SAFETY

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1 OVERVIEW

1.1 PURPOSE AND CONTENT

The Hazard Protection section of the Stockton Safety Element is one of the state-mandated general plan elements and must identify potential natural and human-created hazards that could affect Stockton's residents, businesses, and services. The purpose of the Safety Element is to establish a framework that anticipates these hazards and prepares the community to minimize exposure to these risks.

The Safety Element conveys the City's goals, policies, and actions to minimize the hazardous situations and protect and improve public health in and around Stockton. It identifies the natural and human-caused hazards that affect existing and future development, describes present and expected future conditions, and sets policies and standards for improved public safety. This includes efforts to minimize physical harm to the buildings and infrastructure in and around Stockton to reduce damage to local economic systems, community services, and ecosystems.

Some degree of risk is inevitable because the potential for many disasters cannot be eliminated completely, and the ability to predict such disasters is limited. However, the Safety Element aims to reduce this risk by:

- Developing a framework by which safety considerations are introduced into the land use planning process.
- Establishing a policy framework for periodic updates of the hazard mitigation plan.
- Facilitating the identification and mitigation of hazards for new development, and strengthening existing codes, project review, and permitting processes.
- Presenting policies directed at identifying and reducing hazards in existing developed areas.
- Strengthening preparedness planning and postdisaster reconstruction policies for earthquake, flood, dam inundation, wildland fire, and other relevant hazards.
- Identifying how natural and climate-related hazards are likely to increase in frequency and intensity in the future and providing policies to increase community resilience through preparedness and adaptation.

The Safety Element addresses the topic of public health and safety following state requirements in Section 65302(g) of the California Government Code. State law requires that the Safety Element contain background information and policies to address multiple natural hazards, analyze the vulnerabilities from climate change and contain policies to improve climate change resilience, and assess residential areas with evacuation constraints. The public safety issues in Stockton include public safety, seismic and geologic hazards, flood and inundation hazards, hazardous materials, drought, fire, and climate change hazards including ecosystem pests, extreme heat, and severe weather. The Safety Element identifies goals and policies for each of these hazards.

1.2 RELATIONSHIP TO OTHER DOCUMENTS

The Stockton Safety Element is one of several plans that address community public safety and related topics. These other plans include other General Plan elements, the 2022 San Joaquin County Emergency Operations Plan, and various local regulations. The Safety Element should be consistent with these other elements and plans to minimize conflicts between documents and ensure that the City has a unified strategy to address public safety issues. The Safety Element incorporates information, technical analyses, and policies from these other documents where appropriate to help support this consistency.

1.2.4 General Plan Elements

The City Council adopted the Envision Stockton 2040 General Plan in 2018. Its six chapters are:

- Introduction
- Planning Framework
- Land Use (containing the Land Use, Open Space, and Conservation Elements)
- Transportation (containing the Circulation and Land Use Elements)
- Safety (containing the Safety and Noise Elements)
- Community Health (containing the Land Use, Environmental Justice, Conservation, and Air Quality Elements)

The Safety Element provides policy direction and identifies safety improvements that complement the intent and policies of other General Plan elements. Crucial relationships exist between the Safety Element and the other General Plan elements. How land uses are determined in areas prone to natural hazards, what regulations limit development in these areas, and how hazards are mitigated for existing development, are among the issues that tie the elements together.

Environmental justice concerns discussed in the Community Health chapter may exacerbate residents' vulnerability to environmental hazards. The Open Space and Conservation Elements in the Land Use chapter are closely tied to the Safety Element. Floodplains, for example, are not only hazard areas, but often serve as sensitive habitat for threatened or endangered species or provide recreation or passive open space opportunities for residents and visitors. Therefore, flood and inundation policies balance the need to protect public health and safety with the need to protect habitat and open space. Community Health and Safety chapters policies, especially those concerning evacuation routes and critical facilities, must also be consistent with those of the Transportation chapter. This Safety Element is consistent with the other elements of the Stockton General Plan.

1.2.5 San Joaquin County Emergency Operations Plan

The EOP describes the planned response to extraordinary emergency situations associated with natural disasters, technological (human-caused) emergencies, and war emergency operations in or affecting San Joaquin County. The EOP establishes an emergency management structure that coordinates and supports on-scene responses, including maintenance of situational awareness, facilitation of effective communication between operations centers at various levels of government, continuity of government, and interaction with public information sources; establishes the overall operational concepts associated with the management of incidents, emergencies, crises, disasters, and catastrophes at the county and city levels; and provides a flexible platform for planning and response to all hazards, incidents, events, and emergencies believed to be important to the operational area. It is applicable to a wide variety of anticipated events, including floods, droughts, earthquakes, and public health issues.

1.3 COMMUNITY PROFILE

Founded in 1849 and incorporated in 1850, the City of Stockton is one of the oldest incorporated cities in California and the current seat of San Joaquin County. In 1922, Stockton city voters approved a city charter (municipal constitution) with a city council–manager form of government that is still being used today. With a population of approximately of 322,489, Stockton is one of the largest cities in the Central Valley. It is in Northern California, south of Sacramento and north of Modesto; surrounded by farmland; and along Interstate 5, State Route 99, and State Route 4. It is connected to San Francisco Bay by the San Joaquin River, and is, with Sacramento, one of the state's two inland seaports. The Stockton Municipal Airport, just south of the city limit, provides commercial passenger service to limited destinations, along with air cargo service and other operations.

Historically, Stockton's major economic endeavors have revolved around agriculture and shipping, including ship building. Stockton's unique position as an inland seaport adjacent to agricultural land continues to influence the local economy. Today, major economic drivers include the construction, manufacturing, and engineering industries; e-commerce and logistics; education services; food processing; and healthcare services. Major employers include the Stockton Unified School District, St. Joseph's Medical Center, Amazon, the City of Stockton, and San Joaquin County.

In and around Stockton are thousands of miles of waterways and rivers that make up the California Delta. Local climate is generally characterized by warm, dry summers and mild winters. The historical average high temperature is 74.2°F, and the historical average low is 47.3°F. The city receives an average of 14.5 inches of rain per year.[1]

Stockton's long history is marked by periods of systemic economic and racial discrimination. South Stockton was redlined by the Home Owners Loan Corporation in the 1930s, discouraging lenders from offering loans in the area. The Federal Housing Administration (FHA) and the Veteran's Administration used the HOLC maps for underwriting, meaning residents of redlined communities could not benefit from federal mortgage subsidies the way white homebuyers and businesses could. This policy reinforced segregation and led to disinvestment in redlined neighborhoods. Historical redlining has been shown to correlate closely with the present-day environmental quality and injustices in Stockton. Therefore, it is not surprising that historically redlined communities in Stockton also have higher social vulnerability than other neighborhoods in the city.[2]

1.3 CLIMATE CHANGE VULNERABILITY

Changes to the global climate system are expected to affect future occurrences of natural hazards in and around Stockton. Many hazards are projected to become more frequent and intense in coming years and decades, and in some cases, these changes have already begun. Key effects of climate change that affect Stockton include increasing temperatures, changes in precipitation, and sea level rise. Overall, precipitation levels are expected to increase slightly; however, there are likely to be more years of extreme precipitation events and droughts that last longer and are more severe.

Both droughts and floods are expected to become more frequent and intense. Although Stockton is likely to experience only a slight increase in overall annual precipitation levels from climate change, rainfall is expected to fall in fewer, extreme precipitation events.

Drought conditions will likely strain the water supplies obtained from the Stockton East Water District, causing the water shortage contingency plan and demand-reduction actions to go into effect more frequently. Droughts also cause soil to dry out and condense, meaning that when precipitation does return, water will be more likely to run off the surface rather than being absorbed into the ground, which can lead to floods.

High intensity and potentially catastrophic flooding is expected to occur more frequently in Stockton as a result of heavy rain events, which may overwhelm stormwater systems, flood the San Joaquin and Calaveras Rivers, and contribute to levee failure. Sea level rise will further exacerbate the risk of levee failure and flooding.

Sea level rise is a gradual process, taking place over years or decades. Because Stockton is not immediately on the coast, it is not affected by sea level rise as directly as a coastal community might be, and there is uncertainty regarding which parts of the city will be most affected by sea level rise. However, sea level rise will cause water levels in the San Joaquin River Delta to rise, increasing the risk of flooding and threatening the integrity of the region's levees. Saltwater intrusion due to sea level rise can also harm local ecosystems and agricultural production and increase the salinity levels of local groundwater supplies.

What is vulnerability?

Vulnerability is the degree to which natural, built, and human systems are susceptible to harm from exposure to stresses associated with environmental and social change and from the absence of a capacity to adapt.

Source: California Governor's Office of Emergency Services. 20202. California Adaptation Planning Guide. https://www.caloes.ca.gov/climate.

Severe weather events, such as lightning, hail, heavy rainfall, and high winds, may become more frequent and intense due to climate change. Climate change is expected to cause an increase in intense rainfall, which is usually associated with strong storm systems. Heavy rainfall may also contribute to an increased risk of inland flooding. Though landslide risk in Stockton is generally low, severe weather could exacerbate this risk.

Warmer temperatures are projected to cause an increase in extreme heat events. The number of extreme heat days—defined in Stockton as a day when the high temperature is at least 102.3°F—is expected to rise from a historical annual average of 4 days per year to 23 days per year by the middle of the century (2035 to 2064), and to an average of 44 days per year by the end of the century (2070 to 2099). In addition, Stockton is expected to see an increase in the number of warm nights—defined in Stockton as a night when the minimum temperatures stay above 66°F—from a historical annual average of 4 nights per year to 27 nights per year by the middle of the century (2035 to 2064), and to an average of 66 nights per year by the end of the century (2070 to 2099). Extreme heat and warm nights pose a significant human health risk, especially to senior citizens, outdoor workers, and persons who do not have access to adequate cooling, including people experiencing homelessness. Some buildings and infrastructure systems may be damaged by very high temperatures, constraining their ability to meet community needs.

Hotter, drier weather because of climate change is expected to lead to an increase in wildfires across Northern California. Wildfire risk in Stockton is generally low. However, air quality in the city could be negatively impacted by smoke from wildfires burning in other parts of the state.

Climate change can increase the rates of infection and pest infestation for plants and animals because many of the pests that spread diseases are more active during warmer weather. There are a number of diseases that are linked to climate change and can be harmful to the health of Stockton community members, such as hantavirus pulmonary syndrome, Lyme disease, West Nile fever, and Valley Fever. Many of these diseases are carried by mice and rats, ticks, mosquitos, and other pests. Weeds, insects, and diseases such as bark beetles and Sudden Oak Death can impact local agricultural operations and ecosystems. Warmer temperatures earlier in the spring and later in the winter can cause these animals to be active for longer periods, increasing the time that diseases can be transmitted.

1.4.4 Vulnerability Assessment Results

Under California law, the Safety Element is required to include a vulnerability assessment that looks at how people, buildings, infrastructure, and other key community assets may be affected by climate change. The City conducted a Climate Change Vulnerability Assessment in the winter of 2023 to analyze Stockton's susceptibility to climate-related hazards. Stockton's vulnerability assessment, prepared in accordance with the most recent available guidance in the *California Adaptation Planning Guide*, assesses how nine climate-related hazards (agricultural and ecosystem pests, drought, extreme heat and warm nights, human health hazards, inland flooding, landslides, sea level rise, severe weather, and wildfire and smoke) may affect 62 different population groups and community assets.

Each population or asset received a score of V1 (minimal vulnerability) to V5 (severe vulnerability) for each climate-related hazard. The Climate Change Vulnerability Assessment indicates that Stockton's populations and assets are most vulnerable to inland flooding and sea level rise, followed by extreme heat, severe weather, wildfire and smoke, and human health hazards. The most vulnerable communities include low-resourced people of color, outdoor workers, and individuals experiencing homelessness, all of whom are highly vulnerable to extreme heat, human health hazards, inland flooding, sea level rise, severe weather, and poor air quality due to wildfire. Additional highly vulnerable populations include households in poverty; immigrant communities; persons with chronic illnesses or disabilities; people without access to lifelines such as private vehicles, internet, and phone service; seniors; seniors living alone; and unemployed persons.

Citywide, energy delivery is vulnerable to multiple hazards, including severe weather and flooding that can damage or down power lines or flood or undermine substations. It is also vulnerable extreme heat, which reduces the transmission capacity and strains the system, ultimately disrupting energy service. Extreme heat can also lead to power outages by causing mechanical failure of grid equipment, heat damage to power lines, and creating a high demand for electricity to power air conditioners, all of which place stress on the network and lead to rolling blackouts.

Public safety power shutoff (PSPS) events or interruptions in energy service due to extreme heat can create vulnerabilities for Stockton community members. A loss of electricity can cause a loss of refrigeration for food and medical supplies; limit cooking; and cause loss of cooling (particularly dangerous during extreme heat events), lighting, and limited or no access to the Internet or other information systems. Many businesses are forced to close during a power outage, causing economic hardships and depriving community members of important services, such as grocery stores, gas stations, and banks/ATMs. Power outages may also be harmful to people who depend on electrically powered medical devices.

The combined effects of flooding and sea level rise could cause significant damage and disruption to the majority of the city's infrastructural systems, structures, economic drivers, and community services. Transportation infrastructure, including bridges, roads, and railways, are all vulnerable to flood damage. SR-4 from Stockton west to Contra Costa County plays an important role in economic development, daily commutes, shipping for agricultural products and other goods, and evacuation from the San Joaquin Delta in the event of flooding. This route runs through the 100-year floodplain and crosses areas that are projected to be flooded under one foot of sea level rise (plus storm) scenarios. It is important to reduce flood risk along this roadway because it serves a rural area with few alternative routes.[3] Impacts to the transit system are a major concern for the South Stockton neighborhood, which has a disproportionately high percentage of transportation-disadvantaged communities.* Several bus stops in downtown Stockton are within the 100-year floodplain, and the vast majority of bus stops surrounding transit-dependent census tracts in the Hammer Triangle area and the Harrell Park area are within the 500-year floodplain.[4]

Rail lines can be damaged by intermittent flooding. High water levels, particularly fast-moving flows, can damage railroad bridges and rail lines. These impacts cause increased wear and tear on infrastructure, increasing maintenance costs and disruptions during construction and repair activities.[5] When flood water rises above the rails, trains must reduce their speed to prevent damage to the train, slowing the movement of goods and people. The Union Pacific Railroad Stockton Railyard is immediately surrounded by a 500-year floodplain. The BNSF Intermodal Railyard is in the 100-year floodplain. Flooding of these areas could cause widespread economic impacts and subject nearby communities to health risks associated with exposure to hazardous materials.[6]

Ports, including the Port of Stockton, are particularly vulnerable to flooding because they depend on the waterfront and have limited ability to relocate. While the Port generally has 100-year flood protection, some of its access roads do not. Most terminals of the Port of Stockton are projected to be exposed to flooding by midcentury, and the entire port is projected to be exposed by end of century.[7] Flooding at the Port of Stockton could interrupt the Port's operations, with potentially significant regional economic impacts.

Much of the Delta's energy industry may be exposed to flooding in the future, with the greatest number of exposed assets in San Joaquin County. Energy infrastructure has a high sensitivity to flooding. Associated facilities are typically complex, with many electrical and mechanical components that are susceptible to flood damage. Energy facilities also rely on a network of at- or below-grade pipelines and transmission lines to distribute natural gas and power throughout the region. Large floods may cause scouring or removal of sediment around pipelines, creating support issues or damage. Submergence of pipes can also cause them to float or become displaced due to buoyancy effects. Depending on the materials, exposure to saltwater flooding may corrode transmission pipes, requiring replacement before the end of the project's design life and or impediments to access for maintenance and inspections.[8]

The City's water and wastewater treatment infrastructure are also vulnerable to flooding and sea level rise. Water pipes, wells, and water intake and treatment infrastructure systems could be inundated by flood waters and sea level rise. Wastewater treatment plants (WWTP) contain numerous treatment basins that may be overwhelmed during a flood, resulting in sewage overflows. Damage to WWTPs could cause backup and overflows of untreated sewage into adjacent neighborhoods and waterways, which could cause serious public health and environmental impacts.[9] Long-term sea level rise can exacerbate wet weather flows into WWTPs.

Sea level rise is expected to place stress on the operation of the State Water Project and Central Valley Project and the ability of these projects to continue to meet water quality requirements in the Delta. Salinity intrusion into the Delta and San Joaquin Valley Groundwater Basin is exacerbated by both sea level rise and drought.[10] Water treatment plants can be corroded and damaged by salt water, preventing the plants from functioning as needed.

Sea level rise and changes in hydrological patterns in Delta watersheds will place greater stress on the Delta's flood management infrastructure, such as Delta levees and upstream reservoirs. Most of the Delta's flood management infrastructure are designed to operate under historical sea level and hydrologic conditions that do not consider potential future climate change. Changing

* The U.S. Department of Transportation identifies transportation-disadvantaged communities as places where residents spend more and take longer to get where they need to go. Indicators considered when determining a community's degree of transportation disadvantage include the percentage of the population that does not have access to a vehicle, commute length, walkability, and transportation costs as a percentage of household income.

climate conditions will place greater stress on the flood management system in the future.[11] Levees may be overtopped or damaged by rising sea levels, reducing their flood protection benefits. Damage to Stockton's key infrastructure systems could have significant impacts on the economy, provision of basic services, and public health and safety. Floodwaters and sea level rise can also damage homes, schools, medical buildings, and businesses.

Though Stockton is most vulnerable to extreme heat, flooding, and sea level rise, other hazards may also damage buildings and infrastructure, interrupt community services and economic activity, threaten public health and well-being, and harm ecosystems. These include increases in agricultural and ecosystem pests, drought, human health hazards, landslides (in limited areas), severe weather, and wildfire and smoke events. Agricultural and ecosystem pests may make plant communities more vulnerable to the effects of other climate stressors such as drought and may impact the operations of the local food processing industry. Drought may harm local ecosystems and the communities and industries that depend on them, as well as facilitate saltwater intrusion and declines in local water quality. Overall landslide risk in the city is low, but landslides may damage buildings and roads in select areas (see Figure 3). Stockton is most likely to experience the effects of wildfire through increased exposure to wildfire smoke, which poses a threat to public health. Outdoor workers, those with chronic health conditions, those experiencing homelessness, and those lacking access to adequate air filtration systems are most vulnerable to the impacts of wildfire smoke.

The Safety Element includes goals, policies, and implementation actions to increase community resilience and help lower vulnerability scores, particularly for the populations and assets that received a score of V4 or V5 in the Vulnerability Assessment. A full list of the Vulnerability Assessment results is in Appendix A.

2 PUBLIC SAFETY ISSUES

This section outlines the existing and likely future hazardous conditions and other public safety issues in Stockton and the policy responses to these issues. The public safety issues include:

- Public safety
- Seismic and geologic hazards
- Flood and inundation hazards
- Hazardous materials
- Drought
- Fire Hazards
- Agricultural and ecosystem pests
- Extreme heat
- Severe weather

This section provides details about the locations each hazard or issue is likely, past notable events in and around Stockton, agencies responsible for providing protection from these public safety issues, and other background information required by the State of California Government Code Section 65302(g)(4).

The results of the Vulnerability Assessment are integrated into the hazards and other public safety issues previously mentioned.

2.1 PUBLIC SAFETY

2.1.4 Public Safety Services

The Stockton Police Department (SPD) and Fire Department (SFD) provide essential services to keep the community safe.

2.1.4.1 Stockton Police Department

Stockton has one police station within the city limits, with two additional stations in the city's sphere of influence, and provides 1.5 sworn officers per 1,000 residents.

The SPD provides service to a 65-square-mile area and is organized into two bureaus: the Operations Bureau, which includes the Field Operations, Special Operations, Investigations Divisions; and the Logistics Bureau, which includes the Technical Services and Administrative Services Divisions. These divisions provide patrol, investigation, law enforcement, apprehension, and community programs in Stockton. Other special programs in the SPD include Special Weapons and Tactics Team (SWAT), Crisis Negotiations Team, Community Response Teams (CRT), Explosive Ordnance Disposal (EOD) Team, Mobile Field

Force, and Canine Unit. The animal service section is included as part of the Administrative Services Division, which provides contracted shelter services to San Joaquin County.

The SPD maintains an average response time of five minutes or less for priority one calls (where a threat to persons may exist).

2.1.4.2 Stockton Fire Department

Stockton contains 13 fire stations throughout the city, with 1.23 sworn firefighters per 1,000 residents. The SFD mission is centered on providing emergency and nonemergency services through public education, prevention, and suppression and rescue activities. Fire prevention and response services include fire suppression, code enforcement, fire safety education, fire investigation, and special services such as plan checking and fire code operation permits. The SFD is an all-hazard fire department, capable of mitigating all types of both human-made and natural disasters. As such, the SFD contains the following specialized teams:

- Hazardous Materials Team: A California Office of Emergency Services Type II Hazardous Materials Team staffed with seven personnel daily, trained to the Hazardous Materials Technician and Specialist level.
- Water Rescue Team: Staffed by a team of four personnel daily, the water rescue team is capable of both surface and subsurface water rescues, helping to protect over 1,000 miles of waterways surrounding the city. The team has specialty apparatus including personal watercraft, inflatable boats, and a water rescue vehicle.
- Urban Search and Rescue (USAR) Team: Staffed by a team of seven personnel daily, the USAR Team is trained in rope rescue, confined space rescue, trench rescue, and building collapse. The team utilizes specialty apparatus including a Type I heavy rescue and a California Office of Emergency Services rescue trailer.

The SFD maintains mutual aid agreements with the Lincoln, Tuxedo-Country Club, Boggs Tract, and Eastside Fire Districts and formal reciprocal agreements with the Woodbridge Fire Protection District, City of Lodi Fire Department, and Cosumnes Fire Department in Elk Grove. The City and San Joaquin County coordinate response in emergency situations.

The SFD also supports the Community Emergency Response Team (CERT), which provides training to residents and members of the business community to increase disaster awareness and emergency response capacity.

The first arriving engine company typically arrives at the incident scene within 240 seconds. For low-rise structures, deployment of an initial full alarm assignment occurs within 480 seconds. For high-rise structures, deployment of an initial full alarm assignment occurs within 610 seconds.

2.1.5 Funding for Public Safety

Measure W was approved by voters November 2, 2004. It was originally adopted by Ordinance 038-04 C.S. and is codified in Section 3.52 of the Stockton Municipal Code, Funding for Police and Fire Protection. The ordinance provides for a ¼-cent transaction and use tax, a tax dedicated to providing for police and fire personnel and services. The ordinance calls for Program Guidelines, which were developed and adopted by the City Council on August 4, 2004. The Program Guidelines prescribe two methods of ensuring that tax monies are used as specified by the ordinance—an independent audit and a citizen's committee. Measure W provides funding for 23 suppression positions in the SFD.

2.1.6 Emergency Response

The City maintains an EOP that addresses the City's planned response to natural disasters and public health emergencies. The plan is intended to facilitate multi-agency and multi-jurisdictional coordination, particularly between the City of Stockton and its jurisdictions, including special districts, utilities, major businesses, and other government agencies.

The Stockton Municipal Code, Chapter 2.82, Emergency Organization and Functions, establishes that the City Manager is delegated to act as the Director of Emergency Services. In this role, the City Manager is authorized to manage the emergency events of the city, as well as to develop, modify, and take other actions as may be necessary to maintain and implement the City's emergency response.

When emergency conditions exceed or have the potential to exceed local resources and capabilities, the City may request, through the County, that the governor proclaim a state of emergency.

2.1.7 Community Warning Systems

San Joaquin County has partnered with Everbridge, a public warning platform, to implement SJREADY, a community notification system to alert residents about emergency events and other important public safety information. This system allows San Joaquin County to provide residents with critical information quickly in a variety of situations, such as severe weather, unexpected road closures, and evacuations of neighborhoods and buildings.

Other emergency alert systems include notifications through broadcasters, cable television systems, and digital audio services, among others. These systems may be used by state and local authorities in cooperation with the broadcast community to deliver important emergency information, such as weather information, imminent threats, AMBER alerts, and local incident information targeted to specific areas. San Joaquin Office of Emergency Services has historically used this system to provide real-time information to citizens about evacuations, flood dangers, and other emergencies in our county.

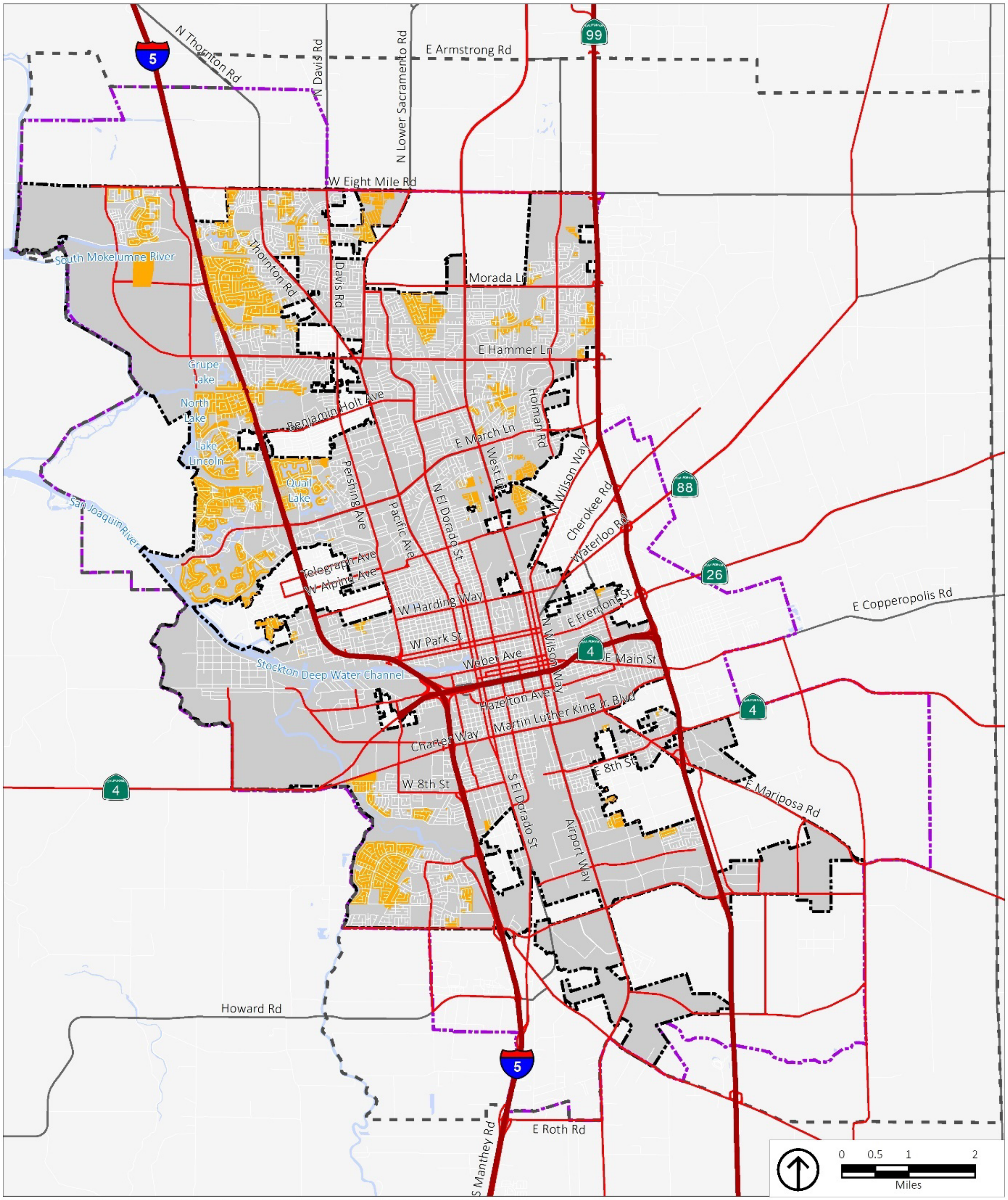
2.1.3 Emergency Evacuation

With advanced warning, evacuation can be effective in reducing injury and loss of life during a catastrophic event. The San Joaquin County Office of Emergency Services has prepared an evacuation plan for response to flooding due to failure of a levee or dike. The evacuation plan includes routes for people evacuating by car; rally points for people needing assistance evacuating; and instructions for evacuation and safety during a flood.

Figure 1 shows major evacuation routes in Stockton. The city has numerous roadways that may be called upon for evacuation in the event of an emergency. Major evacuation routes include SR-4, SR-26, SR-88, I-5, Airport Way, S El Dorado Street, W 8th Avenue, E Mariposa Road, Charter Way, Martin Luther King Jr Blvd, Hazelton Ave, E Main St, Weber Ave, W Park St, E Fremont St, Waterloo Blvd, W Harding Way, Cherokee Rd, N El Dorado St, Pacific Ave, Telegraph Ave, W Alpine Ave, Pershing Ave, Pacific Ave, N El Dorado St, E March Ln, N Wilson Way, Holman Rd, E Hammer Ln, Morada Ln, Davis Rd, Thornton Rd, and W Eight Mile Rd. If there is a need for an evacuation, emergency responders will direct community members to the suitable evacuation routes given the specific needs and characteristics of the emergency.

Figure 1 also shows residential parcels with evacuation constraints, as required by Senate Bill 99, meaning that they are at least a half mile from a major roadway and may have access to only one emergency evacuation route. The lack of multiple emergency access points limits roadway access for these properties, which may create difficulties if there is a need to evacuate. Clusters of evacuation-constrained parcels are located throughout the city. Large clusters occur along the western edge of the city, especially in areas west of I-5 and north of Hammer Ln.

Figure 1 Evacuation Routes and Residential Parcels with Evacuation Constraints



Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019

- General Plan Planning Area
- City Limit
- Sphere of Influence
- Residential Parcel with Potential Evacuation Constraints
- Possible Evacuation Route - Freeway
- Possible Evacuation Route - Surface Street

2.1.4 Evacuation Constraints Analysis

As a part of the work to prepare the Safety Element, the City has identified the level of evacuation constraints in different parts of Stockton under four different emergency scenarios:

- A major flood, inundating both the 100-year and 500-year flood plains and resulting in city-wide levee failures.
- Areas at risk of inundation from sea level rise by 2050.
- Areas at risk of inundation from sea level rise by 2085.
- Areas in the inundation zone of one or more dams.

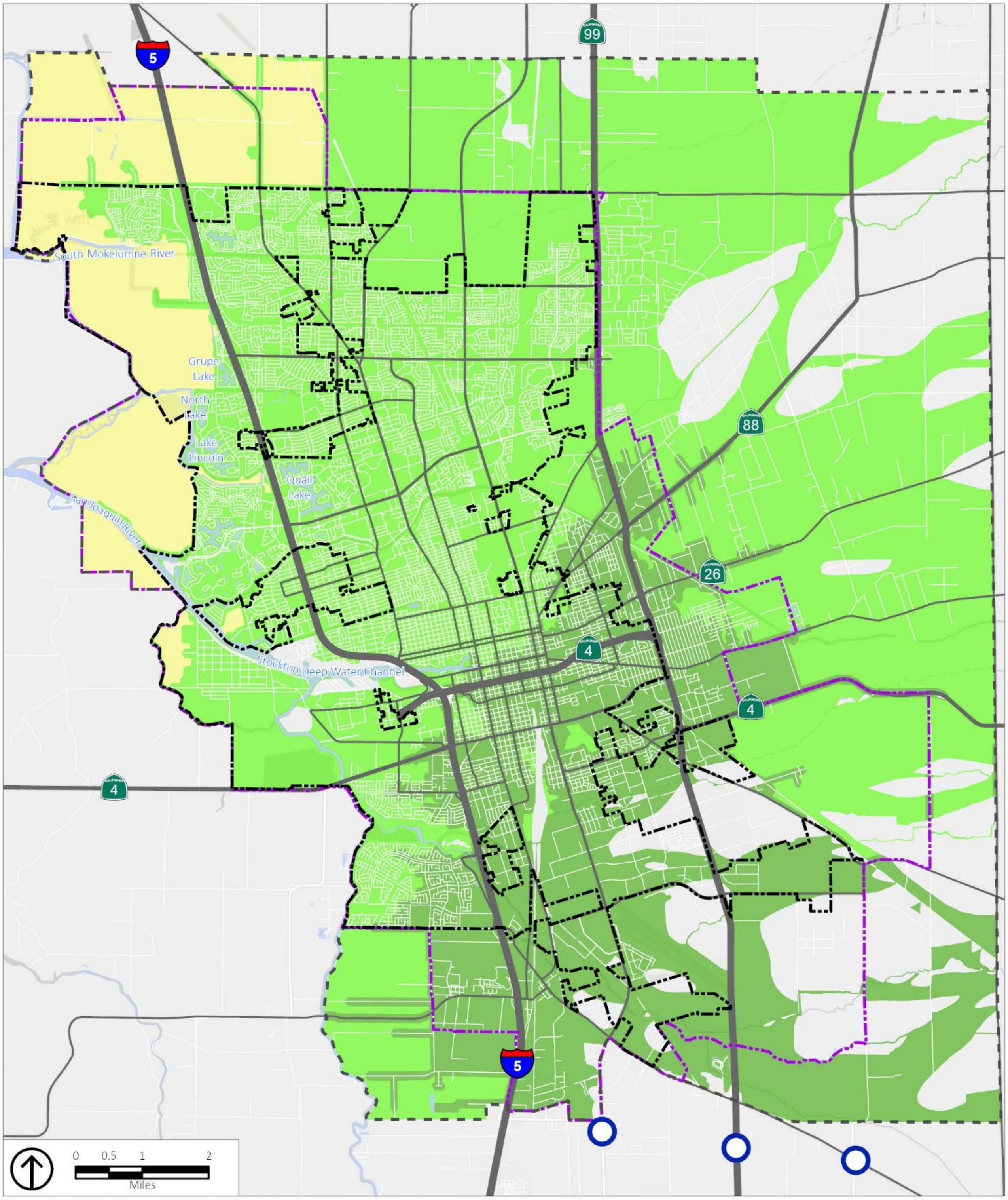
The City has modeled potential evacuation times under these four scenarios. There are two sets of modeling results for each of the four scenarios. The first set assumes that all evacuees will be able to travel at the maximum speed limit along local roads and highways. The second set assumes that all evacuees will be limited to a top speed of 5 miles per hour due to roadway constraints. Evacuees may be able to travel at the maximum speed limit in some instances, especially in the case of smaller evacuations or those that have enough advance warning to adequately phase the evacuations. In a mass, sudden evacuation, lower speeds are more likely.

This modeling uses a geographic information system (GIS) software to model travel times between residential areas in the affected hazard zones and points called "evacuation gateways". These are access points out of Stockton, both highways and surface streets, that would not be blocked by the hazard event (including being blocked outside of Stockton's borders, before evacuees could reach another community). These gateways are not ultimate destinations to which evacuees are traveling, but are points along roadways where they can safely consider themselves evacuated from Stockton once they have reached this point. The more widespread the hazard, the more potential evacuation gateways are blocked, forcing evacuees to use a smaller number of gateways, creating additional constraints. This modeling assumes a single car per evacuating residential property. The modeling also assumes some additional residential development in areas that are currently used for agriculture or open space, and includes modeling of unincorporated areas within the Stockton's sphere of influence.

Figures 2 through 9 show the results of the four scenarios under the two different speed results. Even under the smaller evacuation scenarios, all viable evacuation gateways are in northeast, east, and southeast Stockton. Under the more widespread evacuation scenarios, evacuation gateways are further limited to east or southeast Stockton. If evacuees can travel at the maximum legal speed, almost all of Stockton can be safely evacuated in approximately 30 minutes or less, although some areas in east Stockton may take longer. If evacuees can only travel at 5 miles per hour, evacuation times become significantly longer. Most of the evacuating areas would need an hour or more to reach an evacuation gateway, with some locations taking longer than three hours.

Many groups are likely to face higher levels of evacuation constraints, especially as flooding and other emergency events increase in frequency and severity. Disabled persons and those with access and functional needs, persons without access to a reliable personal vehicle, and similar groups are often most at risk. These persons may not be able to evacuate on their own and would require assistance from the City or other government agencies, community groups, or others (such as neighbors, family, or friends) to safely leave their homes. Stockton residents who have limited English proficiency or lack access to reliable communications face evacuation constraints because they may not receive accurate or timely evacuation notices. Independent of other factors, residents in west Stockton generally face a greater level of constraints because they are typically located further from safe ways out of the community.

Figure 2 Evacuation Constraints Modeling – Major Flood Event (Max Legal Speed)

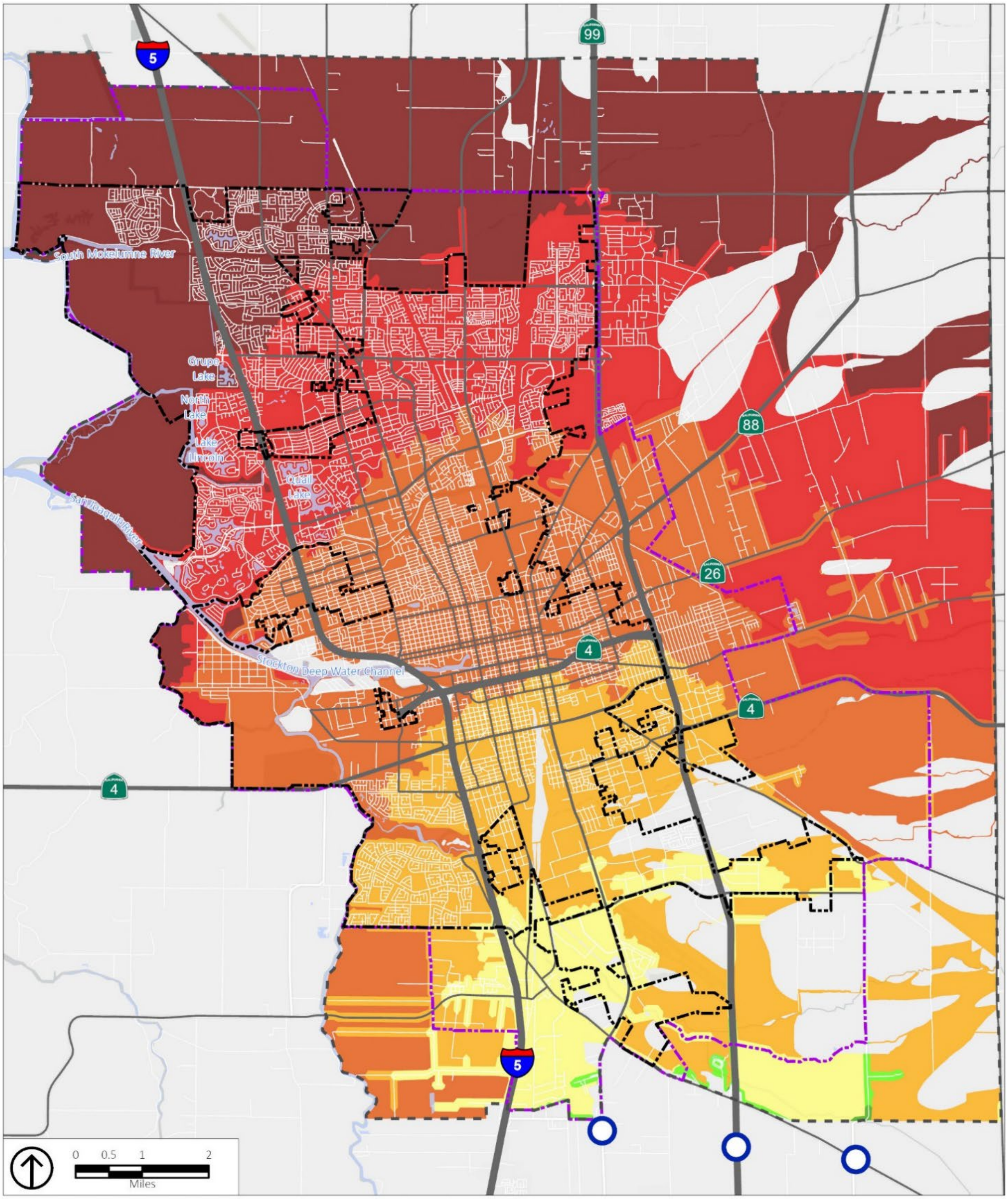


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, FEMA 2020, BAM 2022

City Limit
General Plan Planning Area
Sphere of Influence
Potential Evacuation Gateway

Baseline Drive Times to Nearest Evacuation Gateway - max allowed speeds
0 - 12 Minutes
12 - 24 Minutes
24 Miutes - 1 Hour

Figure 3 Evacuation Constraints Modeling – Major Flood Event (5 mph)

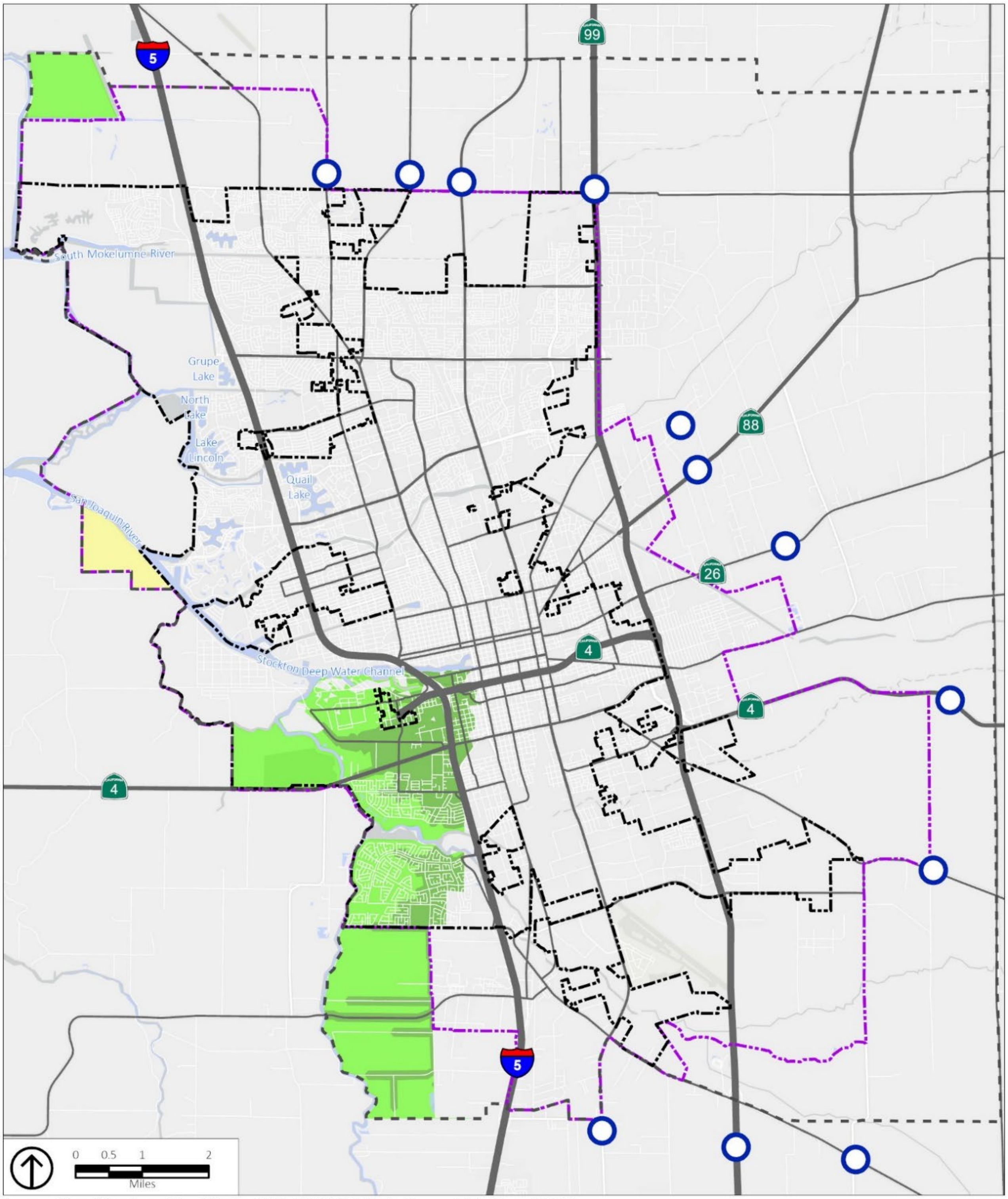


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, FEMA 2020, BAM 2022

City Limit
General Plan Planning Area
Sphere of Influence
Potential Evacuation Gateway

Drive Time assuming 5 MPH speed on all roadways
6-12 Minutes
12 - 24 Minutes
24 Minutes - 1 Hour
1 Hour - 1:36
1:36 - 2:24
2:24 - 3:00
More than 3 Hours

Figure 4 Evacuation Constraints Modeling – 2050 Sea Level Rise (Max Legal Speed)

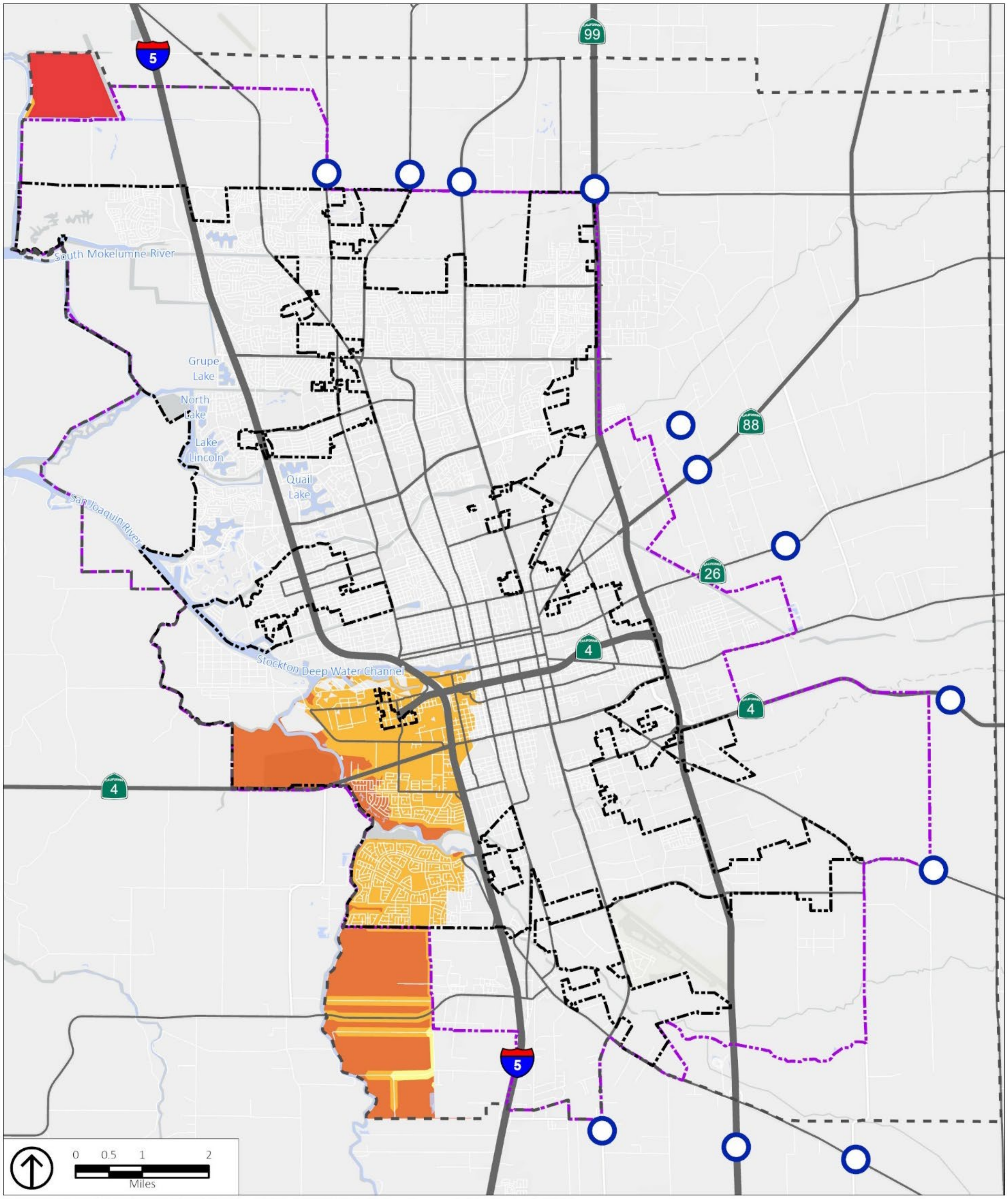


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

General Plan Planning Area
City Limit
Sphere of Influence
Potential Evacuation Gateway

Baseline Drive Times to Nearest Evacuation Gateway - max allowed speeds
0 - 12 Minutes
12 - 24 Minutes
24 Miutes - 1 Hour

Figure 5 Evacuation Constraints Modeling – 2050 Sea Level Rise (5 mph)

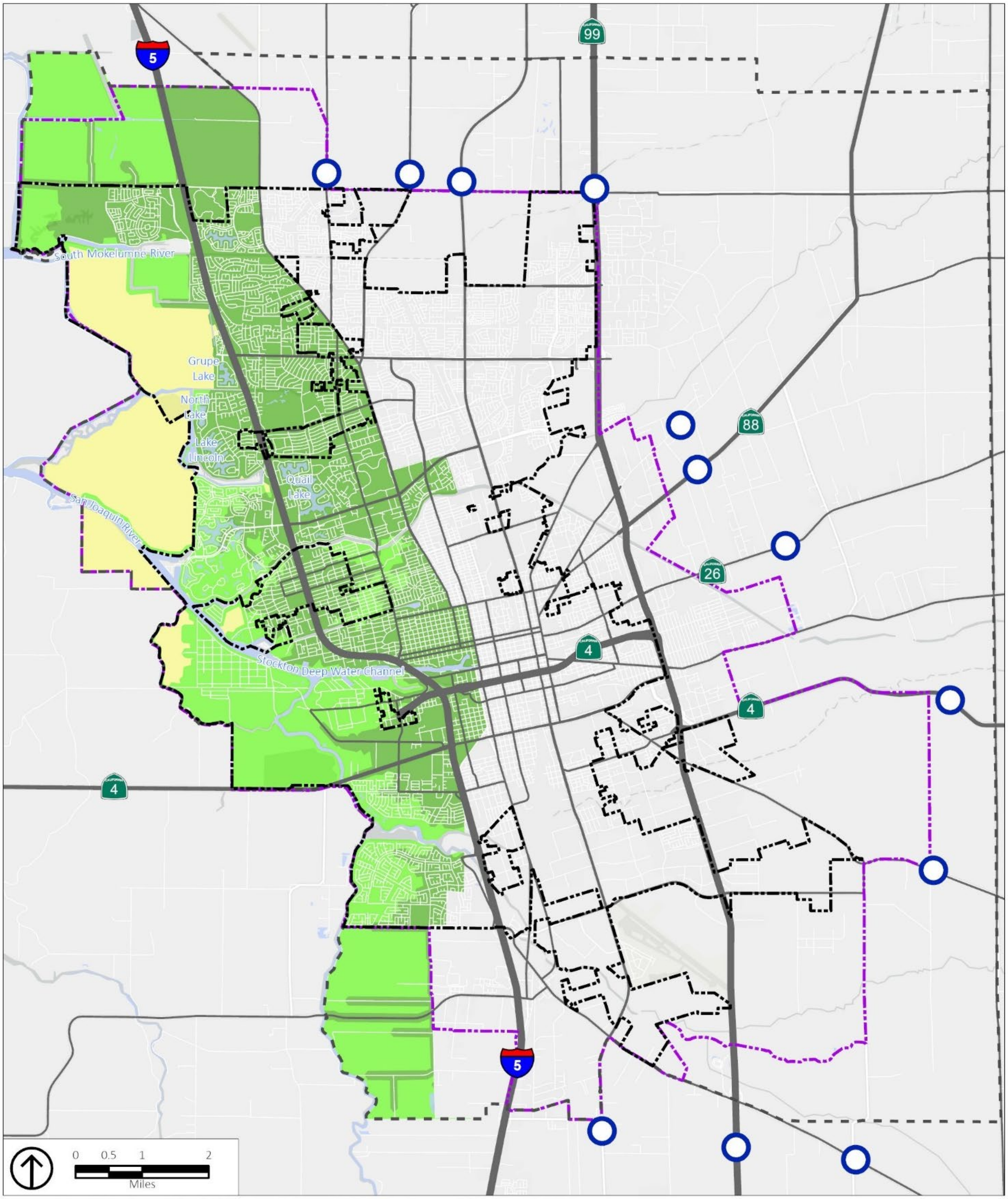


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

General Plan Planning Area
City Limit
Sphere of Influence
Potential Evacuation Gateway

Drive Time assuming 5 MPH speed on all roadways
12 - 24 Minutes
24 Minutes - 1 Hour
1 Hour - 1:36
1:36 - 2:24
2:24 - 3:00
More than 3 Hours

Figure 6 Evacuation Constraints Modeling – 2085 Sea Level Rise (Max Legal Speed)

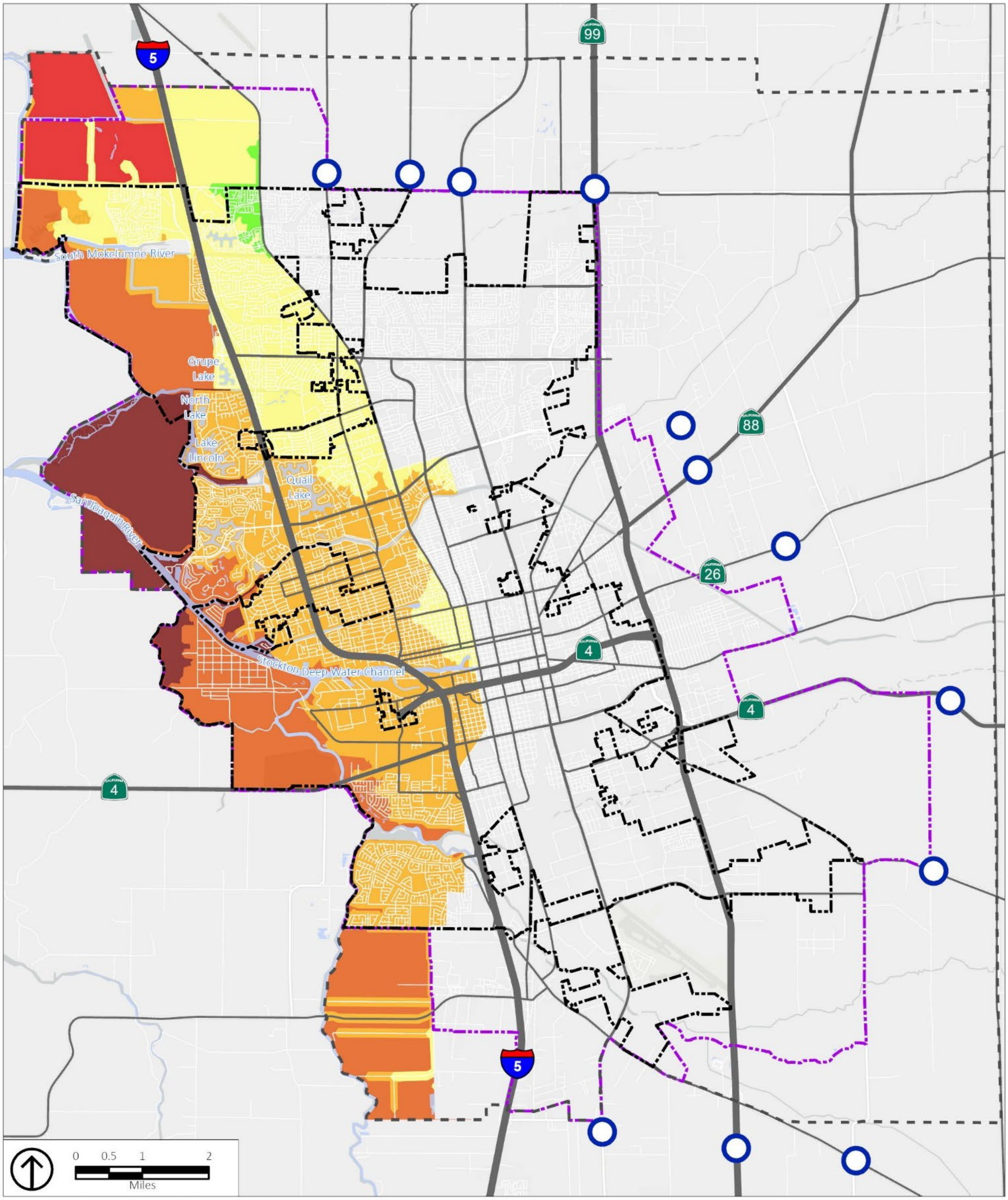


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

General Plan Planning Area
Sphere of Influence
Potential Evacuation Gateway

Baseline Drive Times to Nearest Evacuation Gateway - max allowed speeds
0 - 12 Minutes
12 - 24 Minutes
24 Miutes - 1 Hour

Figure 7 Evacuation Constraints Modeling – 2085 Sea Level Rise (5 mph)

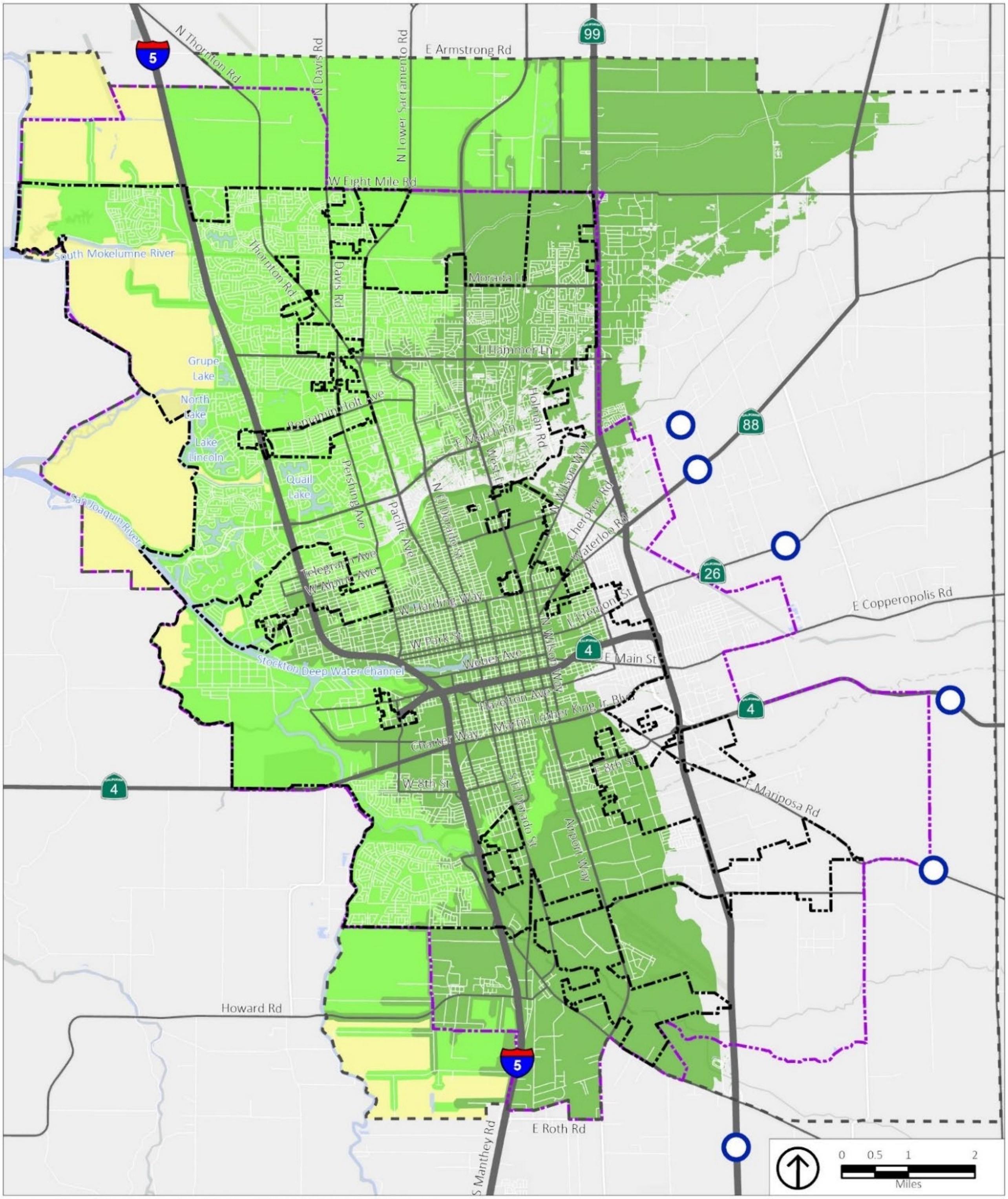


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

City Limit
General Plan Planning Area
Sphere of Influence
Potential Evacuation Gateway

Drive Time assuming 5 MPH speed on all roadways
12 - 24 Minutes
24 Minutes - 1 Hour
1 Hour - 1:36
1:36 - 2:24
2:24 - 3:00
More than 3 Hours

Figure 8 Evacuation Constraints Modeling – Dam Inundation (Max Legal Speed)

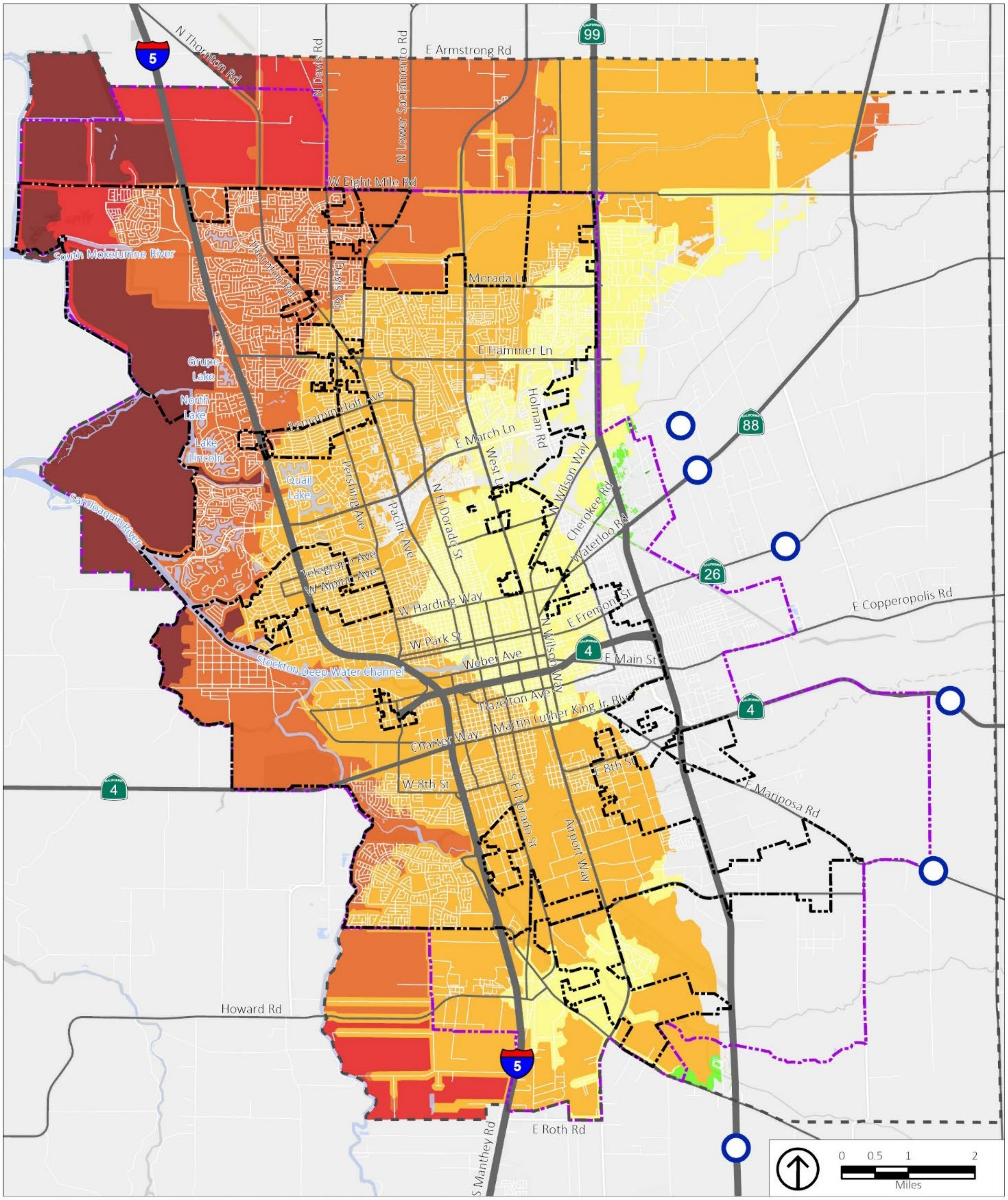


Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, DWR 2023

General Plan Planning Area
City Limit
Sphere of Influence
Potential Evacuation Gateway

Baseline Drive Times to Nearest Evacuation Gateway - max allowed speeds
0 - 12 Minutes
12 - 24 Minutes
24 Miutes - 1 Hour

Figure 9 Evacuation Constraints Modeling – Dam Inundation (5 mph)



Source: City of Stockton; PlaceWorks, 2023; ESRI 2019, DWR 2023

General Plan Planning Area
City Limit
Sphere of Influence
Potential Evacuation Gateway

Drive Time assuming 5 MPH speed on all roadways
- 6-12 Minutes
- 12 - 24 Minutes
- 24 Minutes - 1 Hour
- 1 Hour - 1:36
- 1:36 - 2:24
- 2:24 - 3:00
- More than 3 Hours

There are several steps Stockton can take to prepare for evacuations and improve their effectiveness:

- Develop plans to safety evacuate Stockton residents who do not have reliable access to a private vehicle or would otherwise need assistance evacuating. This can include using transit vehicles, school buses, and other van and bus fleets to provide evacuation support.
- Look at establishing shelter-in-place locations throughout Stockton, especially in areas with high levels of evacuation constraints, that are adequately protected against flooding and other hazards. For people who are unable to safely evacuate the city, these locations can provide a safe point of refuge. They should be combined with resilience centers whenever possible.
- If an evacuation is necessary, provide as much advanced warning as possible. As the situation allows, provide phased evacuation notices so that those who need the most time to evacuate are alerted first.
- In areas with low levels of English proficiency or access to communication systems, conduct in-person evacuation noticing. Be sure to provide information in multiple languages.
- Work with the San Joaquin County Council of Governments and other relevant agencies to elevate or otherwise protect evacuation routes and gateways, increasing the number of safe paths out of Stockton.

The policies included in the Safety Element address these issues.

2.2 SEISMIC AND GEOLOGIC HAZARDS

Seismic and geologic hazards are risks caused by the movement of the Earth's surface, or crust. Seismic hazards are earthquakes and related hazards. Geologic hazards are other hazards involving land movements that are not linked to seismic activity.

2.2.4 Seismic Hazards

Seismic activity occurs along boundaries in the Earth's crust called faults. Pressure along the faults builds over time and is ultimately released, resulting in ground shaking that we refer to as an earthquake. Earthquakes can also trigger other hazards, including surface rupture (cracks in the ground surface), liquefaction (causing loose soil to lose its strength), landslides, and subsidence (sinking of the ground surface). Earthquakes and other seismic hazards often damage or destroy property and public infrastructure, including utility lines, and falling objects or structures pose a risk of injury or death.

Earthquakes

An earthquake has the potential to cause significant damage to life and property.

The Working Group on California Earthquake Probabilities—a collaborative effort involving the US Geological Survey, the California Geological Survey, and the Southern California Earthquake Center—estimates that the 30-year probability of a magnitude 6.7 or greater earthquake striking the nearby San Francisco Bay area is 63 percent. The Hayward Fault, a major earthquake fault in the San Francisco Bay region, lies roughly 40 miles west-southwest of Stockton. Recent seismological research concluded that the average earthquake recurrence interval on this fault is approximately 138 years, and the forecast probability of an earthquake of magnitude 6.7 or greater by 2036 is greater than 31 percent.

The Greenville Fault lies much closer to the city (i.e., estimated 22 miles), although its forecast activity is far less than the Hayward Fault. The maximum probable earthquake is estimated to be magnitude 6.0, and the probability of an earthquake of magnitude 6.7 or greater along this fault by 2036 is 3 percent.[12] Figure 10 shows the location of faults around Stockton.

An earthquake of moderate to high magnitude generated in the nearby San Francisco Bay area could cause significant ground shaking in the Stockton area. This ground shaking could cause damage to structures and foundations not designed to resist those forces. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate seismic ground motion. If an earthquake of this magnitude were to occur, most parts of Stockton could experience potential casualties and damage from collapsed buildings, damaged roads and bridges, fires, flooding, and other threats to life and property. Modeling from the US Geological Survey suggests that the shaking in Stockton would be considered "moderate" to "very strong" in the event of a major Bay area earthquake.

Comparatively few subsurface faults have been mapped in the northern part of the San Joaquin Valley, and the largest of these is the Stockton Fault, which runs east-west across the city's planning area. The fault is not exposed at the surface and is not recently active, with most of the known activity during the Oligocene and early Miocene epochs (i.e., approx. 10 to 30 million years before present). Furthermore, the Stockton Fault has not been classified as an "active" fault by the California Geological Survey.

In the event of an earthquake, the location of the epicenter, as well as the time of day and season of the year, would have a profound effect on the number of deaths and casualties and the extent of property damage. There are several small-scale earthquakes that happen weekly and are barely felt or not felt at all by people, but larger-scale or catastrophic shaking is less likely. Nevertheless, property and human life in Stockton are at some risk for a significant earthquake causing substantial damage and strains on response and mitigation resources.

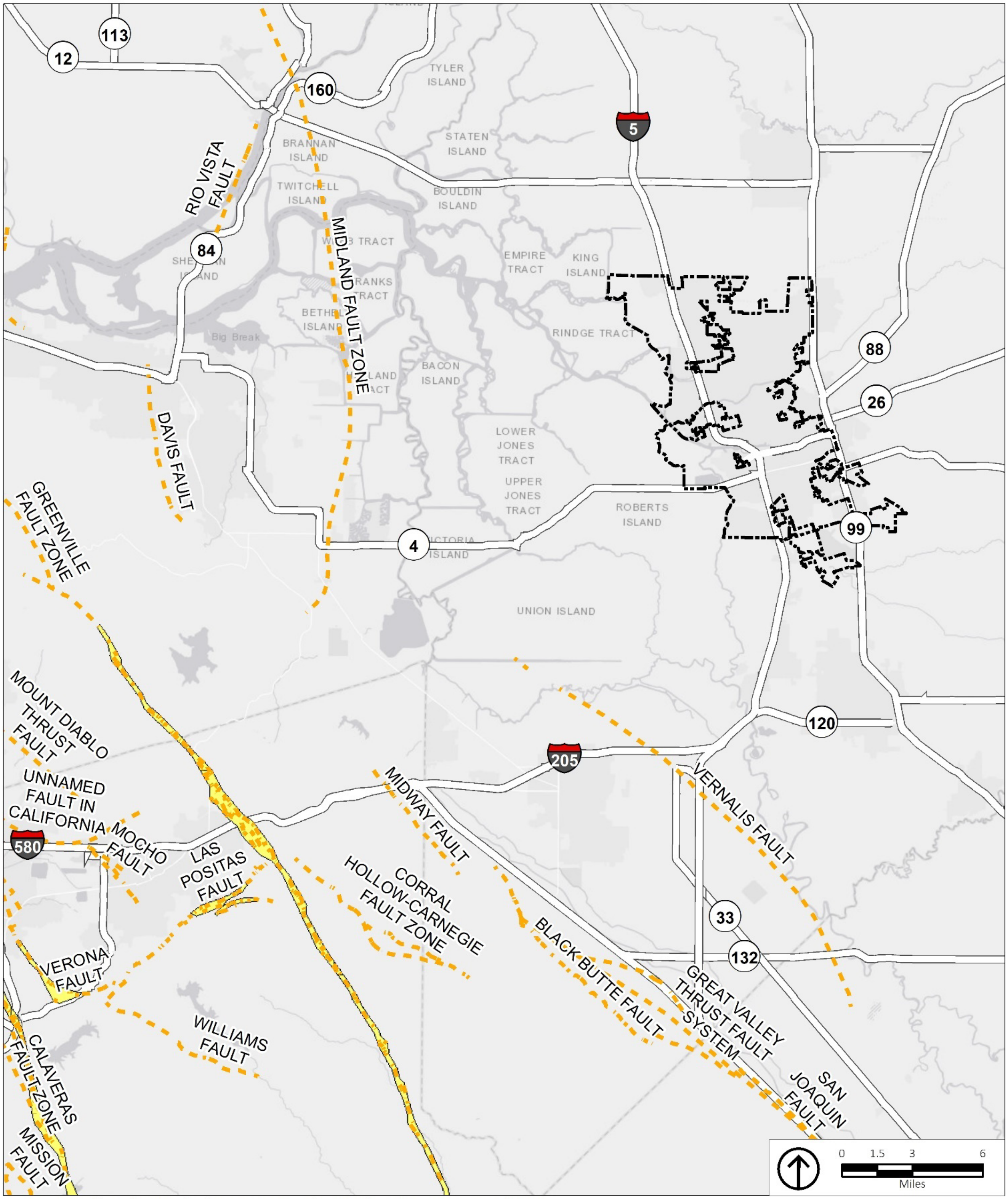
Most of the loss of life and injuries from earthquakes are due to damage and collapse of buildings and structures. Building codes for new construction have generally been made more stringent following damaging earthquakes. However, in Stockton, structures built prior to the enactment of these improved building codes have generally not been upgraded to current standards and are vulnerable in earthquakes. In Stockton, 52,737 homes, or 51 percent of all housing in the community, were constructed prior to 1980.[13] The damage caused by earthquakes may trigger secondary hazards, including urban fires, dam failures, and toxic chemical releases.

Liquefaction

In addition to the direct physical damage that can result from the motion of the earthquake, damage can result from liquefaction. Liquefaction occurs where water-logged soils near the ground surface lose compaction during strong ground motion, causing the soils to lose strength and behave as a liquid. This can cause building foundations to shift and can result in significant structural damage. Soils susceptible to liquefaction are typically found in areas of low-lying, current, or former floodplains containing moist, fine-grained sediment.

Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. The potential for liquefaction is greatest in areas underlain by bay mud or alluvium. Buildings in areas that experience liquefaction may suddenly subside and suffer major structural damage. There are no liquefaction zones mapped in or around Stockton, although there may still be a risk of liquefaction in the community.

Figure 10 Regional Fault Lines



Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023, USGS 2010/2021

City Boundary Line
USGS Regional Fault Lines
Alquist Priolo Fault Zones

2.2.5 Geologic Hazards

Geologic hazards such as subsidence, landslides, liquefaction, and erosion depend on the geologic composition of the area.

Landslides

Landslides are gravity-driven movements of earth materials that can include rock, soil, unconsolidated sediment, or combinations of such materials. The rate of landslide movement can vary considerably; some move rapidly, as in a soil or rock avalanche, and others creep or move slowly for long periods of time. The susceptibility of a given area to landslides depends on many variables, but some of the more important contributing factors are:

- Slope material: Loose, unconsolidated soil and weakly hardened or highly fractured bedrock are more prone to landslides.
- Slope steepness: Most landslides occur on moderate to steep slopes.
- Structural geometry: The orientation of soils or bedrock layers and their relationship to the ground surface can affect landslide probability.
- Moisture: Increased moisture in subsurface soil, bedrock pores, or bedrock fractures can increase the likelihood of a landslide due to decreased internal friction and increased weight of the earth materials.
- Vegetation: Well-established vegetation and the associated root structures help promote slope stability.
- Eroded slopes or human-made cuts: Proximity to eroded faces in soil or bedrock, as well as proximity to cut (i.e., excavated) slope faces, can increase landslide potential.
- Seismic shaking: Strong seismic shaking can trigger landslides in otherwise stable slopes or loosen the slope materials so they are more prone to landslides in the future.

Due to the gentle topography throughout the city's planning area and lack of steep slopes, the probability of earthquake-induced landslides is very low.[14] However, several small landslide hazard areas are scattered throughout the city, as seen on Figure 11.

Subsidence

Subsidence is the gradual caving in or sinking of an area of land. The Delta is vulnerable to subsidence; since the initiation of intense land management practices in the 1850s, half of the volume of organic peat soils in the Delta has been lost due to groundwater pumping, disturbance, and oxidation, resulting in the lowering of some Delta islands by as much as 25 feet below sea level. Subsidence rates have decreased substantially from early 20th century values and range from a few tenths of an inch per year to approximately 0.8 inches per year today.[15]

Subsidence of Delta islands creates height differences between the land and adjacent water surface elevations in channels. These height differences amplify forces against the levees and drive flow through and underneath levees into the subsided islands. Irrigation water further contributes to the accumulation of water in island drainage ditches, where it is routed to pumps and returned to adjacent channels.[16]

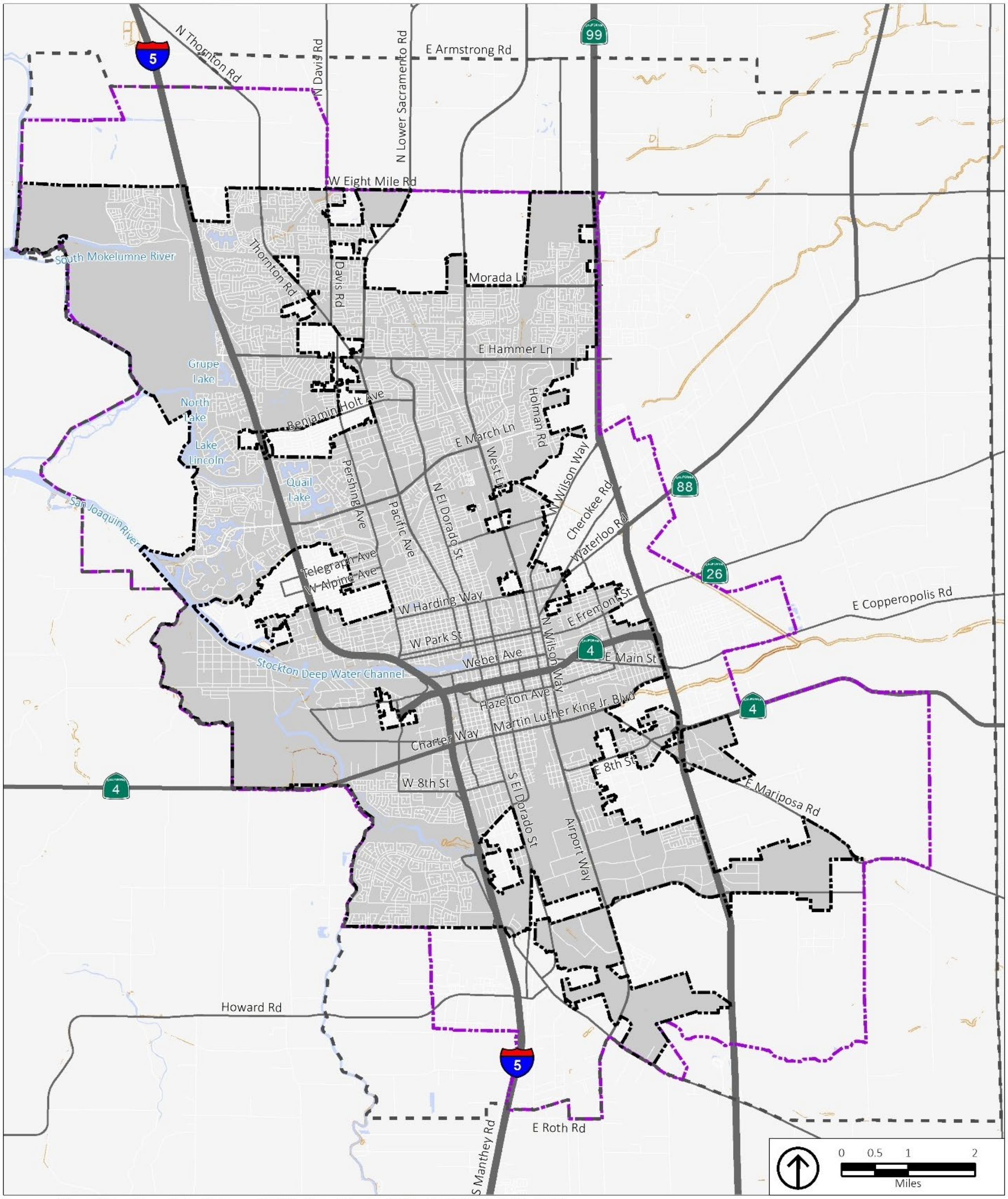
Expansive Soils

Expansive soils can change dramatically in volume depending on moisture content. When wet, these soils can expand; conversely, when dry, they can contract or shrink. Sources of moisture that can trigger this shrink-swell phenomenon include seasonal rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soil can develop wide cracks in the dry season, and changes in soil volume have the potential to damage concrete slabs, foundations, and pavement. Special building/structure design or soil treatments are often needed in areas with expansive soils.

Expansive soils are typically very fine grained with a high to very high percentage of clay. The clay minerals typically include montmorillonite, smectite, and/or bentonite.

Based on a countywide map of expansive soils published by the San Joaquin County Geographical Information Systems Unit, much of the city's planning area appears to be underlain by expansive soils, with shallow soils exhibiting moderate shrink-swell potential.[17] Measures such as emplacement of nonexpansive fill or special compaction of clay-rich soil may need to be considered prior to construction. Soil shrink-swell properties often vary from site to site, and detailed geotechnical investigations generally provide the most reliable means of identifying and mitigating these soil characteristics.

Figure 11 Landslide Susceptibility



Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019, CGS 2018

General Plan Planning Area
City Limit
Sphere of Influence

Landslide Susceptibility
0 (Not Susceptible)
3
5
6
7
8
9
10 (High Susceptibility)

2.2.6 Past Occurrences

The 1989 Loma Prieta earthquake was a magnitude 6.9 earthquake on the San Andreas Fault near Mt. Loma Prieta in the Santa Cruz Mountains, approximately 80 miles southwest of Stockton. Statewide, approximately 18,306 houses were damaged and 963 were destroyed, and approximately 2,575 businesses were damaged and 147 were destroyed. The most notable damage included the collapse of the elevated Cypress Structure section of I-880 in Oakland, the collapse of a section of roadbed on the Bay Bridge, and extensive damage to downtown Santa Cruz and San Francisco's Marina District. The Bay Bridge was unusable for a month.

The quake caused localized damages and significant shaking across San Joaquin County. It resulted in 63 people killed, 3,757 reported injured, and 12,053 displaced, and the economic loss was approximately $10 billion. This earthquake was felt as far away as San Diego and western Nevada. As experienced before, an earthquake equivalent to this strength in the Bay Area would produce strong shaking and ground failure throughout the region, including in Stockton. Other notable seismic and geologic activity has occurred periodically within and around San Joaquin County. Significant incidents include:

- Linden earthquake, 1881. This earthquake, possibly located on the Tracy-Stockton Fault, had an estimated Modified Mercalli intensity of VII.*
- The San Francisco earthquake of 1906, which caused historic destruction in San Francisco, also caused strong seismic shaking in San Joaquin County.
- Two small quakes of magnitude 5.0 occurred in Linden in 1940.
- Seismic shaking occurred within the Delta in 1979, 1980, 1983, 1984, and 1989. Impacts of these shaking events were not verified.
- A magnitude 5.8 earthquake occurred along the Greenville fault near Brentwood in 1980.
- In April 2006, heavy rains caused a landslide along Corral Hollow Road at a Lawrence Livermore Labs site in Tracy.
- Though subsidence is generally a gradual process, it can be exacerbated by periods of drought with increased levels of groundwater pumping. Significant subsidence in the San Joaquin Valley was recorded during the 2012–2016 drought; between May 2015 and September 2016, subsidence of 25 inches was recorded near the community of Corcoran.[18]

Earthquake Magnitude Scale

Magnitude 2.5 or less: Usually not felt but can be recorded by seismograph.

Magnitude 2.5 to 5.4: Often felt, but only causes minor damage.

Magnitude 5.5 to 6.0: Slight damage to buildings and other structures.

Magnitude 6.1 to 6.9: May cause a lot of damage in very populated areas.

Magnitude 7.0 to 7.9: Major earthquake. Serious damage.

Magnitude 8.0 or greater: Great earthquake. Can destroy communities near the epicenter.

Source: Michigan Technological University. 2022. Earthquake Magnitude Scale. https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/magnitude/.

2.2.7 Potential Changes to Geologic and Seismic Risk in Future Years

Likelihood of Future Occurrence

a) Seismic Risk

Earthquakes are likely to continue on an occasional basis and are likely to be small in most instances. Most are expected to cause no substantive damage and may not even be felt by most people. Major earthquakes are rare, but a possibility in the region. A major earthquake along

* The Modified Mercalli Intensity (MMI) estimates the shaking intensity of an earthquake at a specific location by considering its effects on people, objects, and buildings. It measures shaking on a scale of I (not felt) to X (extreme). At high intensities (MMI VII or above), earthquake shaking damages buildings.

any of the nearby faults could result in substantial casualties and damage. A major earthquake on the Hayward Fault could damage or destroy the primary evacuation routes and bridges, limiting access in and out of the community. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate the ground motion. If serious shaking does occur, newer construction is in general more earthquake resistant than older construction because of improved building codes. Though liquefaction often causes severe damage to structures, structural collapse is uncommon. Furthermore, the risk to public safety is relatively low as structures can be protected from liquefaction by special foundations.

b) Geologic Risk

Given the small area of the city that is subject to landslide risk, a major landslide in Stockton is unlikely. However, the city and larger Delta area will likely continue to be susceptible to the effects of subsidence and expansive soils.

Climate Change and Geologic and Seismic Hazards

Though climate change is unlikely to increase earthquake frequency or strength, the threats from seismic and geologic hazards are expected to continue. Climate change may result in precipitation extremes (i.e., wetter rainfall periods and drier dry periods), though total average annual rainfall may not change significantly. Heavy rainfall could cause an increase in the number of landslides or make landslides larger than normal. The combination of a generally drier climate in the future, which will increase the chance of drought and wildfires, and the occasional extreme downpour, is likely to cause more mudslides and landslides. Impacts from these conditions would compound landslide potential for the most susceptible locations.

The subsidence of Delta islands is exacerbated by groundwater pumping, which in turn is exacerbated by drought. Though groundwater management techniques may reduce the severity of pumping-related subsidence, they are not likely to eliminate it completely. Additionally, increasing water surface elevations due to sea level rise, hydrological changes, subsidence, and drainage ditch deepening will increase pressure on levees and increase rates of seepage onto Delta islands. These effects will increase the probability of levee failure over time.[19]

2.3 FLOOD AND INUNDATION HAZARDS

Flooding is the rising and overflowing of a body of water onto normally dry land. Floods are among the costliest natural disasters in terms of human hardship and economic loss nationwide, significantly threatening people's health and lives and causing substantial damage to structures, landscapes, and utilities. Flooding can be extremely dangerous, and even six inches of moving water can knock a person over given a strong current. Floodwaters can transport large objects downstream that can damage or remove stationary structures, such as dam spillways. Ground saturation can result in instability, collapse, or other damage, and objects can be buried or destroyed through sediment deposition. Floodwaters can break utility lines and interrupt services, and even standing water can cause damage to roads, foundations, and electrical circuits. Other problems connected with flooding and stormwater runoff include erosion, degradation of water quality, losses of environmental resources, and certain health hazards.

A relatively common weather pattern that brings strong winds and heavy rain to California, including Stockton, is often referred to as an atmospheric river. Atmospheric rivers are long, narrow regions in the atmosphere that transport most of the water vapor carried away from the tropics. When an atmospheric river makes landfall, it can release substantial amounts of water vapor in the form of rain or snow, often causing heavy rains that can lead to flooding and mudslides. On average, California experiences five to six atmospheric rivers per year, though in some years it may only experience one to two atmospheric rivers. Atmospheric rivers are responsible for up to half of the state's annual precipitation and more than 80 percent of the flood damage, including levee breaches in the Delta.[20]

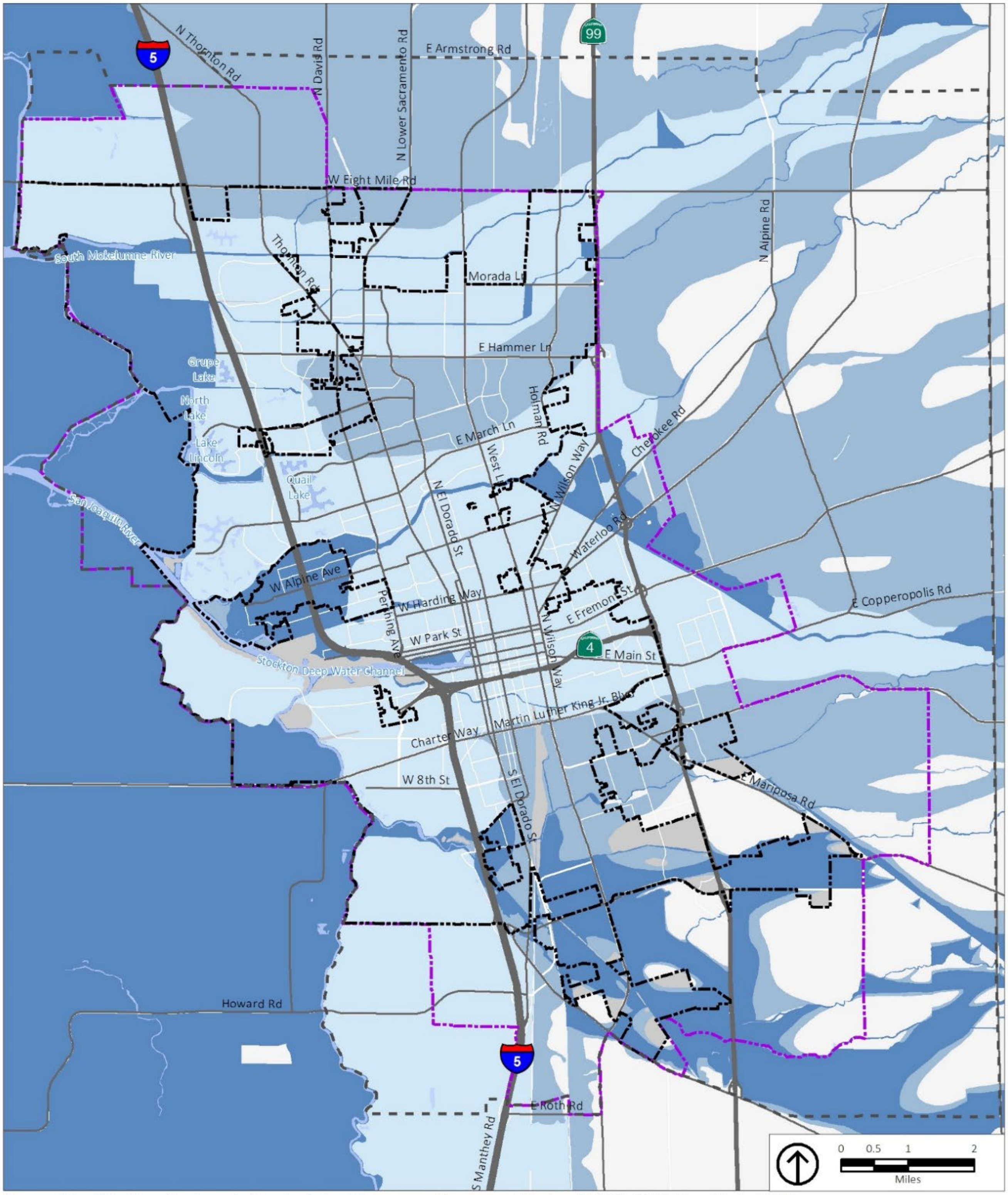
Reclamation of Delta land over many years has reduced available floodplain and increased flooding potential. Flood risk is therefore one of the most pressing threats to the Delta area, and Stockton is one of the areas at highest risk.

2.3.4 Flood Hazard Areas

Areas at an elevated risk of flooding are generally divided into 100-, 200-, and 500-year flood zones. A 100-year flood zone has a 1 percent chance of experiencing a major flood in any given year, a 200-year flood zone has a 0.5 percent chance, and a 500-year flood zone has a 0.2 percent chance. The majority of the city is in one of these flood zones, as shown on Figure 12, making flooding a hazard of significant concern for Stockton. Areas that fall in the 100-year flood zone include undeveloped land in the northwestern portion of the City's Planning Area, the area around the Country Club neighborhood with inadequate levee protection, areas along the San Joaquin River and its floodplain in southern parts of the city, and the area north of the Stockton Diversion Canal, east of the city limit.[21]

FEMA's flood hazard zones are established based on historical data and may not fully predict the future areas that are most at risk of flooding or the frequency of future flood events.

Figure 12 Flood Hazard and Levee Protection Zones



Source: City of Stockton; San Joaquin County; Federal Emergency Management System (FEMA), 2016; PlaceWorks, 2017.

Flood Zones
- 100-Year Flood Zone
- 500-Year Flood Zone
- Protected by a Levee
- City Limit
- Sphere of Influence
- General Plan Planning Area

2.3.5 Flood Protection

Since 1998, flood risks have been reduced significantly by the Locally Constructed Flood Control Project by the San Joaquin Area Flood Control Agency, which includes flood protection facilities on Bear Creek, Little Bear Creek, Pixley Slough, Upper Mosher Creek, the Mosher Diversion, Mosher Slough, the Calaveras River, the Stockton Diverting Canal, and Mormon Slough.

Stormwater management infrastructure in and around Stockton includes storm drains, canals, and ditches. Storm drains convey runoff to pump stations discharging into rivers, creeks, and sloughs, all of which flow westward to the San Joaquin River and Delta. Most storms drains have capacity for a 100-year storm.[22]

Levees

Waterways in Stockton have been heavily modified since the 1800s by dredging natural channels, constructing bypasses, and narrowing floodplains through levee construction. Most of the city is protected from flooding by levees, which are shown on Figure 13. Despite this, areas within levee protection zones are still subject to flooding hazards due to the geotechnical instability of the levees, primarily seepage through and under levees; one bank of the levee being higher than the other; burrowing from rodents; water flowing around the upstream end of a levee; and encroachments such as culverts and roadway crossings.[23,24] The Country Club neighborhood and areas along the San Joaquin River and its floodplain within the southern part of the city do not receive adequate flood protection from levees.[25] In the event of a major levee break, much of the city would be inundated, potentially damaging tens of thousands of homes.

Many Delta levees were initially constructed more than a century ago using rudimentary equipment and nonengineered fill material excavated from adjacent channels, sloughs, and marshes. Over the past century, there have been more than 140 levee failures and island inundations; however, few have occurred over the past 30 years since state and local agencies—such as the Delta Stewardship Council, the Central Valley Flood Protection Board, Department of Water Resources, U.S. Army Corps of Engineers, and local reclamation districts—adopted a more active role in supporting the maintenance and enhancement of the levees.[26]

Levee maintenance and improvement activities over the last few decades have focused on raising crest elevations to meet freeboard requirements, achieve modern standards of flood protection, and improve levee stability.

In 2005, FEMA began requiring local communities and levee owners to submit documentation showing levee systems providing 100-year flood protection. FEMA de-accredited levees that did not provide the required documentation.[27]

FEMA revoked accreditation of the Smith Canal levees in 2009.* During a 100-year flood, water from the San Joaquin River to the west could back up into the Smith Canal. Should the Smith Canal levees overtop or fail, the Country Club area, most of which lies at or near sea level, would be inundated by flood waters flowing through the breach.[28]

The San Joaquin Area Flood Control Agency (SJAFCA) is currently pursuing the design and construction of a gate structure at the mouth of Smith Canal. The gate would normally rest on the bottom of the channel, allowing for boat traffic and normal tidal fluctuations. During high water periods, the gate would be raised, preventing floodwaters from the San Joaquin River from entering Smith Canal. The proposed wall and gate and structure would provide a minimum 200-year level of performance, as required in the Central Valley Flood Protection Plan (CVFPP).[29]

In addition, FEMA is currently reviewing a Conditional Letter of Map Revision for the Bear Creek system, Upper Calaveras and Diverting Canal, which could be remapped into the floodplain.[30]

Lower Bear Creek and Lower Mosher Slough, west of I-5 at the Twin Creeks subdivision, currently do not meet FEMA criteria, and Twin Creeks could be placed in the floodplain if FEMA remaps the area. The levee protecting the Boggs Tract does not currently meet FEMA criteria, and the local Reclamation District (#404) has been working to

** An accredited levee system is a system that FEMA has determined to meet the design, data, and documentation requirements sufficient to be shown on a Flood Insurance Rate Map (FIRM) as reducing the base flood hazard.*

resolve the issues. There are also issues with the levee that provides protection for the Weston Ranch area.[31]

Although all remaining levees provide 100-year flood protection, no levees meet the State's 200-year flood protection requirement in the CVFPP. There is currently a feasibility study underway to reach a 200-year flood protection standard.[32]

The Delta's levees are also threatened by the active seismic zones west of the Delta, including the San Andreas and Hayward faults. A strong earthquake could damage Delta levees because of the potential for deformation or cracking of levees or liquefaction of levee embankments and foundations during strong ground shaking. Moderate earthquakes between 1979 and 1984 damaged nearby Delta levees, and many Delta islands' levees failed during floods within a year after the 1906 San Francisco earthquake. If a levee failed on an island subsided below sea level or during high flows or if a flood were to occur soon after an earthquake, the protected area could be inundated.[33]

Even without an earthquake or flood, Delta levees can fail during high tides or even on sunny days. Generally, these failures may be the result of a combination of high tide and pre-existing internal levee and foundation weaknesses caused by burrowing animals, internal erosion of the levee and foundation through time, and human interventions such as dredging or excavation at the toe of the levee. Examples of sunny-day failures include the Brannon Andrus Tract in 1972 and Upper Jones Tract in 2004. It is estimated that, based on current conditions, a sunny-day failure would occur once every 9 years on average.[34]

Flood Management Agencies

Several local reclamation districts play a role in maintaining levees and other flood protection facilities in and around Stockton, including the Smith Tract, Weber Tract, Boggs Tract, Rough and Ready Island, Sargent Barnhart Tract, Smith Tract, and Wright-Elmwood Tract Reclamation Districts.[35]

The Central Valley Flood Protection Board (CVFPB), is the regulating authority over flood risk management in the Central Valley and is responsible for adopting the CVFPP. The CVFPB's governing body consists of seven members appointed by the governor and confirmed by the Senate. The board works in close partnership with the California Department of Water Resources (DWR), the US Army Corp of Engineers (USACE), and stakeholders to implement the CVFPP. The CVFPB works closely with the California Department of Fish and Wildlife, US Fish and Wildlife, and the National Marine Fisheries Service to evaluate the environmental impacts of flood control.

The CVFPB, as part of its responsibility to oversee the flood control projects on the Sacramento and San Joaquin Rivers, has adopted regulations to control encroachments on these rivers and some of the streams that flow into them. It also regulates encroachments within designated floodways, which are the channels of a river or other watercourse and the adjacent land areas that convey floodwaters The CVFPB regulates encroachment in floodplains by designating floodways in the Sacramento River and San Joaquin River drainages, including the Delta.[36]

The CVFPP was last adopted by the CVFPB on December 16, 2022. The plan provides a policy, program, and project implementation framework to help guide regional- and State-level financing plans and investments. The CVFPP proposes a State Systemwide Investment Approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). The CVFPP suggests improvements to SPFC levees along the San Joaquin River and tributary channels in the Stockton Metropolitan Area.[37]

SJAFCA is a joint powers agency made up of San Joaquin County, the City of Stockton, and the San Joaquin Flood Control and Water Conservation District. The SJAFCA's mission is to study, plan, and implement flood protection projects in order to reduce the flood risk to people, structures, and the economy.

The Regional Flood Management Plan provides a framework for managing flood risk within the Lower San Joaquin River Region and Delta South Region. The plan provides a reconnaissance-level assessment of flood risks and presents a prioritized list of short-term and long-term flood risk reduction projects for each region. The Lower San Joaquin River Region and Delta South Region are further divided into five planning regions. The city is in the Upper Sacramento / Mid-Sacramento River planning region.

The City of Stockton sets stormwater quality requirements in Municipal Code Chapter 13.16, Stormwater Management and Discharge Control, and 13.20, Stormwater Quality Control Criteria Plan. Chapter 15.44, Flood Damage Prevention, includes provisions that serve to minimize public and private losses due to flood conditions. In addition, Chapter 15.48 regulates grading and erosion control in the city.

Federal and State agencies responsible for flood control in Stockton include the USACE, Federal Insurance Administration, and the DWR.

- The USACE identifies the need for and constructs major flood-control facilities. It also develops flood and dam inundation maps and reports.
- FEMA manages the National Flood Insurance Program, providing insurance to the public in communities that participate in the program. FEMA is the main federal government agency contact during natural disasters and publishes the Flood Insurance Rate Maps that identify the extent of flood potential in flood-prone communities based on a 100-year flood (or base flood) event.
- The Federal Insurance Administration is the primary agency that delineates potential flood hazard areas and floodways through the rate maps and the Flood Boundary and Floodway Map. Flood insurance is required of all homeowners who have federally subsidized loans.
- DWR is responsible for managing and protecting California's water. DWR works with other agencies to benefit the state's people and to protect, restore, and enhance the natural and human environments. DWR also works to prevent and respond to floods, droughts, and catastrophic events that would threaten public safety, water resources and management systems, the environment, and property.

2.3.6 Sea Level Rise

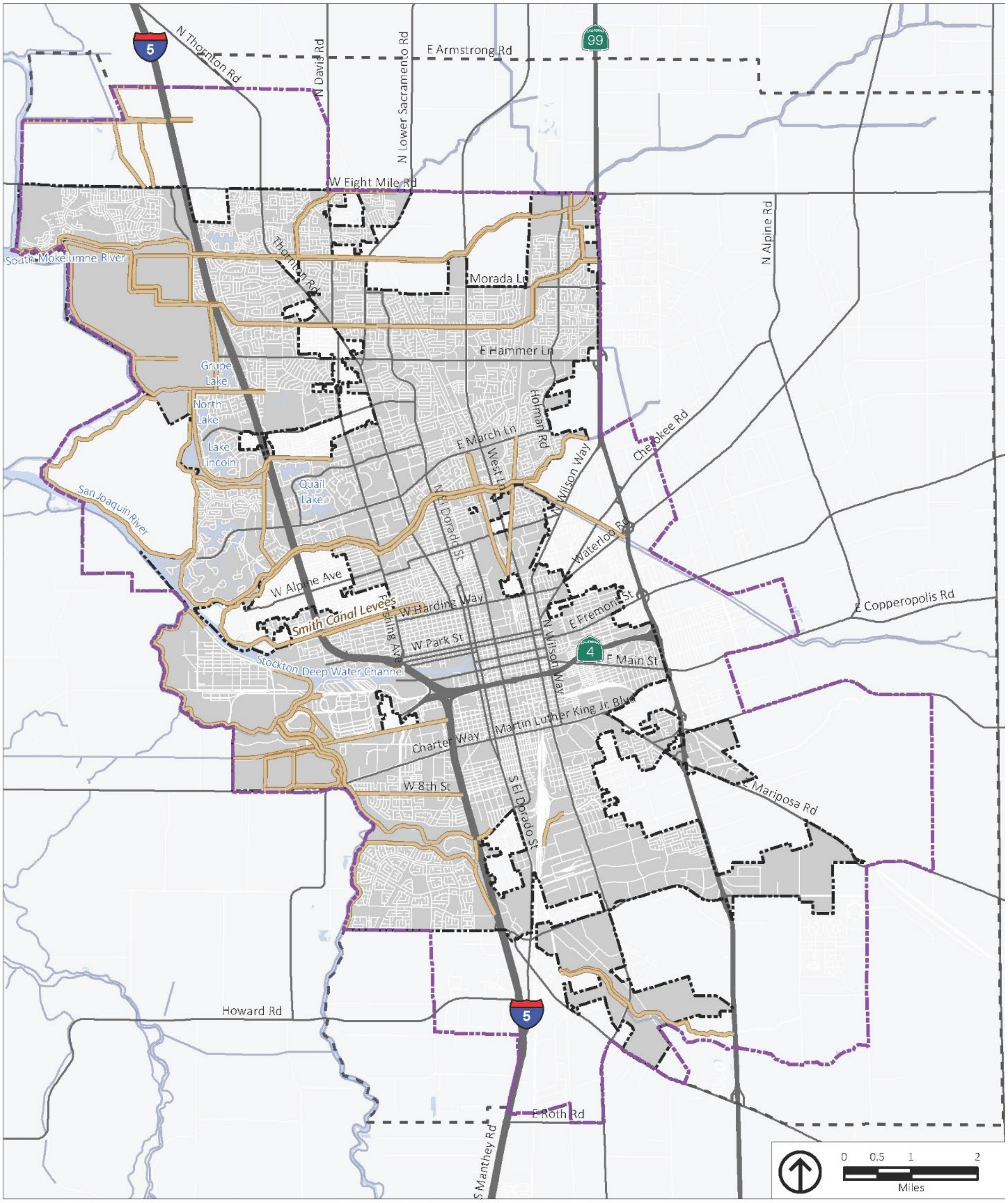
Sea level rise is an increase in the ocean's surface height relative to the land in a particular location. The two major causes of sea level rise are thermal expansion caused by warming of the ocean (since water expands as it warms) and increased melting of land-based ice such as glaciers and ice sheets. Sea level rise is a gradual process that takes place over years or decades and is a direct result of climate change. It affects coastal communities as well as those along the San Francisco Bay and into the Sacramento/San Joaquin Delta region. Sea level rise has the potential to inundate homes, businesses, and infrastructure near the shorelines and to cause erosion of coastal lands over time. The sea level rose during the twentieth century, and observations and projections suggest that it will rise at a higher rate during the twenty-first century. San Francisco has recorded an average sea level rise of about 2.0 millimeters (mm) per year since the late nineteenth century. This is comparable to a global average during the twentieth century of 1.4 mm per year, a pace that has not been exceeded in any century since at least 2,800 years ago.[38] Rising seas increase the risk of coastal flooding, storm surge inundation, coastal erosion and shoreline retreat, and wetland loss. The cities and infrastructure that line many coasts are already vulnerable to damage from storms, which will likely increase as the sea level continues to rise and inundate areas further inland.

Sea levels in the San Francisco Bay-Delta Estuary are likely to rise at least 0.6 to 1.1 feet (7.2 to 13.2 inches) by 2050, and potentially as high as 1.9 feet (22.8 inches). By the end of the century, sea levels are likely to rise to at least 1.2 to 3.4 feet (14.4 to 40.8 inches), and potentially as high as 6.9 feet to 10.2 feet (82.8 to 122.4 inches).[39] The Delta Stewardship Council has mapped levels of flooding associated with sea level rise under two scenarios: deterministic and probabilistic. The deterministic scenario shows areas that are expected to be underwater given a particular amount of sea level rise. The probabilistic scenarios show the likelihood that a particular area will be underwater as a result of sea level rise by a certain year. [40]Figure 14 shows sea level rise for Stockton under the deterministic scenario by 2050. Figures 15 and 16 show the probabilistic sea level rise for Stockton by 2050 and 2085, respectively.

There are a range of factors that impact water levels in the San Joaquin Delta, including inflows (from local and upstream precipitation), San Joaquin Delta exports, astronomical tides, atmospheric effects (pressure and wind), and flow control operations. Regional and local land subsidence further complicates local sea level trends for the Delta region. Decomposition of drained and converted marsh and peat soils within diked Delta islands have caused much of the Delta region to lie below sea level—in some places by as much as 15 to 20 feet. Continued land subsidence may increase the relative rate of locally observed sea level change for the Delta area when comparing water levels to local land elevations.[41]

The San Francisco Bay Conservation and Development Commission requires that shoreline protection projects, such as levees and seawalls, be designed to withstand the effects of projected sea level rise and be integrated with adjacent shoreline protection. Whenever feasible, projects must integrate hard shoreline protection structures with natural features, such as marsh or upland vegetation, that enhance the Bay ecosystem. The Commission also requires risk assessments for projects within 100 feet of the shoreline; however, as a matter of best practice, development within areas susceptible to sea level rise should be designed for resilience.

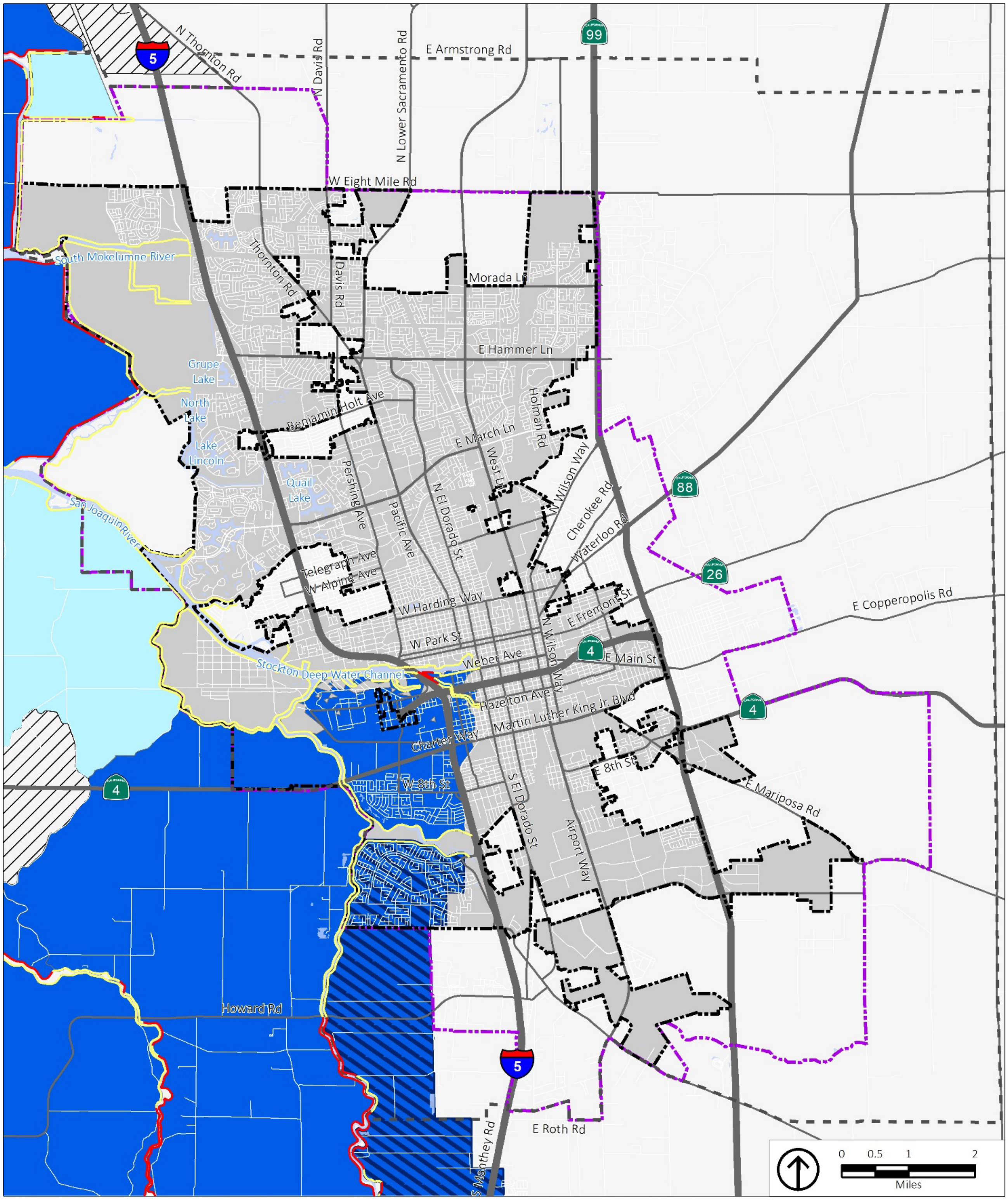
Figure 13 Levees



Source:Federal Emergency Management System (FEMA), 2017; PlaceWorks, 2017.

Levees
City Limit
Sphere of Influence/ EIR Study Area
General Plan Planning Area

Figure 14 Sea Level Rise Projections: 2050 (Deterministic)



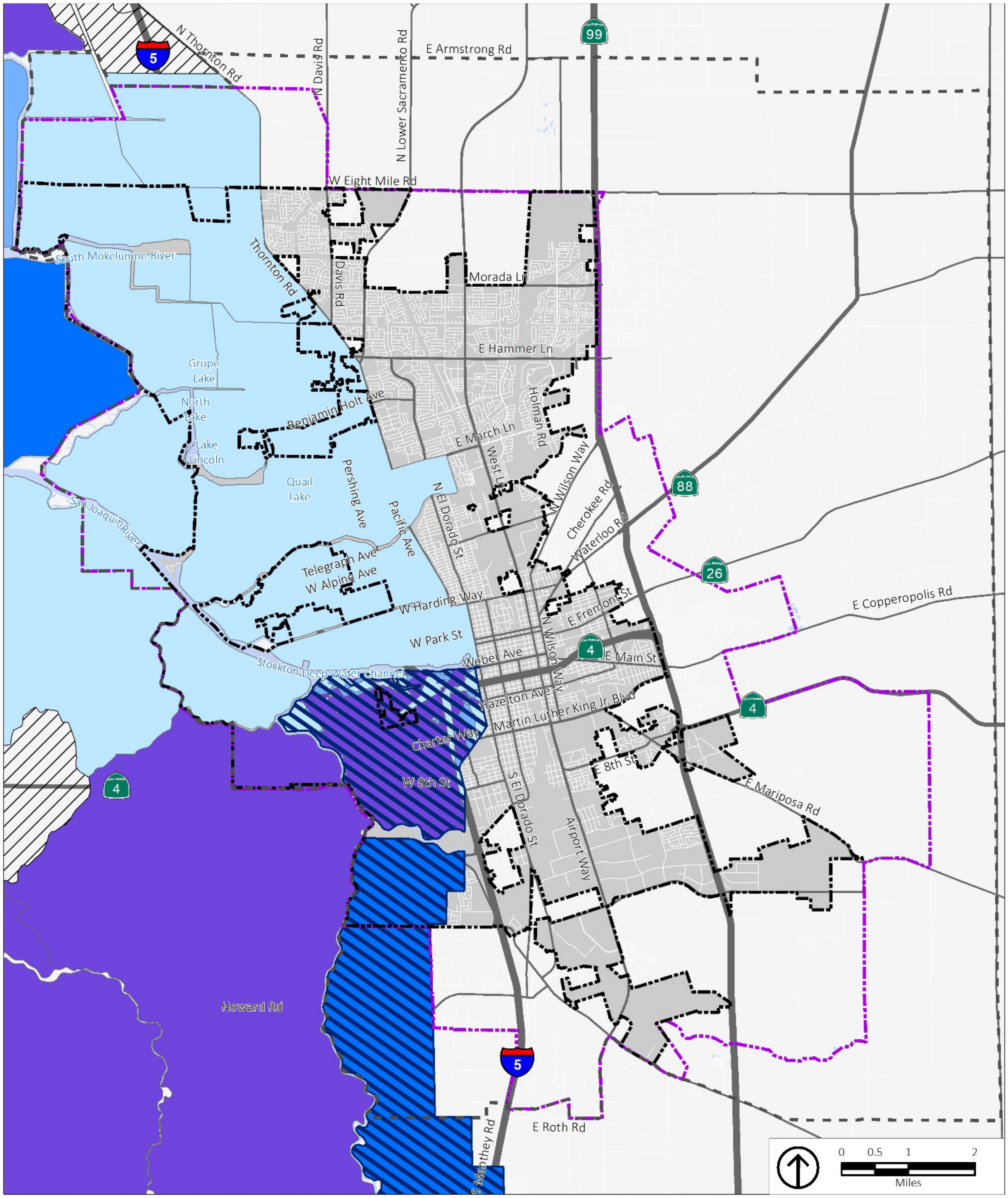
Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Coucil 2021

General Plan Planning Area
City Limit
Sphere of Influence

Improbable Overtopping
Probable Overtopping
Not Modeled
High Risk of River Flooding

2050 Conditions 100-Year Flood With 2 feet of Sea Level Rise
Flooding (mitigable with flood fighting)
Flooding

Figure 15 Sea Level Rise Projections: 2050 (Probabilistic)



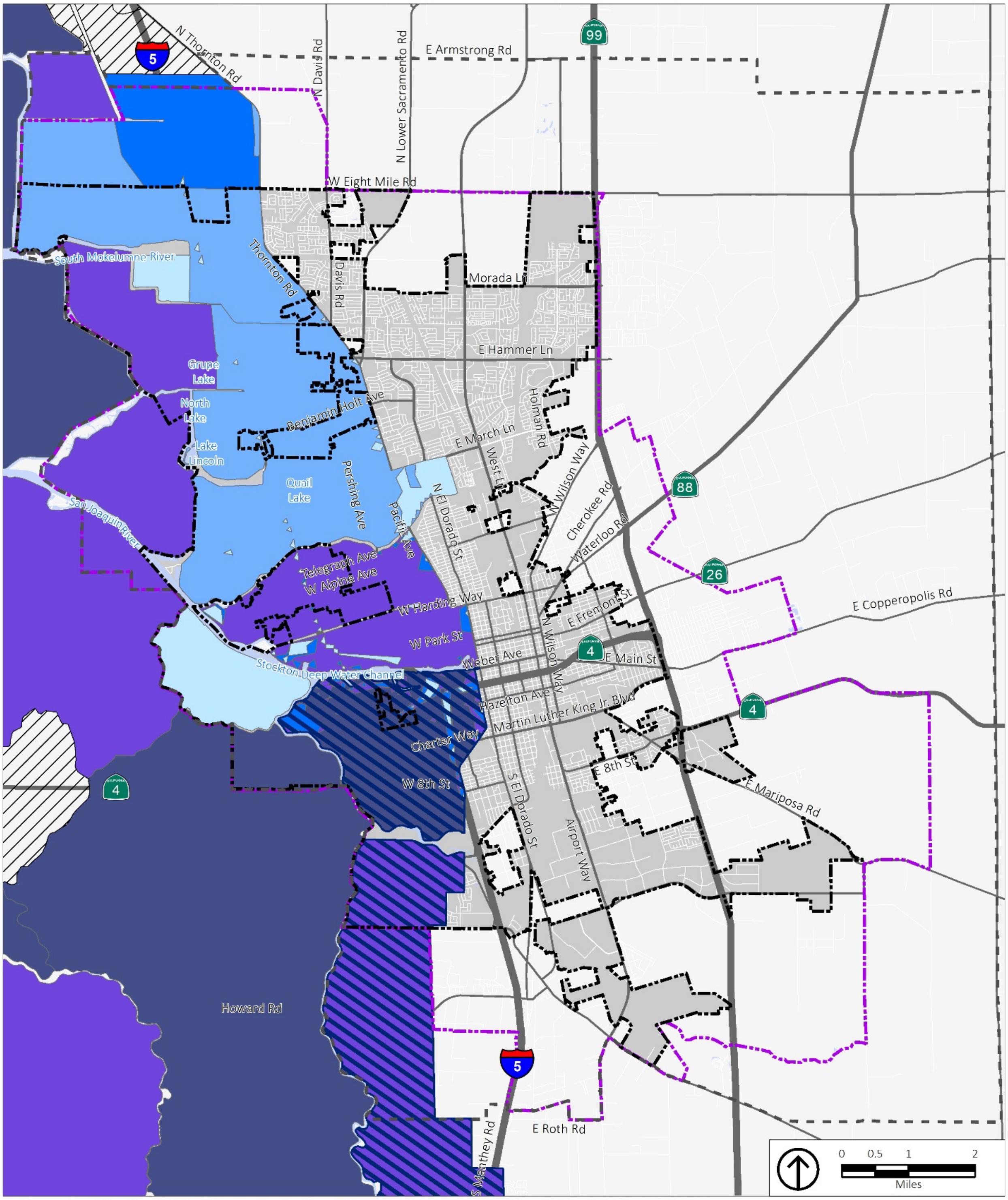
Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

- General Plan Planning Area
- City Limit
- Sphere of Influence
- Not Modeled
- High Risk of River Flooding

Flood Hazard for 2050 Probablistic Conditions

Annual Chance	*Return Period*	*Chance over 10 years*
10%	Less than 10 years	Greater than 65%
2-10%	10 to 50 years	18% to 65%
1-2%	50 to 100 years	10% to 18%
.5-1%	100 to 200 years	5% to 10%
<.5%	Greater than 200 years	Less than 5%

Figure 16 Sea Level Rise Projections: 2085 (Probabilistic)



Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019, Delta Stewardship Council 2021

- General Plan Planning Area
- City Limit
- Sphere of Influence
- Not Modeled
- High Risk of River Flooding

Flood Hazard for 2085 Probablistic Conditions

Annual Chance	*Return Period*	*Chance over 10 years*
10%	Less than 10 years	Greater than 65%
2-10%	10 to 50 years	18% to 65%
1-2%	50 to 100 years	10% to 18%
.5-1%	100 to 200 years	5% to 10%
<.5%	Greater than 200 years	Less than 5%

2.3.7 Dam Failure

A dam failure is an uncontrolled release of water from a reservoir through a dam because of structural failures or deficiencies in the dam, usually associated with intense rainfall or prolonged flooding. Dam failures can range from minor to catastrophic and can potentially harm human life and property downstream from the failure. In addition, ecosystems and habitats are destroyed because of waters flooding them. In a dam failure scenario, the greatest threat to life and property typically occurs in the areas immediately below the dam, since flood depths and discharges generally decrease as the flood wave moves downstream. The primary danger associated with dam failure is high-velocity flooding downstream and limited warning times for evacuation.

Although dam failures are very rare, they are not unprecedented. There are four major causes of dam failures:

- Overtopping: These failures occur when a reservoir fills too high with water, especially in times of heavy rainfall, leaving water to rush over the top of the dam. Other causes of this type of failure include settling of the crest of the dam or spillway blockage.
- Foundation defects: These failures occur as a result of settling in the foundation of the dam, instability of slopes surrounding the dam, uplift pressures, and seepage around the foundation. All these failures result in structural instability and potential dam failure.
- Piping and seepage failures: These failures occur as a result of internal erosion caused by seepage and erosion along hydraulic structures such as the spillways. Erosion may also be caused by animal burrows and cracks in the dam structure.
- Conduit and valve failure: These failures occur as a result of problems with valves and conduits.

Many dam failures are also the secondary result of other natural disasters, such as earthquakes, landslides, extreme storms, or heavy snowmelt. Other causes include equipment malfunction, structural damage, and sabotage.

Stockton is within the inundation areas of four major dams: the New Hogan Dam on the Calaveras River, the New Melones Dam on the Stanislaus River, the Camanche Dam on the Mokelumne River, and the Don Pedro Dam across the Tuolumne River at the Don Pedro Reservoir. Figure 17 illustrates areas in the city that would be affected by inundation if any of these dams failed. The majority of the city is within the dam inundation area of the New Hogan Dam and Don Pedro Dam, and the west half of the city is in the dam inundation area of the New Melones Dam and Camanche Dam[42]. Failure of any of these dams would give residents about seven hours to evacuate. Other major regional dams could also affect Stockton, but would have longer warning times.

The New Hogan Dam is owned and operated by the USACE, the New Melones Dam is operated by the US Bureau of Reclamation; the Camanche Dam is owned and operated by the East Bay Municipal Utilities District; and the Don Pedro Dam is owned and operated by the Modesto Irrigation District (MID) and Turlock Irrigation District (TID) and falls within the jurisdiction of the California Division of Dam Safety.

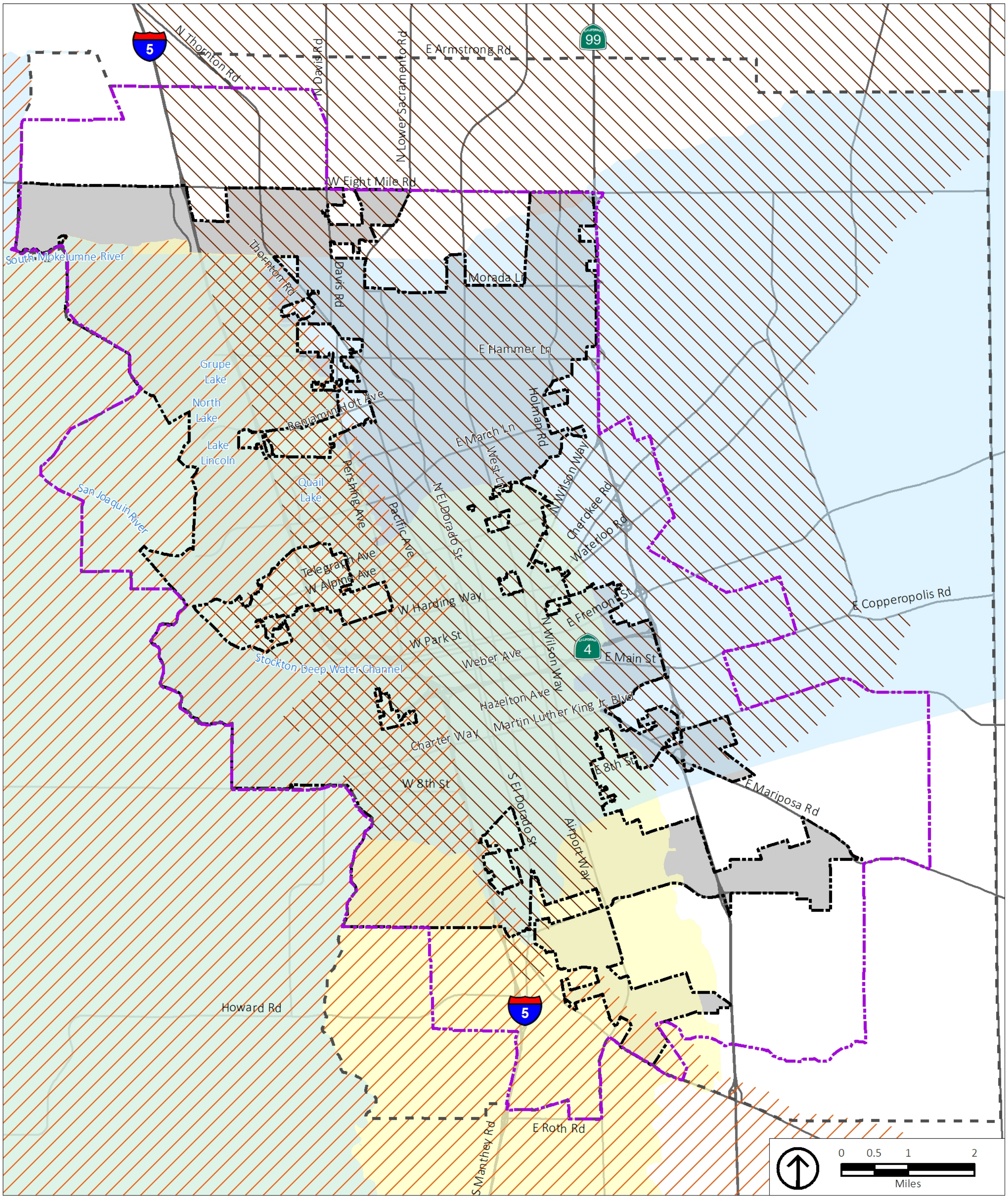
The USACE's Dam Safety Program conducts dam inundation risk assessments and repairs and rehabilitates dams deemed to be at high risk.

The Bureau of Reclamation's Dam Safety Program works to perform site evaluations and identify dams in need of corrective action or which pose a near-term or elevated threat to the public.

The Division of Dam Safety inspects dams on an annual basis to ensure the dam is safe and performing as intended. Dams are also assessed for seismic stability and are projected to withstand the maximum credible earthquake.

The Federal Energy Regulatory Commission, as required by federal law, has reviewed and approved comprehensive emergency action plans (EAP) for each of these dams. The EAPs minimize the threat to public safety and the response time to an impending or actual sudden release of water from project dams. EAPs are also designed to provide emergency notification when floodwater releases present the potential for major flooding.

Figure 17 Dam Inundation



Source: San Joaquin County, 2017; PlaceWorks, 2023; DWR, 2023 .

Dam Inundation Areas

- Camanche Dam
- New Melones Dam
- New Hogan Dam
- Don Pedro Reservoir
- City Limit
- Sphere of Influence/ EIR Study Area
- General Plan Planning Area

2.3.8 Past Occurrences

Floods are a regular feature in California and cause the second-greatest number of disaster declarations in the state. Stockton and the greater San Joaquin County have been subject to periodic flooding, including:

- 1950: Almost 14,000 acres of the Delta flooded, washing out the Southern Pacific Railroad tracks and U.S. 50 west of Stockton.
- 1955 to 1956: Extensive flooding occurred along the eastern tributaries of the San Joaquin River. This event had the highest flows as recorded on the Calaveras River at Bellota, with approximately 1,500 acres of Stockton inundated to depths of six feet for as long as eight days.[43]
- 1958: Approximately 250,000 acres from Stockton to Fresno along the San Joaquin River flooded, in part due to prolonged and unusually voluminous snowmelt from the Sierra Nevada.
- 1972: The San Joaquin River breached the Andrus Island levee 6 miles south of Isleton between Bruno's Yacht Harbor and Spindrift Resort, about 20 miles northwest of Stockton. The breach eventually grew to 300 feet long, flooding Highway 12, the low-lying residential area of Isleton, and portions of Andrus and Brannan Islands, in some places up to 20 feet deep. At least 1,400 Isleton residents were evacuated as well as 1,500 residents from the Andrus and Brannan Islands. A full year after the levee break, more than one-third of the residents had neither moved back into their homes nor begun to rebuild. Officials estimated that damages were $21.8 million, slightly more than half of that from crop loss and saltwater damage to farmland. The cost for levee repairs was put at $800,000, and $500,000 went to pump the 20 square miles of flooded land dry. More than $1.5 million in federal disaster relief was made available. No definitive cause was ever determined for the levee breach.[44]
- 1997: Flooding resulted in a voluntary evacuation of the Weston Ranch area of Stockton at the north end of Mossdale Tract. While it did not directly damage areas of Stockton, 1,842 residences and businesses were affected in San Joaquin County. Significant flood-fighting efforts were conducted by Reclamation Districts 404 and 17 at breaches upstream of Mossdale Tract along the San Joaquin and Stanislaus Rivers. Estimated damages in San Joaquin County were approximately $80 million.[45]
- 2004: The Upper Jones Tract levee near Woodward Island failed, flooding the island, creating $100 million in damages, and threatening the state's water supply.[46] The island, which lies approximately 10 feet below sea level, required three weeks to repair the breach, and an additional five months for dewatering.

2.3.9 Potential Changes to Flood Risk in Future Years

Likelihood of Future Occurrence

The city's proximity to the Delta, relatively low elevation, and potential to experience heavy rains mean that flood will continue to pose a significant hazard to the community.

Floodplains can change over time. The floodplain and watercourse of a stream can be affected by anthropogenic (human) influences, such as the development of land into residential or commercial structures and the resulting reduction of pervious land (resulting in increased stream flow), the construction of bridges or culverts, or the creation of levees or other impoundment structures that control the flow in the watercourse.

Sea levels have risen in the Bay and Delta and are expected to continue to rise over the coming century. Sea levels will rise slowly and increase impacts of other coastal hazards, such as shoreline erosion and subsidence.

The potential for a dam failure event in Stockton is likely to remain a risk in future years, although the odds of such events are expected to remain very low.

Climate Change and Flooding

Climate change is expected to increase the severity of flooding. Although climate change may not change average precipitation levels significantly, scientists expect that it will cause more years with extreme precipitation events that drop enough precipitation over a short enough period to cause flooding. Floods are thus expected to occur more often in Stockton, and climate change may expand the parts of the city that are considered prone to flood. By 2050, an addition 29,550 residents of Stockton are expected to be exposed to flooding, and 55,690 by the end of the century.[47]

Although there is no doubt that sea levels have risen and will continue to rise over the coming century, it is difficult to predict with certainty how much the sea level will rise within a given time frame. The uncertainties increase over time (i.e., the uncertainties associated with 2100 projections are greater than those associated with 2050 projections) because of uncertainties in future greenhouse gas (GHG) emissions, the sensitivity of climate conditions to GHG concentrations, and the overall capabilities of climate models. Nonetheless, rising seas increase the risk of tidal flooding, storm surge inundation, levee failure, coastal erosion and shoreline retreat, and wetland loss. The impacts to the community are compounded when atmospheric rivers coincide with king tides. King tides bring unusually high water levels and can cause local tidal flooding. By 2050, rising sea levels will more than double the probability of flooding if levees are not actively improved. Drainage of Delta islands will also be more difficult, impairing agriculture.[48]

There are some indirect effects of climate change that may also increase flooding in the city. Climate change is expected to increase the frequency and severity of droughts, which cause soil to dry out and become hard. When precipitation does return, more water runs off the surface than is absorbed into the ground, which can lead to floods. In addition to the pressure resulting from sea level rise, climate change will result in increased severity of winter storms, particularly in El Niño years.* Such weather events will result in higher levels of seasonal flooding than currently. This too will strain levees and increase floodplain areas. More intense storms and increased runoff could impact Delta water quality by increasing sediment load or contaminants from urban and agricultural runoff.[49]

Future flooding is anticipated to impact safety facilities (fire stations, police stations, and hospitals); schools; water infrastructure; flood infrastructure; wastewater treatment facilities; and hundreds of miles of critical infrastructure supporting energy, utilities, and transportation, potentially resulting in economic disruption across the Delta region.[50] Increased frequency and severity of Delta flooding could have significant impacts on some of Stockton's most vulnerable residents. Approximately 65 percent of the Delta's population that could be exposed to the 100-year flood by 2050 reside in areas with high concentrations of socially vulnerable residents.[51] The City of Stockton has high concentrations of socially vulnerable block groups and constitutes a significant percentage of the Delta population exposed to flooding. Increases in damaging flood events will cause greater property damage, public health and safety concerns, displacement, and loss of life. Displacement of residents can include both temporary and long-term displacement, increase in insurance rates, or restriction of insurance coverage in vulnerable areas.

As sea levels rise and high-flow events become more common, the likelihood of levee overtopping will increase. Levee breaks could cause large amounts of salt water from the Bay to enter the Delta and would have an adverse effect on Delta water quality and water system operations. Saltwater intrusion could take months to dissipate, depending on the severity of the levee break and the degree of intrusion.[52]

Of the ecosystems currently protected by levees in the Delta region, 73 percent are at risk of flooding due to levee overtopping resulting from a combination of sea level rise and storm events. By 2085, rising sea levels will cause all critical remaining tidal wetland ecosystems in the Delta to transition to different plant communities or drown completely.[53]

2.4 HAZARDOUS MATERIALS

Hazardous materials are materials that pose a significant risk to public safety or human or environmental health. These include toxic chemicals, flammable or corrosive materials, petroleum products, and unstable or dangerously reactive materials. They can be released through human error, malfunctioning or broken equipment, or as an indirect consequence of other emergencies (e.g., if a flood damages a hazardous

* El Niño is a naturally occurring climate pattern associated with warming of the ocean surface temperatures in the central and eastern tropical Pacific Ocean, which can significantly influence weather patterns and ocean conditions globally. El Niño occurs on average every 2 to 7 years, and episodes typically last 9 to 12 months. El Niño has its largest impacts during the winter. In the winter, El Niño typically brings milder weather to the northern parts of the United States and wetter conditions across the southern United States.

material storage tank). Hazardous materials can also be released accidentally during transportation as a consequence of vehicle accidents.

A release or spill of bulk hazardous materials could result in fire, explosion, toxic cloud, or direct contamination of water, people, and property. The effects may involve a local site or many square miles. Health problems may be immediate, such as corrosive effects on skin and lungs, or gradual, such as the development of cancer from a carcinogen. Damage to property could range from immediate destruction by explosion to permanent contamination by a persistent hazardous material.

Most hazardous materials in the region are transported on truck routes along major roadways that pass through Stockton, such as I-5, SR-99, SR-4, SR-26, and SR-88; via the Port of Stockton; and along the Union Pacific Railroad. Transporters of hazardous wastes are required to be certified by the United States Department of Transportation, and manifests are required to track the hazardous waste during transport.

Although hazardous materials are carefully regulated today, past activities have left several contaminated sites in Stockton, and there are others where contamination is suspected and investigation is underway. Contamination has resulted from leaking underground storage tanks, disposal of hazardous materials, and various past industrial practices. The potential for accidents and spills means that the City must strive to reduce risks and be prepared for emergencies. The California Department of Toxic Substances Control (DTSC) oversees the environmental cleanup of contaminated sites.

Several state agencies monitor hazardous materials/waste facilities. Potential and known contamination sites are monitored and documented by the Regional Water Quality Control Board and the DTSC. A review of the DTSC EnviroStor database indicates that there are 145 hazardous waste facilities within Stockton, 53 of which require no further remediation. The Regional Board's GeoTracker database shows 553 sites within Stockton that may impact or have the potential to impact water quality. Of these, 403 are leaking underground storage tank sites and 68 are military sites.

The Stockton Fire Department's Hazardous Materials (Haz Mat) Team is charged with mitigating hazardous materials releases and environmental emergencies. The Haz Mat Team is also responsible for coordinating with State and local authorities to prepare, prevent, respond to, mitigate, and determine the responsible party for a variety of hazardous materials releases.

Hazardous materials and waste in San Joaquin County are managed by the Certified Unified Program Agency (CUPA), a local administrative agency within the San Joaquin County Environmental Health Department. The CUPA consolidates, coordinates, and makes consistent the regulatory activities of several hazardous materials and hazardous waste programs, including Hazardous Materials Management, California Accidental Release Prevention, Hazardous Waste Management, Underground Storage Tanks, Aboveground Storage Tanks, and Emergency Response.

2.4.4 Past Occurrences

Stockton and the greater San Joaquin County area has been subject to periodic hazardous materials incidents; San Joaquin County typically responds to more than 200 incidents per year. Notable hazardous materials incidents occurred in the 1998 Tracy Tire Fire and the 1989 Manteca freight train derailment.

2.4.5 Potential Changes to Hazardous Materials in Future Years

Likelihood of Future Occurrence

Given the presence of the Port of Stockton, Union Pacific Railroad, and several major highways within Stockton, as well as the centrality of the shipping and logistics industries to the region's economy, there is a high chance that hazardous materials will continue to be transported in the community. Though the likelihood of a major hazardous materials incident may be small, minor and moderate-scale hazardous materials spills will likely continue to occur.

Climate Change and Hazardous Materials

Climate change is unlikely to substantially affect hazardous materials transportation incidents or conditions relating to the exposure of pollution and contamination in the community. However, increases in the frequency and intensity of hazards, such as floods, landslides, and severe storms, may create a greater risk of hazardous materials releases during these events.

2.5 DROUGHT

A drought is an extended period when precipitation levels are well below normal and is a normal part of the climate cycle. Drought may cause losses to agriculture; affect domestic water supply, energy production, public health, and wildlife; or contribute to wildfire. Like most of California and the western United States, Stockton chronically experiences drought cycles. Drought impacts the city's water supply, which in severe instances, ultimately makes less water available for people, businesses, and natural systems.

Less snow falling in mountainous areas causes water levels in lakes and reservoirs to drop, which can affect recreation activities. Local ecosystems that are not well adapted to drought conditions can be more easily harmed. Droughts can also indirectly lead to more wildfires, and the stress caused by water shortages can weaken plants, making them more susceptible to pests and diseases.

The U.S. Drought Monitor recognizes a five-point scale for drought events: D0 (abnormally dry), D1 (moderate drought), D2 (severe drought), D3 (extreme drought), and D4 (exceptional drought). As of May 2023, San Joaquin County, including Stockton, was not in drought conditions, although the County was in a state of extreme to exceptional drought as recently as December 2022. During severe drought conditions, water shortages are common and water restrictions may be imposed to meet essential community needs.

2.5.4 Water Supply

Two water purveyors serve the city—California Water Service Company Stockton District (Cal Water) and the City of Stockton Municipal Utilities Department (COSMUD). Cal Water serves the central part of the city, and COSMUD serves the northern and southern parts of the city. Cal Water and COSMUD water supplies consist of purchased water and groundwater. Both Cal Water and COSMUD purchase water from the Stockton East Water District (SEWD), which obtains supplies from the New Hogan Reservoir on the Calaveras River and the New Melones Reservoir on the Stanislaus River. Both obtain groundwater from the East San Joaquin Subbasin of the San Joaquin Valley Groundwater Basin. Cal Water Stockton District obtains approximately 84 percent of its water from SEWD.

COSMUD also obtains surface water from the Mokelumne River via the Woodbridge Irrigation District (WID) and from the San Joaquin Delta via the Delta Water Supply Project.[54] WID's water supply is from the Mokelumne River. This water augments supply if diversions from the San Joaquin River are not available due to environmental restrictions. The water is conveyed through WID's Wilkerson Canal and Pixley lateral pipeline for treatment and conveyance to the water distribution system. In 2020, COSMUD obtained approximately 20 percent of its water from SEWD, 25 percent from WID, 25 percent from groundwater, and 30 percent directly from the San Joaquin River.

The City's primary water sources during base years are surface water from the San Joaquin River and WID and purchased water from SEWD. These water supply sources complement each other; when water diversion from the San Joaquin River is curtailed due to environmental restrictions, COSMUD obtains supplemental water supply from WID. Groundwater supply is used to meet increased water demands primarily in the summer months.

The COSMUD Water Shortage Contingency Plan (WSCP) projects that COSMUD will have adequate water supply through 2045 for normal year, single dry, and multiple dry year water supply conditions.[55] The COSMUD WSCP also contains water conservation provisions to be implemented in the event of a water shortage. These include expanding public education about water conversation, restricting uses of potable water, implementing or modifying a drought rate structure, increasing water waste patrols, and reducing system water loss. Should the COSMUD water supply portfolio prove insufficient to meet the planned demands of its customers, COSMUD may augment its water supply by engaging in exchanges and transfers with other water providers. COSMUD may also activate standby wells in the North and South Stockton water service areas to address shortages in surface water supplies.

Cal Water expects that its combination of purchased water and groundwater supply for the Stockton District will fully meet future demands under all hydrological conditions, including normal, single dry, and multiple dry years.[56] Cal Water's WSCP defines specific policies and actions that will be implemented at various shortage level scenarios. The WSCP includes six levels to address shortage conditions from up to 10 percent to greater than 50 percent shortage, identifies a suite of demand mitigation measures for the Stockton District to implement at each level, and identifies procedures for the Stockton District to annually assess whether a water shortage is likely in the coming year. Demand reduction measures include restricting uses of potable water, expanding rebates for water efficiency upgrades, implementing or modifying a drought rate structure, increasing water waste patrols, and reducing system water loss.

Groundwater Resources

The San Joaquin Valley Groundwater Basin is divided into several subbasins. Most of Stockton is above the Eastern San Joaquin Subbasin, which is classified as critically overdrafted.

Historically, average groundwater elevations have declined about 1.7 feet per year, creating a gradient that allows saline water underlying the Delta region to migrate northeast in the southern portion of the City's Planning Area. This flow from the Delta area is significant because it moves poor-quality water eastward toward the Stockton area. Degradation of water quality due to saline migration threatens the long-term sustainability of the underlying basin. Salt-laden groundwater is unusable for urban drinking water needs and for irrigating crops. However, demand for water in San Joaquin County has declined since the 1990s, and long-term groundwater elevations suggest water level recovery in some areas.[57]

The Eastern San Joaquin Subbasin is recharged by water from various sources, including streams, percolation of rainfall and irrigation water, inflow from other groundwater basins, and intentional recharge at numerous facilities. Intentional recharge is conducted in recharge ponds and on some farm fields, with compensation to landowners.[58]

Several agencies in the Eastern San Joaquin and Tracy Subbasins have become groundwater sustainability agencies under the Sustainable Groundwater Management Act, including the City of Stockton, San Joaquin County, the East Stockton Water District, Central San Joaquin Water Conservation District, and South San Joaquin Groundwater Sustainability Agency. The Eastern San Joaquin County Groundwater Basin Authority (GBA), a joint powers agency, was established in 2001 to collectively develop locally supported projects to strengthen water supply reliability in eastern San Joaquin County. The GBA issues annual reports for the subbasin and prepares the Eastern San Joaquin Groundwater Basin Groundwater Sustainability Plan (GSP), intended to achieve a sustainable withdrawal-recharge balance in the subbasin by 2040.

Although the Basin as a whole is considered overdrafted, groundwater conditions vary spatially within the Basin. In the vicinity of the Stockton District, groundwater conditions (as represented by water levels measured in the District's wells) have been generally stable over the long term, varying within a relatively small and consistent range of approximately 20 feet over the past 25 years. These conditions indicate that overdraft is not occurring in the local vicinity of the City of Stockton and the Stockton District.[59]

Water quality issues have been detected on the west side of the subbasin, some of which are from wells underlying the city. The GSP outlined the need to reduce basinwide overdraft conditions and identified 23 projects for potential development that, along with management actions, either replace groundwater use or supplement groundwater supplies to meet current and future water demands. The 23 potential projects in the GSP represent a variety of project types, including direct and in-lieu recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse, to be undertaken by the member agencies.[60]

2.5.5 Past Occurrences

Droughts occur periodically across California and drought conditions have been present in Stockton and the greater San Joaquin area numerous times. Noteworthy countywide droughts occurred in 1977, 1990, 2002, 2004, 2008, 2014-2017, and 2020-2023.

2.5.6 Potential Changes to Drought in Future Years

Likelihood of Future Occurrence

Drought is different than many of the other natural hazards in that it is not a distinct event and usually has a slow onset. Drought can severely impact a region both physically and economically, affecting different sectors in different ways and with varying intensities. Adequate water is the most critical issue for commercial and domestic use. As the population in the city continues to grow, so will the demand for water. However, water supply is currently considered adequate to meet projected water needs through the year 2045. The COSMUD and Cal Water 2020 Urban Water Management Plans demonstrate that Stockton has adequate capacity to accommodate its water demand through 2045 through a diversified and resilient portfolio that includes conservation programs.

Based on historical information, the occurrence of drought in California, including San Joaquin County, is cyclical, driven by weather patterns. Drought has occurred in the past and will occur in the future. 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 comparing observed precipitation with what is normal (climatologic); comparing soil moisture and crop conditions with what is normal (agricultural); or by looking at how much water is contained in snow, the level or flow rate of moving water, water in reservoirs, or groundwater levels (hydrologic). How individuals recognize drought depends on the ways that it affects them. The impacts from drought include reduction in water supply and an increase in dry fuels.

Drought and Climate Change

Although droughts are a regular feature of California's climate, scientists expect that climate change will lead to more frequent and intense droughts statewide. Overall, precipitation levels are expected to stay similar and may even increase in some places. However, the state's current data say that there will be more years with extreme levels of precipitation, both high and low, as a result of climate change. This is expected to cause more frequent and intense droughts compared to historical norms. Climate change will reduce reservoir storage in all year types, meaning less water can be carried over from one year to the next, increasing the water supply system's vulnerability to drought. In addition, the type of extreme drought that California experienced from 2012 to 2016 will be five to seven times more likely to occur by 2050. These changes will result in greater water shortages, especially in dry years.[61]

In the past, Delta water quality has been compromised during droughts, as salt water is able to penetrate further into the Delta when freshwater flows are reduced. Future drought combined with sea level rise may once again compromise Delta water quality and expose more acres of Delta agriculture to more salt water than historically.[62]

Drought conditions can cause soil to dry out and become hard, so that when precipitation does return, more water runs off the surface than is absorbed into the ground, which can lead to floods. Higher air temperatures are expected to increase evaporation, causing more water loss from lakes and reservoirs, exacerbating drought conditions. Reduced winter precipitation levels and warmer temperatures have greatly decreased the size of the Sierra Nevada snowpack (the volume of accumulated snow), which in turn makes less freshwater available for communities throughout California, including the imported water supply for Stockton. Continued decline in the Sierra Nevada snowpack volume is expected, which may lead to lower volumes of available imported water.

In the Mokelumne/Amador/Calaveras area (origin of the Mokelumne and Calaveras Rivers), the state Cal-Adapt database indicates the snowpack levels (i.e., snow water equivalent) in the spring are expected to decline from a historical average of 815.4 inches to as low as an average of 118.1 by the middle of the century (2051 to 2070). In the Tuolumne-Stanislaus area (origin of the Tuolumne-and Stanislaus Rivers), snowpack levels in the spring are expected to decline from a historical average of 1,765.3 inches to as low as an average of 565.3 by the middle of the century (2051 to 2070). Within the Madera region (origin of the San Joaquin River), snowpack levels in the spring are expected to decline from a historical average of 942.8 inches to as low as an average of 288.4 inches by the middle of the century.

Climate change is expected to cause more precipitation to fall as rain instead of snow, and the snow that does fall will melt earlier, reducing the Sierra Nevada spring snowpack by as much as 70 to 90 percent. How much snowpack will be lost depends in part on future precipitation patterns, the projections for which remain uncertain. However, even under wetter climate projections, the loss of snowpack would pose potential water shortage issues and exacerbate drought conditions. The operation of storage reservoirs could be impacted by shifting runoff and snowmelt patterns, making it more difficult to refill reservoir flood control space during late spring or early summer and potentially reducing the amount of surface water available for use during the summer/fall season.[63]

Drought and other climate change impacts may exacerbate existing water affordability issues. In the short term, drought can contribute to increased water rates because water utilities may have to enact temporary charges to cover costs when mandatory or voluntary restrictions lead to declining water use. Longer term, utilities are weighing options to adapt to increased frequency and intensity of droughts by diversifying their water supply portfolios, purchasing or developing costlier water supplies, or pumping groundwater from greater depths. Increased frequency of droughts may also contribute to harmful algal blooms and degrade raw water quality, requiring drinking water treatment system upgrades.[64]

Increasing frequency and severity of droughts will likely have negative impacts on Delta agriculture. Drought, especially in combination with other climate change stressors and hazards such as extreme heat, may reduce crop productivity. Reductions in agricultural productivity would disproportionately impact low-income agricultural laborers, who would be more likely to lose their jobs first and tend to have fewer resources to cope with drought and other climate change impacts. Agricultural adaptation strategies to cope with drought, such as shifting to less labor-intensive crops and increasing groundwater use, can result in increased vulnerability for farmworkers.[65]

Projected reductions in spring and fall precipitation and increased interannual precipitation variability will stress Delta species, favor less diverse species assemblages, and lead to increased presence of nonnative species.

2.6 FIRE HAZARDS

Fire hazards include both wildfires and urban fires. Though the city is vulnerable to both kinds of fire threats, the climatic and vegetative conditions in Stockton are generally not conducive to the spread or development of wildfires.

2.6.4 Wildfires

Wildfires occur on mountains, hillsides, and grasslands. Fuel, weather, and topography are primary factors that affect how wildland fires spread. Wildfire risk in San Joaquin County is generally low.

Wildfire Smoke

Greater frequency of regional fires can create recurrent air quality degradation, leading to respiratory health effects. Wildfire smoke consists of a mix of gases and fine particulate matter from burning vegetation and materials. The pollutant of most concern from wildfire smoke is fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ from wildfire smoke is damaging to human health due to its ability to deeply penetrate lung tissue and affect the heart and circulatory system. Although wildfire smoke presents a health risk to everyone, sensitive groups may experience more severe acute and chronic symptoms from exposure to wildfire smoke, such as children, older adults, people with chronic respiratory or cardiovascular disease, or people experiencing low socioeconomic status.

Public Safety Power Shutoff Events

High winds can bring tree branches and debris into contact with energized lines, damage equipment, and ignite a wildfire. As a result, PG&E sometimes turns off power during severe weather to help prevent wildfires. This is called a public safety power shutoff.

San Joaquin County and the City of Stockton have been subject to PSPS events and warnings during severe weather events, most notably in October 2021.

Wildland-Urban Interface Fires

The wildland-urban interface (WUI) is an area where buildings and infrastructure (e.g., cell towers, schools, water supply facilities) mix with areas of flammable wildland vegetation. There are two types of WUI: interface and intermix communities. Intermix WUI refers to areas where housing and wildland vegetation intermingle, and interface WUI refers to areas where housing is in the vicinity of a large area of dense wildland vegetation. In addition, the Wildfire Influence Zone refers to an area made up of wildfire-susceptible vegetation up to 1.5 miles from the WUI, and the threat zone is an additional strip of vegetation modified to reduce flame heights and radiant heat.

The WUI is where most buildings are destroyed by wildfire in California.[66] The interface WUI in California contains approximately 50 percent of the buildings destroyed by wildfire, and the intermix WUI contains approximately 32 percent. Human-caused fires are the leading cause of wildland fires, and with thousands of people living near and visiting wildland areas, the probability of human-caused fires is growing.

The city of Stockton contains small areas of WUI scattered throughout the city (see Figure 18).

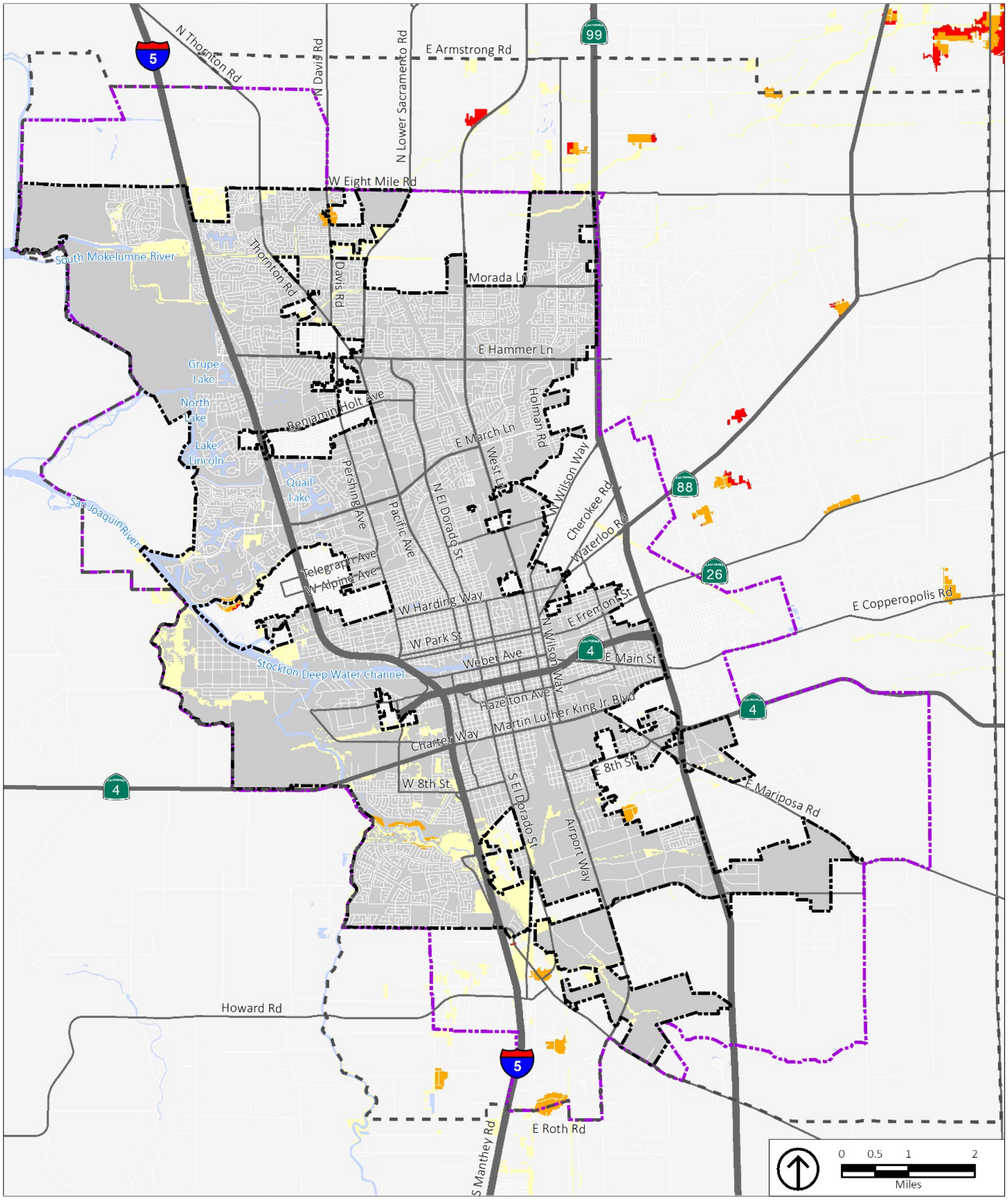
Structural Fires

Stockton is at risk from structural fires. These fires occur in built-up environments, destroying buildings and other human-made structures. Structural fires are often due to faulty wiring or mechanical equipment and combustible construction materials. The absence of fire alarms and fire sprinkler systems are often conditions that exacerbate the damages associated with a structural fire. Structural fires are largely from human accidents, although some fires may be started deliberately (arson). Older buildings that lack modern fire safety features may face greater risk of damage from fires. To minimize fire damage and loss, the City's Fire and Building Codes, based on the California Fire and Building Codes, sets standards for building and construction. They require the provision of adequate water supply for firefighting, fire-retardant construction, and minimum street widths, among other things.

2.6.5 Fire Hazard Zones

CAL FIRE (California Department of Forestry and Fire Protection) establishes fire hazard severity zones (FHSZ), designating each as moderate, high, or very high severity. Incorporated areas where local agencies are responsible for fire protection service, such as Stockton, are called Local Responsibility Areas (LRAs). Unincorporated areas where State agencies have responsibility for providing fire protection are called State Responsibility Areas (SRAs). CAL FIRE only designates very high FHSZs in LRAs. There are no very high FHSZs in the city. However, there are notable high and very high FHSZs in neighboring counties, and smoke from fires in these areas could impact local air quality.

Figure 18 Wildland-Urban Interface Zones



Source: City of Stockton; Fehr & Peers, 2016; PlaceWorks, 2023; ESRI 2019, CalFire 2015

- General Plan Planning Area
- City Limit
- Sphere of Influence
- Wildland/Urban Intermix Zone
- Wildland/Urban Interface Zone
- Wildland/Urban Influence Zone

2.6.6 Fire Protection

Fire protection in Stockton is provided by the SFD, as described in Section 2.1, Public Safety.

2.6.7 Past Occurrences

There is limited detail on historical fires in the Stockton area. However, small- to medium-sized wildfires have periodically occurred in San Joaquin County. In 2018, the Waverly Fire burned 12,300 acres and prompted evacuations and road closures in San Joaquin County. The fire started near the town of Milton.[67] In 2020, a 150-acre fire burned west of Tracy off Highway 580.[68] In 2022, the 23-acre Cord Fire was ignited in the community of Clements.[69]

Air quality in Stockton has been impacted by major recent wildfires, most notably the Lightning Complex Fire of 2020, Creek Fire of 2020, and Camp Fire of 2018. All of these fires resulted in elevated levels of particulate matter in San Joaquin County for several days.

2.6.8 Potential Changes to Fire Risk in Future Years

Likelihood of Future Occurrence

Given the limited range of fire hazard areas within and immediately around the city, the likelihood of the city experiencing a large-scale fire is small. However, the city is still susceptible to structural fires and may be affected by wildfire smoke from fires in the broader region.

Climate Change and Wildfire

Warmer weather, reduced snowpack, and earlier snowmelt attributable to climate change are expected to increase wildfire risk due to increased fuel and ignition risks. Additionally, increased flood frequency may exacerbate wildfire risk by facilitating the growth of flammable materials. However, projections from the state's Cal-Adapt database indicate that Stockton's annual wildfire risk is unlikely to change significantly.

However, wildfire risk is generally projected to increase across Northern California, and wildfires are expected to become larger and harder to control, so Stockton will likely continue to be subject to wildfire smoke. Regional wildfires may also interfere with the city's power supply via PSPS events or damage to electricity transmission infrastructure.

2.7 AGRICULTURAL AND ECOSYSTEM PESTS

Though there is limited agricultural land and open space within Stockton itself, San Joaquin County contains significant farmland, including prime farmland and farmland of statewide importance, as well as extensive wetlands and levee systems. Therefore, the county is vulnerable to agricultural and ecosystem pests. Pests that have been of particular concern in San Joaquin County recently include nutria and Russian knapweed.

The nutria is a large, semiaquatic rodent that is native to South America and highly invasive in California. Nutria are regulated as a California Department of Food and Agriculture (CDFA) A-rated pest and California Department of Fish and Wildlife (CDFW) live restricted animal. Nutria are notorious for their ecological and economic impacts, causing extensive damage to wetlands, riparian habitats, restoration efforts, levees and other infrastructure, agriculture crops, and water supplies. In 2018, nutria were found in San Joaquin County near the town of Lathrop. Since then, nutria have been detected and/or captured in Walthall Slough and Riley Slough. These nutria sightings are troubling because the Delta has an extremely fragile levee system. Nutria are known to burrow in levees, which can cause them to collapse.[70]

Russian knapweed has become an invasive nuisance in San Joaquin County. In an effort to minimize spreading, California Department of Food and Agriculture within the San Joaquin County Agricultural Commissioner's Office has released Russian knapweed gall wasps, a biological control method to slow the weed's spread.[71]

2.7.1 Potential Changes to Agricultural and Ecosystem Pests in Future Years

Likelihood of Future Occurrence

Agricultural and ecosystem pests will likely maintain a presence in San Joaquin County, though their activity can be at least partially managed via the County's pest-control initiatives.

Climate Change and Agricultural and Ecosystem Pests

Pest activity is likely to increase because higher temperatures caused by global warming allow insects to reproduce more rapidly and increase the activity window for pests and diseases. Row crops can be affected by fungal pathogens and invasive disease vectors as temperatures continue to rise, affecting the quality and viability of crops.

2.8 EXTREME HEAT

California's Cal-Adapt database of climate change effects defines extreme heat as temperatures that are hotter than 98 percent of the historical high temperatures for the area, as measured between April and October of 1961 to 1990. Days that reach this level are called extreme heat days. In Stockton, the extreme heat threshold is 102.3°F. An event with five extreme heat days in a row is called a heat wave. Extreme heat also takes the form of warm nights when temperatures do not cool down overnight to provide community members with relief from the hot days. This can also cause higher electricity use during the nighttime hours as community residents use more energy to cool homes. In Stockton, a warm night occurs when the temperature stays above 66°F.

Health impacts are the primary concern with this hazard, though economic impacts are also an issue. The Centers for Disease Control and Prevention recognize extreme heat as a substantial public health concern. Historically, data from the National Oceanic and Atmospheric Administration indicate that about 175 Americans succumb to the demands of summer heat every year, although this number has increased in recent years. From 2004 to 2018, studies by the U.S. Department of Health and Human Services indicate an average of 702 deaths annually that are directly or indirectly linked to extreme heat. Following a record-breaking heat wave in 2006, over 16,000 emergency room visits, more than 1,100 hospitalizations, and at least 140 deaths were reported. Because heat events are projected to become more frequent and last longer, preparing for the public health challenges they pose is critical.

People exposed to extreme heat can suffer heat-related illnesses such as heat cramps, heat exhaustion, and (most severely) heat stroke. . The elderly, individuals below the poverty level, outdoor workers, immigrant communities, and those experiencing homelessness are among the most vulnerable to extreme heat. Nursing homes and elder-care facilities are especially vulnerable to extreme heat events when power outages occur and air conditioning is not available. In addition, individuals below the poverty level may be at increased risk to extreme heat if use of air conditioning is not affordable.

Very high temperatures can harm plants, animals, and natural ecosystems that are not well adapted to them. Extreme heat can increase the temperature of water in lakes, streams, creeks, and other water bodies, especially during drought events when water levels are lower. In some cases, water temperatures may exceed comfortable levels for several plants and animals, causing ecological harm. Outdoor workers in construction or landscaping are much more exposed to the elements than most people, so they are more susceptible to extreme heat conditions and the potential illnesses associated with very high temperatures. Indirectly, extreme heat puts more stress on power lines, causing them to run less efficiently. The heat causes more demand for electricity (usually to run air conditioning units), and in combination with the stress on the power lines, may lead to brownouts and blackouts. Wildfire risk increases as vegetation dries out. Damage to roadways, bridges, and other transportation infrastructure may also occur.

Over half of all homes in Stockton—51 percent or 52,737 homes—were constructed prior to 1980, and some may lack air conditioning and effective insulation. People living in these homes, especially vulnerable populations, are at higher risk for heat-related illnesses from extreme heat events.

To help provide relief from the heat, the City opens cooling centers at the Arnold Rue Community Center, Seifert Community Center, Stribley Community Center, and Van Buskirk Community Center during extreme heat days and heat waves. These air-conditioned community spaces provide essential cooling for vulnerable populations, especially those susceptible to heat-related illnesses. Trees and other vegetation in the natural and urban environment also help to lower surface and air temperatures by providing shade and through evapotranspiration. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2°F to 9°F.[72] [73]

2.8.1 Past Occurrences

Warm temperatures are a regular occurrence in Stockton and the greater San Joaquin County area. Significant high heat events in summer 2003 and summer 2006 resulted in agricultural and economic losses, and the event in 2006 also resulted in 23 casualties.

2.8.2 Potential Changes to Extreme Heat in Future Years

Likelihood of Future Occurrence

Extreme heat tends to occur on an annual basis and is likely to continue occurring annually.

Climate Change and Extreme Heat

The warmer temperatures brought on by climate change are likely to cause an increase in extreme heat events. Depending on the location and emissions levels, the state Cal-Adapt database indicates that the number of extreme heat days in Stockton is expected to rise from a historical annual average of 4 to 23 by the middle of the century (2035 to 2064) and 44 by the end of the century (2070 to 2099), with occasional years experiencing many more extreme heat days. The number of warm nights in Stockton is projected to increase from an annual average of 4 historically to 27 by midcentury and 66 by the end of the century.

Overall, Stockton is expected to see an increase in the average daily high temperatures. Depending on the future severity of climate change, the Cal-Adapt database indicates that the annual average maximum temperature is expected to increase from a historical 74.2°F to 79.4°F by the middle of the century (2035 to 2064) and 82.7°F by the end of the century (2070 to 2099). Although the temperature increases may appear modest, the projected high temperatures are substantially greater than historical norms. These increases also make it more likely that an above-average high temperature will cross the extreme heat threshold. As temperatures increase, Stockton residents can expect to face increased risk of death from dehydration, heat stroke, heat exhaustion, heart attack, stroke, and respiratory distress caused by extreme heat.

Increases in both average air temperature and extreme heat days, especially when these occur sequentially, will stress Delta plant and wildlife species and alter ecosystem dynamics.[74]

2.9 SEVERE WEATHER

Severe weather is generally any destructive weather event, but usually occurs in Stockton as local storms that bring heavy rain, hail, thunderstorms, strong winds, and heavy fog. Severe weather is usually caused by intense storm systems, although strong winds can occur without a storm. The types of dangers posed by severe weather vary widely and may include injuries or deaths, damage to buildings and structures, fallen trees, roads and railways blocked by debris, and fires sparked by lightning. Severe weather can produce high winds and lightning that can damage structures and cause power outages. Lightning from these storms can ignite structure fires that can cause damage to buildings and endanger people. Objects such as vehicles, unprotected structures (e.g., bus stops, car ports), fences, telephone poles, or trees can also be struck directly by lightning, which may result in an explosion or fire.

Atmospheric rivers are a relatively common weather pattern that bring southwest winds and heavy rain to California. They can be hundreds to thousands of miles long, and though they are narrow in the context of weather systems, narrow can mean up to 300 miles across. When atmospheric rivers make landfall, they can release substantial amounts of water vapor in the form of rain or snow, often causing heavy rains that lead to flooding and mudslide events. On average, California experiences five to six atmospheric rivers per year, but in some years may only experience one or two. Atmospheric rivers are responsible for up to half of the state's annual precipitation and more than 80 percent of the flood damage, including levee breaches in the Delta.[75]

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it includes one or more of the following: hail with a diameter of three-quarters of an inch or greater, winds gusting in excess of 57.5 miles per hour (mph), or a tornado.

High winds often accompany severe storms and can cause significant property damage, threaten public safety, and have adverse economic impacts from business closures and power loss. High winds, as defined by the National Weather Service, are sustained wind speeds of 40 mph or greater lasting one hour or longer, or wind gusts of 58 mph or greater for any duration. These winds may occur as part of a seasonal climate pattern or in relation to other severe weather events, such as thunderstorms. All wind events pose several different types of threats. By themselves, winds pose a threat to the health of people and structures in the county. Dust and plant pollen blown by the wind can create breathing problems. The winds can blow roofs off buildings and cause tree limbs to fall on structures. High winds also increase the threat of wildfires. Wind dries out brush and forest areas, increasing the fuel load in fire-prone areas. Winds can spark wildfires by knocking down power lines or causing them to arc. If wildfires do start, high winds can push flames quickly into new areas, contributing to the rapid spread of wildfires and making them harder to control. This can affect the air quality in Stockton and may disrupt regional infrastructure networks.

Dense fog diminishes visibility to the point of creating a hazard, especially to transportation. San Joaquin County is subject to periods of localized dense fog in the winter called tule fog, which creates a visibility hazard on roads, freeways, airports, and rail lines throughout the county.[76] While thick tule fog presents hazards to users of local transportation systems, the fog is valuable to the agricultural community. Several crops, including almonds, apricots, cherries, peaches, and pistachios rely on tule fog to aid in their production of flowers and fruit.

2.9.1 Past Occurrences

Stockton and the greater San Joaquin County area regularly experience severe weather incidents. Countywide, notable incidents of excessive rain and severe storms occurred in 1982, 1990, 1993, 1995, 2005, 2006, and 2019.[77] These incidents were responsible for tens of millions of dollars of damage to agricultural products and road closures.

Vehicle collisions have occurred due to tule fog in San Joaquin County. One of the worst such fog-caused chain-reaction accidents involved 108 vehicles and closed Highway 99 in Fresno for more than 12 hours in November 2007. The collision unfolded over 10 minutes and resulted in two fatalities and 40 injuries.[78]

2.9.2 Potential Changes to Severe Weather in Future Years

Likelihood of Future Occurrences

Severe weather is an annual occurrence in San Joaquin County. However, actual damage associated with the primary effects of severe weather have been limited.

Climate Change and Severe Weather

Climate change is expected to cause an increase in intense rainfall and strong storm systems. This means that Stockton could see more intense weather resulting from these storms in the coming years and decades, although such an increase may not affect all forms of severe weather. Though average annual rainfall may increase only slightly, climate change is expected to cause an increase in the number of years with intense levels of precipitation. Heavy rainfall can increase the frequency and severity of other hazards, including flooding. The incidence of winter fog has decreased dramatically over the past three decades, due in part to declines in winter chill caused by climate change.

2.10 HUMAN HEALTH HAZARDS

Human health hazards are bacteria, viruses, parasites, and other organisms that are spread by insects, animals, and other pest organisms and can cause diseases and illness in people. Some of these diseases may cause only 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, seniors and seniors living alone, and pollution-burdened populations), and those who may live in sub-standard housing or not have access to health insurance and medical care (households in poverty, low-resourced people of color, immigrant communities, and overcrowded households). These persons may live in conditions that increase their chances of catching vector-borne illnesses, lack the ability to fight off infection, or lack the financial resources to seek timely medical care.

2.10.1 Past Occurrences

Incidence of West Nile virus increases with growth of the mosquito population, which typically swells in the summer months. Recorded incidents of West Nile virus occur annually in San Joaquin County in recent years. Lyme disease, Zika virus, and malaria are occasionally reported in San Joaquin County.[79]

2.10.2 Potential Changes to Human Health Hazards in Future Years

Likelihood of Future Occurrence

Human health hazards of various scales and levels of severity are likely to occur in the future.

Climate Change and Human Health Hazards

Climate change is projected to contribute to increases in average temperature and changes in precipitation patterns that favor large precipitation events and associated flooding. These changes in climatic changes promote the reproduction and speed the growth of many pest species, leading to higher populations of potential disease vectors. Overall risk of human health hazards is thus expected to increase.

[1] Cal-Adapt. Annual Averages. https://cal-adapt.org/tools/annual-averages.
[2] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[3] San Joaquin County Council of Governments. 2020. "San Joaquin Council of Governments Climate Adaptation & Resiliency Study: Climate Adaptation Report."
[4] San Joaquin County Council of Governments. 2020. "San Joaquin Council of Governments Climate Adaptation & Resiliency Study: Climate Adaptation Report."
[5] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[6] San Joaquin County Council of Governments. 2020. "San Joaquin Council of Governments Climate Adaptation & Resiliency Study: Climate Adaptation Report."
[7] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[8] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[9] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[10] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[11] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[12] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[13] United States Census Bureau. 2017 - 2021 American Community Survey 5-Year Estimates: Year Structure Built.
[14] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[15] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[16] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[17] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[18] Wyatt, D. 2021. "San Joaquin Valley Sinks in Droughts." https://www.mantecabulletin.com/news/local-news/san-joaquin-valley-sinks-droughts/
[19] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[20] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[21] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[22] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[23] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[24] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[25] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[26] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[27] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[28] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[29] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[30] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[31] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf

[32] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[33] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[34] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[35] San Joaquin County. 2022. "Reclamation Districts." https://sjmap.org/mapdocs/FrontCounter_Reclamation_Districts.pdf
[36] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[37] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[38] San Francisco Bay Keeper. 2022. Sea Level Rise in California. https://baykeeper.org/shoreview/california-slr.
[39] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[40] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future – Technical Memorandum, Flood Hazard Assessment". https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-17-flood-hazard-assessment-technical-memorandum.pdf.
[41] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[42] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[43] San Joaquin Area Flood Control Agency. 2022. "Strategic Plan." https://www.sjafca.org/home/showpublisheddocument/1325/637991766105930000
[44] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[45] San Joaquin Area Flood Control Agency. 2022. "Strategic Plan." https://www.sjafca.org/home/showpublisheddocument/1325/637991766105930000
[46] Meehan, R. "High Risk in the California Delta." https://web.stanford.edu/~meehan/deltalevees/Introduction.html
[47] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[48] Delta Stewardship Council. 2022. "The Delta Plan." https://deltacouncil.ca.gov/delta-plan/
[49] City of Stockton Municipal Utilities District. 2021. "City of Stockton 2020 Urban Water Management Plan."
[50] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[51] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[52] City of Stockton Municipal Utilities District. 2021. "City of Stockton 2020 Urban Water Management Plan."
[52] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."
[53] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[54] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[55] City of Stockton Municipal Utilities Department. 2021. "Water Shortage Contingency Plan."
[56] Cal Water. 2020. "2020 Urban Water Management Plan." https://www.calwater.com/docs/uwmp2020/STK_2020_UWMP_FINAL.pdf
[57] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[58] City of Stockton. 2018. "Envision Stockton 2040 General Plan Update and Utility Master Plan Supplements Draft EIR." http://www.stocktonca.gov/files/EnvisionStockton2040GP_DEIR.pdf
[59] Cal Water. 2021. "2020 Urban Water Management Plan." https://www.calwater.com/docs/uwmp2020/STK_2020_UWMP_FINAL.pdf
[60] City of Stockton Municipal Utilities District. 2021. "City of Stockton 2020 Urban Water Management Plan."
[61] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[62] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[63] City of Stockton Municipal Utilities District. 2021. "City of Stockton 2020 Urban Water Management Plan."
[64] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future."

https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[65] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[66] Kramer, Heather Anu; Mockrin, Miranda H.; Alexandre, Patricia M.; Radeloff, Volker C. 2019. High wildfire damage in interface communities in California. *International Journal of Wildland Fire* 28(9): 641. https://doi.org/10.1071/WF18108.
[67] CBS Sacramento. 2018. "Wavely Fire Grows to 12,300 Acres in San Joaquin County, Evacuations Lifted." https://www.cbsnews.com/sacramento/news/san-joaquin-county-calaveras-county-waverly-fire/
[68] FOX40 Web Desk. 2020. "Fire burned 150 acres in San Joaquin County, 100% contained." https://fox40.com/news/local-news/fire-burns-150-acres-in-san-joaquin-county-50-contained/
[69] Walike, L. 2022. "Sparks from grinder ignited 23-acre wildfire in San Joaquin County, Cal Fire says." https://www.abc10.com/article/news/local/wildfire/cord-fire-san-joaquin-county/103-64b77fe3-26f1-4336-a669-e45bc43aba18
[70] San Joaquin County. "2019 San Joaquin County Crop Report." https://www.sjgov.org/docs/default-source/agricultural-commissioner-documents/croprpt-archive/2010to2019/2019.pdf?sfvrsn=441fa1_5
[71] San Joaquin County. "2018 San Joaquin County Crop Report." https://www.sjgov.org/docs/default-source/agricultural-commissioner-documents/croprpt-archive/2010to2019/2018.pdf?sfvrsn=caf2adda_5
[72] Huang, J., H. Akbari, and H. Taha. 1990. The Wind-Shielding and Shading Effects of Trees on Residential Heating and Cooling Requirements. ASHRAE Winter Meeting, American Society of Heating, Refrigerating and Air-Conditioning Engineers. Atlanta, Georgia.
[73] Kurn, D., S. Bretz, B. Huang, and H. Akbari. 1994. The Potential for Reducing Urban Air Temperatures and Energy Consumption through Vegetative Cooling. ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy. Pacific Grove, California.
[74] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[75] Delta Stewardship Council. 2021. "Delta Adapts: Creating a Climate Resilient Future." https://www.deltacouncil.ca.gov/pdf/delta-plan/2021-06-25-delta-adapts-vulnerability-assessment.pdf
[76] San Joaquin County. 2017. "Local Hazard Mitigation Plan."
[77] San Joaquin County Council of Governments. 2020. "San Joaquin Council of Governments Climate Adaptation & Resiliency Study: Climate Adaptation Report."
[78] Duginski, P. 2020. "What causes dangerous tule fog in California's Central Valley, and why is it becoming less common?" Los Angeles Times. https://www.latimes.com/california/story/2020-01-11/what-causes-dangerous-tule-fog-in-californias-central-valley-and-why-is-it-becoming-less-common
[79] Bays, J. 2018. "Tick, mosquito borne diseases on the rise – outside of San Joaquin." https://www.lodinews.com/news/article_7a76bf18-5025-11e8-a9c6-2f3d3f25fb3a.html