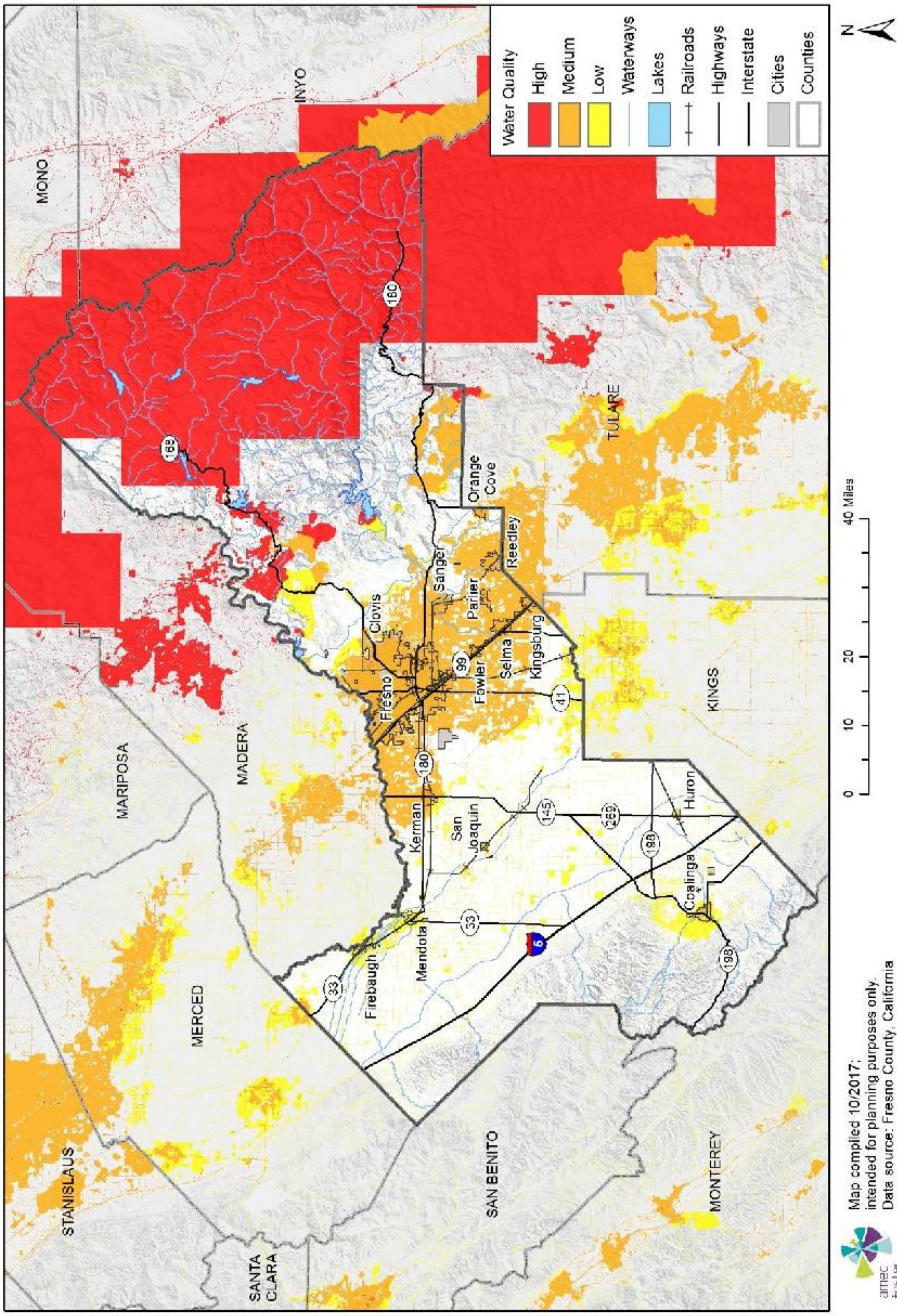
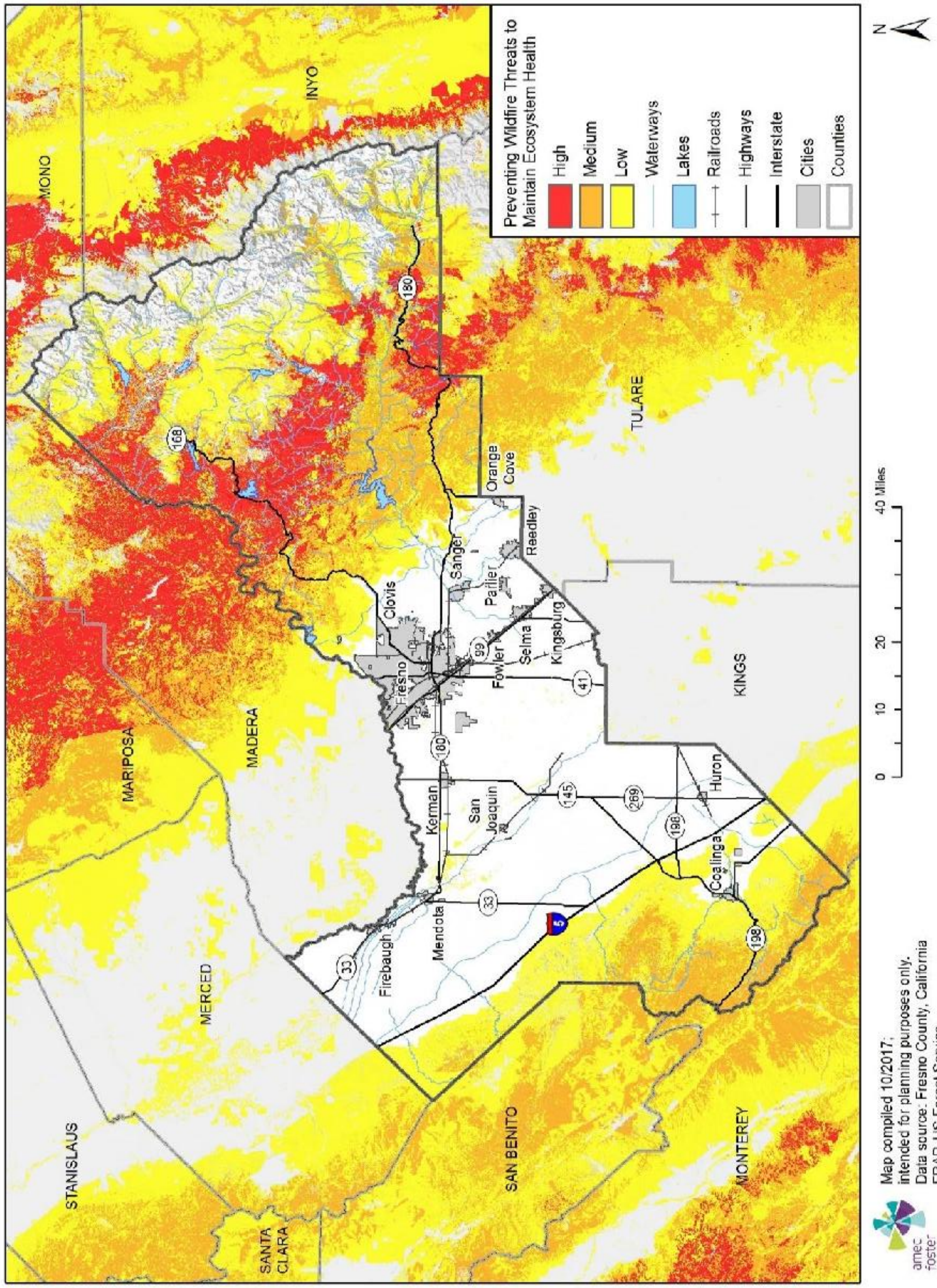


Figure 4.73 Fresno County Preventing Wildfire Threats to Maintain Ecosystem Health



The Fresno County planning area has substantial cultural and natural resources located throughout the County as previously described. Wildfires also cause watershed and ecosystem losses. These losses include impacts to water supplies and water quality as well as air quality. Another loss is to the aesthetic value of the area. Major fires that result in visible damage detract from that value. Other natural resources at risk from wildfire include wildland recreation areas, wildlife and habitat areas, rangeland, and timber resources. The loss to these natural resources would be significant.

The historical and potential impacts of wildfire on the natural environment are widespread throughout public and private lands within the County, exacerbated by drought and tree mortality, with impacts to all flora and fauna, and the destabilization (erosion, subsidence) of land dependent on healthy plants and trees for stability.

The data and mapping captures the full range of vulnerable species, habitat types, biotic regions, parks and forests, and other environmental features within Fresno County. Also provided is each jurisdiction's location within these natural areas, and the location of both jurisdictions and natural areas/species relative the wildfire risk zones on the wildfire risk map. It should be noted that those species and natural zones most greatly affected by drought appear to be most vulnerable to wildfire - The history of drought and (pine) tree mortality locations (section 4.2.4, p. 25, 26) in the County highly correlates with the Very High hazard zone on the Wildfire Severity Map (Figure 4.53) (Source: http://frap.fire.ca.gov/projects/projects_drought).

Critical Facilities

Wildfire impacts to critical facilities include structural damage or destruction, risk to persons located within facilities, and interruption of facility operations and critical functions.

Critical facilities are those community components that are most needed to withstand the impacts of disaster as previously described in Section 4.3.1. An analysis was performed using GIS software to determine where critical facilities are located within the wildfire threat zones. Table 4.69 lists the critical facilities in the different wildfire hazard zones for the entire Fresno County planning area.

Table 4.69 Critical Facilities at Risk to Wildfire by Hazard Class: Fresno County Planning Area

Fire Severity	Jurisdiction	Facility Type	Counts
Very High	Unincorporated	Fire Station	8
		School	7
		Total	**15**
High	Unincorporated	Fire Station	7
		School	15
		Sheriff	1
		Total	**23**
Moderate	Coalinga	Department of Public Works	1
		Fire Station	2
		Total	**3**
	Firebaugh	Airport	1
		Total	**1**
	Fresno	Daycare	1
		Total	**1**
	Unincorporated	CalARP	3
		Department of Public Works	1
		Fire Station	3
		School	2
		Sheriff	1
		Total	**10**
		Grand Total	**15**

Sources: Fresno County GIS, California Department of Forestry and Fire Protection, Amec Foster Wheeler analysis 2018

Future Development

Given that large, destructive fires continue to plague California communities (and Fresno County), recent research points out that such impacts are related to growth/land-use development and federal, state and local policy makers continue to expand the demarcations of the Wildland Urban Interface (WUI). Because future development encompasses all forms of property, buildings, infrastructure, critical facilities and all related populations and their functions, drought impacts to future development align with the historical and potential impacts to populations, property, natural environment, and critical facilities discussed (above). Population growth and development in Fresno County is on the rise. Additional growth and development within the WUI interface will continue to increase the risk and vulnerability of the planning area to damaging wildfires.

Figure 4.74 Localized Development Threat

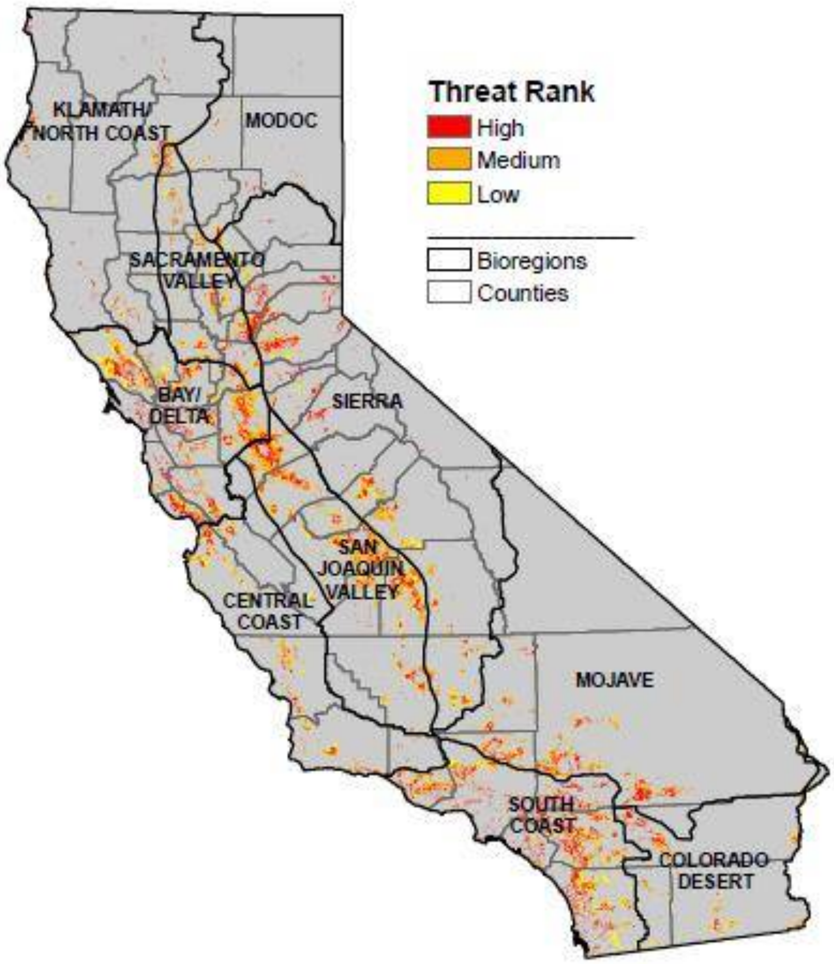


Figure 1.1.3.
Localized development threat.
Data Sources: U.S. Census Bureau (2000); ICLUS, U.S. Environmental Protection Agency (2009); Commission on Local Governance for the 21st Century (2000)

In general, continuing past trends, much development in Fresno County is projected on land currently used for agriculture. Figure 4.74 (above) shows high risk of development across large extents of the San Joaquin Valley **(Source: http://frap.fire.ca.gov/data/assessment2010/pdfs/1.1population_growth.pdf).**

Overall Community Impact

The overall impact to the community from a severe wildfire includes:

- Injury and loss of life;
- Commercial and residential structural damage;
- Decreased water quality in area watersheds;
- Increase in post-fire hazards such as flooding, sedimentation, and mudslides;
- Damage to natural resource habitats and other resources, such as timber and rangeland;
- Loss of water, power, roads, phones, and transportation, which could impact, strand, and/or impair mobility for emergency responders and/or area residents;
- Economic losses (jobs, sales, tax revenue) associated with loss of commercial structures;
- Negative impact on commercial and residential property values;
- Loss of churches, which could severely impact the social fabric of the community;
- Loss of schools, which could severely impact the entire school system and disrupt families and teachers, as temporary facilities and relocations would likely be needed; and
- Impact on the overall mental health of the community.

4.4 Human-Caused Hazards

This risk assessment differs from the risk assessment for natural hazards in that it does not include an assessment of potential losses from human-caused hazards. Such an assessment is very difficult, primarily because of how unpredictable and complex such events are. Human-caused hazard events are often measured in terms such as human lives and economic disruption as well as the value of the facilities actually impacted. The value of impacted facilities is often negligible as compared to the emotional value and the economic impact of affected local, regional, national, and world markets. The unpredictability of human-caused hazard events creates a level of complexity in modeling potential losses which is often covered in other planning mechanisms and is well beyond the scope of this DMA planning effort.

The risk assessment process for human-caused hazards identifies the areas most susceptible to potential hazard events by evaluating which populations and facilities are most vulnerable to human-caused hazards. It is presented in two sections: Hazard Identification and Profiles: Human Caused-Hazards and Asset Inventory and Vulnerability Assessment.

4.4.1 Hazard Identification and Profiles: Human-Caused Hazards

Natural hazards, while essentially uncontrollable events, do follow the fundamental laws of earth science and physics. Therefore, the types, frequencies, and locations of many natural hazards can be identified and often predicted with a certain level of confidence. For example, within floodplains, it can be stated that in any given year there is a 1 percent chance of a flood event at a given discharge and flood depth that will be equaled or exceeded. These predictions are based on historical flood records combined with hydrologic and hydraulic modeling. In many cases, warning systems are in place to notify the public of a pending natural event. The same is not usually true for human-caused hazards.

With human-caused hazards, the recurrence interval cannot be predicted and human behaviors, such as incompetence, carelessness or malice cannot be forecast with any level of accuracy. While some warning systems have been established to notify at risk populations of impending threats from human-caused hazards, these types of hazards usually do not follow a predictable pattern. The potential exists for most types of human-caused hazards to occur anywhere at any time. Due to their unpredictability, human-caused hazards can pose great danger to public health and safety. Education, warning, and response capability are particularly important in preparing for human-caused incidents.

Human-caused hazards are hazards that directly result from human activity. These hazards can be accidental or intentional. FEMA guidance generally separates human-caused hazards into two broad categories: technological hazards (accidental) and terrorism hazards (intentional). The HMPC chose to only address technological hazards associated with a hazardous materials release in this plan.

Hazardous Materials Incidents

Hazardous Material Incidents usually result from accidents or system failures. These hazards are largely unforeseen and therefore are difficult to predict with any level of accuracy. **Hazards of concern in Fresno County include fixed facility incidents and transportation incidents** (these are discussed further below); in other words, facilities and operations that produce, transport, store, and/or use hazardous materials.

Hazardous materials are substances that are flammable or combustible, explosive, toxic, noxious, corrosive, reactive, an oxidizer, an irritant, carcinogenic, or radioactive. These materials can harm people through skin contact, inhalation, ingestion, or pharmaceutical action. Hazardous materials have the potential to be released into the environment during use, processing, storage, and transport or when improperly disposed. A release of a hazardous material can pose a risk to life safety, public health, and property and can result in the evacuation of a few people, a portion of a facility, or an entire area. Other concerns include impacts to air quality, water quality, and other short- and long-term impacts to the natural environment. As a result of these risks, the use, storage, transport, and disposal of hazardous materials is highly regulated at the federal, state, and local levels.

Hazardous materials are everywhere, and spills or releases occur in this nation on a daily basis. **According to FEMA, the impact to life and property from any given release depends on a number of factors:**

- **Application Mode** describes the human act(s) or unintended event(s) necessary to cause the hazard to occur.
- **Duration** is the length of time the hazard is present on the target.
- The **dynamic/static characteristic** of a hazard describes its tendency, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space.
- **Mitigating conditions** are characteristics of the target and its physical environment that can reduce the effects of a hazard.
- **Exacerbating conditions** are characteristics that can enhance or magnify the effects of a hazard

Additional factors contribute to the impact of hazardous materials releases from a fixed facility or transportation incident: Cal A

- Solid, liquid, and/or gaseous hazardous materials can be released from fixed or mobile containers either accidentally or on purpose (see Table 4.70).
- The resulting release can last for hours or for days.
- The substances released may be corrosive or otherwise damaging over time, and they may cause an explosion and/or fire.
- Contamination may be carried out of the incident area by people, vehicles, water, and/or wind.
- Weather conditions will directly affect how the hazard develops.
- The micrometeorological effects of buildings and terrain can alter travel and duration of agents.
- Shielding in the form of sheltering in place can protect people and property from harmful effects.
- Noncompliance with fire and building codes as well as failure to maintain existing fire protection and containment features can substantially increase the damage from a hazardous materials release.

Table 4.70 Potential Human-Caused Actions Resulting in Technological Hazard Events

Industrial (Fixed Facility)	Industrial (Transportation Accidents)	Supervisory Control and Data Acquisition
Failure to adhere to procedures	Tanker truck spills	Failure of automated systems
Leaks	Truck accidents	Sabotage/intrusion
Failure of equipment	Railway accidents	
Failure of safety systems		

Source: Integrating Manmade Hazards into Mitigation Planning, FEMA 386-7, 2003; HMPC

Fixed Facility Incidents

Industrial accidents occur due to inadequate human oversight or the failure of systems used to move or store materials, such as pipes and storage tanks. Numerous facilities in the Fresno County region have been identified as sites that store hazardous materials as part of their daily operations.

The threat that these sites pose to the region depends on the type of material present and the proximity of these facilities to populations and whether or not these materials are transported.

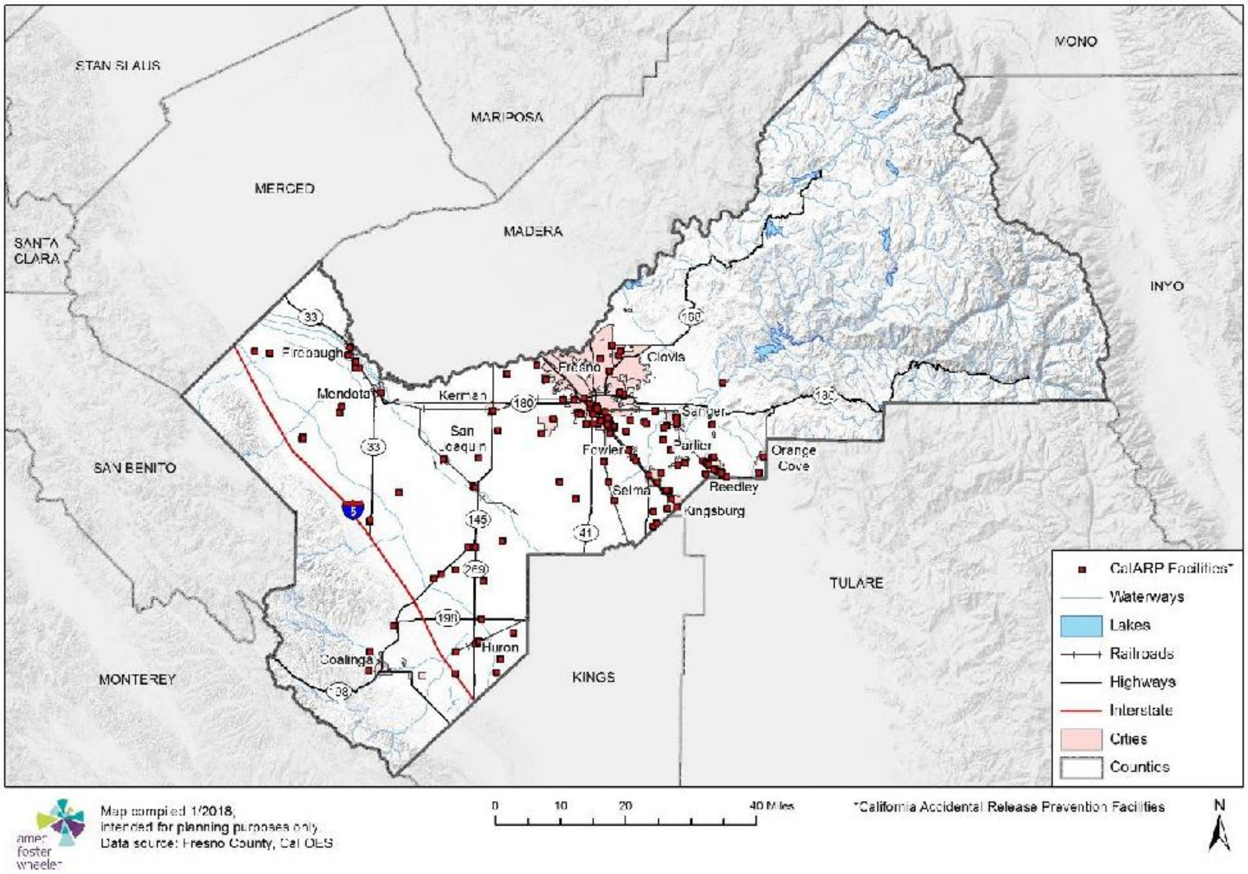
In order to identify those facilities with the greatest potential for a hazardous materials release that could adversely impact communities within the Fresno County planning area, the HMPC took an initial inventory of potential sites by utilizing data from **the California Accidental Release Prevention Program (CalARP).** The program was implemented on January 1, 1997 and replaced the California Risk Management and Prevention Program (RMPP). The purpose of the CalARP program are to prevent accidental releases of substances that can cause serious harm to the public and the environment, to minimize the damage if releases do occur, and to satisfy community right-to-know laws. This is accomplished by requiring businesses that handle more than a threshold quantity of a regulated substance listed in the regulations to develop a Risk Management Plan (RMP). An RMP is a detailed engineering analysis of the potential accident factors present at a business and the mitigation measures that can be implemented to reduce this accident potential. The RMP contains:

- Safety information
- A hazard review
- Operating procedures
- Training requirements
- Maintenance requirements
- Compliance audits
- Incident investigation procedures

The CalARP program is implemented at the local government level by Unified Program Agencies (UPAs). Of benefit to the HMPC's efforts to address hazardous materials incidents is the fact that the CalARP program is designed so that UPA's work directly with regulated facilities.

Figure 4.75 (below) identifies the all CalARP regulated facilities within the planning area, as well as the location and density of such facilities in relation to jurisdictions (at risk population centers), and critical infrastructure such as railways and major transportation routes. The mapped sites below represent those most critical (CalARP) sites as determined by the HMPC for the purposes of the plan update.

Figure 4.75 Fresno County CalARP Facilities



- In addition to the Cal ARP sites mapped (above), the following sites are identified in the Fresno County 2040 General Plan (2017 public review draft):
- As of February 1, 2016, there are 70 active Leaking Underground Storage Tanks (LUST) sites and 28 Superfund sites, including five National Priorities List (NPL) listed sites, in Fresno County.
- There are 1,678 small quantity hazardous waste generators and 150 large quantity hazardous waste generators in Fresno County.
- There are three hazardous waste disposal facilities in Fresno County: A collection facility and a recycling facility, both operated by Safety Kleen Corporation, and a Regional Permanent Household Hazardous Waste Facility operated by Fresno County to accommodate the disposal of hazardous household waste. The Safety Kleen recycling facility handles immersion cleaners and mineral spirits.
- Agriculture operations in proximity to urbanized areas, particularly near residential uses, present some risks associated with agricultural chemicals (pesticides and fertilizers). As more residential development is built close to existing agricultural uses, risks associated with

agricultural chemicals may increase (Source: Fresno County 2040 General Plan, (2017 Public Review Draft, p. 8.67).

The following table (Source: CalARP) identifies the number of hazardous materials facilities within each jurisdiction and in unincorporated Fresno County. It is useful as a cross-reference to illustrate how the risk varies by jurisdiction.

Table 4.71 Hazmat Facilities by Jurisdiction

Jurisdiction	Counts
Clovis	2
Firebaugh	2
Fowler	3
Fresno	28
Huron	7
Kerman	2
Kingsburg	5
Mendota	1
Orange Cove	1
Parlier	2
Reedley	8
San Joaquin	1
Sanger	5
Selma	2
Unincorporated	87
Total	**156**

Source: CalARP

Transportation Incidents (e.g., Rail, Highway)

Transportation incidents can occur during the transportation of hazardous materials to and from storage facilities. The most likely routes for the transportation of hazardous materials are major roadways and railroads. Two major north-south roadways are located in Fresno County. Highway 99 runs through the central part of the County and provides a north-south corridor through several counties. Most of the County's industrial and residential activity is positioned along Highway 99. In western Fresno County, Interstate 5 traverses the County at the base of the Coast Range foothills. State Routes 33, 41, 43, 63, 145, 168, 180, 198, and 269 provide local service to urban and rural areas in the County. A network of County roads connects the various communities to these major arteries. Major rail lines include Union Pacific, Burlington Northern and Santa Fe Company, Port Railroads, Inc., and San Joaquin Valley Railroad. The major transportation corridors and rail lines are listed in Table 4.72 and illustrated in Figure 4.76 and Figure 4.77.

The United States Department of Transportation (USDOT) has established nine hazardous materials classifications: explosive, compressed gases, flammable/combustible liquids, flammable solids, oxidizers, poisons, corrosive, radioactive, and miscellaneous. Transporters of such materials must adhere to routing requirements that are enforced by the California Highway Patrol. Transportation must take the most direct route, utilizing State or interstate highways whenever possible, and only roadways with sufficient width and load bearing capacity. All nine classes of hazardous materials, including hazardous waste, may be transported on Interstate 5. Materials that are poisonous by inhalation, explosives or high level radioactive may be transported on certain State Routes, including SR 33, 41, 63, 99, 180, and 198, but are subject to restrictions (Source: Fresno County 2040 General Plan, (2017 Public Review Draft).

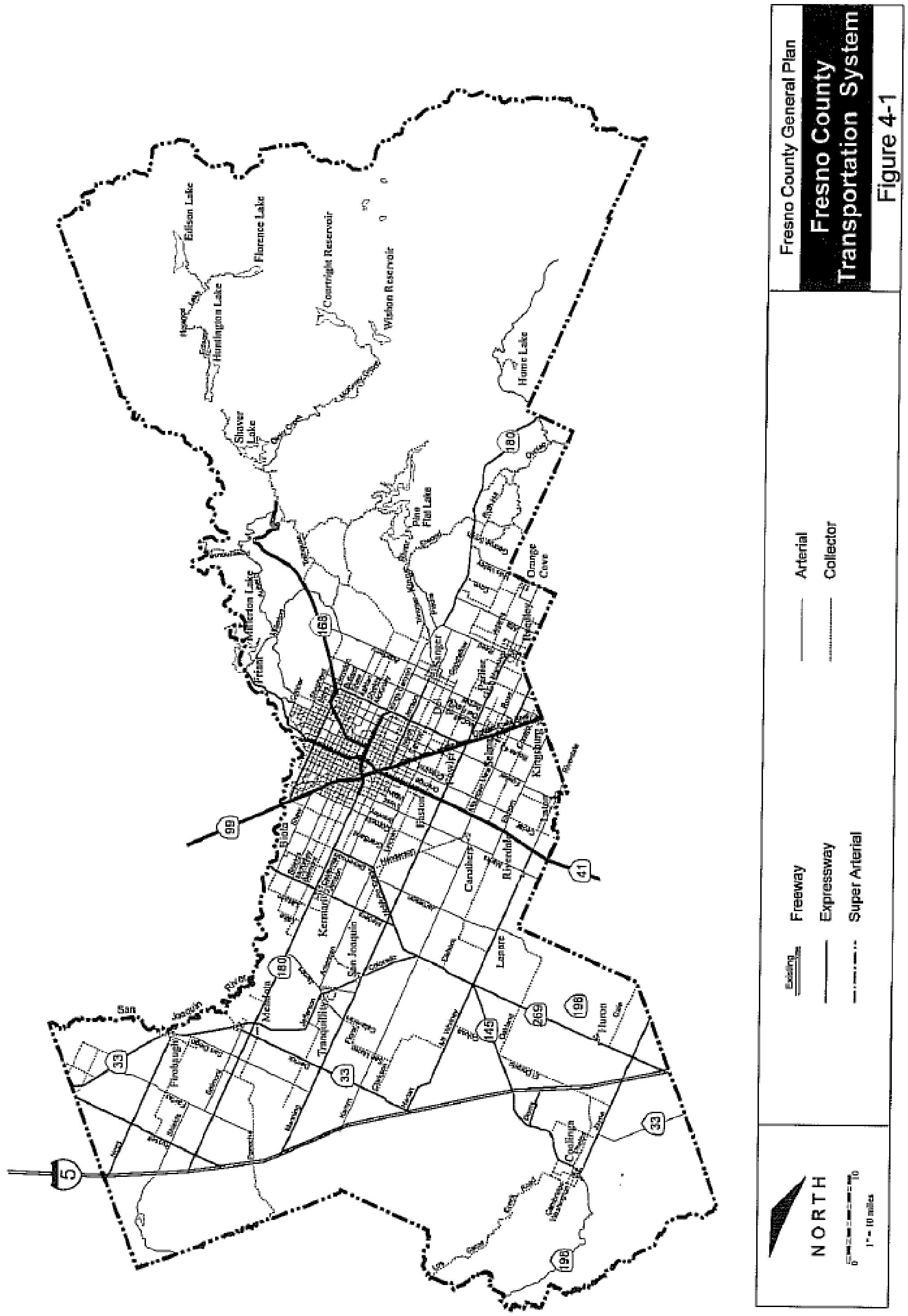
Table 4.72 Major Fresno County Transportation Corridors

Major Roadways	Rail Lines/Operators
Highway 99 *	Union Pacific Railways
Interstate 5*	Burlington Northern and Santa Fe Company
State Route 33	Port Railroads Inc.
State Route 41	San Joaquin Valley Railroad
State Route 43	
State Route 63	
State Route 145	
State Route 168	
State Route 180	
State Route 198	
State Route 269	
Golden State Boulevard*	
Manning Avenue	
Jensen Avenue*	

Source: Fresno County General Plan

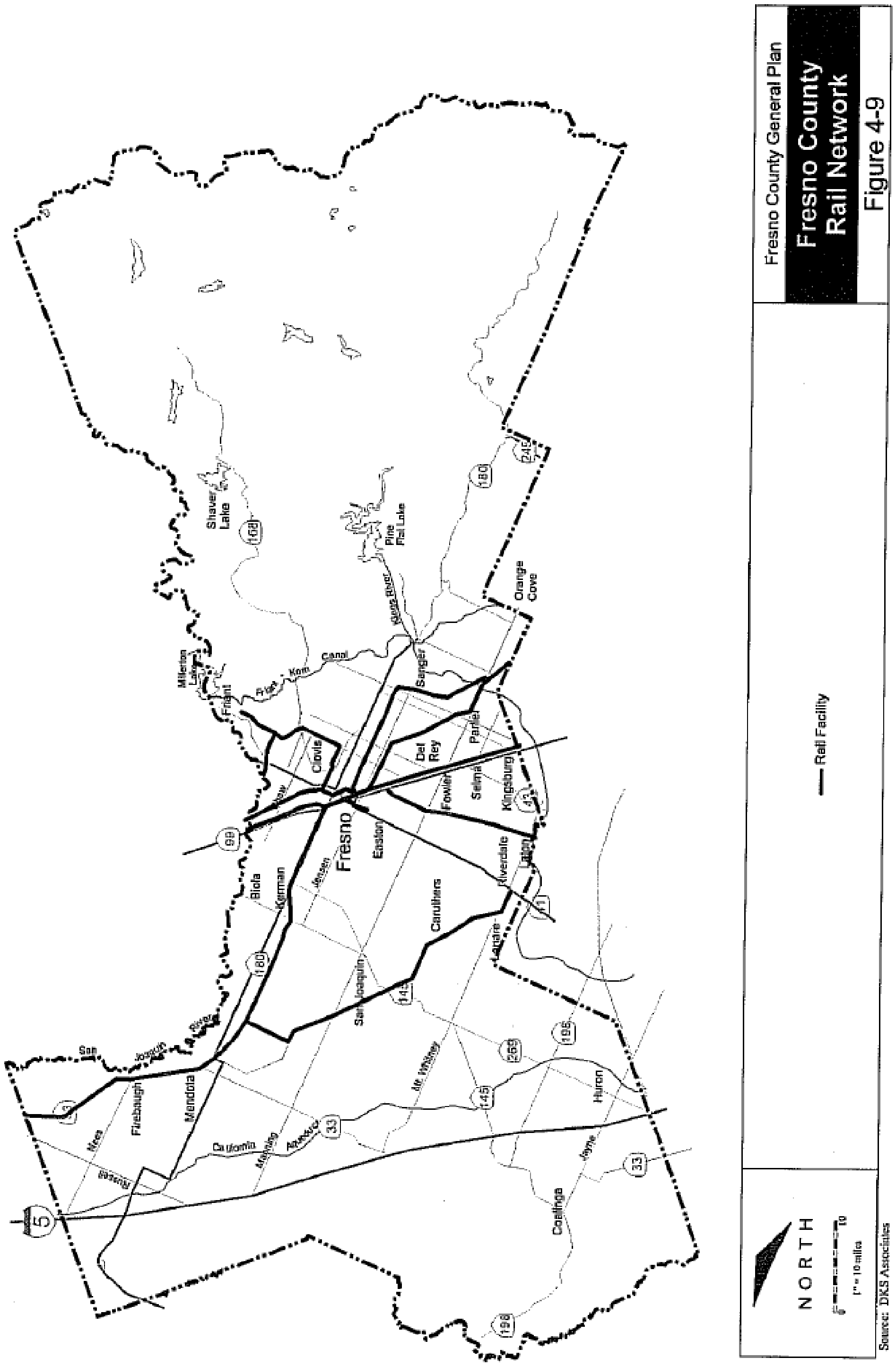
*Indicates corridor experiences truck traffic in excess of 2,000 vehicles per day

Figure 4.76 Fresno County's Transportation System



Source: Fresno County General Plan, 2000

Figure 4.77 Fresno County's Rail Network



Source: Fresno County General Plan, 2000

Of the County's transportation corridors, Interstate 5, Highway 99, and State Route 41 are the most significant because they provide direct links between the County transportation system, the surrounding regions, and beyond. The other corridors identified in Table 4.72 connect cities and communities in Fresno County with each other.

According to the Fresno County General Plan Background Report, truck transportation, followed by rail, air, and pipeline, provides the majority of goods movement in Fresno County, including the transportation of hazardous materials. Fresno County has considerable long-distance trucking activity due to the presence of Interstate 5 and Highway 99. According to the background report, Highway 99 carries the greatest volume of truck traffic in Fresno County (between 7,800 and 22,100 vehicles per day); Interstate 5 also experiences large volumes of truck traffic (between 5,500 and 6,500 vehicles per day). Other routes with significant truck traffic (i.e., more than 2,000 vehicles per day) include Golden State Boulevard and Jensen Avenue.

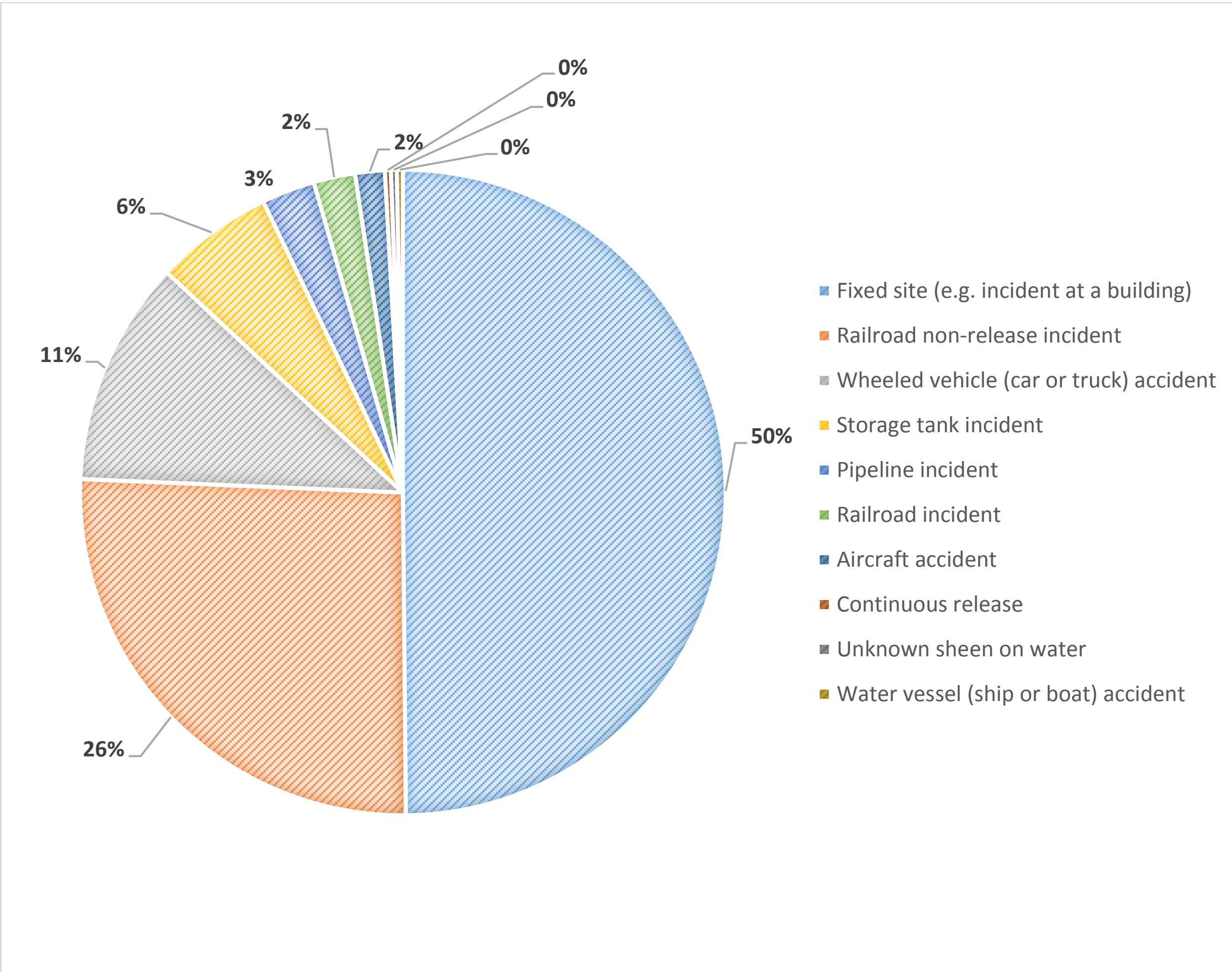
There are two mainline rail lines that run north-south through Fresno County. The first, owned by the Burlington Northern and Santa Fe Company, connects the County to Sacramento and the San Francisco Bay Area to the north and Bakersfield to the south. The second, owned by Union Pacific Railways, parallels the Highway 99 corridor and connects the County to Sacramento and the Bay Area to the north and Bakersfield to the south. Both lines service the City of Fresno. Other lines provide rail service primarily to communities within the County and to adjacent counties. According to the HMPC, approximately 40 trains travel through the City of Fresno each day, and sometimes the trains carry hazardous materials very close to schools and residential areas.

Past Occurrences

Hazardous materials incidents in Fresno County are frequent events. Statistics from the National Response Center, which serves as the sole national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories, indicate that between 2009 and the end of 2016, 337 incidents were reported in Fresno County. Of these, 64 included fatalities, 61 included injuries, 38 included hospitalizations. The incidents required 1,874 people to be evacuated, and caused $353,888 in property damage.

Figure 4.78 shows the breakdown of the types of incidents that occurred in Fresno County in this time period. Of the incidents, 50 percent were fixed, 26 percent were railroad non-release, 11 percent were mobile (transportation on land), 3 percent were pipeline and 2 percent were railroad.

Figure 4.78 Reports of Hazardous Materials Incidents in Fresno County, 2009-2016



Source: National Response Center, www.nrc.uscg.mil/

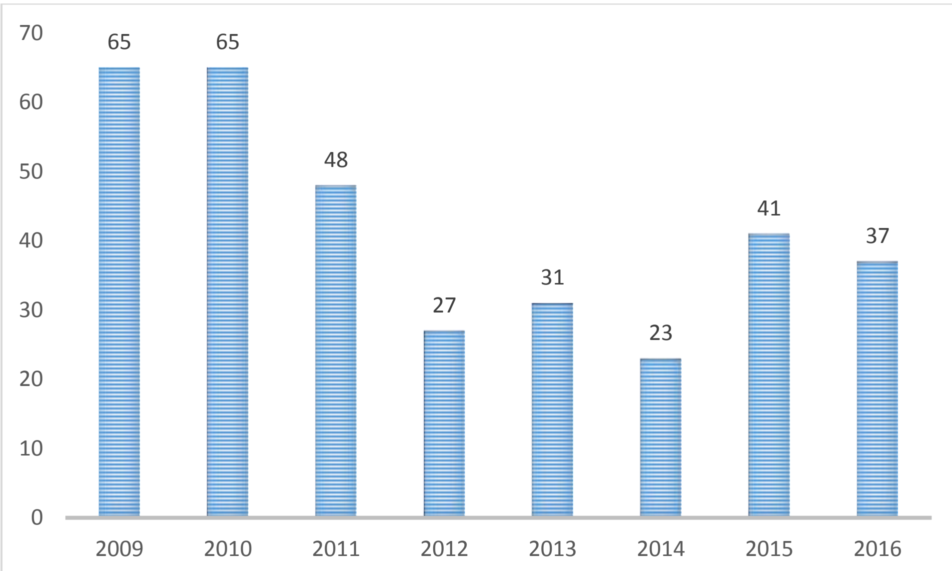
Table 4.73 NRC-Reported Hazardous Materials Incidents in Fresno County, 2009-2016

Incident Type	Number of Incidents
Fixed site (e.g. incident at a building)	168
Railroad non-release incident	87
Wheeled vehicle (car or truck) accident	38
Storage tank incident	20
Pipeline incident	9
Railroad incident	7
Aircraft accident	5
Continuous release	1
Unknown sheen on water	1
Water vessel (ship or boat) accident	1
Drilling platform incident	0
Unknown	0
Left Blank	0

Source: National Response Center, www.nrc.uscg.mil/

Trend data between 2009 and 2016 shows a high of 65 incidents reported to the NRC per year (2009, 2010), and a low of 23 incidents per year (2014). The data shows a gradual decline in number of incidents per year.

Figure 4.79 Reports of Hazardous Materials Incidents in Fresno County, 2009-2016



Source: National Response Center, www.nrc.uscg.mil/

NRC data shows that a majority of incidents occurred in Fresno, with 197 reported; the following table shows total number of incidents reported to the NRC for Fresno County by jurisdiction.

Table 4.74 NRC-Reported Hazardous Materials Incidents by Jurisdiction 2009-2016

Cities	Incidents
Fresno*	197
Sanger*	19
Auberry	11
Old Fig Garden	11
Clovis*	10
Big Creek	7
Fowler*	7
Selma*	7
Reedley*	6
Coalinga*	5
Firebaugh*	5
Not Identified	5
Helm	4
Kingsburg*	4
Conejo	3
Del Rey	3
Laton	3
Shaver Lake	3
Cantua Creek	2
Huron*	2
Kerman*	2
Lemoore	2
Squaw Valley	2
Tranquility	2
Canejo	1
Caruthers	1
Corcoran	1
Five Points	1
Hammond	1
Mendota*	1
NAS Lemoore	1
North Fork	1
Pickley	1
Pitdria	1
Riverdale	1
Sigarden	1
Sunmaid	1

Cities	Incidents
Traver	1
Trigo	1

Note: Municipalities are noted with an *
Source: National Response Center, www.nrc.uscg.mil/

The County's emergency response team receives numerous calls each year related to hazardous materials releases. Since 2004, the team has received over 1,000 reports. The majority of incidents in Fresno County were fuel spills and characterized as relatively minor. As such, it is just a response/cleanup issue that generally does not pose a significant impact to the community. However, other incidents can and have occurred in the County. The HMPC provided details about some of the hazardous materials incidents that have occurred in Fresno County (see Table 4.75 and Table 4.74.

Table 4.75 Hazardous Materials Fixed Facility Incidents in Fresno County

Date	Location	Incident Type	Damage/Exposures
7/7/2004	Sun West Fruit Company, 755 E. Manning Avenue, Parlier	Anhydrous ammonia (approximately 50 pounds) leaked	86 people were employees, 28 were taken to the hospital

Source: Fresno County HMPC

Table 4.76 Hazardous Materials Transportation Incidents in Fresno County

Date	Location	Incident Type	Damage/Exposures
6/5/2000	Interstate 5 in Fresno County	Pressurized anhydrous ammonia released (truck was hauling 19,500 pounds) in accident	Employees of nearby business affected, one person hospitalized, Interstate 5 was closed for 29 hours
4/28/2006	Southbound Freeway 41 at Highway 99	Automotive fluid released (20 gallons) onto the roadway and into a culvert as a result of an overturned big rig	Spill contained and cleaned up
1/22/2007	Northbound Highway 99 North of Ashlan Avenue	Sodium hydroxide (up to 5 gallons) Methanol, Alkanolamine, and Tolad resulting from a motor vehicle accident	Spill contained and cleaned up, northbound Highway 99 was closed for 9 ½ hours
6/19/2007	Blackstone and McKinley Avenue	Suspected propane resulting from train derailment	Due to potential danger, Fresno City College campus was closed for the evening; no actual release occurred
6/28/2007	Southbound State Route 41 below the Jensen Avenue overpass	Diazinon 50W (insecticide, 10 gallons) occurring when products shifted in a truck and containers fell onto the freeway and were struck by an oncoming truck	Two people exposed and decontaminated; Spill contained and cleaned up
11/3/2007	Highway 99 and Clovis Avenue	Small amount of diesel fuel spilled due to numerous car accidents	Spill contained and cleaned up

Source: Fresno County HMPC

4.4.2 Asset Inventory and Vulnerability Assessment

The probability and potential losses of human-caused technological hazards are difficult to quantify due to the "human" element. These hazards can occur at any time and virtually any place with little or no warning. However, they can often be inventoried because they typically occur in conjunction with a particular facility/business that produces, transports, stores, or uses substances that present a specific hazard to the local community or environment, or the hazard is present due to the shipment of potentially harmful substances from outside the region across various transportation arteries that bisect Fresno County communities.

The facilities and transportation corridors identified in Table 4.72 and Figure 4.76 and Figure 4.77 are those that the HMPC has identified as potential sites for hazardous materials releases that may adversely affect the Fresno County planning area.

Asset Inventory

Section 4.3 Vulnerability Assessment and the jurisdictional annexes identify the total assets at risk in the Fresno County planning area to both natural and human-caused hazards. Also included in those sections are inventories of critical facilities. These critical facilities, as previously defined, are considered vital to the daily continuity of life, unobstructed flow of commerce, and the continued health and welfare of the planning area as a whole.

Vulnerability Assessment

As previously stated, it is often quite difficult to quantify the potential losses from human-caused hazards. While the facilities themselves have a tangible dollar value, loss from a human-caused hazard often inflicts an even greater toll on a community, both economically and emotionally. The impact to identified assets will vary from event to event and depend on the type, location, and nature of a specific technological hazard event.

Given the difficulty in quantifying the losses associated with technological hazards, this section focuses on analyzing key assets and populations relative to the hazardous materials sites identified previously.

Fixed Facility Incidents

As discussed above, there are over 157 fixed facilities (CalARP sites) identified in the Fresno County planning area with the potential to cause a hazardous materials release of sufficient type and magnitude to adversely impact surrounding areas. These sites are regulated and most have emergency action plans in place. The impact to surrounding areas would depend on the nature and quantity of any release as well as the time of the event and prevailing weather conditions.

Critical Facilities at Risk

The following table is derived from a GIS analysis on the CalARP data, and focuses on the number and types of critical facilities within each jurisdiction that are located within a half-mile of a hazardous materials facility. The analysis indicates the City of Fresno having the highest number of critical facilities within a half-mile mile of CalARP designated facilities.

Table 4.77 Critical Facilities Within a ½ Mile Buffer from Hazmat Facilities

Jurisdiction	Facility Type	Counts
Clovis	Fire Station	1
	School	2
	Total	**3**
Firebaugh	Fire Station	1
	Police	1
	School	4
	Urgent Care	1
	Total	**7**
Fowler	Fire Station	1
	Police	1
	School	1
	Total	**3**
Fresno	Colleges & Universities	1
	Communications	1
	County Government	4
	Courthouse	1
	Daycare	11
	Department of Public Health	2
	Department of Social Services	4
	Detention Center	4
	District Attorney	2
	Fire Station	4
	Health Care	3
	Nursing Home	4
	Police	1
	School	17
	Sheriff	1
	Supplemental College	1
	Urgent Care	1
	Total	**62**
Huron	Fire Station	1
	Police	1

Jurisdiction	Facility Type	Counts
	School	3
	Total	**5**
Kerman	Police	1
	Total	**1**
Kingsburg	Fire Station	1
	Police	1
	School	2
	Total	**4**
Mendota	Airport	1
	Total	**1**
Orange Cove	Fire Station	1
	School	2
	Total	**3**
Parlier	Police	1
	School	1
	Total	**2**
Reedley	Colleges & Universities	1
	Communications	1
	Fire Station	1
	Police	1
	School	8
	Total	**12**
San Joaquin	School	2
	Total	**2**
Sanger	Behavioral Health	1
	Department of Agriculture	1
	Fire Station	1
	Nursing Home	1
	Police	1
	School	9
	Total	**14**
Selma	Fire Station	1
	Nursing Home	1
	Police	1
	Sheriff	1
	Urgent Care	1
	Total	**5**
Unincorporated	Department of Public Works	3
	Fire Station	3
	Nursing Home	1
	School	11

Jurisdiction	Facility Type	Counts
	Total	**18**
	Grand Total	**142**

Source: Amec Foster Wheeler Analysis of County, CalARP, and Federal Data

4.5 Fresno County's Mitigation Capabilities

Thus far, the planning process has identified the hazards posing a threat to Fresno County and described, in general, the vulnerability of the County to these risks. The next step is to assess what loss prevention mechanisms are already in place. This part of the planning process is the mitigation capability assessment. Combining the risk assessment with the mitigation capability assessment results in the County's "net vulnerability" to disasters and more accurately focuses the goals, objectives. and proposed actions of this plan.

As such, this section presents Fresno County's mitigation capabilities: programs and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. It also identifies select state and federal departments/agencies that can supplement the County's mitigation capabilities. This assessment is divided into three sections: regulatory mitigation capabilities, administrative and technical mitigation capabilities, and fiscal mitigation capabilities. Information about capabilities specific to the other participating jurisdictions can be found in the jurisdictional annexes.

The HMPC used a two-step approach to originally conduct this assessment for the County. First, an inventory of common mitigation activities was made through the use of a matrix. The purpose of this effort was to identify policies and programs that were either in place, needed improvement, or could be undertaken, if deemed appropriate. Second, the HMPC reviewed existing policies, regulations, plans, and programs to determine if they contributed to reducing hazard-related losses or if they inadvertently contributed to increasing such losses. During the 2017-2018 update this section was reviewed by County and Amec Foster Wheeler consultant team staff to update information where applicable. This included revising sections to align with changes that will be reflected in the updated General Plan.

4.5.1 Fresno County's Regulatory Mitigation Capabilities

Table 4.78 lists regulatory mitigation capabilities, including planning and land management tools, typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in Fresno County. Excerpts from applicable policies, regulations, and plans and program descriptions follow to provide more detail on existing mitigation capabilities.

Table 4.78 Fresno County's Regulatory Mitigation Capabilities

Regulatory Tool (ordinances, codes, plans)	Yes/No	Comments
General plan	Yes	Adopted October 2000; in process of update 2017-2018
Zoning ordinance	Yes	
Subdivision ordinance	Yes	
Site plan review requirements	Yes	
Growth management ordinance	No	
Floodplain ordinance	Yes	
Other special purpose ordinance (e.g., stormwater, steep slope, wildfire)	Yes	See ordinance discussion that follows
Building code	Yes	2016 California Building Code
Fire department ISO rating	No	
Erosion or sediment control program	Yes	Via grading permits
Stormwater management program	No	See Fresno Metropolitan Flood Control District/Drainage of Land Ordinance
Capital improvements plan	Yes	
Economic development plan	Yes	Policies in County's documents
Local emergency operations plan	Yes	Fresno County Operational Area Master Emergency Services Plan
Other special plans	Yes	
Flood insurance study or other engineering study for streams	Yes	FEMA Flood Insurance Study, 2016, via floodplain administrator
Elevation certificates	Yes	

As indicated in the table above, Fresno County has several plans and programs that guide the County's development in hazard-prone areas. Starting with the Fresno County General Plan, which is the most comprehensive of the County's plans when it comes to mitigation, some of these are described in more detail below.

Fresno County General Plan

The Fresno County General Plan consists of multiple documents: the countywide General Plan Background Report, the countywide General Plan Policy Document, and over 40 regional, community, and specific plans. This discussion is derived primarily from the Fresno County General Plan Policy Document, from which the text that follows is largely extracted.

The Fresno County General Plan is a comprehensive, long-term framework for the protection of the county's agricultural, natural, and cultural resources and for development in the county. Designed to meet state general plan requirements, it outlines policies, standards, and programs and sets out plan proposals to guide day-to-day decisions concerning Fresno County's future. It is a legal document that serves as the County's "blue print" or "constitution" for land use and development.

The General Plan Policy Document is organized into the following seven elements, which generally correspond with the content requirements specified in State Planning Law:

- Economic Development
- Land Use
- Transportation and Circulation
- Public Facilities and Services
- Open Space and Conservation
- Health and Safety
- Housing

Each of these elements includes goal statements relating to different aspects of the issues addressed in the element. Under each goal statement, the plan sets out policies that amplify the goal statement. Implementation programs are listed in a separate Administration and Implementation Section and describe briefly the action proposed by the program, the County agencies or departments with primary responsibility for carrying out the program, and the time frame for accomplishing the program.

The County is conducting a comprehensive review of its current General Plan. Based on the review, County staff has proposed revisions to the Plan's goals, policies, and programs. These revisions will be subject to review and deliberation by the Planning Commission and Board of Supervisors prior to adoption, which is expected to occur by the end of 2018.

Following is an element-by-element summary of the General Plan goals and policies that are most relevant to the Hazard Mitigation Plan Update. The summary tracks the organization of each element, with topically-focused goals followed by related policies. Note that the summaries reflect to policies as proposed by the County as a result of its ongoing review, including deletions and revisions.

Health and Safety Element

Planning for growth and development requires the consideration of a wide range of public safety issues. Many of the health and safety risks associated with development, including risks to buildings and infrastructure, can be avoided through siting decisions made at the planning stages of development, while others may be lessened through the use of mitigation measures in the planning and land use review process. This element outlines Fresno County's strategy for ensuring the maintenance of a healthy and safe physical environment. Applicable goals and policies are presented below.

Emergency Management and Response

Policies in this section seek to create an effective emergency response and management system by ensuring that vital public infrastructure is designed to remain operational during and after a major disaster event, by siting critical emergency response facilities as far from potential disaster impact areas as is practical, and through continuing public education and outreach on emergency preparedness and disaster response programs.

Goal HS-A:	To protect public health and safety by preparing for, responding to, and recovering from the effects of natural or technological disasters.
Policy HS-A.2	In coordination with cities, special districts, and other State and Federal agencies, the County shall maintain the Fresno County Multi-Jurisdictional Hazard Mitigation Plan to identify and mitigate, to the extent feasible, natural and human-made hazards within the county.
Policy HS-A.3:	The County shall, within its authority and to the best of its ability, ensure that emergency dispatch centers, emergency operations centers, communications systems, vital utilities, and other essential public facilities necessary for the continuity of government are designed in a manner that will allow them to remain operational during and following an earthquake or other disaster.
Policy HS-A.4:	The County shall ensure that the siting of critical emergency response facilities such as hospitals, fire stations, sheriff's offices and substations, dispatch centers, emergency operations centers, and other emergency service facilities and utilities are sited and designed to minimize their exposure and susceptibility to flooding, seismic and geological effects, fire, avalanche, and explosions as required by state regulations.
Policy HS-A.5	The County shall maintain coordination with other local, State, and Federal agencies to provide coordinated disaster response.
Policy HS-A.6:	The County shall continue to conduct programs to inform the general public of emergency preparedness and disaster response procedures.
Policy HS-A.7	The County shall review the design of all buildings and structures to ensure they are designed and constructed to State and local regulations and standards as part of the building permit plan check process.

Fire Hazards

Policies in this section are designed to ensure that new development is constructed to minimize potential fire hazards, minimize the risk of fire in already developed areas, and to provide public education concerning fire prevention.

Goal HS-B:	To minimize the risk of loss of life, injury, and damage to property and natural resources resulting from fire hazards.
Policy HS-B.1:	The County shall review project proposals to identify potential fire hazards and to evaluate the effectiveness of preventive measures to reduce the risk to life and property.
Policy HS-B.2:	The County shall ensure that development in high fire hazard areas is designed and constructed in a manner that minimizes the risk from fire hazards and meets all applicable state and County fire standards. Special consideration shall be given to the use of fire-resistant construction in the underside of eaves, balconies, unenclosed roofs and floors, and other similar horizontal surfaces in areas of steep slopes.
Policy HS-B.3:	The County shall require that development in high fire hazard areas have fire- resistant vegetation, cleared fire breaks separating communities or clusters of structures from native vegetation, or a long-term comprehensive vegetation and fuel management program. Fire hazard reduction measures shall be incorporated into the design of development projects in fire hazard areas.
Policy HS-B.4:	The County shall require that foothill and mountain subdivisions of more than four parcels provide for safe and ready access for fire and other emergency equipment, for routes of escape that will safely handle evacuations, and for roads and streets designed to be compatible with topography while meeting fire safety needs.
Policy HS-B.5:	The County shall require development to have adequate access for fire and emergency vehicles and equipment. All major subdivisions shall have a minimum of two points of ingress and egress.
Policy HS-B.6:	The County shall work with local fire protection agencies, the California Department of Forestry and Fire Protection, and the U.S. Forest Service to promote the maintenance of existing fuel

Goal HS-B:	To minimize the risk of loss of life, injury, and damage to property and natural resources resulting from fire hazards.
	breaks and emergency access routes for effective fire suppression and in managing wildland fire hazards.
Policy HS-B.7:	The County shall require that community fire breaks be coordinated with overall fire break plans developed by the foothill and mountain fire agencies. Firebreak easements in subdivisions of more than four parcels or in built-up areas shall include access for firefighting personnel and motorized equipment. Easements shall be dedicated for this purpose.
Policy HS-B.8:	The County shall refer development proposals in the unincorporated County to the appropriate local fire agencies for review of compliance with fire safety standards. If dual responsibility exists, both agencies shall review and comment relative to their area of responsibility. If standards are different or conflicting, the more stringent standards shall apply.
Policy HS-B.9:	The County shall require that provisions for establishing year-round fire protection in foothill and mountain areas are developed where concentrations of population are such that structural fire protection is needed.
Policy HS-B.10:	The County shall ensure that existing and new buildings of public assembly incorporate adequate fire protection measures to reduce potential loss of life and property in accordance with state and local codes and ordinances.
Policy HS-B.11:	The County shall require new development to have water systems that meet County fire flow requirements. Where minimum fire flow is not available to meet County standards, alternate fire protection measures, including sprinkler systems, shall be identified and may be incorporated into development if approved by the appropriate fire protection agency.
Policy HS-B.12:	The County shall promote installation and maintenance of smoke detectors in existing residences and commercial facilities that were constructed prior to the requirement for their installation.
Policy HS-B.13:	The County shall work with local fire agencies to develop high-visibility fire prevention programs, including education programs and voluntary home inspections.

Flood Hazards

Policies in this section are designed to minimize flood hazards by restricting development in flood-prone areas, requiring development that does occur in floodplains to be designed to avoid flood damage, and through public education about flood hazards.

Goal HS-C:	To minimize the risk of loss of life, injury, and damage resulting from flood hazards.
Policy HS-C.1	The County shall coordinate with the cities in Fresno County to develop and maintain a countywide flood emergency plan that is consistent with the Fresno County General Plan and city general plans.
Policy HS-C.2	The County shall prohibit new development in existing undeveloped areas (i.e., areas devoted to agriculture or open space that are not designated for development) protected by a State flood control project without appropriately considering significant known flooding risks and taking reasonable and feasible action to mitigate the potential property damage to the new development resulting from a flood.
Policy HS-C.3	The County shall not enter into a development agreement, approve any building permit or entitlement, or approve a tentative or parcel map unless it finds one of the following: a. The flood control facilities provides 200-year level of protection in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan; b. Conditions imposed on the development will protect the property at a 200-year level of protection in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan; or c. The local flood management agency has made "adequate progress" on the construction of a flood protection system which will result in protection equal or greater than the 200-year flood event in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan.
Policy HS-C.4	The County shall require new flood control projects or developments within areas subject to 100- and 200-year frequency floods are designed and constructed in a manner that will not cause

Goal HS-C:	To minimize the risk of loss of life, injury, and damage resulting from flood hazards.
	floodwaters to be diverted onto adjacent property or increase flood hazards to property located elsewhere.
Policy HS-C.5	The County shall encourage all agencies that operate public facilities, such as wastewater treatment plants, gas, electrical, and water systems, located within areas subject to 100- and 200-year frequency floods to locate and construct facilities to minimize or eliminate potential flood damage.
Policy HS-C.6	The County shall encourage expansion of stormwater and flood protection infrastructure capacity in order to accommodate changes in precipitation and extreme weather events.
Policy HS-C.7	The County shall support State and local flood management agencies to provide relocation assistance or other cost-effective strategies for reducing flood risk to existing economically-disadvantaged communities located in non-urbanized areas.
Policy HS-C.8	The County shall work with local, regional, State, and Federal agencies to maintain an adequate information base, prepare risk assessments, and identify strategies to mitigate flooding impacts.
Policy HS-C.9:	The County shall encourage the Fresno Metropolitan Flood Control District to control stormwater flows originating in the streams of the Fresno County Stream Group and the stormwater resulting from urban development by means of construction of dams or joint-use flood control and recharge facilities at appropriate locations.
Policy HS-C.10:	The County shall require that the design and location of dams and levees be in accordance with applicable design standards and specifications and accepted design and construction practices.
Policy HS-C.11:	The County shall promote a floodplain management approach in flood hazard areas that are presently undeveloped by giving priority to regulation of land uses over development of structural controls as a method of reducing flood damage.
Policy HS-C.12:	The County shall encourage the performance of appropriate investigations to determine the 200-year water surface elevations for the San Joaquin River, taking into account recent storm events and existing channel conditions, to identify the potential extent and risk of flooding. New development, including public infrastructure projects, shall not be allowed along the river until the risk of flooding at the site has been determined and appropriate flood risk reduction measures identified.
Policy HS-C.13:	Where existing development is located in a flood hazard area, the County shall require that construction of flood control facilities proceed only after a complete review of the environmental effects and a project cost benefit analysis.
Policy HS-C.14:	The County shall promote flood control measures that maintain natural conditions within the 200-year floodplain of rivers and streams and, to the extent possible, combine flood control, recreation, water quality, and open space functions. Existing irrigation canals shall be used to the extent possible to remove excess stormwater. Retention-recharge basins should be located to best utilize natural drainage patterns.
Policy HS-C.15:	The County shall continue to participate in the Federal Flood Insurance Program by ensuring compliance with applicable requirements.
Policy HS-C.16:	The County shall continue to implement and enforce its Floodplain Management Ordinance. During the building permit review process, the County shall ensure project compliance with applicable Federal Emergency Management Agency (FEMA) standards pertaining to residential and non-residential development in the floodplain, floodway, or floodway fringe.
Policy HS-C.17:	The County shall prohibit the construction of essential facilities (e.g., hospitals, police and fire facilities) in the 100- and 200-year floodplains, unless it can be demonstrated that the facility can be safely operated and accessed during flood events.
Policy HS-C.18:	The County shall require that all placements of structures and/or flood proofing be done in a manner that will not cause floodwaters to be diverted onto adjacent property, increase flood hazards to other property, or otherwise adversely affect other property.
Policy HS-C.19:	The County shall encourage open space uses in all flood hazard areas. Land Conservation contracts and open space and scenic easements should be made available to property owners.
Policy HS-C. 20:	The County shall consider dam failure inundation maps of all reservoirs in making land use and related decisions.
Policy HS-C.21:	The County shall continue public awareness programs to inform the general public and potentially affected property owners of flood hazards and potential dam failure inundation.

Seismic and Geological Hazards

Policies in this section seek to ensure that new buildings and facilities are designed to withstand seismic and geologic hazards.

Goal HS-D:	To minimize the loss of life, injury, and property damage due to seismic and geologic hazards.
Policy HS-D.1:	The County shall continue to support scientific geologic investigations that refine, enlarge, and improve the body of knowledge on active fault zones, unstable areas, severe groundshaking, avalanche potential, and other hazardous geologic conditions in Fresno County.
Policy HS-D.2:	The County shall ensure that the General Plan and/or County Ordinance Code is revised, as necessary, to incorporate geologic hazard areas formally designated by the state geologist (e.g., earthquake fault zones and seismic hazard zones). Development in such areas, including public infrastructure projects, shall not be allowed until compliance with the investigation and mitigation requirements established by the state geologist can be demonstrated.
Policy HS-D.3:	The County shall require that a soils engineering and geologic-seismic analysis be prepared by a California-registered engineer or engineering geologist prior to permitting development, including public infrastructure projects, in areas prone to geologic or seismic hazards (i.e., fault rupture, ground shaking, lateral spreading, lurchcracking, fault creep, liquefaction, subsidence, settlement, landslides, mudslides, unstable slopes, or avalanche).
Policy HS-D.4:	The County shall require all proposed structures, additions to structures, utilities, or public facilities situated within areas subject to geologic-seismic hazards as identified in the soils engineering and geologic-seismic analysis to be sited, designed, and constructed in accordance with applicable provisions of the Uniform Building Code (Title 24 of the California Code of Regulations) and other relevant professional standards to minimize or prevent damage or loss and to minimize the risk to public safety.
Policy HS-D.5:	Pursuant to the Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code, Chapter 7.5), the County shall not permit any structure for human occupancy to be placed within designated earthquake fault zones unless the specific provisions of the act and Title 14 of the California Code of Regulations have been satisfied.
Policy HS-D.6:	The County shall ensure compliance with state seismic and building standards in the evaluation, design, and siting of critical facilities, including police and fire stations, school facilities, hospitals, hazardous material manufacture and storage facilities, bridges, large public assembly halls, and other structures subject to special seismic safety design requirements.
Policy HS-D.7:	The County shall require a soils report by a California-registered engineer or engineering geologist for any proposed development, including public infrastructure projects, that requires a County permit and is located in an area containing soils with high “expansive” or “shrink-swell” properties. Development in such areas shall be prohibited unless suitable design and construction measures are incorporated to reduce the potential risks associated with these conditions.
Policy HS-D.8:	The County shall seek to minimize soil erosion by maintaining compatible land uses, suitable building designs, and appropriate construction techniques. Contour grading, where feasible, and revegetation shall be required to mitigate the appearance of engineered slopes and to control erosion.
Policy HS-D.9:	The County shall require the preparation of drainage plans for development or public infrastructure projects in hillside areas to direct runoff and drainage away from unstable slopes.
Policy HS-D.10:	The County shall not approve a County permit for new development, including public infrastructure projects where slopes are over 30 percent unless it can be demonstrated by a California-registered civil engineer or engineering geologist that hazards to public safety will be reduced to acceptable levels.
Policy HS-D.11:	In known or potential landslide hazard areas, the County shall prohibit avoidable alteration of land in a manner that could increase the hazard, including concentration of water through drainage, irrigation, or septic systems, undercutting the bases of slopes, removal of vegetative cover, and steepening of slopes.
Policy HS-D.12:	The County shall not approve a County permit for new development, including public infrastructure projects, in known or potential avalanche hazard areas unless it can be demonstrated by a California-registered engineer or engineering geologist that the structures will be safe under anticipated snow loads and avalanche conditions.

Goal HS-D:	**To minimize the loss of life, injury, and property damage due to seismic and geologic hazards.**
Policy HS-D.13:	Whenever zoning is employed to restrict the use of land subject to severe geologic hazards (e.g., landslides), the County shall designate parcels so restricted for open space uses.

Hazardous Materials

Policies in this section are designed to ensure that development projects minimize public risks associated with both intended and unintended exposure to hazardous materials and wastes.

Goal HS-F:	**To minimize the risk of loss of life, injury, serious illness, and damage to property resulting from the use, transport, treatment, and disposal of hazardous materials and hazardous wastes.**
Policy HS-F.1:	The County shall require that facilities that handle hazardous materials or hazardous wastes be designed, constructed, and operated in accordance with applicable hazardous materials and waste management laws and regulations.
Policy HS-F.2:	The County shall require that applications for discretionary development projects that will use hazardous materials or generate hazardous waste in large quantities include detailed information concerning hazardous waste reduction, recycling, and storage.

Agriculture and Land Use Element

Applicable goals and policies from the Agriculture and Land Use Element are presented below.

Resource Lands

This section addresses land that will remain primarily open in character. The goals, policies, and implementation programs for these topics reflect a basic commitment to preserve the existing open rural character of the County and its natural and managed resources. While necessarily protective and restrictive, the policies also recognize the need to maintain economic productivity and allow for urban growth. The intent of the policies is not to preclude intensive development but to direct it to minimize loss of valuable open space.

Agriculture

Policies in this section seek to sustain agriculture by protecting agricultural activities from incompatible land uses, promoting agricultural land preservation programs, developing programs to preserve or maintain soil conditions or improve soil productivity, facilitating agricultural production by supplying adequate land for support services, and controlling expansion of nonagricultural development onto productive agricultural lands.

Goal LU-A:	**To promote the long-term conservation of productive and potentially- productive agricultural lands and to accommodate agricultural-support services and agriculturally-related activities that support the viability of agriculture and further the County's economic development goals.**
Policy LU-A.13:	The County shall protect agricultural operations from conflicts with nonagricultural uses by requiring buffers between proposed non-agricultural uses and adjacent agricultural operations.
Policy LU-A.14:	The County shall ensure that the review of discretionary permits includes an assessment of the conversion of productive agricultural land and that mitigation be required where appropriate.

Goal LU-A:	**To promote the long-term conservation of productive and potentially- productive agricultural lands and to accommodate agricultural-support services and agriculturally-related activities that support the viability of agriculture and further the County's economic development goals.**
Policy LU-A.20:	The County shall adopt and support policies and programs that seek to protect and enhance surface water and groundwater resources critical to agriculture.

Westside Rangelands

Policies in this section seek to preserve rangelands by maintaining their open space character, minimizing grading and erosion, maintaining grazing and agricultural operations, accommodating mineral resource recovery, and protecting biological resources from development.

Goal LU-B:	**To preserve the unique character of the Westside Rangelands, which includes distinctive geologic and topographic landforms, watersheds, important agricultural activities, and significant biological resources, while accommodating agriculture, grazing, recreation, resource recovery, and other limited uses that recognize the sensitive character of the area.**
Policy LU-B.12:	The County shall require a preliminary soils report for discretionary development projects when the project site is subject to moderate or high risk landslide potential and has slopes in excess of 15 percent. If the preliminary soil report indicates soil conditions could be unstable, a detailed geologic report by a registered geologist and registered civil engineer, or a registered engineering geologist, shall be required indicating the suitability of any proposed or additional development.

River Influence Areas

Policies in this section seek to preserve and enhance the County's river influence areas by avoiding adverse impacts from development and encouraging environmentally friendly recreational and agricultural activities.

Goal LU-C:	**To preserve and enhance the value of the river environment as a multiple use, open space resource; maintain the environmental and aesthetic qualities of the area; protect the quality and quantity of the surface and groundwater resources; provide for long term preservation of productive agricultural land; conserve and enhance natural wildlife habitat; and maintain the flood-carrying capacity of the channel at a level equal to the 1 percent flood event (100-year flood).**
Policy LU-C.7:	Fresno County shall take into consideration the presence of the regulatory floodway or other designated floodway, the FEMA-designated 100-year floodplain, estimated 250-year floodplain, the Standard Project Flood, and the Fresno Metropolitan Flood Control District (FMFCD) Riverine Floodplain Policy in determining the location of future development within the San Joaquin River Parkway area. Any development sited in a designated 100-year floodplain shall comply with regulatory requirements at a minimum and with the FMFCD Riverine Floodplain Policy criteria, or requirements of other agencies having jurisdiction, where applicable.

Rural Development

This section guides development in areas designated Rural Residential, Rural Settlement Area, and Planned Rural Community. The policies provide for the continued development of areas within these designations in a manner that minimizes environmental impacts and public infrastructure investments, but generally limits expansion of these designations.

Nonagricultural Rural Development

Policies in this section provide for appropriate development in rural areas by directing development away from productive and potentially productive agricultural areas, limiting expansion of existing designated rural residential areas, and minimizing the environmental and service impacts of continued development within areas already designated for rural development.

Goal LU-E:	**To provide for the continued development of areas already designated for nonagricultural rural-residential development in a manner that minimizes environmental impacts and public infrastructure and service costs while restricting designation of new areas for such development.**
Policy LU-E.6:	The County shall allow planned residential developments in areas that are currently designated for rural residential development subject to the following conditions: f. The size and configuration of the buildable portion of the lot shall be based on sufficient geological and hydrological investigations.
Policy LU-E.8	The County shall not allow further parcelization of uncommitted rural residential areas lying northeast of the Enterprise Canal due to potential groundwater supply problems. These areas shall be zoned to a limited agricultural zone district. However, rezoning and development for rural residential use may be permitted subject to established criteria.
Policy LU-E.10	The County shall require new subdivisions within areas designated rural residential be designed to use individual on-site sewer and water systems. All proposals shall be reviewed by the County to determine the appropriate minimum lot size based on local hydrogeological conditions.
Policy LU-E.11	The County shall require subdividers of rural residential lots to install, provide, or participate in an effective means for utilization of available surface water entitlements for the area included in the subdivision.
Policy LU-E.12	The County shall ensure through discretionary permit approvals and other development regulations that development within areas designated rural residential does not encroach upon natural water channels or restrict natural water channels in such a way as to increase potential flooding damage. Land divisions shall not render inoperative any existing canal.
Policy LU-E.22	The County shall allow development within the designated Quail Lakes Planned Rural Community to proceed in accordance with the Specific Plan adopted at the time the designation was granted by the County. The County may grant amendments to the Specific Plan provided the overall density of development is not increased and the plan continues to demonstrate the following: a. The development will have no significant adverse impacts on groundwater. c. Impacts on Fresno County for the provision of services including, but not limited to, police, fire protection, schools, and other essential public services are adequately mitigated. f. Provide for monitoring of mitigation measures established by the required environmental impact report.

Public Facilities and Services Element

Applicable goals and policies from the Public Facilities and Services Element are presented below.

Water Supply and Delivery

Policies in this section seek to ensure an adequate water supply for both domestic and agricultural users by providing necessary facility improvements, ensuring water availability, and utilizing water conservation measures.

Goal PF-C:	To ensure the availability of an adequate and safe water supply for domestic and agricultural consumption.
Policy PF-C.1:	The County shall engage in and support the efforts of others within Fresno County to retain existing water supplies and develop new water supplies.
Policy PF-C.2:	The County shall actively engage in efforts and support the efforts of others to import flood, surplus, and other available waters for use in Fresno County.
Policy PF-C.3:	To reduce demand on the County's groundwater resources, the County shall encourage the use of surface water to the maximum extent feasible.
Policy PF-C.4:	The County shall support efforts to expand groundwater and/or surface water storage that benefits Fresno County.
Policy PF-C.5:	The County shall support water banking when the program has local sponsorship and involvement and provides new benefits to the County.
Policy PF-C.6:	The County shall recommend to all cities and urban areas within the County that they adopt the most cost-effective urban best management practices published and updated by the California Urban Water Agencies, California Department of Water Resources, or other appropriate agencies as a means of meeting some of the future water supply needs.
Policy PF-C.7:	The County shall require preparation of water master plans for areas undergoing urban growth.
Policy PF-C.8:	The County shall work with local irrigation districts to preserve local water rights and supply.
Policy PF-C.10:	The County shall actively participate in the development and implementation of Sustainable Groundwater Management Plans to ensure an on-going water supply to help sustain agriculture and accommodate future growth.
Policy PF-C.11:	The County shall approve new development only if an adequate sustainable water supply to serve such development is demonstrated.
Policy PF-C.12:	In those areas identified as having severe groundwater level declines or limited groundwater availability, the County shall limit development to uses that do not have high water usage or that can be served by a surface water supply.
Policy PF-C.13:	The County shall require that water supplies serving new development meet U.S. Environmental Protection Agency and California Department of Public Health and other water quality standards.
Policy PF-C.15:	If the cumulative effects of more intensive land use proposals are detrimental to the water supplies of surrounding areas, the County shall require approval of the project to be dependent upon adequate mitigation. The County shall require that costs of mitigating such adverse impacts to water supplies be borne proportionately by all parties to the proposal.
Policy PF-C.16:	The County shall, prior to consideration of any discretionary project related to land use, undertake a water supply evaluation.
Policy PF-C.17:	In the case of lands entitled to surface water, the County shall approve only land use-related projects that provide for or participate in effective use of the surface water entitlement.
Policy PF-C.21:	The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.
Policy PF-C.22:	The County supports short-term water transfers as a means for local water agencies to maintain flexibility in meeting water supply requirements. The County shall support long-term transfer, assignment, or sale of water and/or water entitlements to users outside of the county only under circumstances identified in the General Plan.
Policy PF-C.23:	The County shall regulate the transfer of groundwater for use outside of Fresno County. The regulation shall extend to the substitution of groundwater for transferred surface water.
Policy PF-C.24:	The County shall encourage the transfer of unused or surplus agricultural water to urban uses within Fresno County.
Policy PF-C.25:	The County shall require that all new development within the county use water conservation technologies, methods, and practices as established by the County.
Policy PF-C.26:	The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.
Policy PF-C.27:	The County shall maintain and recommend to all cities and community water system providers that they also adopt, the most cost-effective urban best water conservation management practices circulated and updated by the California Urban Water Agencies, California Department of Water Resources, or other similar authoritative agencies and organizations.

Goal PF-C:	To ensure the availability of an adequate and safe water supply for domestic and agricultural consumption.
Policy PF-C.28	The County shall participate in integrated Regional Water Management Planning efforts with other local and regional water stakeholders to plan for the efficient use, enhancement, and management of surface and groundwater supplies.
Policy PF-C.29:	The County shall encourage agricultural water conservation where economically, environmentally, and technically feasible.
Policy PF-C.30:	The County shall, in order to reduce excessive water usage, require tiered water pricing within County service areas and County waterworks districts.
Policy PF-C.31:	The County shall not approve land use-related projects that incorporate a manmade lake or pond that will be sustained by the use of groundwater.

Storm Drainage and Flood Control

Policies in this section seek to ensure safe, efficient, and environmentally sound means to drain, divert and retain stormwater and provide flood control by providing necessary facility improvements, ensuring adequate funding, providing a means to detain/retain runoff, and ensuring the facilities meet state environmental regulations. This includes retention strategies that could lessen the county's vulnerability to drought and wildfire.

Goal PF-E:	To provide efficient, cost-effective, and environmentally sound storm drainage and flood control facilities that protect both life and property and to divert and retain stormwater runoff for groundwater replenishment.
Policy PF-E.1:	The County shall coordinate with the agencies responsible for flood control or storm drainage to assure that construction and acquisition of flood control and drainage facilities are adequate for future urban growth authorized by the County General Plan and city general plans.
Policy PF-E.2:	The County shall encourage the agencies responsible for flood control of storm drainage to coordinate the multiple use of flood control and drainage facilities with other public agencies.
Policy PF-E.3:	The County shall encourage the Fresno Metropolitan Flood Control District to spread the cost of construction and acquisition of flood control and drainage facilities in the most equitable manner consistent with the growth and needs of this area.
Policy PF-E.4:	The County shall encourage the local agencies responsible for flood control or storm drainage to require that storm drainage systems be developed and expanded to meet the needs of existing and planned development.
Policy PF-E.5:	The County shall only approve land use-related projects that will not render inoperative any existing canal, encroach upon natural channels, and/or restrict natural channels in such a way as to increase potential flooding damage.
Policy PF-E.6:	The County shall require that drainage facilities be installed concurrently with and as a condition of development activity to ensure the protection of the new improvements as well as existing development that might exist within the watershed.
Policy PF-E.7:	The County shall require new development to pay its fair share of the costs of Fresno County storm drainage and flood control improvements within unincorporated areas.
Policy PF-E.8:	The County shall encourage the local agencies responsible for flood control or storm drainage to precisely locate drainage facilities well in advance of anticipated construction, thereby facilitating timely installation and encouraging multiple construction projects to be combined, reducing the incidence of disruption of existing facilities.
Policy PF-E.9:	The County shall require new development to provide protection from the 100-year flood as a minimum.
Policy PF-E.10:	In growth areas within the jurisdiction of a local agency responsible for flood control or storm drainage, the County shall encourage that agency to design drainage facilities as if the entire areas of service were developed to the pattern reflected in the adopted general plans to assure that the facilities will be adequate as the land use intensifies.

Goal PF-E:	To provide efficient, cost-effective, and environmentally sound storm drainage and flood control facilities that protect both life and property and to divert and retain stormwater runoff for groundwater replenishment.
Policy PF-E.11:	The County shall encourage project designs that minimize drainage concentrations and maintain, to the extent feasible, natural site drainage patterns.
Policy PF-E.12:	The County shall coordinate with the local agencies responsible for flood control or storm drainage to ensure that future drainage system discharges comply with applicable State and Federal pollutant discharge requirements.
Policy PF-E.13:	The County shall encourage the use of natural stormwater drainage systems to preserve and enhance natural drainage features.
Policy PF-E.14:	The County shall encourage the use of retention-recharge basins for the conservation of water and the recharging of the groundwater supply.
Policy PF-E.15:	The County should require that retention-recharge basins be suitably landscaped to complement adjacent areas and should, wherever possible, be made available to the community to augment open space and recreation needs.
Policy PF-E.16:	The County shall minimize sedimentation and erosion through control of grading, cutting of trees, removal of vegetation, placement of roads and bridges, and use of off-road vehicles. The County shall discourage grading activities during the rainy season, unless adequately mitigated, to avoid sedimentation of creeks and damage to riparian habitat.
Policy PF-E.17:	The County shall encourage the local agencies responsible for flood control or storm drainage retention-recharge basins located in soil strata strongly conducive to groundwater recharge to develop and operate those basins in such a way as to facilitate year-round groundwater recharge.
Policy PF-E.18:	The County shall encourage the local agencies responsible for flood control or storm drainage to plan retention-recharge basins on the principle that the minimum number will be the most economical to acquire, develop, operate, and maintain.
Policy PF-E.19:	In areas where urbanization or drainage conditions preclude the acquisition and use of retention-recharge basins, the County shall encourage the local agencies responsible for flood control or stormwater drainage to discharge storm or drainage water into major canals and other natural water courses subject to established conditions.
Policy PF-E.20:	The County shall require new development of facilities near rivers, creeks, reservoirs, or substantial aquifer recharge areas to mitigate any potential impacts of release of pollutants in floodwaters, flowing rivers, streams, creeks, or reservoir waters.
Policy PF-E.21:	The County shall require the use of feasible and practical best management practices (BMPs) to protect streams from the adverse effects of construction activities, and shall encourage the urban storm drainage systems and agricultural activities to use BMPs.
Policy PF-E.22:	The County shall encourage the local agencies responsible for flood control or storm drainage to control obnoxious odors or mosquito breeding conditions connected with any agency facility by appropriate measures.

Fire Protection and Emergency Medical Services

Policies in this section seek to ensure the prompt and efficient provision of fire and emergency medical facility and service needs, ensure adequate funding is available in new development areas, and protect the life and property of residents of and visitors to Fresno County.

Goal PF-H:	To ensure the prompt and efficient provision of fire and emergency medical facility and service needs, to protect residents of and visitors to Fresno County from injury and loss of life, and to protect property from fire.
Policy PF-H.1:	The County shall work cooperatively with local fire protection districts to ensure the provision of effective fire and emergency medical services to unincorporated areas within the County.
Policy PF-H.2:	Prior to the approval of a development project, the County shall determine the need for fire protection services. New development in unincorporated areas of the county shall not be approved until such time that fire protection facilities and services acceptable to the Public Works and Planning Director in consultation with the appropriate fire district are provided.

Goal PF-H:	To ensure the prompt and efficient provision of fire and emergency medical facility and service needs, to protect residents of and visitors to Fresno County from injury and loss of life, and to protect property from fire.
Policy PF-H.3:	The County shall require that new fire stations be located to achieve and maintain a service level capability consistent with services for existing land uses.
Policy PF-H.4:	The County shall reserve adequate sites for fire and emergency medical facilities in unincorporated locations in the County.
Policy PF-H.5:	The County shall require that new development be designed to maximize safety and minimize fire hazard risks to life and property.
Policy PF-H.6:	The County shall limit development to very low densities in areas where emergency response times will be more than 20 minutes.
Policy PF-H.7:	The County shall encourage local fire protection agencies in the County to maintain the following as minimum fire protection standards (expressed as Insurance Service Organization (ISO) ratings): a. ISO 4 in urban areas; b. ISO 6 in suburban areas; and c. ISO 8 in rural areas.
Policy PF-H.10:	The County shall ensure that all proposed developments are reviewed for compliance with fire safety standards by responsible local fire agencies per the Uniform Fire Code and other State and local ordinances.

Open Space and Conservation Element

The Open Space and Conservation Element is concerned with protecting and preserving natural resources, preserving open space areas, managing the production of commodity resources, protecting and enhancing cultural resources, and providing recreational opportunities. Applicable goals and policies are presented below.

Productive Resources

Water Resources

Policies in this section seek to protect and enhance the surface water and groundwater resources in the County. The policies address broad water planning issues, groundwater recharge, the relationship of land use decisions to water issues, and water quality problems.

Goal OS-A:	To protect and enhance the water quality and quantity in Fresno County's streams, creeks, and groundwater basins.
Policy OS-A.1:	The County shall develop, implement, and maintain a plan for achieving water resource sustainability, including a strategy to address overdraft and the needs of anticipated growth.
Policy OS-A.2:	The County shall provide active leadership in the regional coordination of water resource management efforts affecting Fresno County and shall continue to monitor and participate in, as appropriate, regional activities affecting water resources, groundwater, and water quality.
Policy OS-A.3:	The County shall provide active leadership in efforts to protect, enhance, monitor, and manage groundwater resources within its boundaries.
Policy OS-A.4:	The County shall develop and implement public education programs designed to increase public participation in water conservation and water quality awareness.
Policy OS-A.5:	The County shall encourage, where economically, environmentally, and technically feasible, efforts aimed at directly or indirectly recharging the County's groundwater.
Policy OS-A.6	The County shall ensure that new development does not limit the capacity or function of groundwater recharge areas.
Policy OS-A.7	The County shall direct, to the extent feasible, its available water resources to groundwater recharge areas.

Goal OS-A:	**To protect and enhance the water quality and quantity in Fresno County's streams, creeks, and groundwater basins.**
Policy OS-A.8	The County should, in cooperation with respective groundwater sustainability agencies, develop and maintain an inventory of sites within the County that are suitable for groundwater recharge.
Policy OS-A.9:	The County shall support and/or engage in water banking (i.e., recharge and subsequent extraction for direct and/or indirect use on lands away from the recharge area) based on the established criteria.
Policy OS-A.10	The County shall coordinate with the relevant Groundwater Sustainability Agency(ies) concerning their Groundwater Sustainability Plan(s) and refer any substantial proposed General Plan amendment to the agency for review and comment prior to adoption. The County shall give consideration to the adopted groundwater sustainability plan when determining the adequacy of water supply.
Policy OS-A.11:	The County shall permit and encourage, where economically, environmentally, and technically feasible, overirrigation of surface water as a means to maximize groundwater recharge.
Policy OS-A.12:	The County shall directly and/or indirectly participate in the development, implementation, and maintenance of a program to recharge the aquifers underlying the County. The program shall make use of flood and other waters to offset existing and future groundwater pumping.
Policy OS-A.13:	The County shall require the protection of floodplain lands and, where appropriate, acquire public easements for purposes of flood protection, public safety, wildlife preservation, groundwater recharge, access, and recreation.
Policy OS-A.14:	The County shall support the policies of the San Joaquin River Parkway Master Plan to protect the San Joaquin River as an aquatic habitat, recreational amenity, aesthetic resource, and water source.
Policy OS-A.15:	The County shall, where economically, environmentally, and technically feasible, encourage the multiple use of public lands, including County lands, to include groundwater recharge.

Natural Resources

Wetland and Riparian Areas

Policies in this section seek to protect riparian and wetland habitats in the County while allowing compatible uses where appropriate.

Goal OS-D:	**To conserve the function and values of wetland communities and related riparian areas throughout Fresno County while allowing compatible uses where appropriate. Protection of these resource functions will positively affect aesthetics, water quality, floodplain management, ecological function, and recreation/tourism.**
Policy OS-D.1:	The County shall support the "no-net-loss" wetlands policies of the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game. Coordination with these agencies at all levels of project review shall continue to ensure that appropriate mitigation measures and the concerns of these agencies are adequately addressed.
Policy OS-D.2:	The County shall require new development to fully mitigate wetland loss for function and value in regulated wetlands to achieve "no-net-loss" through any combination of avoidance, minimization, or compensation. The County shall support mitigation banking programs that provide the opportunity to mitigate impacts to rare, threatened, and endangered species and/or the habitat that supports these species in wetland and riparian areas.
Policy OS-D.3:	The County shall require development to be designed in such a manner that pollutants and siltation do not significantly degrade the area, value, or function of wetlands. The County shall require new developments to implement the use of best management practices to aid in this effort.
Policy OS-D.7:	The County shall support the management of wetland and riparian plant communities for passive recreation, groundwater recharge, nutrient storage, and wildlife habitats.

Vegetation

Policies in this section seek to protect native vegetation resources primarily on private land within the County.

Goal OS-F:	To preserve and protect the valuable vegetation resources of Fresno County.
Policy OS-F.1:	The County shall encourage landowners and developers to preserve the integrity of existing terrain and natural vegetation in visually-sensitive areas such as hillsides and ridges, and along important transportation corridors, consistent with fire hazard and property line clearing requirements.
Policy OS-F.2:	The County shall require developers to use native and compatible nonnative plant species, especially drought-resistant species, to the extent possible, in fulfilling landscaping requirements imposed as conditions of discretionary permit approval or for project mitigation.
Policy OS-F.6:	The County shall require that development on hillsides be limited to maintain valuable natural vegetation, especially forests and open grasslands, and to control erosion.
Policy OS-F.7:	The County shall require developers to take into account a site's natural topography with respect to the design and siting of all physical improvements in order to minimize grading.
Policy OS-F.9:	The County shall support the continued use of prescribed burning to mimic the effects of natural fires to reduce fuel volumes and associated fire hazards to human residents and to enhance the health of biotic communities.

Recreation and Cultural Resources

Parks and Recreation

Policies in this section seek to enhance recreational opportunities in the County by encouraging the further development of public and private recreation lands, and requiring development to help fund additional parks and recreation facilities.

Goal OS-H:	To designate land for and promote the development and expansion of public and private recreational facilities to serve the needs of residents and visitors.
Policy OS-H.11:	The County shall support the policies of the San Joaquin River Parkway Master Plan to protect the San Joaquin River as an aquatic habitat, recreational amenity, aesthetic resource, and water source.
Policy OS-H.13:	The County shall require that structures and amenities associated with the San Joaquin River Parkway be designed and sited to ensure that such features do not obstruct flood flows, do not create a public safety hazard, or result in a substantial increase in off-site water surface elevations, and that they conform to the requirements of other agencies having jurisdiction. For permanent structures, such as bridge overcrossings, the minimum level of flood design protection shall be the greater of the Standard Project Flood (which is roughly equivalent to a 250-year event) or the riverine requirements of other agencies having jurisdiction to ensure flood flows are not dammed and to prevent flooding on surrounding properties.

Historic, Cultural, and Geological Resources

Policies in this section seek to preserve the historic, archeological, paleontological, geological, and cultural resources of the County through development review, acquisition, encouragement of easements, coordination with other agencies and groups, and other methods.

Goal OS-J:	To identify, protect, and enhance Fresno County's important historical, archeological, paleontological, geological, and cultural sites and their contributing environment.
OS-J.1	The County shall encourage preservation of any sites and/or buildings identified as having historical significance pursuant to the list maintained by the Fresno County Historic Landmarks and Records Advisory Commission.
OS-J.2	The County shall consider historic resources during preparation or evaluation of plans and discretionary development projects.
OS-J.3	Whenever a historical resource is known to exist on a proposed project site, the County (i.e., Fresno County Historic Landmarks and Records Advisory Commission) shall evaluate and make recommendations to minimize potential impacts to said resource.
Policy OS-J.4:	The County shall require that discretionary development projects, as part of any required CEQA review, identify and protect important historical, archeological, paleontological, and cultural sites and their contributing environment from damage, destruction, and abuse to the maximum extent feasible. Project-level mitigation shall include accurate site surveys, consideration of project alternatives to preserve archeological and historic resources, and provision for resource recovery and preservation when displacement is unavoidable.

Fresno County Ordinances

The Fresno County General Plan provides policy direction for land use, development, open space protection, and environmental quality, but this policy direction must be carried out through numerous ordinances, programs, and agreements. The following ordinances are among the most important tools for implementing the general plan and/or are critical to the mitigation of hazards identified in this plan.

Emergency Organization (Title 2, Chapter 2.44)

The declared purposes of this chapter are to provide for the preparation and carrying out of plans for the protection of persons and property within the County in the event of an emergency; the direction of the emergency organization; and the coordination of the emergency functions of the County with all other public agencies, corporations, organizations, and affected private persons.

Health Authority (Title 8, Chapter 8.70)

Among the primary purposes of the health authority are to meet the problems of delivery of publicly assisted medical care in the County and to demonstrate ways of promoting quality care and cost efficiency.

Groundwater Management (Title 14, Chapter 14.03)

This chapter protects the County's important groundwater resources by requiring a permit from the County to extract, on a long-term basis, groundwater for transfer outside the County, including groundwater extracted to replace a surface water supply that has been, is being, or will be transferred for long-term use outside of Fresno County. This chapter is limited to requiring a permit for the long-term direct or indirect transfer of groundwater outside the County and is not intended to regulate groundwater in any other way.

Building Code (Title 15, Chapter 15.08)

This chapter adopts the California Building Code, including the appendices, as referenced, except as otherwise provided in the 2001 California Building Standards Code and the Uniform Building Code Standards.

Fire Code (Title 15, Chapter 15.10)

This chapter adopts the California Fire Code as referenced in the 2001 California Fire Code.

Grading and Excavation (Title 15, Chapter 15.28)

This chapter establishes that Chapter 33 and Chapter 33 of the Appendix of the 1998 California Building Code is adopted by reference and except as otherwise provided is applicable to and shall cover all grading and excavation within the unincorporated area of the County.

Flood Hazard Areas (Title 15, Chapter 15.48)

It is the purpose of this chapter to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

- Protect human life and health;
- Minimize expenditure of public money for costly flood control projects;
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- Minimize prolonged business interruptions;
- Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in areas of special flood hazard;
- Help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future blighted areas caused by flood damage;
- Ensure that potential buyers are notified that property is in an area of special flood hazard; and
- Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

This chapter includes methods and provisions to:

- Restrict or prohibit uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or flood heights or velocities;
- Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
- Control the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters;
- Control filling, grading, dredging, and other development that may increase flood damage; and
- Prevent or regulate the construction of flood barriers that will unnaturally divert floodwaters or that may increase flood hazards in other areas.

Requirements of this chapter apply to all new development, substantial improvements, minor improvements, and conversions of existing nonresidential structures to residential uses within flood hazard areas. Notably, it requires that a development permit be obtained before start of construction or beginning of development within any area of special flood hazard. It appoints the director of the Public Works and Planning Department to administer and implement the chapter by granting or denying development permit applications in accordance with its provisions.

This chapter addresses the following for construction in areas of special flood hazard:

- Standards of construction
- Standards for storage of materials and equipment
- Standards for utilities
- Standards for subdivisions
- Standards for manufactured homes and manufactured home parks and subdivision
- Provisions for floodway development

California Department of Forestry State Responsibility Area Fire Safe Regulations of the County (Title 15, Chapter 15.60)

This chapter provides for basic emergency access, perimeter wildfire protection measures, signing and building numbering, private water supply reserves for emergency fire use, and vegetation modification.

Development requirements in this chapter address setbacks for structures, road improvements, road width, cul-de-sacs and dead-end roads, one-way roads, driveways, gates, road signs, building signs, flammable vegetation and fuels, water supply, and hydrant locations.

Fire District Development Impact Mitigation Fees (Title 15, Chapter 15.64)

The purpose of this chapter is to implement the Fresno County General Plan policy providing for the adoption of development impact mitigation fees and for the collection of such fees at the time of the issuance of building permits or other permits. Subject to the requirements of this chapter, such fees are to be allocated to a fire district within the Fresno County for the acquisition of capital facilities to ensure the provision of the capital facilities necessary to maintain current levels of fire protection services necessitated by new development.

Subdivisions (Title 17, Chapters 17.01-17.60)

Chapters 17.04 through 17.60 makeup Fresno County's subdivision ordinance, which is deemed necessary to protect the public health, safety, and general welfare. It addresses orderly growth and development of the County; beneficial use of land in the public interest; and conservation, stabilization, and protection of property values and assures adequate provision for necessary utilities, public roads, and other public conveniences in subdivided areas. The subdivision ordinance regulates the design and improvement of land divisions and the dedication of public improvements needed in connection with land divisions. All land divisions must by law be consistent with the general plan and the zoning ordinance.

Drainage of Land (Title 17, Chapter 17.64)

Since the development of land for urban uses substantially accelerates the concentration of surface water and stormwater, it is necessary to require the construction of, and to establish and collect fees to defray the actual or estimated cost of, planned local drainage facilities for the control and safe disposal of surface water and stormwater from local drainage areas to promote and protect the public welfare, safety, peace, comfort, convenience, and the general welfare.

Fresno County Zoning Ordinance

The purpose of the zoning ordinance is to regulate the use of land in each zoning district. The ordinance typically establishes a list of land uses permitted in each district plus a series of specific standards governing lot size, building height, and required yard and setback provisions in the unincorporated area of Fresno County in a manner consistent with the Fresno County General Plan. This ordinance incorporates zoning regulations implementing the Fresno County General Plan and all of its elements.

One of the zones created by the ordinance is the Open Space Conservation District (Section 815). This zone is intended to provide for permanent open spaces in the community and to safeguard the health, safety, and welfare of the people by limiting developments in areas where police and fire protection, protection against flooding by stormwater, and dangers from excessive erosion are not possible without excessive costs to the community.

Fresno Area Regional Groundwater Management Plan

The Fresno Area Regional Groundwater Management Plan is a comprehensive strategy to enhance and maintain the quantity and quality of local groundwater resources. It provides a vehicle for future groundwater management actions. As part of a regional effort, other basin- specific plans have also been developed for the Kings River and San Joaquin River basins. There are also efforts to create a statewide water management plan. All plans are coordinated for the County through the Public Works and Planning departments.

Fresno County Hazardous Waste Management Plan

The Fresno County Hazardous Waste Management Plan is designed to ensure that safe, effective, and economical facilities for the management of hazardous wastes are available when they are needed. To attain this goal, the plan establishes goals, policies, and programs to encourage the safe handling, storage, and transportation of hazardous materials. The Fresno County Environmental Health Department administers this plan.

Special Districts

There are numerous special districts that provide a variety of public services in Fresno County. Special districts can provide one or more types of public services, facilities, or infrastructure within a prescribed boundary, and they play an important role in growth management because the availability of their services can encourage or discourage new development. Special districts can tax the properties within their boundaries to pay for the services they provide. Monthly fees may also be assessed. Some of the special districts that provide mitigation-related services in Fresno County are presented below.

Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District is a special act district. It was created to provide fully coordinated and comprehensive stormwater management and related services on a regional basis through a quasi-joint powers relationship between the Cities of Fresno and Clovis and the County of Fresno. The district service area includes most of the Fresno-Clovis metropolitan area (excluding the community of Easton), and unincorporated lands to the east and northeast.

The mission of the district is to provide to the citizens living within its boundaries the ability to control and manage the water resources of the area so as to prevent damage, injury, and inconvenience; to conserve such waters for local, domestic, and agricultural use; and to maximize the public use and benefit of the district's programs and infrastructure. The district maintains a services plan that presents district goals, program objectives, current program descriptions, and implementation strategies.

(See Annex J: Fresno Metropolitan Flood Control District for more information.)

Lower San Joaquin Levee District

The Lower San Joaquin Levee District is a special act district. It was created to operate, maintain, and repair levees, bypasses, and other facilities built in connection with the Lower San Joaquin River Flood Control Project. The district encompasses approximately 468 square miles in Fresno, Madera, and Merced counties, of which 94 square miles are in Fresno County.

(See Annex K: Lower San Joaquin Levee District for more information.)

Kings River Conservation District

The Kings River Conservation District is a special act district. It is responsible for planning for the proper management of water within its service area, including essential flood control and groundwater management services. The district contains about 2,049 square miles in Fresno, Kings, and Tulare counties. The Fresno County portion has 1,001 square miles. It encompasses the Cities of Clovis, Fresno, Fowler, Kerman, Kingsburg, Parlier, Reedley, San Joaquin, Sanger, and Selma and intervening agricultural lands.

Fresno County Fire Protection Districts

Fire protection districts provide a variety of services, which may include fire protection, rescue, emergency medical, hazardous material emergency response, and ambulance services.

- Bald Mountain Fire Protection District
- Fig Garden Fire Protection District
- Fresno County Fire Protection District
- North Central Fire Protection District
- Orange Cove Fire Protection District

Fresno County Irrigation Districts

Irrigation districts provide water for irrigation to users within their boundaries. They may also use water under their control for other beneficial purposes and provide flood protection measures.

- Alta Irrigation District
- Central California Irrigation District
- Consolidated Irrigation District
- Fresno Irrigation District
- Hills Valley Irrigation District
- James Irrigation District
- Laguna Irrigation District
- Orange Cove Irrigation District
- Riverdale Irrigation District
- Tranquillity Irrigation District

Fresno County Drainage Districts

Drainage districts control storm and other waste waters within a district's boundaries, protect property and infrastructure within a district from damage by stormwater or wastewater, and conserve stormwater and waste water for beneficial purposes.

- Camp 13 Drainage District
- Dos Palos Drainage District
- Panoche Drainage District
- Silver Creek Drainage District

Fresno County Mosquito Abatement Districts

Mosquito abatement districts provide mosquito surveillance and control.

- Coalinga-Huron Mosquito Abatement District
- Consolidated Mosquito Abatement District
- Fresno Mosquito and Vector Control District

- Fresno-Westside Mosquito Abatement District

Fresno County Pest Control Districts

Pest control districts are comprised of local growers to control, eradicate, or respond to the effects of pests and/or diseases affecting crops.

- Central Valley Pest Control District
- West Fresno County Red Scale Protective District

Reclamation Districts

Reclamation districts reclaim and protect any body of swampland and overflowed salt marsh, tidelands, or other lands subject to overflow to irrigate lands inside or outside their boundaries. Services include drainage, levee maintenance, and irrigation services.

- No. 1606
- Zalda No. 801

Fresno County Resource Conservation Districts

Resource conservation districts address a wide variety of conservation issues such as forest fuel management, water and air quality, wildlife habitat restoration, soil erosion control, conservation education, and much more.

- Excelsior/Kings River Resource Conservation District
- Firebaugh Resource Conservation District
- James Resource Conservation District
- Los Banos Resource Conservation District
- Navelencia Resource Conservation District
- Panoche Resource Conservation District
- Poso Resource Conservation District
- San Luis Resource Conservation District
- Sierra Resource Conservation District (See Annex L)
- Tranquillity Resource Conservation District
- Westside Resource Conservation District

Fresno County Water Districts (California)

Water districts provide water services. Powers may include the acquisition and operation of works for the production, storage, transmission, and distribution of water for irrigation, domestic, industrial, and municipal purposes and any related drainage or reclamation works.

- Broadview Water District
- Eagle Field Water District
- Farmers Water District

- Firebaugh Canal Water District
- Fresno Slough Water District
- Garfield Water District
- International Water District
- Kings River Water District
- Liberty Water District
- Mercy Springs Water District
- Mid-Valley Water District
- Oro Loma Water District
- Pacheco Water District
- Panoche Water District
- Pleasant Valley Water District
- Raisin City Water District
- San Luis Water District
- Santa Rita Water District
- Stinson Water District
- Tri-Valley Water District
- Westlands Water District
- Wildren Water District

Fresno County Water Districts (County)

County water districts furnish imported water.

- Freewater County Water District
- Malaga County Water District
- Pinedale County Water District

Fresno County Local Boards, Commissions, and Committees

There are a number of local boards, commissions, and committees in Fresno County. Those that have responsibilities related to hazard mitigation are described briefly below.

- **Agricultural Land Conservation Committee**—This committee reviews cancellation of land conservation contracts and makes recommendations to the Board of Supervisors.
- **Association of Metropolitan Water Agencies**—This organization is charged with providing sufficient quality water to satisfy future requirements for municipal, industrial, and agricultural uses within the areas served by the member agencies.
- **Planning Commission**—This commission is charged with the review and approval or denial of discretionary land use permits. The Commission is also advisory to the Board of Supervisors on proposed amendments to the General Plan and the Zoning Ordinance.

Fire Safe Councils

The Fire Safe Council provides resources for establishing and maintaining local fire safe councils to mobilize Californians to protect their homes, communities, and environments from wildfire. These councils serve as forums for stakeholders to share and validate fire safety and fire planning information. There are two fire safe councils in Fresno County:

- Highway I-168 Fire Safe Council (northeastern Fresno County)
- Highway I-80 Oak to Timberline Fire Safe Council (southeastern Fresno County)

Both fire safe councils were active in the 2017-2018 update of the HMP and participated with the Sierra Resource Conservation District in the development and update of their annex (see Annex L).

4.5.2 Fresno County's Administrative/Technical Mitigation Capabilities

Table 4.79 identifies the County personnel responsible for activities related to mitigation and loss prevention in Fresno County.

Table 4.79 Fresno County's Administrative and Technical Mitigation Capabilities

Personnel Resources	Department/Position
Planner/engineer with knowledge of land development/land management practices	Public Works and Planning Development Services Division, principal planner/senior engineer
Engineer/professional trained in construction practices related to buildings and/or infrastructure	Public Works and Planning Development Services Division, supervising plan check engineer/senior engineer
Planner/engineer/scientist with an understanding of natural hazards	Public Works and Planning Development Services Division (no one official is designated, all are familiar)
Personnel skilled in GIS	Public Works and Planning, Development Services Division, staff analyst; Computer Data Services
Full-time building official	Public Works and Planning Development Services Division, director
Floodplain manager	Public Works and Planning Development Services Division
Emergency manager	Office of Emergency Services
GIS data—Hazard areas	Public Works and Planning, Development Services Division, staff analyst (some)
GIS data—Critical facilities	Office of Emergency Services and Internal Services Department
GIS data—Land use	Public Works and Planning Development Services Division, staff analyst
GIS data—Assessor's data	Public Works and Planning, Development Services Division, staff analyst; Computer Data Services

Fresno County Department of Public Health

A number of important mitigation and emergency management programs and services are located in the Fresno County Department of Public Health, which provides health promotion, surveillance, and disease prevention services to protect the public health. Some of these are described below:

Office of Emergency Services and its Mission

The Fresno County Office of Emergency Services (OES) is a program located within the Department of Public Health, Environmental Health Division. Fresno County OES coordinates planning and preparedness, response and recovery efforts for disasters occurring within the unincorporated area of the County. The mission of the Fresno County Office of Emergency Services is to develop and maintain the capability to prepare for, mitigate, respond to, and recover from emergencies and disasters, and to ensure the most effective use of all available resources. To accomplish this mission OES communicates and coordinates with all levels of government and many other entities in order to minimize the impact of disasters and enable affected communities to return to pre-disaster conditions as soon as possible.

On November 14, 1995, the Fresno County Board of Supervisors adopted the State's Standardized Emergency Management System (SEMS), established the geographic area of the County of Fresno as the Fresno County Operational Area, and designated Fresno County as the Operational Area Lead Agency. Fresno County OES is mandated by the California Emergency Services Act (Chapter 7, Division 1, Title 2 of Government Code) to serve as the liaison between the State and all the local government political subdivisions comprising Fresno County. As the Operational Area lead agency, Fresno County OES maintains ongoing communication with local government agencies (County Departments, Incorporated Cities, Special Districts, and Public School Districts) as well as many state and federal agencies and nonprofit organizations to maintain and enhance the capability to respond to and recover from disasters.

During a Disaster

The Office of Emergency Services provides the initial staffing and coordination of the County's Emergency Operations Center (EOC), which is the primary coordination point for response to major emergencies and disasters. During a disaster event OES staff gathers information from the affected jurisdictions and determines the level of response required. OES acts as the link between local government agencies and the State to transmit emergency related information and to request necessary State and Federal assistance.

Between Disasters

The Office of Emergency Services coordinates a wide variety of emergency management functions including developing and updating response plans, maintaining and enhancing the emergency operations center and related equipment, administering emergency preparedness grants, assisting county agencies and local jurisdictions with emergency related activities, and identifying and coordinating appropriate emergency training activities

Fresno County Operational Area Master Emergency Services Plan

The program coordinates the development and maintenance of the Fresno County Operational Area Master Emergency Services Plan, which serves as a guide for the County's response to emergencies/disasters in the Fresno County Operational Area, and to coordinate and assist with disaster response in jurisdictions both within and outside of the Fresno County Operational Area.

Certified Unified Program Agency

The Certified Unified Program Agency (CUPA) is responsible for implementing a unified hazardous materials and hazardous waste management regulatory program. The agency provides oversight of businesses that require hazardous materials business plans, require California accidental release prevention plans or federal risk management plans, operate storage tanks, generate hazardous waste(s), and have onsite treatment of hazardous waste(s)/tiered permits.

Land Use Program

Land Use program staff are responsible for reviewing proposed land use development applications submitted to the various planning agencies in the County and providing comments regarding project compliance with the appropriate environmental health standards relative to the staff's areas of expertise. The program evaluates proposed land developments for compliance with laws and regulations pertaining to domestic and public water supplies and vector control, among other things.

Water Surveillance Program

The Water Surveillance Program permits, monitors, and inspects small public water systems and state small water systems within Fresno County and permits new water well construction, reconstruction of existing wells, and destruction of abandoned wells within unincorporated Fresno County. These activities are designed to help assure that a reliable supply of pure, wholesome, and potable water is provided to small public and state small water systems within Fresno County. In addition, the water well permitting program helps assure that private water wells are constructed to minimize the potential for contamination of the groundwater supply and eliminate safety hazards associated with abandoned wells.

Communicable Disease Division

The Communicable Disease Division of the Public Health Department participates in hazard mitigation in several ways, including immunizations, education, and preventive medication to prevent and/or control the spread of disease. The ultimate result is a reduction in human suffering, medical costs, and lost productivity.

In the case of a pandemic influenza or bio-terrorism event, the division would mobilize to mitigate the effects on the general population as well as first responders and essential personnel by administering antivirals, antibiotics, and immunizations. The County has a pandemic response plan that is implemented by this division.

Education and Prevention Services

Education and Prevention Services supports the public health objectives of the Department of Public Health. It conducts research on current health issues and, where appropriate, develops and implements programs to provide information, education, and services that promote and improve the public health and safety within the Fresno community. Staff also participate in a variety of public health partnerships with schools, community-based organizations, health and safety coalitions, public health agencies, managed care, medical institutions, and community members. Activities include:

- Conducting research and development on identified unmet public health needs;
- Developing, implementing, and evaluating primary prevention interventions intended to address targeted health needs of children, youth, and families;
- Providing consumer, youth, and employer health and wellness education;
- Creating and implementing informational marketing campaigns on health and safety topics;
- Coordinating selected training, assessment, and evaluation activities for the department.

Public Health Laboratory

The Public Health Laboratory provides surveillance and detects the presence of disease producing agents that have the potential to adversely affect the health of an entire community. The information generated by this testing is furnished to other agencies and departments to be used for the purpose of monitoring infectious disease outbreaks and environmental threats to the public's health. The information can then be used to plan containment strategies and assess the effectiveness of various health education programs.

Fresno County Heat Emergency Contingency Plan

Administered by a number of the departments within the Department of Public Health, the Fresno County Heat Emergency Contingency Plan was developed to reduce the incidence of morbidity and mortality associated with local extreme heat events. The plan describes County operations during heat-related emergencies and provides guidance for County departments and personnel.

Fresno County Department of Public Works and Planning

The Fresno County Department of Public Works and Planning is responsible for a wide variety of programs and activities related to planning, zoning, permits, water, community service districts, housing, community and economic development, and roads and bridges for the unincorporated portion of Fresno County. Most of the department's mitigation activities take place in the Development Services Division, which consists of the following sections:

- **Building and Safety Section**—Responsibilities include administration of building codes and regulations to ensure the public's safety.
- **Land Development, Policy Planning, and Environmental Analysis Units -** Responsibilities include processing of land use applications, land division, administration of the County's

general plan, Regional, Community and specific plans, urban growth management, and project-related amendments to General Plan and the Zoning Ordinance.

- **Development Engineering –** Responsibilities include processing grading permits, processing parcel maps and lot line adjustments.

Development Engineering is also responsible for floodplain administration and administers the National Flood Insurance Program (NFIP) for unincorporated areas of the County. The NFIP is a FEMA program that makes flood insurance available to communities that have enacted local ordinances restricting development within the 100-year floodplain. Fresno County has been an NFIP participant since 1982.

Floodplain management in Fresno County is based on mapping associated with the 2016 FEMA Flood Insurance Study, which contains revised and updated information on flood hazards in the geographic area of Fresno County, including the Cities of Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron, Kerman, Kingsburg, Mendota, Orange Cover, Parlier, Reedley, Sanger, San Joaquin, and Selma and the unincorporated areas of Fresno County. This study developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management.

Community Development

The department's Community Development Division provides a variety of services and activities to improve the quality of life and ensure a healthy economy for residents of unincorporated Fresno County and its partner cities. The division is responsible for the administration of the Community Development Block Grant Program, which provides funding, including mitigation funding, to upgrade low and moderate income neighborhoods.

Fresno County Department of Agriculture

The Fresno County Department of Agriculture, under direction of the California Department of Food and Agriculture, is responsible for conducting regulatory and service functions pertaining to the multi-billion dollar agricultural industry in Fresno County. The primary purpose and objective of the department is the promotion and protection of the County agricultural industry and the general public. Three divisions carry out the department's program objectives:

- Pest Detection and Exclusion Division
- Environmental Protection and Pest Management Division
- Weights and Measures/Standardization and Statistics Division

County Administrative Office

The County Administrative Office functions as the operations arm of the County Board of Supervisors and carries out its mission of delivering the highest quality of public services. The office administers the County's $1.45 billion dollar budget that funds services in public safety, law enforcement, agriculture, public works, human services, libraries, and elections. It takes the lead in activities to improve the quality of life in Fresno County, including economic development, capital improvements, and tourism.

Fresno County Public Library

The Fresno County Public Library provides collections and services through its Central Resource Library and 34 branches. It is part of the San Joaquin Valley Library System, a cooperative network of nine public library jurisdictions in the counties of Fresno, Kern, Kings, Madera, Mariposa, and Tulare. The library is an excellent resource for information about hazards and emergency preparedness.

State and Federal Programs

A number of state and federal programs exist to provide technical and financial assistance to local communities for hazard mitigation. Some of the primary agencies/departments that are closely involved with local governments in the administration of these programs include:

- California Governor's Office of Emergency Services
  - State of California Multi-Hazard Mitigation Plan
- California Department of Water Resources (San Joaquin District)*
  - San Joaquin River Management Plan
- California Department of Forestry and Fire Protection (Fresno King's Unit)*
- California Environmental Protection Agency
- California Department of Fish and Game*
- California Department of Transportation (Caltrans)
- California Highway Patrol
- California State Parks and Recreation Department*
- California State Lands Commission*
- San Joaquin River Conservancy*
- Federal Emergency Management Agency (Region IX)
- U.S. Army Corps of Engineers (South Pacific Division/Sacramento District)*
- Bureau of Reclamation (Mid-Pacific Region, Hollister planning area)*
- USDA Forest Service (Pacific Southwest Region)*
- National Parks Service (Pacific West Region)*
- USDA Natural Resources Conservation Service (Fresno Service Center)*
- U.S. Environmental Protection Agency (Region IX)
- American Red Cross (Fresno/Madera)

*Owns and/or manages land and/or facilities (or has some sort of administrative role, e.g., fire protection) in the County, potential partner for mitigation activities

4.5.3 Fresno County’s Fiscal Mitigation Capabilities

Table 4.80 identifies financial tools or resources that the County could potentially use to help fund mitigation activities.

Table 4.80. Fresno County’s Fiscal Mitigation Capabilities

Financial Resources	Accessible/Eligible to Use (Yes/No)	Comments
Community Development Block Grants	Yes	Based on direction of chief administrative officer and Board approval
Capital improvements project funding	Yes	Based on direction of chief administrative officer
Authority to levy taxes for specific purposes	Yes	Based on approval by Board of Supervisors and taxpayers
Fees for water, sewer, gas, or electric services	No/Yes	
Impact fees for new development	Yes	Based on approval by Board of Supervisors
Incur debt through general obligation bonds	Yes	Based on approval by Board of Supervisors, via County election process
Incur debt through special tax bonds	Yes	Based on approval by Board of Supervisors, via County election process
Incur debt through private activities	Yes	Based on approval by Board of Supervisors
Withhold spending in hazard prone areas	Yes	Based on direction of chief administrative officer and Board approval

5 MITIGATION STRATEGY

Requirement §201.6(c)(3): [The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This section describes the mitigation strategy process and mitigation action plan for the Fresno County Multi-Hazard Mitigation Plan. It describes how the County and participating jurisdictions met the requirements for the following from the 10-step planning process:

- Planning Step 6: Set Goals
- Planning Step 7: Review Possible Activities
- Planning Step 8: Draft an Action Plan

The results of the planning process, the risk assessment, the goal setting, the identification of mitigation actions, and the hard work of the HMPC led to the action plan in Section 5.3 Mitigation Action Plan. Taking all of the above into consideration, the HMPC developed the following overall mitigation strategy:

- **Communicate** the hazard information collected and analyzed through this planning process as well as HMPC success stories so that the community better understands what can happen where and what they themselves can do to be better prepared.
- **Implement** the action plan recommendations of this plan.
- **Use** existing rules, regulations, policies, and procedures already in existence. Given the flood hazard in the planning area, an emphasis should be placed on continued compliance with the National Flood Insurance Program and participation by all communities in the Community Rating System.
- **Monitor** multi-objective management opportunities so that funding opportunities may be shared and packaged and broader constituent support may be garnered.

5.1 Goals and Objectives

Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

Up to this point in the planning process, the HMPC has organized resources, assessed hazards and risks, and documented mitigation capabilities. The resulting goals, objectives, and mitigation actions were developed based on these tasks. The HMPC held a series of meetings and exercises designed to achieve a collaborative mitigation strategy as described further throughout this section.

During the initial goal-setting meeting, the HMPC reviewed the results of the hazard identification, vulnerability assessment, and capability assessment with the HMPC. This analysis of the risk assessment identified areas where improvements could be made and provided the framework for the HMPC to formulate planning goals and objectives and the ultimate mitigation strategy for the Fresno County planning area.

Goals were defined for the purpose of this mitigation plan as broad-based public policy statements that:

- Represent basic desires of the community;
- Encompass all aspects of community, public and private;
- Are nonspecific, in that they refer to the quality (not the quantity) of the outcome;
- Are future-oriented, in that they are achievable in the future; and
- Are time-independent, in that they are not scheduled events.

Goals are stated without regard to implementation. Implementation cost, schedule, and means are not considered. Goals are defined before considering how to accomplish them so that they are not dependent on the means of achievement. Goal statements form the basis for objectives and actions that will be used as means to achieve the goals. Objectives define strategies to attain the goals and are more specific and measurable.

During the 2009 planning process, HMPC members were given a list of sample goals to consider. They were told that they could use, combine, or revise the statements provided or develop new ones, keeping the risk assessment in mind. Each member was each given three index cards and asked to write a goal statement on each card. Goal statements were collected and grouped into similar themes and pasted onto the wall of the meeting room. The goal statements were then grouped into similar topics. New goals from the HMPC were discussed until the team came to consensus. Some of the statements were determined to be better suited as objectives or actual mitigation actions and were set aside for later use. Next, the HMPC developed objectives that summarized strategies to achieve each goal. During this plan update process, HMPC members reviewed the existing goals and objectives. In general, the committee found that the 2009 plan goals and objectives were still relevant and valid; however, following discussion the group decided to update Goal 2 to incorporate an emphasis on resilience.

Based on the risk assessment review and goal setting process, the HMPC identified the following goals and objectives, which provide the direction for reducing future hazard-related losses within the Fresno County planning area. One jurisdiction, the City of Kingsburg, chose to modify the countywide goals to better reflect the desires specific to their community. Kingsburg's modified goals are included in their jurisdictional annex to this plan.

Goal 1: Provide Protection for People's Lives from Hazards

Objective 1.1: Provide timely notification and direction to the public of imminent and potential hazards

Objective 1.2: Protect public health and safety by preparing for, responding to, and recovering from the effects of natural or technological disasters

Objective 1.3: Improve community transportation corridors to allow for better evacuation routes for the public and better access for emergency responders

Goal 2: Improve All Communities' Resilience and Capabilities to Mitigate Hazards and Reduce Exposure to Hazard-Related Losses

Objective 2.1: Reduce wildfires/protect life, property, and natural resources from damaging wildfires

Objective 2.2: Reduce flood and storm-related losses

Objective 2.3: Reduce hazards that adversely impact the agricultural industry

Objective 2.4: Minimize the impact to the communities due to recurring drought conditions that impact both ground water supply and the agricultural industry

Objective 2.5: Minimize the risk/loss to endangered species, native plants, land (erosion), and native wildlife

Goal 3: Improve Community and Agency Awareness about Hazards and Associated Vulnerabilities that Threaten Fresno County Planning Area Communities

Objective 3.1: Increase public awareness about the nature and extent of hazards they are exposed to, where they occur, what is vulnerable, and recommended responses to identified hazards (i.e., both preparedness and response)

Goal 4: Provide Protection for Critical Facilities, Utilities, and Services from Hazard Impacts

Goal 5: Maintain Coordination of Disaster Planning

Objective 5.1: Coordinate with changing U.S. Department of Homeland Security/FEMA needs

Objective 5.2: Coordinate with other community plans

Objective 5.3: Maximize the use of shared resources between jurisdictions and special districts for mitigation/communication

Objective 5.4: Standardize systems among agencies to provide for better interoperability

Goal 6: Maintain/Provide for FEMA Eligibility and Work to Position Jurisdictions for Grant Funding

Objective 6.1: Provide County departments and other jurisdictions with information regarding mitigation opportunities

Objective 6.2: As part of plan implementation, review actions in this plan on an annual basis to be considered for annual FEMA Pre-Disaster Mitigation grant allocations or after a presidential disaster declaration in California for Hazard Mitigation Grant Program funding as well as for other local, state, and federal funding opportunities

5.2 Identification and Analysis of Mitigation Actions

Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In order to identify and select mitigation actions to support the mitigation goals, each hazard identified in Section 4.1 Identifying Hazards: Natural Hazards was evaluated. Only those hazards that were determined to be a priority hazard were considered further in the development of hazard-specific mitigation actions.

These priority hazards are:

- Agricultural Hazards
- Dam Failure
- Drought
- Earthquake
- Flood/Levee Failure
- Human Health Hazards
  - Epidemic/Pandemic
- Severe Weather
  - Extreme Temperatures
  - Heavy Rain/Thunderstorm/Hail/Lightning
  - Fog
  - Windstorm
- Soil Hazards
  - Land Subsidence
- Wildfire

Hazardous materials incident (release from a fixed facility or transportation accident) was also identified by the HMPC as a priority hazard, as noted in Section 4.4 Human-caused Hazards.

The HMPC eliminated the hazards identified below from further consideration in the development of mitigation actions because the risk of a hazard event in the County is unlikely or nonexistent, the vulnerability of the County is low, or capabilities are already in place to mitigate negative impacts. The eliminated hazards are:

- Avalanche
- Human Health Hazards
  - West Nile Virus
- Landslide
- Severe Weather
  - Snow
  - Tornado
- Soil Hazards
  - Erosion
  - Expansive Soils
- Volcano

It is important to note, however, that all the hazards addressed in this plan are included in the countywide multi-hazard public awareness mitigation action.

Once it was determined which hazards warranted the development of specific mitigation actions, the HMPC analyzed viable mitigation options that supported the identified goals and objectives. The HMPC was provided with the following list of categories of mitigation actions, which originate from the Community Rating System:

- **Prevention**: Administrative or regulatory actions or processes that influence the way land and buildings are developed and built.
- **Property protection**: Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area.
- **Structural**: Actions that involve the construction of structures to reduce the impact of a hazard.
- **Natural resource protection**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- **Emergency services**: Actions that protect people and property during and immediately after a disaster or hazard event.
- **Public information/education and awareness**: Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them

The HMPC was also provided with examples of potential mitigation actions for each of the above categories. A facilitated discussion then took place to examine and analyze the options. This was followed by a brainstorming session that generated a list of preferred mitigation actions by hazard.

5.2.1 Prioritization Process

Once the mitigation actions were identified, the HMPC was provided with several decision-making tools, including FEMA’s recommended prioritization criteria, STAPLEE sustainable disaster recovery criteria; Smart Growth principles; and others, to assist in deciding why one recommended action might be more important, more effective, or more likely to be implemented than another., STAPLEE stands for the following:

- Social: Does the measure treat people fairly? (e.g., different groups, different generations)
- Technical: Is the action technically feasible? Does it solve the problem?
- Administrative: Are there adequate staffing, funding, and other capabilities to implement the project?
- Political: Who are the stakeholders? Will there be adequate political and public support for the project?
- Legal: Does the jurisdiction have the legal authority to implement the action? Is it legal?
- Economic: Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- Environmental: Does the action comply with environmental regulations? Will there be negative environmental consequences from the action?

In accordance with the Disaster Mitigation Act requirements, an emphasis was placed on the importance of a benefit-cost analysis in determining action priority. Other criteria used to assist in evaluating the benefit-cost of a mitigation action included:

- Does the action address hazards or areas with the highest risk?
- Does the action protect lives?
- Does the action protect infrastructure, community assets or critical facilities?
- Does the action meet multiple objectives (Multiple Objective Management)?
- What will the action cost?
- What is the timing of available funding?

The mitigation categories, multi-hazard actions, and criteria are included in Appendix C: Mitigation Categories, Alternatives, and Selection Criteria.

At the mitigation strategy meeting the HMPC used STAPLEE to determine which of the identified actions were most likely to be implemented and effective. With these criteria in mind, team members were given a set of four green sticky-dots. The team was asked to use the dots to prioritize projects with the above criteria in mind, essentially voting on the projects. The projects with the most dots became the higher priority projects. This process provided both consensus and priority for the recommendations. Follow-up meetings were held within each jurisdiction to finalize the actions that are part of this plan. Participating jurisdictions were given the leeway to prioritize the actions specific to them, using the previously mentioned criteria.

This plan also carries forward many mitigation actions developed during the 2009 planning process. HMPC members and jurisdictional planning teams were asked to review their existing mitigation actions and report on the progress made toward implementation and decide whether and incomplete actions should be carried forward for continued or future implementation or be deleted. In some cases, mitigation actions were adjusted to reflect new situations or needs.

The process of identification and analysis of mitigation alternatives allowed the HMPC to come to consensus and to collectively prioritize recommended mitigation actions. During the voting process, emphasis was placed on the importance of a benefit-cost review in determining project priority; however, this was not a quantitative analysis. After completing the prioritization exercise, some team members expressed concern that prioritizing all the actions as a group is not very effective, since many of the actions are jurisdiction- or department-specific. However, the team agreed that prioritizing the actions collectively enabled the actions to be ranked in order of relative importance and helped steer the development of additional actions that meet the more important objectives while eliminating some of the actions which did not garner much support.

Benefit-cost was also considered in greater detail in the development of the Mitigation Action Plan detailed below in Section 5.3. Specifically, each action developed for this plan contains a description of the problem and proposed project, the entity with primary responsibility for implementation, any other alternatives considered, a cost estimate, expected project benefits, potential funding sources, and a schedule for implementation. Development of these project details for each action led to the determination of a High, Medium, or Low priority for each action.

Recognizing the limitations in prioritizing actions from multiple jurisdictions and departments and the regulatory requirement to prioritize by benefit-cost to ensure cost-effectiveness, the HMPC decided to pursue mitigation action strategy development and implementation according to the nature and extent of damages, the level of protection and benefits each action provides, political support, project cost, available funding, and individual jurisdiction and department priority. This process drove the development of a prioritized action plan for the Fresno County planning area. Cost-effectiveness will be considered in greater detail through a formal benefit-cost analysis when seeking FEMA mitigation grant funding for eligible actions associated with this plan.

5.3 Mitigation Action Plan

Requirement §201.6(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

This action plan was developed to present the recommendations developed by the HMPC for how the Fresno County planning area can reduce the vulnerability of people, property, infrastructure, and natural and cultural resources to future disaster losses. Over time the implementation of these projects will be tracked as a measure of demonstrated progress on meeting the plan's goals.

5.3.1 Progress on Previous Mitigation Actions

Fresno County and the many of the participating jurisdictions have been successful in implementing actions identified in the 2009 LHMP Mitigation Strategy, thus, working steadily towards meeting the 2009 plan goals. Projects that helped meet five of the six goals have been completed as of early 2018.

The 2009 mitigation strategy contained 89 separate mitigation actions including 19 actions led by Fresno County. Of the County's actions, three have been completed. Several others have had aspects implemented or are ongoing, such as 'Develop and Conduct a Multi-Hazard Seasonal Public Awareness Program.' Across all jurisdictions, 18 actions from the 2009 Plan have been completed, including several by the City of Clovis. Table 5.1 provides a summary of the mitigation action projects completed from the 2009 Plan. More details on in-progress and ongoing actions are discussed in the "Status" associated with the County Mitigation Action details and jurisdictional annexes. These actions are included in Table 5.3.

Table 5.1 Mitigation Actions Completed from 2009 Plan

Jurisdiction	Mitigation Action Title	Corresponding Hazard	Priority	Related Goals
Fresno County	Implement Mass Notification System for Fresno County	Multi-Hazard	High	1
	Develop and Conduct Disaster Response/Disaster Management Training for Designated County/City Staff	Multi-Hazard	Medium	2
	Install Automated Fog Warning System	Fog	High	1
City of Clovis (Annex A)	Establish Post-Disaster Action Plan for City Continuity of Operations Plan	Multi-Hazard	High	4
	Train and Certify City Inspectors to Conduct Post-Disaster Damage Assessment	Multi-Hazard	High	2
	Implement a System of Automatic Vehicle Location	Multi-Hazard	High	2
	Install Battery Back-Up Systems at Traffic Signals in the City of Clovis on Major Transportation Routes	Multi-Hazard	High	1, 4
	Replace Traffic Management Center Software and Herndon Avenue Traffic Signal Equipment and Implement Communications Upgrades	Multi-Hazard	Medium	1
	Modify and Enhance Emergency Traffic Control System	Multi-Hazard	Medium	1
	Implement a System to Share Information with City Police Officers/Employees (SharePoint)	Multi-Hazard	Medium	3, 5
	Integrate Local Hazard Mitigation Plan into Safety Element of General Plan	Multi-Hazard	High	5
	Implement a Flood Awareness Program for the Public	Flood	Medium	3

Jurisdiction	Mitigation Action Title	Corresponding Hazard	Priority	Related Goals
City of Coalinga (Annex B)	Improve Nonstructural Earthquake Mitigation in Public Buildings	Earthquake	High	1, 4
	Inventory At-Risk Buildings	Earthquake	High	1
City of Kingsburg (Annex G)	Conduct Disaster Response Training	Multi-Hazard	High	2
	Replace Storm Drains on Lewis and Washington Streets	Flood	High	2
Sierra Resource Conservation District (Annex P)	Create an Integrated Regional Water Management Plan for Eastern Fresno County	Drought	Medium	5
	Conduct a Fractured Rock Groundwater Capacity Study for Eastern Fresno County	Drought	Medium	2

During the 2017-18 update, the actions from the 2009 plan were revisited, re-evaluated, and in some cases re-prioritized. During this process several actions were noted as not completed and no longer relevant to continue forward in the updated plan. Some actions were deleted because they were considered response actions rather than mitigation, while others were simply no longer a priority. The actions from the 2009 Plan that were not completed but are no longer being pursued are noted in the table below.

Table 5.2 Mitigation Actions Deleted

Jurisdiction	Mitigation Action Title	Corresponding Hazard	Related Goals	Reason for Deleting
Fresno County	Establish an Abandoned Water Well Program	N/A	N/A	Not tied to mitigation of a specific hazard
	Develop Mitigation and Monitoring Program for Groundwater Supplies in the Northeast Portion of the County	Drought	2	Replaced by new action #9 SGMA Compliance and Implementation
	Create and Maintain a Water Stewardship Forum of Stakeholders in Northeastern Fresno County	Drought	2	Replaced by new action #9 SGMA Compliance and Implementation
	Control E. Coli through Wild Hog Population Management	Agricultural	2	No longer considered a relevant project
City of Coalinga	Provide Bilingual Neighborhood Emergency Response Team	Earthquake	2	Considered a Response Activity

Jurisdiction	Mitigation Action Title	Corresponding Hazard	Related Goals	Reason for Deleting
	(NERT) Training to Community Residents and Businesses			
City of Sanger (Annex I)	Implement a Flood Awareness Program for the Public	Flood	3	No longer a priority; replaced with flood awareness outreach targeting areas with localized flooding issues
	Install Battery Back-Up Systems at Traffic Signals in the City of Sanger on Major Transportation Routes	Multi-Hazard	1	No longer considered a priority
	Improve City's Floodplain Management Program and Apply to Community Rating System	Flood	2	Participation in the CRS no longer considered a priority
City of Selma (Annex J)	Construct a Railroad Crossing Underpass	Multi-Hazard	1	No longer considered a viable alternative
Fresno Metropolitan Flood Control District (Annex M)	Construct Control Structures and Flood Channel for Mud Creek Flows between the Gould and Fresno Canals	Flood	2	Replaced with New Project
	Construct Improvements to the Vernon Drain Between the Gould and Fresno Canals	Flood	2	Replaced with New Project

5.3.2 Continued Compliance with NFIP

Recognizing the importance of the NFIP in mitigating flood losses, an emphasis will be placed on continued compliance with the NFIP by Fresno County and other NFIP participating communities including the cities of Clovis, Coalinga, Firebaugh, Fowler, Fresno, Kingsburg, Mendota, Reedley, San Joaquin and Sanger. As NFIP participants, these communities have and will continue to make every effort to remain in good standing with NFIP. This includes continuing to comply with the NFIP's standards for updating and adopting floodplain maps and maintaining and updating the floodplain zoning ordinance. The City of Selma has chosen not to participate in the NFIP for several years due to limited flood risk, though some Special Flood Hazard Area exists within city limits. Other details related to NFIP participation are discussed in the flood vulnerability discussion in Chapter 4 and in the capability assessment in Section 4.5 and jurisdictional annexes.

5.3.3 Updated Mitigation Action Plan

The action plan summarizes who is responsible for implementing each of the prioritized actions as well as when and how the actions will be implemented. Each action summary also includes a discussion of the benefit-cost review conducted to meet the regulatory requirements of the Disaster Mitigation Act. Table 5.3 identifies the mitigation actions and lead jurisdiction for each action.

Only those actions where the County is the lead jurisdiction are detailed further in this section. Actions specific to other participating jurisdictions, or where other jurisdictions are taking the lead, are detailed in the jurisdictional annexes.

It is important to note that Fresno County and the participating jurisdictions have numerous existing, detailed action descriptions, which include benefit-cost estimates, in other planning documents, such as community wildfire protection plans and capital improvement budgets and reports. These actions are considered to be part of this plan, and the details, to avoid duplication, should be referenced in their original source document. The Fresno County planning area also realizes that new needs and priorities may arise as a result of a disaster or other circumstances and reserves the right to support new actions, as necessary, as long as they conform to the overall goals of this plan.

The results of the 2017-18 project identification and prioritization exercise are summarized below in Table 5.3. Included in the table are actions that are being carried forward from the 2009 plan, which are noted as continuing or deferred projects in the 'project status' column. Deferred projects are those that were identified in 2009 but not yet started. Continuing projects are those identified in 2009 that may have been started but either more work remains, or they are annually implemented projects. The actions are grouped by jurisdiction and priority. More detail about the actions identified for Fresno County follow the table, including a description of the activity, the entity responsible for implementation, any other alternatives considered, cost estimate, and a schedule for implementation. The jurisdictional annexes contain the detailed action item descriptions respective to each jurisdiction. The summary table can be used for reference during future HMPC meetings to track progress moving forward.

Table 5.3 Fresno County's Mitigation Actions

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
Fresno County Mitigation Actions					
County 1	Multi-Hazard	Develop and Conduct a Multi-Hazard Seasonal Public Awareness Program	High	3	Continuing
County 2	Multi-Hazard	Identify Critical Facilities and Inspect for Vulnerability to Major Hazards	High	2	Continuing
County 3	Multi-Hazard	Upgrade or Replace Critical County Facilities Found to be Vulnerable to Major Hazards	High	4	Continuing
County 4	Multi-Hazard	Enhance the County Emergency Operations Center	High	2, 5	Continuing
County 5	Multi-Hazard	Develop Animal Carcass Disposal Plan	Medium	2	Deferred

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
County 6	Agricultural	Control Bubonic Plague through Coyote and California Ground Squirrel Population Management	High	2	Continuing
County 7	Dam Failure	Minimize Flood Events by Exercising Reclamation's Emergency Action Plan and Provide an Early Warning System to Downstream Emergency Response Agencies	High	1, 2	Continuing
County 8	Dam Failure	Update Dam Failure Evacuation Plan	Medium	1	New
County 9	Drought, Subsidence	Sustainable Groundwater Management Act Compliance including Groundwater Sustainability Planning and Implementation	High	2	New Project
County 10	Flood	Conduct Feasibility Study for Panoche-Silver Creek Flood Detention Facility (see Mendota)	High	2	Deferred
County 11	Flood	Investigate and Construct Water Storage Options for the Upper San Joaquin River Basin	High	2	Continuing
County 12	Flood	Analyze System, Condition, and Management of Flood Water Conveyance Facilities	High	2	Deferred
County 13	Flood	Prepare Stormwater Drainage Master Plans	Medium	2	Continuing
County 14	Human Health	Control West Nile Virus through Beaver Population Management	High	2	Continuing
County 15	Wildfire/ Wind	Wildfire Defensible Fuel Modification Zones in Areas of Tree Mortality	High	2, 3	New Project
City of Clovis Mitigation Actions					
Clovis 1	Multi-Hazard	Construct a Water Intertie between the Cities of Clovis and Fresno	High	5	Continuing
Clovis 2	Multi-Hazard	Modernize Information Technology Backup Infrastructure	High	4	Continuing
Clovis 3	Multi-Hazard	Improve the City's Capabilities for Sheltering Animals in a Disaster	High	1	Continuing
Clovis 4	Multi-Hazard	Purchase Hazard Mitigation Public Notification Boards	High	1	Deferred
Clovis 5	Multi-Hazard	Make Improvements to Emergency Evacuation and Emergency Vehicle Routes	High	1, 4	Deferred
Clovis 6	Earthquake	Conduct a Seismic Vulnerability Assessment of City-Owned Critical Facilities	Medium	2	Continuing
Clovis 7	Flood	Construct Channel Improvements for Dog Creek Stream, South of Gettysburg-Ashlan	High	2	Continuing
Clovis 8	Flood	Improve Flow Design Parameters for Big Dry Creek and the Enterprise Canal	High	2	Continuing

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
Clovis 9	Flood	Improve City's Floodplain Management Program and Apply to Community Rating System	Medium	2	Continuing
Clovis 10	Flood	Continue to Enforce Master Drainage Plan Requirements	Low	1	Continuing
Clovis 11	Other	Install a System of Surface Water Hazard Detection	High	2	Continuing
City of Coalinga Mitigation Actions					
Coalinga 1	Multi-Hazard -	Plan for Alternative Water Sources for the Water System	High	2	New
Coalinga 2	Multi-Hazard	Plan for Water System Sustainability in the Event of Long Term Power Failure	High	4	New
City of Firebaugh Mitigation Actions					
Firebaugh	Flood	Levee System Improvements	Medium	1,2,4	New
City of Fowler Mitigation Actions					
Fowler 1	Multi-Hazard	Back-up Power System for City Critical Facilities	High	4	New
City of Fresno Mitigation Actions					
Fresno 1	Multi-Hazard	Establish Post-Disaster Action Plan for City Continuity of Operations Plan	High	5	Continuing
Fresno 2	Multi-Hazard	Improve the City's Capabilities for Sheltering Animals in a Disaster	High	1	Continuing
Fresno 3	Multi-Hazard	Train and Certify City Inspectors to Conduct Post-Disaster Damage Assessment	High	2	Deferred
Fresno 4	Flood	Implement a Flood Awareness Program for the Public	Medium	3	Deferred
Fresno 5	Multi-Hazard	Southwest Fresno - Recycled Water Distribution System	High	2	New
City of Kerman Mitigation Actions					
Kerman 1	Flood	California Avenue Parallel Storm Drain Line	High	2	Deferred
Kerman 2	Severe Weather: Fog	Warning Lights for the Intersection of State Route 145 and Highway 180	Medium	1	Deferred
City of Kingsburg Mitigation Actions					
Kingsburg 1	Multi-Hazard	Enhance Traffic Diversion System	High	1	Deferred
Kingsburg 2	Multi-Hazard	Create Emergency Evacuation Plan for Large Scale Incident	High	1	New
Kingsburg 3	Multi-Hazard	Identify High Risk and High Value Target Areas	High	2	New
City of Mendota Mitigation Actions					

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
Mendota 1	Flood	Build a Stormwater Detention/Desilting Basin	High	1	Continuing
City of Reedley Mitigation Actions					
Reedley 1	Flood	Develop Stormwater Detention Basin	High	2	New
City of San Joaquin Mitigation Actions					
San Joaquin	Multi-Hazard	Construct Water Storage Tank and Booster Pump Station including emergency generators	High	2,4	New
City of Sanger Mitigation Actions					
Sanger 1	Multi-Hazard	Establish Post-Disaster Action Plan for City Continuity of Operations Plan	High	4	Continuing
Sanger 2	Multi-Hazard	Add Potable Water Storage Capacity (500,000 Gallon above Ground Tank) to the City of Sanger’s Water System	High	2	Continuing
Sanger 3	Multi-Hazard	Provide Backup Power to City Pumps/Wells	High	1, 4	Continuing
Sanger 4	Flood	Replace Old Drainage System to Prevent Flooding	Medium	2	Continuing
Sanger 5	Flood	Provide Fire Department Office Security	Medium	4	Deferred
Sanger 6	Other	Provide Compound Security for Police and Fire Departments	Medium	4	Deferred
City of Selma					
Selma 1	Multi-Hazard	Institute a Disaster Preparedness Education Program for the Public	High	3	Deferred
Selma 2	Flood	Install Back-up Power for Storm Drain Pumps	High	4	Deferred
Selma 3	Flood	Sheridan Street Pump Station	High	4	Deferred
Selma 4	Technological	Construct New Police and Fire Department Headquarters	High	2	Deferred
Fresno Metropolitan Flood Control District Mitigation Actions					
FMFCD 1	Flood	Construct the Gould Canal to Fancher Creek Detention Basin Pipeline	High	2, 4	New
FMFCD 2	Flood	Construct the Fancher Creek Detention Basin Pump Station and Telemetry System	High	2, 4	New
FMFCD 3	Flood	Provide for Local Stormwater Drainage System Infrastructure	High	2	Continuing
FMFCD 4	Flood	Retain 200-Year Flood Control Protection	Medium	2	Continuing
FMFCD 5	Flood	Retrofit Areas with Surface Outlets to Protect Existing Structures	Medium	2, 4	Continuing
FMFCD 6	Flood	Install Back-up Generators for Pump Only Facilities	Low	4	Deferred
FMFCD 7	Flood	Big Dry Creek Diversion Additional Drop Structure	Medium	4	New

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
Lower San Joaquin Levee District Mitigation Actions					
LSJLD 1	Flood	Institute a Dredging Management Program for the Purpose of Flood Damage Reduction	High	2	Continuing
LSJLD 2	Flood	Institute an Invasive Vegetation Management Program for the Purpose of Flood Damage Reduction	High	2	Continuing
Sierra Resource Conservation District Mitigation Actions					
SRCD 1	Multi-Hazard	Strengthen Non-Native Noxious Weed Control Efforts	Low	2	Deferred
SRCD 2	Dam Failure	Strengthen Dam Failure/Flood Planning, Coordination, and Training	Low	2	Deferred
SRCD 3	Wildfire	Improve Alternate Emergency Access Roads	High	1	Continuing
SRCD 4	Wildfire	Conduct Community Fuel Break Construction and Maintenance on a Landscape Scale	High	2	Continuing
SRCD 5	Wildfire	Create a Fuel Break Along Highway 168	High	2	Deferred
SRCD 6	Wildfire	Implement a Neighborhood Chipper Program	High	2	Continuing
SRCD 7	Wildfire	Conduct Prescribed Fires	High	2	Continuing
SRCD 8	Wildfire	Establish a System of Fire Pumper/Tanker Fill Stations and Water Storage	High	2	Continuing
SRCD 9	Wildfire	Implement a Public Fire Prevention, Survival, and Mitigation Education Program	Medium	3	Continuing
SRCD 10	Wildfire	Update Highway 168 FireSafe Council's Community Wildfire Protection Plan through CA FireSafe Council Funding	High	2	New
SRCD 11	Wildfire	Develop Wildfire Protection Plan with Oak to Timberline FireSafe Council through CA FireSafe Council Funding	High	5	New
SRCD 12	Wildfire	Implement a biomass utilization and dispositioning program for excessive forest and rangeland vegetation	High	2	New
SRCD 13	Wildfire	Partner with U.S. Forest Service to reduce fire risk in Wildland Urban Interface (WUI)	High	2	New
SRCD 14	Wildfire	Removal of Illegal marijuana grows to reduce fire risk in Wildland Urban Interface (WUI)	High	2	New
SRCD 15	Wildfire	Burns Flat Fuel Break	High	2	New
SRCD 16	Wildfire	Whispering Springs Fuel Break	High	2	New
SRCD 17	Wildfire	The Beal Fire Road Fuel Break	High	2	New
SRCD 18	Wildfire	Peterson Road Fuel Break	Medium	2	New
Westlands Water District					

Action ID	Hazard Addressed	Mitigation Action Title	Priority	Related Goals	Action Status (New, Continuing, Deferred)
WWD 1	Drought	Institute a Groundwater Replenishment and Drought Resiliency Project	High	2, 4	New
Kings River Conservation District					
KRCD 1	Flood	Levee Integrity Analysis and Improvement Project	High	1, 2	New

Fresno County Multi-Hazard Mitigation Actions

1. Develop and Conduct a Multi-Hazard Seasonal Public Awareness Program

Issue/Background: Fresno County is subject to several natural hazards. Each poses a different degree of risk and associated vulnerability. Some hazards have a combination of attributes, including a high likelihood of occurrence, a specific location that would likely be impacted, and proven approaches that could reduce the impact. For other hazards, where either the likelihood of occurrence is very low, the area of likely impact is not specifically known, or there is very little that can be done to reduce the impacts, the HMPC has determined that the best approach is public awareness. People should have information describing historical events and losses, the likelihood of future occurrences, the range of possible impacts, appropriate actions to save lives and minimize property damage, and where additional information can be found. Any information provided through this effort should be accurate, specific, timely, and consistent with current and accepted local emergency management procedures as promoted by the California State Office of Emergency Services and the American Red Cross. This public outreach effort should be conducted annually and should include:

- Using a variety of information outlets, including local news media;
- Creating and printing (where applicable) brochures, leaflets, water bill inserts, websites, and public service announcements;
- Displaying current brochures and flyers in County and City office buildings, libraries, and other public places; and
- Developing public-private partnerships and incentives to support public education activities.

Other Alternatives: Continue public information activities currently in place

Responsible Office: Fresno County Office of Emergency Services, Department of Public Works and Planning, and Chamber of Commerce; American Red Cross

Priority (High, Medium, Low): High

Cost Estimate: $5,000-20,000 annually, depending on printing and mailing costs, level of volunteer participation, and scope and frequency of events

Potential Funding: FEMA's Hazard Mitigation Grant Program, Fresno County funds, other available grants

Benefits (Avoided Losses): Life safety, reduction in property losses, relatively low cost

Schedule: Part of seasonal multi-hazard public awareness campaign

Status: 2009 project, implementation ongoing

2. Identify Critical Facilities and Inspect for Vulnerability to Major Hazards

Issue/Background: The County has various facilities that may need to function in times of crisis and/or emergency.

- The facilities should be identified.
- The identified facilities should be reviewed and inspected to determine if the infrastructure can withstand and operate under critical conditions.
- Required upgrades to each of the facilities should be identified and prioritized.

Other Alternatives: No action

Responsible Office: Internal Services Department in coordination with Fresno County Department of Public Works and County OES

Priority (High, Medium, Low): High

Cost Estimate: Up to $3 million, depending on the number of facilities identified for review

Potential Funding: Annual budgets

Benefits (Avoided Losses): The County will be able to develop a plan to methodically upgrade the infrastructure and systems necessary to operate in times of emergency.

Schedule: 1-5 years

Status: 2009 project, implementation in progress

3. Upgrade or Replace Critical County Facilities Found to be Vulnerable to Major Hazards

Issue/Background: The County has various facilities that may need to function in times of crisis and/or emergency. The County should upgrade or replace those facilities found to be vulnerable in accordance with a developed prioritized schedule.

Other Alternatives: Contact other jurisdictions to determine if capacity exists to accommodate County critical functions within facilities they control.

Responsible Office: Fresno County Department of Public Works and Planning Capital Projects Division

Priority (High, Medium, Low): High

Cost Estimate: Unknown at this time, will depend on the number of facilities identified, total cost could approach $100 million or more

Potential Funding: FEMA's Hazard Mitigation Grant Program and Pre-Disaster Mitigation Program, state funds, Fresno County budgets

Benefits (Avoided Losses): The County will have reliable infrastructure and systems necessary to operate in times of emergency

Schedule: 2-10 years

Status: 2009 project, implementation in progress

4. Enhance the County Emergency Operations Center

Issue/Background: The Emergency Operations Center (EOC) for Fresno County is located in multiple rooms on multiple floors within the Public Health Department. Because the EOC sections are isolated, communications are limited, and section staff are unable to interact well. A centralized modern day EOC in a single location would greatly enhance communications and improve the effectiveness of those who work in it.

Other Alternatives: Enhance the EOCs of other jurisdictions and activate them in the event of an emergency

Responsible Office: Fresno County Office of Emergency Services

Priority (High, Medium, Low): High

Cost Estimate: $2.5 million

Potential Funding: Fresno County General Fund, grants

Benefits (Avoided Losses): A modern EOC in one location would decrease emergency response time and the public notification process, reducing potential loss of life and damage. The more time people are given to prepare for a potential emergency, the better chance they have of avoiding the effects of that event. The benefits would reduce set-up time currently needed. This would result in greater efficiencies that could leverage current technologies and result in improved communication and save time, money and lives through a faster response

Schedule: within 5-10 years

<u>Status</u>: 2009 project, implementation in progress; Some improvements are in place. A centralized EOC is not yet in place.

5. Develop Animal Carcass Disposal Plan

Issue/Background: In some instances (e.g., due to heat, freeze, or animal disease), the number of animal carcasses exceeds the rendering capacity for the area. There is no legal disposal location for unrenderable carcasses within the County. Dead animal carcasses are a significant reservoir for disease that is detrimental to human health. A plan is necessary to identify options for disposing of animal carcasses in Fresno County.

Within the counties of Fresno, Kings, and Tulare, there are over 1 million head of dairy cattle alone. This does not include the large numbers of beef cattle, poultry, and horses, etc. that also exist in the area. The only approved way of disposing of dead animal carcasses is to render them. For these three counties, there is limited rendering capacity, with only two rendering plants in operation (Baker Commodities and Darling Delaware). Both of these plants are located in Fresno County and carcasses are shipped from other counties to the plants. When one of the plants experiences problems, or more animals die off than the plants can process, there is a disposal issue. Fresno County landfills are not permitted to take animal carcasses unless there is an emergency. Fresno County has had to declare an emergency at least once a year for the last two years to legally dispose of carcasses in the landfill. This has created significant short- and long- term issues for the landfill.

Direct disposal costs from one event in which 25 20-ton truckloads were hauled to a disposal location outside of the County exceeded $100,000. Within the last two years, there were approximately 10 disposal events costing an estimated $1 million.

Most experts agree that it is only a matter of time before there will be an outbreak of a disease that will require mass culling of animal stocks. Pre-determined disposal options would shorten the disposal interval and reduce human exposure to the disease.

Other Alternatives:

- Limit growth of animal numbers through Fresno County Planning Department policies until the number of rendering plants is adequate to meet demand
- Install new plants
- Create new disposal locations for carcass disposal

Responsible Office: Fresno County Environmental Health

Priority (High, Medium, Low): Medium

Cost Estimate: $250,000

Potential Funding: Fresno County General Fund, local agricultural industry, grants

Benefits (Avoided Losses): Reduced human exposure to disease due to the proper disposal of animal carcasses; reduced disposal costs

Schedule: 36 months

<u>Status</u>: 2009 project, implementation not started

Fresno County Agricultural Hazards Mitigation Actions

6. Control Bubonic Plague through Coyote and California Ground Squirrel Population Management

Issue/Background: Bubonic plague is endemic to parts of Fresno County. Coyotes and the California ground squirrel are free ranging wildlife that are present in all of Fresno County. Coyotes and ground squirrels cause extensive agricultural livestock, crop, and property damage. Coyotes are very mobile and can travel 20 to 25 miles in a day. Coyotes are known to carry and transmit diseases to humans, domestic animals, and livestock. Coyotes are carriers of the bubonic plague bacteria, which they receive from the bite of an infected flea. Coyotes can spread the disease to various California ground squirrel colonies. Human interaction with ground squirrels in open spaces, parks, and recreational areas can potentially result in bubonic plague infection through flea bites. Blood samples from coyotes can be tested for the presence of bubonic plague.

Other Alternatives: No action

Responsible Office: Fresno County Department of Agriculture Wildlife Damage Management

Priority (High, Medium, Low): High

Cost Estimate: $100,000

Potential Funding: Fresno County General Fund, California Department of Public Health, unrefunded gas tax

Benefits (Avoided Losses):

- One human life saved is $3.1 million
- Avoids disease transmission to humans
- Reduces the discomfort and adverse effects of flea bites

Schedule: Annually, June through October

<u>Status</u>: 2009 project, continuing implementation on an as needed basis

Fresno County Dam Failure Mitigation Actions

7. Minimize Flood Events by Exercising Reclamation's Emergency Action Plan and Provide an Early Warning System to Downstream Emergency Response Agencies

Issue/Background: Friant Dam was constructed in 1942 and is located 20 miles northeast of the City of Fresno. It serves as a water conservation and flood control facility. The dam has a structural height of 319 feet with a top of crest elevation of 581.25 feet. Millerton Lake reservoir has a storage capacity of 520,500 acre-feet.

The Bureau of Reclamation has the ability to divert water to the Friant Kern Canal, Madera Canal, and the San Joaquin River. During unforeseen events, the Bureau of Reclamation may be required to release water into the San Joaquin River that may exceed the river channel capacity.

Other Alternatives: Divert flood water to the Friant Kern Canal and the Madera Canal, reduce encroachment of development in the San Joaquin River floodplain, construct a new storage facility

Responsible Office: Bureau of Reclamation, South Central California Area Office-Fresno; U.S. Army Corps of Engineers Sacramento Branch

Priority (High, Medium, Low): High

Cost Estimate: $5,000-10,000 to exercise and update emergency action plan

Potential Funding: FEMA's Hazard Mitigation Grant Program, state funding, other available grants

Benefits (Avoided Losses): Minimized risk of loss of life and property damage

Schedule: 1-3 years

Status: 2009 project, continuing ongoing implementation

8. Update Dam Failure Evacuation Plan

Issue/Background: New statues in the California Water code will require dam operators to update inundation maps. Development of new inundation maps will need to be incorporated into the County's dam failure evacuation plans. This will impact at least 23 dams within the County.

Other Alternatives: None

Responsible Office: County OES, PW and Sheriff's Office

Priority (High, Medium, Low): Medium

Cost Estimate: $150,000-$200,000

Potential Funding: Annual budget, grants

Benefits (Avoided Losses): This plan will provide updated information that will enable an effective method for warning and evacuating downstream residents if a dam were to fail. This will enable the lives of many residents to be saved.

Schedule: 1-3 years depending on when updated inundation maps are completed

Status: New project

Fresno County Drought and Subsidence Mitigation Actions

9. Sustainable Groundwater Management Act Compliance including Groundwater Sustainability Planning and Implementation

Issue/Background: Like many groundwater basins throughout the State, three (Kings, Westside, Delta-Mendota) of the four groundwater subbasins that underlay Fresno County are in overdraft condition with underground aquifers adversely impacted by overuse. Such impacts include significant decline in water storage and water levels, degradation of water quality, and land subsidence resulting in the permanent loss of storage capacity. Recognizing the importance of groundwater and the consequences of overuse, the Sustainable Groundwater Management Act (SGMA) was signed into law in 2014, to address the sustainable management of groundwater in California. The Sustainable Groundwater Management Act (SGMA) provides for the establishment of local Groundwater Sustainability Agencies (GSAs) to manage groundwater sustainability within groundwater subbasins defined by the California Department of Water Resources (DWR). Each GSA is required to develop and implement, no later than January 31, 2020, a Groundwater Sustainability Plan (GSP) to ensure a sustainable yield of groundwater, without causing undesirable results. Failure to comply with that requirement could result in the State asserting its power to manage local groundwater resources. Fresno County is working cooperatively with multiple GSAs within the four subbasins located within Fresno County towards the preparation and implementation of required GSPs. Maintaining sustainable groundwater supplies will provide insurance against periods of long-term drought, and assist in the mitigating the potential for land subsidence.

Other Alternatives: None, compliance required by law, failure to meet requirements will result in State intervention and oversight.

Responsible Office: Responsibilities for compliance with the Sustainable Groundwater Management Act have been assumed through the formation of Groundwater Sustainability Agencies within the four Fresno County groundwater subbasins recognized by the California Department of Water Resources. Fresno County is generally party to each of the GSAs within Fresno County by agreement or memorandum of understanding.

Priority (High, Medium, Low): High

Cost Estimate: Varies by GSA for preparation of the required GSP. Further expenses are anticipated to be accrued for the planning and construction of groundwater recharge projects.

Potential Funding: Property owner assessments along with grant funding opportunities from the State.

Benefits (Avoided Losses): Preparation and implementation of the GSP by the respective GSAs will result in the management of groundwater in a manner that is sustainable and avoids undesirable results as defined by the California State Department of Water Resources.

Schedule: GSAs must complete and submit the required GSP to DWR by January 31, 2020, which is to be fully implemented and result in sustainability of the groundwater basin, with no undesirable effects, by the year 2040.

Status: New project in 2018

Fresno County Flood/Levee Failure Mitigation Actions

10. Conduct Feasibility Study for Panoche-Silver Creek Flood Detention Facility

Issue/Background: Panoche-Silver Creek downstream of the California Aqueduct causes frequent flooding of Belmont Avenue, a major transportation corridor connecting west Fresno County to I-5, the future Route 180 alignment, and the City of Mendota, a downstream community. Flooding occurs during normal-intensity storm events. High-intensity events result in extended road closures in an area of the County with limited transportation corridors. A feasibility study is needed to assess feasibility and location of facilities to route flood flows to a detention reservoir.

Other Alternatives: None identified

Responsible Office: Joint, possible partners include California Department of Water Resources, Bureau of Reclamation, Fresno County, City of Mendota, Westlands Water District

Priority (High, Medium, Low): High

Cost Estimate: $1.2 million

Potential Funding: State or federal grant sources

Benefits (Avoided Losses): Finding potential solution to reduce traffic disruptions

Schedule: 2-5 years

Status: 2009 project; Deferred. As of March 2018, Project has not started but a need for the project remains.

11. Investigate and Construct Water Storage Options for the Upper San Joaquin River Basin

Issue/Background: The Upper San Joaquin River Storage Investigation will investigate feasibility and cost to provide on- or off-stream storage in the upper San Joaquin River Basin. The objectives are conjunctive beneficial uses, including restoration of the San Joaquin River, increased management and exchange opportunities to secure and stabilize deliveries to urban and agricultural uses, flood control, recreation, reduced groundwater overdraft, and potentially hydropower.

Other Alternatives: No action

Responsible Office: California Department of Water Resources, Bureau of Reclamation

Priority (High, Medium, Low): High

Cost Estimate: Study—to be determined; resulting project—$1-1.5 billion

Potential Funding: State or federal sources

Benefits (Avoided Losses): Reduction of flood risk downstream of Friant Dam

Schedule: 5-10 years

Status: 2009 project; As of March 2018, a draft Environmental Impact Statement has been completed and funding is being sought for implementation

12. Analyze System, Condition, and Management of Flood Water Conveyance Facilities

Issue/Background: Flood water conveyance occurs over a disparate system of natural and manmade channels, levees, irrigation canals, and ad-hoc structures whose primary function may be for purposes other than flood management. A systemwide inventory and analysis is needed to develop priorities across many jurisdictions, both public and private, for rehabilitation and upgrade of critical flood management facilities, including public and private levees.

Other Alternatives: No action

Responsible Office: Potentially San Joaquin Valley-wide, possible lead or joint lead entities include California Department of Water Resources; Bureau of Reclamation; irrigation, water, and conservation districts; regional partners through integrated regional water management plans; Fresno County

Priority (High, Medium, Low): High

Cost Estimate: $5 million (Fresno County)

Potential Funding: State and federal grant funding

Benefits (Avoided Losses): Reduced flood risk and flood losses

Schedule: 10-20 years

Status: 2009 project; Deferred. As of March 2018 implementation of this project has not started but a study is still needed.

13. Prepare Stormwater Drainage Master Plans

Issue/Background: Some unincorporated communities in Fresno County do not have master plans for stormwater drainage, which provide for flow, collection, and diversion of stormwater from public streets to detention or recharge facilities. Lacking appropriate drainage, stormwater may flood streets and/or property, and standing water may persist, leading to health or traffic safety concerns.

Other Alternatives: No action

Responsible Office: Special or community service districts or County service area zones of benefit

Priority (High, Medium, Low): Medium

Cost Estimate: $150,000-500,000 per community

Potential Funding: Undetermined

Benefits (Avoided Losses): Reduced property damage and adverse impacts on health and traffic safety

Schedule: 3-5 years

Status: 2009 project; Continuing

Fresno County Human Health Hazards: West Nile Virus Mitigation Actions

14. Control West Nile Virus through Beaver Population Management

Issue/Background: Between 2004 and 2007, there were over 2,000 cases of West Nile virus in California; 71 of those cases resulted in fatalities. On August 2, 2007, the governor of California declared a disaster in three California counties because of deaths related to the virus. Fresno County had 111 cases with 4 fatalities between the years of 2004 and 2007. Fresno County has averaged one virus-related death and 28 virus cases per year since 2004.

West Nile virus is transmitted by mosquitoes. One breeding area for mosquitoes is beaver ponds. Beavers are native to Fresno County, and their dams create ponds in waterways. Beaver dams cause streams and waterways to overflow, which causes flooding of farm and private land. The resulting excess standing water provides another breeding source for mosquitoes. The Mosquito

Abatement District estimates that removing the beaver ponds from waterways near residential areas will reduce mosquito populations, thus potentially reducing the number of West Nile virus infections.

Other Alternatives: No action

Responsible Office: Fresno County Department of Agriculture Wildlife Damage Management

Priority (High, Medium, Low): High

Cost Estimate: $10,000-25,000

Potential Funding: California Department of Public Health, Fresno County general fund

Benefits (Avoided Losses):

- Reduction of incidence of infection and resulting fatalities: .5 human lives saved is $1.55 million
- Reduction in the number of cases, resulting in improved human health and reduced medical costs
- Reduction in discomfort and adverse effects of mosquito bites
- Reduction in treatments to suppress mosquito population by the Mosquito Abatement District and related jurisdictions
- Reduction of future costs associated with mosquito control
- Repeated removal of beaver dams

Schedule: Annually, February through June

Status: 2009 project, continuing implementation on an as needed basis

Fresno County Wildfire and Wind Mitigation Actions

15. Wildfire Defensible Fuel Modification Zones in Areas of Tree Mortality

Issue/Background: The foothill and mountain areas of Fresno County have been severely impacted by the drought and subsequent bark beetle outbreak since 2014. This has caused tree mortality across 216,000 acres and over 21 million trees have died. Not only have the trees died but the brush and shrubs throughout the County have died back creating an additional fuel load. All the communities in these areas are at an increased risk of a damaging wildland fire due to the mortality and fuel loading. Much of this mortality is on open land, both private and public, that will not get removed causing an increased ground fuel loading that will persist for decades to come. The Communities, businesses and local infrastructure will need increased Defensible Fuel Modification Zones (DFZ's) and hazard tree removal to reduce the damaging effects of a wildland fire. In addition this project would help mitigate wind-fall hazards on property and people.

Other Alternatives: In the past CAL FIRE, United State Forest Service and local fire safe councils have been creating DFZ's throughout the County in high fire prone areas. Due to the change in the fuels and health of the forest all communities in the affected areas are at high risk and need to implement integrated community DFZ's. These community DFZ's need to tie into existing DFZ's, roads, designated escape routes and homeowner defensible space to create a network that allows for increased community protection. Ingress and egress corridors need to be created by removing both dead trees and brush for the public to evacuate safely and allow emergency response personnel safe access. These DFZ's will need to be created using heavy equipment, masticators, hand crews and prescribed fire to remove dead trees, reduce understory brush and remove ground fuels. This network will need to be maintained over time and retreatment of the fuels will need to occur every 3 to 7 years for them to be effective. Community education related to fire safety, building construction, evacuation procedures and fuels management is a main part of this plan to be successful.

Responsible Office:

Priority (High, Medium, Low): High

Cost Estimate: $10,000,000

Potential Funding: CAL FIRE grants, CAL OES funds, FEMA grants, County funds, CAL FIRE Unit funds, USDA Forest Service funds, Private funds and other funds not currently identified

Benefits (Avoided Losses): By completing these types of projects, it is estimated to reduce the impacts of fire to over 4,816 residences, numerous businesses and critical infrastructure directly affected by the tree mortality.

Schedule: September 1, 2015 until completed through 2020

Status: New project in 2018

6 PLAN ADOPTION

Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, county commissioner, Tribal Council).

The purpose of formally adopting this plan is to secure buy-in from Fresno County and participating jurisdictions, raise awareness of the plan, and formalize the plan's implementation. The adoption of this plan completes Planning Step 9 of the 10-step planning process: Adopt the Plan, in accordance with the requirements of DMA 2000. This adoption also establishes compliance with AB 2140 requiring adoption by reference or incorporation into the safety element of the general plan. The governing board for each participating jurisdiction has adopted this multi-hazard mitigation plan by passing a resolution. A copy of the generic resolution and the executed copies are included in Appendix A: Adoption Resolutions.

7 Plan Implementation and Maintenance

Requirement §201.6(c)(4): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

Implementation and maintenance of the plan is critical to the overall success of hazard mitigation planning. This is Planning Step 10 of the 10-step planning process. This chapter provides an overview of the overall strategy for plan implementation and maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

7.1 Implementation

Once adopted, the plan faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the participating jurisdictions will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

Implementation will be accomplished by adhering to the schedules identified for each action (see Chapter 5 Mitigation Actions for the County and the actions detailed in the jurisdictional annexes) and through constant, pervasive, and energetic efforts to network and highlight the multi-objective, win-win benefits of each project to the Fresno County community and its stakeholders. These efforts include the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community. The three main components of implementation are:

- IMPLEMENT the action plan recommendations of this plan;
- UTILIZE existing rules, regulations, policies and procedures already in existence; and
- COMMUNICATE the hazard information collected and analyzed through this planning process so that the community better understands what can happen where, and what they can do themselves to be better prepared. Also, publicize the "success stories" that are achieved through the HMPC's ongoing efforts.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation will be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network and highlight the multi-objective, win-win benefits to each program and the Fresno County community and its stakeholders. This effort is achieved through the routine actions of monitoring agendas, attending meetings, and promoting a safe, sustainable community. Additional mitigation strategies could include consistent and ongoing enforcement of existing policies and vigilant review of programs for coordination and multi-objective opportunities.

One example of an important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other plans and mechanisms, such as the general plans for Fresno County and the participating jurisdictions. The County and participating jurisdictions already implement policies and programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms.

Simultaneously to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. This will include creating and maintaining a bank of ideas on how to meet local match or participation requirements. When funding does become available, the participating jurisdictions will be in a position to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, special district budgeted funds, state and federal earmarked funds, and other grant programs, including those that can serve or support multi-objective applications.

7.1.1 Role of Hazard Mitigation Planning Committee in Implementation and Maintenance

With adoption of this plan, the participating jurisdictions will be tasked with plan implementation and maintenance. The participating jurisdictions, led by the Fresno County Office of Emergency Services, agrees to:

- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high-priority, low/no-cost recommended actions;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Maintain a vigilant monitoring of multi-objective cost-share opportunities to help the community implement the plan’s recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Report on plan progress and recommended changes to the Fresno County Board of Supervisors and the governing boards of the other participating jurisdictions; and
- Inform and solicit input from the public.

The primary duty of the participating jurisdictions is to see the plan successfully carried out and to report to their community governing boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, considering stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the County website (and others as appropriate).

7.2 Maintenance/Monitoring

Plan maintenance implies an ongoing effort to monitor and evaluate plan implementation and to update the plan as progress, roadblocks, or changing circumstances are recognized.

7.2.1 Maintenance/Monitoring Schedule

The Fresno County Office of Emergency Services is responsible for initiating plan reviews and will consult with the heads of participating departments and other participating jurisdictions. In order to monitor progress and update the mitigation strategies identified in the action plan, the Fresno County Office of Emergency Services will revisit this plan annually and after a hazard event. The annual review will be conducted by re-convening the HMPC in November of each year.

This plan will be updated, approved and adopted within a five-year cycle as per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000 unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule. With the initial approval of this plan occurring in mid-2018, the plan will need to be updated, reviewed by Cal OES and FEMA Region IX, and re-adopted by all participating jurisdictions no later than June of 2023. The County will monitor planning grant opportunities from Cal OES and FEMA for funds to assist with the update. These grants should be pursued as early as 2021, as some grants have a three-year performance period to expend the funds, plus there is no guarantee that the grant will be awarded when initially submitted. This allows time to resubmit the grant in 2022 if needed.

7.2.2 Maintenance Evaluation Process

The planning team will continually observe the incorporation process, evaluation method, updating method, continued public participation, and completion of the action/projects to assure that the planning team and the plan itself are performing as anticipated. By monitoring these processes, the planning team will then be able to evaluate them at the time of the plan update, determining if any changes are needed.

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or

- Increased vulnerability as a result of new development (and/or annexation).

The HMPC will use the following process to evaluate progress and any changes in vulnerability as a result of plan implementation.

- A representative from the responsible entity identified in each mitigation measure will be responsible for tracking and reporting on an annual basis to the HMPC on project status and provide input on whether the project as implemented meets the defined objectives and is likely to be successful in reducing vulnerabilities.
- If the project does not meet identified objectives, the HMPC will determine what alternate projects may be implemented, and an assigned individual will be responsible for defining action scope, implementing the action, monitoring success of the action, and making any required modifications to the plan.
- New projects identified will require an individual assigned to be responsible for defining the project scope, implementing the project, and monitoring success of the project.
- Projects that were not ranked high priority but were identified as potential mitigation strategies will be reviewed as well during the monitoring and update of this plan to determine feasibility of future implementation.
- Changes will be made to the plan to accommodate for projects that have failed or are not considered feasible after a review for their consistency with established criteria, the time frame, priorities, and/or funding resources.

Updating of the plan will be by written changes and submissions, as the Fresno County Office of Emergency Services deems appropriate and necessary, and as approved by the Fresno County Board of Supervisors and the governing boards of the other participating jurisdictions. Updates to this plan will:

- Consider changes in vulnerability due to action implementation;
- Document success stories where mitigation efforts have proven effective;
- Document areas where mitigation actions were not effective;
- Document any new hazards that may arise or were previously overlooked;
- Document hazard events and impacts that occurred within the five-year period;
- Incorporate new data or studies on hazards and risks;
- Incorporate new capabilities or changes in capabilities;
- Incorporate documentation of continued public involvement;
- Incorporate documentation to update the planning process that may include new or additional stakeholder involvement;
- Incorporate growth and development-related changes to building inventories;
- Incorporate new project recommendations or changes in project prioritization;
- Include a public involvement process to receive public comment on the updated plan prior to submitting the updated plan to Cal OES/FEMA; and

- Include re-adoption by all participating entities following Cal OES/FEMA approval.

7.2.3 Incorporation into Existing Planning Mechanisms

Another important implementation mechanism that is highly effective and low-cost is incorporation of the hazard mitigation plan recommendations and their underlying principles into other County and City plans and mechanisms. Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. As previously stated in Section 7.1 of this plan, mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. This point is re-emphasized here. As described in this plan's capability assessment, the County and participating jurisdictions already implement policies and programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through these other program mechanisms. These existing mechanisms include (but not limited to) the following:

- County and city general and master plans
- County and city emergency operations plans
- County and city ordinances
- Flood/stormwater management/master plans
- Community Wildfire Protection plans
- Drought management and response plans
- Capital improvement plans and budgets
- Other plans and policies outlined in the capability assessments in the jurisdictional annexes
- Other plans, regulations, and practices with a mitigation focus

HMPC members involved in the updates to the planning mechanisms will be responsible for integrating the findings and recommendations of this plan with these other plans, programs, etc, as appropriate. As an action step to ensure integration with other planning mechanisms the County Office of Emergency Services Manager or designee will discuss this topic at the annual meeting of the HMPC previously described in the Maintenance Schedule. The HMPC will discuss if there are opportunities to incorporate the plan into other planning mechanisms and who would be responsible for leveraging those opportunities.

Examples of a process for incorporation of the LHMP into existing planning mechanisms include:

- As recommended by Assembly Bill (AB) 2140, each community should adopt (by reference or incorporation) this LHMP into the Safety Element of their General Plan(s). Evidence of such adoption (by formal, certified resolution) shall be provided to Cal OES and FEMA.

- Integration of wildfire actions identified in this mitigation strategy with the actions and implementation priorities established in existing Community Wildfire Protection Plans (CWPPs). This has already occurred and will continue to occur as the CWPPs are updated and implemented. Specifically, key people responsible for development of the Highway 168 Fire Safe Council CWPP and Oak to Timberline Fire Safe Council CWPP participated as a member of the HMPC in the original development and 2017-2018 update of this LHMP. They identified key projects in the CWPPs and integrated them into the Mitigation Strategy of this LHMP. Likewise, actual implementation of these wildfire projects will likely occur through the CWPP implementation process through the efforts of these same individuals.
- Using the risk assessment information to update the hazard analysis in the Fresno County Operational Area Master Emergency Services Plan.

Efforts should continuously be made to monitor the progress of mitigation actions implemented through these other planning mechanisms and, where appropriate, their priority actions should be incorporated into updates of this hazard mitigation plan.

7.2.4 Continued Public Involvement

Continued public involvement is also imperative to the overall success of the plan's implementation. The update process provides an opportunity to solicit participation from new and existing stakeholders and to publicize success stories from the plan implementation and seek additional public comment. The update process provides an opportunity to publicize success stories from the plan's implementation and seek additional public comment. A public hearing(s) or survey to receive public comment on the plan will be held during the update period. When the HMPC reconvenes for the update, they will coordinate with all stakeholders participating in the planning process, including those who joined the HMPC after the initial effort, to update and revise the plan. Public notice will be posted and public participation will be invited, at a minimum, through available website postings and press releases to the local media outlets as well as email and social media announcements. Continued public outreach and education is an aspect of the mitigation strategy Chapter 5 of this plan. Activities related to public involvement during the 2017-2018 update are documented in Chapter 3 and Appendix E.