



Modesto 2050

General Plan Update and Environmental Impact Report

**Final Technical Memorandum:
Climate Change Vulnerability Assessment**

June 2022

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1. INTRODUCTION

The City of Modesto prepared this Vulnerability Assessment Report in conformance with State of California requirements to assess climate change vulnerability and address climate change adaptation and resilience as part of the General Plan Update (California Government Code Section 65302(g)(4)). The goal of this requirement is to enable the community to prepare for, respond to, withstand, and recover from disruptions worsened or caused by climate change. This report discusses the regulatory framework and method for preparing a vulnerability assessment and incorporating adaptation and resilience into the General Plan, the climate change hazards affecting the resilience of Modesto, specific populations and assets included in the assessment, and a summary of Modesto's Vulnerability Assessment results. The Vulnerability Assessment acts as a foundation for integrating adaptation and resilience policies into the Safety Element and other elements of the General Plan by developing a set of priority vulnerabilities in the City of Modesto. These policies and programs are discussed in the General Plan Implications section.

Community Profile

Modesto is the seat of Stanislaus County, located in central San Joaquin Valley, approximately 95 miles east of San Francisco and 80 miles south of Sacramento. The Tuolumne River runs along the southern edge of the city. State Route (SR) 99 runs north-south through Modesto, and SR 132 runs east-west through the community. As of 2021, Modesto covers approximately 37 square miles and has a population of 219,300 people.¹

State agencies divide California into several distinct climate zones, and Modesto is part of Climate Zone 12. This climate zone is part of the Northern California Central Valley, situated just inland of the Bay Area. This climate zone experiences cooler winters and hotter summers than nearby Climate Zone 3 (Bay Area). Winter rains fall from November to April. Tule fog is common in the winter. Some lower areas receive frost on winter nights. On average, annual high temperatures in Modesto range from 71.7 to 77.6 degrees Fahrenheit, and low temperatures range from 46 to 51.3 degrees Fahrenheit.² The city receives an average of approximately 12.5 inches of precipitation annually, although precipitation levels are highly variable from year to year.³

Modesto is a demographically and economically diverse community. Approximately 14 percent of Modesto's population is under the age of 10,⁴ 14 percent are seniors,⁵ and 18 percent were born outside of the United States.⁶ Approximately 40 percent of Modesto's households are classified as low income (with an income of 80 percent or less of Modesto's median income of \$59,287),⁷ 41 percent spend 30 percent or more of their income on housing expenses (housing cost-burdened),⁸ and 45 percent of housing units are occupied by renters.⁹ Approximately 34 percent of Modesto residents have some form of disability,¹⁰ and 13 percent of households lack internet access.¹¹ Residents that identify with one or more of these characteristics could face unique barriers in responding to and recovering from the effects of climate change, including health effects and economic dislocations.

Major economic drivers in the Modesto area include the industrial and manufacturing industries, agriculture and food processing, and livestock and grazing. Major employers include Bartles & Jaymes Co, Del Monte Foods Inc, E&J Gallo Winery, Frito Lay Inc, the City of Modesto, and the *Modesto Bee*. Agricultural and animal-rearing industries are especially vulnerable to climate change because business operations may be affected by high heat, drought, severe weather, poor air quality, and animal and plant pests and disease. Climate-changed-induced effects on these industries could have ripple effects on the overall economic stability of Modesto.

Regulatory Framework

In 2015, the State adopted Senate Bill (SB) 379, amending Section 65302(g) of the California Government Code to require the safety element of the general plan to include more information about wildfire hazards, flooding risks, and other short-term and long-term threats posed by climate change. SB 379 is the foundation for adaptation and resiliency in general plan safety elements; it requires local governments to conduct vulnerability assessments as part of their long-range public safety planning efforts and to prepare policies that will protect against harm caused by climate change.

Other important updates to Section 65302(g) of the California Government Code that are related to safety elements and resiliency and will be addressed in the City's General Plan Update include SB 1035, SB 99, and AB 747/1409.

- SB 1035, which established Section 65302(g)(6) of the California Government Code, builds on previous legislation and requires local governments to review and update their safety element as needed during an update to their housing element or local hazard mitigation plan (at least every 8 years). Any revisions should include updated information related to flood hazards, fire hazards, and climate adaptation and resilience.
- SB 99 established Section 65302(g)(5) of the California Government Code and requires jurisdictions to review and update the safety element to include information identifying residential developments in hazard areas that do not have at least two emergency evacuation routes.
- AB 747 added Section 65302.15 to the California Government Code (subsequently amended by AB 1409), requiring local governments to identify the capacity, safety, and viability of evacuation routes and locations in the safety element or local hazard mitigation plan.

This Vulnerability Assessment, along with the update to the Safety Element, will help the City of Modesto meet the State's requirements, in addition to increasing consistency with and integration of the General Plan and the *Stanislaus County Local Hazard Mitigation Plan*.

The State of California prepared a guidance document, the [California Adaptation Planning Guide](#) (APG), to assist communities with addressing climate adaptation and resilience and complying with Section 65302(g) of the California Government Code. The guide presents a step-by-step process for gathering the best available climate change science, completing a climate change vulnerability assessment, creating adaptation strategies, and integrating those strategies into general plans and other policy documents. This Vulnerability Assessment is consistent with the guidance and recommended methods in the APG.

Climate Change and Modesto

What Is Climate Change?

Climate change is a long-term change in the average meteorological conditions in an area. Currently, the global climate is changing due to an increase in greenhouse gas (GHG) emissions that trap heat near the Earth's surface.¹² Though these gases are necessary to maintain a comfortable temperature on Earth, the high concentration of these gases due to human activity traps additional heat, changing Earth's climate system in several ways. This can create intensified or new hazardous conditions that can increase the risk of damage to critical infrastructure, injury to sensitive populations, and disruption of essential services. To have a better understanding of how a changing climate may harm Modesto and which aspects of the community—including people, buildings and infrastructure, services, and economic drivers—are most vulnerable to its effects, the City prepared this Vulnerability Assessment as part of the process to update the General Plan Safety Element. This report presents a summary of the Vulnerability Assessment methods and results.

Climate Change Modeling Considerations

The Intergovernmental Panel on Climate Change (IPCC), an organization that represents the global scientific consensus about climate change, identified four climate scenarios in the Fifth Assessment Report, also called “representative concentration pathways” (RCP), that can be used to project future conditions. RCPs are labeled with different numbers (e.g., RCP 2.6, RCP 6) that refer to the increase in the amount of energy that reaches each square meter of Earth's surface under that scenario. The four RCPs are:

- **RCP 2.6:** Under this scenario, global GHG emissions peak around 2020 and then decline quickly.
- **RCP 4.5:** Under this scenario, global GHG emissions peak around 2040 and then decline.
- **RCP 6:** Global emissions continue to rise until the middle of the century.
- **RCP 8.5:** Global emissions continue to increase at least until the end of the century.

The IPCC recently released “The Physical Science Basis” of the Sixth Assessment Report that updates global climate change projections for the near-term, midterm, and long-term based on GHG emission trends from the past decade. It moves away from using RCPs, instead using five different scenarios called “shared socioeconomic pathways,” which consider socioeconomic trends underlying each scenario. This Vulnerability Assessment does not use these updated projections because at time of writing they are not available at a local scale. However, the IPCC report does reaffirm the use of projections comparable to RCP 8.5 as the suggested emission scenario to use for Cal-Adapt data.

Projections of climate hazards from Cal-Adapt, California's Fourth Climate Change Assessment, and other sources rely on climate models, which are computer simulations that forecast future climate conditions under these different RCP scenarios. It is critical that the City account for all reasonably plausible future conditions, including the most severe of plausible conditions, to support greater resiliency from climate change. Therefore, the projections in the Vulnerability

Assessment use the RCP 8.5 scenario, following State of California guidance and to be consistent with the IPCC Sixth Assessment Report. No model can project future conditions perfectly, but current models are heavily reviewed by climate scientists and can accurately reproduce observed climate conditions.

The Vulnerability Assessment also relies on the understanding that “weather” and “climate” are two different things. “Weather” describes the conditions at a particular time and place, and “climate” describes the long-term average of conditions. Because there are large variations in the weather, it is difficult to accurately project weather conditions more than a few days in advance. However, because climate is a long-term average, it can be projected out for years or decades with a high degree of accuracy. It is important to remember that, because climate is an average, it does not say whether an event will or will not occur, only how likely it is. For example, extreme heat is likely to become more frequent in Modesto, but a year with few heat waves does not mean that this projection is wrong, because the projection only says that extreme heat days are expected to occur, on average, more often than in the past.

Cal-Adapt

Cal-Adapt is a collaboration between State agency funding programs and university and private-sector researchers that provides downloads and visualizations of data portraying changes to the California climate under different climate change scenarios.

Climate Change in California

The most accurate data for California-specific projections are available for the RCP 4.5 and RCP 8.5 scenarios. These scenarios help generate climate models, which are meant to simulate conditions across the globe. The model divides Earth’s surface into cells using a grid, then forecasts the conditions in each square of the grid. The size of these squares makes them suitable for projecting global conditions, but they are too big to accurately model the difference in climate across smaller areas.¹³ Per State guidance, these models have been “downscaled” to much finer grids, which means that they have grids that are less than four miles on each side to show projections on a county or city level. The *California Fourth Climate Change Assessment* and Cal-Adapt provide a foundation of climate change science and downscaling for the state. The State of California has also developed a comprehensive set of reports and tools that local jurisdictions can use to assess climate change hazards and how to prepare for these hazards. The State-provided reports and tools that were used in the Vulnerability Assessment include:

- Cal-Adapt.org
- *California Fourth Climate Change Assessment* (statewide and regional reports) (2018)
- California Adaptation Clearinghouse
- *California Adaptation Planning Guide* (2020)
- California Climate Adaptation Strategy (2021)
- California Building Resilience Against Climate Effects (2018)
- Defining Vulnerable Communities in the Context of Climate Adaptation (2018)
- Department of Transportation Climate Change Vulnerability Assessments (2019)

- *Planning and Investing for a Resilient California* (2018)
- *Safeguarding California* (2018)

Modesto Vulnerability Assessment

In Modesto, climate change is expected to intensify many existing hazards, such as flooding, extreme heat, and drought. The Vulnerability Assessment evaluates how hazards are expected to occur, including frequency and severity, and how this will affect community populations and assets.

Vulnerability Assessment Method

The Vulnerability Assessment primarily follows the recommended process in the APG, published in 2020 by the California Governor’s Office of Emergency Services. This includes a four-step process: (1) characterize the community’s exposure to current and projected climate hazards; (2) identify potential sensitivities and potential impacts to city populations and assets; (3) evaluate the current ability of the populations and assets to cope with climate impacts, also referred to as its adaptive capacity; and (4) identify priority vulnerabilities based on systematic scoring. **Figure 1** presents these steps.

Figure 1. California Adaptation Planning Guide Recommended Model



Step 1. Identify Exposure

The goal of this step is to characterize the community’s exposure to current and projected climate change hazards. The climate change hazards in the Vulnerability Assessment are **agricultural and ecosystem pests, air quality, drought, extreme heat, flooding, human health hazards, landslides, and severe weather**. These hazards are discussed in more detail later in this report. Some of the hazards compound climate change effects—when one climate change hazard leads to another—also known as “cascading effects.” **Figure 2** provides an example of cascading effects.

Figure 2. Example of Cascading Effects



The City derived climate change hazard data from up-to-date information, including the state Cal-Adapt database, the APG, the *California Fourth Climate Change Assessment*, and the 2017 *Stanislaus County Local Hazard Mitigation Plan*.

As discussed previously, projections of climate change hazards rely on multiple scenarios that reflect different levels of GHG emissions and concentrations over time. The Cal-Adapt database, which provides California-specific climate change hazard projections, uses RCP 4.5 for a low emissions scenario and RCP 8.5 for a high emissions scenario. The Governor’s Office of Planning and Research’s *Planning and Investing for a Resilient California* and the APG recommend using RCP 8.5 for analyses considering impacts through 2050 and 2100, because the differences are minimal between emission scenarios for the first half of the century and for late-century projections, accounting for more adverse risks and providing a more conservative approach. This Vulnerability Assessment uses the RCP 8.5 scenario as input for global climate models on the Cal-Adapt database and other resources.

Step 2. Identify Sensitivities and Potential Impacts

This step involves evaluating potential future climate change impacts to community populations and assets. The City first identified a comprehensive list of populations and assets to understand how different people, places, ecosystem services, and services in the community are affected by climate change hazards. This list includes 18 populations, 18 infrastructure types, 8 building types, 8 important economic assets, 6 ecosystems and natural resources, and 9 key community services, as shown in **Table 1** and **Appendix A**. Following confirmation of this list, the City developed an applicability matrix, which considers which hazards are likely to affect which populations and assets. For example, human health hazards are likely to impact most populations, but would not physically affect buildings.

Table 1. Populations and Assets in the Vulnerability Assessment			
Category	Populations or Assets		
Populations	Children (Under 10)	Formerly incarcerated individuals	Persons in overcrowded households
	Cost-burdened households	Linguistically isolated populations	Persons with chronic illnesses
	Households in poverty	Low-income households	Persons with disabilities
	Households that lack a private vehicle	Outdoor workers	Renters
	Households that lack internet access	Persons living in mobile homes	Seniors (65+)
	Immigrants and refugees	Persons experiencing homelessness	Seniors living alone
Infrastructure	Airports	Electrical substations and transmission lines	Power plants
	Biking and hiking trails	Evacuation routes	Public transit facilities
	Bridges	Flood control infrastructure	Single access roads
	Communication facilities	Major roads, highways, and truck routes	Solid waste facilities and closed landfills
	Dams and reservoirs	Natural gas pipelines	Water and wastewater infrastructure
	Electrical vehicle charging stations	Parks and open space	
Buildings	Commercial centers	Government buildings	Public safety buildings
	Community centers and libraries	Homes and residential structures	Schools
	Emergency and transitional housing	Medical and care facilities	
Important Economic Assets	Agricultural and commercial food processing centers	Industrial/manufacturing centers	Major employers
	Agricultural land and agricultural activities	Livestock and grazing lands and animal husbandry	Outdoor recreation
	Historic and cultural resources	Local and small businesses	

Table 1. Populations and Assets in the Vulnerability Assessment			
Category	Populations or Assets		
Ecosystems and Natural Resources	Aquatic habitat	Groundwater resources	Valley Foothill riparian habitat
	Grassland	Surface water resources	Wetlands and vernal pools
Key Community Services	Emergency communication services	Food-providing agencies and organizations	Public transit access
	Emergency medical response	Freight and shipping	Solid waste management and removal
	Energy delivery	Government administration and community services	Water and wastewater

After the applicability review, the City evaluated potential impacts to the applicable populations and community assets. To identify how great the impacts of each relevant hazard are on the populations and community assets, staff considered several different questions that helped ensure the assessment broadly covered a range of potential harm. Based on the results of the impact (IM) assessment, staff ranked each sensitivity on a three-point scale (1 to 3) for each relevant exposure. IM1 is the lowest score (lowest impact) and IM3 is the highest score (highest impact). Impact is considered a negative quality, so a higher impact score means that there is a higher potential for harm to a population or asset. A lower impact score means that there is a lower potential for harm to a population or asset.

Step 3. Assess Adaptive Capacity

Adaptive capacity is the ability of populations and community assets to prepare for, respond to, and recover from the impacts of climate change. Staff evaluated each population and asset for adaptive capacity by considering a series of questions. Based on the results of the adaptive capacity (AC) assessment, staff ranked each population or asset on a three-point scale (1 to 3), ranging from AC1 (the lowest adaptive capacity) to AC3 (the highest adaptive capacity). Adaptive capacity is a positive attribute, so a higher adaptive capacity score means that a population or asset is better able to adapt to the hazard. A lower adaptive capacity score means that a population or asset may have difficulty adjusting to changing conditions.

Direct Impacts vs. Indirect Impacts

Direct impacts are those that immediately affect buildings and infrastructure, health or populations, or immediate operations of economic drivers or community services, and they can lead to secondary *indirect impacts* on the broader system or community, including populations or asset types in a different category.

For example, severe weather can *directly* damage electrical transmission lines, causing power outages, which can *indirectly* impact persons with chronic illnesses who depend on electricity for life-support systems.

Step 4. Prioritize Vulnerability Scoring

Staff used the impact and adaptive capacity scores for each population and asset for each relevant hazard to determine the vulnerability score. The vulnerability (V) score reflects how susceptible a population or asset is to harm from a particular hazard. Vulnerability is assessed on a scale of 1 to 3. The matrix in **Table 2** shows how impact and adaptive capacity scores combine into a vulnerability score.

Table 2: Vulnerability Scoring Matrix			
	Low Impact	Medium Impact	High Impact
Low Adaptive Capacity	Medium	High	High
Medium Adaptive Capacity	Low	Medium	High
High Adaptive Capacity	Low	Low	Medium

2. CLIMATE CHANGE HAZARDS AND KEY VULNERABILITIES

The Vulnerability Assessment assigns vulnerability scores to 337 different pairings of hazards and populations or assets. This section summarizes the climate change hazards at the local level and discusses the significant vulnerabilities created by those hazards. For a complete list of vulnerability scores, see **Appendix B**.

Agricultural and Ecosystem Pests

According to the *2020 Stanislaus County Agricultural Report*, agriculture and livestock in the county had total gross production of nearly \$3.5 billion in 2020—almonds, milk, and chickens were the largest-grossing products.¹⁴ Agricultural pests and diseases can affect tree nuts, crop plants, and livestock in the region. This hazard is measured by the number of pests and disease incidents, which are likely to increase because higher temperatures allow insects to reproduce more rapidly.

Pests and diseases such as the Asian citrus psyllid, European pine shoot moth, Japanese beetle–melon fruit fly, Mexican fruit fly, European corn borer, and glassy-winged sharpshooter can slow the growth of plants and animals, damage them so that their products are less appealing and harder to sell, or even kill them.¹⁵ Tree nuts, such as almonds, are especially vulnerable to the navel orangeworm, which is capable of causing significant economic loss despite the application of pest control measures. Temperature variations can affect the developmental rates, behavior, and overall population dynamics of the navel orangeworm, which may be able to complete its life cycle much faster due to climate change.¹⁶ Though there are treatment options for many agricultural pests and diseases, some have no cure. Many pests and organisms that carry diseases are most active during warmer months, so the threat of infection or infestation is higher during that time of year. Projection trends show temperatures getting warmer earlier in the year and remaining warmer until later in the year, which creates a wider activity window for pests and diseases.

Agriculture and ecosystem pests and diseases can severely harm the agriculture and outdoor recreation industries in and surrounding Modesto. Row crops and vineyards can be affected by fungal pathogens and invasive diseases vectors as temperatures continue to rise, affecting the quality and viability of crops.¹⁷ Pesticides and herbicides can help crops resist these pests and diseases, and new crop varieties may be pest resistant; however, pests can develop resistance to pesticides and herbicides, and these chemical compounds may have cascading impacts on ecosystem and community health. Quickly evolving pests can make it difficult for some plant species to survive, and changing crop varieties can be expensive for farm owners. Management of pests and diseases thus may be difficult and expensive.

Due to the vulnerability of the agriculture sector to agriculture pests and diseases, agricultural workers are also highly vulnerable. Agricultural workers may be indirectly affected by agriculture and ecosystem pests and diseases that damage crops, livestock, and trees as well as by exposure to pesticides and herbicides. Economic losses in the agricultural sector can reduce work opportunities, create economic hardships for some workers, and cause employee layoffs when farms experience economic hardships.¹⁸ Individuals working in these industries may have few options if the industry suffers damage. Immigrant communities can be especially vulnerable to disruptions in the agricultural community because immigrants and seasonal workers tend to be overrepresented in the agricultural industry compared to the general population.

Air Quality

The dominant factors of air quality in Modesto are ozone pollution from vehicle exhaust, particulate matter from diesel trucks, and smoke from regional wildfires.

Modesto is in the San Joaquin Valley Air Basin, which has one of the most severe air pollution problems in the state. Surrounding high-elevation terrain in conjunction with temperature inversions frequently restrict lateral and vertical dilution of pollutants. Abundant sunshine and warm temperatures in late spring, summer, and early fall are ideal conditions for the formation of ozone, and the San Joaquin Valley frequently experiences unhealthy air pollution days.¹⁹ Low wind speeds and low inversion layers in the winter create a climate conducive to high particulate matter (PM) concentrations. Higher temperatures can increase surface ozone concentrations, and increased water vapor in the air can trap ozone in already polluted areas. Ground-level ozone is associated with a variety of negative health outcomes, including reduced lung function, pneumonia, asthma, cardiovascular diseases, and premature death. These pollutants, as well as smoke from regional wildfires, can increase cardiovascular and asthma-related health complications, especially if people are exposed for prolonged periods.

Persons who spend a disproportionate amount of time outdoors, such as outdoor workers, children, and persons experiencing homelessness, are severely vulnerable to poor air quality. Exposure to increased ground-level ozone concentrations, smoke, and particulate matter can lead to asthma, lung disease, and cardiovascular health risks.²⁰ These persons may not have the resources or financial stability to stay indoors to prevent health impacts from poor air quality. Those with fragile immune systems, such as persons with chronic illnesses and seniors, are also highly vulnerable, because poor air quality can exacerbate existing conditions and has the potential to cause pneumonia. Those who cannot control indoor air quality environments or who may be isolated from the community, such as linguistically isolated persons (i.e., those with limited English proficiency) and households in poverty, may become more susceptible to

respiratory and cardiovascular illnesses from poor air quality and smoke. Some populations can stay indoors or travel to community centers to protect themselves from smoke and other air pollutants. However, those who lack medical insurance or have other financial hardships may face difficulties adapting to air quality impacts.

Drought

A drought occurs when conditions are drier than normal for an extended period, making less water available for people and ecosystems. Droughts are a regular occurrence in California; however, scientists expect that climate change will lead to more frequent and more intense droughts statewide. Though yearly precipitation is not expected to decline significantly, rainfall is expected to become concentrated in less frequent, larger events. Longer periods of time between rainfall events could facilitate the development of drought. As of May 2022, Modesto and the majority of Stanislaus County are in severe drought conditions.

Modesto obtains its water from a combination of sources, including City-operated groundwater wells and surface water provided by the Modesto Irrigation District (MID). Groundwater is sourced from the Turlock and Modesto subbasins of the San Joaquin Valley Groundwater Basin. Surface water comes from the Tuolumne River via the Modesto Reservoir, which is fed by snowmelt from the central Sierra Nevada. Residents in the City's contiguous service area north of the Tuolumne River rely primarily on treated surface water, which is supplemented with groundwater during periods of high demand. Water demands from the City's contiguous service area south of the Tuolumne River and the outlying service areas are met with groundwater supply year-round.²¹ The City's use of both surface and groundwater affords the City's water system a certain degree of resiliency to drought conditions; if dry conditions reduce MID's deliveries to the City, the City could compensate by increasing groundwater pumping.²²

The Tuolumne River is fed by slowly melting snowpack that provides water throughout the year. During drought conditions, water flows along the Tuolumne River could decrease due to lack of rainfall and reduction in snowpack due to higher temperatures, causing water shortages during extended drought conditions. The watershed feeding the Tuolumne River could experience a reduction in average baseflow from 11.1 inches to 7.4 inches (or 33 percent) during an extended drought period.²³ Snow-to-water equivalence, or the amount of water stored in the snowpack in the southeastern Sierra region is projected to decrease from a historical average of 391.8 inches to 153.5 inches (or 61 percent) during a late-century drought (2051 to 2070).²⁴

At the local level, the aquatic habitat, wetlands, and riparian habitats that depend on water from the Stanislaus River, Tuolumne River, and Dry Creek are most vulnerable. In a late-century drought (2051 to 2070), precipitation in Modesto could drop from an average of 12.1 inches per year to 9.8 inches per year (or 19 percent) and cause baseflows in streams to drop from 1.1 inches per year to 0.9 inches per year.²⁵ Declines in water level could lower water quality and raise water temperatures, leading to lower dissolved oxygen levels and algae growth that can harm a variety of fish species.²⁶

The City of Modesto has developed the “One Water Modesto” program to internally align staff from various departments to communicate the value of the City’s water resources. Through One Water Modesto, the City takes a holistic approach to its water resources, including potable water, stormwater, groundwater, surface water, wastewater, and recycled water. By providing consistent messaging from staff, the City seeks to improve awareness of water resources and infrastructure through public outreach and engagement.

Goals of the One Water Modesto program include stimulating economic development, developing public and private partnerships, improving water resource management and policies, promoting civic pride, ensuring regulatory compliance, and fostering confidence in the City’s utilities. The One Water Modesto program is ongoing. The City continues to integrate this program in its operational practices and messaging with its staff and customers.

The City of Modesto also maintains a Water Conservation Plan, most recently updated in 2021. As outlined in the plan, the City’s current water demand management measures include water waste prevention ordinances, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, residential conservation programs, commercial and industrial conservation programs, large landscape irrigation conservation programs, and rebate programs, as summarized in **Table 3**.

Table 3: Existing Demand Management Measures			
Measure Name	Description	Applicable Customer Class(es)	Recent Implementation
Water Waste Prevention Ordinances	Prohibit water waste within service area through rules and regulations formalized in the Modesto Municipal Code (MMC).	All Customers	MMC § 11-1.14 defines water waste, includes rules and regulations requiring compliance to the Drought Contingency Plan, and provides for enforcement; Resolution 2017-406 limits outdoor water use and remains effective.
Metering	Use water meters to measure and track customer water use.	All Customers	As of 2022 the City of Modesto is 100 percent metered. Approximately 75,000 water meters are currently in operation.
Conservation Pricing	Assess a volumetric charge to encourage conservation, so high-use customers pay more.	All Customers	Current water rates include a volumetric charge, which may be increased during droughts.

Table 3: Existing Demand Management Measures			
Measure Name	Description	Applicable Customer Class(es)	Recent Implementation
Public Education and Outreach	Promote water conservation to the public as a standard behavior.	All Customers	Attending public events, distributing conservation kits, and giving school presentations.
Managing Distribution System Losses	Maintain and monitor the water distribution system to minimize water losses.	All Customers	Implementing regular maintenance programs (e.g., meter recalibration, pump efficiency testing, water main flushing, water production monitoring, and leak detection/repair).
Water Conservation Program Coordination and Staffing Support	Provide dedicated staff to develop, implement, and manage the City's water conservation program.	All Customers	Employing a full-time water conservation specialist, administrative support, and temporary/seasonal employees as needed.
Residential Conservation Programs	Provide services to raise awareness and reduce everyday water use at home.	Residential	Conducting water surveys, programming sprinkler systems, and providing water conservation kits.
Commercial and Industrial Conservation Programs	Provide water use survey services to new and existing commercial and industrial customers.	Commercial and Industrial	Adopting Commercial Green Building Code, conducting water use surveys, and evaluating operations and equipment.
Large Landscape Irrigation Conservation Programs	Improve water efficiency of large landscapes.	All Customers	Implementing smart irrigation systems and/or using shallow aquifers at City parks, conducting large landscape surveys, and City staff reviewing plans and inspecting construction for projects with large landscaped areas.
Rebate Programs	Reimburse customers for replacing or improving existing appliances, equipment, or facilities to improve water use efficiency.	All Customers	Ongoing rebates for turf replacement, high efficiency clothes washers and toilets, drip irrigation systems, and smart irrigation controllers.

Potential future demand management measures under consideration by the City include a dishwasher rebate and a requirement to replace inefficient water fixtures in homes being sold or remodeled.

Modesto's Water Shortage Contingency Plan enables the City to enact additional water conservation measures in the event of a water shortage, including limiting or prohibiting outdoor water use (including commercial and residential irrigation and car washing), limiting water used by hotels and restaurants, requiring toilet retrofits in homes undergoing renovation, issuing a moratorium on all new landscaping, and issuing a moratorium on all new water connections. The City is also able to pursue additional water supplies, including increased groundwater pumping and a temporary arrangement with MID for additional surface water at a higher rate.

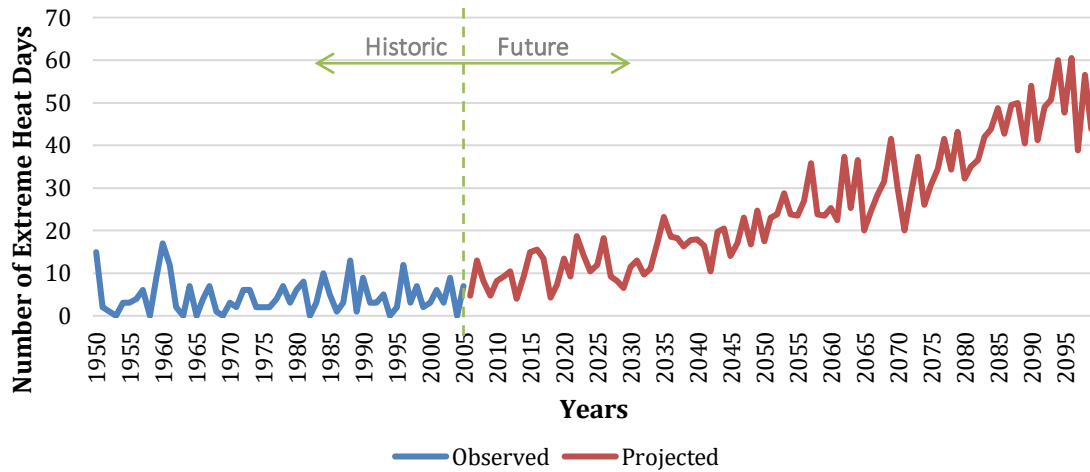
Despite Modesto's efforts to improve water resiliency, drought conditions may stress some members of the Modesto community. Agricultural and livestock industries are sensitive to changes in water availability, and reductions in water availability may lead to reductions in crop yield and/or fallowing of fields. Changes in agricultural operations and landscaping practices may also have consequences for those who rely on agriculture and landscaping for employment. Increases in water prices may strain the budgets of low-income households, and those who lack access to a reliable personal source of water, such as individuals experiencing homelessness, may experience increased levels of water insecurity.

Extreme Heat

Extreme heat occurs when temperatures rise significantly above normal levels. In Modesto, an extreme heat day occurs when temperatures reach above 102.9 degrees Fahrenheit (°F). As shown in **Figure 3**, the number of extreme heat days in Modesto is projected to increase from 4 days historically²⁷ to an average 22 extreme heat days per year by midcentury and an average of 42 extreme heat days per year by the end of the century.

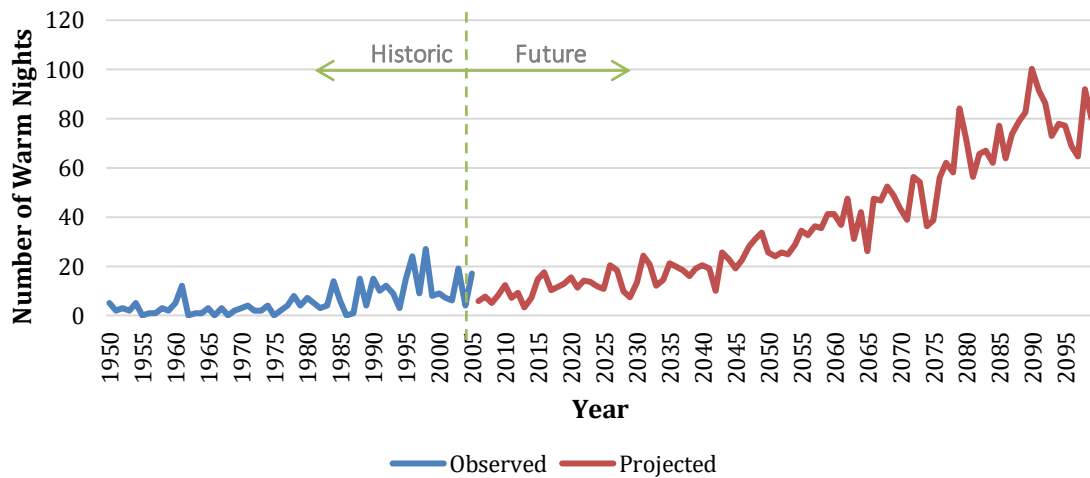
Extreme heat can also occur in the form of warmer nights when temperatures do not cool down overnight to provide relief from the heat. In Modesto, a warm night occurs when the temperature stays above 67°F. As shown in **Figure 4**, the number of warm nights in Modesto is projected to increase from an average of 5 historically²⁸ to an average of 28 warm nights per year by midcentury, and an average of 68 warm nights per year by the end of the century.

Figure 3. Projected Extreme Heat Days in Modesto



Sources: Cal-Adapt, 2020; National Oceanic and Atmospheric Administration, 2020.

Figure 4. Projected Warm Nights in Modesto



Sources: Cal-Adapt; National Oceanic and Atmospheric Administration, 2020.

Extreme heat can cause heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, in addition to worsening respiratory and cardiovascular conditions. The most vulnerable populations are those that spend a disproportionately high amount of time outside, such as children, outdoor workers, and persons experiencing homelessness; those with limited capacity to relocate or modify their housing situation in response to heat, such as low-income households; and those with sensitive or compromised immune systems, including persons with chronic illnesses and seniors.

Agricultural and adjacent industries may be affected by high heat if temperatures interfere with crop development, increase water demands, or pose a health threat to livestock and agricultural workers.

Transportation and energy delivery infrastructure can be damaged by extreme heat. High temperatures can damage roads, stress and overload the electric grid, and cause power outages and damage to transmission lines. Additional vulnerabilities include outdoor recreation, because people may be deterred from recreating outdoors in high temperatures, and aquatic and wetland habitats, which can experience decreases in water quality as temperatures increase.

Flooding

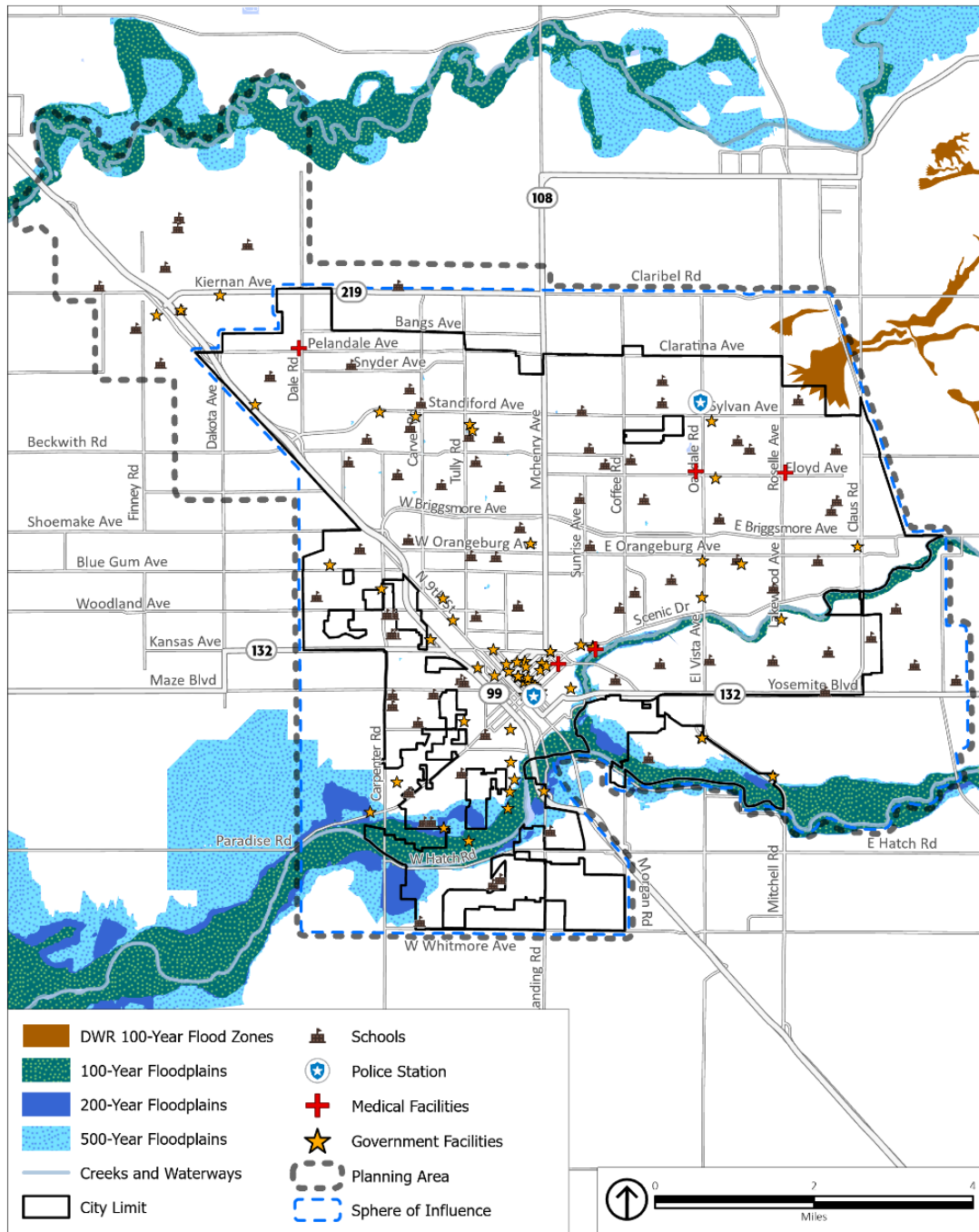
Flooding can cause significant harm to buildings, people, and infrastructure. Floodwater can be deep enough to drown people and may move fast enough to carry away people or heavy objects (such as cars). Flooding can be caused by heavy rainfall, long periods of moderate rainfall, or clogged drains during periods of rainfall. In rare instances, a break in a water pipe or water tank can also cause flooding.

As shown in **Figure 5**, both the Tuolumne River and Dry Creek have 100-, 200-, and 500-year floodplain areas along their respective banks, and both pose flood hazards to Modesto. Though 100-year and 200-year floods are traditionally defined as floods that have a 1 percent or 0.5 percent chance of occurring per year, respectively, floods of 100-year and 200-year magnitude will likely become more frequent under climate change.

Several populations and assets face particularly high risks from flooding events. Persons experiencing homelessness, households in poverty, residents of mobile homes, and formerly incarcerated individuals are severely vulnerable to flooding because they may live in or near flood hazard areas, lack financial resources to protect their homes, or have difficulty evacuating during a flood emergency. Persons with limited mobility and those without access to lifelines (i.e., persons without access to a car, transit, or communication systems) may have difficulty evacuating prior to a flooding event and therefore are also highly vulnerable.

Transportation infrastructure, such as bridges, electric vehicle charging stations, railways, evacuation routes, and major roads and highways, which are essential for public transit access, solid waste removal, and other services, can be inundated, blocked, and damaged by floodwaters along the creeks. There are two wastewater treatment plants (WWTP)—Sutter WWTP and Jennings WWTP—in 100-year floodplains along the Tuolumne and San Joaquin Rivers, which pose risks related to the release of contaminated wastewaters in Modesto.

Figure 5. Flood Zones



Source: Department of Water Resources, 2020; Federal Emergency Management Agency, 2020; City of Modesto, 2021.

Community-wide resilience to flooding can be increased by ensuring that the City's storm drainage and flood management systems are adequate to mitigate the effects of large floods. Approximately 70 percent of the City's stormwater infrastructure relies on positive storm drainage systems. The positive storm drainage system is a network of conveyance pipe that was originally built to serve a five-year storm event. In 2002, the City updated its Standard Specifications for Storm Drainage Design to be in line with the common industry practice of systems being able to convey a 10-year storm event. City-owned detention basins are built in conjunction with new residential and commercial development. Detention basins built before 2002 have the capacity to hold runoff generated by a 10- to 50-year storm event. After 2002, the standard was updated to require that new detention basins have capacity to store the runoff from 100-year storm events.

Where positive storm drainage systems are not available, the sanitary system is used for drainage of stormwater collected in streets. Reliance on the sanitary sewer system is less desirable because it is expensive to treat stormwater and reduces capacity in the city's wastewater collection and treatment system. Parts of the city not near discharge points are served by catch basins and rockwells, which are deep holes filled with rocks that are connected to a catch basin. Rockwells perform well for a few years but require regular maintenance to alleviate sediment buildup. They may take up to 40 hours to fully absorb all stormwater and do not have enough capacity to handle all the runoff produced in annual storm events, which can result in the formation of standing water and flooding of city streets. The City plans to construct positive storm drainage systems in areas that are exclusively served by rockwells. However, updating the City's storm drainage system will be a cost-intensive process, and additional funding will likely be required.

Human Health Hazards

Human health hazards are bacteria, viruses, parasites, and other organisms that can cause diseases and illness in people. Some of these diseases may only cause mild inconvenience, but others are potentially life threatening. These diseases can be and often are carried by animals such as mice and rats, ticks, and mosquitos. Warmer temperatures and high levels of precipitation can lead to increased populations of disease-carrying animals, creating a greater risk of disease and increased rates of infection.

Populations most vulnerable to human health hazards are those who spend a disproportionate amount of time outdoors (such as outdoor workers or persons experiencing homelessness), those with fragile immune systems or existing illnesses (which may include persons with chronic illnesses and seniors), and those who may live in substandard housing or not have access to health insurance and medical care (which may include households in poverty, low-income households, and undocumented persons). These persons may be living in conditions that increase their chances of catching vector-borne illnesses or lack the ability to fight off infections. Many populations may also not have access to air purification systems that can filter out harmful particulate matter.²⁹

Emergency medical response services are also highly vulnerable to human health hazards, as they may not be able to provide adequate services if there is an influx of health-related emergencies.

Landslides

Landslides occur when a hillside becomes unstable, causing soil and rocks to slide downslope. Landslides can include rock falls, deep failures of slopes, and shallow debris flows. Heavy rainfall, wildfire, flooding, earthquake, changes in groundwater, and human-induced modifications to existing slopes can contribute to landslide hazards.³⁰ The Vulnerability Assessment looks at landslides that are caused by precipitation, although earthquakes can also trigger landslides. Hillsides commonly absorb water, which increases instability of the slope and may increase the risk of slope failure. Steep slopes made up of loose or fractured material are more likely to slide. In some cases, the hillsides can become so saturated that slope failures can result in a mudslide (a mixture of soil and water moving downslope). As shown in **Figure 6**, the parts of Modesto that are most susceptible to landslides are the banks of Dry Creek and the Stanislaus and Tuolumne Rivers.

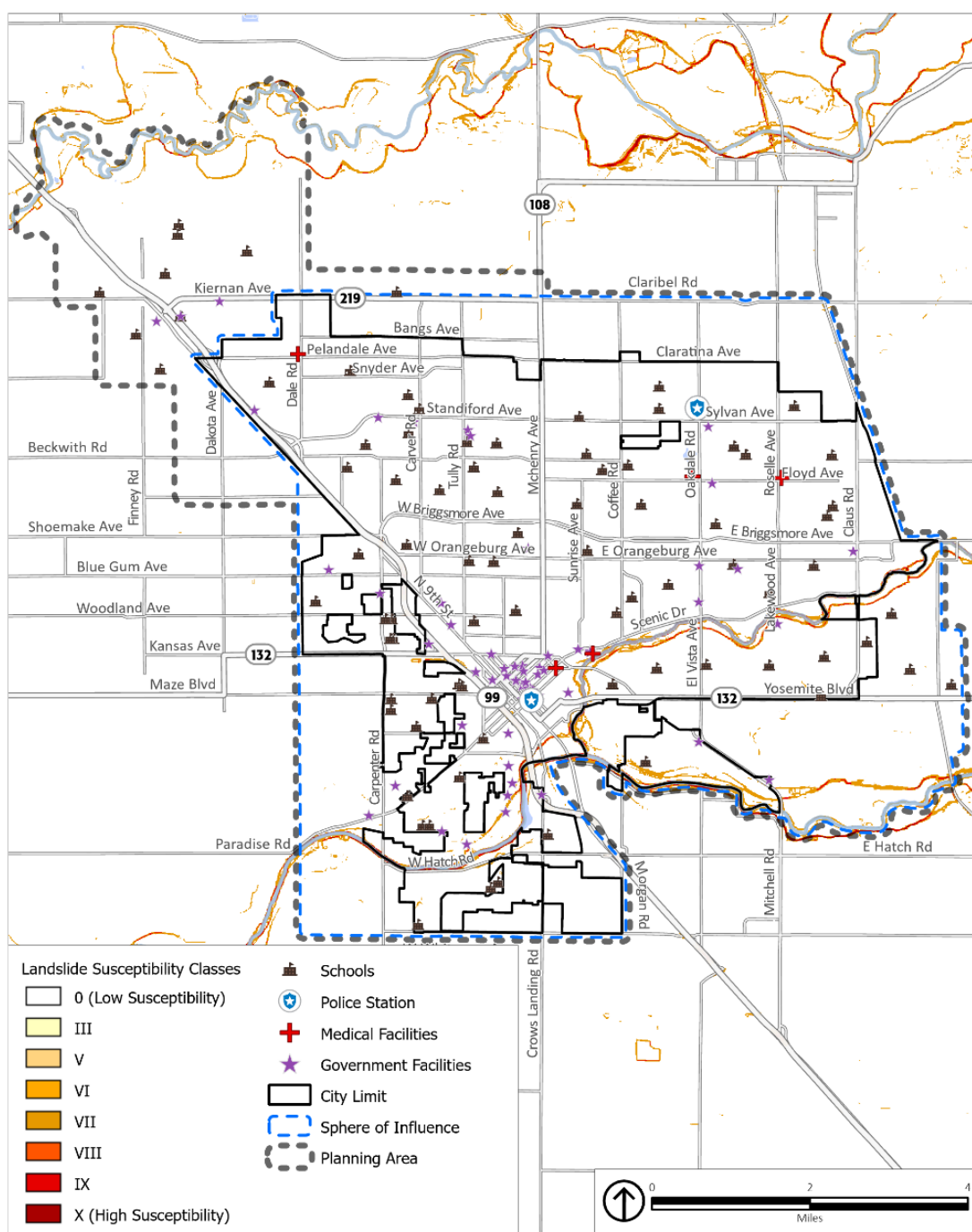
Landslides and mudslides can move fast enough to damage or destroy homes or other structures in their path, block roadways (including evacuation routes), and injure or kill people caught in them. The most vulnerable populations are those that live in or adjacent to landslide-prone areas and who may be unable to evacuate due to limited mobility, lack of access to a vehicle, or language barriers that prevent awareness of emergency notifications. Many homes in or adjacent to landslide-prone areas are mobile homes, which may be more easily damaged or whose residents may have limited financial means to prepare for or recover from a disaster. Infrastructure, such as natural gas pipelines and water or wastewater infrastructure, can break or malfunction if the soil supporting them fails. This can lead to disruptions in energy delivery and water or wastewater services.

Severe Weather

Severe storms include windstorms, hail, lightning, thunderstorms, and heavy rainfall. Severe weather is usually caused by intense storm systems, although types of strong winds can occur without a storm. The connection between climate change and severe storms is not as well established as other exposures, but severe storms may occur more often and become more intense than in the past. Hail can damage buildings and plants (and in extreme cases injure people), and lightning can spark fires, injure people, or cause fatalities. Heavy rainfall, which is characterized by rainfall amounts that exceed normal levels, can lead to flooding and landslides.³¹

The most vulnerable to severe weather are persons experiencing homelessness; those who may live in less structurally resilient buildings, such as households in poverty; and those who may have difficulty preparing or responding to severe weather due to mobility or language barriers. These populations include linguistically isolated populations, persons living on single-access roads, persons with chronic illnesses, formerly incarcerated individuals, and seniors living alone.

Figure 6. Landslide Susceptibility Areas



Source: California Geological Survey, 2010; City of Modesto, 2021.

3. GENERAL PLAN IMPLICATIONS

Equity and Uncertainty

When addressing vulnerability and adaptation through General Plan policies and implementation actions, the *APG* and *General Plan Guidelines* recommend consideration of equity and uncertainty.

Equity means that all people are justly and fairly included in society, and that everyone can participate, prosper, and achieve their full potential. Equitable climate adaptation planning involves identifying persons who are most vulnerable to climate change hazards and ensuring that the planning process, distribution of resources, and efforts to address systematic wrongs are all conducted in an equitable manner. This Vulnerability Assessment identifies 18 vulnerable populations and assesses climate change impacts and the ability of these populations to prepare for, respond to, and recover from climate change hazards (see list under “Vulnerability Assessment Method” Section).

Uncertainty is the second component to consider when determining how hazardous conditions may affect Modesto. Climate change is a response to the concentration of GHGs in the atmosphere, which is determined by how our societies use resources and how we regulate those uses through local, state, federal, and international GHG-reduction goals, regulations, plans, and programs. As more action is taken to reduce GHG emissions, the less severe the effects of climate change are expected to be. Climate change models consider the concentrations of atmospheric GHG emissions and the potential changes in these levels over time to project the future extent or intensity of hazardous events.

Even with extensive modeling, analysis of potential impacts is based on projections of probable future conditions, which are not certain. Similarly, there is substantial uncertainty about the future state of technology, socioeconomic conditions, and other factors that may affect atmospheric concentrations of GHGs. The best approach to uncertainty is to monitor how future conditions evolve and adjust adaptation efforts over time as new climate data and studies are completed. The State and the City have ample evidence to support science-based policy and decision-making.

Opportunities

Modesto currently experiences a wide range of climate change hazards that are projected to increase in frequency and intensity in the future. Though GHG reduction measures in the General Plan Update will help reduce the amount of carbon dioxide in the atmosphere, adaptation strategies will be needed to increase the resilience of residents and businesses in Modesto. The General Plan should include adaptation and resilience goals, policies, and actions that will help the community prepare for, respond to, and recover from climate change hazards.

- **Safety.** Due to the recent update of the California Government Code, Section 653029(g), with the approval of SB 379, safety elements are required to address climate adaptation and resilience strategies. The safety element’s goals, policies, and implementation actions can provide resilience strategies that support both reduced impacts and

improved adaptive capacity of the community to climate-change-related hazards, along with policies on other hazards such as flooding, fire, and geologic hazards. Policies in this element can ensure that health and safety concerns of the community are met, even with an increase in frequency and intensity of climate change hazards. Examples of specific policies or implementation actions could include:

- Create an extreme heat response plan that includes establishment of community cooling centers and temperature triggers for when they will open, weatherization of City buildings, and cooling strategies for persons engaged in outdoor work and persons experiencing homelessness.
- Expand participation of programs and services that provide funding resources for economically disadvantaged households and businesses to conduct weatherization and floodproofing.
- Identify existing facilities to serve as resilience hubs and cooling centers that open during emergencies or specific temperature triggers for residents to seek refuge from extreme heat days or emergency shelter.
- Coordinate with emergency management services to establish backup power, preferably from renewable energy sources, and water resources at emergency shelters, resilience hubs, and cooling centers in case of power outages.
- Develop an evacuation assistance program, in coordination with the Stanislaus Regional Transit Authority, paratransit, and dial-a-ride agencies, to help those with limited mobility or who lack access to a vehicle to effectively evacuate.
- Ensure evacuation routes remain open and functional during emergencies.
- Identify locations for critical city facilities that are outside of hazard zones and promote the relocation of critical facilities to locations outside of hazard zones, as feasible.
- Support the expansion of fiber optic services within the city.
- **Circulation and Mobility.** The Circulation Element will include policies for the existing roadways, public transit, bicycle, and pedestrian networks in the city. These facilities are assessed in the Vulnerability Assessment, and therefore resilience strategies for these transportation systems would be appropriate to add to the Circulation Element. Policies and implementation measures may include the following:
 - Coordinate with City and regional transit providers to identify alternative routes and stops if normal infrastructure is damaged or closed because of extreme events.
 - Harden or raise roadways to ensure evacuation access during hazardous events.
 - Use heat-resistant materials on roadways, bicycle, and pedestrian infrastructure.
 - Ensure that public transit facilities and high-volume pedestrian routes provide adequate protection from extreme heat and flooding, such as by installing covered bus stops and/or shaded areas along bike and pedestrian routes.

- **Open Space.** The Open Space Element will provide background and policies for open space, parks, and recreation in Modesto. Resilience strategies for open space include managing open space to provide recreation, wildfire management, and pest control measures through vegetation management, brush clearing, and pest management.

The parks and recreation section of this element can promote public health and safety by ensuring recreation opportunities and a variety of parks are available and welcoming to all residents and visitors. Park and open space areas can help reduce air pollution, decrease ambient air temperatures, provide shade during hot days, and function as buffers to slow down and absorb stormwater, among other benefits. Indoor recreation facilities can provide opportunities for recreation when outdoor air quality or temperatures are unhealthy. This section can include policies and actions that increase the urban tree canopy to reduce the heat island effect, clean the air, and protect residents and visitors from hazardous conditions. Policies in this element can also promote drought- and heat-tolerant landscaping on City property.

- **Conservation.** The Conservation Element will include information on the ecosystems and natural resources in the city, including the ecosystems evaluated in the Vulnerability Assessment. California Government Code Section 65302(g)(4) requires natural infrastructure to be used in adaptation projects where feasible, which can be integrated into this element. Policies and implementation measures can include conducting ecosystem restoration projects to protect against flooding and improve carbon retention.
- **Environmental Justice.** The Environmental Justice Element will focus on reducing unique or compounded health risks in disadvantaged communities identified in Modesto. Policies can include increasing equitable healthy and affordable food access and promoting safe homes to directly address the needs of disadvantaged communities. Environmental justice policies and implementation actions can increase resiliency of vulnerable populations by reducing the nonclimate stressors that can introduce barriers to low-resourced and pollution-burdened populations responding to and recovering from hazards. This element will also ensure that these populations have opportunities to participate in the public decision-making process. Specific adaptation measures can include providing affordable healthy foods in schools and other public spaces; assisting in the repair, rehabilitation, and improvement of residential structures; and demolishing and replacing structures that are dilapidated and beyond repair.
- **Air Quality.** The Air Quality Element will address current air quality concerns in Modesto and will provide a framework for promoting air quality improvements. The Air Quality Element can address air quality concerns associated with climate change by ensuring that multimedia, multilingual outreach is available citywide, and providing personal health equipment and refuge centers in the event of a significant air quality event such as a regional wildfire; imposing limitations on the use of equipment and vehicles that release air pollutants; and expanding networks of trees and other natural systems that help improve air quality.

- **Economic Development.** The Economic Development Element will provide a policy framework to diversify Modesto's economic base. The Economic Development Element can:
 - Support workers affected by climate change by providing career training opportunities and economic support to outdoor workers whose health or job security may be jeopardized by heat, drought, or poor air quality; providing protective equipment to workers in response to high heat, poor air quality, or public health crisis; and advocating for the provision of living wages for Modesto residents and employees.
 - Help existing industries prepare for and respond to the effects of climate change by encouraging collaboration between business and local, regional, and state government to share resources, best practices, and financial opportunities.
 - Provide career training opportunities and investment in the renewable energy, energy efficiency, public health, and ecosystem services industries.
- **Land Use.** The Land Use Element will shape future physical development and conservation throughout the city. Climate adaptation policies could be incorporated into the Land Use Element by promoting the use of permeable pavements and heat-reflective surfaces and ensuring that land use decisions incorporate analysis of potential hazards.

Conclusion

The Vulnerability Assessment identifies which hazards are expected to harm sensitive populations and assets, and which assets are most vulnerable to various hazards that are projected to intensify with climate change. The effects of climate change that are expected to have the largest impacts on Modesto's communities, infrastructure, buildings, activities, ecosystems, and services are extreme heat, flooding, and severe weather. Though each member of the Modesto community faces their own unique vulnerability considerations, some of the populations most vulnerable to climate change are persons with chronic illnesses, persons with disabilities, linguistically isolated populations, formerly incarcerated individuals, outdoor workers, households in poverty, and persons experiencing homelessness. Some of Modesto's assets most vulnerable to climate change are major roads and transportation routes; electrical infrastructure and energy delivery; agricultural, livestock, and food processing industries; aquatic habitats and wetlands; and public transit access.

A comprehensive set of results from this Vulnerability Assessment is presented in **Appendix B**. Understanding how climate change will affect the community and identifying the vulnerable populations and assets will enable Modesto to implement effective GHG reduction measures and climate adaptation strategies to create a safer, sustainable, and healthier community.

As the climate continues to change and GHG emissions rise, climate change hazards will continue to harm populations, infrastructure and buildings, economic drivers, and key community services in Modesto. The City's General Plan Update will include goals, policies, and actions that will help reduce GHG emissions in the city and increase resiliency through adaptation strategies that will reduce vulnerability throughout the city.

APPENDIX A: LIST OF HAZARDS, ASSETS, AND POPULATIONS

MEMORANDUM

DATE December 1, 2021
TO Jaylen French, Steve Mitchell, and Brad Wall, City of Modesto
FROM Tammy Seale, Eli Krispi, and Jessica Robbins, PlaceWorks
SUBJECT Modesto Climate Change Vulnerability Assessment – List of Hazards, Populations, and Assets

Introduction

The PlaceWorks team will be preparing a Climate Change Vulnerability Assessment (Vulnerability Assessment) to analyze how climate change may harm the Modesto community. While this work is a requirement of California Government Code Section 65302(g)(4) as amended by Senate Bill (SB) 379, it is also an opportunity to identify how to use City and community resources to improve resiliency in the city in an integrated, thorough, and tailored way. The Vulnerability Assessment will inform updates to the General Plan and other City plans and resources to help safeguard Modesto against current and future hazard conditions, including the changes in hazard events caused by climate change.

The Vulnerability Assessment will consider the threats from all relevant climate *hazards*, which are events or physical conditions that have the potential to cause harm or loss and will emphasize changes to hazard frequency and severity due to climate change. The Vulnerability Assessment will also assess *populations* or *assets* facing potential harm from climate hazards. This includes the risk of physical damage to buildings and infrastructure, social vulnerability of persons likely to be disproportionately harmed by hazards, potential disruption to the city's economic engines, loss of important services, and damage to sensitive ecosystems. The outline [under "Vulnerability Considerations"] presents the hazards, populations, and assets we plan to address.

The Vulnerability Assessment will be based on accurate and up-to-date information, including the Cal-Adapt database¹, the California Adaptation Planning Guide², and the County Multi-Jurisdictional Local Hazard Mitigation Plan. As outlined in the Adaptation Planning Guide, the Vulnerability Assessment will follow a four-step process:

¹ The Cal-Adapt platform is available online: <https://cal-adapt.org/>.

² Published by the Governor's Office of Emergency Services, the 2020 California Adaptation Planning Guide is available online: <https://resilientca.org/apg/>.

1. **Identify Exposure.** In a vulnerability assessment, *exposure* is the presence of people; infrastructure; natural systems; and economic, cultural, and social resources in areas subject to harm. A *hazard*, or climate hazard, is an event or physical condition that has the potential to cause types of harm or loss. This step includes confirming applicable hazards in the city, describing historical hazards, identifying new hazards, describing how hazards are expected to change, and mapping the hazard-prone areas. The creation and review of this memo completes this step of the Vulnerability Assessment.
2. **Analyze Sensitivity and Potential Impacts.** *Sensitivity* is defined as the level to which changing climate conditions affect a species, natural system, community, government, etc. Potential impacts are the effects of a climate change hazard, or the combination of exposure and sensitivity. For example, suppose an increase in extreme heat events is the hazard. In that case, the greater risk of heat-related illness in susceptible persons is the exposure, and the sensitivity is the degree of the impact from the exposure. Each population and asset in the City of Modesto is likely to experience different impacts. The project team will assess the sensitivities and potential impacts to each population or asset from each applicable climate change hazard.
3. **Evaluate Adaptive Capacity.** *Adaptive capacity* is the ability of people and assets to adjust to potential damage from climate change hazards, to take advantage of existing opportunities such as funding, tools, and resources, or to respond to the impacts of climate change. The project team will assess the adaptive capacity of each population or asset for each applicable identified hazard.
4. **Conduct Vulnerability Scoring.** *Vulnerability* is defined as the combination of impact and adaptive capacity as affected by the level of exposure to changing climate conditions. In accordance with the process in the Adaptation Planning Guide, the project team will use the impact and adaptive capacity scoring to identify and prioritize the most vulnerable populations and assets in Modesto.

Vulnerability Assessment Considerations

PlaceWorks recommends that the following climate hazards, populations, and other assets be covered in the Vulnerability Assessment. The list includes a description and data source for each item or group of items. PlaceWorks requests that City staff review this list and confirm if any items should be added, removed, or altered, and if other data sources should be consulted.

CLIMATE HAZARDS

- **Agricultural and Ecosystem Pests:** The health and productivity of natural ecosystems and farmland are affected by the presence of a variety of pests whose abundance, range, and periods of activity may be enlarged by climate change. Data on agricultural and ecosystem pests will be collected from the *California Fourth Climate Change Assessment* and the *Stanislaus County Agricultural Report*.
- **Air Quality:** Air quality hazards include ozone, particulate matter, smoke created by fires in the region, and other pollutants that are exacerbated by climate change. Data on air quality will be collected from the *California Fourth Climate Change Assessment* and CalEnviroScreen 4.0.

- **Drought:** A drought is when conditions are drier than normal for an extended period, making less water available for people and ecosystems. This data is available through Cal-Adapt and the *California Fourth Climate Change Assessment*.
- **Extreme Heat and Warm Nights:** Extreme heat is when temperatures rise significantly above normal levels (an extreme heat day for Modesto is defined as a day with temperature exceeding 102.9°F). Warm nights are when minimum temperatures remain significantly above normal levels during nighttime hours (a warm night in Modesto is defined as a night with temperature exceeding 67°F). This data will be gathered from Cal-Adapt.
- **Flooding:** A flood is when there is too much water on the ground to be carried away by drains or creeks, or to soak into the soil, usually the result of very heavy or extended periods of precipitation. This data will be derived from the 2018 FEMA flood hazard maps and the *Stanislaus County Local Hazard Mitigation Plan*.
- **Human Health Hazards:** Human health hazards are bacteria, viruses, parasites, and other organisms that can cause diseases in people. Climate-related human health hazards are usually diseases carried by animals that are considered pests, such as mice and rats, mosquitos, and ticks. This data will be gathered from the *California Fourth Climate Change Assessment* and *Safeguarding California Plan*.
- **Landslides:** A landslide occurs when a slope, like the side of a riverbed, becomes unstable, causing soil and rocks to slide down slope. Landslide data will be gathered from the California Geological Survey and the *California Fourth Climate Change Assessment*.
- **Severe Weather:** Severe weather includes intense winds, lightning, hail, and related events. This data will be gathered from the *California Fourth Climate Change Assessment* and the *Stanislaus County Local Hazard Mitigation Plan*.

POPULATIONS

The Vulnerability Assessment will consider populations that may be more vulnerable to climate-related hazards than the average person, consistent with State guidance. PlaceWorks will collect population data from the US Census, the California Healthy Places Index, and Homeless Point in Time Count. Populations considered include:

- Children under 10 (approximately 14% of the population, per the US Census 2019 ACS 5-Year Estimate)
- Seniors aged 65 and older (approximately 14% of the population, per the US Census 2019 ACS 5-Year Estimate)
- Seniors living alone (approximately 10% of households, per the US Census 2019 ACS 5-Year Estimate)
- Persons with chronic illnesses
- Persons with disabilities (approximately 34% of the population, per the US Census 2019 ACS 5-Year Estimate)
- Immigrants and refugees (approximately 18% of individuals, per the US Census 2019 ACS 5-Year Estimate)

- Linguistically isolated populations, including those speaking Spanish, Hindi, Tagalog, Khmer, Cantonese, Mandarin, and Arabic
- Formerly incarcerated individuals
- Outdoor workers (e.g., construction workers, agricultural workers, and firefighters) (approximately 12% of the civilian population age 16 or over, per the US Census 2019 ACS 5-Year Estimate)
- Households in poverty: households with an income below the federal poverty line of \$26,400 as an annual household income for a household of four (approximately 18% of households, per the US Census 2019 ACS 5-Year Estimate)
- Low-income households: households with an income of 80% or less of Modesto's median income of \$59,287 (approximately 40% of households, per the US Census 2019 ACS 5-Year Estimate)
- Cost-burdened households: households paying 30% or more of their income towards housing expenses (approximately 41% of households, per the US Census 2019 ACS 5-Year Estimate)
- Households that lack internet access (approximately 13% of households, per the US Census 2019 ACS 5-Year Estimate)
- Households that lack access to a private vehicle (approximately 7% of households, per the US Census 2019 ACS 5-Year Estimate)
- Persons experiencing homelessness (approximately 1,592 individuals, as of the 2020 Stanislaus County Point-in-Time Count)
- Persons living in mobile homes (approximately 3% of households, per the US Census 2019 ACS 5-Year Estimate)
- Persons in overcrowded households: housing units that have more than one person per room, excluding bathrooms and kitchens (approximately 6% of households, per the US Census 2019 ACS 5-Year Estimate)
- Renters (approximately 45% of housing units are renter-occupied, per the US Census 2019 ACS 5-Year Estimate)

INFRASTRUCTURE

PlaceWorks will collect infrastructure data from a variety of State, regional, and local sources, including the 2019 Modesto General Plan Amendment and associated EIR, the Utilities and Infrastructure Technical Memorandum prepared for the 2050 General Plan Update, and the *Stanislaus County Local Hazard Mitigation Plan*. The analysis will consider structures that provide various services to Modesto community members, including the following infrastructure assets.

- Modesto Airport
- Bridges, as mapped by the California Office of Emergency Services and the California Department of Transportation

- Major roads, highways, and truck routes, including SR 99, SR 132, Kiernan Avenue, Pelandale-Claratina Avenue, Briggsmore Avenue, Claus Road, Dale Road, Oakdale Road, Tully Road, Standiford Avenue, Sylvan Avenue, Floyd Avenue, Orangeburg Avenue, and Lakewood Avenue
- Electric vehicle charging stations
- Biking and hiking trails
- Evacuation routes
- Railways and train stations, including the Union Pacific Railroad, Burlington Northern-Santa Fe Railway, and Modesto and Empire Traction Railroad
- Transit facilities, including the Modesto Train Station and Modesto Transportation Center
- Single access roads
- Communication facilities, including television and radio antennae and Internet lines, as mapped by the California Office of Emergency Services
- Electrical substations and transmission lines, as mapped by the California Energy Commission and California Office of Emergency Services
- Power plants, including McClure Generation Station and Stone Drop Mini-Hydro
- Natural gas pipelines
- Dams and reservoirs, including Don Pedro Dam, New Melones Dam, New Exchequer Dam, La Grange Dam, Hetch-Hetchy Reservoir, Modesto Reservoir, and Turlock Lake
- Flood control infrastructure, including canals, levees, and reservoirs, as mapped by the California Department of Water Resources and California Office of Emergency Services
- Parks and open space, including Aqueduct Park, Ashby Park, Bellenita Park, Beyer Community Park, Brewers Rose Park, Brookway Park, Catherine Everett Park, Cesar E. Chavez Park, Charles M. Sharp Park, Chrysler 99 Park, Chrysler Park, City Gate Childrens Park, Coffee-Claratina Park, Coleman F. Brown Park, Creekwood Park, Davis Community Park, Downey Community Park, Dr. Martin Luther King, Jr. Park, Dry Creek Regional Park, East La Loma Park, Eisenhut Park, Elk Park, Enslin Park, Fairway Park, Freedom Park, Garrison Park, George Rogers Park, Graceada Park, Hetch Hetchy Trail, J.M. Pike Park, James Marshall Park, John Muir Park, John Thurman Ball Field, John Thurman Field, Kewin Pak, Lakewood Park, Lateral Number 2 Park, Legion Park, Mancini Bowl, Mancini Park, Mark Twain Park, Martone Tot Lot, Mary E. Grogan Community Park, McKinney Colony Park, Mildred Perkins Park, Monterosso Park, Moose Park, Moran Estates Park, Muncy Park, Orchard Park, Pierre Park, Ralston Tower Park, Rancho Encantado Park, Revard Park, Riverside Park, Robertson Road Park, Roosevelt Park, Rose Avenue Park, Sanders Park, Sherwood Park, Siphherd Park, Sonoma Park, Standiford Park, Stockard Coffee Park, Sutter Park, Sylvan Park, Thomas B. Scott Park, Thousand Oaks Park, Tuolumne River Regional Park, Ustach Park, Virginia Corridor Trailway, Wesson Ranch Park, Whitmore Park, and Woodrow Park
- Solid waste facilities and closed landfills, as mapped by CalRecycle

- Water and wastewater infrastructure, including the Sutter Wastewater Treatment Plant, Jennings Wastewater Treatment Plant, Modesto Regional Water Treatment Plant, City-operated groundwater wells, water storage tanks and booster pump stations, and the City's positive drainage and rockwell stormwater capture systems

BUILDINGS

PlaceWorks will collect building data from the City's website and various providers of social services within the city. The Vulnerability Assessment will consider homes, non-residential buildings, and other building assets, including the following building assets.

- Commercial centers, including the Modesto Centre Plaza, Vintage Faire Mall, McHenry Village Shopping Center, Central Valley Plaza, Caruso Shopping Center, Biggsmore Plaza, Promenade Shopping Center, and Roseburg Square
- Emergency and transitional housing, including the Modesto Gospel Mission, Salvation Army Haig & Isabel Berberian Shelter & Transitional Living Center, Children's Crisis Center, Hutton House, and Modesto Women's Mission
- Public safety buildings, including 11 fire stations and the police headquarters
- Government buildings, including the Modesto City Hall, Stanislaus County Superior Court, and Stanislaus County Emergency Operations Center
- Homes and residential structures
- Medical and care facilities, including the Memorial Medical Center, Kaiser Permanente Modesto Medical Center, Stanislaus Surgical Hospital, Doctor's Medical Center, and Central Valley Specialty Hospital
- Community centers and libraries, including the King Kennedy Memorial Center, Maddux Youth Center, Neighborhood Center at Marshall Park, Senior Center, and MoPride Center
- Schools, including those under the jurisdiction of the Modesto City Schools, Hart-Ransom Union, Stanislaus Union, Salida Union, Sylvan Union, Paradise Elementary, Empire Union, and Keyes Union School Districts; Modesto Junior College; and 13 private schools

IMPORTANT ECONOMIC ASSETS

PlaceWorks will determine important economic assets based on the Economic Development Technical Memorandum prepared for the 2050 General Plan Update. These important economic assets will cover properties and activities that make significant contributions to the Modesto economy, including the following employers and businesses.

- Major employers, including Stanislaus Foods, Del Monte Foods Inc., E&J Gallo Winery, Frito Lay Inc., City of Modesto and County of Stanislaus
- Industrial/manufacturing centers
- Local and small businesses
- Historic and cultural resources, including the McHenry Mansion and Museum
- Outdoor recreation, including biking, golf, and court or field sports

- Agricultural land, including land dedicated to major crops like grapes, almonds, walnuts, and peaches
- Agricultural and commercial food processing centers
- Livestock and grazing lands

ECOSYSTEMS AND NATURAL RESOURCES

PlaceWorks will collect data on key ecosystems and natural resources from the 2019 Modesto General Plan Amendment and associated EIR and Modesto Irrigation District's Joint 2020 Urban Water Management Plan. These resources include:

- Aquatic habitat, including streams, rivers, ponds, and lakes, such as the Stanislaus River, Tuolumne River, and Dry Creek
- Valley foothill riparian habitat
- Groundwater resources
- Surface water resources, including local community water provided by City-operated wells and the Modesto Irrigation District, acquired from the Tuolumne River
- Wetlands and vernal pools
- Grassland

KEY COMMUNITY SERVICES

The Vulnerability Assessment will consider key community services provided by government agencies and private companies. The list below is based on typical services provided in cities throughout California, the infrastructure and buildings assets listed above, and information provided in the Stanislaus County Local Hazard Mitigation Plan, Modesto General Plan and its associated EIR, and the City's website.

- Emergency communication services, including Stanislaus Regional 911, the Stanislaus County Emergency Preparedness Program, and StanAware ***(Note for City Staff: Please confirm that this information is up to date)***
- Emergency medical response, including the Stanislaus County Office of Emergency Services, Stanislaus County Emergency Preparedness Program, Valley Regional Emergency Communications Center, PHI Air Medical, and CALSTAR 12 ***(Note for City Staff: Please confirm that this information is up to date)***
http://www.mvemsa.org/component/users/index.php?option=com_content&view=article&id=139&Itemid=57
- Energy delivery, including the Modesto and Turlock Irrigation Districts and Pacific Gas and Electric Company
- Government administration and community services
- Public transit access (provided by the Stanislaus Regional Transit Authority)

- Solid waste management and removal, including Gilton Solid Waste Management and Bertolotti Disposal
- Water and wastewater service (provided by the City in partnership with Modesto Irrigation District and Modesto Municipal Sewer District)
- Freight and shipping
- Food assistance agencies and organizations, including the Modesto Love Center, Good Samaritan Foodbank at Big Valley Grace Community Church, Commodity Food Program, Food Distribution Center, and Christ Unity Baptist Church

APPENDIX B: COMPLETE SCORING MATRIX

The table below shows the vulnerability score for each asset-hazard pair considered as part of the Vulnerability Assessment. Gray boxes are used when the given asset-hazard pair was deemed to not be significantly affected by climate change (for example, bridges are not impacted by changes in agricultural pests and diseases).

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
POPULATIONS								
Children	-	V4	V3	V4	V3	V3	V3	V3
Seniors	-	V5	V3	V4	V3	V4	V3	V3
Seniors living alone	-	V5	V3	V5	V4	V5	V3	V4
Persons with chronic illnesses	-	V4	V3	V5	V4	V4	V2	V4
Persons with disabilities	-	V3	V3	V4	V3	V3	V2	V3
Immigrants and refugees	-	V5	V3	V4	V4	V4	V3	V4
Linguistically isolated populations	-	V3	V3	V3	V3	V3	V2	V3
Formerly incarcerated individuals	-	V3	V3	V3	V4	V3	V3	V3
Outdoor workers	V4	V5	V4	V5	V4	V5	V2	V5
Households in poverty	-	V4	V4	V4	V5	V5	V3	V5

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
Low-income households	-	V3	V3	V4	V4	V3	V2	V3
Cost-burdened households	-	V3	V3	V3	V4	V3	V2	V3
Households that lack internet access	-	V3	V2	V2	V3	V3	V2	V3
Households that lack a private vehicle	-	V3	V1	V2	V4	V3	V3	V3
Persons experiencing homelessness	-	V5	V4	V5	V5	V5	V4	V5
People living in mobile homes	-	V3	V4	V4	V5	V2	V4	V3
Persons in overcrowded households	-	V3	V3	V3	-	V4	V2	V2
Renters	-	V3	V2	V2	V2	V2	V2	V2
INFRASTRUCTURE								
Airport	-	-	-	V3	V2	-	-	V3
Bridges	-	-	-	V3	V4	-	-	V3
Major roads, highways, and truck routes	-	-	-	V4	V5	-	V4	V3
Electric vehicle charging stations	-	-	-	V3	V2	-	-	V2

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
Biking and hiking trails	-	-	-	-	V3	-	V2	V3
Evacuation routes	-	-	-	V4	V4	-	V3	V3
Railways and train stations	-	-	-	V4	V4	-	V3	V3
Public transit facilities	-	-	-	V3	V3	-	V3	V4
Single access roads	-	-	-	V4	V4	-	V3	V4
Communication facilities	-	-	-	V3	-	-	-	V3
Electrical substations and transmission lines	-	-	-	V4	V4	-	V3	V4
Power plants	-	-	V2	V3	-	-	V2	V3
Natural gas pipelines	-	-	-	-	V3	-	V5	V2
Dams/Reservoirs	-	-	-	-	V2	-	V3	V1
Flood control infrastructure	-	-	-	-	V3	-	V2	V2
Parks and open space	V4	-	V3	V2	V3	-	V4	V3
Solid waste facilities and closed landfills	-	-	-	-	V3	-	-	V2
Water and wastewater infrastructure	-	-	-	V2	V4	-	V4	V3

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
BUILDINGS								
Commercial centers	-	-	-	V2	-	-	-	V2
Emergency and transitional housing	-	-	-	V3	-	-	-	V3
Public safety buildings	-	-	-	V1	-	-	-	V1
Government buildings	-	-	-	V2	-	-	-	V1
Homes and residential structures	-	-	-	V2	V4	-	V2	V3
Medical and care facilities	-	-	-	V3	V3	-	V3	V2
Community centers and libraries	-	-	-	V3	-	-	-	V2
Schools	-	-	-	V3	V3	-	V3	V2
IMPORTANT ECONOMIC ASSETS								
Major employers	V4	V3	V4	V4	V3	V4	-	V3
Industrial/manufacturing centers	-	-	V2	V3	V3	V3	-	V2
Local and small businesses	V3	V3	V2	V3	V3	V4	-	V3
Historic and cultural resources	-	-	-	V2	V3	V3	-	V3

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
Outdoor recreation	-	-	-	-	-	-	-	-
Agricultural land and agricultural activities	V4	V4	V4	V5	V3	V3	-	V3
Agricultural and commercial food processing centers	V4	V4	V4	V4	V3	V4	-	-
Livestock and grazing lands and animal husbandry	V4	V4	V4	V4	V3	V3	-	V3
ECOSYSTEMS AND NATURAL RESOURCES								
Aquatic habitat	V4	-	V4	V3	V3	-	V4	V2
Valley Foothill riparian habitat	V3	-	V3	V3	V3	-	V3	V2
Groundwater resources	V3	-	V3	-	V3	-	-	-
Surface water resources	V3	-	V4	V4	V3	-	V2	-
Wetlands and vernal pools	V4	-	V4	V4	V3	-	V3	-
Grassland	V3	-	V3	V2	V1	-	-	-

Table B-1: Hazard Scoring Matrix								
Populations and Assets	Agricultural Pests and Diseases	Air Quality	Drought	Extreme Heat and Warm Nights	Flooding	Human Health Hazards	Landslides	Severe Weather
KEY COMMUNITY SERVICES								
Emergency communication services	-	-	-	V3	V3	V3	-	V4
Emergency medical response	-	V3	V3	V3	V2	V4	-	V2
Energy delivery	-	V1	V3	V5	V3	-	V4	V4
Government administration & community services	-	V2	-	V1	V1	V3	-	V2
Public transit access	-	V3	-	V4	V4	V2	V2	V4
Solid waste management and removal	-	V3	-	V3	V3	V2	-	V3
Water and wastewater	-	-	V3	V3	V5	-	V4	V2
Freight and shipping	-	-	-	V3	V3	V3	V3	V3
Food-providing agencies and organizations	V3	-	-	-	V3	V3	-	-
Total High/Severe Vulnerability (V4 and V5)	8	12	9	25	21	13	9	13

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