CHAPTER 3: RISK ASSESSMENT

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OVERVIEW OF “RISK ASSESSMENT” (Chapter 3)

Chapter 3, “Risk Assessment” of Merced’s Local Hazard Mitigation Plan, profiles and describes Merced’s vulnerability to natural and manmade hazards most likely to impact the community.

3.1 PLANNING AREA AND COMMUNITY PROFILE

3.2 HAZARD IDENTIFICATION

3.3 HAZARD PROFILES

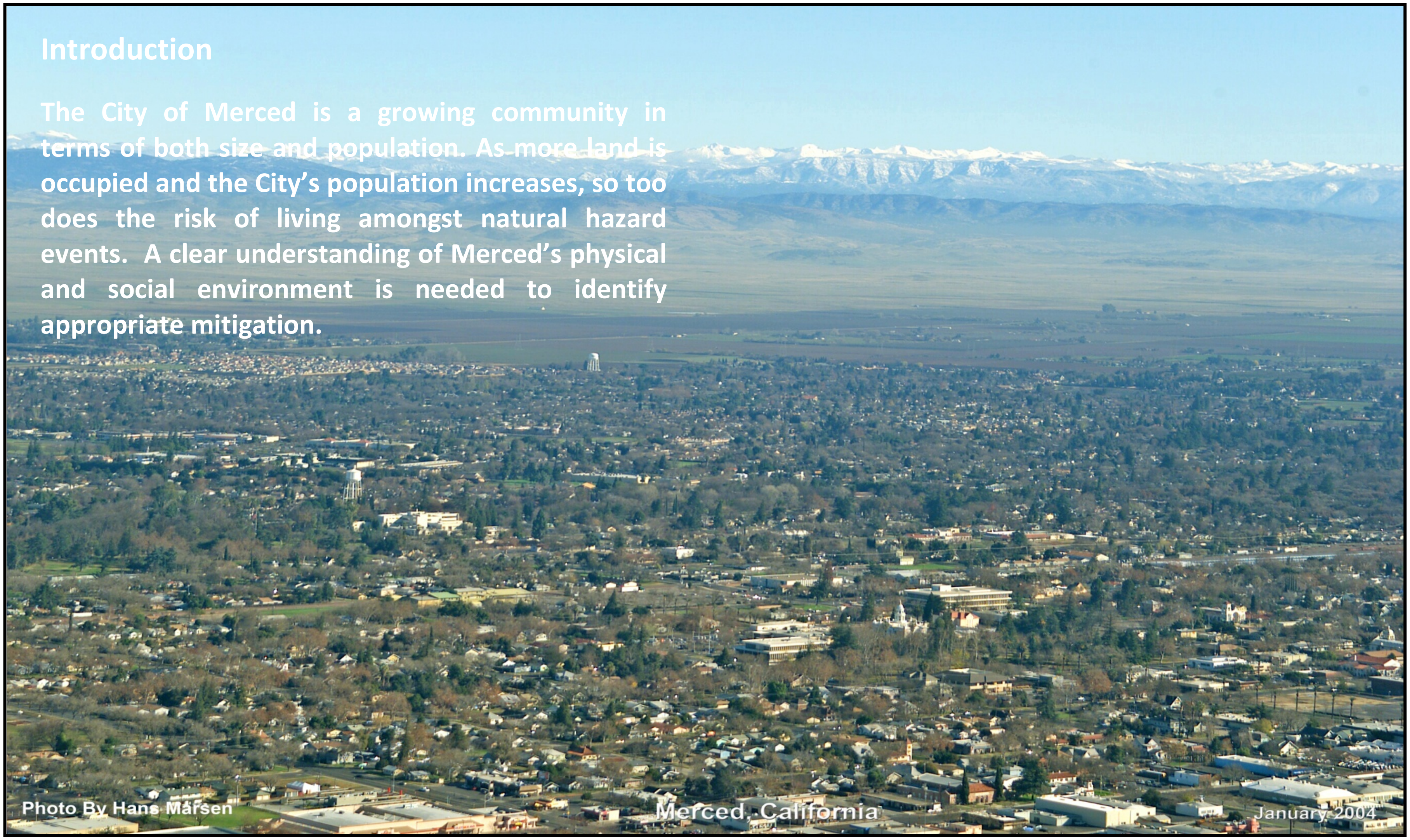
3.4 VULNERABILITY

At their public meetings of March 9, 2012, and December 7, 2012, the *Technical and Plan Preparation Team* provided the City of Merced *Disaster Council* and attending stakeholders and members of the public an overview of the draft “Risk Assessment” Chapter of the draft Merced Hazard Mitigation Plan (MHMP). Comments were received and the draft was amended to reflect the concerns of the Disaster Council and public.

3.1 Planning Area and Community Profile

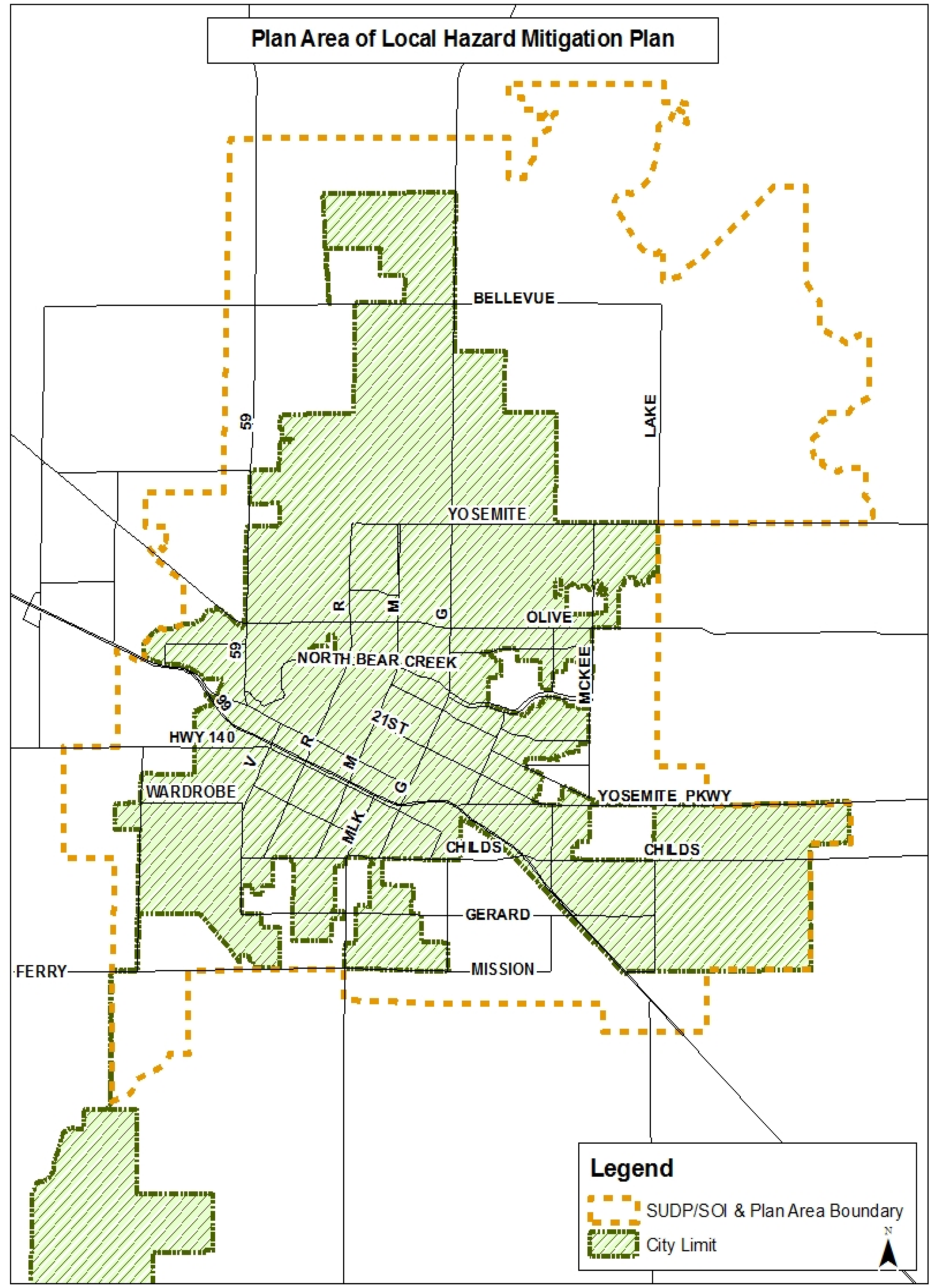
Introduction

The City of Merced is a growing community in terms of both size and population. As more land is occupied and the City's population increases, so too does the risk of living amongst natural hazard events. A clear understanding of Merced's physical and social environment is needed to identify appropriate mitigation.



3.1.1 Scope of Plan and Planning Area

The Merced Hazard Mitigation Plan (MHMP) includes the territory located within the City's planned growth area, which is delineated by the Specific Urban Development Plan / Sphere of Influence (SUDP/SOI) boundary as shown in the City's *Merced Vision 2030 General Plan*. The hazard assessments, goals and objectives, and mitigation measures of the Merced Hazard Mitigation Plan (MHMP) apply to City-owned facilities and properties. As the City grows, the application of the LHMP will expand to the larger geographic area located within the City Limits.



3.1.2 Community Profile

This section includes an overview of characteristics that have influenced the composition and form of Merced, including: 1) geography and climate; 2) areas of historic significance; 3) history and impact of natural hazards; 4) major economic, industrial, and agricultural activities; 5) demographics; and 6) land use patterns and trends. When necessary, greater detail of some of these topics can be found in the hazard profile and vulnerability sections. For example, more information about the community's weather patterns can be found in the hazard profiles for extreme temperatures, fog, tornadoes, and storm-related hazards.

Geography and Climate

GEOGRAPHY

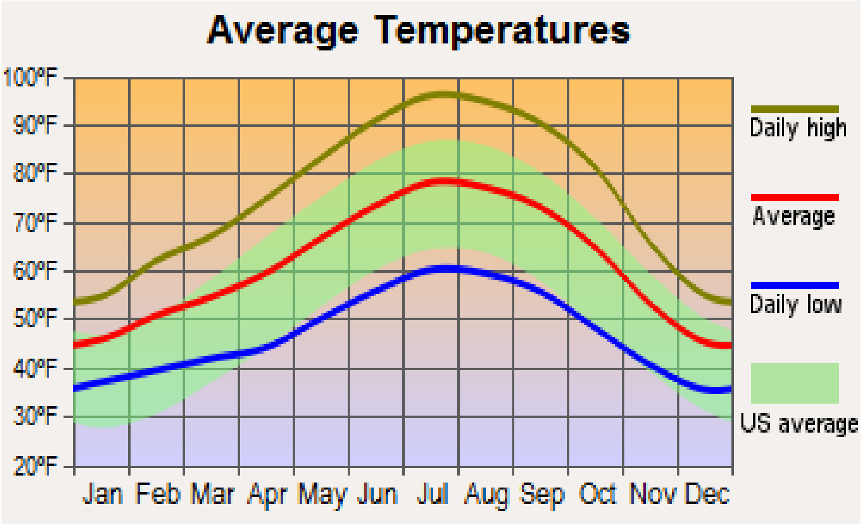
The City of Merced is located near the geographic center of the County of Merced, which is located in California's San Joaquin Valley along the western slope of the Sierra Nevada Mountain range. Merced is located approximately 100 miles southeast of Sacramento, and is one of a chain of cities located along State Highway 99. The northern portion of the City is characterized by gently rolling terrain, while the southerly portion is relatively flat. The northern, western, and eastern portions of the City contain a number of creeks, including Bear Creek, Black Rascal Creek, Fahrens Creek, and Cottonwood Creek which drain the local foothill country located northeast of the City.

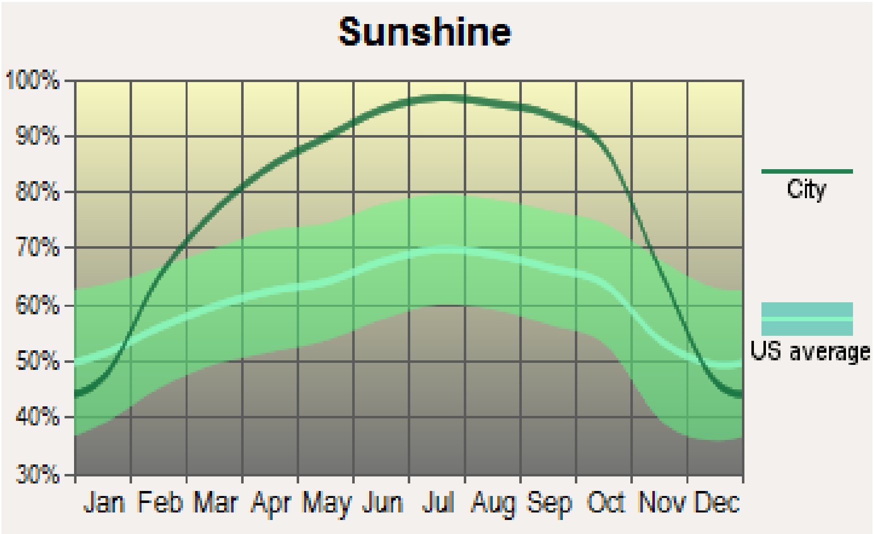
CLIMATE

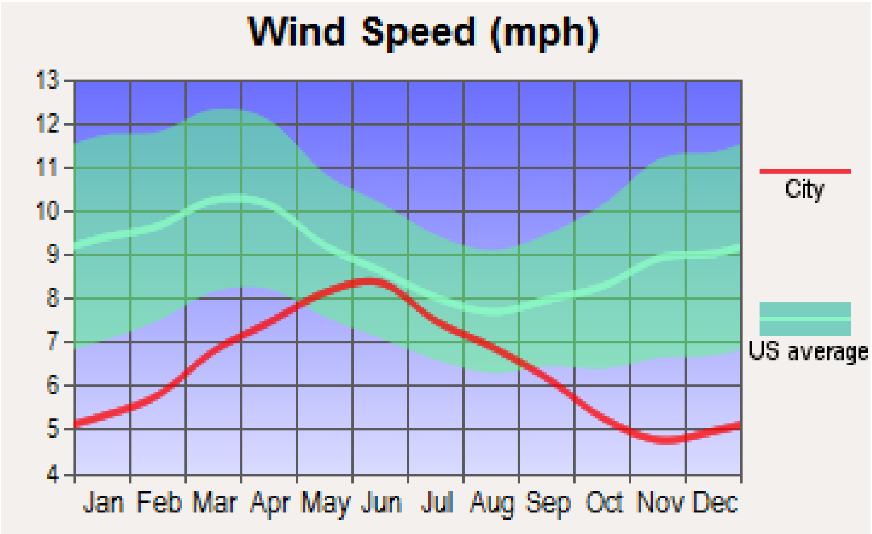
These geographic features strongly influence Merced's climate. The inland low-elevation valley and general southern latitude ensures hot and dry summers, while its relative proximity to the ocean and position west of the Sierra Nevada Mountain range boosts rainfall events during the winter. The diagrams of average temperatures, sunshine and precipitation were obtained from: *http://www.city-data.com/city/Merced-California.html* [4]

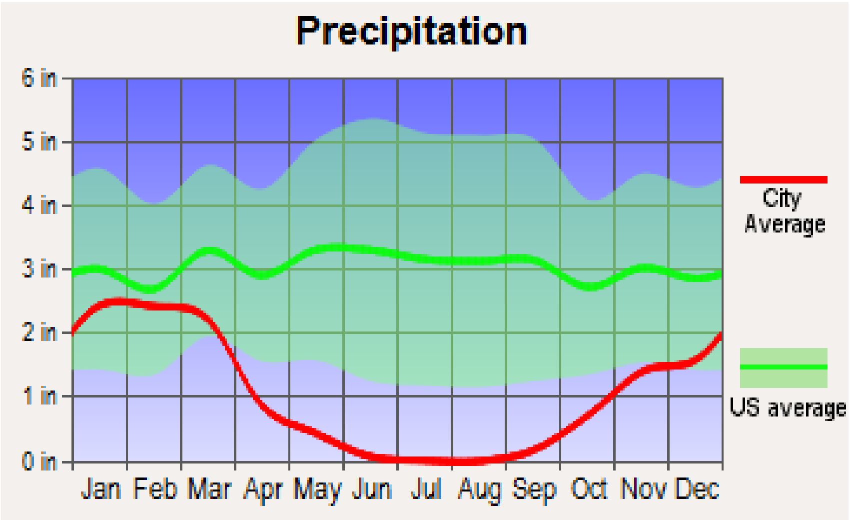
Precipitation in the San Joaquin Valley is strongly influenced by the position of the semi-permanent subtropical high pressure belt located off the Pacific coast (Pacific High). Between winter storms, high pressure and light winds allow cold moist air to pool on the valley floor. This creates strong low level temperature inversions and very stable air conditions. This situation leads to the Valley's famous "Tule Fog."

The topography of the San Joaquin Valley has a dominating effect on wind flow patterns. Winds tend to blow somewhat parallel to the valley and mountain range orientation. Seasonal weather patterns and the region's topography produce the high incidence of relatively strong northwesterly winds in the spring and early summer.




Sunshine
100%
90%
80%
70%
60%
50%
40%
30%
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
City
US average


Wind Speed (mph)
13
12
11
10
9
8
7
6
5
4
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
City
US average


Precipitation
6 in
5 in
4 in
3 in
2 in
1 in
0 in
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
City Average
US average

ENVIRONMENTALLY SIGNIFICANT SITES

Environmentally significant sites within the Plan area include riparian corridors along Fahrens Creek, Cottonwood Creek, Black Rascal Creek, Bear Creek, Miles Creek, Owens Creek, Canal Creek, and the Hartley Slough.

The City also contains land designated as Critical Habitat. Critical Habitat is a term defined and used in the Endangered Species Act (Act). It is a specific geographic area that is essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but that will be needed for its recovery. The SUDP/SOI currently contains critical habitat areas near Lake Yosemite and UC Merced Campus (in northeast Merced). The species that have critical habitat areas include:

- San Joaquin Valley Orcutt Grass
- Green Tuctoria
- Conservancy Fairy Shrimp
- Vernal Pool Fairy Shrimp
- California Tiger Salamander

NOTE: A critical habitat designation does not necessarily restrict further development. It is a reminder to federal agencies that they must make special efforts to protect the important characteristics of these areas.

Areas of Historic Significance

Early development in the San Joaquin Valley was driven by the development of the Central Pacific Railroad. Today, most of the major cities in the Valley are located along this historic rail line. Transportation corridors were a major influence in the growth and development of San Joaquin Valley communities and Merced is no exception.

In 1871, Charles H. Huffman was locating town sites along the new railroad line. Grid type street system were laid out by Huffman, and are oriented along the alignment of the railroad line. As a result, the older parts of Merced between Bear Creek and the Central Pacific Railroad line are along a southeast/northwest trending angle.

In the 1870's, the City served as an entry point to the gold mining industry of the region. Later, as Yosemite Valley became world renowned, Merced became an important gateway to Yosemite National Park.

The new courthouse, dedicated in 1875, was oriented towards the railroad line and connected to the railroad by Courthouse Avenue (now "N" Street) lined with palm trees. Early planners envisioned Courthouse Avenue and Huffman Avenue ("M" Street) as the main business section of the new city, but development occurred on the less expensive lots near the tracks along Main and Front (16th) Streets.

Merced's commercial and industrial districts were well established by 1875. Commercial establishments located on the north side of Front Street with hotels, stables, and small stores situated on Main Street behind the Front Street business district. The railroad depot, warehouses, and other industrial buildings were located along the tracks. Water was supplied to this area by a large elevated water tank near Main and "M" Streets.

Merced had three distinctive residential districts after only three years of existence. Most of Merced's residences were located on 18th and 19th Streets between J (now Martin Luther King Jr. Way) and M Streets and on the eastern end of Main Street. The first prestigious neighborhood in Merced was "Little Snelling," settled by former residents of the old county seat. Little Snelling was located south of the tracks across from the El Capitan Hotel, between "N" and "O" on 14th and 15th Streets and included elaborate homes.

Chinatown, a compact self-sustaining community, was located one block to the east of Little Snelling, but was built at a higher density and included a mix of homes and businesses and a Buddhist Temple (or Joss House). Early churches and school facilities were developed in the vicinity of the new courthouse. The new city grew rapidly in the ensuing years, reaching a population of 1,525 by 1880 and 2,009 by 1890.

By 1888, the City had a street light system, and Lake Yosemite was constructed and supplied the City with water by 1889. By 1896, electrical power was being supplied to domestic and commercial customers by the Merced Falls Gas and Electric Company. The community's educational system was enhanced by the construction of Merced's first public high school in Courthouse Park in 1897.

Santa Fe Railroad Station (1892)

In the late 1890's, transportation again had a major impact on the urban design of Merced. The San Francisco and San Joaquin Valley Railroad was granted a right-of-way through Merced. The railroad was given the use of 24th Street in the hope that the competition would force the Southern Pacific to lower its exorbitant freight rates. A station was built along the newly laid tracks near "K" Street in 1896. The elevated road bed may have retarded growth in northern Merced by greatly reducing access to this area, which remained rural in character until the 1920's. The railroad later became part of the Atchison, Topeka, and Santa Fe in 1900.

Another significant transportation feature changed the growth characteristics of the City with the construction of the Yosemite Valley Railroad (1905-1907). The station was located off the end of Main Street in the present day Westgate Shopping Center while the roundhouse and support facilities were situated where Fremont School stands today. The tracks, laid down the middle of "R" Street, may have impeded growth in the west end of Merced, which did not develop until after the removal of the tracks in 1946.

Another major change that would alter Merced's growth pattern also took place in the 1960's. In 1960, the elevated Highway 99 was constructed along 13th Street, effectively dividing South Merced from the downtown and creating three distinct sub-areas of Merced--1) North Merced, north of Bear Creek; 2) Central Merced, between Bear Creek and Highway 99; and 3) South Merced, south of Highway 99.

Major Economic, Industrial and Agricultural Activities

Employment and Industry

Merced has experienced large growth over the last several years and has seen an increase in industry and retail businesses. Between 2000 and 2007, the City added over 550,000 square feet of retail space, over 280,000 square feet of office space, nearly 374,000 square feet of industrial buildings, approximately 55,000 square feet of building space in a business park, and 259 hotel/motel rooms. In 2005, the University of California opened its 10th campus, UC Merced, just beyond the current city limits. In 2009 the City welcomed the opening of the new Mercy Hospital in North Merced.

Unfortunately, the current economy has left its mark on Merced. As with most of California and the nation, the current economic climate has taken a toll on businesses in Merced. Over the last year, several businesses and industrial users have closed their doors, which are reflected in the high unemployment rates in Merced County (17.4%, August 2010). As the economy improves, Merced hopes to see a renewal in the number of businesses coming to Merced.

Unlike many communities of Merced's size, Merced has several fully-serviced industrial parks "ready-to-go" to offer industries an opportunity for quick development.

Merced has many strengths and opportunities to offer businesses. Merced has excellent access to higher education resources, not only through the UC, but also through the Merced Community College. In addition, Merced is within driving distance to CSU Stanislaus and CSU Fresno.

Merced is also close to major markets. Being centrally located in the state, Merced has easy access to both the Bay Area and Southern California. In addition, Merced is located on major transportation routes. Highway 99 and Highway 140 run through Merced and I-5 is close by. Rail access is also available to both Union Pacific and Burlington North Santa Fe Railroads with both railroads having main lines running through Merced.

Although there are currently a large number of unemployed residents in Merced, in the event of an emergency, businesses and industries should have a plan in place to ensure the safety and welfare of workers and limit damage to industrial infrastructure. The majority of workers rely on local roads and Highway 99 for commuting to and from work. This creates a need for mitigation plans to ensure access to these roads or alternate routes for commuting and a plan for emergency communication. Before a natural hazard event, large and small businesses should develop strategies to prepare for natural hazards, respond efficiently, and prevent loss of life and property.

Demographics

It is important for hazard-related plans to consider the demographics of the communities they seek to protect. Some populations experience greater risk from hazard events not because of their geographic proximity to the hazard, but because of decreased resources and/or physical capabilities. Elderly people, for example, may be more likely to be injured in a disaster and are also more likely to require additional assistance after a disaster. Research has shown that people living near or below the poverty line, the elderly and especially older single men, the disabled, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than the general population.

Vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, their capabilities during a hazard, and access to resources for post-disaster recovery. Despite the fact that they often disproportionately experience the effects of a disaster, vulnerable populations are rarely accounted for in the current hazard planning process.

POPULATION

The City of Merced is home to approximately 80,985 residents according to the California Department of Finance 2010 estimates. Merced is comprised of 23.17 square miles of land. From 1980 to 2000, the City population increased from 36,499 to 63,893, a 75 percent increase over 20 years. However, in 2012, Merced experienced a decrease in population to 79,328. Projections from the City's *Draft Merced Vision 2030 General Plan* indicate that by the year 2015, the population will have grown to 99,463 and by 2030 it will have grown to 154,951. The table below shows the population projections for the City from 1980 to 2030. Based on these projections, the city's population is expected to increase by 91 percent over the next 20 years.

City of Merced Population Projections (2000 to 2030)

Year	*Population*
1980	36,499
1990	56,216
2000	63,893
2005	74,010
2010	80,985
2015	99,463
2020	115,305
2030	154,961

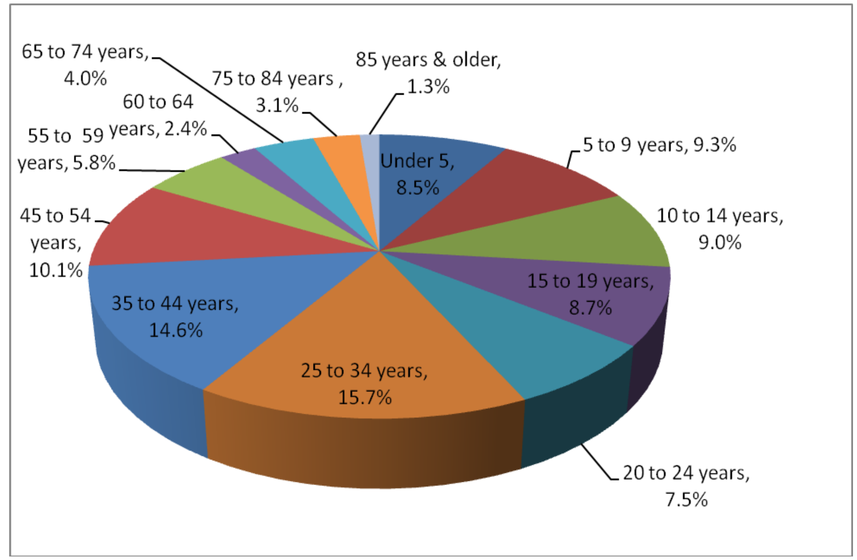
Average Household Size for Merced in 2000 was 3.06 persons. The 2008 American Community Survey estimates indicate that number has grown to an average of 3.13 persons per household. As the number of students increase at UC Merced, this number is expected to continue to increase.

Age Characteristics

According to the 2008 American Community Survey, the City's population in 2008 was estimated to be 79,266. That population was made up primarily of residents 20 to 44 years old. This age group made up 40.4 percent of the City's population.

The vulnerability of the elderly population can vary significantly based on health, age, and economic security. As a group, the elderly are more apt to lack the physical and economic resources necessary for response and are more likely to suffer health-related consequences and be slower to recover.

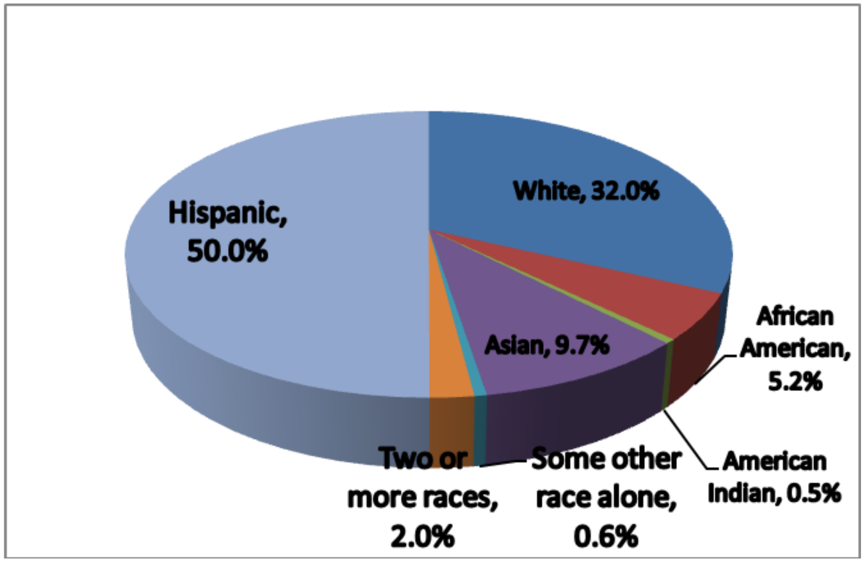
The elderly are also more likely to live in group quarters such as assisted-living facilities, where emergency preparedness occurs at the discretion of the entity operating the facility. While some may be very well prepared, others may not be. This could put a large number of elderly residents at a higher risk if the facility where they reside doesn't take the necessary steps to be prepared for a disaster.



Race and Ethnicity

Merced has a wide, very diverse community. Hispanics make up the majority of the residents in Merced accounting for 50% of the total population (39,660) according to the 2008 American Community Survey estimates and a total estimated population in 2008 of 79,260. The white population comprised 32%, or 25,365 total residents. The Asian population totaled 7,698, or 9.7%, and the African-American population was 4,145, or 5.2% of the total population.

Because of the diversity of residents, not all residents speak English. This has important implications for emergency managers, who must get crucial information out to all members of the population in emergency events.



Disabled Persons

People with disabilities have a special stake in emergency planning because they are more likely to have difficulty responding to a hazard event than the general population. According to the 2000 U.S. Census roughly 1/5 of the U.S. population lives with a disability. These numbers are rising, and disabled populations are increasingly integrated into society. This means that a large segment of the population will require assistance during the 72 hours post-event, the period generally reserved for self-help.

Disabilities can vary greatly in severity and permanence, making populations difficult to define and track. There is no "typical" disabled person, which can complicate disaster-planning processes that attempt to incorporate them. Furthermore, disability is likely to be compounded with other vulnerabilities, such as age, economic disadvantage, and ethnicity, all of which mean that housing is more likely to be substandard.

While the percentage of disabled persons in Merced is relatively small, the overall numbers are significant and warrant special attention from planner and emergency managers.

Disability Status for the Non-Institutionalized Population

Age	Number	Percent
5-17 years	165	0.3%
18-34 years	479	0.7%
35-64 years	1067	1.6%
65+ years	2000	3.0%

INCOME

Median income is the amount that divides the income distribution into two equal groups: one group having incomes above the median, and the other having incomes below. Median family income is different from median household income. Median family income indicates income for those households with two or more related individuals, i.e. families, while median household income indicates the income of all households, including persons living alone or with unrelated individuals. Median family income is, generally speaking, higher than median household income.

The 2008 American Community Survey Estimates reports a total of 24,674 households in Merced and 17,074 families. The median *household* income was estimated to be $36,064 and the median *family* income was $38,246. The number of households with an income less than $10,000 is 3,792, or 15.4% of all households. The number of families with an income less than $10,000 is 1,997, or 11.7% of the total families. The number of households with an income between $10,000 to $19,999 was 3,564 (14.4%) and the number of families with an income in this range was 2,446 (14.3%). Over 60% of all households in Merced earn less than $50,000, 55% of all families earn less than $50,000. Only 24% of all households earn between $50,000 and $99,999 and 17.9% of families fall into this income category. In the higher income category of $100,000 to $200,000 and over, 15% of all households are in this range and 19.1% of families are within this range.

Impoverished people may experience greater harm from disasters than members of the general population. 27.5 percent of all households in Merced are considered to be below poverty level (*source: ACS 2008 estimates).*

In the United States, individual households are expected to use private resources to prepare for, respond to, and recover from disasters to some extent. This expectation means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in hurricanes, tornadoes, and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of unreinforced masonry, which is particularly susceptible to damage during earthquakes. In general, the poor are more likely to die as a result of a disaster because they tend to live in older or poorly constructed homes in more hazardous areas, such as floodplains, and they are less likely to fully recover after one.

Land Use Patterns and Trends

LAND AND DEVELOPMENT

The City is approximately seven miles long from north to south and six miles at its widest point from east to west. In 2012, the City of Merced has an area of 23.17 square miles.

Much of Merced's recent population growth can and will be attributed to the opening of University of California's 10th Campus, UC Merced. The campus opened its doors in 2005. Since that time, the campus population has grown to more than 2,700 students. The campus is expected to continue to grow at a steady pace, with the addition of approximately 680 students in 2010 and by 2014 the campus will have grown to more than 6,600 full-time enrolled students. The UC's Long Range Development Plan (LRDP) defines a campus that can accommodate a total of 25,000 students: 22,500 undergraduates and 2,500 graduate students, with a faculty and staff of 6,560.

Land Use

The City of Merced is situated within an area containing important soils capable of producing a wide range of agricultural products. Throughout the region, growth patterns of cities have resulted in these soils being converted to urban uses.

The Land Use Element of the General Plan establishes the proposed general distribution and extent of land uses within the City of Merced and its SUDP/SOI. There are a number of underlying principles that form the foundation for the goals and policies of the City's Land Use Plan. The Land Use Element includes a description of the different land use designations within the City's SUDP/SOI. These descriptions also include standards of population density and building intensity. All land uses are depicted on the City's General Plan map.

Housing Units

Over the last 5 years, Merced has experienced significant growth in the number of housing units in the City. With the much-anticipated opening of the 10th University of California Campus in the Merced area, growth began to increase at the beginning of 2000. From 2000 to 2006, 5,389 permits were issued for new single-family dwellings (this is an average of 900 permits per year). An additional 823 new multi-family units were also built during that time frame. In 2007, the surge for housing slowed and the issuance of building permits for residential construction fell dramatically. The number of building permits for single-family dwellings dropped to 164 units. The number of multi-family units constructed fell to only 6 units. For 2008 and 2009, only 34 single-family dwelling permits were issued and 1 permit for a duplex. The drop in the average of 900 permits per year issued from 2000 to 2006 to the total number issued in 2007 represents an 81% decline in building permit activity for single-family dwellings. This drastic decline has continued into 2010 and is not expected to make any dramatic changes in the near future.

On a positive note, In November, 2011, building permits were issued for a 75-unit apartment complex (Woodbridge) in North Merced and in October, 2012 building permits were issued for a 66-unit apartment complex (Gateway Terrace) in South Merced. Both of the permits were made possible with funding assistance from tax credits, HOME, Neighborhood Stabilization and Redevelopment Agency low and moderate income set aside funds.

According to the 2006-2008 American Community Survey, the total number of housing units within the City of Merced is 23,600. Of this number 14,055 are renter-occupied and 9,545 are owner-occupied.

TRANSPORTATION AND COMMUTING PATTERNS

Being centrally located in the state, Merced has easy access to both the Bay Area and Southern California. In addition, Merced is located on major transportation routes. Highway 99 and Highway 140 run through Merced and I-5 is close by. Rail access is also available to both Union Pacific and Burlington North Santa Fe Railroads with both railroads having main lines running through Merced.

In August 2008, the California Transportation Commission awarded the City of Merced a $9,000,000 Grant to construct the G Street Railroad Undercrossing of the Burlington Northern & Santa Fe (BNSF) tracks (Project No. 106076). This was part of the Prop 1B $250 million Highway-Railroad Crossing Safety Account (HRCSA) Program. The total project cost was estimated at $18 million. The conversion of the City's G Street at-grade railroad crossing to an undercrossing had been a long-term goal of the City of Merced for many years.

Prior to completion of the undercrossing, thousands of Merced commuters, emergency responders and school bus drivers experienced delays at railroad tracks bisecting the community at G Street and Santa Fe Avenue. The BNSF Railroad alone has more than 70 trains running through town every day, previously causing significant delays to traffic, and as much as two (2) hours of response time lost to rail traffic delays each day for emergency service providers such as police and fire personnel.

G Street was formally re-opened with a Community Celebration and Dedication on December 3, 2011. The underpass was the largest road project in the City's history. In addition to the reconstruction of the railroad crossing with the installation of 45 pilings to hold the bridge, there was construction of a massive storm water drainage system, rerouting water and sewer lines, along with moving natural gas lines and power poles.

Private automobiles are the dominant means of transportation, but Merced also contains a significant bike path and trail system and provides public transportation through the Merced County Transit ("The Bus") system. "The Bus" operates on 16 fixed routes and also provides demand responsive service. Weekday and Saturday service is provided.

Merced does not have significant numbers of commuters either traveling to the City for work or leaving the City to work elsewhere.
The City has an extensive network of arterial, collector, and local streets throughout the City. This roadway network connects Merced residents to local and regional destinations.

EMERGENCY SERVICES

An overview of the City's Emergency Services is provided in Chapter 4, Section 4.1..

3.2 Hazard Identification

Introduction

Before detailed risk assessments can be prepared, hazards likely to affect Merced need to be identified and ranked. This process involves review of hazard-related data, such as listings of State and Federal disaster declarations. Community-based knowledge from local individuals and groups can also help to identify those hazards that most affect Merced.

3.2.1 Overview

The City of Merced is exposed to a number of man-made and natural hazards that vary in potential intensity and impact on the City. The Merced Hazard Mitigation Plan (MHMP) addresses 10 prevalent hazards. This Chapter describes how the Plan Leadership Team (PLT) and Disaster Council (DC) identified and ranked these hazards. In general, hazards were included in the plan based on the likelihood of occurrence and the potential impact on the City.

Through an evaluation and screening process, the PLT and DC identified several hazards having the potential to affect the City. These hazards include natural and human-caused occurrences that might affect people and property. The screening process involved two steps:

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- Step 1, identifying ***likely hazards*** that may occur in the study area; and
- Step 2, identifying ***prevalent*** hazards by ranking

Screening Methodology

LIKELY HAZARDS

The PLT began with a broad list of natural and man-made occurring hazards that take place in the State of California and that might possibly affect the City of Merced (Table 3-1); these are presented in the first column of the table. Then at their February 10, 2012, meeting, the Disaster Council performed an assessment of which hazards may occur in the study area; these are denoted by a check-mark in the second column of the table.

RISK RANKING - PREVALENT HAZARDS

Additional assessments with the Disaster Council were conducted to identify those hazards which are more prevalent, and could pose significant threats to the community; these are denoted by a "threat level" in the third column of Table 3-1. More information about these "threat levels" is discussed later in this Chapter, and was the topic of the Merced Disaster Council meeting of March 9, 2012.

Items involving sensitive and security matters, such as the location of natural gas transmission lines, are not included in the MHMP; such information is available through other sources. Topics such as terrorism, civil unrest, and crime, which are beyond the scope and purpose of the MHMP, are not included either.

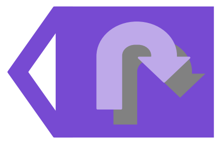
Table 3-1 - Hazard Identification and Screening for the City of Merced / Natural Hazards			
Hazards	**May Occur**	**Threat Level**	**Why or Why not**
Avalanche		----	The City is not located in a mountain area.
Coastal Erosion		----	The City is not located within a coastal area.
Coastal Storm		----	The City is not located within a coastal area.
Debris Flow		----	The topography of Merced is low and not subject to debris flows.
Drought	✓	8	The Central Valley is semiarid, and Merced's sole source of water is groundwater.
Earthquake	✓	12	Echo or secondary waves reach Merced from the coastal range and the Sierra Nevada foothills.
Expansive Soil	✓	----	Some expansive soils exist in Merced, but foundation design and moisture control addresses this concern.
Extreme Heat	✓	24	Most summers bring hot, dry weather, and heat spells historically can be extreme.
Flood	✓	27	Past events have been experienced by the City of Merced
Fog	✓	24	Merced experiences "Tule" and patchy fog yearly, with some periods of zero visibility.
Extreme Cold	✓	----	Merced generally has mild winters, with a few days of freezing temperatures.
Hailstorm	✓	----	Hailstorms in Merced are usually associated with severe storm events.
Hurricane		----	Hurricanes do not occur at Merced's latitude
Land Subsidence		----	No past evidence of this hazard has been recorded.
Landslide		----	Merced does not have any elevated areas that would be susceptible to landslides.
Severe Storm	✓	18	Severe storms may occur in Merced.
Tornado	✓	12	Tornadoes of very low intensity occur.
Tsunami		----	Merced is not located within a coastal area.
Volcano		----	Merced is not located in an active volcanic region.
Wildfire	✓	24	Flatland grassfires are a concern at the urban-agricultural interface.
Windstorm	✓	----	Windstorms in Merced are usually associated with severe storm events.
Aviation	✓	----	The Merced Regional Airport and Atwater's Castle Airport affect the Plan Area.
Agricultural		----	The amount of agricultural resources within the Planning Area is limited
Dam Failure	✓	16	The inundation area from two earthern-type reservoirs occur in Merced
Pipelines	✓	----	Pipelines in Merced are usually associated with hazardous material events.
Hazardous-Mat	✓	36	Trains and commercial freight vehicles travel on Plan Area railways and roadways.
Highway	✓	----	Although the Plan Area includes several state highways, these hazards are not the focus of this Plan.
Power Supply	✓	----	Electrical supply is taxed during times of extreme heat.
Urban Fire	✓	24	The City of Merced is subject to this hazard.

3.2.2 Likely Hazards

General Background

The Plan Leadership Team (PLT) performed an assessment of which hazards may occur in the study area. In addition to the information about state and federal disaster declarations, this initial assessment was based on research of information gathered from newspapers, historical records, existing plans and reports, and local experts.

<u>Existing Plans and Reports Examined</u>:



- Emergency Operations Plan
- City's Merced Vision 2030 General Plan
- State of California's Multi-Hazard Mitigation Plan
- 2009 Analysis of Community Risk within the City of Merced

<u>Local Experts</u>

- Merced City Engineer
- Merced Fire Chief
- Merced Police Chief
- Merced County Historical Society

<u>Other Sources of Hazards Data:</u>

- California Governor's Office of Emergency Services (CA-OES)
- State of California Hazard Mitigation Plan
- The Federal Emergency Management Agency
- The National Oceanic and Atmospheric Administration

City Staff also confirmed the relevance of floods, earthquakes, and tornadoes by researching the suggested websites provided in the State and Local Mitigation Planning "How-to Guide: Understanding Your Risks," provided by CAL EMA. The DC provided local expertise and historical knowledge to this effort. The draft selection prepared by the PLT was confirmed and adjusted by the DC at its January 13, 2012, meeting.

MERCED COUNTY DISASTER DECLARATION HISTORY

One method the PLT used to learn of hazards was the researching of past events that triggered federal and/or state emergency or disaster declarations in the study 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. 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 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.

Details on federal and state disaster declarations were obtained by the FEMA and CA-OES and compiled in chronological order in Table 3-2. A review of state and federal declared disasters indicates that Merced County received 10 state declarations between 1950 and July 2007, 10 of which also received federal disaster declarations. Of these state declarations, 8 were associated with severe winter storms, heavy rains, or flooding, and 2 were for freezes. This disaster history (combined FEMA and state) suggests that Merced County experiences a major event worthy of a disaster declaration every 5.7 years.

Table 3-2. Merced County Disaster History: State Proclamations, Federal Declarations, and Selected Events (1950 to May 2007)					
Hazard Type	**Disaster Cause**	**State Disaster #**	**Year**	**Federal Declaration**	**Damage* (in millions)**
Flood	Storms	DR-1646	2006	Declared	28.9
	Freeze	GP 98-02, DR-1267	1998	Declared	17.5
Flood	Storms	DR-1203	1998	Declared	385.1
Flood	Storms	DR-1155	1997	Declared	194.3
Flood	Storms	DR-1046	1995	Declared	132
Freeze	Freeze	DR-894	1990	Declared	856.3
Flood	Flood	DR-677	1982	Declared	523.6
Drought	Drought	Not Listed	1976	Not Declared	2,664
Freeze	Freeze	Not Listed	1972	Not Declared	111.5
Flood	Storms	DR-253	1969	Declared	300
Flood	Storms	Not Listed	1958	Declared	24
Flood	Flood	DR-47	1955	Declared	200
Flood	Flood	OCD 50-01	1950	Not Declared	32.2
* Note: damage amount and deaths and injuries reflect totals for all impacted counties.					

Source: 2007 State of California Multi-Hazard Mitigation Plan, Appendix.

NATIONAL CLIMATIC DATA CENTER STORM EVENTS DATABASE

The National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to current (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 (1950-1992). This database contains 84 severe weather events that occurred in the County of Merced between January 1, 1950, and November 30, 2010.

Table 3-3. Hazard Event Reports for the County of Merced, 1950-2010*					
Type	**#**	**Property Loss ($)**	**Crop Loss ($)**	**Deaths**	**Injuries**
Dense Fog	2	50,000	0	0	12
Funnel Clouds	20	0	0	0	0
Gusty Wind	1	0	0	0	0
Hail	4	0	220,000	0	0
Heavy Rain	20	2,033,000	15,660,000	0	0
Lightning	8	0	0	0	1
Severe Thunderstorm/Wind	2	50,000	3,000,000	0	0
Small Hail	3	30,000	913,000	0	0
Thunderstorm/Wind	6	380,000	100,000	0	0
Tornado: F0	13	115,000	50,000	0	0
Tornado: F1	4	695,000	0	0	1
Wind	1	0	0	0	0

*Note: Losses reflect totals for all impacted areas

Source: National Climatic Data Center Storm Events Database [11]

The NCDC table above summarizes severe weather events that occurred in the County of Merced. Only a few of the events actually resulted in state and federal disaster declarations.

2009 CITY OF MERCED ANALYSIS OF COMMUNITY RISK

A Community Risk Assessment for the City of Merced was prepared by Fire Chief Mike McLaughlin, in 2009. The 2009 Community Assessment analyzed various types of risks. Natural and technological hazards identified in that assessment are discussed below and summarized in Table 3-4.

Table 3-4
Threat Levels of the 2009 City of Merced Community Risk Assessment for Natural and Technological Events

Threat Level	Natural	Technological
SEVERE RISK	Flood	Highway
HIGH RISK	Pandemic/Epidemic	Dam
		Pipelines
		Railway
MODERATE	Earthquake	Fire
	Heat/Cold	Utilities
	Thunderstorm	
	Wildland Fire	
LOW	Tornado	Airport/Aircraft
	Tropical Storm	

SAFETY ELEMENT / MERCED VISION 2030 GENERAL PLAN

According to the Safety Element of the Merced Vision 2030 General Plan, seismically induced ground shaking, ground failure, dam failure, flooding, urban and wildland fires, airport safety, crime and policing, and hazardous materials are considered the relevant hazards to the City of Merced.

3.2.3 Risk Ranking

General Background

In this step, additional assessments were conducted to identify those hazards which are more prevalent, and could pose significant threats to the community. The results of this step guided further risk assessment analysis in later chapters of the MHMP. At its March 9, 2012 meeting, the Disaster Council utilized a ranking process to identify priority hazards of the study area. Risk Assessments were completed for these priority hazards, which were the basis for the selected mitigation initiatives of the MHMP.

RISK FACTOR SCORING

To determine whether or not a hazard was prevalent and could pose significant threats to the community, all hazards that could occur in the study area were ranked according to three broad "risk factors," namely:

Probability and Frequency - Prediction of how often a hazard will occur in the future.

Consequence and Severity - Describes extent of physical damage to structures and lifelines (power, water, sanitation, roads, etc.)

Vulnerability - Describes three inter-related factors: 1) area impacted by a hazard event; 2) the events capability of triggering additional hazards; and 3) onset, the period of time between initial recognition of an approaching hazard and when the hazard begins to impact the community.

"Descriptors," applicable to each risk factor, are used to determine "threat scores;" the higher the score, the higher the threat will be.

Probability and Frequency:

Score	Descriptors
0	Infeasible event – not applicable due to geographic location characteristics.
1	Rare Event – occurs less than once every 50 years
2	Infrequent Event – occurs between once every 8 years and once every 50 years (inclusive)
3	Regular Event – Occurs between once a year and once every 7 years
4	Frequent Event – occurs more than once a year.

Consequence and Severity:

Score	Descriptors
1	No damage
2	Minor/slight damage to buildings and structures, no loss of lifelines
3	Moderate building damage, minor loss of lifelines
4	Moderate building damage, moderate loss of lifelines
5	Extensive building damage, widespread loss of lifelines

Vulnerability:

Score	Descriptors
1	No physical damage, no secondary impacts
2	Localized damage area
3	Localized damage area, minor secondary impacts, delayed hazard onset
4	Moderate damage area, moderate secondary impacts, moderate warning time
5	Widespread damage area; significant secondary impacts, no warning time

RISK RANKING MATRIX

To determine each hazard's "Threat Level", the *Risk Factor Scores* were entered into the applicable "Risk Ranking Matrix" (see below).

Probability/Frequency Value: (1)						
		Consequence/Severity Scores				
		1	**2**	**3**	**4**	**5**
Vulnerability Scores	**1**	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

Probability/Frequency Value: (2)						
		Consequence/Severity Scores				
		1	**2**	**3**	**4**	**5**
Vulnerability Scores	**1**	2	4	6	8	10
	2	4	8	12	16	20
	3	6	12	18	24	30
	4	8	16	24	32	40
	5	10	20	30	40	50

Probability/Frequency Value: (3)						
		Consequence/Severity Scores				
		1	**2**	**3**	**4**	**5**
Vulnerability Scores	**1**	3	6	9	12	15
	2	6	12	18	24	30
	3	9	18	27	36	45
	4	12	24	36	48	60
	5	15	30	45	60	75

Probability/Frequency Value: (4)						
		Consequence/Severity Scores				
		1	**2**	**3**	**4**	**5**
Vulnerability Scores	**1**	4	8	12	16	20
	2	8	16	24	32	40
	3	12	24	36	48	60
	4	16	32	48	64	80
	5	20	40	60	80	100

HAZARD SCORES

At their March 9, 2012 meeting, the Disaster Council and attending stakeholders assigned risk factor scores for each identified likely hazard. This occurred after the Disaster Council had an opportunity to review the draft hazard profiles and held a group discussion on the topic.

Some adjustments were made to the qualitative "probability" scoring based on the City's *ACS Firehouse Software* that includes a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23). The following adjustments to the "probability" scores were made:

Fire	increased to 4 from 3
Hazardous Materials:	increased to 4 from 2
Storm-Related:	decreased from 3 to 2

Based on information gathered in the Risk Hazard Assessment, the following adjustments were made:

Drought	decreased from 3 to 2

The "Consequence/Severity" and 'Vulnerability' scores for Dam failure were increased from 3 to 4 to reflect anticipated impacts.

The average scores, after adjustments, are presented below:

Flooding	
Risk Factors	***Scores***
- Probability /Frequency	3
- Consequence / Severity	3
- Vulnerability	3
Threat Level	**27**

Fire	
Risk Factors	***Scores***
- Probability /Frequency	4
- Consequence / Severity	3
- Vulnerability	2
Threat Level	**24**

Drought	
Risk Factors	***Scores***
- Probability /Frequency	2
- Consequence / Severity	2
- Vulnerability	2
Threat Level	**8**

Hazardous Materials	
Risk Factors	***Scores***
- Probability /Frequency	4
- Consequence / Severity	3
- Vulnerability	3
Threat Level	**36**

Earthquakes	
Risk Factors	***Scores***
- Probability /Frequency	2
- Consequence / Severity	2
- Vulnerability	3
Threat Level	**12**

Dam Failure	
Risk Factors	***Scores***
- Probability /Frequency	1
- Consequence / Severity	4
- Vulnerability	4
Threat Level	**16**

Extreme Temperatures	
Risk Factors	***Scores***
- Probability /Frequency	4
- Consequence / Severity	2
- Vulnerability	3
Threat Level	**24**

Tornadoes	
Risk Factors	***Scores***
- Probability /Frequency	2
- Consequence / Severity	2
- Vulnerability	3
Threat Level	**12**

Fog	
Risk Factors	***Scores***
- Probability /Frequency	4
- Consequence / Severity	2
- Vulnerability	3
Threat Level	**24**

Storm-Related Hazards	
Risk Factors	***Scores***
- Probability /Frequency	2
- Consequence / Severity	3
- Vulnerability	3
Threat Level	**18**

PRIORITY HAZARDS

The Disaster Council decided that hazards with Threat Levels 18 and above would be identified as "Priority Hazards." Priority Hazards have a broader, more detailed hazard profile & vulnerability assessment. Thus, the hazards evaluated as part of this plan include those that have occurred historically or have the potential to cause significant human and/or monetary losses in the future. Tables 3-5 and 3-6 display the hazard threat levels and scores.

Table 3-5 - Hazard Threat Levels

Level	Threat Score Range
High Hazard	50-100
Moderately-High Hazard	25-49
Moderate Hazard	15-24
Moderately-Low Hazard	5-14
Low Hazard	1-4

Table 3-6 - Hazard Threat Level Scores

Hazard Threat Levels	Hazard Threat Scores
Moderately-High Hazard	
• *Hazardous Materials*	**36**
• *Flooding*	27
Moderate Hazard	
• *Fire*	**24**
• *Extreme Temperatures*	24
• *Fog*	24
• *Storm-Related Hazards*	**18**
• *Dam Failure*	**16**
Moderately-Low Hazard	
• *Earthquake*	12
• *Tornadoes*	12
• *Drought*	8

Although the ranking did not place any hazards in the "High" or "Low" categories, the relative ordering of hazards is similar to those identified in the Community Risk Assessment for the City of Merced.

NON-PRIORITY HAZARDS

Hazards that were not identified as "Priority Hazards" were eliminated from further consideration in the MHMP Risk Assessment. These hazards either occur rarely or not at all in the City of Merced, and when they do occur, they are very limited in magnitude—no or very limited damage is sustained. These include:

- Volcanoes

RC#B1.b.

City of Merced
Hazard Frequency Table
01/01/03 - 01/01/12

Year	Fire			
	Total	Structure	Wildland	Other[1]
2003	377	97	85	195
2004	369	112	77	180
2005	409	119	84	206
2006	426	109	94	223
2007	440	138	89	213
2008	407	101	91	215
2009	380	100	85	195
2010	330	111	57	162
2011	373	104	67	202
Total	**3511**	**991**	**729**	**1791**
Avg. Incidents Per Year	390.11	110.11	81.00	199.00
% of Incidents	100.00%	28.23%	20.76%	51.01%
Probability and Frequency Score		4	4	4

Year	Hazardous Condition			
	Total	Gas Leak	Chemical Spill/Biological Hazard	Other[2]
2003	224	41	2	181
2004	189	29	4	156
2005	197	29	3	165
2006	223	29	3	191
2007	144	23	0	121
2008	163	31	5	127
2009	143	29	5	109
2010	145	23	1	121
2011	118	26	2	90
Total	**1546**	**260**	**25**	**1261**
Avg. Incidents Per Year	171.78	28.89	2.78	140.11
% of Incidents	100.00%	16.82%	1.62%	81.57%
Probability and Frequency Score		4	4	4

Year	Severe Weather and Natural Disaster					
	Total	Earthquake	Lighting Strike	Windstorm, tornado/hurricane assessment	Flood Assessment	Severe Weather
2003	3	1	2	0		0
2004	3			3		0
2005	0					
2006	6				6	
2007	3			2	1	0
2008	3			2		1
2009	1					1
2010	2			2		0
2011	0					
Total	**21**	**1**	**2**	**9**	**7**	**2**
Avg. Incidents Per Year	2.33	0.11	0.22	1.00	0.78	0.22
% of Incidents	100.00%	4.76%	9.52%	42.86%	33.33%	9.52%
Probability and Frequency Score		2	1	3	3	2

Source: ACS Firehouse Software
Time Period: 01/01/03 to 01/01/12
Hazard Frequency Table reflects the number of occurrences of the hazard as recorded by the Merced Fire Department.
[1] Fuel burner/boiler malfunction; trash or rubbish fire, contained; mobile property (vehicle) fire, other; passenger vehicle fire; road freight or transport vehicle fire; camper or recreational vehicle (RV) fire; off-road vehicle or heavy equipment fire; outside rubbish fire, other; outside rubbish, trash or waste fire; dumpster or other outside trash receptacle; special outside fire, other; ouside equipment fire; cultivated grain or crop fire; culativated trees or nurery stock fire.
[2] Hazardous condition, other; combustible,flammable gas/liquid condition; gasoline or other flammable liquid spill; oil or other combustible liquid spill; carbon monoxide incident; electrical wiring/equipment problem, other; heat from short circuit (wiring); overheated motor; breakdown of light ballast; power line down; arcing, shorted electrical equipment; accident, potential accident, other; building or structure weakened or collapsed; vehicle accident, general cleanup; attempted burning, illegal action, other; attempt to burn.

Methodology:
The probability was determined by comparing historial data from the Hazard Frequency Table and categorizing the data based on the Probably and Frequency Scoring Table.

Probability and Frequency Scoring	
Score	Descriptors
0	Infeasible Event - Not applicable due to geographic location characteristics.
1	Rare Event - Occurs less than once every 50 years.
2	Infrequent Event - Occurs between once every 8 years and once every 50 years (inclusive).
3	Regular Event - Occurs between once a year and once every 7 years.
4	Frequent Event - Occurs more than once a year.

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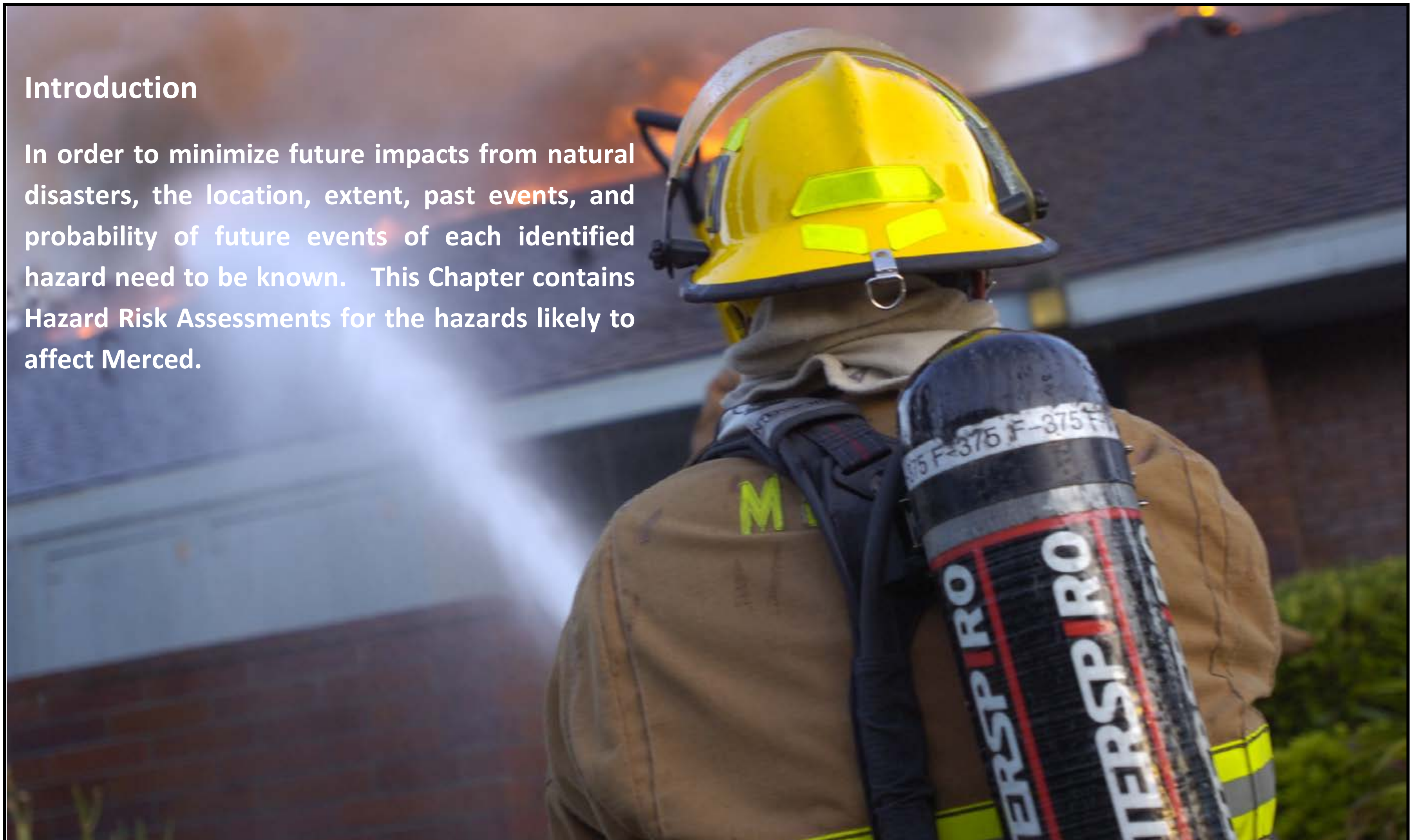
3.3 Hazard Profiles



Introduction

In order to minimize future impacts from natural disasters, the location, extent, past events, and probability of future events of each identified hazard need to be known. This Chapter contains Hazard Risk Assessments for the hazards likely to affect Merced.

Overview - Hazard Risk Assessments

Under 44 CFR, Section 201.6(c)(2)(i) of the Disaster Mitigation Act (DMA), risk assessments are required to include a description of the location and extent of hazards that can affect the jurisdiction.

Under 44 CFR, Section 201(6)(c)(2)(ii) of the DMA, risk assessments are also required to include a description of the jurisdiction's vulnerability to specified hazards and their potential impact on the community. This description should also describe the community's vulnerability (see Section 3.4) in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the hazardous materials incident hazard area; estimated potential dollar losses to vulnerable structures; and an analysis of development trends.

The Disaster Committee identified 10 hazards as likely to impact the City of Merced. For each of these hazards, this Chapter includes a Hazard Risk Assessment, focused on location, extent, previous occurrences, and future probability, and include the following hazards:

3.3.1 Flooding
3.3.2 Fire
3.3.3 Drought
3.3.4 Hazardous Materials
3.3.5 Earthquakes
3.3.6 Dam Failure
3.3.7 Extreme Temperatures
3.3.8 Tornadoes
3.3.9 Fog
3.3.10 Storm-Related Hazards

RC#B1c/B2

3.3.1 Flooding

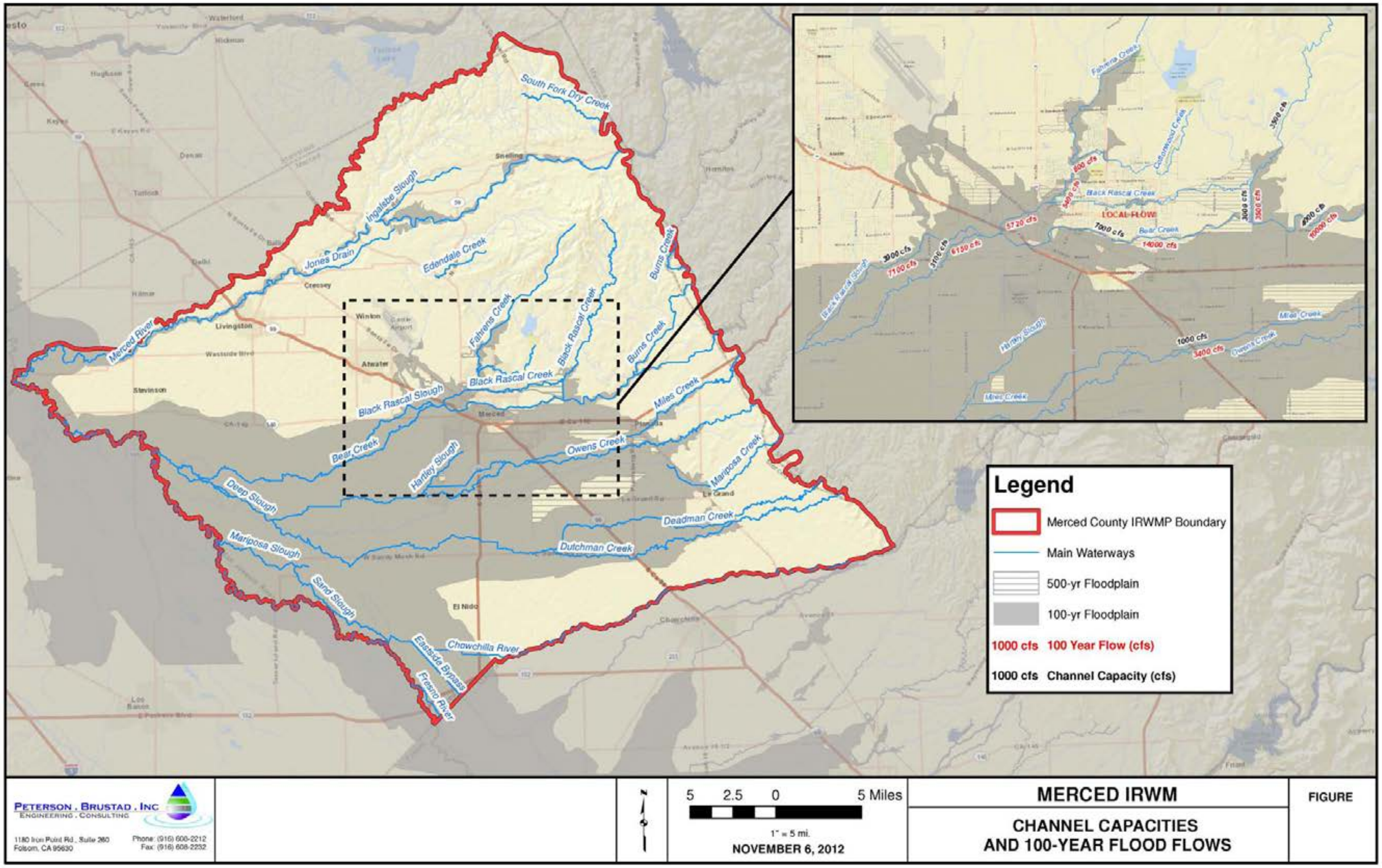
California flood of 1861-61, K Street, Sacramento. (USGS)

General Background

A flood is defined as an overflowing of water onto an area of land that is normally dry. Floods generally occur from natural causes, usually weather-related, such as a sudden snow melt, often in conjunction with a wet or rainy spring or with sudden and very heavy rainfalls. Floods can, however, result from human causes as a dam impoundment bursting. [2]

PHYSICAL SETTING

The Plan Area has no major rivers, but is traversed from east to west by four creeks. These are Bear Creek, Fahrens Creek, Cottonwood Creek, and Black Rascal Creek (see image on next page). These are not completely independent of each other. Black Rascal Creek begins many miles east of Merced near Haystack Mountain. As it flows westerly through Merced, Fahrens Creek connects into it in Merced's northwest area. Cottonwood Creek has a smaller drainage area that connects to Fahrens Creek above Black Rascal Creek. Bear Creek also begins miles east of Merced, but is south of Black Rascal Creek. Originally, both Bear Creek and Black Rascal Creek flowed independently west of town and reached the San Joaquin River. However, the Merced Irrigation District connected these two creeks west of town behind a small irrigation dam. Below the dam, the two creeks continue through their original channels.


South Fork Dry Creek
Ingalsbe Slough
Jones Drain
Edendale Creek
Merced River
Fahrens Creek
Black Rascal Creek
Burns Creek
Black Rascal Slough
Bear Creek
Hartley Slough
Owens Creek
Miles Creek
Mariposa Creek
Deep Slough
Deadman Creek
Dutchman Creek
Mariposa Slough
Sand Slough
Chowchilla River
Eastside Bypass
Fresno River
LOCAL FLOW
Legend
Merced County IRWMP Boundary
Main Waterways
500-yr Floodplain
100-yr Floodplain
1000 cfs 100 Year Flow (cfs)
1000 cfs Channel Capacity (cfs)
PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING
5 2.5 0 5 Miles
1" = 5 mi.
NOVEMBER 6, 2012
MERCED IRWM
CHANNEL CAPACITIES
AND 100-YEAR FLOOD FLOWS
FIGURE

Regulatory Setting

The occurrence of flooding can be influenced by regulatory-based actions and practices such as:

- Storm-Water Management;
- National Flood Insurance Program (NFIP);
- Managing Repetitive Loss Properties (Also see section 3.4.5);
- Merced Streams Group Project; and,
- A suite of new state laws enacted in 2007 that demand specific actions and imposes deadlines.

An overview of each of these is discussed in this section.

These regulatory-based actions and practices have different approaches, but all work to reduce flooding impacts. For example, the Merced Streams Group Project is designed to control flood waters, whereas the NFIP approach is to prohibit construction in floodways and to encourage construction in low risk areas. The largest benefit of the Streams Group Project is the provision of flood control benefits to virtually the entire community, specifically to older homes and businesses built before the NFIP flood maps were developed.

STORMWATER MANAGEMENT

Overview - Changes in land use from agriculture to urban have profound effects on runoff and erosion of the land surface. Urbanization is commonly accompanied by paved and other impervious surfaces, and the construction of storm sewers. Impervious surfaces and storm drains increase the frequency of floods and the size of flood peaks.

Storm-water System Description - The City requires the construction of storm water percolation/detention basins with new development per the City's Storm Water Master Plan. Percolation basins are designed to collect storm water and filter it before it is absorbed into the soil and reaches groundwater tables. Detention basins are designed to temporarily collect runoff so it can be metered at acceptable rates into canals and streams which have limited capacity. The City's storm-water conveyance system is mainly composed of Merced Irrigation District canals and laterals, drains, and natural channels that traverse the City.

The disposal system is mainly composed of Merced Irrigation District facilities, including water distribution canals and laterals, drains, and natural channels that traverse the area.

The City has a storm drain master plan that incorporates 50 year and 10 year storm analyses as well as allowable discharge and requirements for detention volumes. The City's Storm Drainage Standards originate from the Merced Critical Area Flooding and Drainage Plan of 1983. The 1983 Drainage Plan determined allowable rates of discharge into the four local creeks for Merced and several other creeks in County areas. Storm-water discharge rates were based on pre-existing conditions and the capacities of local creeks.

The City's storm drainage master plan calls for: a 50-year design storm with 2 year allowable discharge balanced with detention volume, updated potential locations for detention basins, and master-planned storm drain pipe sizes.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

RC#C2a

The National Flood Insurance Program (NFIP) is a program created by the Congress of the United States in 1968 through the National Flood Insurance Act of 1968. [51] Community participation in the NFIP is voluntary. Nearly 20,000 communities across the United States and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. Under the program, construction in floodplains is acceptable provided that floors are elevated to minimize the risk of damage. In exchange, the NFIP makes Federally-backed flood insurance available to homeowners, renters, and business owners in these communities. In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of the flood hazards and provides the data needed for floodplain management programs. [2] As of April 2010, the program insured about 5.5 million homes, the majority of which were in Texas and Florida.[51]

The City of Merced has participated in FEMA's National Flood Insurance Program since the 1974,[53] is registered as Community Identification Number (CIN) #060191, and intends to continue its participation. Prior to 1974, developments were required to meet the minimum elevation and construction methods prescribed by the City Engineer in the pre-FIRM years when Federal programs were just getting started. Currently, the City of Merced Floodplain Administrator (City Engineer) actively implements and enforces the City's storm-drainage and flood prevention program through the *Merced Vision 2030 General Plan*, Uniform Building Codes, FIRM maps and the City's Flood Prevention Ordinance. Developments are conditioned to comply with code, standards, and programs to prevent vulnerability to floods from increasing. Compliance with the City's flood program is also required of certain building rehabilitations and reconstructions.

Stricter evaluation of development in all flood hazard zones would strengthen the Flood Insurance Program locally, and provide greater protection from future flooding. As an example of regulated development, certain future higher occupancy or critical facilities such as schools and hospitals, could be discouraged in floodplains and could be strictly reviewed where placement within a floodplain is necessary. The City of Merced has not deployed such optional evaluation methods, however.

Flood Insurance Rate Maps (F.I.R.M) - Flood Insurance Rate Maps (F.I.R.M.) are used to identify areas of flood risk in the community. FEMA has provided the City of Merced with all FIRM maps for City Limits and surrounding unincorporated areas. These maps provide detailed flood information for the planning area, and are periodically updated to reflect new information. FIRM maps have received large scale changes and local revisions requested by developers and independent property owners. The most recent map revision was issued by FEMA with a date of June 30, 2010, for the Fahrens Creek at "R" Street area.

Characteristics of Merced's FIRMs

To understand the dynamic nature of the changing amounts of flood-related lands within the City of Merced as it grows, comparisons were made for three boundaries. The selected boundaries include present day city limits and future growth areas, commonly known as the City's Specific Urban Development Plan (SUDP). These boundaries contain the following total acres:

- 2013 City Limit Boundary 14,927
- SUDP of the Merced Vision 2015 General Plan 21,156
- SUDP of the Merced Vision 2030 General Plan. 29,012

Table 3-7: Total Acres and Percent of Flood Related Lands in Merced's Planning Area						
Flood Zones	**2013 City Limits**		**2015 SUDP**		**2030 SUDP**	
	Acres	*%*	*Acres*	*%*	*Acres*	*%*
Floodway	282	.019	382	.018	382	.013
100-Year Floodplain	4,909	33	5735	27	6682	23
500-year Floodplain	5,748	38	6,876	32	7929	27
Total Flood-prone Acres	**10,657**	**71**	**12,611**	**59**	**14,611**	**50**

On the nearly 15,000 acres currently in the City of Merced, 71% is within the 100-year and 500-year floodplains. Upon build-out of the 2030 SUDP, this percentage will decrease to 50%, however. This is due to the fact that most future growth will be located outside flood sensitive areas.

The data also reveals that the 2030 SUDP does not add any floodway acreage to the prior 2015 SUDP. Regardless of which SUDP is compared, there is still about 100-acres of floodway outside the current City Limits that will eventually be incorporated with urban growth patterns.

Flood Damage Prevention Ordinance

On June 18, 1979, the City of Merced created Ordinance No. 1250 which thoroughly outlined methods to be enforced by the City to reduce potential loss of life and property. The ordinance's requirements were based on special flood hazard areas identified by the Federal Insurance Agency (FIA) in a document entitled, "The Flood Insurance Study for the City of Merced," dated January, 1979. The ordinance appointed the City Engineer to administer the program and processes involved.

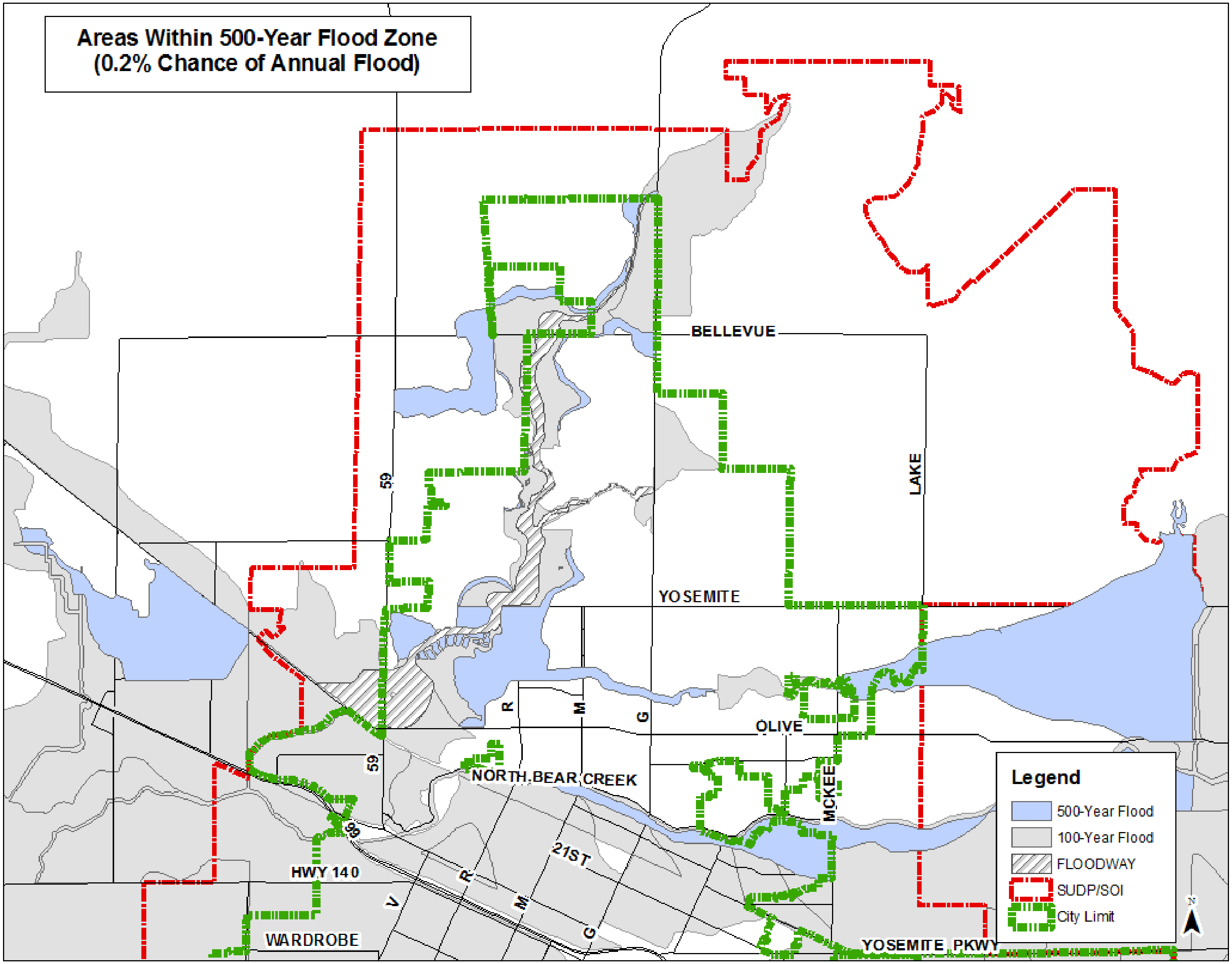
In 2008, the City's Flood Damage Prevention Ordinance was updated to make it compliant with new Federal regulations governing the National Flood Insurance Program. Should the City fail to enforce restrictions and standards, it runs the risk of losing Federal Insurance monies. The City's Flood Control Ordinance is patterned on FEMA's model ordinance.

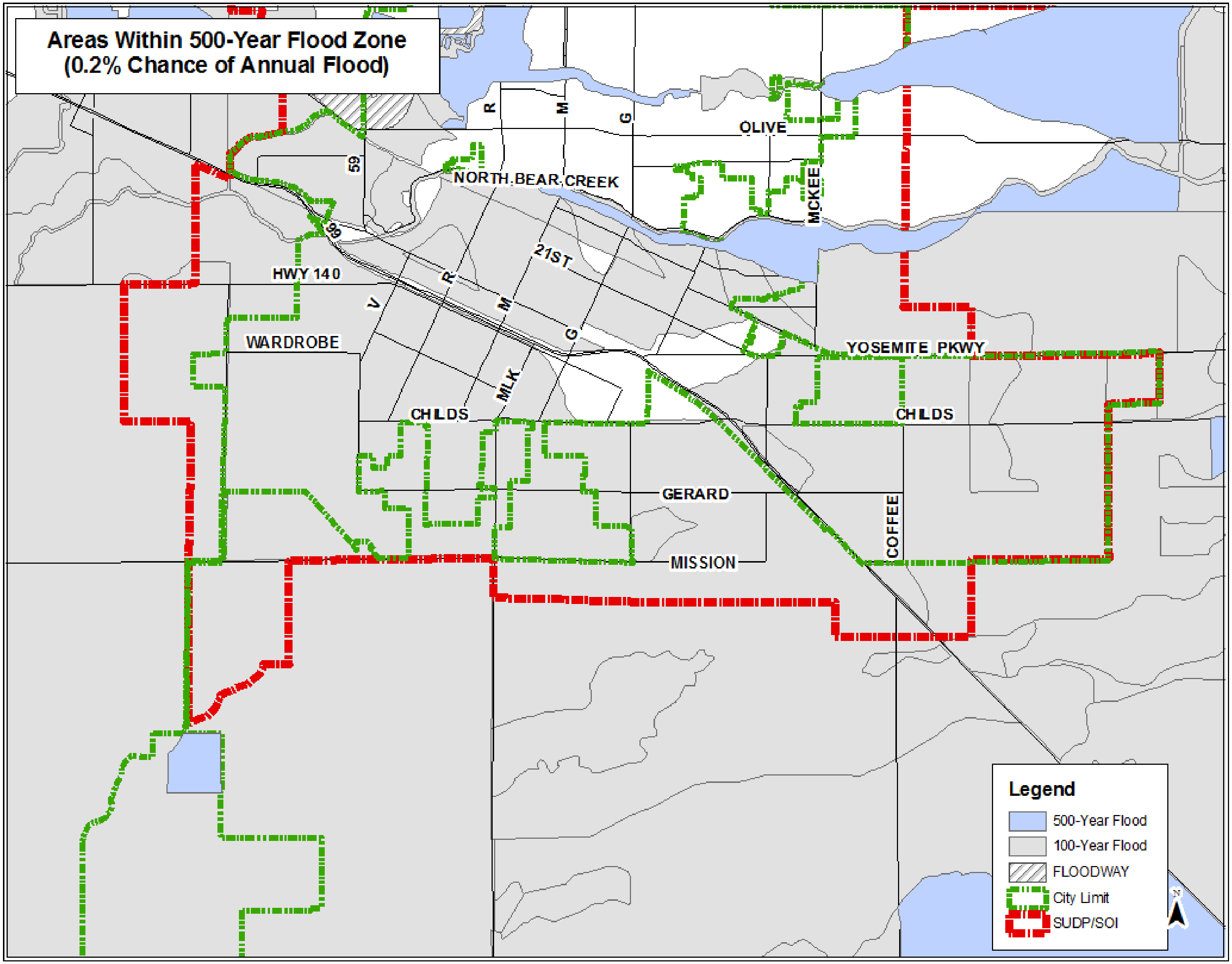
Flood Elevation Certificates / Letters of Map Revision

Prior to the final inspection of any project wherein a new building is constructed or additional area is added to an existing building, the City of Merced requires submittal of a Flood Elevation Certificate stamped and signed by a licensed surveyor.

FEMA deems that any structure that experiences changes meeting their definition of "substantial improvement" shall be raised to meet the minimum flood elevation height if not already in compliance. Although a rare occurrence, the City is required to enforce accordingly.

The City Engineer, as the floodplain administrator, reviews applications for Letter of Map Revision (LOMR), Conditional Letter of Map Revision (CLOMR), and others for content and relation to the City's flood ordinance prior to submittal to FEMA. By so doing, the City can monitor proposed changes to help avoid or reduce potentially negative effects on adjacent areas.


Areas Within 500-Year Flood Zone
(0.2% Chance of Annual Flood)
BELLEVUE
YOSEMITE
OLIVE
NORTH BEAR CREEK
LAKE
MCKEE
59
R
M
G
99
21ST
V
HWY 140
WARDROBE
YOSEMITE PKWY
Legend
500-Year Flood
100-Year Flood
FLOODWAY
SUDP/SOI
City Limit
N



Areas Within 500-Year Flood Zone
(0.2% Chance of Annual Flood)
R
M
G
OLIVE
59
NORTH BEAR CREEK
MCKEE
99
21ST
HWY 140
R
V
M
G
WARDROBE
YOSEMITE PKWY
MLK
CHILDS
CHILDS
GERARD
COFFEE
MISSION
Legend
500-Year Flood
100-Year Flood
FLOODWAY
City Limit
SUDP/SOI

MANAGING REPETITIVE LOSS PROPERTIES

RC#B4a

A repetitive loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. An RL property may or may not be currently insured by the NFIP. Structures that flood frequently strain the National Flood Insurance Fund. Community leaders and residents are also concerned with the RL problem because residents' lives are disrupted and may be threatened by the continual flooding. In 2004, Congress found that repetitive-loss properties cost the taxpayer about $200 million annually. [51]

Additional information about RL properties is included in the Hazard Vulnerability Section 3.4.5.

MERCED STREAMS GROUP PROJECT

Origin - The Merced County Stream Group (MSG) project, originally authorized by the Flood Control Act of 1944, aimed to provide flood protection as part of the comprehensive flood management plans for the Sacramento and San Joaquin Basins. The MSG is one of several USACE flood control projects in the Region. The project consisted of four flood control reservoirs on Burns, Bear, Owens, and Mariposa Creeks and was completed in 1957. Numerous subsequent projects have also been undertaken to address the problem of regional flooding.

A 1970 authorization provided for enlargement of the four original reservoirs, construction of three additional reservoirs (Castle, Haystack, and Marguerite), and channel improvements on Bear and Mariposa creek systems. These channel improvements included two diversions: Black Rascal Creek to Bear Creek (3,000 cfs capacity) and Owens Creek to Mariposa Creek (400 cfs). Re-evaluation and technical studies later modified the design to include only the construction of Castle and Haystack Reservoirs, enlargement of the Bear Reservoir, and about 33 miles of channel improvements along Bear Creek.

In addition to the reservoir projects, improvements along Black Rascal Creek, Bear Creek, Burns Creek, Miles Creek, Owens Creek, and Mariposa Creek were completed as part of the MSG. Although channels were improved, very few levees were constructed, and the incised channels are subject to periodic overflows, causing widespread but relatively shallow flooding.

Except for the Black Rascal Creek Diversion (Bypass), there are no State Plan of Flood Control (SPFC) levees in the City's Sphere of Influence, which is the plan area of the MHMP. There are no USACE project levees in the plan area.

To date, the MSG is mostly complete, but a key feature intended to protect downtown Merced has not been built.

<u>Completed</u>

- Castle Reservoir
- Castle Check Structure and Gate Rehabilitation
- Burns Reservoir
- Bear Reservoir
- Bear Creek Stream Group
- Owens Reservoir
- Owens Creek Diversion
- Mariposa Reservoir
- Black Rascal Creek Diversion
- Relocate Fahrens Creek A.T. & S.F. railroad stub line and bridge

<u>Remaining Projects</u>

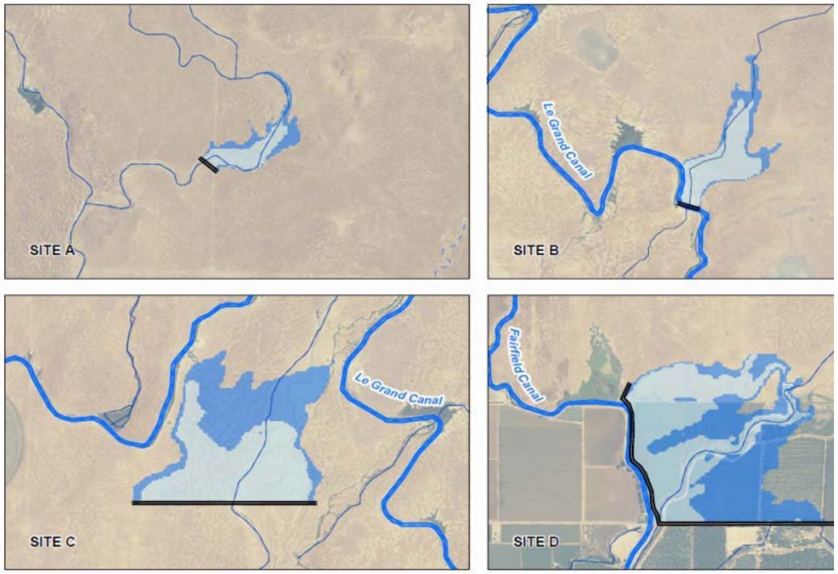
- Haystack Mountain Reservoir

The ***Haystack reservoir*** is the only component of the MSG not completed at this time. Changes in population, downstream development, and new environmental compliance issues have prompted a new analysis, which is being completed by the *USACE as the Merced County Streams Group Feasibility Study*. This study is intended to evaluate options to increase flood protection along Black Rascal Creek and Bear Creek to increase the current level of flood protection beyond a 50-year level of protection, but this study has not started due to lack of Federal funding.

East Side Bypass - Due to environmental considerations, it is unlikely that Haystack Mountain dam will be constructed. The proposed Haystack Mountain reservoir area has significant vernal pool areas. In 2004, the Army Corps of Engineers began considering as an alternative, an East side bypass, extending from the Black Rascal Diversion at Bear Creek south past Hwy 99 to the Miles and Owens Creek drainages. This would divert both Black Rascal and Bear Creek flood flows away from the City of Merced. However, there is insufficient capacity in Miles and Owens Creeks to carry flows down to the San Joaquin River, so that this solution is problematical, without an expensive further extension of a flood bypass.

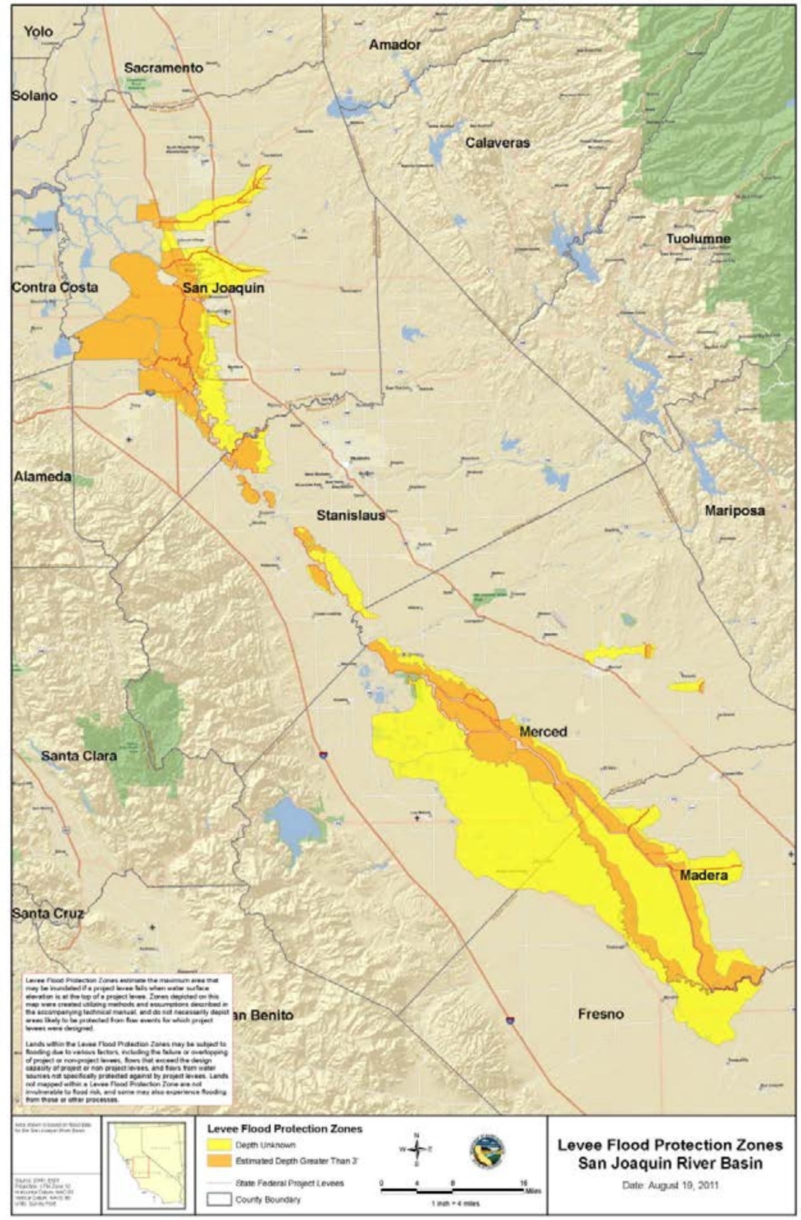
Black Rascal Creek Feasibility Study - Flooding along Bear Creek and Black Rascal Creek near the City of Merced has historically been problematic. In 2008, Merced County completed a local feasibility study evaluating several alternatives for a proposed detention basin upstream of the Black Rascal Creek Diversion. The goal of this study was to identify a preferred alternative which would reduce the flows in the diversion to less than 3,000 cfs, which the County believed might significantly reduce flooding within the city of Merced. This study was updated in 2009 to evaluate 200-yr flood protection.

Two primary challenges were identified in this study. The first is that each of the proposed dams would be larger than the minimum size dam subject to California Division of Safety of Dams (DSOD) permitting authority. According to DSOD requirements, dams greater than 25' tall, or dams which store more than 50 acre feet of water are subject to DSOD jurisdiction. The other major challenge is sensitive biological resources (i.e. vernal pools) which would be impacted by all the alternatives. The apparent recommendation from this study was to further evaluate environmental permitting challenges associated with three of the four alternatives.



LEVEE FLOOD PROJECTION ZONES

Water Code Section 9130 (passed in 2007), requires the Department of Water Resources (DWR) to prepare Levee Flood Protection Zone (LFPZ) maps that identify the areas where flood levels would be more than three feet deep if a project levee were to fail. Under Water Code section 9110(b), "Levee Flood Protection Zone" means the area, as determined by the Central Valley Flood Protection Board or DWR, which is protected by a project levee. DWR delineated the LFPZs by estimating the maximum area that may be flooded if a project levee fails with flows at maximum capacity that may reasonably be conveyed. The maps should not be confused with Federal Emergency Management Agency's Flood Insurance Rate Maps used for the National Flood Insurance Program. They were prepared for different purposes and do not show the same type of flood hazard. [54]



A Project Levee exists along a portion of Black Rascal Creek east of Merced, generally located west of Arboleda Drive and between Olive Avenue and north of Yosemite Avenue. East of the levee, flood depths are estimated to be greater than 3 feet. “Depth Unknown” is denoted for lands highlighted yellow west of the Project Levee.

FloodSAFE INITIATIVE AND SUBSEQUENT STATE REGULATIONS

In 2007, flood risk management legislation AB 162, SB 5, AB 70 and AB 156, were signed by Governor Schwarzenegger, adding to and amending State flood and land use management laws. These new laws are intended to improve local land use and other planning decisions by strengthening the link between land use and flood management. The laws became effective in January 2008, and contain requirements and considerations that outline a comprehensive approach to improving flood management at the State and local levels.

Geographically speaking the requirements of the 2007 Flood Risk Management Legislation apply to three areas of California: (1) statewide; (2) the Sacramento-San Joaquin Valley (SSJV); and (3) the

Sacramento-San Joaquin Drainage District (SSJDD). The City of Merced is located within areas 1 and 2. Adoption of the Central Valley Flood Protection Plan (CVFPP) occurred in June 2012, establishes guidance for required updates to General Plans, adoption of Flood Emergency Plans, and zoning code amendments to occur within three years of the adopt date of the CVFPP.

Under SB5, development in a moderate or high flood hazard zone would only be allowed if the permitting agency can find, based on substantial evidence in the record, that urban or urbanizing areas will be protected to a 200-year-flood level. This applies to all developed areas with population of at least 10,000 (or with plans to reach 10,000 within 10 years), overlain by FEMA Zones A, B, or shaded X. Therefore, as of mid-2015, Merced - along with other Central Valley cities and counties - will be prevented from entering into development agreements, approving discretionary permits that would result in construction of a residence, and approving subdivision maps in urban or urbanizing areas without a finding of 200-year- flood-level protection. This is more restrictive than FEMA regulations.

SB5 was amended in September 2012 by Senate Bill 1278 (SB1278), which removed local drainage and “shallow” flooding from Urban Level of Flood Protection (ULOP) requirements, thus easing SB5 requirements on Merced. Future DWR guidance on legislation aims to define “shallow” and modify other concerns with SB5.

The Department of Water Resources is only preparing 200-yr floodplain maps for areas protected by SPFC facilities, which doesn’t apply to many areas in Merced County. Absent detailed maps will make it difficult for communities to make the findings required by state law.
The removal of interior drainage and shallow flooding help a bit since many of the FEMA floodzones for Merced County show depths less than 3’, which is what we expect to be the limit of “shallow”.

While the discussion above highlights a key benchmark of these laws, there are many facets of the laws with specific deadlines and which affect various planning documents and tools, such as General Plan Elements, funding mechanisms, local flood-related plans, zoning ordinance, development agreements, permits, and maps, among others.

The following required actions, as defined by the applicable laws, apply to the City of Merced.

<u>Beginning January 1, 2008</u>

- Identify and annually review areas subject to flooding. Consider the location of water and natural resources that are used for the purposes of groundwater recharge and stormwater management. Government Code Section 65302(a), and as it applies to the General Plan Land Use Element (Statewide);
- Any new development approved may be subject to liability provisions, if the action to approve was unreasonable, as defined by Water Code Section 8307 (SSJV).

<u>On or after January 1, 2009, upon the next revision of the General Plan Housing Element</u>

- Identify rivers, creeks, streams, flood corridors, riparian habitat and land that may accommodate floodwater for groundwater recharge and stormwater management. Water resources section must be developed in coordination with applicable flood management, water conservation, and groundwater agencies that have developed, served, controlled, managed, or conserved water of any type for any purpose in the City for which the General Plan is prepared. Government Code Section 65302(d), and as it applies to the General Plan Conservation Element (Statewide);
- Identify flood hazard information and establish goals, policies, objectives, and feasible mitigation measures to protect communities from unreasonable risk of flood. The goals, policies and objectives of the safety element must include language specified in the Government Code. In addition, after

the initial revision of the safety element, upon revision of the housing element, the safety element must be reviewed and revised, as necessary to "identify new information that was not available during the previous revision of the safety element. Government Code Section 65302(g), and as it applies to the General Plan Safety Element (Statewide).

By January 1, 2010

- Collaborate with State and local flood management agencies to develop funding mechanisms to finance local flood protection responsibilities, as defined by Water Code Section 9623, (SSJV).

Within 24-months of CVFPP Adoption (July 2015) *

- Amend applicable General Plan elements to include information per CVFPP, as defined by Government Code Section 65302.9, (SSJV).
- Within this timeframe, counties are required to collaborate with the cities within its jurisdiction to develop a flood emergency plan consistent with the adoption of the CVFPP, as defined by Water Code Section 9621, (SSJV).

Within 36-months of CVFPP Adoption (July 2016) *

- Amend the zoning ordinance for consistency per amendments made to the General Plan per the CVFPP, as described in Government Code Section 65860.1, (SSJV).

* SB5 was amended in September 2012 by Senate Bill 1278 (SB1278) and Assembly Bill 1965 (AB 1965). SB1278 and AB 1965 extended the requirement for communities to incorporate the CVFPP into their general plans and zoning ordinances by 12 months (July 2015 and 2016, respectively).

Post CVFPP adoption and amendments to the General Plan and Zoning Ordinance

- The City cannot enter into Development Agreements for any property within a flood hazard zone unless certain flood protection related findings can be made based upon substantial evidence in the record. Government Code Section 65865.5, (SSJV).
- The City cannot approve a project (discretional permits, discretionary entitlements, or ministerial permits) that would result in the construction of a new residence within a flood hazard zone unless certain flood protection related findings can be made based upon substantial evidence in the record. Government Code Section 65962, (SSJV).
- The City cannot approve Tentative Maps or Parcel Maps for any subdivision within a flood hazard zone unless certain flood protection related findings can be made based upon substantial evidence in the record. Government Code Section 66474.5 (SSJV).

By 2025

Achieve urban level of flood protection for urban and urbanizing areas protected by project levees (i.e. 200-year).

Flooding Location

The Plan Area is not affected by the regions closest major waterways, the Merced River and the San Joaquin River. In Merced, the majority of normal flooding occurs adjacent to tributaries of these rivers.

FEMA flood-hazard maps(on page 3-31 and 3-32) best depict the location of various flood boundaries. There is a potential for flooding to occur away from these water courses and associated floodplains in parts of the City experiencing storm-water drainage challenges, however.

Extent

Flood management and planning has significantly shaped the Merced region's history. Flooding in the San Joaquin River basin is typically characterized by infrequent severe winter storms, combined with snowmelt runoff from the foothills east of the region. Runoff from these storm events traverses the region via numerous creeks and rivers, ultimately draining to the San Joaquin River. The relatively flat topography of the region causes floodwaters to exceed the banks of these rivers and streams to spread out over large areas.

The City of Merced is located on the flat San Joaquin Valley floor. Stream channels, well- entrenched and steep in the mountains and foothills, have limited capacity on the valley floor. They are periodically choked with vegetation, causing channel capacities to be quickly exceeded during major floods. Overflow from the channels generally spreads out as slow-moving shallow flooding. Runoff patterns are restricted and ponding occurs behind the many irrigation canal levees and railroad and road embankments that traverse the area. [60]

Flooding is directly related to rainfall events. Most of the rainfall in Merced occurs during the winter and averages 12.21 inches (310 mm) annually. There is an average of 48 days annually with measurable precipitation. The wettest year was 1998 with 21.66 inches (550 mm) and the driest year was 1947 with 5.50 inches (140 mm). The most rainfall in one month was 8.00 inches (203 mm) in January 1909. The most rainfall in 24 hours was 2.20 inches (56 mm), which occurred on January 30, 1911, and March 9, 1911.

The extent of flooding is generally described on FEMA flood hazard maps as 100-year and 500-year floodplains.

Extent of Flooding from Bear Creek

Historically, flood flows in excess of the Bear Creek channel capacity spill over the left bank of Bear Creek approximately 6 miles east of Merced. Due to topography and embankments, overflow from Bear Creek does not return to the channel. The natural slope is southwest from Bear Creek, but some of the overflow moves westward and northwestward into Merced along the Atchison, Topeka, and Santa Fe Railway embankment. There are some flood relief structures along the embankment that allow part of the overflow to proceed southwestward, but much of the floodwater flows into Merced, where it ponds and eventually overtops the Atchison, Topeka, and Santa Fe Railway embankment between R and V Streets. The floodwater then flows as shallow flooding southwestward through downtown Merced, ponds behind the Southern Pacific Railroad embankment, eventually overtops the railroad embankment, and finally continues as shallow flooding through southwest Merced.

Overflow from Bear Creek will also occur upstream of the West 16th Street bridges at several locations near the Daisy Park residential area. This floodwater will flow west through the Daisy Park area as shallow flooding, then over the Snelling Highway and into the Industrial Park area, where it will pond behind the U.S. Highway 99 embankment and the Black Rascal Creek levee.

During the major flood events in 1969, 1997, 1998, and 2006, Bear Creek overflowed at the southwest end of the City of Merced in the vicinity of Thornton Avenue and State Highway 140. Stream gage data is not available to quantify the magnitude of these events. Historical records also indicate that Bear Creek has overflowed its banks upstream from the G Street bridge. This overflow was worsened by debris restricting flow under the bridge. [60]

Extent of Flooding from Black Rascal Creek

Black Rascal Creek flood flows are diverted into Bear Creek approximately 3 miles east of Merced. Minor flooding from local runoff has occurred along Black Rascal Creek between G Street and Parsons Avenue.

Extent of Flooding from Fahrens Creek

Fahrens Creek, which joins Black Rascal Creek near West Olive Avenue and State Highway 59 (Snelling Highway), flows through the northwestern part of Merced. Limited channel capacity, coupled with constricted bridge openings at State Highway 59, produces widespread ponding upstream from the bridges and road embankment.

Previous Occurrences

Most floods in Merced are produced by extended periods of rainfall in the watersheds of the creeks that flow through Merced. Recent flood events occurred in the Region in 1997, 1998, 2000, 2001, 2002, 2005, 2006, and 2007. The frequency of flooding events illustrates the fact that many areas in the Region are prone to flooding from storm events less severe than a 100-year event.

Below, flooding events are listed chronologically, and where known, the extent of the flood is provided.

***Flood of January, 1862**:* On Christmas Eve, 1861, a series of massive storms struck California, which lasted for forty-five days. This caused extreme flooding. The state capital had to be moved to San Francisco, because the Sacramento Valley was flooded. "Governor Leland Stanford had to take a rowboat to his inauguration." The Central Valley was also flooded.

Locally, in Snelling, it washed away the hotel and several other buildings including Judge Fitzhugh's house, as well as the bridges located nearby at Merced Falls. It also changed the course of the river.[45]

The data in Table 3-7 was extracted from a consecutive thirty-year annual record for Sacramento, [46], and provides an indication of probable similar historic events in the Central Valley, including the City of Merced.

Table 3-7: Significant Wet-Weather Years in Sacramento

Year	Rainfall (inches)	Rainy Days
1849-50	36	53
1852-53	36.15	70
1861-62	35.54	83
1867-68	32.76	88
1873-74	22.89	80

Flood of 1925 (Highway 99)

Flood of 1935

In 1911, 1935, and 1955, large floods occurred within those portions of Merced that were developed at the time; in intervening years, flooding occurred every three to five years. Former Fire Chief Ken Mitten articulated there were significant flooding issues in Merced before the 1970's; however, actions were taken to improve drainage infrastructure and to reinforce the banks of Bear Creek. Subsequently, the number of floods dramatically reduced.

November 18, 1950: A three day heavy rain event from November 17 through November 19 in the Sierra brought more than 15 inches of rain to some areas as high as 5,500 feet and heavy rain as high as 10,000 feet, which melted snowpack resulting in historic flooding. Hardest hit were Merced, Chowchilla, Centerville, Visalia, Porterville, Oildale, Isabella, and Kernville. Damage was estimated at 12 million dollars at the time and a few lives were lost. [13]

December 1955 Flooding [42]

Extensive flooding occurred a few days before Christmas throughout central and northern California. Close to record floods occurred on most of the major Central Valley rivers and the greatest flow of record to that time occurred on the Eel River on the North Coast. Statewide disaster declared. Calculated Damages: 74 deaths, $200 million economic losses.

Christmas Eve, 1955. McKee and Bear Creek Drive

1969 Winter Storms and Floods [42]

Significant flooding on Central Valley rivers and reformation of Tulare Lake in the San Joaquin Valley occurred as extended precipitation fell across the state. Heavy snow fell in all mountain ranges and the monthly rainfall record was set in Sacramento. Forty counties were disaster-declared. Calculated Damages: 47 dead, 161 injured, $300 million economic losses.

1982-83 El Niño Storms [42]

Multiple strong storms brought high wind, heavy rain, and heavy snowfall across all of California. This led to direct wind damage, higher tides, immediate flooding to coastal and valley locations, mudslides in coastal mountain areas, record snowfall in the Sierra

Mountains, and resulting spring snowmelt river flooding. In one 36-hour period, 25 inches of rain fell in the Santa Cruz (coastal) mountains while 8.5 feet of snow fell in the Lake Tahoe region. Forty-six counties were disaster-declared.

RECENT EVENTS (1998 TO PRESENT)

Since improvements were made in the 1970's, two significant floods have occurred: March 1998 and March 2007.

Jan 4, 1997: The Flood of January '97 caused flooding in the San Joaquin Valley as well as the adjacent foothills. Numerous houses adjacent to the San Joaquin River flooded, while agricultural lands near the Merced River were inundated. Flooding also impacted areas in the South Valley, especially Earlimart and Porterville.[13]

Jan 16, 1998: Rainfall of up to 3 inches in the Sierra foothills lead to streams in Merced County reaching bankfull. Bear Creek overflowed into the City of Merced where it flooded 180 homes and up to 5,000 acres of farmland just to the southwest. This was the first flood of this creek since 1955. [13]

February of 1998: There was severe flooding that cost Merced County $1.4 million in agriculture damage and $2 million in damage.

March 1998 Flood: Former Fire Chief Mitten identified that the March 1998 flood lasted for three days and caused extensive evacuations and property damage. In certain locations of the City, the water was three to four feet deep. One gauge in the northern part of the City of Merced had 6.80" in a 48 hour period from March 23 to March 25. The Merced Airport recorded 3.25" of rain alone on March 24.

Bear Creek, at the west edge of town just west of Massasso Street, jumped its banks due to variable bank height and gopher holes. Farmlands, a few houses north of State Highway 140, and many more houses south of State Highway 140 and along Thornton Road, received flood damage, as did a City Storm pump facility. According to noaa.gov, this event was the 2nd 100-year event to occur in Merced County in two months. The City of Merced received heavy rainfall that totaled from 3.5" to 5.9." Bear Creek reached a crest of 19.3 feet on the morning of March 25, resulting in the 1,000 people being evacuated. A total of 65 homes and 19 apartments were flooded. The total damage to Merced County was 9.6 million, with agriculture suffering a $1.5 million loss. [13]

April 17 and 18, 2000: There was some minor flooding around Merced around April 17 and 18, 2000. There was some flooding around three miles north of Merced at Black Rascal. Merced received around 1.42" of rain.

November 12, 2001: There was some minor flooding in Merced on November 12, 2001. According to www.noaa.gov there wasn't any crop or property damage.

December 13 to December 17, 2002: There was a tornado and heavy rain from December 13 to December 17, 2002 that caused damage to an apartment and flooding. Merced received 1.78" of rain. This rain caused storm drains to be clogged on 16th Street, west of "V" and 18th Street.

February 15 and February 16, 2005: There was heavy rain in Merced from February 15 and February 16, 2005. Merced received 1.24" of rain. There were reports of flooding throughout the San Joaquin Valley.

March 22, 2005: Quick downpour in Merced: 0.69" fell in one hour during the afternoon. Numerous buildings and homes flooded in downtown Merced and an awning collapsed due to the weight of water on it. Gusty winds around 40 mph also added to the problems as they caused a pump house roof and carport to suffer damage resulting in power outages when they fell on nearby lines. In

Mariposa, 3.22” of rain fell in a 24 hour period resulting in flooding damage to structures. Several creeks also overflowed in Merced, Madera, and Mariposa Counties and some bridges and roads were washed away. [13]

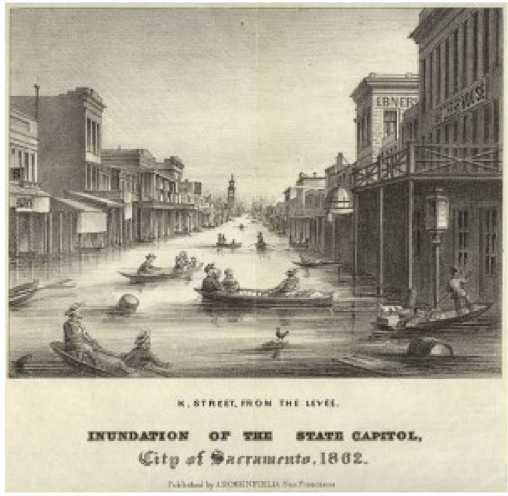
April 4, 2006: Four consecutive days of rain from April 2 through the 5 resulted in the Black Rascal Creek swelling and flooding 300 homes in North Merced, prompting evacuations. [13] Many schools had to be shut down. Crews had to use concrete blocks and sandbags to close the break. Water levels raised at Bear Creek, Black Rascal Creek, and El Capitan Canal.

March 2007 Flood: The March 2007 flood lasted twelve hours, but it forced the evacuation of 3,400 citizens and damaged numerous structures. Another factor of the 2007 flood was that it caused a sanitary sewer treatment plant in a neighboring town to overflow, that led to widespread water contamination issues. Many believe the 2007 flood and related damage hinged on Black Rascal Creek and its complete lack of flood control facilities. The damaged school and mobile home park area is also where Black Rascal Creek used to flow prior to being connected to Bear Creek, so it is a low lying area. NOTE: This site is not located in the Planning Area.

December 28 and December 29, 2010: On December 28 and December 29, 2010, the City of Merced received about three-quarters of an inch of rain. There was a flood advisory for the central and southern San Joaquin Valley. According to the Merced Sun Star, “Bear Creek through Merced was high Wednesday, with parts of the bike path disappearing into swift brown water.” This is a picture of Bear Creek near G Street. [50]

March of 2011: There were more storms around the middle of March of 2011. Bear Creek flooded again. Inmates sandbagged Bear Creek around Highway 59. The inmates put down hundreds of 35-pound bags between Bear Creek and the road. According to the Merced Sun Star (local newspaper), Merced Airport received 1.78 inches of rain between 10 a.m. Saturday and 10 a.m. Monday (March 19- March 21).

ARCSTORM

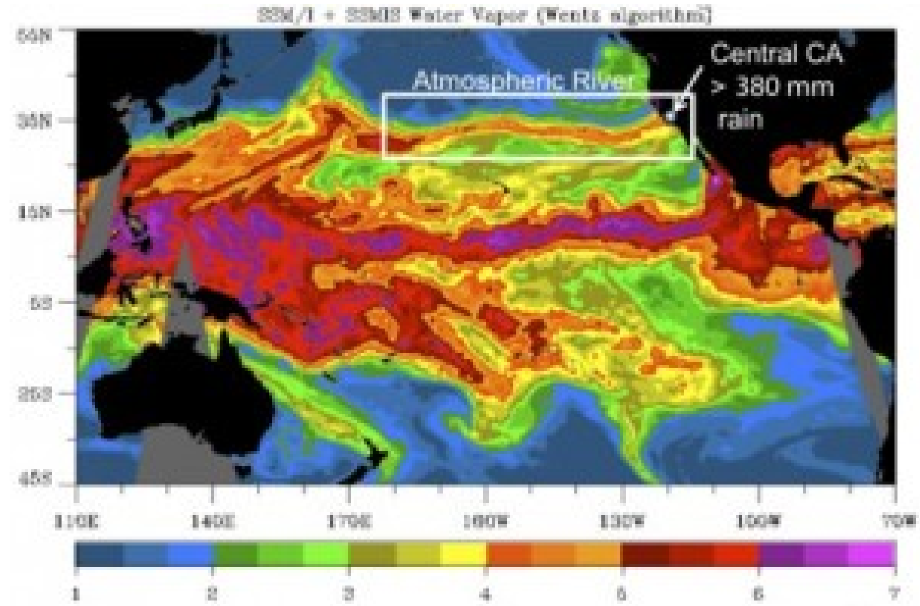


Beginning on Christmas Eve, 1861, and continuing into early 1862, an extreme series of storms lasting 45 days, struck California. The storms caused severe flooding, turning the Sacramento Valley into an inland sea. William Brewer, author of "Up and Down California," wrote on January 19, 1862, "The great central valley of the state is under water—the Sacramento and San Joaquin valleys—a region 250 to 300 miles long and an average of at least twenty miles wide, or probably three to three and a half millions of acres!"

In Southern California lakes were formed in the Mojave Desert and the Los Angeles Basin. The storms wiped out nearly a third of the taxable land in California, leaving the State bankrupt.

The 1861-62 series of storms were probably the largest and longest California storms on record. However, geological evidence suggests that earlier, prehistoric floods were likely even bigger. There is no scientific evidence to suggest that such extreme storms could not happen again. The storms of 1861-62 happened long before living memory, and the hazards associated with such extreme winter storms have not tested modern infrastructure or the preparedness of the emergency management community.

The atmospheric mechanisms behind the storms of 1861-62 are unknown; however, the storms were likely the result of an intense atmospheric river, or a series of atmospheric rivers, that approach the ferocity of hurricanes and then slam into the U.S. West Coast over several weeks. Such a storm might drop as much as 10 feet of rain on California over the course of a single month. Atmospheric Rivers are relatively narrow regions in the atmosphere that are responsible for most of the horizontal transport of water vapor outside of the tropics.



With the right preconditions, just one intense atmospheric river hitting the Sierra Nevada mountain range east of Sacramento could bring devastation to the Central Valley of California. An independent panel wrote in October 2007 to California's Department of Water Resources, "California's Central Valley faces significant flood risks. Many experts feel that the Central Valley is the next big disaster waiting to happen. This fast-growing region in the country's most populous state, the Central Valley encompasses the floodplains of two major rivers—the Sacramento and the San Joaquin—as well as additional rivers and tributaries that drain the Sierra Nevada. Expanding urban centers lie in floodplains where flooding could result in extensive loss of life and billions in damages."

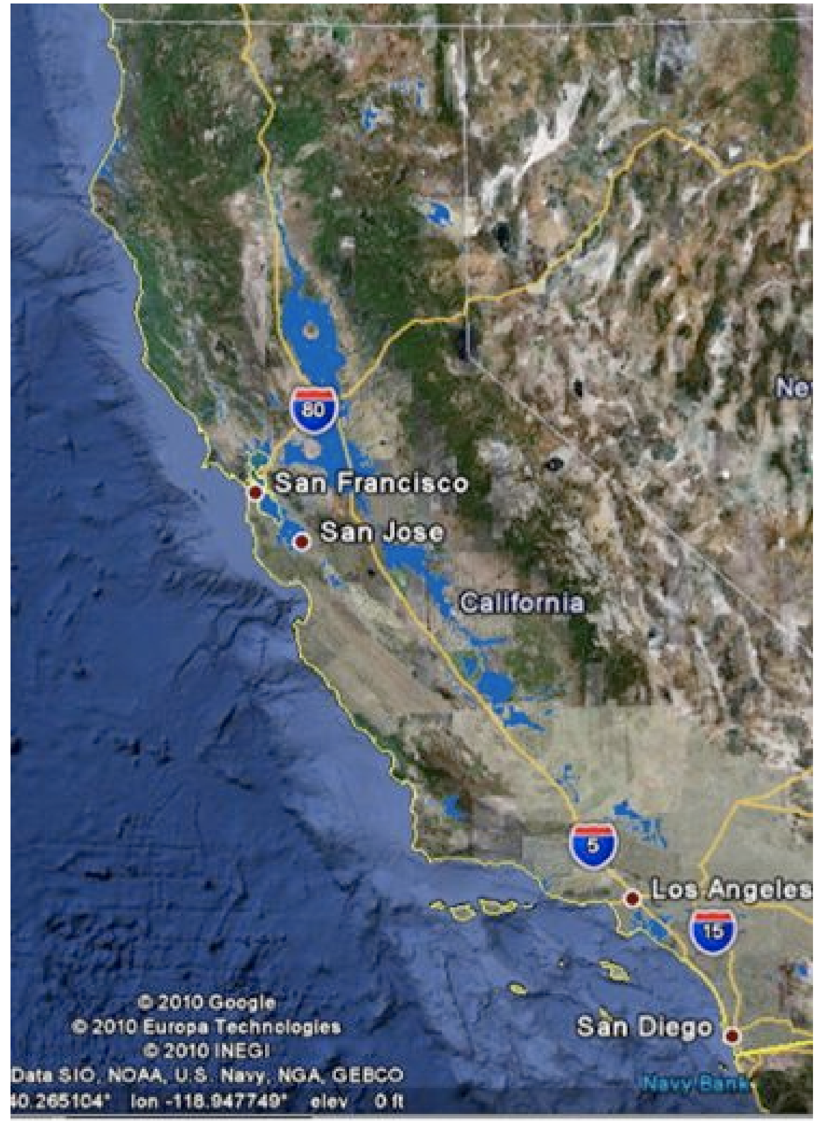
ARkStorm Scenario Project Report: The USGS Multi Hazards Demonstration Project, called ARkStorm, models the physical, economic, and social impacts of massive storms predicted to occur on the west coast of California. Scientists from the NOAA, USGS, Scripps Institute of Oceanography, FEMA, NCAR, California Department of Water Resources, CalEMA, and the University of Colorado are collaborating on this project. Some of the key findings of ARkStorm Scenario Project Report include:

Impacts of a Megastorm

Scientists believe a winter megastorm is inevitable for California. Such a storm might drop as much as 10 feet of rain on California over the course of a single month. [48] A severe California winter storm could realistically flood thousands of square miles of urban and agricultural land, result in thousands of landslides, disrupt lifelines throughout the state for days or weeks, and cost on the order of $725 billion. The $725 billion figure comprises approximately $400 billion in property damage and $325 billion in business-interruption losses. An event like the ARkStorm could require the evacuation of 1,500,000 people. At the same time, traffic from Los Angeles to the north could be cut off for weeks because of highway damage. Because the flood depths in some areas could realistically be on the order of 10-20 ft, without effective evacuation, there could be substantial loss of life.

Megastorms are California's other "Big One"

Lucy Jones, the chief scientist for the Multi-Hazards Demonstration Project, states that, "For a storm of about the same probability of occurrence as a major earthquake on the San Andreas Fault, scientists are predicting four-times as much damage from an ARkStorm flooding event. Californians are aware they face a risk from an earthquake, they are less aware of the risk they face from floods." [47]



California floods in blue from simulated winter megastorm (USGS ARkstorm report). It might not happen this year, or next. But, based on

California's history of storms in the past, another winter megastorm will happen sometime, these scientists say. [48]

An ARkStorm is Extremely Plausible, Perhaps Inevitable

Lucy Jones, Chief Scientist for the USGS Multihazards Demonstration Project, said that her team used the geologic record in order to explore the question of how often winter megastorms can be expected to strike California. They used sediment deposits offshore from some of California's big rivers. She stated, "And, as we analyzed those records – we've done one off of Ventura County and one in the Bay area – we're able to see that in fact, there have been some very, very large storms that led to huge loads of sediment coming out of the rivers. It happened six times in the previous 1,800 years. The storm of 1861-62 doesn't show up in that record. So, that one was smaller than these very big events. This tells us that the very big events are very rare [six occurrences in 1,800 years calculates to one event per 300 years on average], but they are recurring. [47] And the expectation is that the future will be like the past. In a time of global climate change, storms are going to be at least as frequent as the past, along with the potential that they'll actually increase in frequency, as we put more energy into the atmosphere." She said she wanted to be clear is that the USGS report is not a prediction of a particular event. It's a synthetic model, and every reality in the future will be different in some way, she said. But, based on the ARkstorm simulation, Jones and other USGS scientists believe a coming megastorm for California is extremely plausible. [48]

Preparedness Level

California's flood control system has worked so well that people no longer feel the impact of the small or moderate events. Fifty years ago, people experienced major flooding across California pretty frequently. Now, many people haven't really experienced a major flood. But those flood-control systems only function up to some level.

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

- 0 Infeasible Event – not applicable due to geographic location characteristics
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Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for flooding in Merced is considered a regular event.

3.3.2 Fire

Merced Sun Star - Bea Ahbeck

150-acre wind-driven grass fire near the Merced Regional Airport, 4-30-13.

General Background

Fire hazards occur in three zones in the Planning area, including: 1) urban fires; 2) wildfires; and 3) urban-wildland interface fires.

An urban fire or conflagration is an uncontrolled fire occurring in developed area where the fire spreads from one structure/improvement to another structure/improvement. Similar to wildland fire, urban fire hazards are more significant in the hot, dry months, but can occur at any time of the year.

A wildfire is an uncontrolled fire spreading through vegetative fuels, posing danger and destruction to life and property. Wildfires can occur in undeveloped areas and spread to urban areas where structures and other human development are more concentrated. [2] Wildland fire season extends from late-May through October of each year during the hot, dry months.

The "urban-wildland interface" describes an area where urban development has been located in proximity to open space, or wildland areas. [2]

Location

WILDFIRES

There are hundreds of acres of unimproved lands within the City, which produce prolific quantities of annual grasses. These grasses cure during the late-spring and early-summer months to develop a receptive fuel bed of light, flashy fuels. The unimproved lands range in size from a portion of a residential lot, to an entire lot, to multiple lots, to several hundred contiguous acres. The northern and southern aspects of the City are at the greatest risk of a wildfire based on annexations, which have resulted in incomplete residential developments, and the comingling of structures and unimproved areas. As a rule, the central aspects of the City have been built-out; however, scattered vacant lots pose an ongoing risk.

URBAN FIRE

The risk for an urban fire exists in all developed areas of the City; however, the greatest risk exists in the central and southern portions of the City where combustible materials were widely used to construct the buildings, and the applicable fire and building codes were less stringent than are currently in effect.

Geographic Information System (GIS) analysis of structure fire incidents that have occurred within the City were inconclusive regarding the ability to identify areas that are more at-risk than other areas. The data found that structure fires have occurred and continue to occur in all areas of the City without any correlation between geographic areas, occupancy type, construction type, or socioeconomic factors.

An analysis of risk factors, including: construction materials, upkeep, proximity to other structures, and proximity to unimproved lands was conducted to identify general areas that could be at greater risk for urban fires. The analysis found that the northern aspects of the City include construction that is newer than the other areas of the City. As such, the construction materials and the applicable fire codes at the time of construction, create a lower risk for an urban fire than the other areas within the City. Conversely, the southern portion of the City contains older homes that were constructed with greater quantities of combustible materials and were built under the auspices of less stringent fire and building codes. This results in a higher risk for an urban fire.

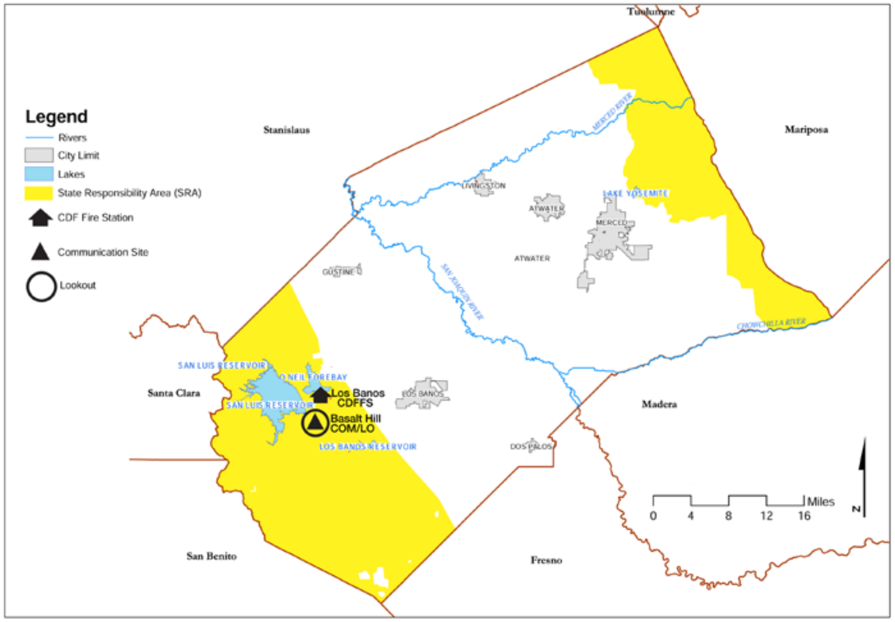
The central portion of the City consists of a mix of residential and commercial occupancies. Some of which exist on zero-clearance lots or are interconnected to neighboring structures. Additionally, this portion of the City consists of older structures that built with combustible materials, do not comply with current building/fire codes, or both. This assessment is an overall generalization of the building and construction types, but is not an absolute statement.

Extent

California Department of Forestry and Fire Protection's (CalFIRE) Fire and Resource Assessment Program (FRAP), models fuel and fire hazard severity rankings and potential fire threat, prioritizes fuel reduction projects, and determines an area's level of service (LOS) rating within State Responsibility Areas. State Responsibility Areas (SRA) occur in the eastern and western portion of Merced County, while Local Responsible Areas (LRA) occur on the floor of the Central Valley (see map on page 3-49). The City of Merced is located within just the LRA.

For both areas, CalFIRE has developed an estimate of fire risk in Wildland Urban Interface areas based a variety of factors in two categories: fire frequency and fire behavior. The State has individually mapped the fire frequency and fire behavior potential and has combined both into a single assessment called Fire Threat.

The Merced County Fire Hazard Severity Zones Map, including the area within the LRA is shown on page 50.



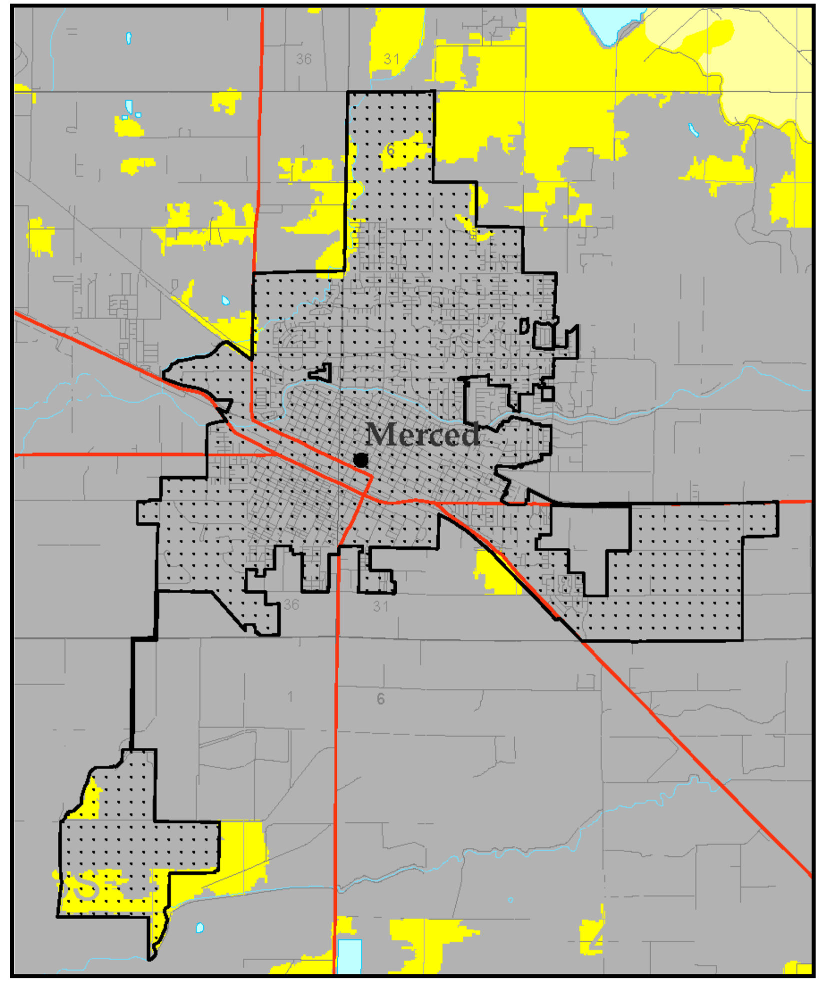
According to CalFIRE's Fire and Resource Assessment Program (FRAP), a significant fire threat is found throughout California, with 48 percent of the state's wildland areas ranked as high, very high, or extremely high. About 37 percent of the state has a moderate fire threat, and 15 percent presents non-fuel conditions. CAL FIRE determined that Merced County has no" Very High Fire Hazard Severity Zones" in the LRA, and the City has both non-fuel and moderate fire hazard threats. Merced County does not have a map of recommended VHFHSZ in LRA.

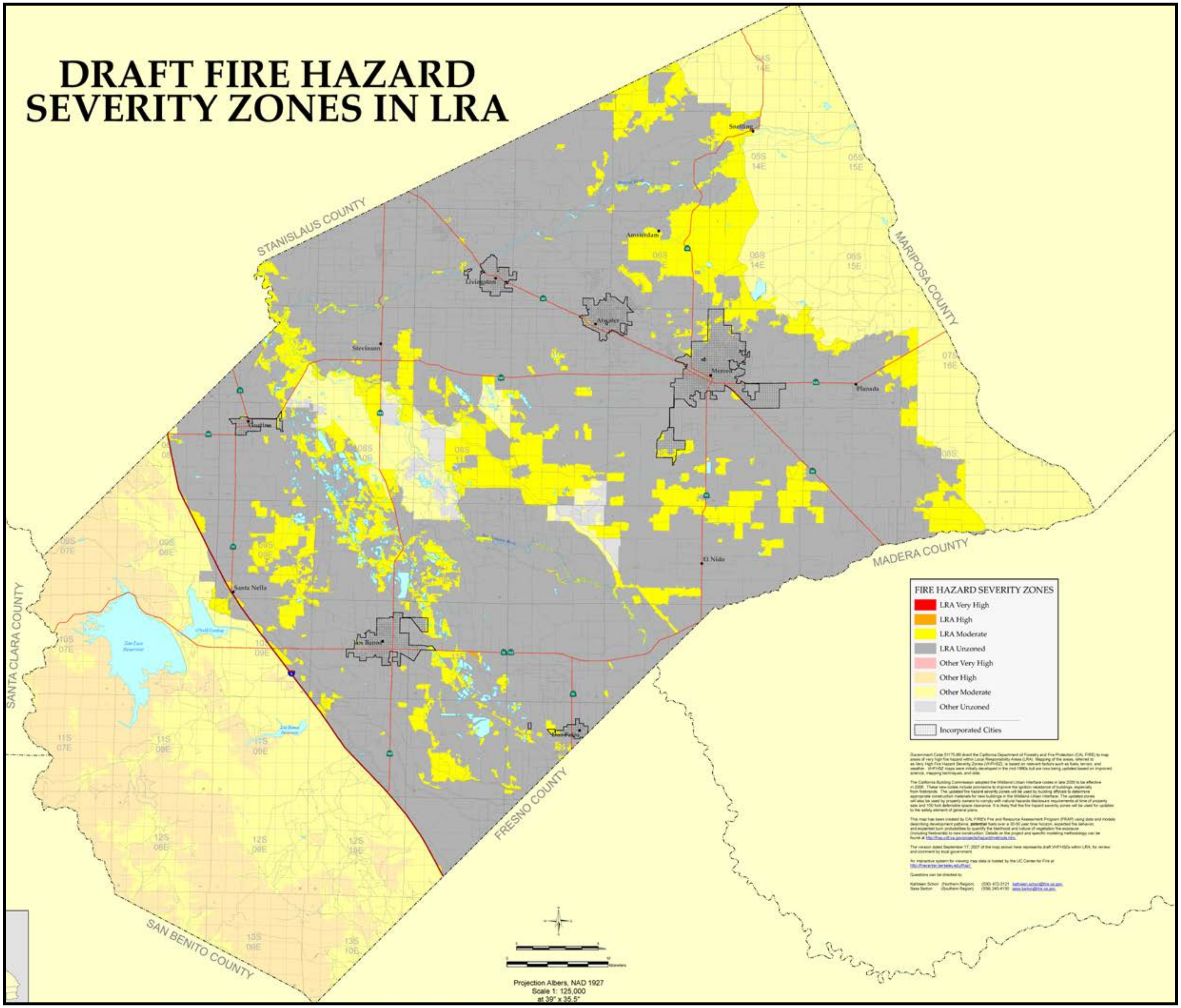
INTERFACE ZONES

According to the CalFIRE, the greatest potential for significant damage to life and property from fire exists in areas designated as Wildland Urban Interface (WUI) areas. A WUI area defines the condition where highly flammable vegetation is adjacent to developed areas.

A significant portion of the area surrounding Merced is used for agricultural purposes. Thus, the City of Merced does not include any areas designated as Wildland-Urban Interface Areas by the State.

While this definition is typically associated with wildland fires, this condition can also exist in an urban setting, where grasslands abut urban areas or where flammable construction materials exist. A LRA "Moderate Fire Hazard Severity Zone" occurs adjacent to several locales in the City of Merced, as shown in a close-up view of the 2007 Merced County Fire Hazard Severity Zone Map below.




DRAFT FIRE HAZARD SEVERITY ZONES IN LRA
STANISLAUS COUNTY
MARIPOSA COUNTY
MADERA COUNTY
FRESNO COUNTY
SAN BENITO COUNTY
SANTA CLARA COUNTY
Snelling
Amsterdam
Livingston
Atwater
Stevinson
Merced
Planada
Gustine
El Nido
Santa Nella
Los Banos
FIRE HAZARD SEVERITY ZONES
LRA Very High
LRA High
LRA Moderate
LRA Unzoned
Other Very High
Other High
Other Moderate
Other Unzoned
Incorporated Cities
Projection Albers, NAD 1927
Scale 1: 125,000
at 39" x 35.5"

Conditions that Exacerbate or Mitigate Potential Effects

Both wildland and urban fire hazards are an ongoing threat within the City of Merced Planning Area. The significance of the fire hazard varies based on the availability of receptive fuels, topography, weather conditions, and human factors.

FUELS

As a result of being located in the Central Valley, Merced does not possess the fuel diversity that is experienced throughout the rest of the State. The City is at risk for wildfires that start in the undeveloped grasslands to the west and north of Merced, in the partially developed areas in the northern part of the City, and in the open space and preserve areas dedicated in perpetuity throughout the City.

FIRE SPREAD / TOPOGRAPHY

The effects of topographical influences on wildland/urban fire within the City are minimal. The City of Merced is essentially flat, and ranges in elevation from one hundred seventy-one feet at the Merced Municipal Airport to two hundred feet at the University of California – Merced campus. The terrain does not consist of any hills or drainages that could significantly affect fire spread.

WEATHER CONDITIONS / WINDS

Based on the geographic and topographic features of California in combination with a wind-based weather phenomenon known as subsidence, the State has annually faced extreme wind and fire conditions. Northern California has historically dealt with the North Winds, whereas Southern California has been affected by the Santa Ana Winds. These winds have caused extreme fire behavior situations by increasing temperatures, dropping the relative humidity to critical levels, and producing sustained and gusting wind speed up to seventy-five miles-per-hour.

The North Winds, in combination with the light, flashy fuels synergistically increase the risk to the City. Merced is also affected during the summer months by a marine influence and the associated diurnal cycles. These cycles can result in sustained westerly winds that can greatly increase the level of fire danger. However, unlike the North Winds, the winds associated with the cycles typically carry moisture, which can reduce the potential hazard.

HUMAN-INFLUENCE FACTORS

Human-influence factors range from preventative measures to active involvement in fire causation. Preventative measures include actions that are designed to mitigate one or more of the factors listed above. This can include fuel abatement, building construction materials, and restrictions placed on outside fires. On the other hand, a majority of fires are associated with careless use or mishandling of hot materials including smoking, campfires, equipment use, and arson.

The possibility of the presence of flammable and hazardous materials in commercial and industrial fire scenes heightens the likelihood of initially uncontrollable structural fire conditions in outbuildings or in items stored outside. Overall, this hazard is considered a moderate risk to the City of Merced. [2]

Previous Occurrences

On average, the City of Merced Fire Department responds to a total of 389.25 fires per year, of which 113.25 (29.1%) are structure fires and 80.5 (20.7%) are wildland fires. The remaining 50.2% of the fire incidents within the City included vehicle fires, rubbish fires, outside fires, and other fire types that did not involve structures or unimproved open areas. NOTE: The MFD responds to an average of 2 wildland fire incidents on an annual basis where structures/improvements are either damaged or destroyed. Former Fire Chief Mitten also identified that there have not been any structures lost within the City as a result of a wildland fire. [1]

WILDLAND FIRES

As the City annexes large blocks of undeveloped land, the potential for wildland fires (mainly grassland fires) within the City increases. The City Fire Department is typically called to 6 to 10 significant grassland fires per year which occur in County fringe areas adjacent to the City limits. The Fire Department is also frequently called to provide mutual aid to the County for grassland fires in the wider Merced area due to increasingly strained fire fighting resources within the County over the last decade. [3]

The historical data conveyed in *California Fire Perimeters – Wildfire 1950-2009* shows that there have been major wildland fires in Merced County; however, none have been in or around the City of Merced.

Major Wildland Fire Defined:

"Timber fires greater than 10-acres, brush fires greater than 50-acres, grass fires greater than 300-acres; wildland fires that destroyed 3 or more structures, or wildland fires causing more than $300,000 in damage.

In 2010, the MFD along with mutual aid responders were dispatched to mitigate a 265-acre wildland fire in the wetlands that surround the southern aspects of the City's wastewater treatment plant. This was the largest wildland fire to have occurred within the City limits in many decades. In May 2008 the City of Turlock, which is located twenty-six miles north of and has the same topography as Merced, experienced a wind-driven wildland fire that resulted in one fatality, several homes destroyed, and dozens of acres burned. Similarly, in June 2008, the City of Stockton suffered a wind driven fire that destroyed thirty-two residences. Stockton is located sixty-four miles north of Merced and is geographically and socioeconomically similar to Turlock and Merced.

On April 30, 2013, a large "wind-driven grass fire" near Merced Regional Airport burned about 150 acres. No injuries were reported and the only known property that was damaged were fence posts. The runway had to be closed for about an hour because of the fire.

ARSON

In regards to fires caused by arson, former Fire Chief Mitten (personal communication, January 20, 2009) discussed an eighteen month period in the early 1980's when there were six major fires that were determined to be arson in origin. The State Fire Marshal's Office and the Department of Alcohol, Tobacco, and Firearms were requested to investigate and seek convictions of the offenders. In total, there were six fires that caused an estimated nine million dollars in damage. [1]

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

- 0 Infeasible Event – not applicable due to geographic location characteristics
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Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Fire" in Merced is considered a frequent event.

3.3.3 Drought

General Background

Drought is a gradual phenomenon, occurring slowly over multi-year periods and increasing with the length of dry conditions. The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area. There are several ways that drought can be defined.

Meteorological - a measure of departure of precipitation from normal. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.

Agricultural - refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop.

Hydrological - occurs when surface and subsurface water supplies are below normal.

Socioeconomic – occurs when the results of drought impacts the health, well being, and quality of life, or when a drought starts to have an adverse economic impact on a region. (Source: National Drought Mitigation Center, University of Nebraska, Lincoln)

Regulatory – occurs when mandatory compliance with environmental protection laws (especially those pertaining to protection of endangered species) combined with low precipitation and runoff, produce deficiencies in agricultural and/or urban water supplies.

Location and Extent

In addition to the description below, see Appendix D that includes updated information.

In general, drought has the potential to directly and indirectly impact each and every person within the City, as well as adversely affect the local economy. Individuals and properties will be affected at varying levels, depending upon their water source and water needs. For example, a property owner with a large water demand and private well, are more likely to be impacted than a small City lot using groundwater from the City's domestic water supply system

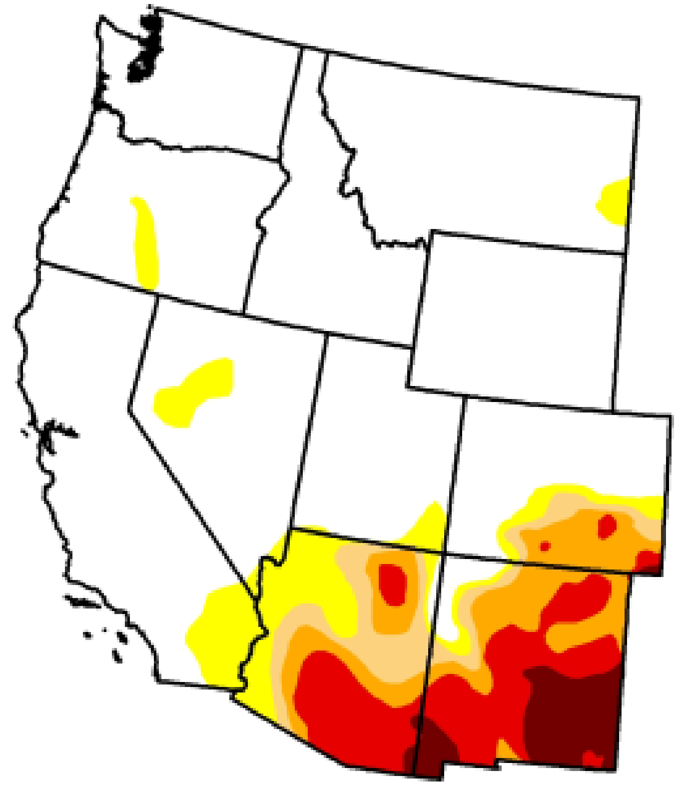
U.S. Drought Monitor

West

November 1, 2011
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	74.16	25.84	18.67	15.19	9.60	2.87
Last Week (10/25/2011 map)	74.12	25.88	18.32	14.67	8.48	2.87
3 Months Ago (08/02/2011 map)	74.90	25.10	18.98	15.44	11.10	5.52
Start of Calendar Year (12/28/2010 map)	73.26	26.74	11.98	0.89	0.00	0.00
Start of Water Year (09/27/2011 map)	66.72	33.28	19.04	14.99	9.30	3.81
One Year Ago (10/26/2010 map)	69.02	30.98	5.39	0.19	0.00	0.00



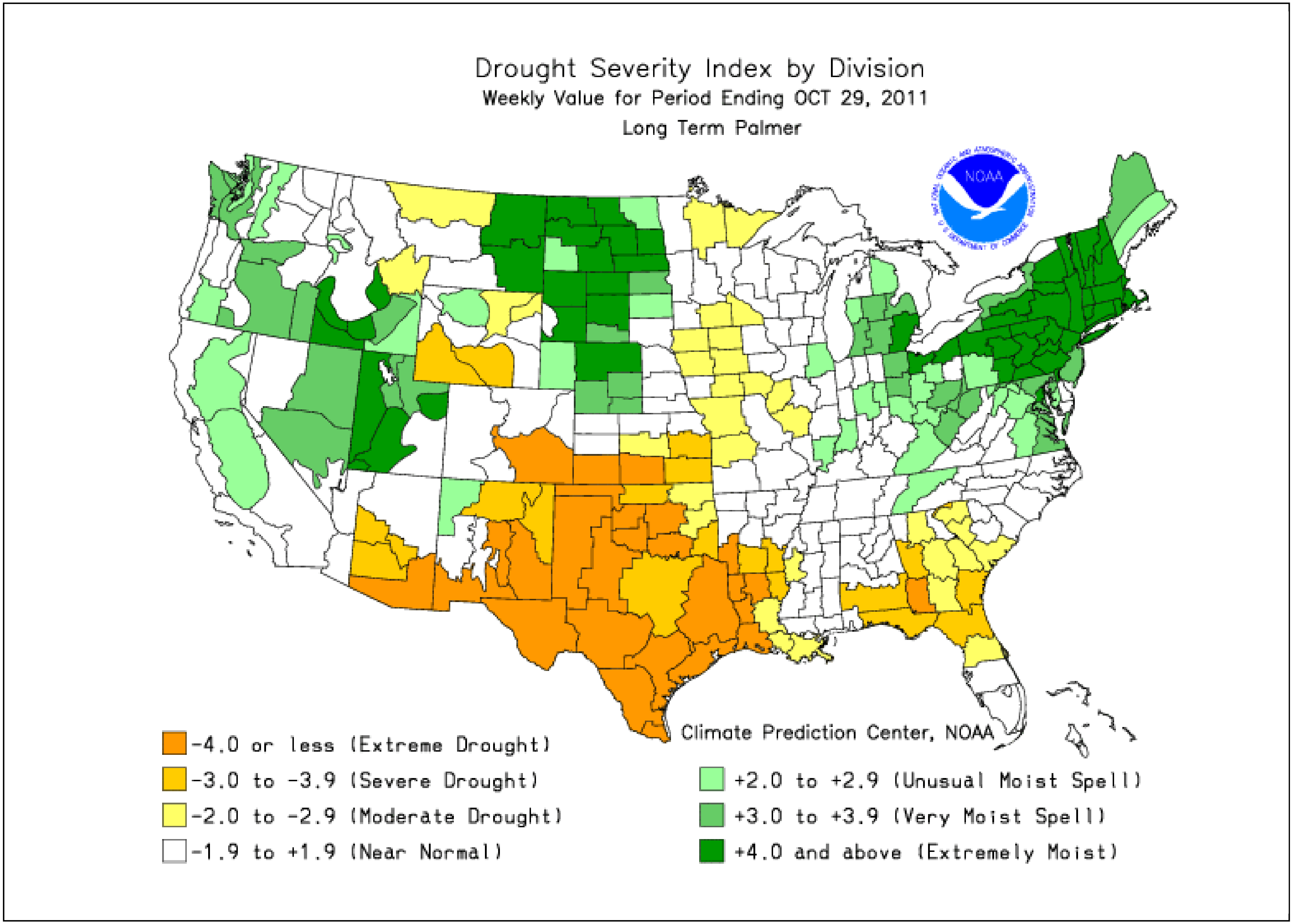
Intensity:

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

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

http://droughtmonitor.unl.edu

Released Thursday, November 3, 2011
Brian Fuchs, National Drought Mitigation Center


Drought Severity Index by Division
Weekly Value for Period Ending OCT 29, 2011
Long Term Palmer
NOAA
Climate Prediction Center, NOAA
-4.0 or less (Extreme Drought)
-3.0 to -3.9 (Severe Drought)
-2.0 to -2.9 (Moderate Drought)
-1.9 to +1.9 (Near Normal)
+2.0 to +2.9 (Unusual Moist Spell)
+3.0 to +3.9 (Very Moist Spell)
+4.0 and above (Extremely Moist)

Conditions that Exacerbate or Mitigate Potential Effects

Drought is a major determinant of wildfire hazard, in terms of greater propensity for fire starts and larger, more prolonged conflagrations fueled by excessively dry vegetation and reduced water supply for firefighting purposes.

Previous Occurrences

Drought is different than many of the other natural hazards in that it is not a distinct event and usually has a slow onset. Periods of actual drought with adverse impacts can vary in duration, and the period between droughts is often extended. Although an area may be under an extended dry period, determining when it becomes a drought is based on impacts to individual water users.

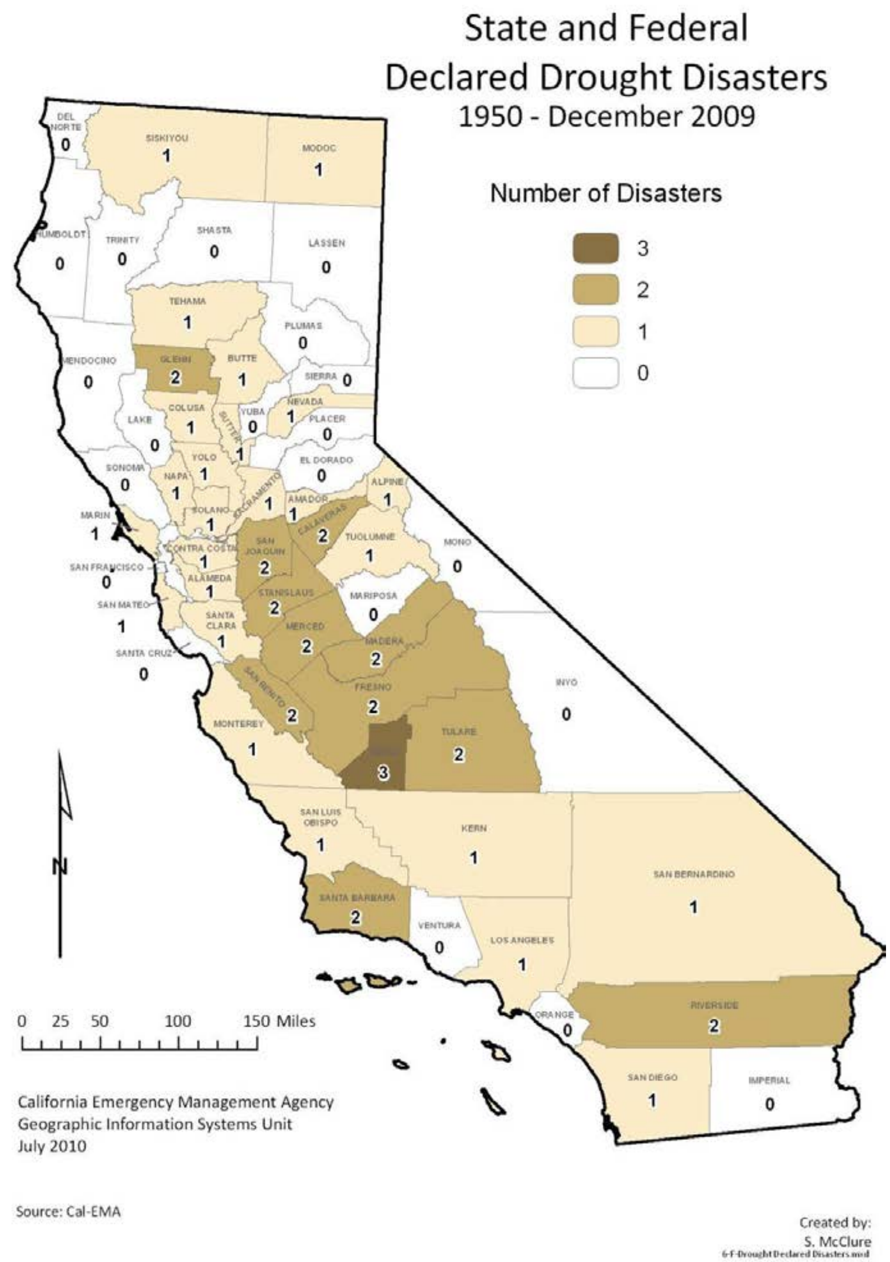
The 1975-1977 Drought: From November 1975 through November 1977, California experienced one of its most severe droughts. Thirty-one counties were disaster-declared. Although people in most areas of the state are accustomed to almost no precipitation during the growing season (April to October), they expect it in the winter. In 1976 and 1977, the winters brought only one-half and one-third of normal precipitation, respectively, leading to the state's fourth and first driest years on record. Most surface storage reservoirs were substantially drained in 1976, leading to widespread water shortages when 1977 turned out to be even drier. Due to this drought, water rights issues moved to the top of political agendas, and low-flow water fixtures and natural landscaping in California were ushered in. [42] Merced County was one of many areas that suffered crop damage, which totaled $2.67 billion statewide during this drought period.

The 1987-1992 Drought: The 1987-92 drought was notable for its six-year duration and the statewide nature of its impacts. For the central coast and central Sierra Nevada, 1987 to 1990 was the driest period on record. In 1988, 45 California counties experienced water shortages that adversely affected about 30 percent of the state's population, much of the dry farmed agriculture, and over 40 percent of the irrigated agriculture. Fish and wildlife resources suffered; recreational use of lakes and rivers decreased; forestry losses and fires increased; and hydroelectric power production decreased. Not since the 1928-34 drought had there been such a prolonged dry period.

The 2007-2009 Drought: California's last major statewide drought was 2007-2009, notably affecting Central Valley communities, including those in Merced County. Following two critically dry years, 2009 had the potential to be one of the most severe drought years in California's recorded history. Water supplies in major reservoirs and many groundwater basins were already well below average. Additionally, court-ordered restrictions on water deliveries from the Delta had significantly reduced supplies from the state's two largest water systems. [43]

STATE AND FEDERAL DECLARED DROUGHT DISASTERS

Map on this page shows the pattern of drought-declared State and Federal Declared Drought Disasters in California between 1950 and December 2009, [14]disasters. Heaviest concentrations are in the Central Valley and inland areas.



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Based on these inputs, the Probability of Occurrence for "Drought" in Merced is considered an infrequent event.

3.3.4 Hazardous Materials

General Background

Hazard Definition: Hazardous materials (Hazmats) consist of substances that by their nature, lack of containment, and reactivity, have the capability for inflicting harm. Hazmat poses a threat to health and the environment when improperly managed. Hazmat can be toxic, corrosive, flammable, explosive, reactive, an irritant, or a strong sensitizer. Hazmat substances also include certain infectious agents, radiological materials, oxidizers, oil, used oil, petroleum products, and industrial solid waste substances. [2]

Hazardous material incidents are one of the most common technological threats to public health and the environment. Incidents may occur as the result of natural disasters, human error, and/or accident.

Location

Hazardous materials are located in the following areas of the City of Merced:

- Hazardous Material Generators/Handler Facilities (Fixed-Locations)
- Hazardous Waste Cleanup Areas;
- Transport Corridors / Transportation-Related Hazardous Materials;
- Natural and Liquified Gas Pipelines;
- Agricultural Sites; and
- Intentional Release-Related Hazardous Materials.

HAZARDOUS MATERIAL GENERATORS / HANDLER FACILITIES

A fixed location may be a factory or holding tank, or any facility that produces, stores, or uses hazardous materials. Fixed facilities for potential releases can be easier to identify and prepare for because of their stationary nature. Fixed locations are also subject to Federal and State reporting requirements and inventory control methods. This category also includes groundwater remediation sites, which occur throughout Merced, and are discussed in greater detail in the "Occurrence" section of this report.

Uncontrolled releases can occur within a fixed facility, such as at a refinery, as a result of a defective industrial process or storage situation. Refineries may have equipment or valves fail. This can result in leaks into the streets or ground or even releases to the atmosphere. Many examples of refinery hazardous materials incidents have been documented. Examples of hazards from a fixed location in Merced include gas stations with fuel spillage from dispensers, delivery trucks, and above ground or underground storage tanks.

The County Department of Environmental Health uses a program called Envision to manage all of the hazardous materials generators.

HAZARDOUS CLEANUP AREAS

The Merced County Division of Environmental Health, which oversees the enforcement of the *Merced County Hazardous Waste Management Plan,* maintains an up-to-date list of known hazardous waste sites within the County. In 2009, there were approximately 63 known hazardous waste sites within the City of Merced. Cleanup is required at sites that exceed State standards for contamination prior to development or reuse of the site. Merced's contaminated sites are generally overseen by Merced County Division of Environmental Health, the State Dept of Toxics Substances Control, the State Regional Water Quality Control Board or US EPA. State Department of Health Services (DHS) has reorganized and deals with hospitals, tobacco, drug abuse, etc., human issues and not contamination sites. DHS may get involved with a contamination site if cancer rates are high in a particular area.

TRANSPORT CORRIDORS

Materials in transport enter and leave the jurisdictional boundaries with little or no notice to the local agency. This is of particular concern in cases of discrete vehicles, such as trains or trucks, traveling with hazardous cargo through the City at any given time. Hazardous materials can be on any road, but shipment by main highways and rail are the most common methods. Materials in pipelines are also considered to be in transit, although it is easier to identify the locations and potential effect of these hazards because pipelines do not move or change material transported. Pipelines are discussed separately in this Section. The State Route Map in the Community Profile section displays the main roads through the City, these roads having increased risk due to a greater number of vehicles moving along this with more varied cargo.

NATURAL AND LIQUIFIED GAS PIPELINES

Natural Gas

Generally speaking, *transmission* lines are large diameter steel pipes carrying natural gas at high pressure and compressed to provide higher carrying capacity. Transmission lines are both interstate and intrastate, with the latter connecting to smaller *distribution* lines delivering gas directly to homes and businesses. Data compiled by the Pipeline and Hazardous Materials Safety Administration (PHMSA) report a total of 115,291 miles of gas pipelines in California, of which 12,414 are classified as gas transmission lines, 403 are gas-gathering lines, and the majority, 102,475, are for gas distribution. Nearly 40 percent of gas transmission lines are located in Los Angeles, Kern, and San Bernardino counties.[72]

Two major natural gas *transmission* pipelines pass through the City of Merced, generally parallel to the Burlington Northern-Santa Fe Railway and the Union Pacific Railway alignments. One is an 8” diameter pipeline installed circa 1931 and the other is a 16” diameter pipeline installed circa 2008. Two additional natural gas *transmission* pipelines originate from these major pipelines and feed areas north and east. A 6” diameter pipeline originates near Childs and SR 99, traverses east to Parsons Ave where it shifts to an alignment in SR 140 (Yosemite Parkway) easterly for approximately 2.5 miles, and a 8”/6” diameter pipeline that originates near 16th St and J-59, follows J-59 north to Yosemite Avenue and east to Merced College. These transmission pipelines operate at a higher pressure and are generally larger than distribution pipelines. Transmission pipelines transport the natural gas from the compressor stations and storage facilities to regulators which reduce the pressure before reaching the distribution system. The distribution system feeds the smaller pipelines at pressures under 60 psi that deliver gas to individual businesses or residences. Distribution pipelines are integrated for capacity and reliability purposes, and typically are located in most streets where there is a residence or facility that requires gas service.

Lessons from San Bruno Natural Gas Explosion

On September 9, 2010, at approximately 6:11 P.M., a 30-inch diameter underground natural gas transmission pipeline suddenly ruptured. The pipeline was located under the asphalt paving at the intersection of Glenview Drive and Earl Avenue in a residential area of San Bruno, California. Installed in 1956, the ruptured pipeline was propelled into the air and landed about 100 feet away. An explosion ensued, fueled by blowing natural gas. The explosion and fire resulted in the loss of eight lives and the total destruction of 38 homes. Seventy homes sustained damage and eighteen homes adjacent to the destroyed dwellings were left uninhabitable.

---Report of the Independent Review Panel, San Bruno Explosion. Prepared For California Public Utilities Commission Revised Copy June 24, 2011.

After the explosion in San Bruno, PG&E was required to show their records to the California Public Utilities Commission to prove that they have strength tested their transmission pipelines to establish the maximum allowable operating pressure (MAOP) of those lines. PG&E has a map on their website that shows where the pipelines are, what areas have documentation that proves that the pipelines have been tested, areas where they want to research the documentation and pipelines further, and areas where repairs are needed. PG&E has documentation that proves that they have tested most of the pipelines according to applicable code requirements. There is an area on Snelling Highway and West Yosemite Avenue that is designated “pipeline segments in high consequence areas” (HCAs) that are still under review. High consequence areas are a “federal natural gas pipeline industry term that refers to the more populated areas of a service territory” (PG&E.com). Although PG&E plans to investigate its records further, this doesn’t mean that there’s an imminent danger. PG&E is prioritizing its HCA areas in its records review and strength testing verification efforts.

Liquefied Petroleum Pipeline

A liquefied petroleum pipeline runs parallel along U.P.R.R on the south end. The high pressure petroleum line is 12” in diameter and varies in depth along the track.

AGRICULTURAL SITES

Merced is surrounded by agriculture activity in the adjacent countryside, including ranching to the north and orchards and field crops to the west, east, and south. This raises concerns due to the use of agricultural chemicals such as fertilizers and pesticides. Application of these items to crops and the soil has been regulated more in recent years, but decades of no regulations has left these lands and related groundwater in an undefined situation. The City is pursuing a joint effort with several entities, such as Merced Irrigation District and Merced County, to perform further groundwater studies and computer modeling.

INTENTIONAL RELEASE

Finally, another source of hazardous materials incidents is the illegal manufacturing of drugs in clandestine laboratories. In many instances, the residue and hazardous waste from these laboratories are illegally dumped, posing a threat to public health, safety, and the environment. In recent years, clandestine laboratories have become an increasingly familiar problem to the City of Merced. [2]

Extent

The magnitude of a hazardous material spill is determined by both the type of material, the size of material released during the incident, and the location of the event.

The City of Merced is home to a few companies and industries that manufacture, store, use, and dispose of toxic materials. The Study Area is highly exposed to hazardous materials transported over major interstate highways, state routes, and railways. On any given day, a vast assortment of petroleum products, agricultural pesticides, and industrial chemicals are moved within and through our City with the possibility of generating a hazardous materials incident. [2]

Hazardous materials incidents in the City of Merced would most likely occur on the transportation routes or at fixed hazardous materials facilities. Hazardous materials are often transported through the City of Merced area on State Route Highways 99 and on the Union Pacific and Burlington Northern Santa Fe Railroads. Surface streets are also used for the local transportation of hazardous materials. [2]

LOCAL CONDITIONS INFLUENCE

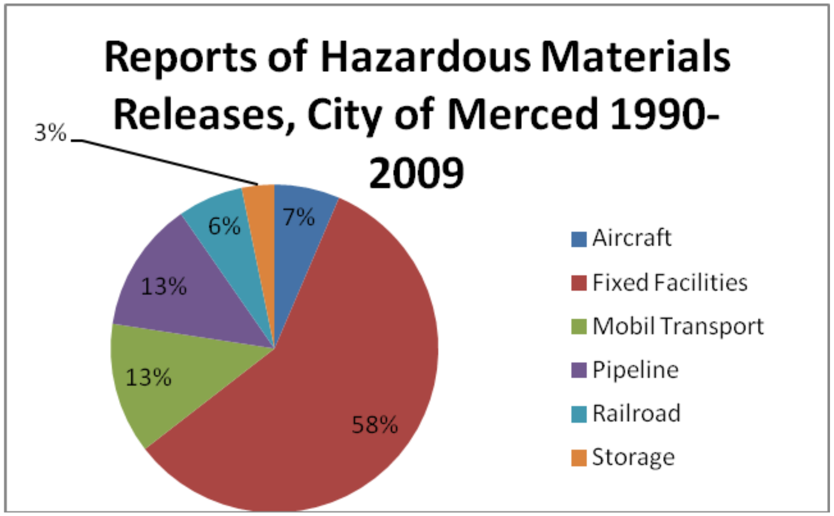
The conditions found at the location of a potential hazardous material incident can exacerbate the effects of the incident. Natural conditions such as severe rain or windy weather, permeability surfaces, and close proximity to ground and surface waters need to be considered during response actions. Additionally human-made conditions, such as storm and sewer drains, also need to be accounted for, as they could lead to an accelerated contaminate spread. The City's Emergency Operation Center (EOC) already keeps information on how to isolate hazardous releases along highways and railroads, in preparation for any such need.

Conversely, certain conditions help to allow a longer response time frame, or even mitigate need for response. Optimal natural conditions include calm weather and impermeable surfaces at the incident site. Proper containment of hazardous materials, both in transport and in fixed facilities will help to mitigate incidents. For many of these substances, secondary containment becomes imperative should these items spill or their initial containers be breached or sustains damage. Many fixed location sites have some type of secondary containment facility and these are often required by law.

For materials being transported by truck, there are two additional concerns in Merced. First, is the elevated freeway, being 20 to 24 feet above adjacent land. This gives an errant truck that much more vertical distance to tumble or roll down rather than just go off the road. The second is a heavy fog season that restricts visibility to 120-feet at times and usually occurs at night or near sunrise.

Previous Occurrences

Due to the constant presence of hazardous materials in the jurisdictional boundaries, it is possible for a hazardous material incident to occur at anytime. Merced has been fortunate enough to have had few major releases of hazardous material, however. Data obtained from the National Response Center from 1990 – 2009 shows all hazardous materials and oil releases reported federally. Of the 76 incidents reported in the City, 31 were actual material releases, the other 45 were non-releases. The pie chart below shows the sources of these material releases.



GROUNDWATER CLEANUP

Merced is involved with a number of groundwater cleanups, clearing the remains of previous materials releases. Common substances, such as gasoline from former gas stations located at 19th Street at N Street and also R Street at 14th Street, are considered hazardous materials when released in the ground. Additionally dry cleaners at several locations are receiving PCE groundwater remediation. The largest cleanup site is on Kibby Road south of Highway 140 where a groundwater extraction and treatment process is used to clean up trichloroethene (TCE). TCE is a chlorinated hydrocarbon solvent used to clean electrical transformers. The former on-site industry used to discharge spent solvents containing TCE to an unlined pond, where it spread to contaminate soil and groundwater.

NATURAL AND LIQUID GAS

Should an incident occur that either breaches or compromises the integrity of natural gas pipelines, many of the citizens within the City would become affected. Such an incident would greatly affect businesses, the railways, highway transportation routes, and the environment. [6]

Pipeline and Hazardous Materials Safety Administration (PHMSA) tracks significant incidents and losses as a result of pipeline accidents occurring on gas transmission lines and gas distribution lines. Significant incidents are those reported by pipeline operators with either: 1) fatality or injury requiring in-patient hospitalization, or 2) $50,000 or more in total costs, measured in 1984 dollars. From 2000 to 2009, a total of 22 incidents were reported on California transmission lines, causing 1 fatality, 2 injuries, and $12 million in property damage. For that period, a total of 65 incidents were reported on local gas distribution lines, resulting in 3 fatalities, 16 injuries, and $14 million in property damage.[73]

There have been gas spills caused by negligent individuals. For example, on April 8, 2008, when thieves tried to siphon gas from a Valero gas station at 655 Yosemite Parkway, the gas spilled out uncontrollably, and the thieves drove away. According to the Merced Sun Star, about 1,014 gallons of fuel spilled out. Incident responders were able to prevent the gas from pouring into the surrounding storm drains.

Regarding natural gas lines, the greatest threat posed to PG&E pipelines, including those in Merced, is damage caused by third parties that dig into buried pipelines without having them properly marked by PG&E, and, these third-party “dig-ins” may have resulted in the release of natural gas, and may also have resulted in small fires, according to James Monninger, Principal – Strategic Planner. [7]

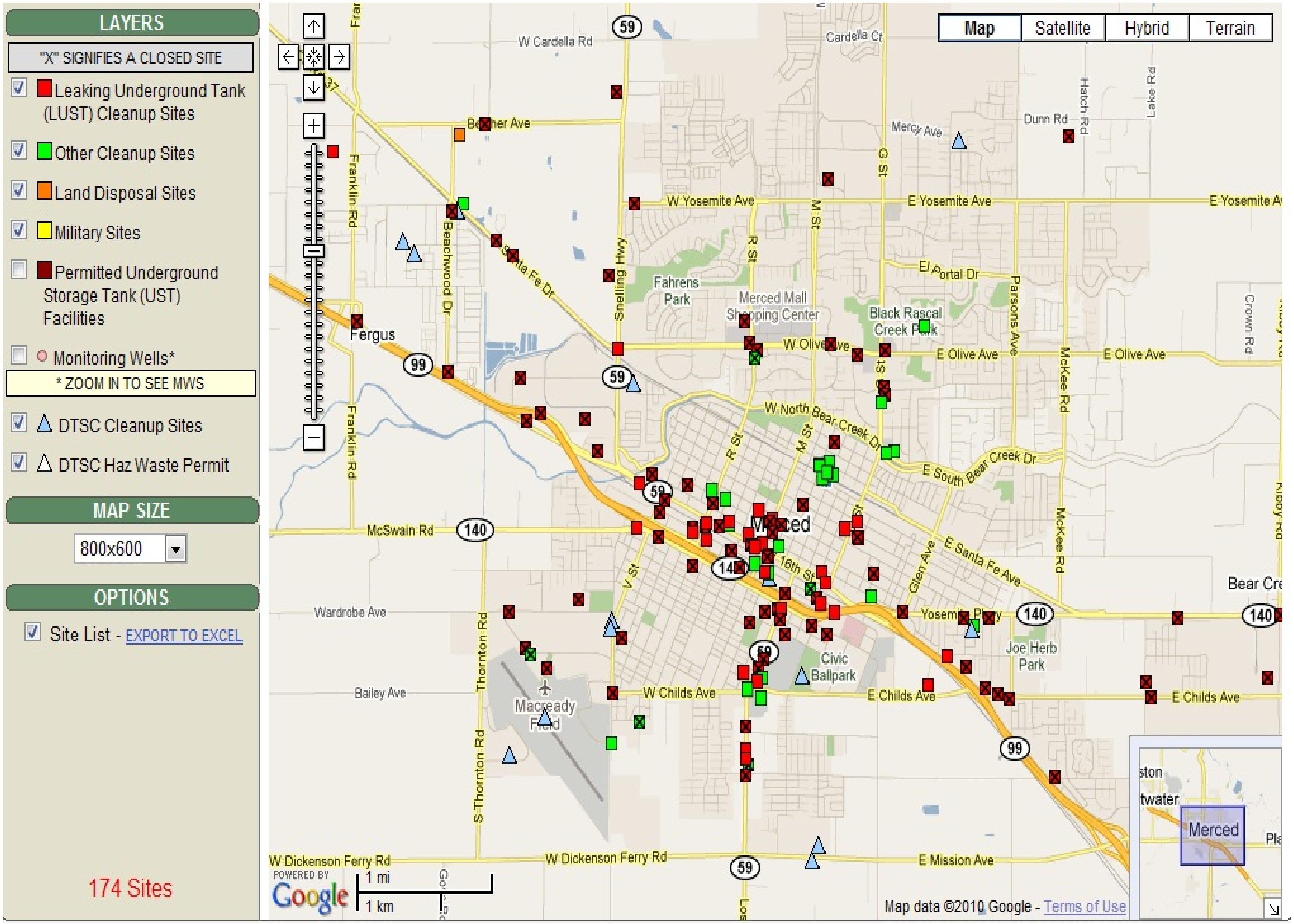
TRANSPORTATION CORRIDORS

Hazardous Materials emergencies, primarily due to surface route and rail accidents, have occurred and will continue to occur in the City of Merced. Although most of these incidents have been easily handled, the potential for and extreme threat to life and property is quite high. [2]

Critical facilities in Merced located within a mile radius of transportation corridors, including highways and railroads, pipelines, and fixed hazardous material facilities are at an elevated risk for hazardous materials incidents disrupting activities contained within these facilities. Of most concern to physical structures are incidents involving fire, water, and chemical interactions which could cause explosions. Releases of toxic substances could also result in the facilities becoming inaccessible for a period of time.

A noteworthy incident, despite hazardous material release not occurring, was the derailment of a Southern Pacific train at the northwest side of town where several train cars were overturned in 1997. The items spilled were not toxic or hazardous. The rails had apparently broken or corroded on the inside. Preparation for future accidents is essential as some rail cargo is hazardous and has the potential to spread out in just a few minutes.

The map on the following page (State Water Resources Control Boards "GeoTracker" database [5]) displays the locations of previous and current cleanup sites. A large concentration of sites is located downtown and along Highway 59, but many other areas are found throughout the City.


LAYERS
"X" SIGNIFIES A CLOSED SITE
Leaking Underground Tank (LUST) Cleanup Sites
Other Cleanup Sites
Land Disposal Sites
Military Sites
Permitted Underground Storage Tank (UST) Facilities
Monitoring Wells*
* ZOOM IN TO SEE MWS
DTSC Cleanup Sites
DTSC Haz Waste Permit
MAP SIZE
800x600
OPTIONS
Site List - EXPORT TO EXCEL
174 Sites
Map
Satellite
Hybrid
Terrain
W Cardella Rd
W Yosemite Ave
E Yosemite Ave
W Olive Ave
E Olive Ave
McSwain Rd
Wardrobe Ave
Bailey Ave
W Childs Ave
E Childs Ave
W Dickenson Ferry Rd
E Mission Ave
Fergus
Merced
Fahrens Park
Merced Mall Shopping Center
Black Rascal Creek Park
Civic Ballpark
Joe Herb Park
Macready Field
Map data ©2010 Google - Terms of Use

Probability/Frequency of Future Events

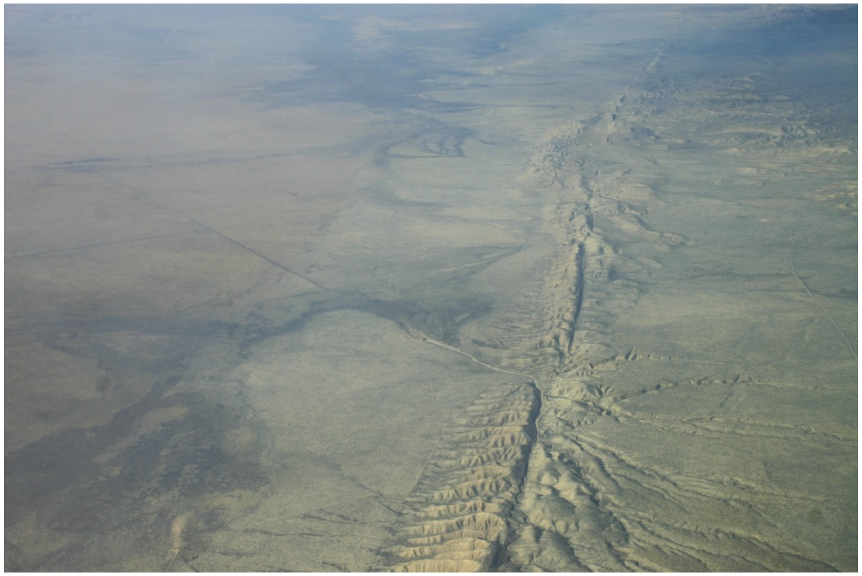
The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

0 Infeasible Event – not applicable due to geographic location characteristics
1 Rare Event – occurs less than once every 50 years
2 Infrequent Event – occurs between once every 8 years and once every 50 years (inclusive)
3 Regular Event – Occurs between once a year and once every 7 years
4 Frequent Event – occurs more than once a year

Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Hazardous Materials" in Merced is considered a frequent event.

3.3.5 Earthquakes



Aerial photo of the San Andreas Fault in the Carrizo Plain

General Background

An earthquake is a sudden, rapid shaking of the ground caused by the breaking and shifting of rock beneath the Earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates. [2]

California has been identified as being subject to frequent and destructive earthquakes; the State experiences more than one hundred earthquakes per day, most of which are very low on the Richter scale. Yet, scientists have determined that the chance of having one or more magnitude 6.7 or larger earthquakes in the California area over the next 30 years is greater than 99%. Furthermore, the USGS identified the possibility that an earthquake with a magnitude greater than 7.5 occurring within the next thirty years to be 46%. While the state as a whole is known for earthquakes, the size of earthquakes, vary considerably by region. The California Geological Survey (CGS) has published numerous maps and reports that were designed to identify the potential for significant shaking and ground acceleration based on specific regions in the State. The City of Merced has been identified on two of these maps, and in both instances, Merced was identified as having a low risk. Also, since Merced is distant from known active faults it will experience lower levels of shaking.

SCIENTIFIC MEASUREMENTS, INTENSITY VS. MAGNITUDE

A commonly used measure of earthquake severity is "intensity." Intensity is an expression of the amount of shaking at any given location on the ground surface. While an earthquake has only one magnitude, it may have many intensity values, which will generally decrease with distance from the epicenter. [23] The Modified Mercalli Intensity (MMI) Scale has been used historically to describe earthquake shaking in terms related to observable effects. The Modified Mercalli (MM) scale measures the strength experienced (intensity) at some point away from where the earthquake started. It is based on damage caused and human perception. Intensity is a strength measurement at a localized point where the person or town is. While the MM Scale measures human reaction and damage, it is subjective and cannot describe the strengths in rural or open country settings due to the lack of moving or falling objects. Magnitudes of M2.5 or smaller are generally not felt by people. While the MM Scale method works for moderate-sized earthquakes, large earthquakes are beyond this method as human emotions distort their observations. The MM scale is a good overview for populated areas without local seismographs.

Magnitude is a measure at the point that initiated the earthquake and uses seismographs. Seismographs can demonstrate effects and energy released (magnitude) in a way that can be verified or determined by seismographs at other locations. Scientists no longer use the original Richter scale, but an updated version. Earthquakes should be referred to as "magnitude X" rather than "an X on the Richter scale." A magnitude 6.0 earthquake releases 32 times more energy than a magnitude 5.0 and nearly 1,000 times more energy than a 4.0. But that doesn't mean the ground shakes a thousand times harder in a 6.0 than a 4.0, because the energy is released over a much larger area.

Table D.1-2
Earthquake Magnitude Scales

Magnitude	Modified Mercalli Intensity Scale	Effects
0.1 – 0.9	I	Not felt except by a very few under especially favorable conditions.
1.0 – 2.9	II	Felt only by a few persons at rest, especially on upper floors of buildings.
3.0 – 3.9	III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
4.0 – 4.5	IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
4.6 – 4.9	V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5.0 – 5.5	VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
5.6 – 6.4	VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6.5 – 6.9	VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
7.0 – 7.4	IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
7.5 – 7.9	X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
8.0 – 8.4	XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
8.5 +	XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: http://earthquake.usgs.gov/learning/topics/mag_vs_int.php, accessed July 14, 2009.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically-induced landslides. Under the Act, seismic hazard zones are to be mapped by the state geologist to assist local governments in land use planning. The Act requires that “cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard.” Merced County has not been mapped under the Seismic Hazards Mapping Act yet since the State has targeted higher risk areas, such as the San Francisco Bay Area and the Los Angeles/Riverside areas. [26] Thus, geotechnical reports are required for projects in the City of Merced. Based on these local studies, the probability of liquefaction for most properties in Merced is very low with no additional measures required beyond following the minimum standards of the current edition of the California Building Codes. [27]

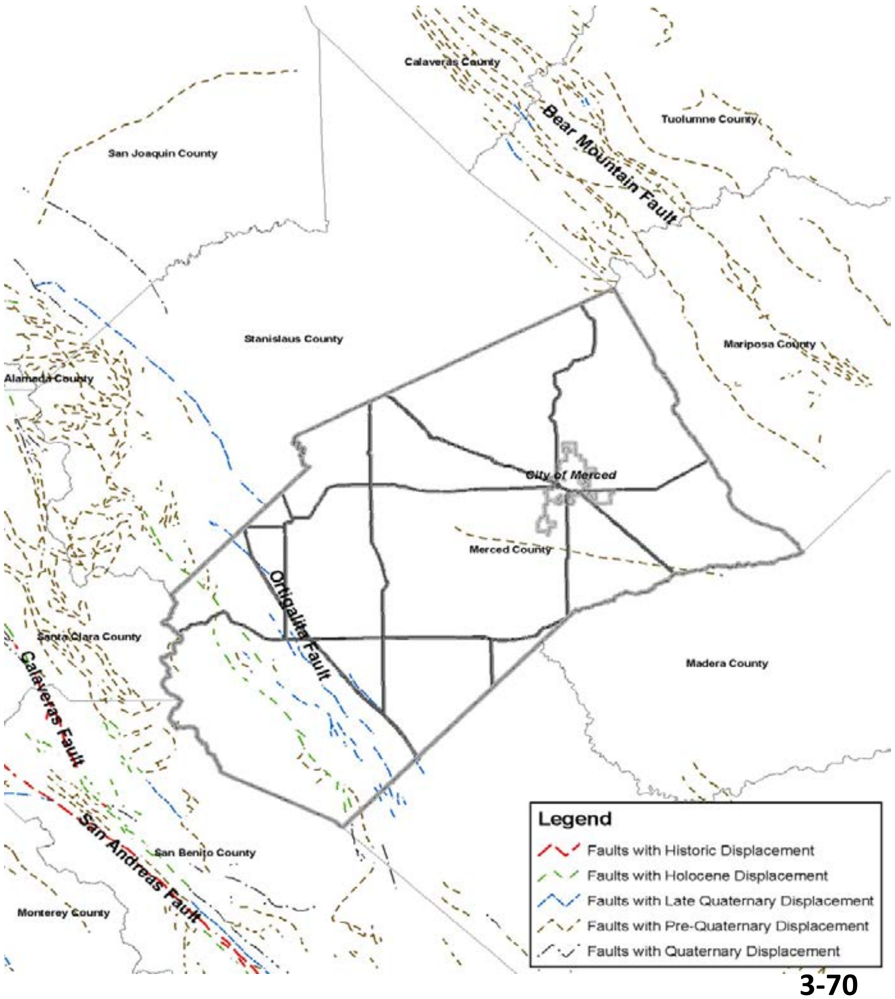
Location

Although no known faults occur in the City of Merced, Merced typically experiences reflected waves from activity on major fault lines that run through the mountains to our east and west. These have shaken Merced in the past. Of most notoriety is the San Andreas Fault, 58 miles away to the west. Other faults include the Ortigalita Fault (also known as the "Tesla-Ortigalita Fault"), the Calaveras Fault, the San Andreas Fault, and the Bear Mountain Fault. Earthquake shockwaves are “carried” by the relatively loose, wet soils that exist between Los Banos and Merced. For this reason, Merced is somewhat more likely to experience heavy shaking from surrounding parts of the state as will some of its neighbors.

TESLA-ORTIGALITA FAULT ZONE

The Tesla-Ortigalita Fault Zone consists of a series of southwest-dipping strike-slip faults separated by pull-apart basins that extend from Orestimba Creek in the north, to Panoche Creek in the south, along the eastern margin of the Coast Range. It is aligned northwest-southeast and is located approximately 40 miles west of the City of Merced. This fault zone is designated by CDMG as an active fault (i.e. a fault having surface displacement within the last 11,000 years), and it has been zoned under the Alquist-Priolo Earthquake Fault Zoning Act. The Tesla-Ortigalita Fault Zone is considered capable of generating a 6–7 Richter magnitude earthquake with a recurrence interval of 2,000 to 5,000 years (Anderson et al. 1982). The last large earthquake attributed to this fault occurred in 1981 and had a Richter magnitude of 3.7.

SAN JOAQUIN FAULT SYSTEM



The San Joaquin Fault System is located along the foothill-valley margin, and consists of a number of northeast dipping faults that offset Quaternary rock formations. The zone parallels Interstate 5 from Tracy south to Panoche Creek. Although the fault has not shown a surface displacement within the last 11,000 years by the California Division of Mines and Geology (CDMG), geomorphic evidence indicates that fault movement has occurred as recently as the Pleistocene epoch (Lettis 1982, Bartow 1991, Jennings 1994). This system is therefore considered potentially active.

Extent

As there are no seismic faults in Merced, earthquake impacts on Merced will be greatly influenced by the magnitude of an earthquake event and the distance from its epicenter to the City. The magnitude or severity of a seismic event can be described several ways, including: Seismic Effects, Peak Ground Acceleration (PGA), and Scientific Measurements (previously discussed).

CGS reports that there are not any known faults and the probability of a seismic event with an epicenter in the Central Valley is very remote (McLaughlin, 2009). The City of Merced is located in an area that has been identified to have the lowest level of Peak Ground Acceleration (PGA). For example, the "Geotechnical Investigation Report - Proposed Additions, Merced Wastewater Treatment Plant," Merced CA, June 2005, states:

"The California Division of Mines and Geology, in cooperation with the UC Geological Survey, performed a probabilistic seismic hazards study for the entire state. Their computed results show that the site area is in a region of relatively low ground motions, in the range of 0.10 to 0.20g. The minimum ground acceleration values used by the CDMG for Central Valley sites is 0.20g"; and,

"Using a probabilistic Seismic Hazards Analysis (PSHA), the PGA for the Upper Bounds Earthquake (UBE) is approximately 0.22g." This corresponds to a Modified Mercalli Intensity score of IV, which translates to a 4.0 to 4.5 magnitude, or light perceived shaking and little to no potential damages.

SEISMIC EFFECTS

The primary effect of an earthquake is fault ground rupture, also called surface faulting. The Alquist-Priolo Act was created to prohibit the location of structures designed for human occupancy across the traces of active faults, thereby reducing the loss of life and property from an earthquake. No faults exist in the City of Merced; therefore, the City does not experience "primary" seismic events, nor is subject to the Alquist-Priolo Act.

Common secondary seismic effects include ground shaking, liquefaction, ground subsidence and induced events. Other than distance from the earthquake epicenter, which is discussed above, this section also includes a discussion of conditions in the area that may exacerbate or mitigate the potential effects of hazards.

***Ground Shaking*:** Ground shaking, a motion that occurs as a result of energy released during faulting, could potentially result in the damage or collapse of buildings and other structures, depending on the magnitude of the earthquake, the location of the epicenter, and the character and duration of the ground motion. Other important factors to be considered are the characteristics of the underlying soil and rock, the building materials used, and the workmanship of the structure.

***Liquefaction*:** The shaking caused by an earthquake may cause relatively loose soil to compact, creating depressions which may cause a myriad of septic, well, pipe, and foundation problems. If the loose soil happens to be saturated with water, the water could be squeezed to the surface where it interacts with the top layers to produce a weak gelatin-like substance of dirt and water. This mixture lends no supporting capability to the buildings that stand on it and is known as liquefaction. Liquefaction poses a hazard to engineered structures. The loss of soil strength can result in bearing capacity insufficient to support foundation loads, increased lateral pressure on retaining or basement walls, and slope instability.

Although no liquefaction hazard areas have been identified to date in the SUDP/SOI, the future potential of liquefaction is recognized because unconsolidated sediments and a high water table do coincide in many areas. The California Office of Emergency Services has indicated that those areas at the time of an earthquake with the combination of fine-grain, sandy soils and perched, or a water table at a depth of 25 feet or less, may experience liquefaction providing that the shaking is of a magnitude and duration that would collapse the ground and the water is able to percolate to the upper soil levels. A deep, thick, unbroken hardpan may prohibit the necessary percolation, and thus prevent liquefaction from occurring where other conditions are present.

Liquefaction may have occurred in the newly organized town of Merced during the San Francisco Earthquake of 1906. The *Merced County Sun* of April 20, 1906, gave the following description:

"... At the Troy Laundry on Main Street where there is a brick oil tank under construction, the excavation filled with two feet of water and the walls of the tank were disturbed. Pools of water on vacant lots throughout the City rose. The earth was separated from some buildings..."

The appearance of pools of water, the "disturbance" of the tank walls, and the earth separating from the building, are common to liquefaction.

Areas of Merced with high water tables and loose soils are likely to experience more damage than their counterparts in other areas of the City because of the shockwave carrying ability of the ground and liquefaction.

Seismic Hazard Zones are regulatory zones that encompass areas prone to liquefaction (failure of water-saturated soil) and earthquake-induced landslides. Areas within Seismic Hazard Zones mean that the state has determined that it is likely that weak soil and/or rock may be present beneath the property. If present, these weak materials can fail during an earthquake and, unless proper precautions are taken during grading and construction, can cause damage to structures. Seismic Hazard Zones are determined by the California Building Code which currently shows the City of Merced to be located within a Seismic Design Category D (unless proven otherwise by a licensed architect or engineer). [22]

Ground Subsidence: Differential settlement, resulting in the compaction of loose, less cohesive soils, may be caused by earthquakes and could occur in parts of Merced. The most likely areas are those which have the following characteristics: 1) the groundwater surface is deep (otherwise liquefaction would be more likely), 2) the soils are loose to medium-dense, and 3) the soil profile includes strata of loose and uniformly graded sand. The potential for ground subsidence due to earthquake motion is largely dependent on the magnitude, duration, and frequency of the earthquake waves.

Induced Events: A hazardous spill caused by tipping and container damage becomes its own, independent concern, as would gas from broken gas mains.

Conditions that Exacerbate or Mitigate Potential Effects

While ground shaking may be the predominant agent of damage in most earthquakes, fires following earthquakes can also lead to catastrophic damage depending on the combination of building characteristics and density, meteorological conditions, and other factors. Fires following the 1906 San Francisco Earthquake led to more damage than that due to ground shaking. Most recently, fires in the Marina District of San Francisco following the 1989 Loma Prieta

Earthquake and in Los Angeles following the 1994 Northridge Earthquake demonstrate that fires following earthquakes pose a significant hazard, especially in densely populated urban areas, and are a potentially serious problem due to severe strain on the fire departments that must respond to multiple simultaneous ignitions. [23]

Previous Occurrences

While there is no record of any seismic activity originating in the City of Merced, the City has been shaken by earthquakes originating elsewhere, for example the 1906 San Francisco earthquake and the 1989 Loma Prieta (Santa Cruz Mountains) earthquake.

The USGS database shows that there is a 47.098% chance of a major earthquake (5.0) within 50 miles of Merced, California within the next 50 years. The largest earthquake within 50 miles of Merced, California was a 4.3 Magnitude in 1976. [58]

Between 1950 and 2009, a time period that is extremely short in relation to geological time, Fresno, San Benito and Santa Clara Counties (adjacent to Merced County) declared earthquake disasters. [23] These are far from Merced and include areas along the coast range, which contain several significant earthquake faults, however.

1906 SAN FRANCISCO QUAKE

The 1906 San Francisco quake resulted in a moderate Modified Mercalli (MM) shaking in the San Joaquin Valley, in which Merced is located. The following is a local first-hand account of the earthquake felt near Merced.

> *On the morning of the earthquake, I was asleep in my room at the Crooker Ranch, about three miles north of Merced on what is now Highway 99. My room was in the same building as the main dining room and kitchen. I was jolted awake by the violent shaking of the building and quickly sprang out of bed. From the door of my room I could see through the dining room and all the way to the back door of kitchen, which was open. Jue Yin Din, the Chinese cook, was clinging to the door jamb, wailing. As soon as the shaking had subsided I rushed to the kitchen where Jue Yin Din (Skinny, as he was called by the men) was safe enough, but in some hysteria that an apricot tree just back of the kitchen door had waved back and forth so violently that the limbs on either side of the tree had touched the ground. Since this was a large and sturdy tree, I suspected that in his frights, Jue Yin Din was exaggerating. Later I changed my mind when we received a report that the S.P. water tank had tipped over at Livingston, fourteen miles to the north. --- John Floyd McSwain.* [25]

Date	Place	M
June 10, 1836	S San Francisco Bay region, CA	~6.5
June 1838	San Francisco Peninsula, CA	~6.8
October 8, 1865	San Jose, CA	~6.5
June 20, 1897	Calaveras fault, CA	~6.3
April 18, 1906	S San Francisco Bay region, CA	7.8
July 1, 1911	Calaveras fault, CA	6.5
October 22, 1926	Monterey Bay, CA	6.1
October 22, 1926	Monterey Bay, CA	6.1
January 24, 1980	Livermore, CA	5.8
May 25, 1980	Mammoth Lakes, CA	6.2
May 25, 1980	Mammoth Lakes, CA	5.9
May 25, 1980	Mammoth Lakes, CA	5.9
May 27, 1980	Mammoth Lakes, CA	6.0
May 2, 1983	Coalinga, CA	6.4
April 24, 1984	Morgan Hill, CA	6.1
November 23, 1984	Round Valley, CA	5.8
October 18, 1989	Loma Prieta, CA	6.9
October 31, 2007	San Francisco Bay Area, CA	5.6

Last revised 12 January 2010 [4] (City Data.com)

The City of Merced has been very fortunate in the past and has not suffered any loss of life. However, major damage occurred in Los Banos in 1906, with minor structural damage recorded throughout the County on other occasions.

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

0 Infeasible Event – not applicable due to geographic location characteristics
1 Rare Event – occurs less than once every 50 years
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Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 201,2 Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Earthquake" in Merced is considered an infrequent event.

3.3.6 Dam Failure

21

At 11:57 p.m. on March 12, 1928, the dam failed, sending a 180-foot-high wall of water crashing down San Francisquito Canyon. An estimated 470 people lay dead by the time the floodwaters reached the Pacific Ocean south of Ventura 5½ hours later (See above).

It was the second-worst disaster in California history, after the great San Francisco earthquake and fire of 1906, in terms of lives lost — and America's worst civil engineering failure of the 20th Century.

General Background

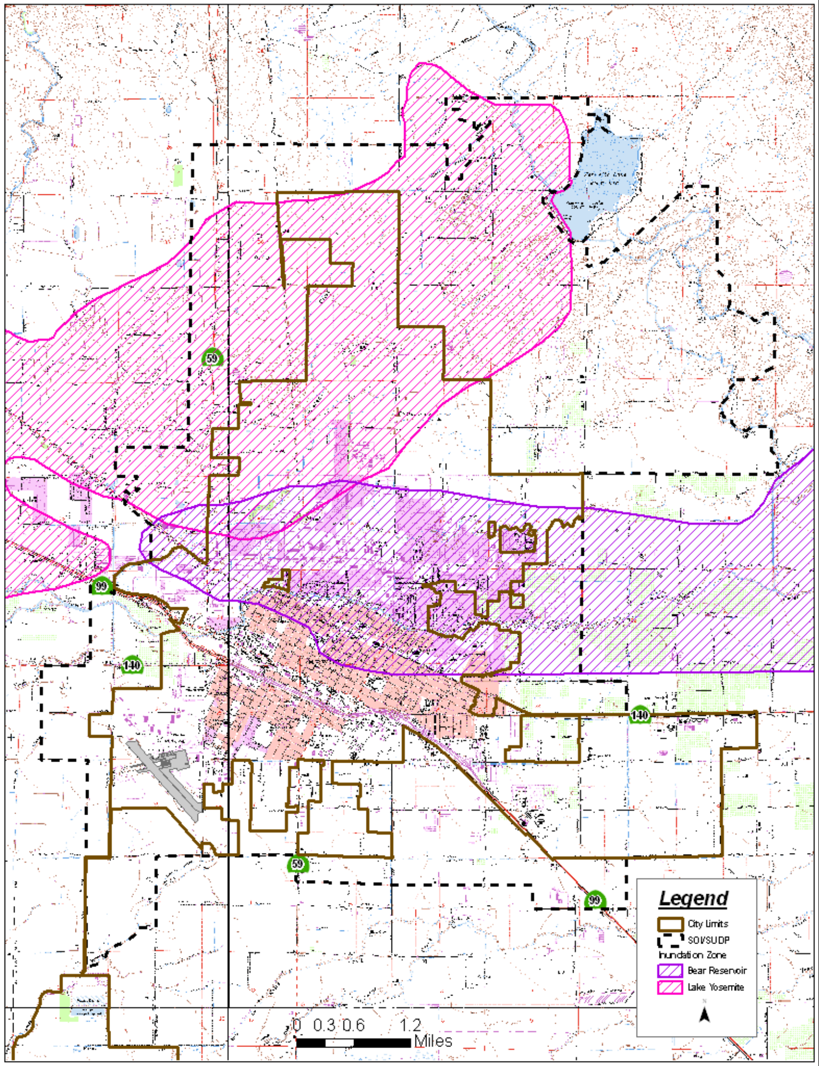
There have been a total of 45 dam failures in California. Failures have occurred for a variety of reasons, the most common failure being overtopping. Other dams have failed due to specific shortcomings in the dam itself or an inadequate assessment of the surrounding geomorphologic characteristics. The first notable dam failure occurred in 1883 in Sierra County, while the most recent failure occurred in 1965.

Dams fail as a result of one or more of the following: overflow due to exceeded capacity, sabotage, faulty dam materials, failure of the foundation, settlement or cracking, internal erosion, or insufficient maintenance. Merced is in the inundation area of two earthen dams: Lake Yosemite and Bear Reservoir (City of Merced, 1995). Both dams are earthen-fill types of structures, are very flexible, and resilient to seismic activity. The *Yosemite Lake Dam Failure Analysis for Bellevue High, 2007,* asserted that the greatest vulnerability to these types of dams is overflowing, however. Previous failures of earthen-fill dams identified that when the capacity is exceeded and overflow occurs, the structure washes-out and ultimately fails.

Location

Lake Yosemite is located northeast of Merced, outside the City limits, but within the City's Specific Urban Development Plan/Sphere of Influence (SUDP/SOI). Bear Reservoir was built approximately twenty miles east of Merced in Mariposa County.

Figure 2 depicts the flood inundation areas of Lake Yosemite and Bear Reservoir as it would affect the existing City Limits (gray line) and proposed growth boundary (yellow line).



LAKE YOSEMITE

Lake Yosemite was constructed in the 1880's on an un-named tributary of Merced River to provide regulation of irrigation flows withdrawn from the Merced River by the MID Main Canal, prior to distribution to the Le Grand and Fairfield Canals. The Main Canal is approximately 16 miles long.[18] The earthen dam was constructed between two buttressing sides of a valley where a small natural creek drained.

The reservoir dam is 45 feet high and 135 feet wide. The lake has an estimated surface area of 1.75 square miles and contains 8,000 acre feet of water. [1] It drains an area of 4.95 square miles. [19] There is no spillway; the outlet gates are adjusted to regulate outflow during storm events.

During the irrigation season, which occurs between April 15 and October 15, the Main Canal feeds irrigation releases into Yosemite Lake from the Merced. [18] For the rest of the year, the dam is used for flood control. In addition to water from the Main Canal, a 1,400 acre local watershed directly flows into Lake Yosemite. The estimated annual runoff from this watershed is 280 acre-feet per year.[18]

Today, the dam is owned by the Merced Irrigation District, and operated by the Department of Water Resources. The inundation area covers a large portion of the City's planning area in North Merced. The inundation area for the Yosemite Lake dam, should it breach, encompasses approximately 6,000 acres southwest of the dam. This area currently consists of agriculture, residential housing, and commercial development. Figure 2 shows the extent of the inundation area. [18]

BEAR RESERVOIR

Bear Reservoir on Bear Creek in Mariposa County, approximately twenty miles east of Merced is used for flood control purposes. Construction was completed in 1954. It is owned by the U.S. Army Corps of Engineers. [19]

As an earth-filled type reservoir, it could fail due to the erosion of the breach if over-topped. Failure is expected to be gradual. The initial flood wave would reach the City's SUDP/SOI six hours after failure, and would pass out of the SUDP/SOI nine hours after failure.

Its height is 92 feet with a length of 1,830 feet. Maximum discharge is 21,400 cubic feet per second. Its capacity is 7,700 acre-feet. Normal storage is 7,700 acre-feet. It drains an area of 72 square miles. It has a normal surface area of 265 acres. [19]

Extent

The extent of a possible breach of Yosemite Lake Dam could be severe. If the dam were to breach, the inundation (water) could flood about 6,000 acres to the southwest. This would affect agriculture, housing, and commercial development.

Previous Occurrences

Tom Stephens works for the Merced Irrigation District as a water resources specialist. He said, "There has never been overflow at Lake Yosemite dam that I am aware of."

In 1968, Yosemite Dam was in danger of failure because of heavy rains and flooding that had swollen the flood control canals that lead into Lake Yosemite. Reportedly, the canal dikes were dynamited and the incoming canal water was diverted to surrounding fields to prevent dam failure. The Merced Streams Group Project and Flood Control Plan authorized by Congress in 1970, which would divert the flood waters from the flood control canals, has only been partially completed due to lack of funds and other reasons. Castle Dam is complete; and a diversion structure, which diverts more than 1,200 cubic feet of water per second from MID's main canal is also complete.

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

- 0 Infeasible Event – not applicable due to geographic location characteristics
- 1 Rare Event – occurs less than once every 50 years
- 2 Infrequent Event – occurs between once every 8 years and once every 50 years (inclusive)
- 3 Regular Event – Occurs between once a year and once every 7 years
- 4 Frequent Event – occurs more than once a year

Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Dam Failure" in Merced is considered a rare event.

3.3.7 Extreme Temperatures

General Background

WILDFIRES

The City of Merced exists in an area which experiences mild temperatures in the spring and fall, some freezing temperatures in the winter, and extreme heat in the peak summer months. Heat and cold events associated with weather patterns have historically impacted the City of Merced. The National Weather Service (2009) identified the average winter temperature to be 54 degrees Fahrenheit, and the average summer temperature to be 98 degrees Fahrenheit. The NWS also noted that hard freezes, where temperatures drop below thirty-two degrees Fahrenheit for a period of several hours and typically kill vegetation, do occur in Merced, but they are limited to two to three nights per year. Conversely, Merced has been regularly challenged with heat related situations as a result of the summer weather pattern (NWS, 2009). [1]

EXTREME HEAT

Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat. Extreme heat effects are characterized by a combination of very high temperatures and high humidity conditions. A heat wave is an unusually high combination of both for extended days in a row. Heat exhaustion occurs when the body is dehydrated resulting in an imbalance of electrolytes. Heatstroke occurs when perspiration cannot occur and the body overheats. Without intervention, heatstroke can lead to confusion, coma, and death.

Killer Heat

The California Climate Adaptation Strategy (CAS), citing a California Energy Commission study, states that "over the past 15 years, heat waves have claimed more lives in California than all other declared disaster events combined." [23]

Heat waves do not cause damage or elicit the immediate response that floods, fires, earthquakes, and other disasters do. They have, however, claimed many lives in comparison with other disasters. For example, the 1989 Loma Prieta Earthquake resulted in 63 deaths while the 1992 Northridge Earthquake was responsible for the loss of 55 lives. The catastrophic 2003 Southern California Firestorms resulted in 24 deaths. However, according to the 2007 State Hazard Mitigation Plan (SHMP), the worst single heat wave event in California occurred in Southern California in 1955, when an eight-day heat wave is said to have resulted in 946 deaths. The 2007 SHMP states that the July 2006 heat wave in California caused the deaths of at least 136 people over a 13-day period (6 deaths were still under investigation in 2007).[23] Nationally, on average, excessive heat claims more lives each year than floods, lightning, tornadoes, and hurricanes combined. In the disastrous heat wave of 1980, more than 1,250 people died. In the heat wave of 1995 more than 700 deaths in the Chicago area were attributed to heat. In August 2003, a record heat wave in Europe claimed an estimated 50,000 lives. [29]

Table 6.D and Table 6.E show the Heat Index (HI) as a function of heat and relative humidity. The Heat Index describes how hot the heat-humidity combination makes the air feel. As relative humidity increases, the air seems warmer than it actually is because the body is less able to cool itself via evaporation of perspiration. As the Heat Index rises, so do health risks. The index helps identify the likelihood of heat disorders, such as heat exhaustion and heatstroke, from occurring. For example, a typical July or August day in Merced, given average high air temperatures and average afternoon relative humidity results in a heat index of 90-105, which includes sunstrokes, heat cramps, and heat exhaustion as possible with prolonged exposure and/or physical activity. When air temperatures exceed this average high, especially in August and September when the humidity is higher, the heat index can be in the 105 to 130 range, where heat stroke is possible with prolonged exposure and/or physical activity. Record high air temperatures have resulted in a heat index of 130 or higher, where heatstroke/sunstroke is highly likely with continued exposure.

EXTREME COLD

Although infrequent, freezes can affect the City of Merced in a number of ways

Wind Chill

If conditions are right, wind chill can expedite the onset of frostbite in a matter of minutes. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. In 2001, the National Weather Service implemented an updated Wind Chill Temperature Index[31] to describe the relative discomfort/danger resulting from the combination of wind and temperature. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature. Applying Merced's winter variables average low temperature (36.0 F), and average wind speed (5 mph in December and January), barely show up on the index and reveals that frostbite is not a concern. Even when Merced's lowest recorded temperature of 13 F and a doubling of the average wind speed is plugged into the index, while the wind chill temperature will be 3 F, the onset of frostbite is still greater than 30 minutes.

Table 6.D: Air Temperature and Relative Humidity (*Source: National Weather Service)*

	0%	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**
115	103	107	111	115	120	127	135	143	151								
110	99	102	105	108	112	117	123	130	137	143	151						
105	95	97	100	102	105	109	113	118	123	129	135	142	149				
100	91	93	95	97	99	101	104	107	110	115	120	126	132	136	144		
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78
70	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71

Table 6.E: Possible Heat Disorders by Heat Index Level

Heat Index	**Possible heat disorders for people in higher risk groups**
130 or higher	Heatstroke/sunstroke highly likely with continued exposure.
105-130	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.
90-105	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity.
80-90	Fatigue possible with prolonged exposure and/or physical activity.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F	77.0	84.0	88.0	98.0	109.0	111.0	114.0	114.0	110.0	102.0	91.0	76.0	114.0
Average high °F	55.0	61.6	67.2	74.3	82.6	90.8	97.1	95.3	90.0	79.8	66.2	55.6	76.3
Average low °F	36.0	38.7	41.2	44.1	50.6	56.4	60.9	58.9	54.8	47.2	39.6	35.7	47.1
Record low °F	13.0	20.0	20.0	22.0)	30.0	37.0	39.0	35.0	32.0	28.0	21.0	15.0	13.0
Precipitation, inches	2.47	2.17	1.94	1.10	0.44	0.09	0.01	0.02	0.15	0.60	1.37	1.90	12.27

Location & Extent

All areas of the City are equally at risk when temperature extremes exist; there are not any topographical changes or influences that can create significant temperature changes from one part of the City to another. Annually, the City of Merced experiences summer temperatures that reach into the 100's and in the winter temperatures can drop below freezing. There is an average of 98.7 days with highs of 90°F (32°C) or higher and an average of 33.6 days with lows of 32°F (0°C) or lower. The record highest temperature of 114°F was recorded on July 24, 1902, and August 8, 1905. The record lowest temperature of 13°F was recorded on January 13, 2007. [28] Although snow is relatively rare in Merced, averaging only 0.6-inch (15 mm) annually, the City's proximity to the Sierra Nevada has resulted in some instances of remarkably heavy snowfall. The record 24 hour snowfall was 13.9 inches (35 cm) on February 16, 1946. The most snowfall in one month was 39.0 inches (99 cm) in December 1906. [28]

MERCED'S MONTHLY AVERAGE TEMPERATURE AND PRECIPITATION DATA

Table 3-10 shows daily temperature averages and extremes (in degrees Fahrenheit) measured at the representative weather station at the Merced Regional Airport (*Source:* [8]).

The key to this table is:

- "Extreme Maximum" is the maximum of all daily maximum temperatures recorded for the day of the year.
- "Average Maximum" is the average of all daily maximum temperatures recorded for the day of the year.
- "Average Minimum" is the average of all daily minimum temperatures recorded for the day of the year.
- "Extreme Minimum" is the minimum of all daily minimum temperatures recorded for the day of the year.

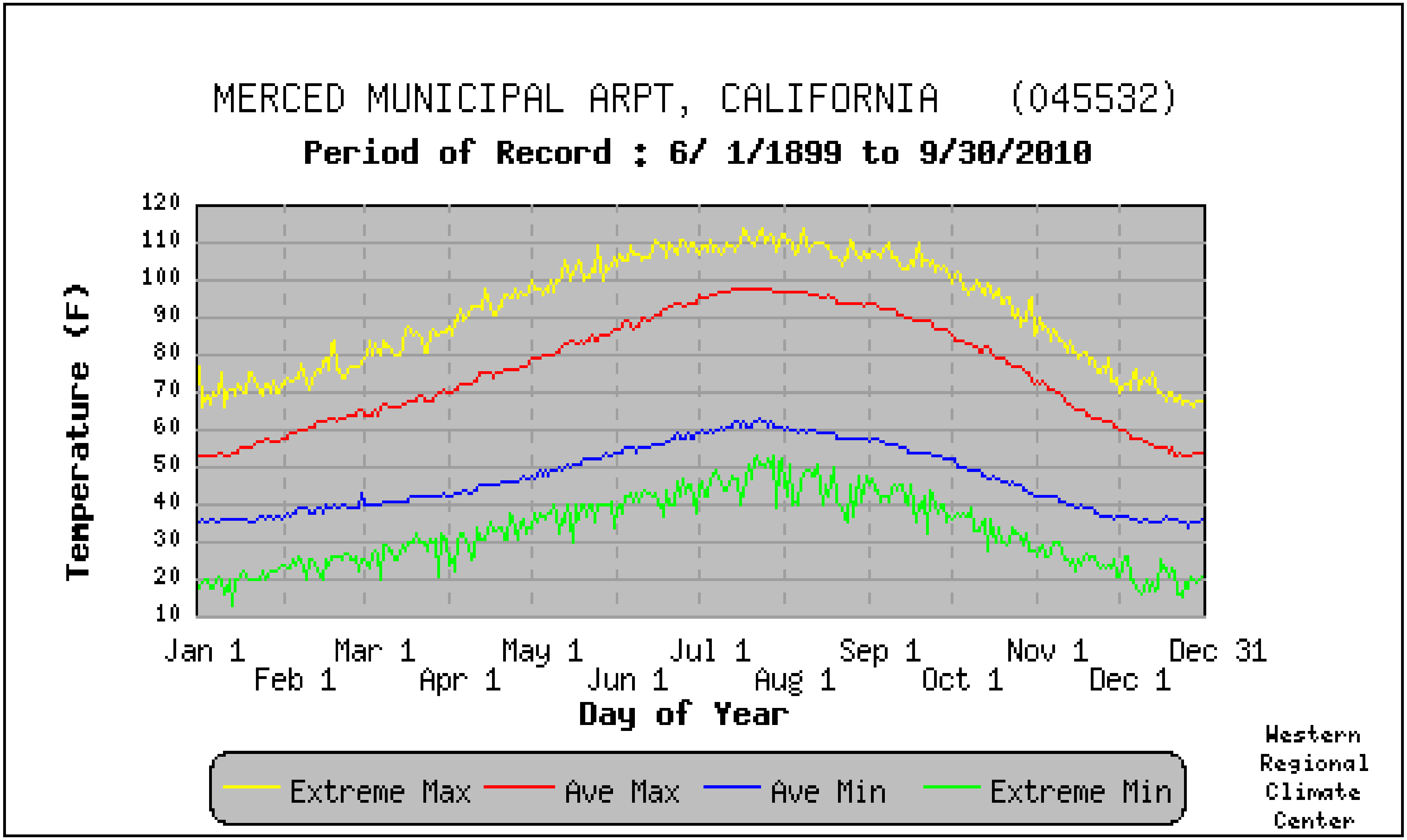
HUMIDITY

Merced's monthly average afternoon relative humidity values, based on late afternoon readings when lowest values generally occur, are depicted in Table 3-11.[34]

Table 3-11: Monthly Average Afternoon Relative Humidity Values

Month	Relative Humidity (%)
January	75
February	64
March	58
April	44
May	35
June	35
July	30
August	33
September	36
October	44
November	58
December	75

Table 3-10. Average and Extreme Minimum and Maximum Temperatures. Source: Western Regional Climate Center, wrcc@dri.edu



Previous Occurrences / Extreme Heat

The City of Merced experiences extreme heat conditions in the summer months, typically late June, July, and August, but it can start as early as May. In the event of an extreme heat occurrence, all areas of the City of Merced are affected. It is a rare year in Merced that does not see temperatures at 100°F or higher. Extended spells of these temperatures are not common. Wikipedia reports Merced as having 98.7 days per year that are 90°F or higher. That is 27% of the whole year.

Despite the fact that heat is the number one weather –related killer in the United States[29], not a single heat emergency was formally proclaimed in California or declared as a federal disaster between 1960 and 2008. Eric Klinenberg, author of an account of a heat wave which killed 739 people in the City of Chicago in July 1995, suggests that the hidden nature of social vulnerability combined with the inconspicuous nature of heat events (unlike earthquakes, floods, wildfires, tornadoes, etc.) prevent them from being declared as legitimate disasters.[23] Additionally, heat emergencies are often slow to develop. It could take a number of days of oppressive heat for a heat wave to have a significant or quantifiable impact.

EVENTS

The two highest recorded daily extremes for the City of Merced were 114°F temperatures in July 1902 (27.8 days) and in August 1905 (26 days).

In June 1925, the City experienced 16.9 days of 111°F temperatures. [33]

In July 2006, California had a two-week heat wave that resulted in 140 deaths that included 5 in Merced County. [30]

In 2000 and 2001, as a partial result of the deregulation and extreme energy prices, power distributers throughout California were required to conduct rolling blackouts to reduce costs. This practice was conducted during peak use times, specifically, the summer months when temperatures were at the highest levels (California electricity crisis). [1]

The National Climate Data Center reports the year 2006 as the second warmest year on record for the 48 contiguous states and that July of 2006 was the second hottest July ever. Merced had nine record highs in July 2006 compared to four Merced record highs in 2008, and 3 record highs in both 2005 and 2007. July 2006 also had twelve consecutive days above 100° (July 16th through July 27, inclusive).

The high for July 23, 2006, was 112°F. The average high for July 23rd is 98°F. The low temperature July 23, 2006, was 81°F compared to an average low of 60°F. At 112°F the humidity was 21%. This combination of air temperature and humidity resulted in a heat index likely to lead to sunstroke, heat cramps or heat exhaustion, and heat stroke possible with prolonged exposure and/or physical activity. In the evening, the temperature was 81°F with humidity at 74%.

Date	High	Date	High
July 16	102	July 22	110 (record)
July 17	105	July 23	112 *
July 18	108 (record)	July 24	111 (record)
July 19	102	July 25	109 (record)
July 20	104 (record)	July 26	107 (record)
July 21	107 (record)	July 27	102 (record)
**reportedly the second highest temperature ever for Merced (114° in July 24, 1902 is the highest)*			

Previous Occurrences / Extreme Cold

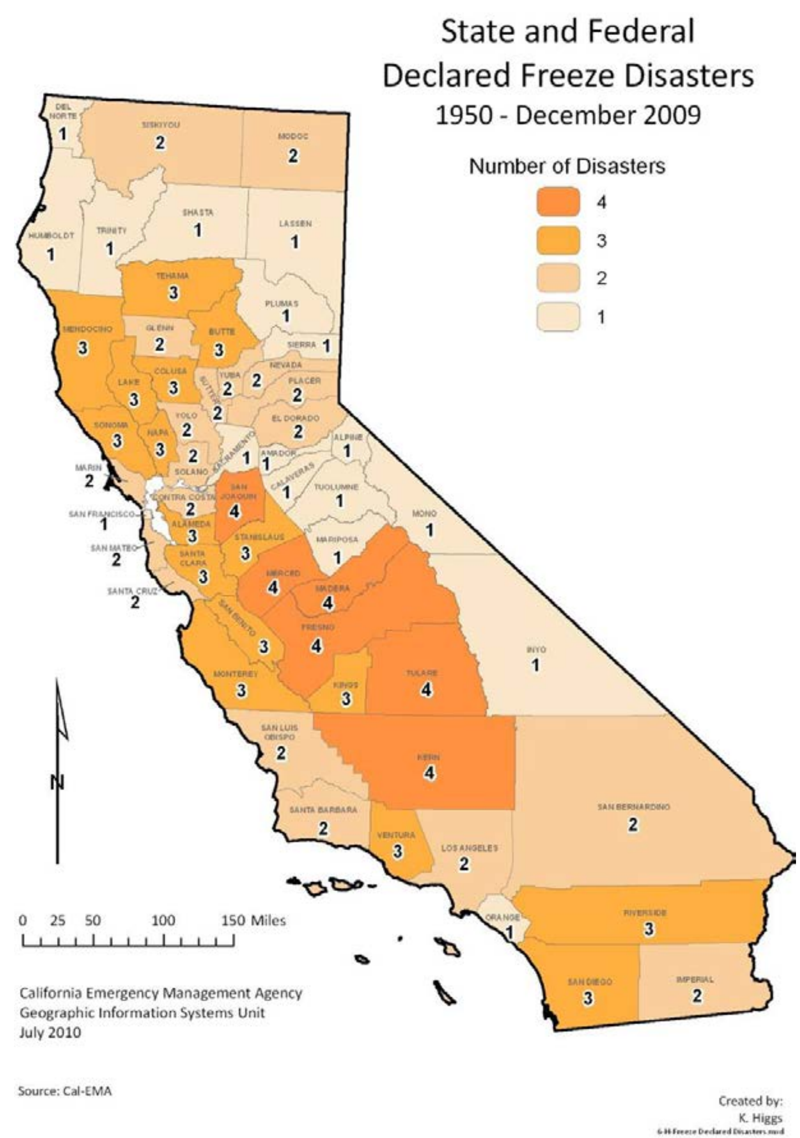
The City of Merced experiences cold weather in the winter months, typically December and January, but freeze isn't experienced every year. As seen in the map below, "State and Federal Declared Freeze Disasters from 1950- December 2009," [9] there were 4 freeze disasters in Merced County between 1950 and 2009.

EVENTS

In January 1913, there were widespread low temperatures for an extended period of time, which caused extreme damage to the fledgling California citrus industry. Temperatures dropped to 10-15°F in some areas, representing some of the coldest nights ever measured in the state. - Long-term Strategic Impact: Led directly to the U.S. Weather Bureau establishment of the fruit frost forecast program. - Calculated Damages: Not available.

In December 1990 there were record-setting low temperatures for an extended period of time during a critical growing period. Temperatures did not get above 25 degrees in parts of the San Joaquin Valley for three to five days and all time record low temperatures were set at Sacramento, Stockton, and Bakersfield. Many records were set for duration of freezing temperatures. The agricultural industry was devastated as acres of trees-not just fruit-were destroyed. Thirty-three counties were disaster-declared. - Long-term Strategic Impact: Changed the way crop protection measures were implemented.

DECLARED STATE AND FEDERAL FREEZE DISASTERS



Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. ‘Probability of Occurrence’ is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

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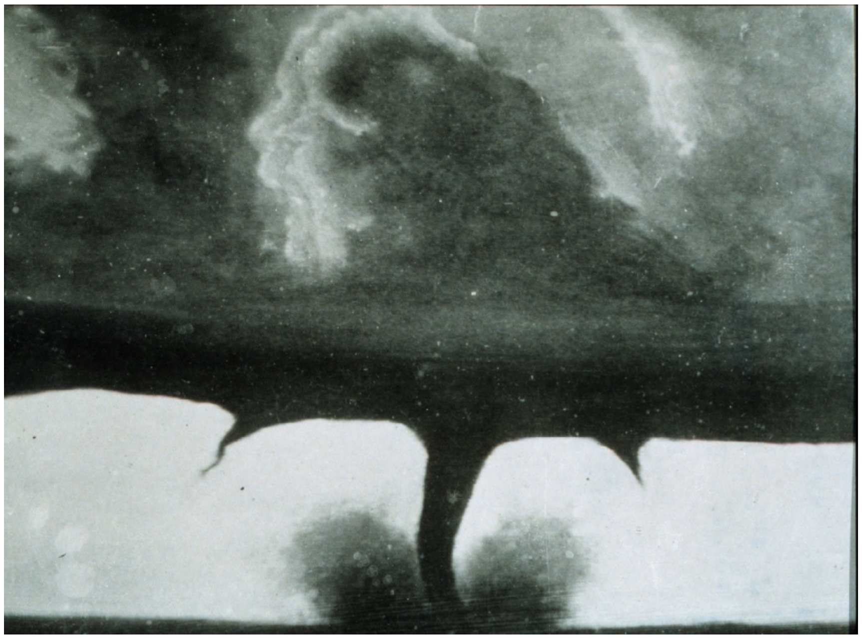
- 4 Frequent Event – occurs more than once a year

Hazard probability scoring was based on a variety of sources, including: 1) the City’s *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative “probability” scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for “Extreme Temperatures” in Merced is considered a frequent event.

3.3.8 Tornadoes



Oldest known photograph of a tornado
South Dakota, 22 miles southwest of Howard
1884 August 28

General Background

The City of Merced is susceptible to extreme weather/storm conditions. *An extreme weather condition is* a generalized term used to describe thunderstorms, tornadoes, heavy precipitation, high winds, and extreme heat or cold. Extreme weather may cause a variety of damages, depending on the type or weather situation. Damage may range from temporary power and utility outages due to thunderstorm and high wind activity to the sometimes, although rare, destruction of a tornado.

Wind speeds in tornadoes range from values below that of hurricane speeds to more than 300 miles per hour. Unlike hurricanes, which produce wind speeds of similar values over relatively widespread areas (when compared to tornadoes), the maximum winds in tornadoes are often confined to extremely small areas and vary substantially over very short distances, even within the funnel itself.

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. [14]

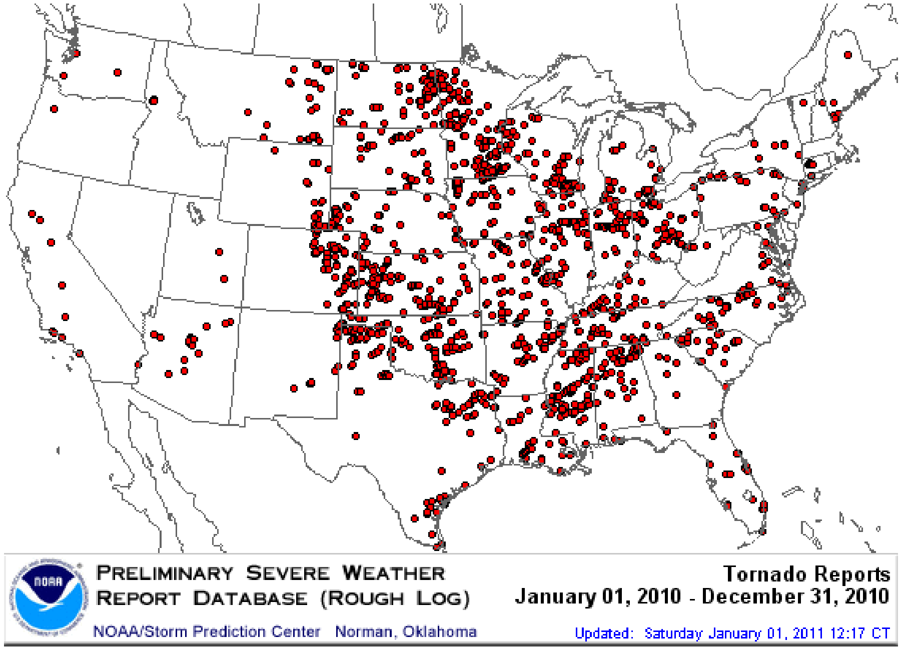
Original Fujita Scale		
Category	**Wind Speed**	**Description**
F0	40-72 miles per hour	Gale Tornado. Light Damage: Some damage to chimneys; breaks twigs and branches off trees; pushes over shallow-rooted trees; damages signboards; some windows broken; hurricane wind speed begins at 73 miles per hour.
F1	73-112 miles per hour	Moderate Tornado. Moderate Damage: Peels surfaces off roofs; mobile homes pushed off foundations or overturned; outbuildings demolished; moving autos pushed off the roads; trees snapped or broken.
F2	113-157 miles per hour	Significant Tornado. Considerable Damage: Roofs torn off frame houses; mobile homes demolished; frame houses with weak foundations lifted and moved; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	158-206 miles per hour	Severe Tornado. Severe Damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off the ground and thrown; weak pavement blown off roads.
F4	207-260 miles per hour	Devastating Tornado. Devastating Damage: Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and disintegrated; large missiles generated; trees in forest uprooted and carried some distance away.
F5	261-318 miles per hour	Incredible Tornado. Incredible Damage: Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 300 feet (100 meters); trees debarked; incredible phenomena will occur.
F6-12	Greater than 319 miles per hour	The maximum wind speeds of tornadoes are not expected to reach the F6 wind speeds.

Enhanced Fujita Scale [15]	
Scale	**Wind Estimate (mph)**
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200

Location

Tornadoes occur throughout the year. Additionally, most tornadoes occur in the afternoon and evening hours, with a minimum frequency around dawn. However, tornadoes have occurred at all hours of the day, and nighttime occurrences may give sleeping residents of a community little or no warning. Because a tornado may occur at any time of the day or year somewhere in the U.S., there really is no national tornado "season." Instead, each region may experience increased tornadic potential at different times of the year. Like with the diurnal pattern, for the United States (and hemisphere) as a whole, the months in which tornadoes are most likely correspond to the times of year with increased solar heating and strong frontal systems. Regionally, the frequency of tornadoes in the United States is closely tied with the progression of the warm season when warm and cold air masses clash.

Although tornadoes are most commonly identified as occurring within the “Tornado Alley” in the mid-western states, California’s Central Valley experiences fairly large numbers of tornadoes (Edwards, 2005). Unlike the tornadoes in the mid-west, which occur in the cusp months between Spring and Summer, California’s tornadoes occur during the winter months. The tornadoes in California have also proven to be less severe and cause less damage than those that occur in “Tornado Alley” of the mid-western states, however. [16]



Extent

The Tornado Project (n.d.) noted that 4 tornado events occurring in Merced County had an intensity of F1 with the remainder having an intensity of F0. The National Climatic Data Center ([NCDC], n.d.) reported ninety-nine significant wind events, tornadoes and funnel clouds, in Merced County between 1950 and 2008. These events resulted in one fatality, twenty injuries, twenty-three million dollars in property damage, and sixty million dollars in crop damage.

Previous Occurrences

The Tornado Project (n.d.) identified three hundred twenty-three California tornadoes between 1880 and 2000; eleven of which were in Merced County or one every 10.9 years. Four of the tornadoes listed in Merced County had an intensity of F1 with the remainder having an intensity of F0. The National Climatic Data Center ([NCDC], n.d.) reported ninety-nine significant wind events, tornadoes and funnel clouds, in Merced County between 1950 and 2008. Based on the data provided by the NCDC (n.d.), the events have increased in regularity over the past decade; no theories were identified to support this pattern.

November 22, 1996 – 3 miles NE of Merced - Following frontal passage through Central California, an unstable airmass brought convective activity to the area this data. This small tornado, the first of four this day, was reported late to the office but eyewitness accounts and damage lead to the assessment of its being an F1 on the damage intensity scale. Its path was northwest to southeast with a length of ¼ mile through pasture and farm land except for an encounter with a farm house's garage. The garage roof was completely removed. [11]

March 25, 1998 – Spotter report of funnel almost touching the ground northwest of Merced. [11]

December 16, 2002 – From low-topped convection, a short duration tornado touched down northwest of Merced, California on the 16th and had a discernible damage track of 1.25 miles. The tornado dissipated but the parent cell after a distance of about 3 miles…generated another weak tornado (with a noticeable condensation funnel). This tornado was reported to have traveled about one mile over pasture land before dissipating. At its most intense, this cell spawned F1 Tornado damage for 3/8-mile when it lifted a roof from a house and carport and caused damage to various light structures along its path. There were no injuries or fatalities despite residents at home when the roof lifted from a house along Highway 59 near mid-day. [11]

October 17, 2004 – Spotter reports indicated a funnel cloud east to southeast of Merced during the early afternoon of the 17th. [11]

March 28, 2006, 2:48 p.m. PST – A trained spotter noted a funnel cloud approaching the City of Merced and tracked the northward movement of that funnel. At 1448 PST the funnel removed half of the corrugated roof of a farm maintenance shop and lifted it up and over adjacent power lines to the north. Eyewitness accounts indicated rotation and movement of the lowest level clouds toward the NE approximately 0.19 miles. Other than two ground contact points, beginning and end of the damage track, there was no evidence of any other ground contact from the funnel. Analysis by a local structural engineer aided in the assignment of the F0 rating. [11]

March 28, 2006, 3:17 p.m. PST - A late report indicated damage from this second small tornado in Merced at 1517 PST shortly after the 1448 PST tornado. There was minimal damage associated with the small track and path. There was an unconfirmed report of another touchdown in the City close to the time this confirmed 1517 PST tornado. [11]

February 9, 2009 – The Federal Aviation Administration office located in Oakland, CA, relayed a pilot report of a brief touchdown of a tornado 12 miles south of Merced Castle Airport. The tornado only lasted for a couple minutes and caused no property damage. The tornado was rated EF0. The touchdown occurred during a period of several funnel cloud reports over an area from Atwater to southeast of Merced Regional Airport (KMCE). [11]

Merced Airport - Funnel Cloud - 09 Feb 2009

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. “Probability of Occurrence” is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

- 0 Infeasible Event – not applicable due to geographic location characteristics
- 1 Rare Event – occurs less than once every 50 years
- 2 Infrequent Event – occurs between once every 8 years and once every 50 years (inclusive)
- 3 Regular Event – Occurs between once a year and once every 7 years
- 4 Frequent Event – occurs more than once a year

Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Tornadoes" in Merced is considered an infrequent event.

3.3.9 Fog

Above is a Satellite image of dense fog in California's San Joaquin Valley on November 20, 2002. This early morning radiation fog was responsible for several car accidents in the region. The white areas to the east of the fog are the snow-capped Sierra Nevada's. (NASA image)

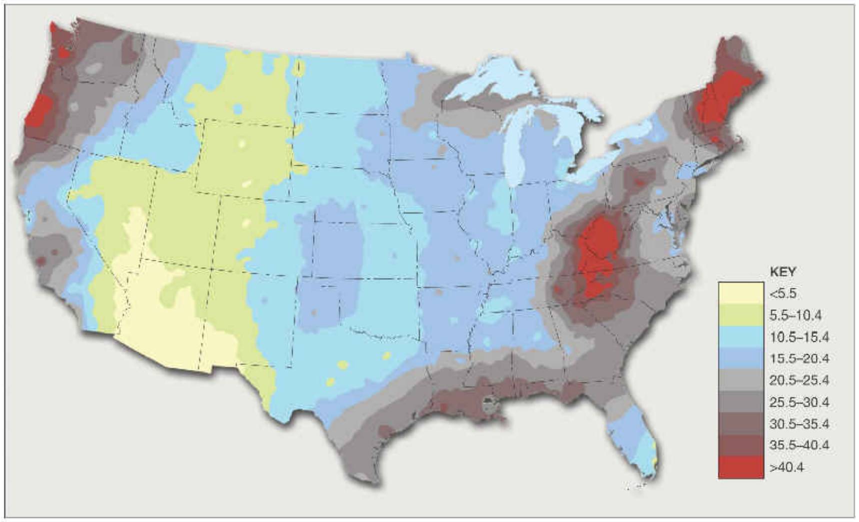
General Background

Fog begins to form when the air cools to the point where the water vapor condenses into tiny liquid droplets. Fog normally occurs at a relative humidity near 100%. For example, rain can cool and moisten the air near the surface until fog forms. There are many forms of fog, two of importance are: radiation fog and advection fog. Radiation fog is formed by cooling land and water surfaces that have warmed up during the summer and are still evaporating water into the atmosphere; and advection fog is warm moist air mass blowing over a cool surface.

After fog develops, it can linger into the late morning and even the afternoon hours before any clearing, lifting of cloud ceilings, or improvements in visibility occur. Sometimes the fog will clear, but it will still remain cloudy for several days with a deck of stratus clouds. The clouds remain after the fog lifts because a thick stratus deck that is more difficult to dissipate (which can be up to a few thousand feet thick) formed above the fog. These stratus clouds will linger for days after high pressure has settled over the area with no fog present in the valley, but in higher areas near the mountains (such as the foothills). Until the next low pressure system arrives, the fog will usually redevelop after sunset if no stratus deck lingers through the rest of the day or it clears out during the night. Until the persistent stratus deck has set up or a low pressure system returns, the valley fog can usually be expected to redevelop. [9]

Location

California's Central Valley has a unique fog called the "Tule Fog." Tule Fog is a radiation fog. High relative humidity, usually after a heavy rain, light winds, and rapid cooling condenses causing the Tule fog. The longer nights during the winter months creates 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.



[10]

Extent

The Tule fog season in the City of Merced is typically in the late fall and winter (November through March) but can occur as early as October and can be as late as May. Fog typically forms rapidly in the early morning hours and nights. It has the potential to last for days, even weeks.

Fog can be widespread throughout the entire San Joaquin Valley; visibilities usually vary from less than a couple of hundred feet to up to one mile. When widespread fog is present, visibility is continuously below a quarter mile for many miles, especially near riverbeds and any low lying areas, and can last beyond the usual time of day that is associated with fog (mostly from evening to mid-morning).

Previous Occurrences

Fog is a typical weather phenomenon to Merced, although as noted by the Table above, extreme events are rare. Nevertheless, when combined with other factors, fog will affect a community on a regular basis. Notable fog incidents include the following:

January 26, 1993 - 5 big rigs were involved in an accident in dense fog injuring 3 drivers.[12]

January 15, 1994 - Dense fog in the central and southern San Joaquin Valley. A pair of chain-reaction accidents near Selma involved 48 vehicles, resulting in 2 fatalities and injuring 32. Another chain-reaction accident, near Merced, involved 19 vehicles, injuring 8. [13]

November 20, 2002 – Fog was a major factor in a 50-vehicle collision on Highway 99 near Merced that resulted in 32 injuries. [13]

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

0 Infeasible Event – not applicable due to geographic location characteristics
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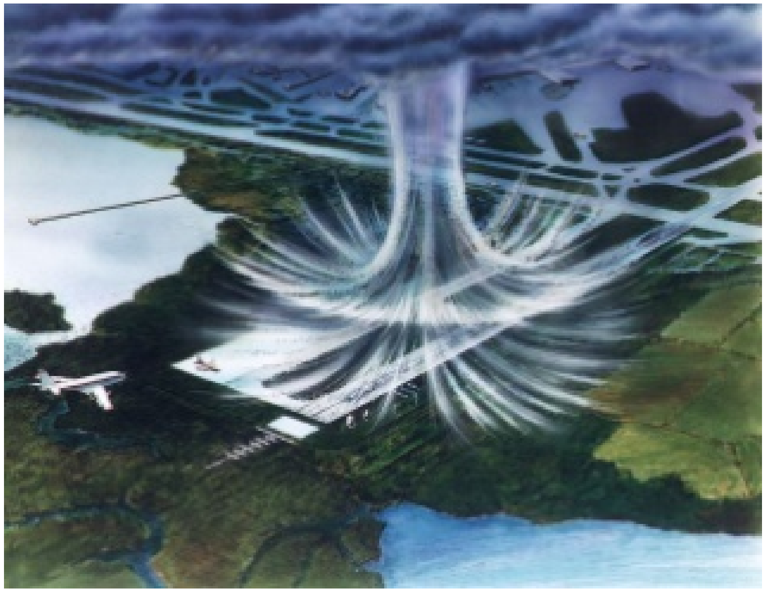
Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Fog" in Merced is considered a frequent event.

3.3.10 Storm-Related Hazards



General Background

Extreme weather is generally any destructive weather event, but usually occurs in the City of Merced as localized thunderstorms that bring heavy rain, hail, lightning, and strong winds. Therefore, this section focuses on "Storm-Related Hazards."

The National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to current (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 (1950-1992). This database contains 84 severe weather events that occurred in the County of Merced between January 1, 1950, and November 30, 2010.

NCDC Hazard Event Reports for the County of Merced, 1950-2010*

Type	# of Events	Deaths	Injuries
Dense Fog	2	0	12
Funnel Clouds	20	0	0
Gusty Wind	1	0	0
Hail	4	0	0
Heavy Rain	20	0	0
Lightning	8	0	1
Severe Thunderstorm/Wind	2	0	0
Small Hail	3	0	0
Thunderstorm/Wind	6	0	0
Tornado: F0	13	0	0
Tornado: F1	4	0	1
Wind	1	0	0
TOTALS	**84**	**0**	**14**

Source: National Climatic Data Center Storm Events Database,
*Note: Losses reflect totals for all impacted areas

STORM-RELATED CHARACTERISTICS

Thunderstorms

Storms in the City of Merced 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 (three quarters of an inch or greater), winds in excess of 50 knots (57.5 mph), or a tornado. Storms can cause difficult driving conditions, especially for small cars and high profile vehicles.

Hail

Heavy storms can bring along with it hail, 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. Hailstones vary in size; they can be less than two inches in diameter and upwards to the size of a melon. Hail can fall at speeds of 120 miles per hour (mph). Severe hailstorms can be quite destructive, causing property damage to buildings, roofs, automobiles, vegetation, and crops.

Lightning

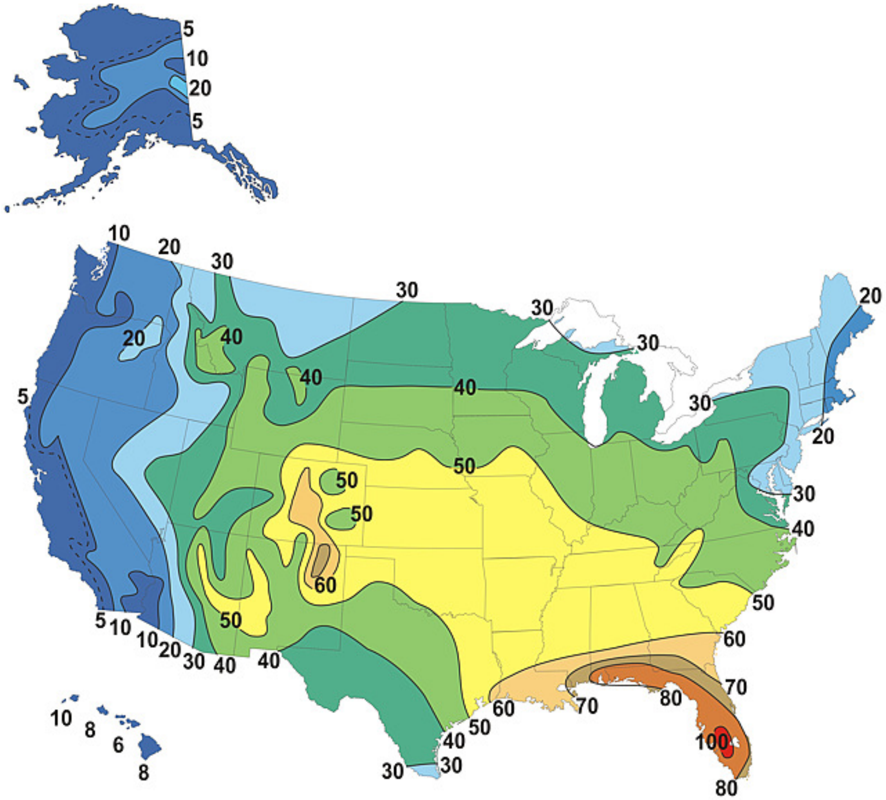
Lightning is defined as any and all of the various forms of visible electrical discharge caused by thunderstorms. Rain does not necessarily accompany thunderstorms and lightning, but every thunderstorm produces lightning. Cloud-to-ground lightning is the most common type of lightning. Lightning can kill 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 lightning strikes an object and the current passes through this can cause damage to whoever is in close vicinity, which generally results in less damage.

Wind

Damaging wind from thunderstorms is much more common than damage from tornadoes. Wind speeds can reach up to 100 mph with a damage path extending many miles. Downdrafts are generated when rain-cooled, more dense air sinks inside a thunderstorm. As precipitation begins to fall, it drags some of the air with it. This "precipitation drag" initiates a downdraft. The downdraft is intensified by evaporative cooling as drier air from the edges of the storm mix with the moist air within the storm. These processes lead to a rapid downward rush of air. As the air impacts the ground it is forced to spread out laterally causing the gusty winds associated with thunderstorms. Occasionally, thunderstorms will produce intense downbursts called a **microburst** that is a very localized column of sinking air, producing damaging divergent and straight-line winds at the surface. Microbursts are recognized as capable of generating wind speeds higher than 168 mph. The scale and suddenness of a microburst makes it a great danger to aircraft due to the low-level wind shear caused by its gust front, with several fatal crashes having been attributed to the phenomenon over the past several decades. [35] A **macroburst** is more than 2½ miles in diameter and can produce winds as high as 135 mph.

Location and Extent

California has relatively few thunderstorms when compared with the rest of the United States. The figure below shows the average number of thunderstorm days each year throughout the U.S. The most frequency of occurrence is greatest in the southeastern states, with Florida having the highest incidence (80 to 100+ thunderstorm days per year). [36]



Previous Occurrences

June 15, 1995 – Sheriff's Department reported three-quarters hail in the City of Merced. Rainfall mostly within a one-hour period of time was 1.81 inches. [37]

March 28, 1998 – Locally heavy rain from a band of thunderstorms that became quasi-stationary in the previous 12-18 hours brought flooding again to the Merced City and some outlying Merced County areas. Thunderstorms developed mid-day Tuesday the 24th and locally heavy rain continued for much of that afternoon and early evening hours. Rainfall totals for 24 hours ending by the morning of the 25th showed unofficial reports for 3.5" to 5.9" in the Merced City area. [38] Power outage to 700 customers of PG&E.

March 28, 1998 – Merced County Sheriff reports plus reports from truck drivers indicated that hail was large and deep enough to cause cars to slide off State Highway 99 just north of the Merced/Madera County line. Numerous thunderstorms developed during the afternoon hours throughout much of Central California and reached severe limits in Merced and Madera counties. [39]

April 7, 2001 – Heavy rain and hail (often less than ¾-inch) accompanying widespread convective activity through interior Central California late in the afternoon and early evening of Saturday, April 7th, caused extensive damage to agriculture. Although isolated severe hail swaths occurred and some were defined as technically non-severe, widespread heavy rain in conjunction with the hail damaged young fruit, grape, grain, and early planted cotton crops in several counties. [40]

On ***June 21, 2008***, a widespread mass of unstable air passed over Northern California. This air mass enabled the development of thunderstorms, specifically dry-lightning thunderstorms, that resulted in the ignition of 3,500 wildland fires that ultimately consumed hundreds of thousands of acres (California Department of Forestry and Fire Protection [CALFIRE], 2008.

Probability/Frequency of Future Events

The identification and ranking of hazards, applicable to Merced, is detailed in Section 3.2 of the LHMP. "Probability of Occurrence" is one of the risk factors used to rank each hazard. The following thresholds and numeric scoring were utilized by the LHMP Disaster Council to rank the Probability of Occurrence:

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Hazard probability scoring was based on a variety of sources, including: 1) the City's *ACS Firehouse Software* -- a nine-year database for fire, hazardous conditions and severe weather and other natural disasters (page 3-23 of the LHMP); 2) a qualitative "probability" scoring based on rankings by the Disaster Council and attending stakeholders at the March 9, 2012, Disaster Council meeting; 3) the 2009 City of Merced Community Risk Assessment; and 4) the hazard occurrence data presented in this hazard risk assessment.

Based on these inputs, the Probability of Occurrence for "Storm-related Hazards" in Merced is considered an infrequent event.

3.4 Vulnerability

Introduction

While hazards occur at varying extent and may impact large or small areas, it is a community's vulnerability to hazards that narrow the scope and need for mitigation to help reduce impacts to local populations and buildings. This Chapter contains an assessment of vulnerability to the hazards likely to affect Merced.

Overview - Vulnerability

RC#B3

A vulnerability analysis predicts the extent of exposure that may result from a hazard event of a given intensity in a given area. The analysis provides quantitative data that may be used to identify and prioritize potential mitigation measures by allowing communities to focus attention on areas with the greatest risk of damage. Per the local mitigation planning requirements, this vulnerability analysis consists of the following seven steps:

- Asset Inventory
- Methodology
- Data limitations
- Exposure Analysis
- Repetitive Loss Properties
- Summary of Impacts

A discussion of *Land Use Patterns and Trends* is included in section 3.1.2 (Community Profile) of this Chapter.

3.4.1 Asset Inventory

Assets that were included in the MHMP's vulnerability analysis are as follows:

- Population
- Residential building stock
- Critical facilities:
  - City Hall and Departments
  - Parks, Community Services and Schools
  - Public Safety Buildings
  - Public Works Infrastructure and Facilities
  - Transportation Backbone

Merced's critical facilities are described more fully and mapped as part of the MHMP *Local Capability Assessment*, Section 4.1.4. Appendix L is the City of Merced *Comprehensive Asset Inventory*, which was included in the HAZUS model runs for flooding and earthquake hazard loss estimates.

3.4.2 Methodology

HAZUS

The MHMP includes information from HAZUS, a PC-based software, which implements the FEMA-developed loss estimate methodology.

First, an inventory of community assets was performed in order to determine the quantity of buildings, people, and asset values that lie in the different hazard areas and what proportion of the City this represents. The baseline data contained in HAZUS (census year 2000) was supplemented with recently constructed assets, (for example, the new Merced Medical Center on "G" Street). Using HAZUS, mock flood and earthquake hazard events were applied to the asset inventory to help the Disaster Council determine where resources should be allocated to address mitigation issues.

HAZUS also compiled general economic loss values for buildings and infrastructure within the City related to flood and earthquake related hazards. This task helped the City determine which assets would be subject to the greatest potential damages and which hazard event is likely to produce the greatest potential losses.

TOTAL VULNERABILITY AND VALUES

A conservative exposure-level analysis was conducted to assess the risks associated with the identified hazards. This analysis is a simplified assessment of the potential effects of the hazards on values at risk without consideration of the probability or level of damage. Using US Census 2010 City of Merced population information, geographic information system (GIS) data was used to determine the number of people located where hazards are likely to occur.

Census block level residential building information and parcel specific data was used to determine the number of residential buildings located where hazards are likely to occur.

Using GIS-data provided by the Merced Association of Governments, locations of physical assets were compared to locations where hazards are likely to occur. If any portion of an asset fell within a hazard area, it was counted as impacted.

For each physical asset located within a hazard area, exposure was calculated by assuming the worst-case scenario (that is, the asset would be completely destroyed and would have to be replaced). The aggregate exposure, in terms of replacement value or insurance coverage, for each category of structure or facility was calculated. A similar analysis was used to evaluate the proportion of the population at risk. However, the analysis simply represents the number of people at risk; no estimate of the number of potential injuries or deaths was prepared.

The data in Appendix L (Comprehensive Asset Inventory) derived from HAZUS that used census 2000 data.

3.4.3 Data Limitations

The vulnerability estimates provided herein use the best data currently available, and the methodologies applied result in an approximation of risk. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning hazards and their effects on the built environment as well as the use of approximations and simplifications that are necessary for a comprehensive analysis.

It is also important to note that the quantitative vulnerability assessment results are limited to the exposure of people, buildings, and assets to the identified hazards. It was beyond the scope of this LHMP to develop a more detailed or comprehensive assessment of risk (including annualized losses, people injured or killed, shelter requirements, loss of facility/system function, and economic losses). Such impacts may be addressed with future updates of the LHMP.

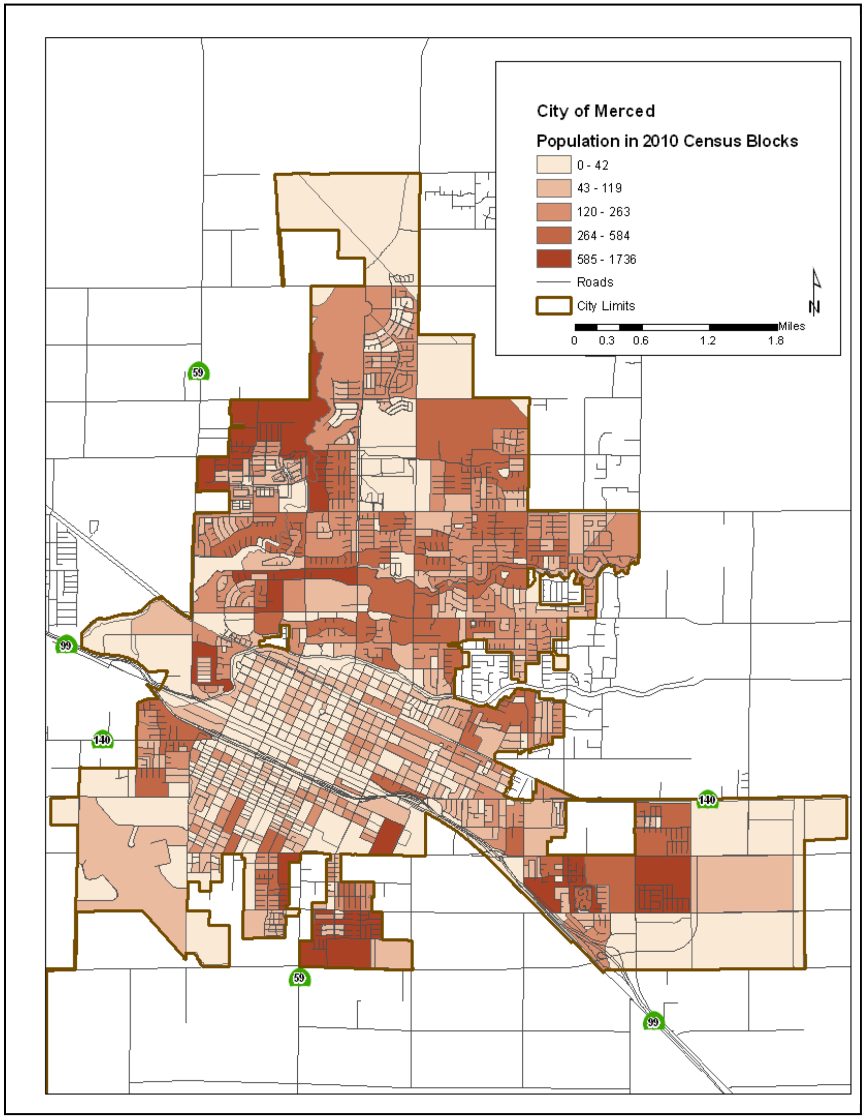
3.4.4 Exposure Analysis

Vulnerable structures, including residential buildings and critical facilities, and population at risk to each identified hazard are detailed in Table 3-12 below. The estimated potential dollar losses for critical facilities at risk to each identified hazard are also shown in this table.

HAZUS

HAZUS scenarios were also run for earthquake and flood hazards; see details in the "HAZUS Event Reports" located in Appendix K.

City of Merced 2010 Population Distribution by Census Block



City of Merced 2010 Dwelling Unit Type Distribution by Parcels

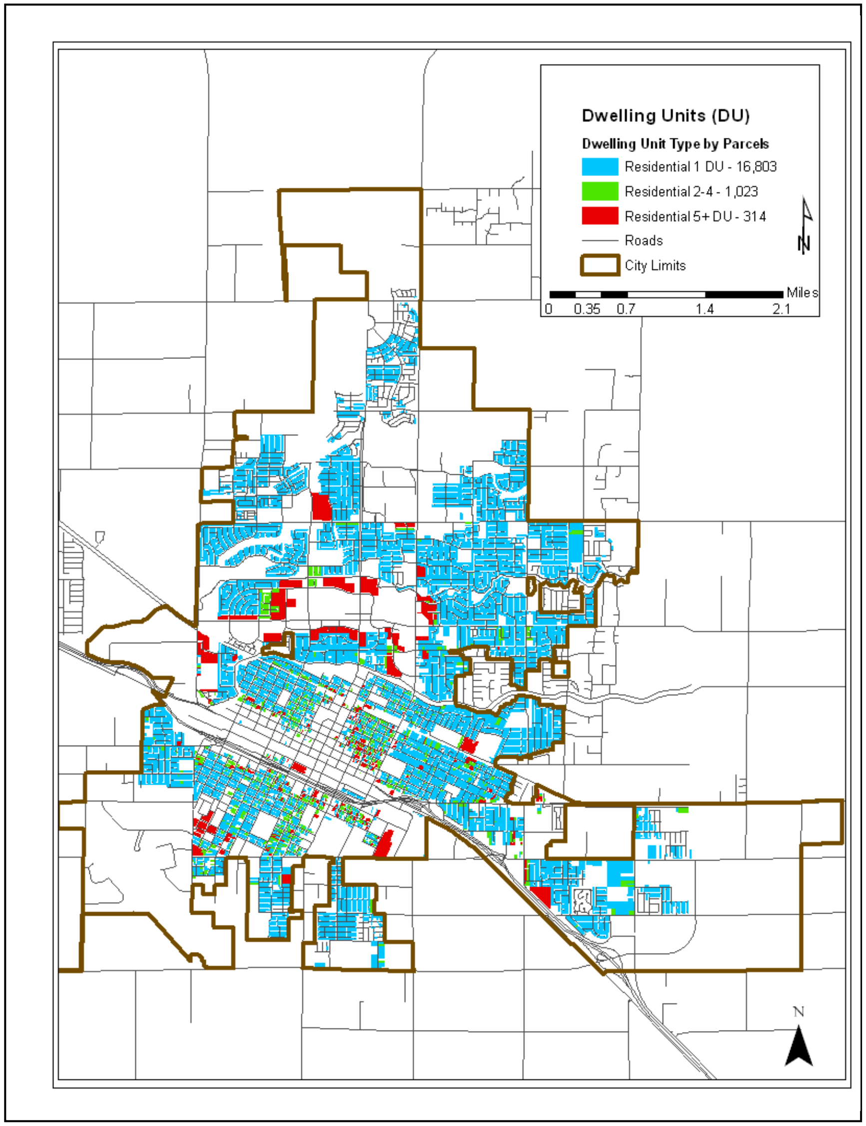


Table 3-12: City of Merced, Overall Summary of Total Assets at Risk							
Hazards	**Hazard Area**	**Population**		**Residential Buildings**		**Critical Facilities**	
		No	**%**	**No.**	**%**	**No.**	**%**
Flooding	100-year floodplain	55,205	65	8,026	44	202	64
	500-year floodplain	67,585	79	9,271	51	37	12
Wildfire	Open Space Grasslands	3,462	4	1,695	9	53	17
Drought	Planning Area	85,190	100	18,227	100	313	100
Hazardous Materials-Transportation Corridor	Highway 99	21,235	25	4,034	22	89	28
	Railroads	33,643	39	6,753	37	127	40
Earthquake	Planning Area	85,190	100	18,227	100	313	100
Dam Failure	Inundation Areas	36,461	43	9,856	54	136	43
Extreme Temperature	Planning Area	85,190	100	18,227	100	313	100
Tornado	Planning Area	85,190	100	18,227	100	313	100
Fog	Planning Area	85,190	100	18,227	100	313	100
Storm-Related	Planning Area	85,190	100	18,227	100	313	100

3.4.5 Repetitive Loss Properties

Types and Numbers of Repetitive Loss Properties in the City's Flood Hazard Area

RC#B4

Eleven repetitive loss properties, all single family homes, occur within the Planning Area of the MHMP. Their general location is marked on the map on the following pages; most of these are located within the 100-year floodplain.

NFIP Insured Structures Repetitively Damaged by Floods

Five of the eleven repetitive loss properties were insured at the time of the flooding event. Flood damage claims to the buildings on the eleven properties, affected by flooding events between January 2008 and August 2011, totaled $552,497.19. This figure was obtained from a list of repetitive loss properties in Merced County located near the City of Merced, provided by the California Emergency Management Agency.

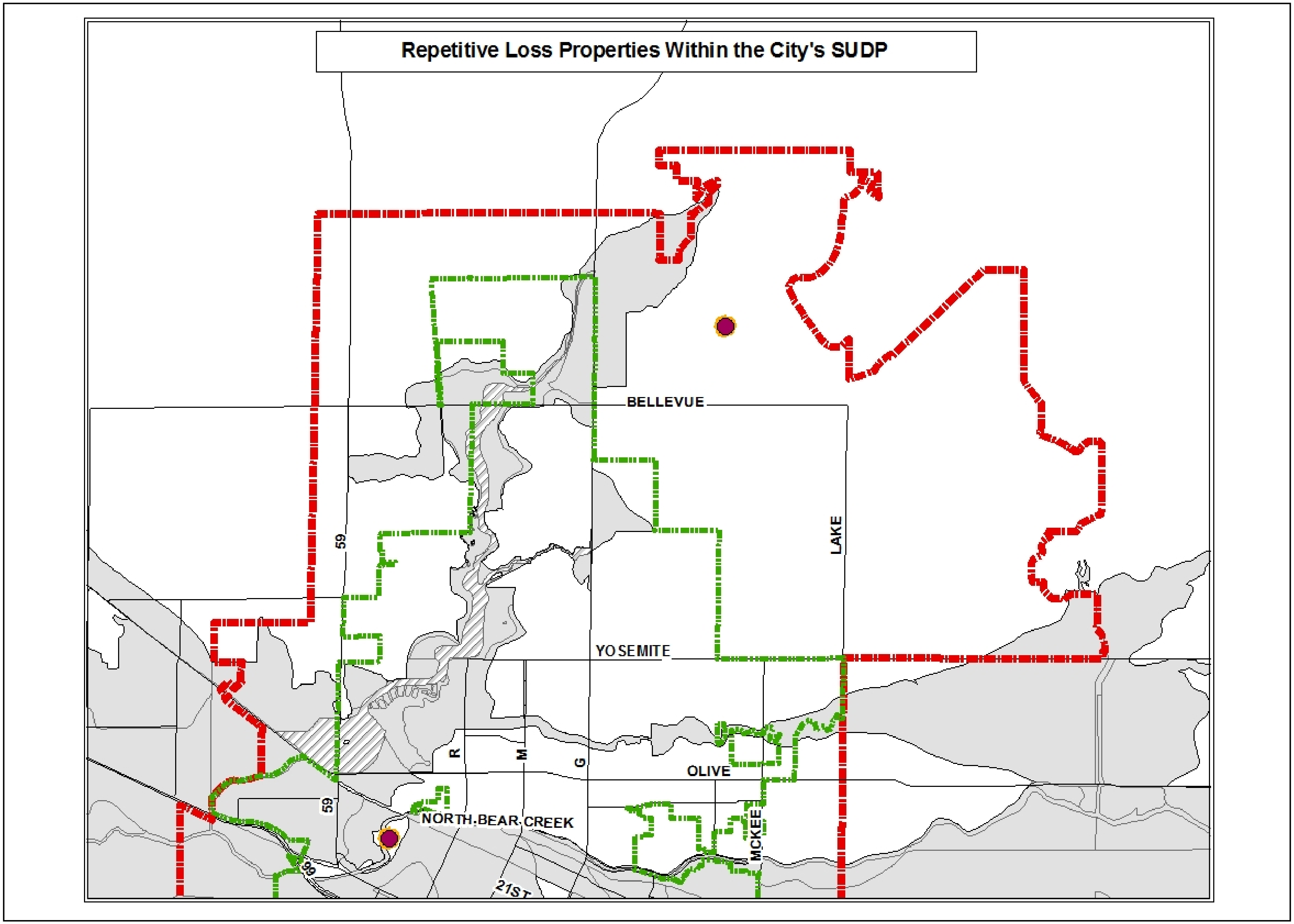
Perpetual Flood Easement Agreements

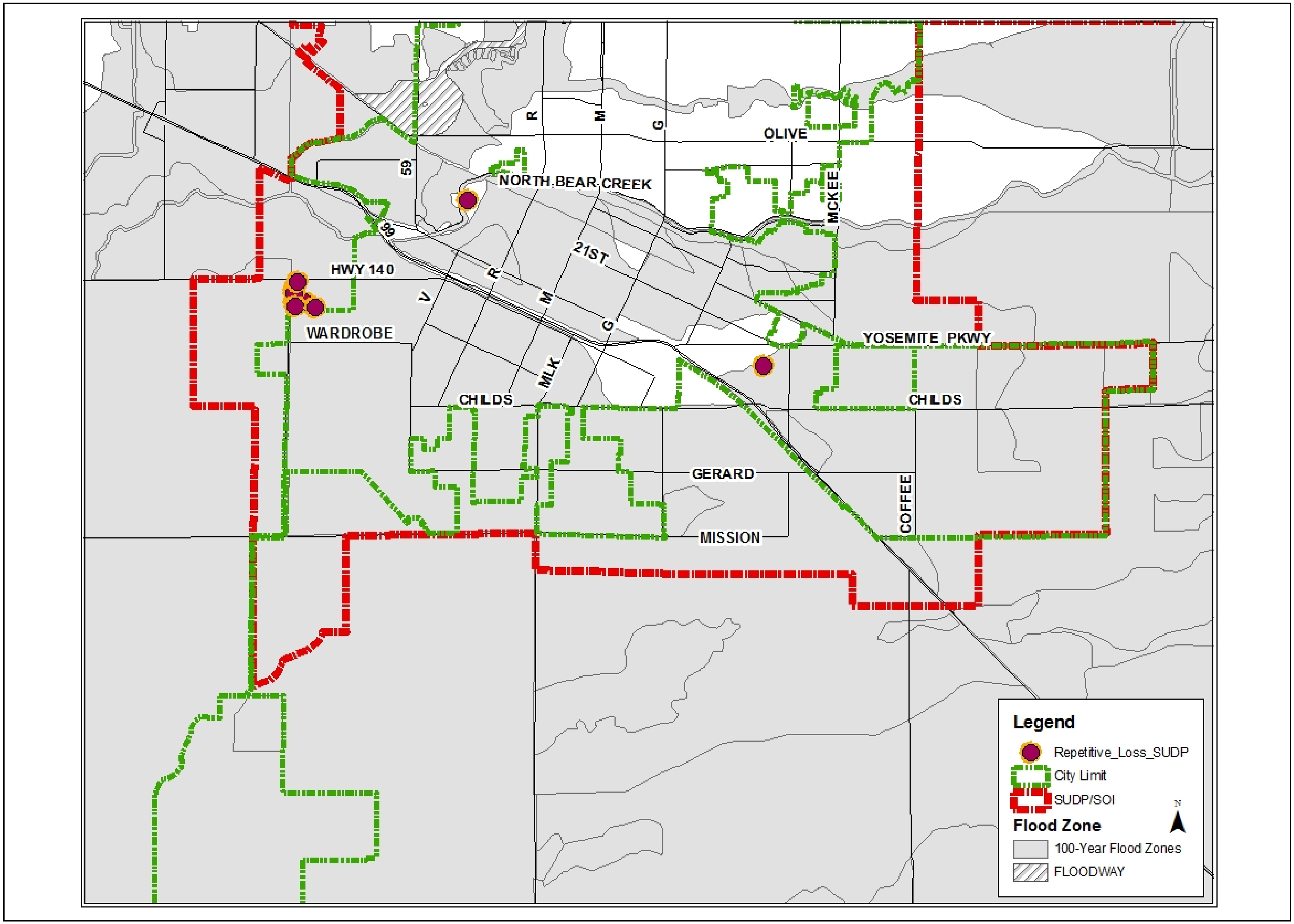
As a result of multiple flooding events in the area of West Highway 140, Thornton Road and Lopes Avenue in Merced County during January and March of 1998, several perpetual flood easement agreements were entered into between plaintiffs and the County of Merced and the Merced Irrigation District. The easement granted in these agreements is an easement for the purposes of allowing flooding of any volume or height across and upon the properties.

Land Uses and Trends in Repetitive Loss Areas

Two of the repetitive loss sites are within fully developed areas, and no further development in these areas will occur. In the vicinity of Highway 140 and Thornton Road, a large cluster of repetitive loss properties are located within the county (but within the City's growth area) on fully developed lots. These properties are located to adjacent vacant lots that have land use designations for "Low Density Single-Family Residential."

Future development will be required to comply with the requirements of the California Environmental Quality Act (CEQA) and to meet the City's Floodplain Ordinance. Due to past repetitive flooding events in this area, nearby areas will be scrutinized to assure that future development will not be impacted by future flooding events.


Repetitive Loss Properties Within the City's SUDP
BELLEVUE
59
LAKE
YOSEMITE
R
M
G
OLIVE
59
NORTH BEAR CREEK
MCKEE
99
21ST



OLIVE
NORTH BEAR CREEK
MCKEE
59
99
R
M
G
21ST
HWY 140
V
WARDROBE
YOSEMITE PKWY
MLK
CHILDS
CHILDS
GERARD
COFFEE
MISSION
Legend
Repetitive_Loss_SUDP
City Limit
SUDP/SOI
Flood Zone
100-Year Flood Zones
FLOODWAY
N

3.4.6 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.

A discussion of *Land Use Patterns and Trends* is included in section 3.1.2 (Community Profile) of this Chapter.

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 U.S. 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. Merced County ranked "medium" to "high" in the county-to-state 2006-2010 comparison of social vulnerability to environmental hazards, and "medium" in the county-to-nation comparison.

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.

3.4.7 Vulnerability to Specific Hazards

Vulnerability to Flooding

The areas south of Bear Creek including downtown (except small islands) and areas along Highway 59-north are affected by potential flood. The greatest risk would come from failure of levees and/or overflow of Bear Creek or Black Rascal Creek. [6]

<u>Evacuation Routes</u>
As indicated previously, flooding could have extensive impacts upon the Merced SUDP/SOI. Two particular concerns relating to flooding are the potential that evacuation from South and Central Merced to the dry areas to the north could get cut-off by rising waters on the bridges over Bear Creek, and that most of the City's emergency facilities are in the floodplain and could become inundated.

<u>Water Supply</u>
The ability of the City to provide potable water under such circumstances, however, seems to be good because of the City's policy of keeping the entrances to the pump facilities above the 100-year flood elevation.

<u>Integrated Regional Water Management</u>

The following vulnerability points were provided by the *Integrated Regional Water Management Plan* (IRWMP) Project consultant on July 24, 2012, concerning *Climate Change Impacts on Surface Water* which include: 1) reduced flows) changes to snowmelt runoff timing; 3) increased low-flow period; and 4) "flashier" runoff from storm events. The consultant also identified Likely Regional Vulnerabilities, which include:

- reduced surface water availability;
- reduced water supply reliability as a result of reduced surface water availability, groundwater recharge and runoff;
- potential increase in groundwater overdraft;
- potential increase in land subsidence; declining water quality;
- loss of riparian habitat, wetlands and other sensitive natural communities;
- reduced hydroelectric generation capacity; and 8) increased flooding.

Planning Area Vulnerability to Flooding

Flooding HAZUS Data: Scenarios for the 100 and 200-year flood events were run using the HAZUS model, and are presented in Appendix K. The City's storm-drainage infrastructure is built to handle a 50-year event.

On the nearly 15,000 acres currently in the City of Merced, 71% is within the 100-year and 500-year floodplains. Upon build-out of the 2030 SUDP, this percentage will decrease to 50%, however. This is due to the fact that most future growth will be located outside flood sensitive areas.

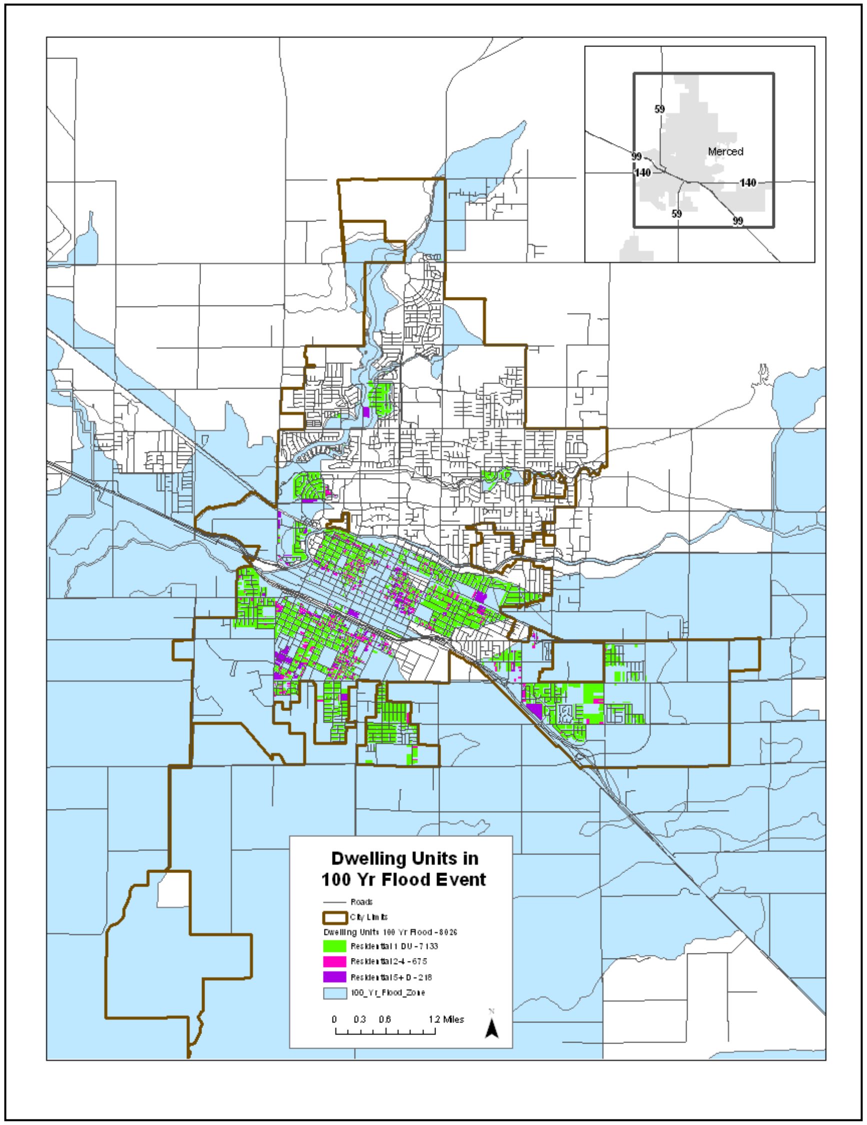
COMMUNITY VULNERABILITY MAPS

Plan Area vulnerability of residential buildings, population and critical facilities to flooding are revealed in the map set below; vulnerabilities are summarized in Table 3-12 above.

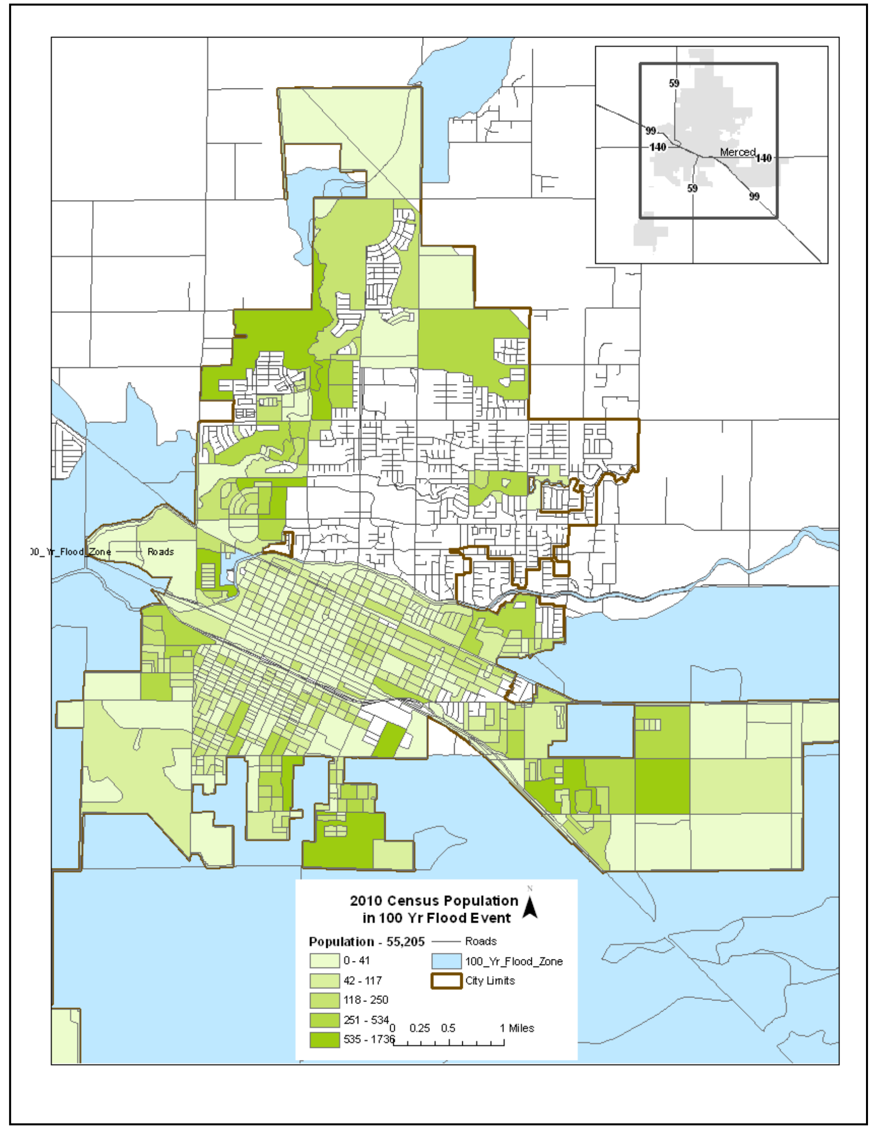
Flood Hazard Impact on Planning Area

Floods will impact the City by inundating certain areas with an overwhelming amount of water resulting in injuries/death, displacement, property damage, and impaired infrastructure. According to former Fire Chief Ken Mitten (personal communication, January 20, 2009), floods have caused millions of dollars worth of direct and indirect damage to the City over the last decade. Flood events place civilians, pets, property, crops, and livestock at risk for injury, death, or damage from the static and swift water conditions that will most certainly exist.

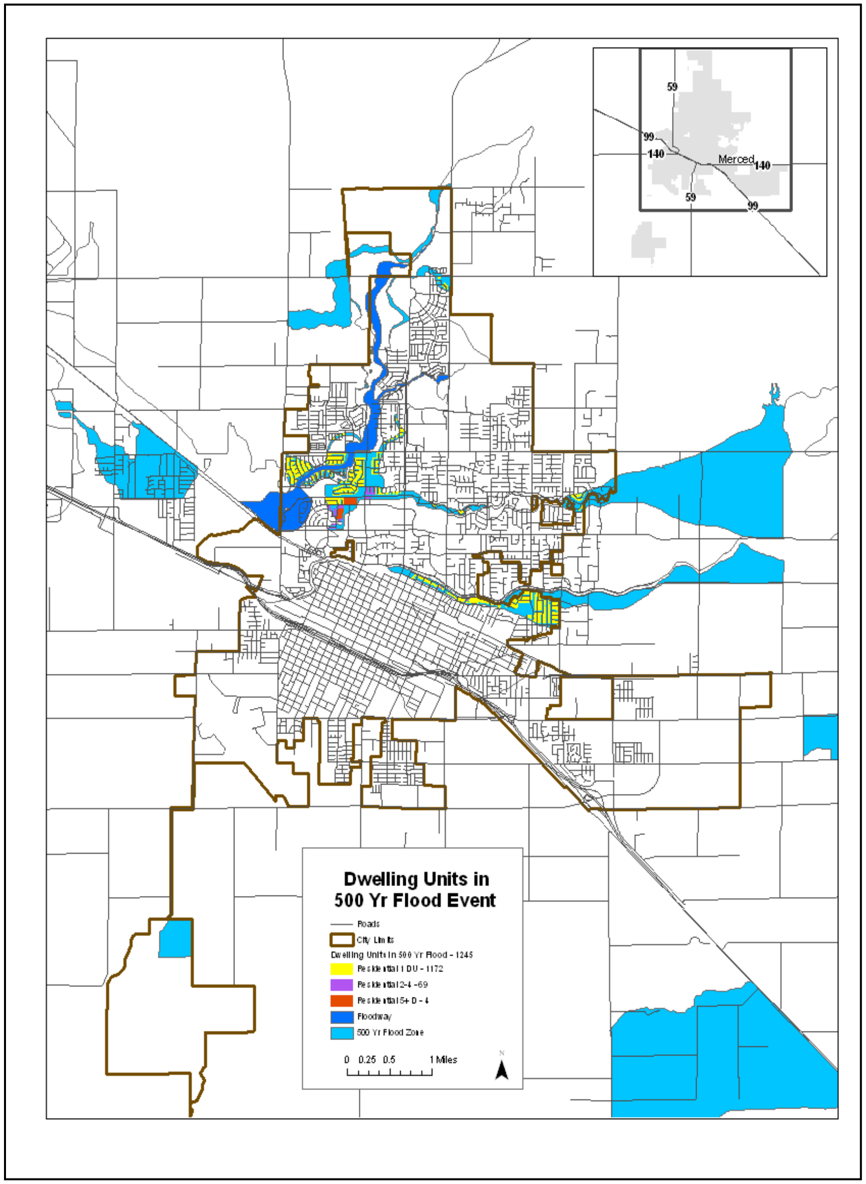
Number of Residential Buildings within the 100-yr Floodplain



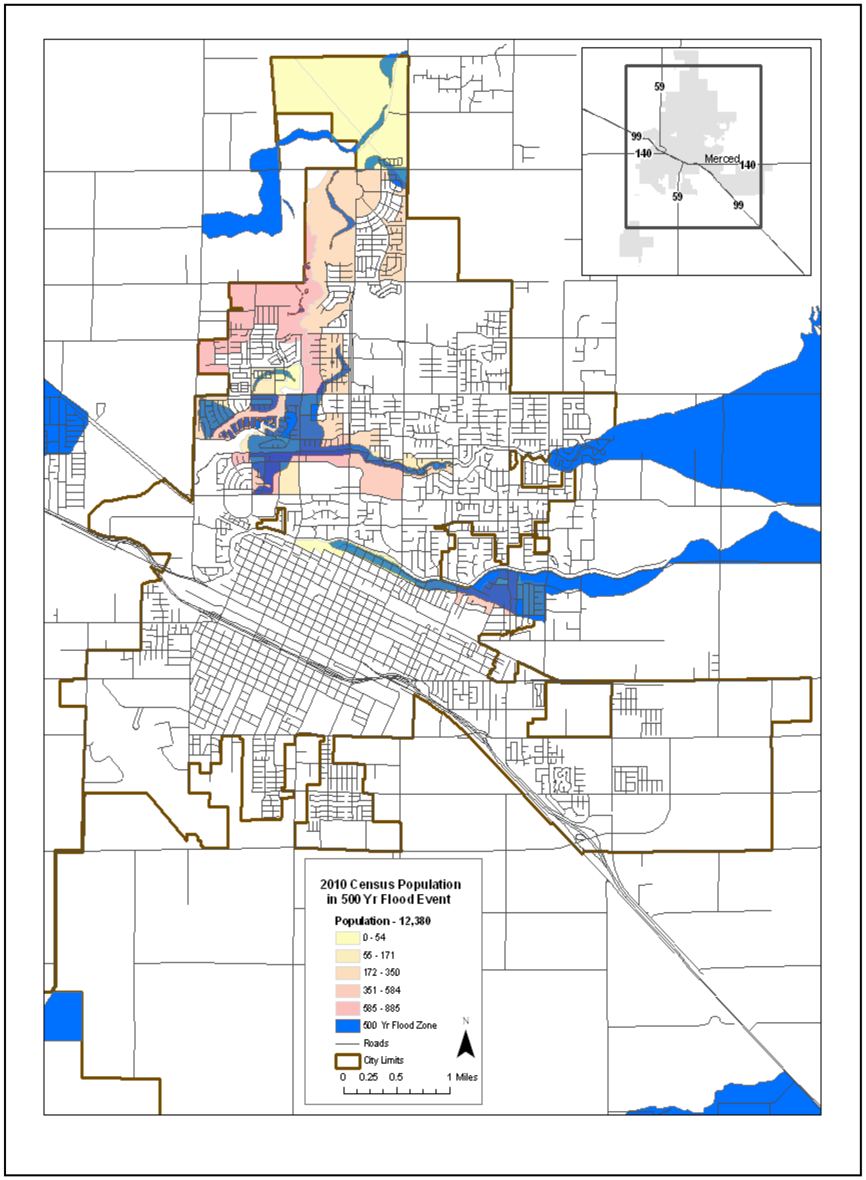
Population within the 100-yr Floodplain



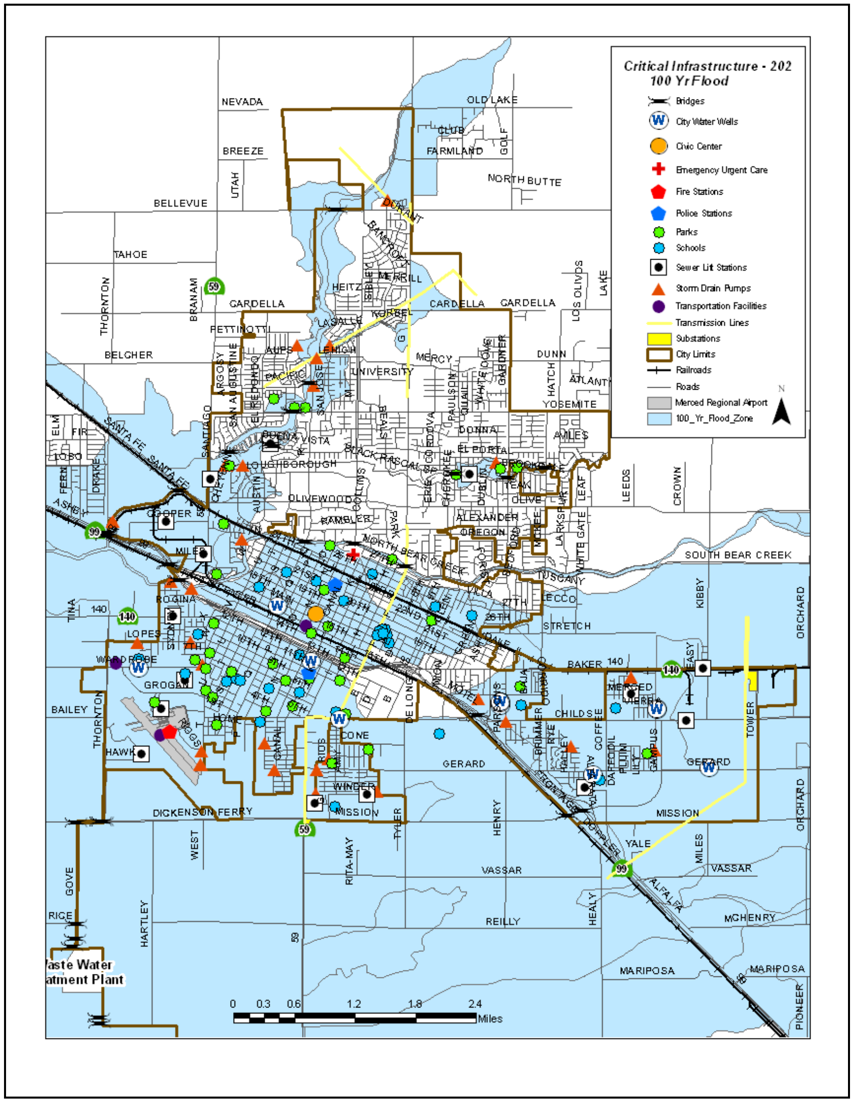
Number of Residential Buildings within the 500-yr Floodplain



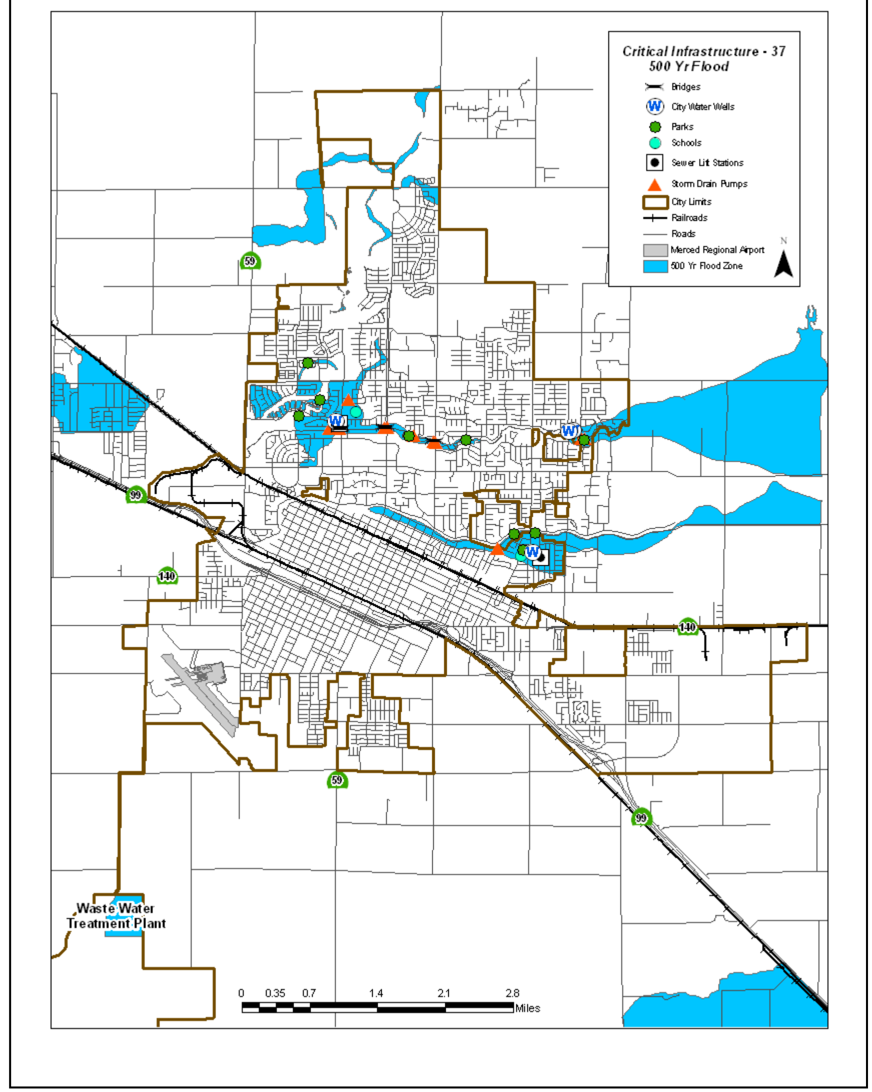
Population within the 500-yr Floodplain



Critical Facilities within the 100-yr Floodplain



Critical Facilities within the 500-yr Floodplain



Vulnerability to Fire

All residences, businesses, and open lands are at risk for fire. The degree of the risk varies based on engineered and administrative controls that are in place. In the early 1980's the City suffered from a rash of arson fires that caused more than $9 million in damage. Soon thereafter, the City adopted an ordinance to require automatic sprinkler systems for all commercial occupancies that exceed 5,000 square feet. Most residential fires within the City are a result of cooking or unattended cooking; this statistic is consistent with the national average. While the frequency of structural fires within the City remains high, the severity is low as a result of short response times and aggressive fire attack operations.

Regarding wildland fire, based on the fuel models of short and tall grasses, the fuels become receptive to fire in the late spring and continue well into the autumn months. The frequency of wildland fires in and about the City of Merced is high, but the severity is low due to the weed abatement program and response times.

The potential for serious structural damage occurs mainly in the grassland areas adjacent to development, especially during adverse wind conditions. [2]

Fire Hazard Impact on Planning Area

IMPACT ON LIFE, SAFETY, AND HEALTH

Wildland/urban fires pose a very real threat to the City of Merced. Although the terrain is flat, Merced is surrounded by grasslands that contain thousands of acres of light, flashy, grass fuels, and is subject to moderate afternoon winds that drive fires. Civilians, pets, and livestock that reside in proximity to open lands are most at risk to the effects of a wildland fire.

Potential losses from wildfire include human life, structures/improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in Merced, and the risk from wildfire has been deemed moderate by both the State and the Merced Fire Department. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Health hazards from the smoke caused by wildfires can include breathing difficulties and exacerbation of chronic breathing and cardiovascular disease. Smoke and air pollution from wildfires can be a severe health hazard especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

Critical facilities are public and private structures where vital community functions are conducted. If the facility is damaged or destroyed by wildfire, there could be severe consequences to public health and safety. The City Fire Department, all first responders, and mutual aid agencies would work to protect those facilities identified in areas where wildfire is a potential.

A critical facility is defined as a facility that is vital for the City's ability to provide essential services and protect life and property and/or the loss of which would have a severe economic or catastrophic impact.

The following table provides a list of critical facilities that are adjacent to potential wildfire areas.

CRITICAL FACILITIES ADJACENT TO POTENTIALWILDLAND FIRE AREAS	
Facility Type	Number
Fire Stations	1
Power Substations	3
UC Merced Campus	1
Wastewater Treatment Plant	1
Water Well Sites	3

The MFD's weed abatement program has all but eradicated wildland fires from within the City limits; however all properties on the outer edges of the City are directly at risk.

IMPACT ON EXISTING AND FUTURE STRUCTURES AT RISK

The Merced Fire Department staff assesses the risk of existing structures annually as they maintain staff, purchase apparatus, and conduct training to protect life and property in Merced. The Fire Department has prepared for the increasing potential for a wildfire as the City has grown and the number of structures adjacent to the grasslands along the City limits has increased.

The City has invested in additional training and equipment as construction in the Bellevue Ranch area has continued to grow. The incomplete build-out on the Bellevue Ranch and other developments in the City has resulted in an increased risk for existing structures. While roads, greenbelts, and infrastructure have been planned and in some instances installed, the empty lots pose wildland fire risks to the residences and outbuilding that have already been built.

ECONOMIC IMPACT

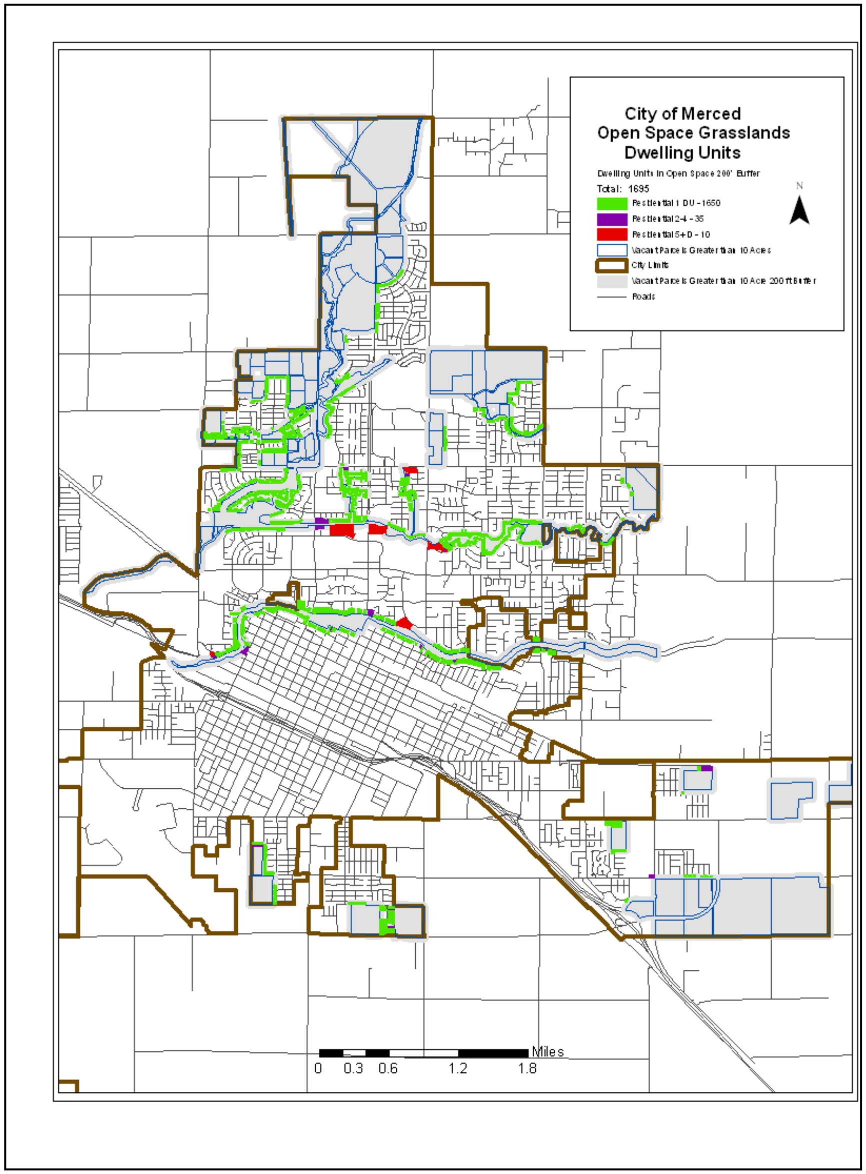
There are direct and indirect economic impacts associated with wildland/urban fires. *Direct Costs* are costs associated with life loss, property damage, suppression, recovery, and all other costs directly connected to the event. *Indirect Costs* are costs associated with business interruption, community degradation, vacant structures, and other costs that were not directly related to the event, but we created as the indirect result of the event. The National Fire Protection Association (NFPA) data finds that in 2007 there was $16.6 billion in direct economic impacts from fire in the United States. NFPA estimates that the direct costs of fire comprise 90% of total loss and the indirect costs make-up the remaining 10%.

Between January 1, 2007, and December 31, 2010, the City of Merced experienced an estimated direct fire loss of $11,770,096, which averages to $2,942,524 per year. Direct costs from structure fires resulted in an average loss of $2,669,110 (90.7%) per year, while wildland fires only resulted in $8,033 (0.003%) of the direct costs.

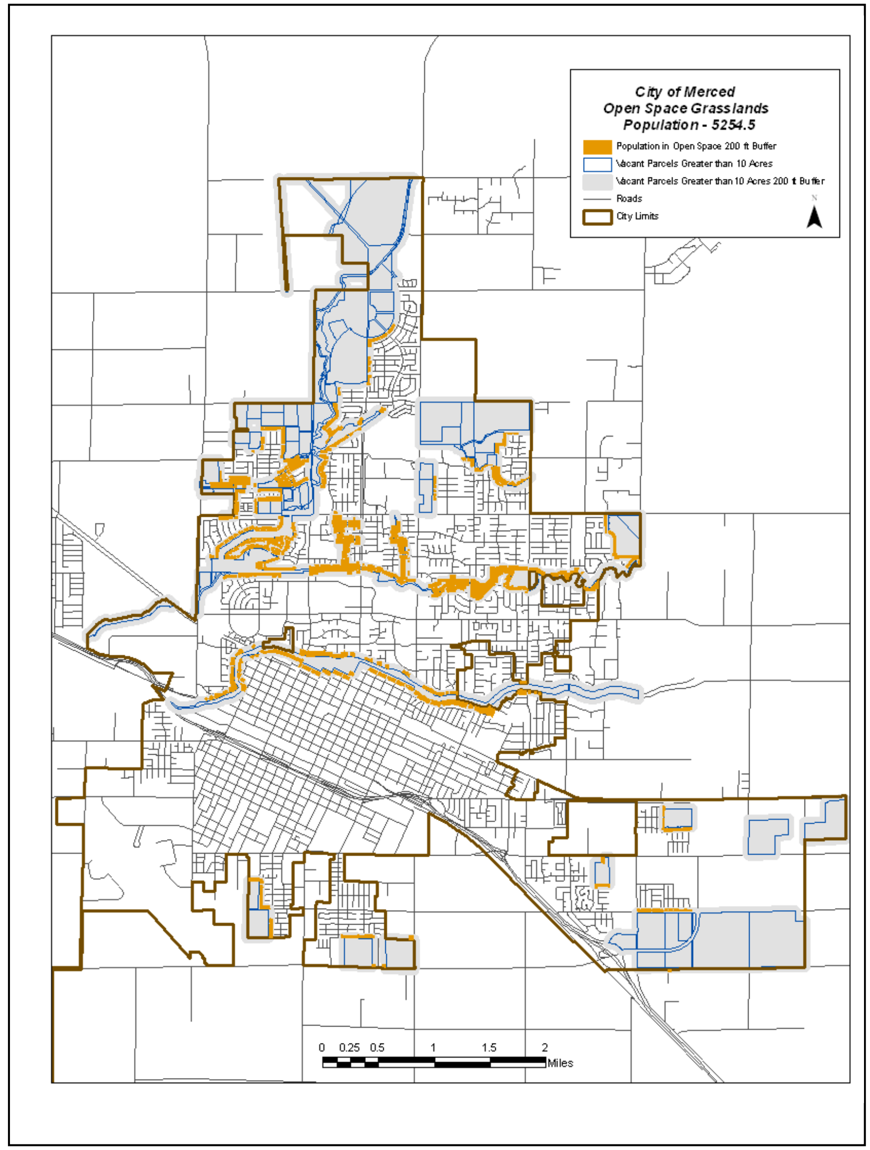
COMMUNITY VULNERABILITY MAPS

Plan Area vulnerability of residential buildings, population and critical facilities to wildfire are revealed in the map set below; vulnerabilities are summarized in Table 3-12 above.

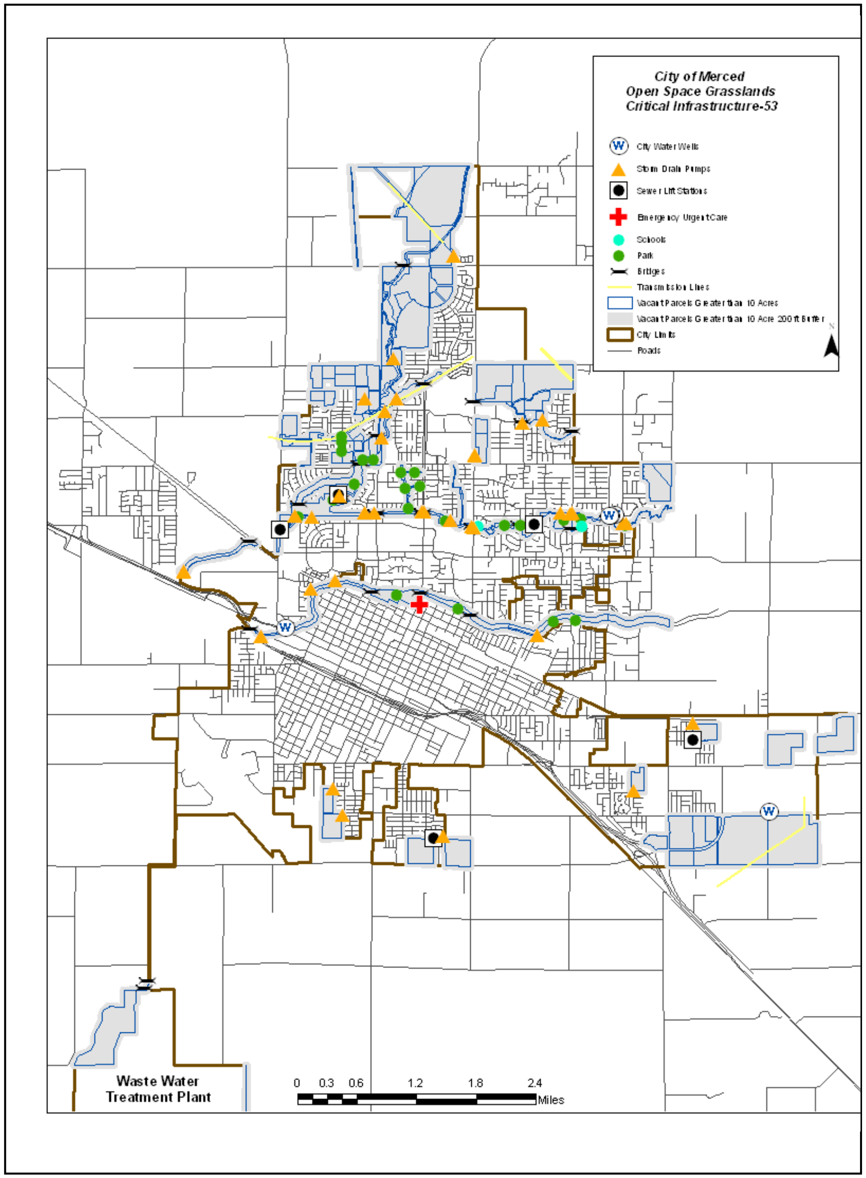
Number of Residential Buildings near Open Space Grasslands



Population near Open Space Grasslands



Critical Facilities near Open Space Grasslands



Vulnerability to Drought

Adequate water is a critical factor, necessary for agricultural, manufacturing, tourism, recreation, and commercial and domestic use. Therefore, drought has the potential to adversely affect many sectors in different ways and with varying intensities. For example, impacts may include: water shortages and associated conservation measures; increased fire danger; reduced or failed crop yields; livestock death; reduction of electric power generation; deterioration of water quality; compact soils and hydrophobic soils, potentially making an area more susceptible to flooding; and desertification.

As an urban community, Merced's vulnerabilities to drought include water shortages, fire danger, and susceptibility to flooding.

Drought Hazard Impact on Planning Area

Past droughts demonstrated that water users affected the earliest and to the greatest extent by drought conditions were those not connected to the State's system of water supply infrastructure, but reliant solely on annual rainfall. Typical examples were rural residents supplied by marginal wells, isolated communities relying on springs or small creeks, and ranchers dependent on dryland grazing. Residential water users and small water systems experiencing the most problems were those located in isolated North Coast communities and in the Sierra Nevada foothills. Water haulage and drilling new wells were typical drought response actions in these areas.

While the City of Merced's water system is independent of the State's, and solely reliant on groundwater, the use of interconnected wells that tap into the deeper and larger aquifer, reduces the City's vulnerability to drought.

Significant economic impacts on California's agriculture industry can occur as a result of short and long term drought conditions, including hardships to farmers, farm workers, packers, and shippers of agricultural products. They can also cause significant increases in food prices to the consumer due to shortages. As an urbanized community, agricultural uses comprise a very small portion of the City.

Vulnerability to Hazardous Materials

The potential vulnerability of hazardous materials incidents is difficult to predict because the cause of these incidents are generally human error or technology failure. Generally, comprehensive regulation for the transporters and facilities producing, using, or storing hazardous materials limits the number of releases, but still a great risk is present if safeguards fail or are not followed.

The types of "hazmat" incidents that can occur and the resulting impacts are: [2]

SPILL OR RELEASE

Immediate threat from any hazardous materials release into the atmosphere is from exposure to toxic vapors, gases, liquids and solids. Even a small release of a hazardous substance can have devastating effects on those who are exposed. A release may result in requiring City residents and businesses to take protective actions such as evacuation or shelter in place. The secondary risk is to the environment. Unchecked exposure can lead to contamination of the air, ground and subsurface water sources, soil and affect the health of wildlife. Large spills can contaminate drinking water supplies that may affect entire communities, especially in rivers, underground aquifers or reservoirs. [2]

FIRE

When hazardous materials burn, toxic chemicals are often present in the smoke. The greatest danger is from inhalation, but eye damage and absorption through the skin can also be a problem. Fire fighting can be quite difficult. Large hazardous materials fires are mainly a hazard in and around industrial areas, although smoke and vapor plumes can travel for miles. [2]

EXPLOSION

The major threats from an explosion involving hazardous materials are from falling objects and flying debris, thermal exposure, released contaminants, and over pressure during detonation. Like hazardous materials fires, explosions are mainly a hazard in and around industrial areas, and along ground or marine transportation corridors. [2]

Should an incident occur that either breaches or compromises the integrity of natural gas pipelines, many of the citizens within the City would become affected. Such an incident would greatly affect businesses, the railways, highway transportation routes, and the environment. [6]

Hazardous Materials Impact on Planning Area

COMMUNITY VULNERABILITY MAPS

Plan Area vulnerability of residential buildings, population and critical facilities to hazardous materials are revealed in the map set below; vulnerabilities are summarized in Table 3-12 above.

IMPACT ON LIFE, SAFETY, AND HEALTH

Exposure to hazardous materials can result in any number of reactions, from temporary respiratory ailments to death. Impacts vary with the use & disposal of substance, population exposed, the dose (concentration) of the exposure, how the exposure happens, duration of exposure, and if the exposure is recurrent. Populations such as the elderly and youth are typically greatest at risk, but people who speak limited English or live in low income areas are at an increased risk of not being able to respond during evacuations.

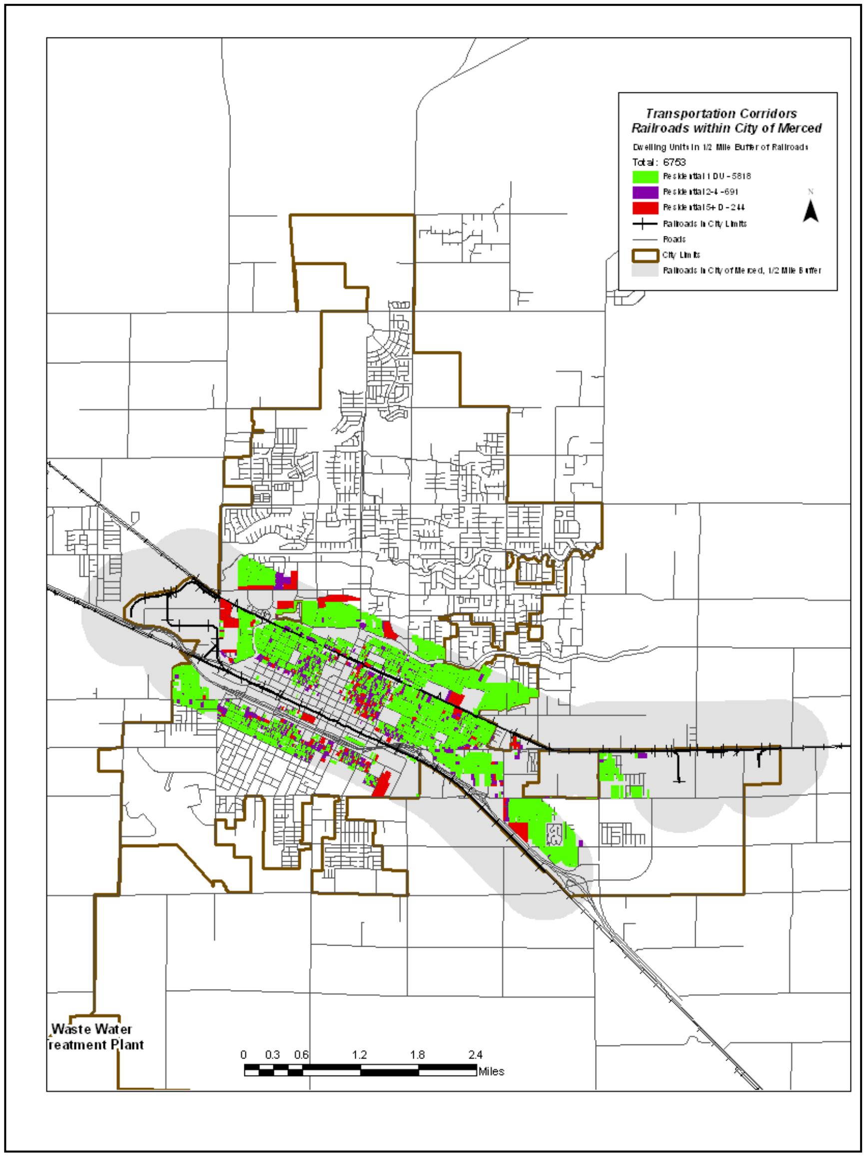
IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

Critical facilities in Merced located within a mile radius of transportation corridors, including highways and railroads, pipelines, and fixed hazardous material facilities, are at an elevated risk for hazardous materials incidents disrupting activities contained within these facilities. Of most concern to physical structures are incidents involving fire, water, and chemical interactions which could cause explosions. Releases of toxic substances could also result in the facilities becoming inaccessible for a period of time.

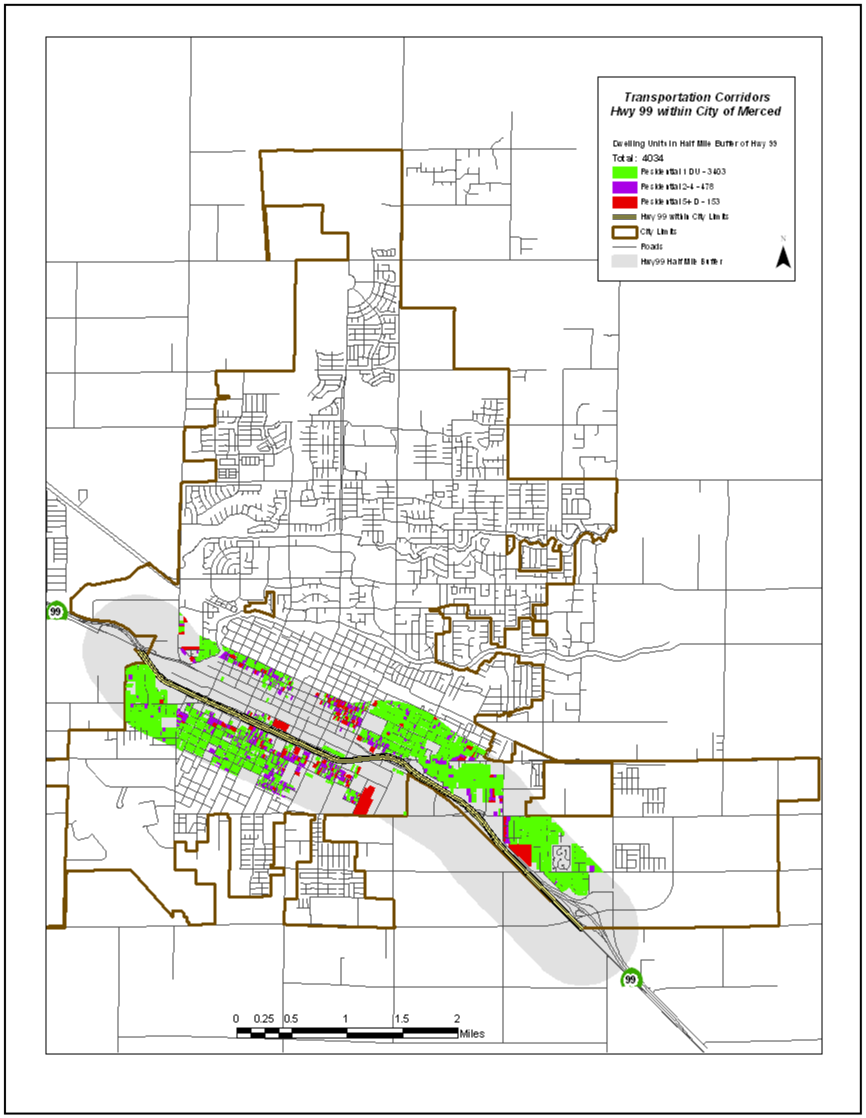
ECONOMIC IMPACT

The economic impact a hazardous material incident will have on the community is dependent on the location, size of the incident, and amount of time and money necessary to clean up the incident. The unpredictable nature of these events makes monetary losses hard to predict. Methods of modeling potential losses are beyond the typical scope of typical hazards such as floods.

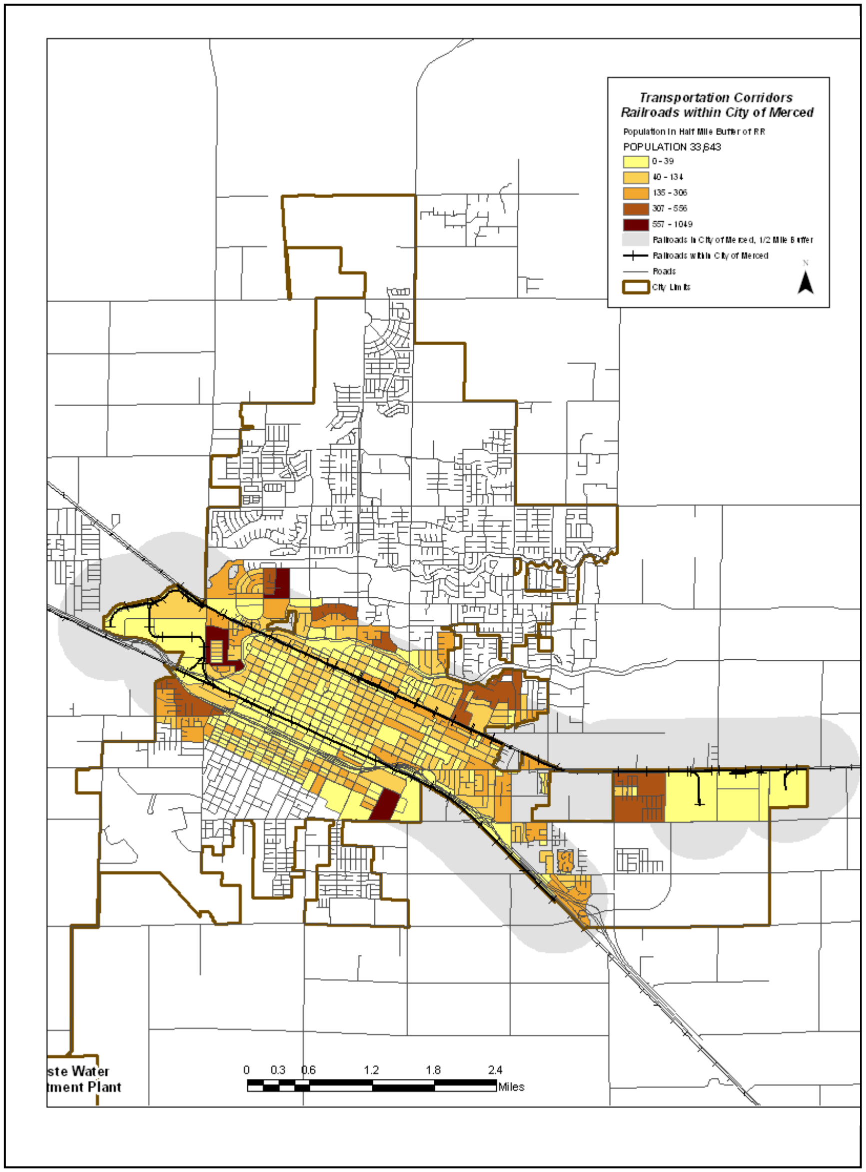
Number of Residential Buildings near Railroads



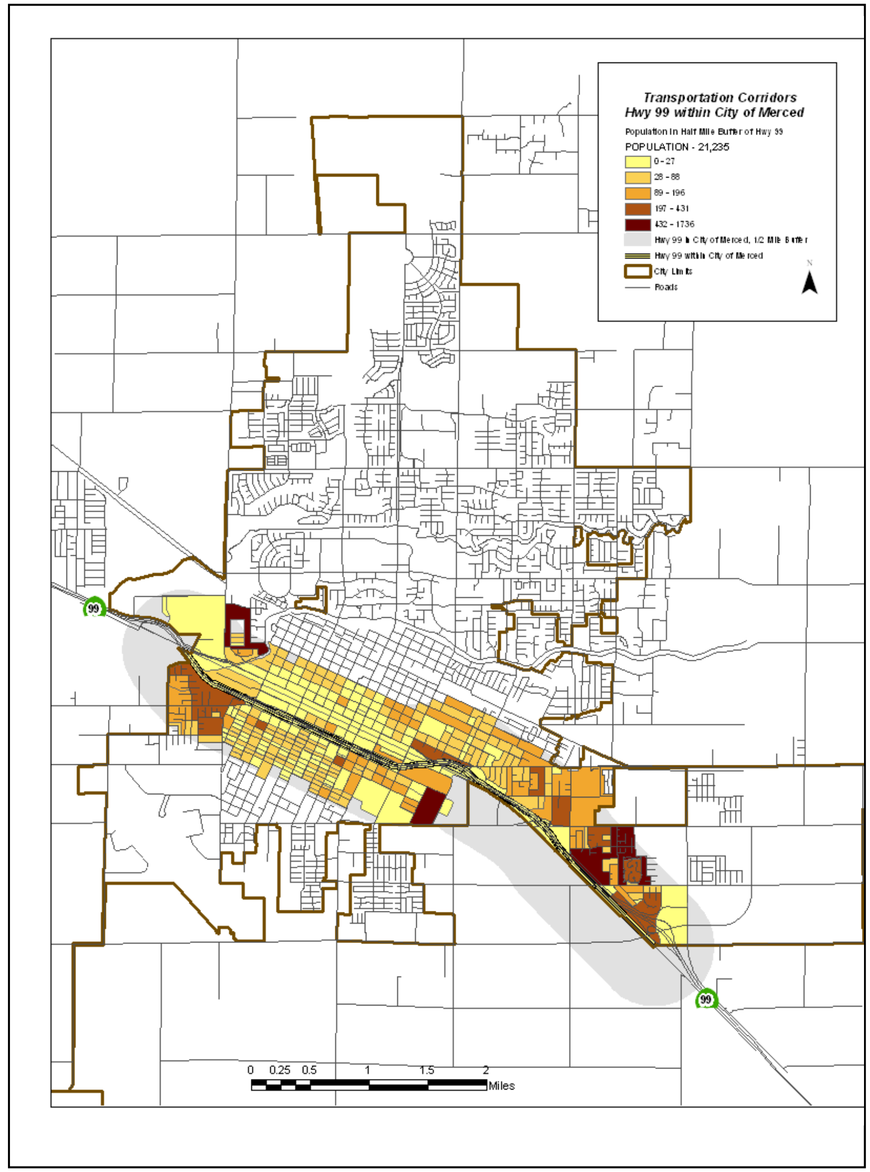
Number of Residential Buildings near Highway 99



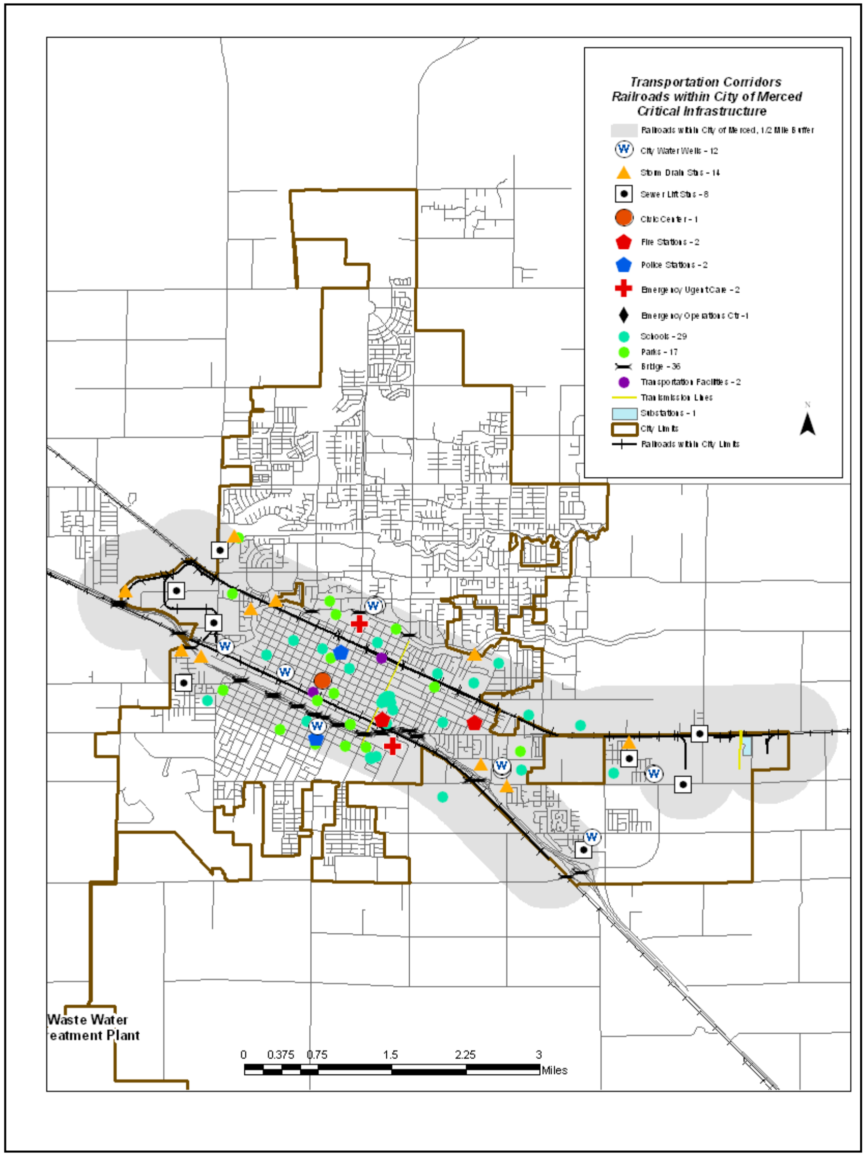
Population near Railroads



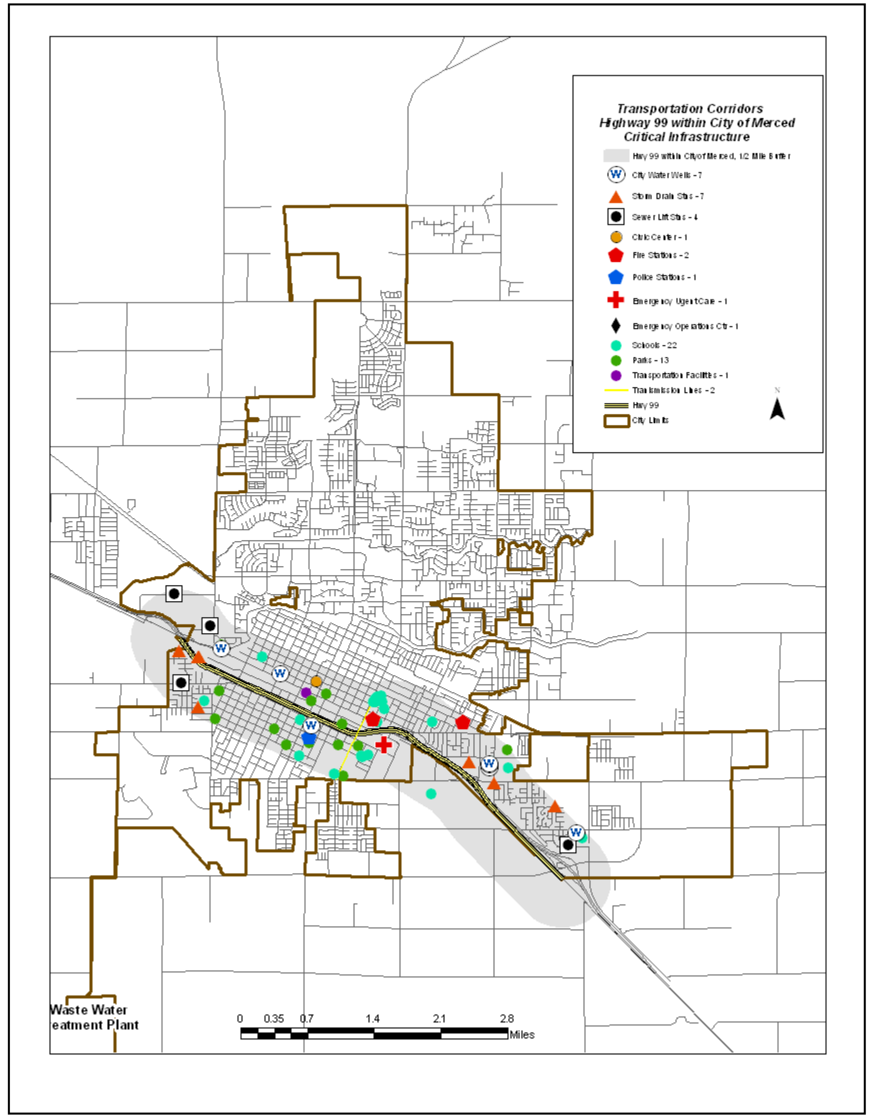
Population near Highway 99



Critical Facilities near Railroads



Critical Facilities near Highway 99



Vulnerability to Earthquakes

Earthquake vulnerability is primarily based upon population and the built environment. Urban areas in high hazard zones tend to be the most vulnerable, while uninhabited areas generally are less vulnerable. [23]

Urbanized areas are now much larger and many more people would be subject to impacts. The possibility of future earthquakes of equal or greater magnitude than those mentioned could cause a great many casualties and extensive property damage in the City. This could be aggravated by aftershocks and by secondary effects, for example, fire and hazardous materials release.

The Merced Vision 2030 General Plan states in its Safety Element, "It has been determined that an earthquakes of 5.0 magnitude or greater on any of the surrounding faults could definitely damage some Downtown buildings and subject the general public to potential life-threatening concerns. "

After the 1989 Loma Prieta earthquake, the City conducted an evaluation of the downtown buildings. A 1999 follow-up study concluded that 30% of the downtown buildings assessed required major remodeling, rehabilitation, seismic upgrades, or demolition.

Though the likelihood of occurrence is low, the impact from any moderate to large-scale seismic event, occurring within or on the periphery of the City of Merced could produce an assortment of conditions that would adversely affect public health and safety, critical infrastructure, and economic well-being throughout the area. [2]

All areas of Merced possess the same degree of risk with minor local variations. [2]

A major earthquake is predicted to strike California within the next thirty-years; although science and technology have dramatically improved, it is not possible to accurately predict the specific timing or magnitude of the event. Merced will possibly be impacted by falling objects, collapsing structures, damaged infrastructure, transportation routes being disrupted, and possible hazardous materials releases. [1]

All citizens and visitors are equally at risk, with the only exception being the specific indoor or outdoor location where someone is present when the earthquake strikes. Public and private structures are all at risk, with a variation applied due to the age of the structure and construction materials used to build it. [1]

Earthquake HAZUS Data: Scenarios for both a magnitude 5.0 and A 7.1 earthquake were run. Under the Merced County wide 5.0 earthquake scenario, assets did not experience any impact. Impacts from a 7.1 magnitude earthquake scenario along the Ortigalita fault were estimated, and are provided in an "HAZUS Event Report" (Appendix K). According to the Risk Assessment, the Tesla-Ortigalita Fault Zone is considered capable of generating a 6 to 7 Richter magnitude earthquake with a recurrence interval of 2,000 to 5,000 years. The last large earthquake attributed to this fault occurred in 1981 and had a Richter magnitude of 3.7.

Earthquake Hazard Impact on Planning Area

IMPACT ON LIFE, SAFETY, AND HEALTH

The City of Merced is home to many companies and industries that manufacture, store, use, and dispose of toxic materials. The City of Merced is highly exposed to hazardous materials transported over major state highways and railroads. On any given day, a vast assortment of petroleum products, agricultural pesticides, and industrial chemicals are moved within the City with the possibility of generating a hazardous materials incident. A natural disaster, such as an earthquake, cannot only cause a hazardous materials event, but it can also cause it to escalate. Emergency response crews may be delayed due to effects of the earthquake by causing roadway blockages and building collapse.

IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

A new hospital opened in 2010 that replaced 2 clinic/hospital facilities that had not been seismically retrofitted. The new hospital was built to the latest California Building Codes (2007 C.B.C.) and has been built to the latest and best available engineered design.

Communication Systems: System failures, overloads, loss of electrical power, and possible failure of some alternative power systems will affect telephone and cellular service systems. Immediately following an event, numerous failures will occur. Telephone, radio, and microwave systems are all expected to be affected and operate at a decreased capacity.

Utilities: Transmission lines are vulnerable to many hazards, due to their length and remoteness of the lines that could be affected in areas adjacent to the City of Merced in a major event.

Generator/Substations Damage to generator/substations may cause outages. Damages to generators affect production. Damage to substations affects delivery. Restoration of local power will be coordinated with regional and local utility representatives. Much of the affected areas may have service restored in days; however, a severely damaged underground distribution system may create longer service delays.

Natural Gas Facilities: Damage to natural gas facilities serving the City of Merced area may consist of isolated breaks in major transmission lines. Breaks in mains and individual service connections within the distribution system could be significant. These many leaks could pose a fire threat as well. Restoration of natural gas service could be significantly delayed.

Potable Water: Water availability and distribution for supporting life and treating the sick and injured is always a concern in any disaster. Although the City's water supply comes from numerous wells, there is still a threat that an earthquake could disrupt an area's water supply through broken distribution lines or contamination from broken sewer systems. Therefore, potable water will most likely have to be supplied in these area communities by outside sources.

Transportation Routes: Highway 99 may be impassable south into Madera and Fresno Counties. All could be impassable for up to 72 hours. Both the Burlington Northern Santa Fe and Union Pacific Railroads could sustain damage that would render them inoperative due to track damage.

IMPACT ON EXISTING AND FUTURE STRUCTURES AT RISK

The amount of damage to structures from an earthquake is determined by several factors: (1) Distance from the earthquake epicenter; (2) nature of the ground; (3) type of construction; and (4) the duration of the shaking.

Nature of the Ground: Earthquake shockwaves are "carried" by the relatively loose, wet soils that exist between Los Banos and Merced. For this reason, Merced is somewhat more likely to experience heavy shaking from surrounding parts of the state as will some of its neighbors. Areas of Merced with high water tables and loose soils are likely to experience damage because of liquefaction.

The Type of Construction Used: The areas that could potentially be most severely affected by earthquake in the City of Merced could typically include concrete or unreinforced masonry buildings built in the downtown area prior to 1976. Typically, buildings designed and constructed since the mid-1970's and according to modern codes, have generally performed very well during earthquakes. However, the following construction types have garnered some concern within the seismologist community regarding their safety in earthquakes:

- *Concrete-Frame Structures Built Before 1976*:

  Merced has relatively few buildings of this type, and the cost of strengthening the necessary connections is relatively inexpensive procedure. These buildings generally house industrial activities and their collapse could cause severe economic loss and possibly the release of hazardous materials.

- *Unreinforced Masonry Buildings*:

  Merced has relatively few buildings of unreinforced masonry. It will be necessary to reinforce these structures as modifications are proposed. If structures of this type are identified as unsafe or a potential risk to the general public, repairs/upgrades could be required. It has been determined that an earthquake of 5.0 magnitude or greater on any of the surrounding faults could definitely damage some downtown buildings and subject the general public to potential life-threatening concerns.

  During 1990, a seismic evaluation of part of downtown Merced was performed by staff of the Building Division. The survey of 78 buildings in Downtown revealed seven buildings of immediate hazard and 58 potentially hazardous buildings. Owners of the seven buildings of immediate hazard were notified and some repairs and further evaluation was performed. However, the repairs made to those structures are not to be considered in lieu of any seismic rehabilitation measures that may be required by the City.

  Of the 58 potentially hazardous buildings, 29 were found to be unreinforced masonry. The remaining 20 buildings surveyed were found to need an evaluation performed when they change use or propose removal, since they were not found potentially hazardous, but did not score high enough to be considered completely safe.

- Unbraced Parapets/Architectural Trim:

  Although a particular building may be structurally sound enough to withstand a particular earthquake, its architectural trim may prove hazardous if not adequately braced or secured.

Observations after recent earthquakes suggest that retrofitted buildings on the whole perform noticeably better than similar buildings that have not been retrofitted (ATC 31, 1992, CSSC 94-06, WJE 1994). However, in many respects their performance has been mixed. Fewer than five percent of California's existing buildings have been structurally retrofitted; the actual number has not been determined. [23]

Sensitive Populations: Additionally, numerous after-care facilities and nursing homes will be affected and should be taken into consideration in the event of a major seismic event.

Vulnerability to Dam Failure

Many parts of the City of Merced are located within the inundation areas for Yosemite Lake and Bear Reservoir. Civilians, pets, livestock, public and private properties, critical facilities, infrastructure, and crops are all potentially at risk should a dam fail. The timing of the failure will be either during or immediately following a torrential rainstorm. If a flood were to occur, initial flood waves would pass out of the SUDP/SOI two hours after failure. The center of the inundation area would have depths of approximately 20 to 30 feet (City of Merced General Plan).

Fortunately for Merced, both the Lake Yosemite and Bear Reservoir dams are earthen-fill constructed (DWS, n.d.). FEMA (n.d.) identified that earthen-fill dams are the most flexible and reliable form of dam for the type of application they are being used for. The greatest vulnerability of these types of dams is overfilling. Should a torrent of precipitation strike north or east of Merced, these bodies of water could quickly rise and result in an overflow situation where the integrity of the structures would be compromised.

The review of existing literature on dam breaches revealed that the formation time of a dam breach ranges from 0.3 hours to 1.5 hours. The literature provides a convincing body of evidence that an instantaneous breach formation time was not physically based, but rather used only as a mathematical exercise of developing a maximum outflow from the breach to produce the most conservative inundation depths.

Dam Failure Hazard Impact on Planning Area

COMMUNITY VULNERABILITY MAPS

Plan Area vulnerability of residential buildings, population and critical facilities to damn failure are revealed in the map set below; vulnerabilities are summarized in Table 3-12 above (pg 3-102).

The ***Critical Facilities near Dam Failure Zones***
The map of "***Critical Facilities near Dam Failure Zones"*** (see maps below) shows critical facilities in relationship to the potential inundation areas.

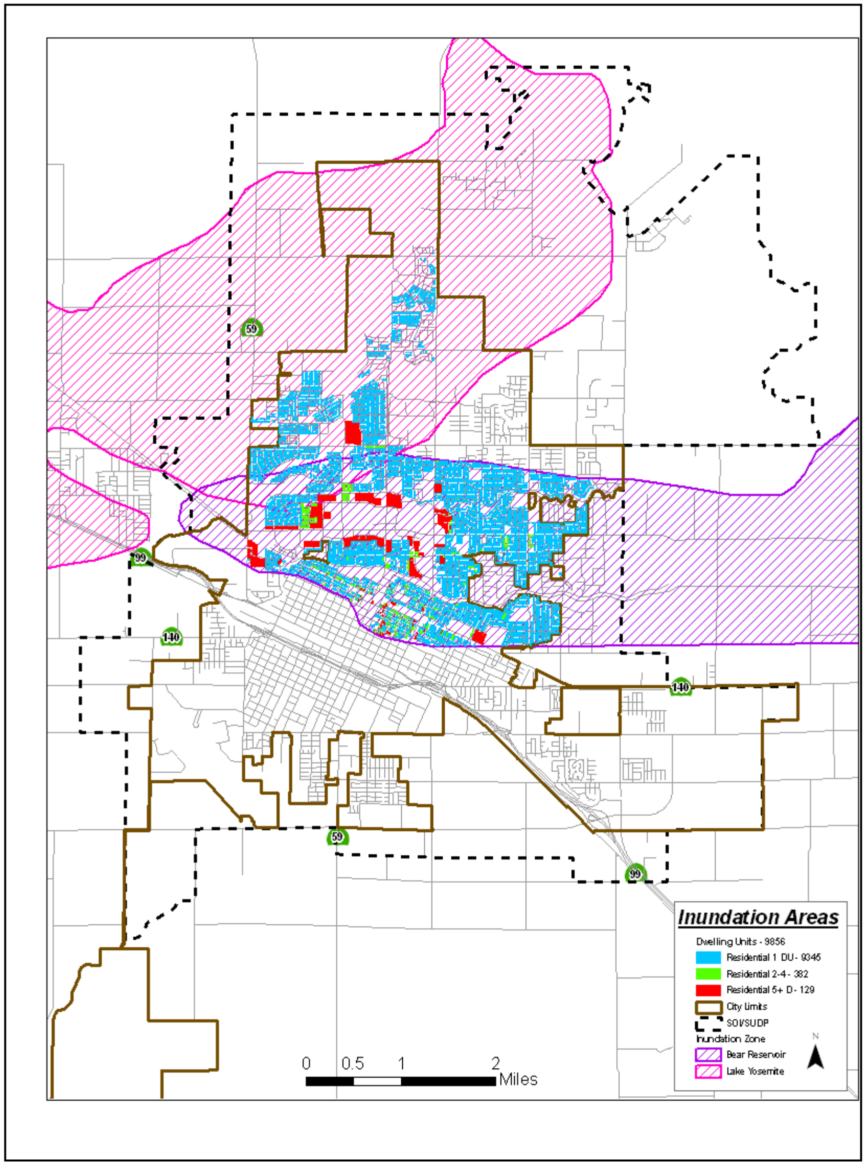
Although the UC Merced Campus and proposed University Community are outside the Lake Yosemite inundation area, there are 3 major facilities in the inundation area:

- 1 community college
- 1 high school (at G Street and Farmland Avenue)
- 1 new hospital (at G Street & Mercy Avenue)

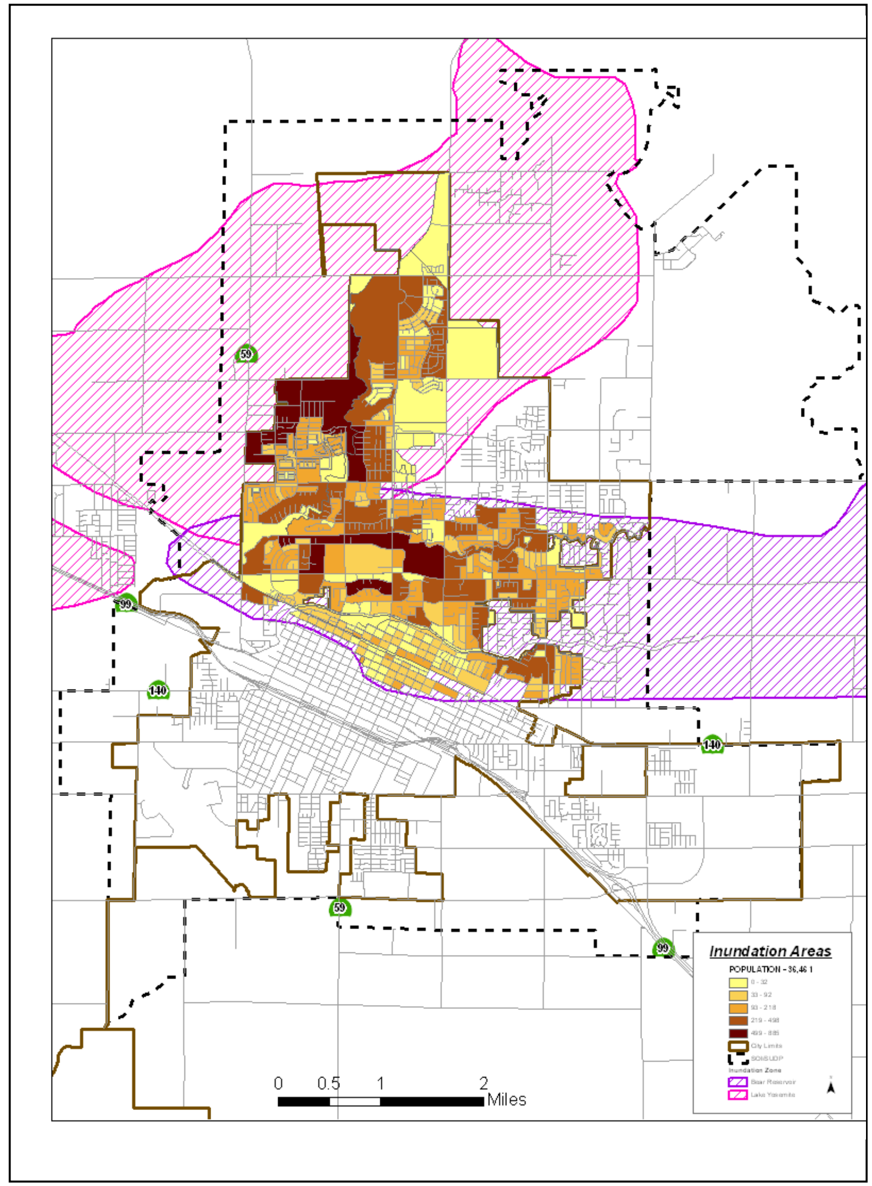
There are 26 major facilities in the Bear Reservoir inundation area, including:

- 10 K through 12 schools
- 1 jail
- 4 hospitals
- 4 of the City's 5 Bear Creek bridges

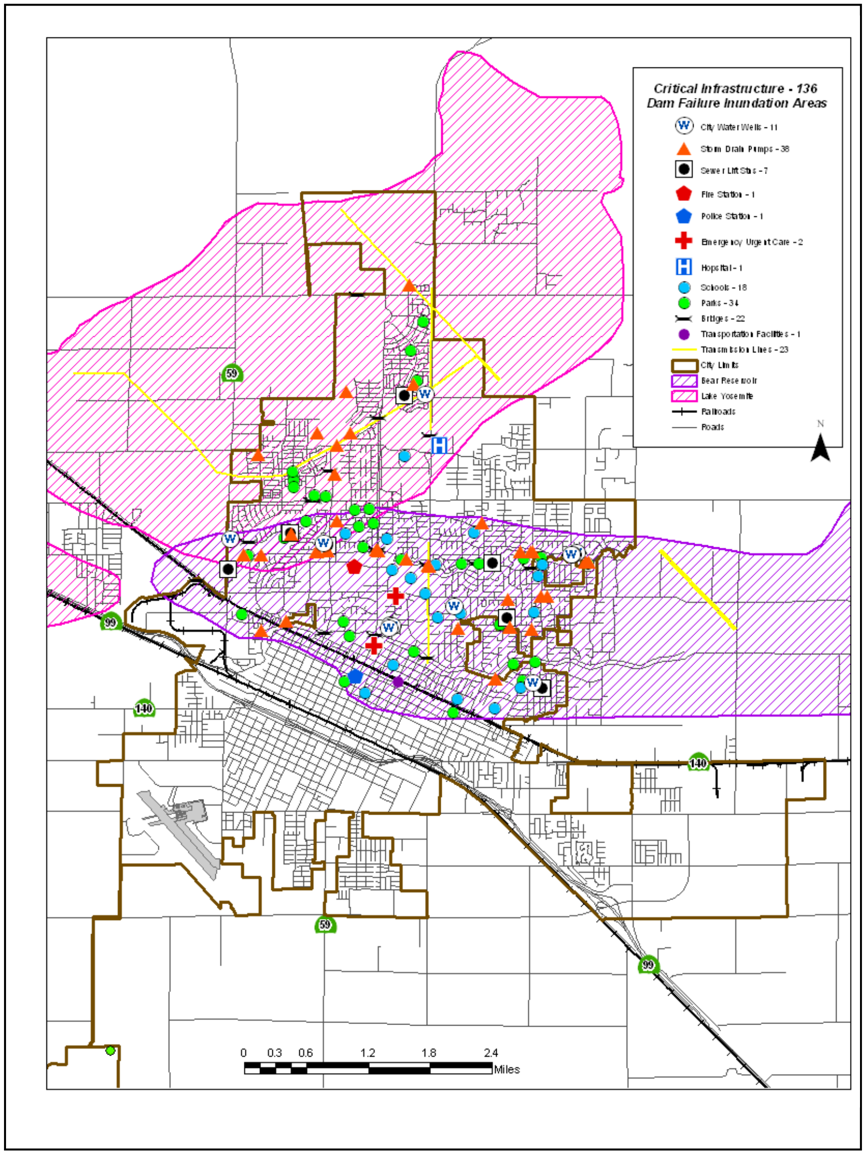
Number of Residential Buildings near Dam Failure Zones



Population near Dam Failure Zones



Critical Facilities near Dam Failure Zones



Vulnerability to Extreme Temperatures

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.

Impact on Life, Safety, and Health

The most vulnerable populations to extreme heat and cold are the elderly or low income households, as they may not be able to afford to operate a cooling or heat source on a regular basis and may not have immediate family or friends to look out for their well being. Situational and physical characteristics help to identify vulnerable populations that may not comfortably or safely access and use disaster resources. Specifically, when discussing heat-related emergency preparedness, the following groups could be considered vulnerable or at greater risk in a heat emergency:

- Infants and small children under age three
- Women who are pregnant
- Elderly people (age 65 and older)
- The obese
- The bedridden
- Mentally ill
- Those with cognitive disorders
- Those with medical conditions (e.g., heart disease, diabetes, high blood pressure)
- Those requiring life-saving medications (e.g., for high blood pressure, depression, insomnia)
- Individuals with drug or alcohol addictions
- Those with mobility constraints
- People who are non-ambulatory
- Those under extreme working conditions
- The poor
- People who are socially isolated
- Non-English speakers who may not have access to information
- The Homeless

EXTREME HEAT

Though heat does not cause much economic damage or damage to the built environment, the number of people it has killed underscores the importance of mitigating its impacts. Everyone is subject to health risks and problems in a heat wave. A major factor is length of exposure. Long exposure periods such as lack of air conditioning, working outdoors, sports, long walks, and so on, is a large factor.

Animals, including domestic pets, livestock, and poultry are also susceptible to extreme heat. For example, dogs and cats are in danger of heat stroke in temperatures of 110°F. The heat wave of 2006 resulted in 15 reported pet deaths and more than 25,000 cattle, and 700,000 fowl heat-related deaths. [10]

EXTREME COLD

Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Freezing temperatures can impact crops, vegetation, and the health and safety of citizens that do not have a source of heating. Casualties resulting from extreme cold may result from a lack of adequate heat, carbon monoxide poisoning from unsafe heat sources, and possible frostbite. The City of Merced can also experience flooding and closed highways due to the snowfall and snowfall melt from the higher elevations.

Impact on Existing and Future Critical Facilities

EXTREME HEAT

Heat does not cause much economic damage or damage to the built environment, but extreme heat can cause power outages due to increased use of air conditioners. Extreme heat combined with drought can also cause a water shortage which could impact crop and other vegetation growth.

EXTREME COLD

Sustained temperatures below freezing in the City of Merced's otherwise generally mild weather region could potentially cause life loss and health risks to vulnerable populations.

Although the City of Merced is less likely to have extreme cold, homes can be affected if they are poorly insulated, without heat, or may have pipes that could freeze and burst.

Impact on Existing and Future Structures at Risk

Also at risk is the infrastructure of the City, including power grids that supply electricity to Merced.

EXTREME HEAT

Extreme heat occurs annually within the City of Merced, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted.

EXTREME COLD

Extreme cold/freeze occurs annually within the City of Merced, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted.

Economic Impact

EXTREME HEAT

Adjusted to 2008 dollars, the Spatial Hazard Events and Loss Data for the United States (SHELDUS) reports that severe heat events in California caused roughly $1.8 million in property damage and $531.7 million in crop damage. [23]

Extreme heat events in the City of Merced can cause rolling blackouts with overuse of air conditioners; this could shut down businesses. Crop damage can also be a factor which would impact the economics of the City of Merced.

EXTREME COLD

Although infrequent, freezes can severely affect the City of Merced agriculture. Freezing temperatures occurring during winter and spring growing seasons can cause extensive crop damage.

Secondary impacts of freeze disasters can include major economic impacts on farmers, farm workers, packers, and shippers of agricultural products. Freezes can also cause significant increases in food prices to the consumer due to shortages.

Vulnerability to Tornadoes

While California has tornadoes, such storms represent a relatively low risk for most areas, compared to states in the Midwestern and southern United States where risk exposure is severe and many lives and millions of dollars are lost annually due to this hazard.

Throughout the years, buildings in Merced were constructed following various methodologies to ensure construction withstood wind related hazards. Today, the California Building Code requires engineers to use a maximum 85 mph wind load when designing roof structures and the lateral force-resisting elements within a building that are needed to keep the roof tied to the structure. Those forces are then transmitted into the soil through the foundation. The result is much like holding a hat on to keep it from blowing off in the wind. Buildings typically have metal connections that hold the roof to the walls, and metal anchors that hold the walls to the foundation. Buildings should be able to fare well from the F0 events, but some damage would be expected from F1 rated tornadoes, especially with wind speeds of greater than 85 mph.

Tornado Hazard Impact on Planning Area

IMPACT ON LIFE, SAFETY, AND HEALTH

The City of Merced experiences few tornadoes and the reported incidents only result in minor property damage, one injury, and no deaths. Most injuries and deaths with tornadoes can result from flying debris. Therefore, potential severity of tornado impact is limited. Although in the case one does occur, access roads and streets may be blocked by debris, delaying necessary emergency response.

IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

While the City of Merced is at low risk for tornadoes, when one does occur the biggest risks include light to moderate damage to homes, destruction of mobile homes, injuries caused by light object projectiles, broken windows, crop damage, and downed trees and power lines.

IMPACT ON EXISTING AND FUTURE STRUCTURES AT RISK

Because it cannot be predicted where a tornado may touchdown within the City of Merced, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted.

ECONOMIC IMPACT

The City of Merced can experience crop damage, property damage to houses and businesses, vehicle damage, downed trees and power lines.

Tornado impact to orchard in LeGrand (a nearby Merced County community).

Vulnerability to Fog

Fog negatively affects the transportation corridors in the City. Night time driving in the fog is dangerous and multi-car pileups have resulted from drivers using excessive speed for the road conditions. 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 hazardous materials are involved. Other disruptions from fog include delayed emergency response vehicles and school delays or closures.

Historically, it has been heavy fog and excessive speed that have resulted in major incidents that have posed risk to Central Valley towns. According to former Fire Chief Mitten (personal communication, January 20, 2008) it has been several years since a major pile-up has occurred within the City [1]

On nearly an annual basis, Highway 99 has been subjected to multi-casualty collisions as a result of dense fog. On December 11, 2008, there was a fifty-three vehicle collision on Highway 99 ninety miles south of Merced near the town of Caldwell. The collision was a result of poor visibility due to foggy conditions (Jalopnik, 2008). On November 3, 2007, there was a 108 vehicle collision in Fresno that resulted in two fatalities; this collision was also the result of dense fog (KSEE 24 News [KSEE], 2007)

IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

Heavy fog occurs annually within the City of Merced, but it has no known impact on existing and future critical facilities.

IMPACT ON EXISTING AND FUTURE STRUCTURES AT RISK

Heavy fog occurs annually within the City of Merced, but it has no known impact on existing and future structures.

ECONOMIC IMPACT

The economic impacts from extreme fog in the City of Merced are usually due to transportation issues; vehicle collisions, trucking, commercial vehicles delay or loss. However, typically these disruptions are not long lasting, nor do they carry a severe long term economic impact on the region.

Vulnerability to Storms

Based on the topography of the City of Merced, the overall severity of a thunderstorm is low and would be limited to direct lightening strikes, wind damage, and precipitation. [2]

Storm Hazard Impact on Planning Area

All thunderstorms are dangerous; every thunderstorm produces lightning. In the United States, an average of 300 people are injured and 80 people are killed each year by lightning. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms.

Other associated dangers of thunderstorms include tornadoes, strong winds, hail, and flash flooding. Flash flooding is responsible for more fatalities—more than 140 annually—than any other thunderstorm-associated hazard.

Dry thunderstorms that do not produce rain that reaches the ground are most prevalent in the western United States. Falling raindrops evaporate, but lightning can still reach the ground and can start wildfires.

High winds can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power outages. Windstorms in the City of Merced are typically straight-line winds. These winds can overturn mobile homes, tear roofs off of houses, topple trees, snap power lines, shatter windows, and sandblast paint from cars and buildings. Other associated hazards include utility outages, arcing power lines, debris blocking streets, dust storms, an occasional structure fire, and downed trees limbs.

IMPACT ON EXISTING AND FUTURE CRITICAL FACILITIES

Storm-related hazards can have an impact on existing and future critical facilities. Heavy rains can also bring damage to roads; road damage can come in the form of potholes which in turn can cause damage to vehicles.

IMPACT ON EXISTING AND FUTURE STRUCTURES AT RISK

Storm-related hazards occur annually within the City of Merced. Existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted.

ECONOMIC IMPACT

The City of Merced can experience crop damage, property damage to houses and businesses, downed trees and power lines, lightning storms can cause fires, flooding, and hail storms can cause vehicle damage.

The National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) has been tracking severe weather since 1950. Their Storm Events Database contains data on the following: all weather events from 1993 to current (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 (1950-1992). This database contains 84 severe weather events that occurred in Merced County between January 1, 1950, and November 30, 2010.

NCDC Hazard Event Reports for the County of Merced, 1950-2010*

Type	# of Events	Property Loss ($)	Crop Loss ($)
Dense Fog	2	50,000	0
Funnel Clouds	20	0	0
Gusty Wind	1	0	0
Hail	4	0	220,000
Heavy Rain	20	2,033,000	15,660,000
Lightning	8	0	0
Severe Thunderstorm/Wind	2	50,000	3,000,000
Small Hail	3	30,000	913,000
Thunderstorm/Wind	6	380,000	100,000
Tornado: F0	13	115,000	50,000
Tornado: F1	4	695,000	0
Wind	1	0	0
TOTALS	**84**	**3,353,000**	**19,943,000**

Source: National Climatic Data Center Storm Events Database,
*Note: Losses reflect totals for all impacted areas