Table of Contents

Table

Figures

PUBLIC HEALTH AND SAFETY

INTRODUCTION

The Public Health and Safety chapter of the General Plan presents the County's vision to protect people and property from natural and human-made hazards, promote public health, protect air resources, preserve and enhance water quality, and guide development in a sustainable manner that respects the needs of both people and the environment. The guiding vision statement developed by the General Plan Citizens' Advisory Committee specifically references a desire to protect health and safety in the county:

> We will use our natural habitat, farmlands, and water resources to maintain separation among our cities and unincorporated communities. These features will continue to contribute to our identity and economy and help to protect our people from flooding and other natural hazards.
>
> Because we value the quality of our air, soil, water, and other finite natural resources, we will continue to preserve agricultural lands and support practices that use renewable and recycled resources and reduce energy consumption and pollution as much as possible.
>
> We will also promote public health, safety and security, and environmental justice as part of an equitable society.

Based on these statements, the major strategies in the Public Health and Safety chapter are:

- Maintaining distance between hazards and humans with agricultural lands and open space.
- Improving air quality on a regional scale through partnerships with other Bay Area organizations.
- Promoting development that works with nature to slow global climate change and its impact on nature and reduces human risks associated with environmental hazards, including hazards created or increased by climate change.

Policies proposed in each section of the chapter address these general health and safety strategies. Programs to implement these policies are also presented to ensure that each policy can be carried out.

Purpose and Content

The Solano County Public Health and Safety chapter is a State-mandated General Plan element that must identify potential natural and human-created hazards that could affect Solano County's residents, businesses, and services. The purpose of the chapter is to establish a framework that anticipates these hazards and prepares the community to minimize exposure to these risks.

The Public Health and Safety chapter conveys the County's goals, policies, and actions to minimize the hazardous situations and protect and improve public health in and around Solano County. 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 Solano County 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 Public Health and Safety chapter aims to reduce this risk by:

- Developing a framework by which safety considerations are introduced into the land use planning process.
- 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 development.
- Strengthening preparedness planning and post-disaster reconstruction policies for earthquakes, flood, dam inundation, wildfire, 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 Public Health and Safety chapter 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 chapter contain background information and policies to address multiple natural hazards, analyze the vulnerabilities from climate change, improve climate change resilience, and assess residential areas with evacuation constraints. The public safety issues in Solano County include emergency preparedness and response, flood and inundation hazards, seismic and geologic hazards, fire hazards, hazardous waste and materials, and climate-related hazards such as drought, extreme heat, and severe weather. The Public Health and Safety chapter identifies goals and policies for each of these hazards.

Collectively, the Public Health and Safety goals, policies, and implementation programs are designed to guide the County to a healthier and safer future. To provide a framework for this effort, the Governor's Office of Planning and Research has established guidelines for the content of general plans in California. The Safety and Noise sections in this Public Health and Safety chapter are required by State law to address specific issues. Although air quality is not required as a separate general plan element, state guidelines recommend that it be addressed in a local general plan, either as a separate, optional, element or through policies in a mandatory element (such as Conservation).

A general plan must examine issues related to protecting the community from any unreasonable risks associated with:

- Seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure.
- Slope instability leading to mudslides and landslides.
- Subsidence, liquefaction, and other seismic hazards identified on seismic hazard maps.
- Other known geologic hazards.
- Flooding and related sea level rise impacts.
- Wildland and urban fires.

It must also address the following as they relate to known fire and geologic hazards:

- Evacuation routes and signage.
- Peak load water supply requirements.
- Military installations.
- Minimum road widths and turnouts.
- Clearances around structures.

Issues to be addressed by the Noise section include:

- Major noise sources, both mobile and stationary.
- Existing and projected levels of noise and noise contours for major noise sources.
- Existing and projected land uses and their proximity to existing and projected noise sources.
- Existing and proposed sensitive receptors, including:
    - Hospitals.

- Convalescent homes.
- Schools.
- Churches.
- Sensitive wildlife habitat, including the habitat of rare, threatened, or endangered species.
- The extent of "noise problems in the community" (survey of community to determine location and extent).
- Methods of noise attenuation and the protection of residences and other sensitive receptors from excess noise.
- Implementation and possible solutions that address existing and foreseeable noise problems.

Issues that could be addressed in an optional Air Quality element or section of the general plan include:

- Meteorological conditions affecting air quality and a description of the area's current air quality attainment status.
- Ambient air quality based on data from local monitoring stations.
- Applicable federal and state standards and laws pertaining to air pollution.
- The types of sources of stationary and mobile air pollution.
- Amounts of emissions produced by different sources of air pollution.
- Reference to applicable regional or local air quality plans.
- State, regional, and local transportation programs that affect the type and location of transportation facilities.

Scope and Content

The chapter begins by introducing the County's health and safety goals. Separate sections describing various hazards and their potential impacts on the county follow. These topics include:

- Flood control
- Seismic safety and land stability
- Fire safety
- Hazardous materials

- Disaster preparedness
- Public health
- Air quality
- Noise

Each section contains a summary of current conditions followed by a brief overview of applicable federal, State, regional, or County agencies, plans, or programs. Policies and implementation programs specific to each topic follow this introduction and are used to ensure that public health and safety goals are accomplished.

Relationship to Other Documents

General Plan Chapters

The Solano County Public Health and Safety chapter does not exist in a vacuum but is one of several plans that address community public safety and related topics. These other plans include other General Plan chapters, the 2022 Solano County Multi-jurisdiction Hazard Mitigation Plan (MJHMP), the Solano County Emergency Operations Plan (EOP), and various local regulations. The Public Health and Safety chapter should be consistent with these other chapters and plans to minimize conflicts between documents and ensure that the County has a unified strategy to address public safety issues. The Public Health and Safety chapter incorporates information, technical analyses, and policies from these other documents where appropriate to help support this consistency.

The Noise and Safety sections in the chapter are related to the rest of the General Plan, specifically the Land Use, Transportation and Circulation, and Housing chapters.

Protecting residents and their property from undue harm requires the County to identify areas that are unsuitable for future development. The Public Health and Safety chapter achieves this by documenting locations of known natural hazards and areas of excessive noise. These findings will guide:

- Land use decisions minimizing human exposure to dangerous areas.
- Circulation policies informing the placement of new roads and other infrastructure, such as utility lines, oil and gas pipelines, and aqueducts.
- Housing locations protecting residences and other noise- sensitive uses from unacceptable sound levels.

The policies and implementation programs in the chapter are supported by those in the rest of the General Plan.

The Public Health and Safety chapter provides policy direction and considers safety improvements that complement the intent and policies of other General Plan chapters. Crucial relationships exist between the chapter and the others in the General Plan. How land uses are determined in areas prone to natural hazards, what regulations limit development and land uses in these areas, and how hazards are mitigated for existing development are all issues that tie the elements together. For instance, the Land Use chapter diagrams and policies must consider the potential for various hazards identified in the Public Health and Safety chapter and must be consistent with the policies to address those hazards. The Open Space section of the Resources chapter is also closely tied to the Public Health and Safety chapter. 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. Public Health and Safety chapter policies, especially those concerning evacuation routes and critical facilities, must also be consistent with those of the Transportation and Circulation chapter.

Solano County Multi-jurisdiction Hazard Mitigation Plan

In collaboration with local agencies and special districts, the County of Solano prepared the 2022 MJHMP in accordance with the federal Disaster Mitigation Act of 2000 and the Federal Emergency Management Agency's (FEMA) hazard mitigation assistance guidance. Solano County's MJHMP is a plan that assesses hazard vulnerabilities from natural and human-caused hazards, including risk to people and facilities, and identifies mitigation actions to reduce or eliminate hazard risks in Solano County, including incorporated communities. The mitigation actions in the MJHMP include both short-term and long-term strategies and involve planning, policy changes, programs, projects, and other activities. These mitigation actions are identified based on assessments of hazards, vulnerabilities, and risks and the participation of a wide range of stakeholders and the public in the planning process. Local governments are required to develop a hazard mitigation plan as a condition for receiving certain types of nonemergency disaster assistance.

The MJHMP and the Public Health and Safety chapter address similar issues, but the Public Health and Safety chapter provides a higher-level framework and set of policies that pertain to the safety of the county, and the LHMP focuses on more specific mitigation, often short-term actions to enable jurisdictions to better protect lives, property, and natural systems. The MJHMP, as its name implies, focuses on mitigation-related actions; the Public Health and Safety chapter also includes policies related to emergency response, recovery, and preparation activities. Hazard mitigation plans form the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. The current MJHMP, approved by FEMA, is incorporated into the chapter by reference, as permitted by California Government Code Section 65302.6.

Solano County Emergency Operations Plan

The EOP describes planned response to extraordinary emergency situations associated with natural disasters, technological (human-caused) emergencies, and war emergency operations in or affecting Solano County. The EOP establishes 1) an emergency management organization that will respond given any significant emergency or disaster affecting Solano County; 2) policies, responsibilities, and procedures required to protect the health and safety of the community, public and private property, and the environment from the effects of natural and human-caused (technological) emergencies and disasters; 3) the operational concepts and procedures associated with field response to emergencies, Emergency Operations Center (EOC) activities, and the recovery process; and 4) the organizational framework for implementation of the Standardized Emergency Management System (SEMS) and National Incident Management System (NIMS) in Solano County. The EOP is the principal guide for the County and special districts who respond to and mitigate emergencies and disasters in Solano County. It is intended to facilitate multi-agency and -jurisdictional emergency operations and coordination, particularly between local government and the operational area (county boundary) as well as state and federal response by request.

Community Profile

Solano County extends from the shores of San Pablo Bay in the west to the heart of the Central Valley in the east and is centrally located between the San Francisco and Sacramento metropolitan regions. The county encompasses approximately 910 square miles—830 square miles of land and 80 square miles of water. The unincorporated area of the county covers approximately 773 square miles (494,437 acres). Approximately 128 square miles of the county, or 14 percent of the total land area, lies within seven incorporated cities: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo.

Because of Solano County's commitment to focus development within urban areas, about 95 percent of the county's population lives in the cities. Approximately 20 percent of the unincorporated land area is undeveloped natural resource land. This includes 101,307 acres of marsh and watershed lands in the southern and western portions of the county. Over 329,000 acres are in agricultural use, or approximately 70 percent of the unincorporated land area. Agricultural land is concentrated in the eastern portion of the county and in smaller areas scattered throughout the county. Watershed lands are also in agricultural use. Residential land uses occupy approximately 6,878 acres that are developed mostly at rural residential densities of one dwelling unit per 2.5 or more acres.

Most of the existing industrial development in the county is within cities. In the unincorporated county, industrial land uses account for about 2,125 acres. Approximately 641 acres are in commercial land use, which includes retail, commercial services, and service stations. Smaller commercial developments in the unincorporated county areas serve the needs of local residents and visitors. Highway-oriented commercial development is the predominant commercial land use in the unincorporated area, and the majority of such land is along Interstate (I-) 80. Other uses of land in the county include public use (such as schools, cemeteries, and federal lands), which accounts for about 1,517 acres; park and recreation

land (791 acres); and vacant land, which includes about 1,011 acres. Travis Air Force Base encompasses 6,258 acres and is near the cities of Fairfield, Suisun City, and Vacaville.

Solano County lies at the intersection of numerous geographical and geological provinces that, together with variations in hydrology and climate, have resulted in the formation of unique and rare biological and ecological conditions and a rich diversity of native species and habitats. Solano County is home to both natural gas deposits and valuable wind resources. Its soils and water resources contribute to a rich agricultural landscape.

Solano County has a Mediterranean climate, with rain in the winters; hot, dry summers; and Diablo winds occurring throughout the year. Solano County's climate is typical of the northern Central Valley just inland of the Bay Area.[1] Annual high temperatures in Solano County range from 55 degrees Fahrenheit (°F) in December and January to 89°F in July and August. Low temperatures range from 38°F in December and January to 57°F in July and August.[2] The county receives an average of approximately 19.4 inches of precipitation annually.[3] Most precipitation falls during the winter months, with rare occurrences of summer storms.

According to the 2020 decennial census, unincorporated Solano County is home to approximately 19,631 residents and 7,398 households. Of the total residents in the unincorporated county, an estimated 8.2 percent are under 10 years of age, and an estimated 24.9 percent are 65 years of age or older.[4] Solano County is composed of seven school districts—Benicia Unified School District (USD), Fairfield-Suisun USD, Travis USD, Dixon USD, Vacaville USD, Vallejo City USD, and River Delta Joint USD. The Solano County Sheriff's Office and several fire protection districts provide police and fire services to communities across the county.

Unincorporated Solano County's primary transportation access is from Interstate I-80, I-680, and I-505. I-80 intersects the county from southwest to northeast; I-680 traverses from south to north in the southwestern region of the county; and I-505 traverses from south to north in the northern region of the county. Other major roadways include SR-12, which intersects the county from west to east; SR-37, which traverses from west to east in the southwestern region of the county; and SR-84 and SR-113, which traverse from south to north in the eastern part of the county. Dixon Readi-Ride, Fairfield and Suisun Transit System, Rio Vista Delta Breeze, Solano County Transit, Solano Express, and Vacaville City Coach provide local transit services, and Amtrak provides regional rail transit services.

Climate Change Vulnerability

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://resilientca.org/apg/.

Changes to the global climate system are expected to affect future occurrences of natural hazards in and around Solano County. Many hazards are projected to become more frequent and intense in the coming years and decades—in some cases, these trends have already begun. Key climate change considerations that affect Solano County include increasing temperatures, changes in precipitation, and sea level rise. Overall, precipitation levels are expected to increase only slightly; however, there are likely to be more years of extreme precipitation events and droughts that last longer and are more severe. According to California's Fourth Climate Change Assessment, Solano County can expect to experience various changes to climate-related hazard events.[5]

Sea level rise is a gradual process, taking place over years or decades that can cause permanent and temporary flooding along coastal and shoreline areas, as well as inland areas in the watershed. Along the Solano County shoreline, sea levels are projected to rise by as much as 24 inches by 2050 and 84 inches by 2100.[6] However, it is possible that sea levels could rise faster than these projections.[7] Rising sea levels can also cause the shoreline to flood more frequently and severely during storms or king tide events. Because ocean levels are higher during normal conditions due to sea level rise, shoreline floods can reach farther onto land. A storm with a 1 in 5 chance of occurring in a given year (known as a 5-year storm) can create a temporary increase in sea levels of 24 inches. This means that if sea levels rise during normal conditions by 24 inches by 2050, a 5-year storm event could create a temporary sea level rise of an additional 24 inches, or 48 inches above the current sea level. Furthermore, sea level rise can also increase Delta salinity, possibly requiring that any water withdrawn from the Delta be desalinated prior to use in agriculture or urban areas.

Both droughts and floods are expected to become more frequent because rainfall is expected in fewer, more intense storms due to climate change. Although Solano County is likely to experience only a slight increase in overall annual precipitation levels due to climate change, that precipitation is expected to fall in fewer, more extreme events. As a result, **floods** are expected more often in Solano County, and climate change may expand the parts of the county that are considered prone to flood, especially in areas adjacent to the shoreline and tributaries in the southern and eastern portions of the county.

Climate change is also expected to increase the frequency and severity of **droughts**, which cause soil to dry out and condense. When precipitation does return, more water runs off the surface of the dry ground rather than being absorbed, and this can lead to floods. Drought conditions will likely strain the water supplies from the State Water Project and Solano Project that meet most of Solano County's water demand, causing the water shortage contingency plan and demand reduction actions to more frequently go into effect. Extended droughts may also reduce groundwater levels and impact shallow wells, especially for drinking water.

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 landslides in the hills around Solano County. Most severe weather events in Solano County consists of atmospheric rivers or high winds. Although a connection between climate change and severe weather is not as well established as for other hazards, severe winds such as the Diablo winds, which tend to be most frequent during the fall and winter months, may coincide more frequently with wildfire conditions. This can cause fires to grow and spread more rapidly or trigger public safety power shutoffs to prevent wildfires from sparking.

Warmer temperatures are projected to cause an increase in **extreme heat events**. The number of extreme heat days—defined in Solano County as a day when the high temperature is at least 100.2°F (varies by location)—is expected to rise from a historical annual average of 4 to 24 days per year by the middle of the century (2035 to 2064), and to an average of 43 days per year by the end of the century (2070 to 2099). Solano County is also expected to see an increase in the average number of warmer nights. The number of warm nights, defined in Solano County as a night when the minimum temperatures stay above 62.6°F, is expected to rise from a historical annual average of 5 to 36 nights per year by the middle of the century (2035 to 2064), and to an average of 89 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.

Wildfire risk in Solano County is increasing, and hotter, drier weather because of climate change is expected to lead to an increase in wildfires across Solano County. Drier conditions earlier in the year could result in a large portion of the region experiencing moderate to extreme drought conditions prior to summer. These continued dry conditions, with above-normal temperatures through spring, will leave fuel moisture levels lower than normal, increasing the potential for wildfire activity and extending fire season. Increased winds may result in more erratic fire behavior, making fires harder to control and increasing the likelihood that wildfires will travel into Solano County. Furthermore, an extended wildfire season increases the likelihood that Diablo wind events will coincide with wildfires, spreading them more rapidly. Across the region, more frequent and intense wildfires may also create poor air quality for Solano County.

Climate change can increase the rates of infection for various **diseases** because many of the animals that carry diseases are more active during warmer weather. Several of these vector-borne diseases are linked to climate change and can be harmful to the health of Solano County community members, such as hantavirus pulmonary syndrome, Lyme disease, and West Nile fever. Many of these diseases are carried by animals, such as mice and rats, ticks, and mosquitos, which are usually seen as pests even if they do not cause infections. Warmer temperatures earlier in the spring and later in the winter allow these animals to be active for longer periods, increasing the window when these diseases can be transmitted.

Vulnerability Assessment Results

Under California law, the Public Health and Safety chapter 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 County conducted a Climate Change Vulnerability Assessment in the spring of 2022 to analyze Solano County's susceptibility to climate-related hazards. The assessment was prepared in accordance with the most recent available guidance in the California Adaptation Planning Guide. It assesses how seven different climate-related hazards (drought, extreme heat, human health hazards, inland flooding, landslides, sea level rise, severe storms, shoreline flooding, and wildfire and smoke) may affect 67 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 Solano County's populations and assets are most vulnerable to inland flooding, severe weather, and wildfire. Overall, populations in Solano County tend to be most vulnerable to inland flooding, extreme heat and warm nights, wildfire and smoke, and human health hazards, which directly affect health outcomes. The most vulnerable communities include outdoor workers, immigrant communities, households in poverty, and low-resourced people of color—all of these are highly or severely vulnerable to all climate change hazards. Additional highly vulnerable populations include persons experiencing homelessness, persons with chronic illnesses and/or disabilities, pollution-burdened populations, and seniors living alone.

Climate change could affect the transportation network and associated economic activity in Solano County by creating strain on transportation infrastructure, resulting in impacts to travel behavior, goods movement, and supply chain continuity. Transportation infrastructure, such as roadways, bridges, and railways, are all potentially at increased risk due to inland and shoreline flooding, landslides, and severe weather. When parts of the transportation infrastructure network fail, typical routes for passenger travel and goods movement may be disrupted, including portions of SR-12, SR-84, and SR 113, which already experience flooding during heavy rainfall. Disruption of these local transportation roadways due to hazards such as flooding, landslides, or severe weather could significantly impact the transportation of goods and services provided in the county, the economic vitality of the community, the ability to evacuate during an emergency, and the livelihood of many businesses.

Countywide, energy delivery is vulnerable to multiple hazards, including severe weather, such as high winds that can trigger public safety power shutoff events; extreme heat that strains the system and reduces its capacity; and wildfires that damage the system, ultimately disrupting energy service. Extreme heat can lead to power outages by causing mechanical failure of grid equipment and heat damage to power lines as well as by creating a high demand for electricity to power air conditioners, all of which place stress on the network and lead to rolling blackouts. Electrical transmission infrastructure is subject to harm from landslides and shoreline flooding, which can undermine the foundations of transmission towers and flood substations.

Public safety power shutoff events or other interruptions in energy service due to extreme heat can create vulnerabilities for Solano County community members. A loss of electricity can cause a loss of refrigeration for food and medical supplies, limit cooking, cause loss of cooling (particularly dangerous during extreme heat events) and lighting, and limit or cut off 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.

Climate change is also expected to affect parts of the county that are considered prone to both inland and shoreline flooding due to sea level rise and stronger storm systems. As a result, agricultural land, homes, and commercial properties throughout the county will likely experience an increase in the frequency and magnitude of inland and shoreline flood events in future years. Increases in damaging flood events in the county are expected to cause greater property damage, public health and safety concerns, displacement, and loss of life. Increased sea level rise and shoreline flooding may also harm the outdoor water recreation industry, which relies heavily on marinas and piers that could be damaged and become unusable in the future.

The Public Health and Safety chapter 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 can be found in **Appendix A**.

PUBLIC SAFETY ISSUES

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

- Emergency preparedness and response
- Flood and inundation hazards
- Seismic and geologic hazards
- Fire hazards
- Hazardous waste and materials
- Agriculture and ecosystem hazards
- Additional climate-related hazards (drought, extreme heat, and severe weather)

This section provides details pertaining to the probable locations of each hazard or issue (per availability of data), past notable events in and around Solano County, agencies responsible for providing protection from these public safety issues, and other background information required by California Government Code Section 65302(g)(4). Goals, policies, and implementation actions are identified following the discussion of each hazard identified.

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

FLOOD AND INUNDATION HAZARDS

Planning Context

Flooding

Flooding is when the level rises in a body of water and it overflows onto normally dry land. Historically, floods are one of the most frequent natural hazards to communities in Solano County. Floods are usually caused by large amounts of precipitation, either very intense precipitation or a long period of steady precipitation.

There are six types of flood events that might happen in Solano County: riverine, flash, urban stormwater, levee or canal, and coastal delta flooding. Regardless of the type, the cause is primarily the result of extreme weather and excessive rainfall, either in the flood area or upstream reach.

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

Riverine flooding, the most common type of flood event, occurs when a watercourse overruns its banks. Riverine flooding occurs as a result of prolonged rainfall that is combined with saturated soils from previous rain events or snowmelt, and it is characterized by high peak flows and a large volume of runoff. The duration of riverine floods varies from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation amount, intensity and distribution, soil moisture content, channel capacity, seasonal variation in vegetation, snow depth, and water resistance of the surface due to urbanization.

In Solano County, riverine flooding can occur anytime during the rainy season, which is usually from November through May. Several streams in the county have long histories of seasonal flooding, often resulting in significant damage. Flooding is more severe when previous rainfall has resulted in saturated ground conditions, which often results in flooding to a number of streams. Also, flood risk is intensified in the lower stream reaches by the probability of coincident high tides and strong offshore winds during heavy rainfall.

The term "flash flood" describes localized floods of great volume and short duration, generally less than four hours. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall in a relatively small drainage area. Precipitation of this sort usually occurs in the spring and summer. Occasionally, flash flooding may occur from short-duration, high-intensity precipitation events (often during thunderstorms), even during drought conditions. Flash floods can tear out trees, undermine buildings and bridges, and scour new channels. In urban areas, flash flooding is an increasingly serious problem due to removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots.

Urbanization may increase peak flow runoff as well as the total volume of stormwater runoff from a site. The increase is dependent upon the type of soil and its topography in relation to the proposed development. Developments create impermeable surfaces and reduce the total surface area that can absorb water. Stormwater runoff is augmented by water flows from development, contributing to street flooding. Moreover, developed areas generate irrigation water runoff from landscaping, which may channel stormwater and other runoff flows into nearby underdeveloped areas and street gutters.

Urbanization is further aggravating the potential for stormwater flood damage in the county by reducing floodplain area available to absorb stormwater in low-lying areas and preventing natural absorption of stormwater in the higher, upstream watersheds. Thus, unchecked urbanization is leading to increased rates and volumes of stormwater runoff in the county. Because of the varying conditions of watersheds in the county, each one should be individually addressed using a coordinated set of County policies that control watershed runoff and stream overflow to reduce flooding.

In Solano County, a large portion of developed and undeveloped county lands are subject to flooding as a result of heavy seasonal rainfall, dam inundation, and canal or levee failure. A majority of these county flood-prone areas are specifically subject to inundation as a result of heavy rainfall and resulting stream overflows.

Agricultural land has long been used for valuable de facto flood protection. Farmers have historically allowed stormwater detention on their properties during storm events and have expressed a desire that the County recognize the positive contributions of farmland as a flood prevention and reduction measure.

Areas at an elevated risk of flooding are generally divided into 100- and 500-year flood zones. A 100-year flood zone has a 1 percent chance (1 in 100) of experiencing a flood in any given year, and a 500-year flood zone has a 0.2 percent chance (1 in 500) of flooding in any given year. Some parts of California,

including Solano County, also have 200-year flood zones. These are areas that have a 0.5 percent chance (1 in 200) of flooding in any given year.

The 100- and 500-year floodplains in Solano County include the areas along the shoreline of the Sacramento River, Suisun Bay and Grizzly Bay, Suisun Marsh, areas around Suisun City and Fairfield, and lands in the eastern portions of the county. The 200-year floodplain is in the eastern part of Solano County, in the Sacramento-San Joaquin Delta area on unincorporated land designated for agricultural use, or land designated for agricultural, industrial, commercial, and residential uses in the City of Rio Vista Municipal Service Area.

Agencies responsible for flood control in Solano County include the Unites States Army Corps of Engineers (USACE), Solano County Water Agency (SCWA), Federal Insurance Administration, and the Department of Water Resources (DWR).

- The USACE identifies the need for and constructs major flood-control facilities. It also develops flood- and dam-inundation maps and reports.

- SCWA is active in flood control and drainage planning. SWCA is responsible for the management of embankments, shoreline protection structures, berms, and five miles of levees along San Pablo Bay, Carquinez Strait, and Suisun Bay. SCWA is also responsible for the operation and maintenance of two flood control projects—the Ulatis Flood Control Project and the Green Valley Flood.

- 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, which 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 Flood Insurance 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.

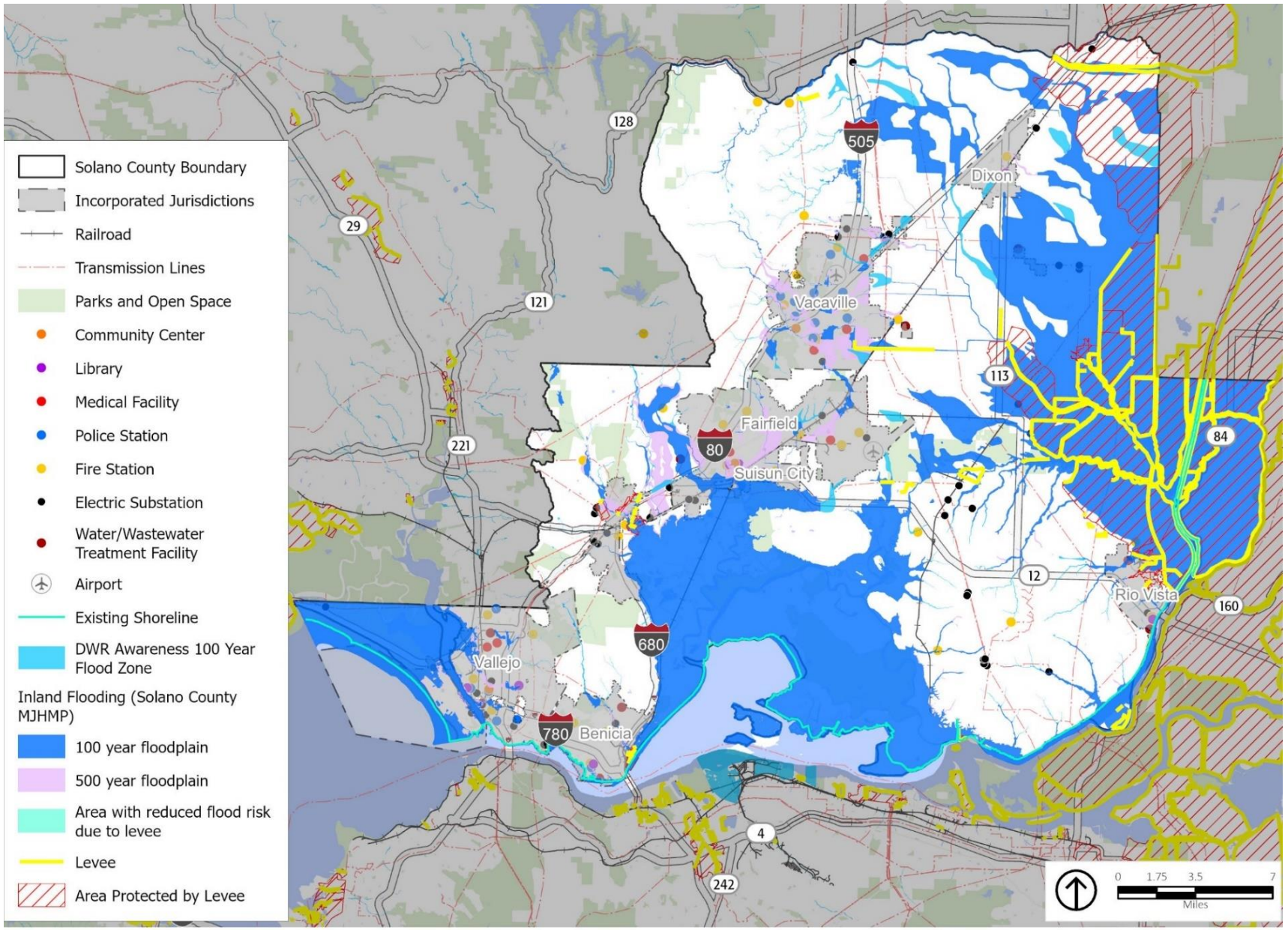
Floodplains can change over time; the floodplain and watercourse of a stream can also be affected by anthropogenic (i.e., human) influences, such as the development of land into residential or commercial structures and the resulting reduction of pervious land, resulting in increased stream flow; the

construction of bridges or culverts; or the creation of levees or other impoundment structures that control the flow in the watercourse.

As required by AB 162, Solano County has incorporated Central Valley Flood Protection Plan (CVFPP) measures into this chapter of the General Plan through inclusion of new 200-year flood, levee, and dam mapping as well as more extensive flood risk analysis. The County will incorporate related measures into the Zoning Ordinance. Additionally, the County will continue to apply CVFPP information in the development and approval of specific projects and developments.

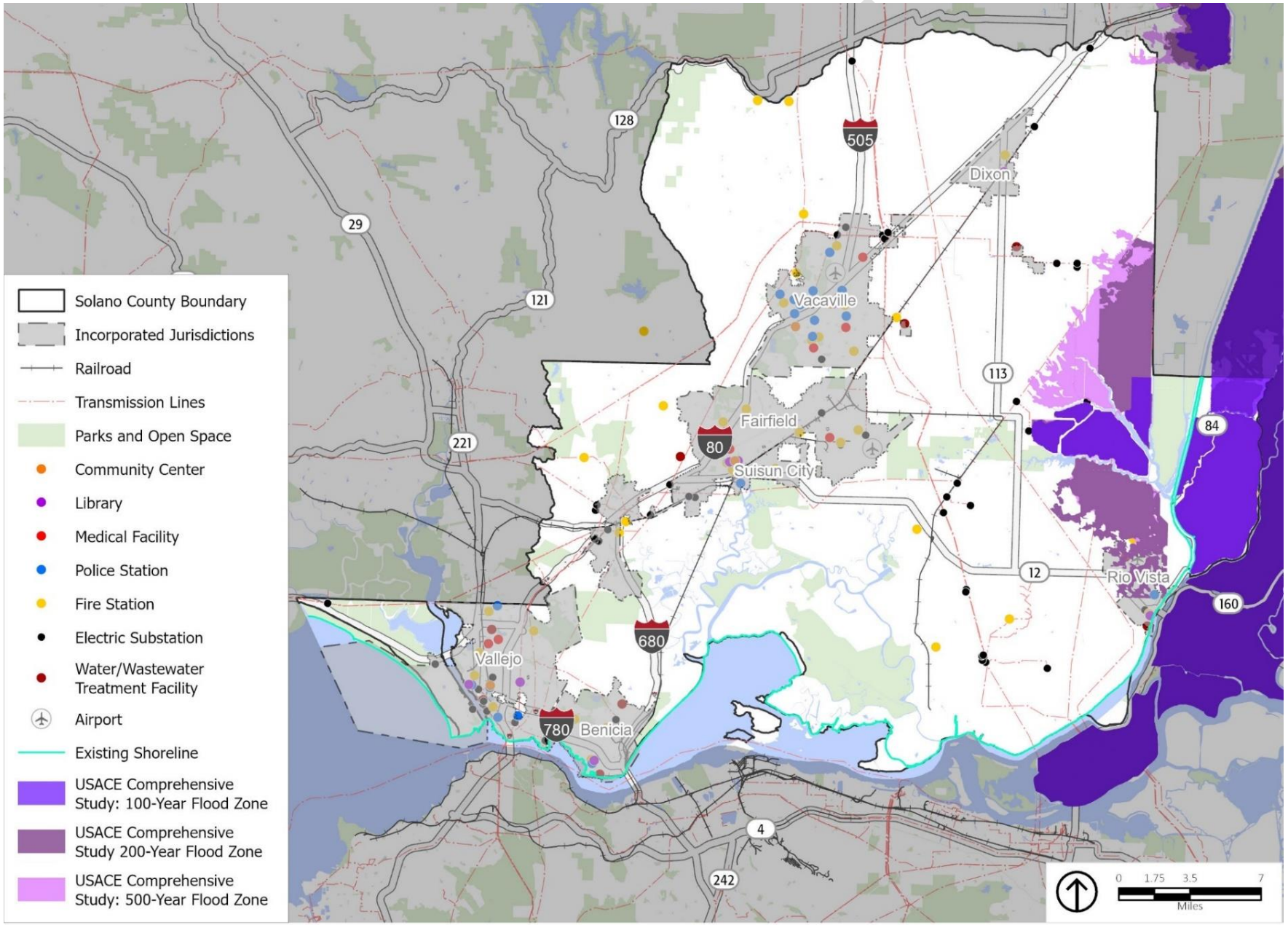
Figure HS-1 shows the 100-year and 500-year flood zones identified by FEMA, the 100-year flood zones identified by DWR, and existing levees and the areas they protect. **Figure HS-2** shows the 100-year, 200-year, and 500-year flood zones identified by the USACE.

Figure HS-1: FEMA and DWR Flood Zones and Levee Protection Zones



Source: National Levee Database 2021, Solano County 2021, PlaceWorks 2022, ESRI

Figure HS-2: USACE Flood Zones



Source: USACE 2002, Solano County 2021, PlaceWorks 2022, ESRI

Sea Level Rise and Shoreline Flooding

Sea level rise is an increase in the ocean's surface height relative to the land. 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, taking place over years or decades. Sea level rise, a direct result of climate change, 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 erode coastal lands over time. The sea level rose during the 20th century, and observations and projections suggest that it will rise at a higher rate during the 21st century. San Francisco recorded an average sea level rise of about 2.0 millimeters (mm) per year since the late 19th century. This is comparable to a global average during the 20th century of 1.4 mm per year—a pace that has not been exceeded in any century since at least 2,800 years ago.[8] 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 inundates areas further inland.

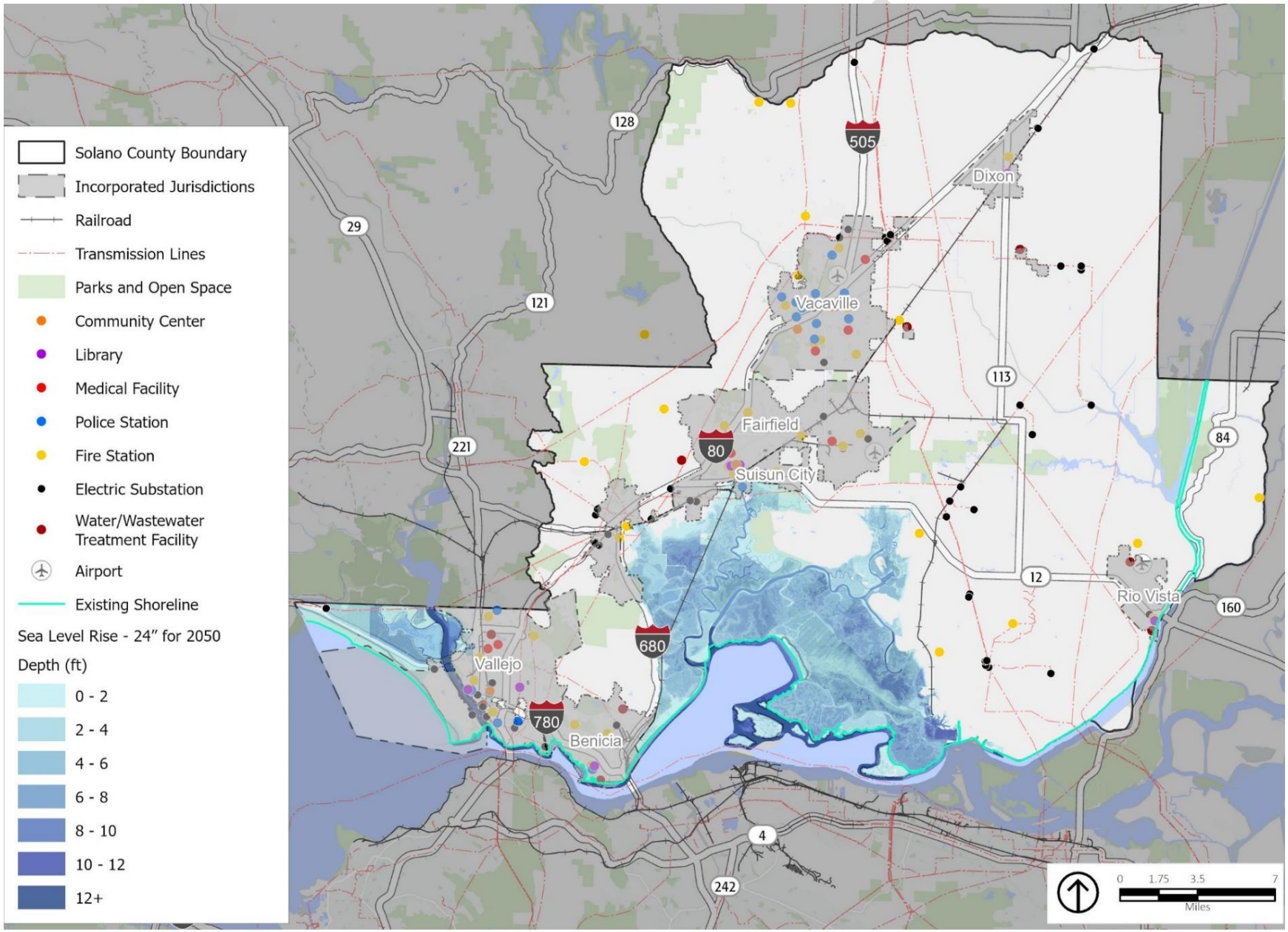
Along the Solano County shoreline, sea levels are projected to rise as much as 24 inches by 2050 (midcentury) and 84 inches by 2100 (end of century). However, it is possible that sea levels could rise faster than these projections. Sea level rise projections for the years 2050 and 2100 in Solano County are shown on **Figures HS-3** and **HS-4**, respectively. Sea levels may increase enough by 2100 to permanently flood low-lying areas in the southern part of Solano County along the shoreline, including Suisun Marsh. Rising sea levels can also result in flooding to inland areas of the watershed. This can be particularly harmful to areas around locations with groundwater or soil contamination, as sea level rise can spread this contamination across a broader area.

Rising sea levels can also cause the shoreline to flood more frequently and severely during storms or king tide events because ocean levels are higher during normal conditions. For example, a storm that has a 1 in 5 chance of occurring in a given year (known as a 5-year storm) can create a temporary increase in sea levels of approximately 24 inches. This means that if sea levels are 24 inches higher during normal conditions, a 5-year storm event would create a temporary sea level rise of an additional 24 inches, that is, around 48 inches higher than at present. Shoreline flooding projections for the years 2050 and 2100 in Solano County are shown on **Figures HS-5** and **HS-6**, respectively.

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 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 in areas susceptible to sea rise should be designed for resilience.

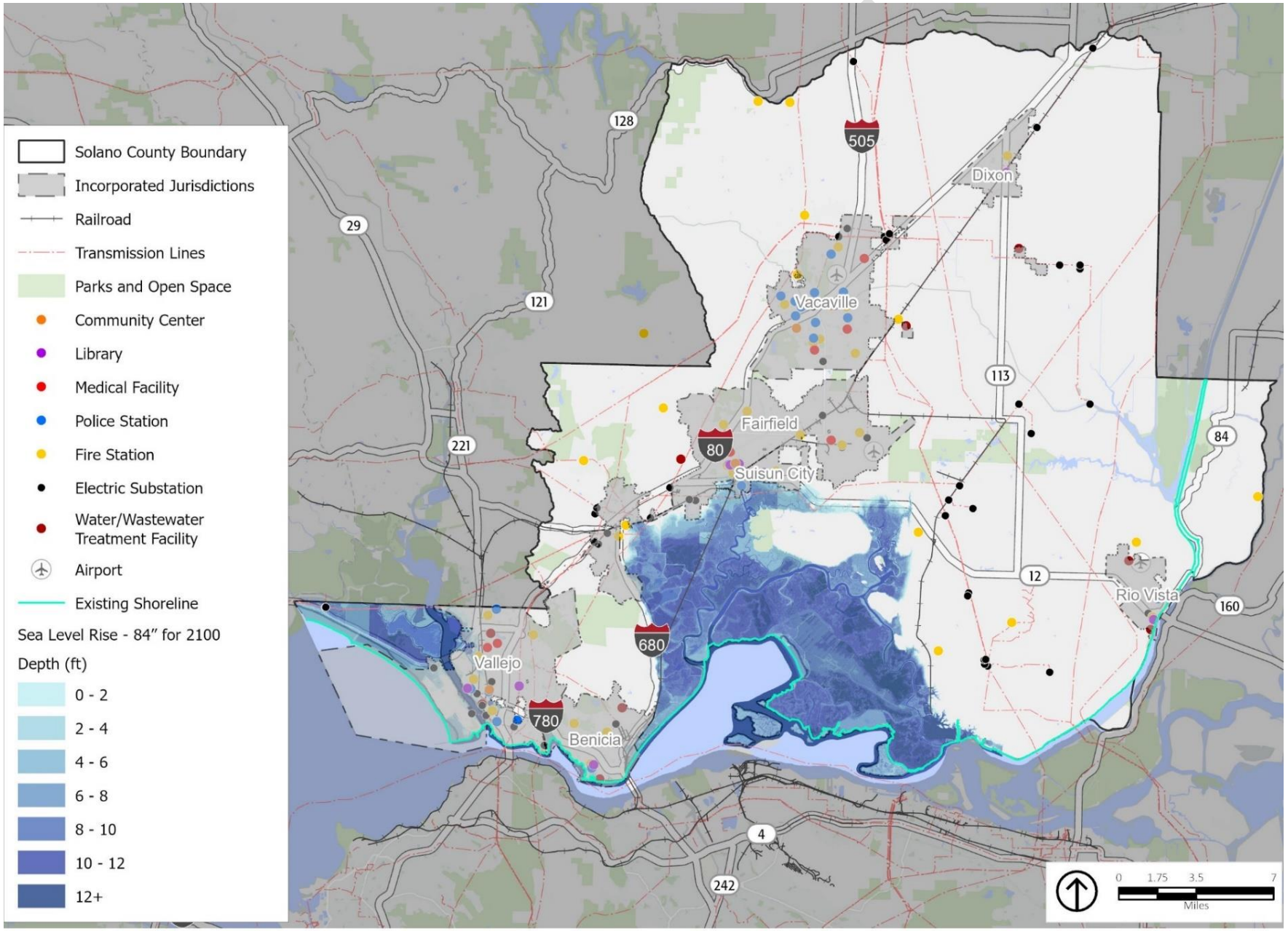
The County of Solano developed a Sea Level Rise Strategic Program (SLRSP) to address climate change and associated sea level rise at the local level. The County prepared the SLRSP with the intent of promoting safety and economic well-being, given that much of the county's land area is within a few feet of current sea level. To raise awareness of the issue and allow for effective, cost-efficient, and timely land use planning and adaptation, the SLRSP evaluates both a short-term and long-term scenario, assessing vulnerabilities at midcentury and end of century. The SLRSP provides the County with a framework to successfully adapt to sea level rise and its anticipated effects.

Figure HS-3: Sea Level Rise Projections – 2050



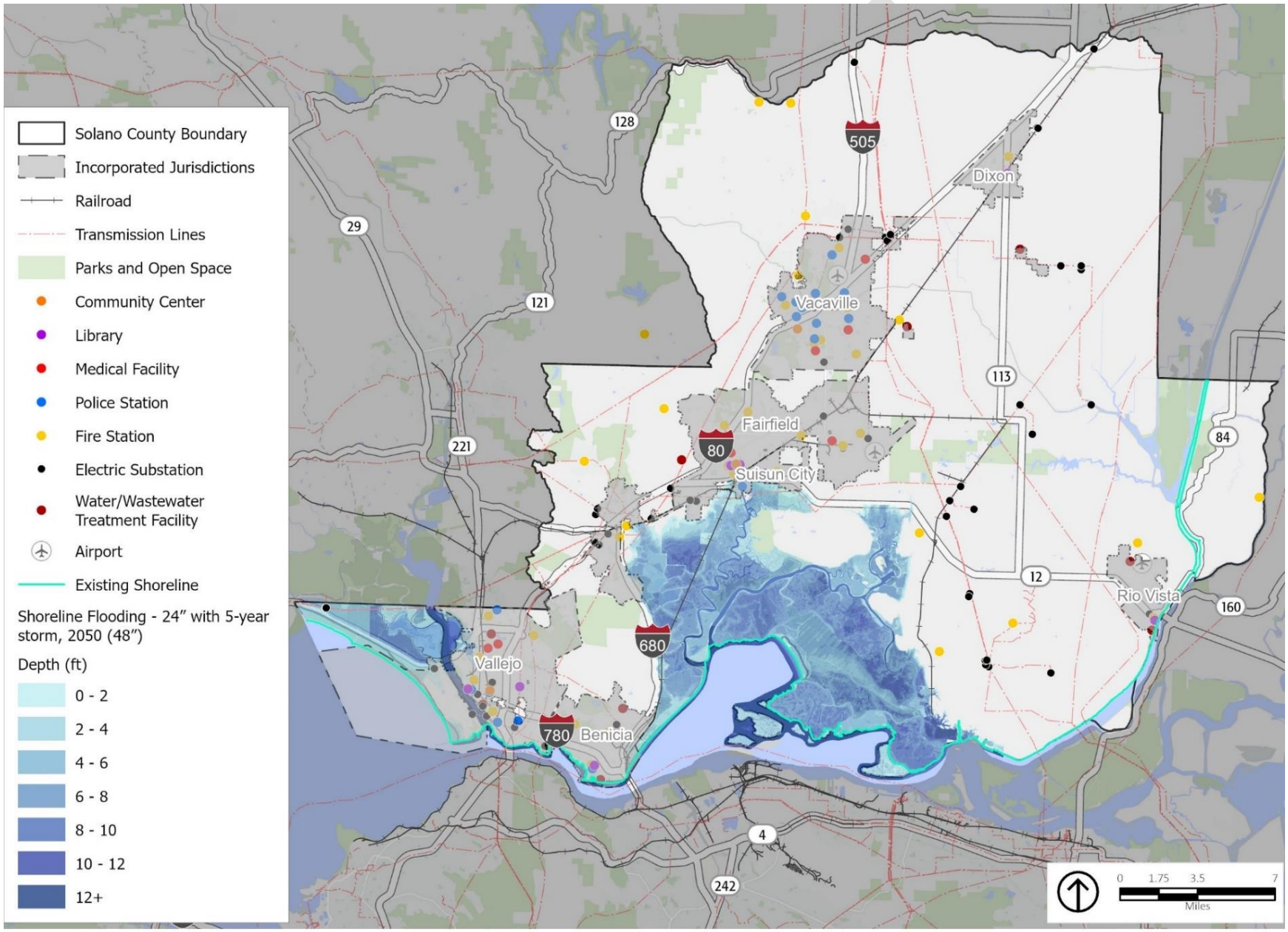
Source: Adapting to Rising Tides 2020, PlaceWorks 2022, ESRI

Figure HS-4: Sea Level Rise Projections – 2100



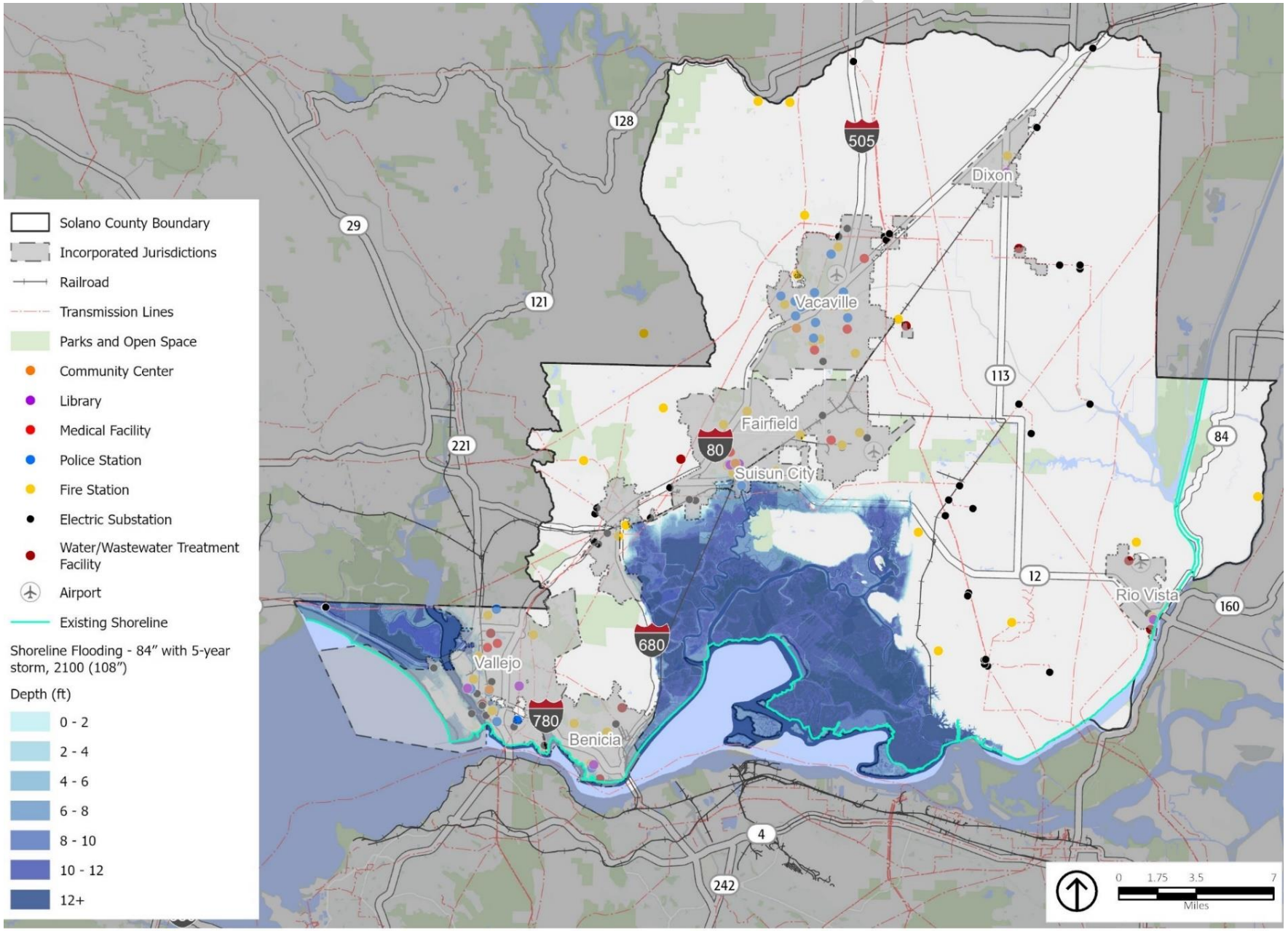
Source: Adapting to Rising Tides 2020, PlaceWorks 2022, ESRI

Figure HS-5: Shoreline Flooding Projections – 2050



Source: Adapting to Rising Tides 2020, PlaceWorks 2022, ESRI

Figure HS-6: Shoreline Flooding Projections - 2100



Source: Adapting to Rising Tides 2020, PlaceWorks 2022, ESRI

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 harm human life and property downstream. In addition, ecosystems and habitats are destroyed by waters flooding them. 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, so that water rushes 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 of 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.

The degree and rapidity of dam failure depends on the dam's structural characteristics. Many dam failures are the secondary result of other natural disasters, such as earthquakes, landslides, extreme storms, or heavy snowmelt or runoff. Other causes include equipment malfunction, structural damage, and sabotage.

Dam inundation zones are based on the highly unlikely scenario of a total catastrophic dam failure over a very short period of time. **Figure HS-7** illustrates areas in the county that would be affected by inundation in the event of a dam failure. The following areas would likely flood:

- Land around Cache Slough and Liberty Island, as well as shoreline areas along the Sacramento River would be affected if Oroville Dam failed.
- Wetlands around Suisun Marsh would be affected if Lake Herman Dam failed.
- Wetlands in the Napa-Sonoma Marshes Wildlife Area would be affected if Milliken Dam or Conn Creek Dam failed.
- Land along Ledgewood Creek and Peytonia Slough would be affected if Pennsylvania Creek Dam failed.
- Land extending from Dug Road Creek and Wild Horse Creek down to the residential areas of Green Valley Creek would be affected if Green Valley Lake Dam failed.

- Land extending from Suisun Reservoir down to the residential and agricultural areas of Suisun Creek and Ledgewood Creek would be affected if Municipal Dam failed.
- Agricultural land south of Dixon would be affected if Detention Pond A Dam failed.
- Land around Cache Slough and Lindsey Slough, north of Rio Vista, would be affected if Indian Valley Reservoir failed.

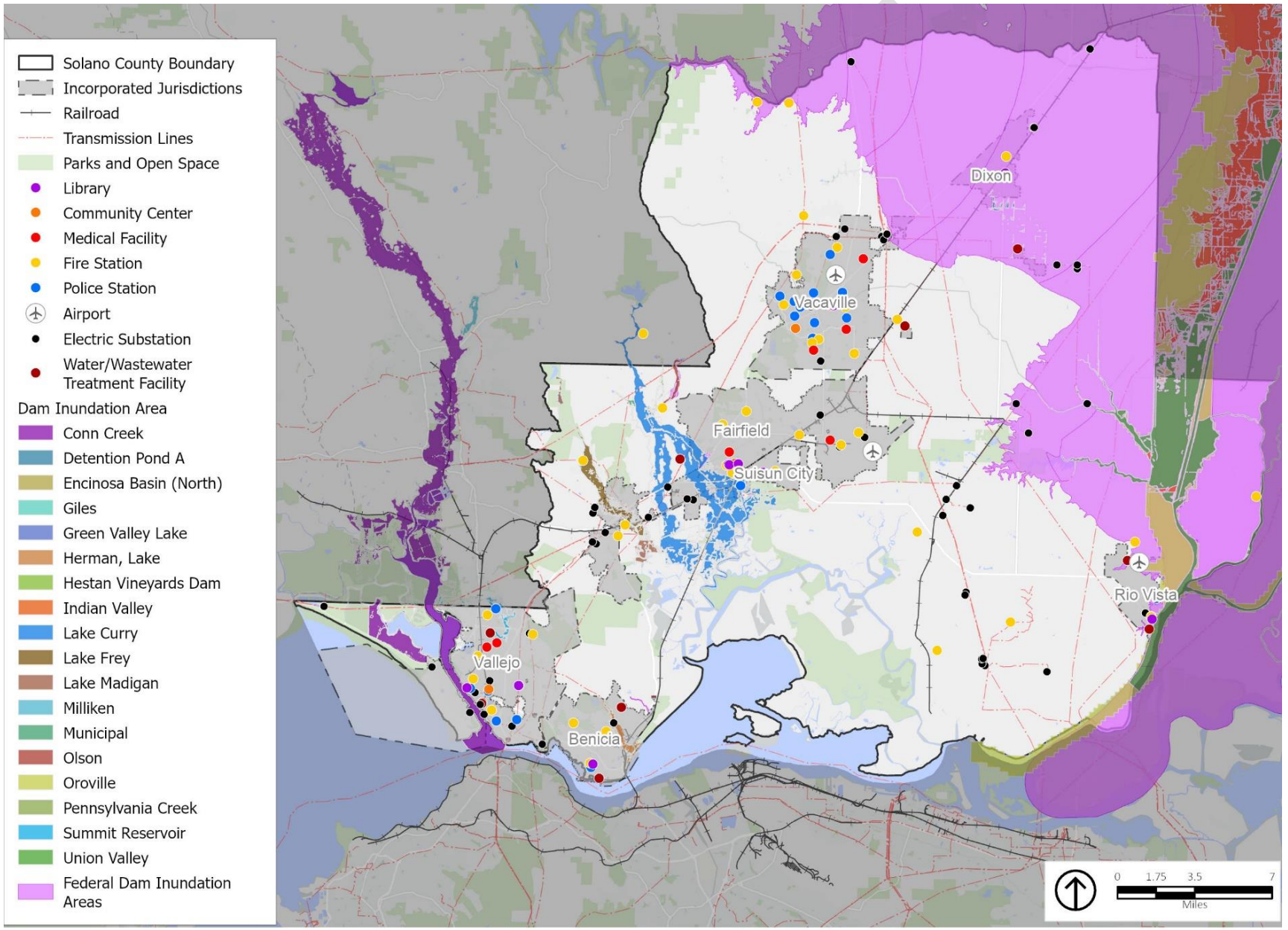
In Solano County, a major earthquake could cause a dam failure. Dams are constructed with safety features known as "spillways" that allow water to overtop the dam if the reservoir fills too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. In a dam failure scenario, the greatest threat to life and property is typically 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 the high-velocity flooding downstream of the dam and limited warning times for evacuation.

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 EAP minimizes the threat to public safety and the response time to an impending or actual sudden release of water from project dams. The EAP is also designed to provide emergency notification when floodwater releases present the potential for major flooding.

As mandated by the National Dam Inspection Act, the USACE has the authority and responsibility to conduct inspections of all dams. The purpose of these inspections is to check the structural integrity of the dam and associated appurtenant structures, ensuring protection of human life and property. Periodic inspections disclose conditions that might disrupt operation or dam safety.

Several regulation dams in Solano County and surrounding jurisdictions meet the specifications under Water Code Sections 6002 to 6004 (25 feet in height above the streambed, or an impounding capacity of 50 acre-feet or more). Of these dams, the State Office of Emergency Services has identified where dam inundation has the potential to cause human injury or loss of life. To reduce the likelihood of dam inundation, policies and programs in this section require an assessment of each dam's potential for earthquake-induced failure, evacuation times, inundation profiles (flood depth), and inclusion of project features that may reduce dam failure hazards.

Figure HS-7: Dam Inundation



Source: DWR DSOD 2014, 2021; PlaceWorks 2022

Canal or Levee Failure

Canals or levees in Solano County may fail because of earthquake-induced slumping, landslides, and liquefaction. The existing levee system in some Solano County marshlands was initially constructed by hand labor, then later by dredging to hold back river floods and daily tides, to obtain additional lands for grazing and crop growing. Constant maintenance is necessary to hold these levees against the high tides and river floods that threaten reclaimed marsh lands. Because levees are vulnerable to peat oxidation as well as sand, silt, and peat erosion, new material is continually added to maintain them. Subsiding farmlands adjacent to levees may increase water pressure against levees, adding to the potential for levee failure. In addition, most levees are not maintained to any specified standard, which can increase the likelihood of failure and inundation.

Flood protection services are often provided by reclamation and levee-maintenance districts in Solano County. Both types of special districts operate and maintain levee and drainage systems to protect adjoining land from flooding. These levees and drainage systems protect agricultural and rural areas, critical infrastructure such as highways, and important environmental resources.

Solano County reclamation and levee districts maintain over 400 miles of levees in the Suisun Marsh, Collinsville, and the Sacramento Delta. Levees in the area are either "project levees," built and maintained in compliance with the USACE guidelines, or "non-project levees," which include all other levees built and maintained by private landowners or local reclamation districts. Only about a third of the levees in Solano County are project levees that are regularly inspected by DWR.

Levee failures can be difficult to predict, since even inspected levees are prone to failure under certain conditions. Using the best available information, DWR has identified areas in the county where flood levels would be more than three feet deep if a project levee were to fail; these areas are called Levee Flood Protection Zones. These zones are shown on **Figure HS-1**. Most are in the eastern portion of the county within the Sacramento-San Joaquin Delta.

In addition to the identified Levee Flood Protection Zones, potential failure of levees as a result of liquefaction constitutes a flood hazard in much of the southern half of Solano County. Some enclosed areas lie several feet below sea level and are subsiding at a rate of up to three inches per year. Most of these diked areas are currently used for agriculture, and some lie so far below sea level that it would be economically infeasible to drain them if they were flooded because of levee failure. Failure of levees protecting Collinsville could flood parts of that community, causing damage to residential areas. Roads in the Suisun Marsh and in the east county are constructed almost exclusively on levees. Thus, levee failures could also disrupt travel through these areas. These roads are primarily used by local farmers, but also serve recreational needs.

Two projects operated and maintained by SCWA use channels for flood control. Both projects have unlined earthen channels with some vegetation for slope reinforcement. The smaller of the two projects is the Ulatis Flood Control Project in the Vacaville-Elmira drainage basin and designed to handle a 10-year flood event. The purpose of the Ulatis project is to protect agricultural land downstream of

Vacaville. The bigger of the two projects is the Green Valley Flood Project, which is partially in the unincorporated community of Cordelia and partially in the city of Fairfield. The Green Valley project consists of six miles of channel and is designed to handle a 40-year flood event.

SCWA has no future improvements planned for either project. However, as development in the watershed continues, SCWA must ensure capacity for additional runoff. SCWA requires the cities in Solano County to adequately mitigate the impacts of stormwater runoff from development projects. SCWA also monitors the channels at both sites to ensure adequate capacity to carry designated flows.

Past Occurrences

Floods are a regular feature in California and cause the second-greatest number of disaster declarations in the state. In 2005, a series of severe winter storms in the Bay Area and Solano County were responsible for flooding, mudslides, and landslides that resulted in two deaths and approximately $100 million in damage to businesses and homes.

Historical records from the San Francisco tidal gage show that the sea level in the San Francisco Bay rose eight inches from 1897 to 2006. Similarly, water level measurements from the tidal gage at Port Chicago show an increase in mean sea level of 2.08 millimeters a year, which is equivalent to a change of 8.6 inches in 100 years. Communities in Solano County report increased damage from king tide events, especially when paired with heavy rain.

Potential Changes to Flood Risk in Future Years

Likelihood of Future Occurrence

Historically, extended heavy rains have resulted in floodwaters that exceed normal high-water boundaries and cause damage in Solano County. Flooding has occurred in the mapped floodplains and other localized areas. As land uses and climate conditions shift and as improvements are made to flood-control channels, the size of these flood zones is likely to change.

Tsunamis in the local vicinity are dependent on a seismic event. The severity of a tsunami also depends on factors such as earthquake magnitude, the proximity to the earthquake epicenter, and the depth of its epicenter. Regional earthquakes are likely to continue on an occasional basis and are likely to be small. Major earthquakes are rare but possible and could generate tsunamis. More likely is a tsunami triggered by a distant earthquake, which could still be large enough to cause damage in Solano County.

Sea levels have risen in the Bay and are expected to continue to rise at an accelerated rate over this century. Sea level rise will occur slowly and increase the impacts of other coastal hazards, such as shoreline erosion and tsunamis. A dam failure in Solano County is likely to remain a risk in future years, although the odds of such an event are expected to remain very low.

Climate Change and Flooding

Climate change will likely result in increased flooding risks throughout California. Climate change–induced sea level rise is likely to create significant impacts in the San Francisco Bay and Delta. The 2007 projections from the International Panel on Climate Change estimate that sea level will increase by 7 to 23 inches by 2100. The San Francisco Bay Conservation and Development Commission and other state agencies are evaluating expected impacts using these projections. Though the extent of sea level rise is uncertain, there is consensus that it will increase the frequency, duration, and magnitude of flood events in the San Francisco Bay and Sacramento–San Joaquin Delta area. With a one-foot rise in sea level, as predicted in low-end sea level rise projections, the occurrence of a 100-year, storm surge induced, flood event would shift to once every 10 years. In other words, the frequency of a 100-year event could increase tenfold. Sea level rise and the associated increases in flood events would place greater strain on existing levee systems and will likely expand floodplains into unprotected areas of the county.

Floods are among the most damaging natural hazards in Solano County, and climate change is expected to make flood events worse. Although climate change may not change average precipitation levels significantly, scientists expect that it will cause more years with extreme precipitation events. This means that more years are likely to see particularly intense storm systems that drop enough precipitation over a short enough period to cause flooding. Because of this, floods are expected to occur more often in Solano County, and climate change may expand the parts of the county that are considered prone to flood, though there are no specific flooding projections for the county. There are some indirect effects of climate change that may also increase flooding in the county. Climate change is expected to increase the frequency and severity of droughts, which cause soil to dry out and harden. 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 more severe 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.

Though the risk and associated short- and long-term impacts of climate change are uncertain, experts in this field tend to agree that the most significant impacts include those resulting from increased heat and precipitation events that increase the frequency and magnitude of 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. Climate change is unlikely to increase earthquake frequency or strength, and therefore unlikely to influence the occurrence of tsunamis, though rising sea levels may expand the areas at risk from tsunami inundation.

The science associated with sea level rise is regularly updated, revised, and strengthened. Although there is no doubt that sea levels have risen and will continue to rise at an accelerated rate 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 flooding, storm surge inundation, coastal erosion and shoreline retreat, and wetland loss. Community assets and infrastructure that border the shoreline are vulnerable to damage from storms, which will likely increase as the sea level continues to rise and inundate areas further inland. As sea levels rise, the area and the number of people at risk because of flooding will also increase.

Related Plans, Programs, and Agencies

Solano County Water Agency Flood Hazard Warning System

The SCWA Flood Hazard Warning System was created in 2006 to provide up-to-date information to the community and public agencies on potential flooding in Solano County.

Solano County One Water Framework

Solano County is currently engaging stakeholders in developing a One Water Framework for water resource management for Integrated Water Resource Management. One Water is a holistic approach to water management which emphasizes that all water has value, and that water managers should maximize the benefit of all water within an integrated water system. The One Water approach promotes cooperation and partnerships across multiple agencies and water-management sectors advocating integrated solutions across systems. This includes water supply, wastewater, storm and flood protection, water quality improvements, and ecosystem enhancements. The Solano County One Water Framework is being developed to proactively plan for the County's changing landscape. The Framework will establish a One Water process toward regional solutions and multi-benefit projects, such as integrating drainage systems to recharge groundwater supplies and enhance local ecosystems. It will also provide the foundation and basis for development of a future Solano County Water Utilities Master Plan (One Water Master Plan) to support the implementation of the County's General Plan.

Federal Emergency Management Agency

FEMA's mission is to reduce the loss of life and property from natural and human-made disasters through a comprehensive, risk-based emergency management system. One of its responsibilities is to maintain flood zone maps.

California Department of Water Resources

DWR implements the California Water Code, including the Cobey-Alquist Flood Plain Management Act. DWR regulates activities in California's floodways, encourages preventative flood control maintenance, and operates some flood-control projects.

Assembly Bill 162 (2007)

This bill, in contrast to the regulations provided by the Cobey-Alquist Flood Plain Management Act, focuses on providing flood protection for California communities through requirements implemented by

local general plans. It calls for flood-related provisions in the state-mandated land use, conservation, and safety elements of general plans. Solano County addresses these requirements in this Public Health and Safety chapter.

Central Valley Flood Protection Board and Plan

The Central Valley Flood Protection Board is the State regulatory agency charged with reducing the risk of catastrophic flooding to people and property in the Central Valley, which is the most flood prone area of the state. The Central Valley Flood Protection Board developed and adopted the CVFPP in 2012 and continues to oversee the plan's implementation. The CVFPP provides conceptual guidance to reduce the risk of flooding for about one million people in California and $70 billion in infrastructure, homes, and businesses, with a goal of providing 200-year flood protection to urban areas and reducing flood risks to small communities and rural agricultural lands. The CVFPP provides conceptual guidance to reduce the risk of flooding for approximately 1.3 million people in California and $223 billion in infrastructure, homes, and businesses, with a goal of providing 200-year flood protection to urban areas and reducing flood risks to small communities and rural agricultural lands.

In 2022, the Flood Protection Board amended the CVFPP. The 2022 update evaluates progress made since passage of major State bonds in 2007 and recommends future management actions led by State, federal, and local partners to continue implementation of the CVFPP, building on the work of the previous 15 years. The 2022 CVFPP Update focuses on climate resilience, performance tracking, and alignment with other state efforts to recommend priority actions to address flood risk in the face of climate change. A robust, multi-year communications and engagement process that involved frequent discussions with State, federal, Tribal, and local partners informed the 2022 CVFPP Update.

SEISMIC AND GEOLOGIC HAZARDS

This section describes various actions to prevent property damage and loss of life caused by earthquakes, landslides, and other geologic hazards. The County's strategy focuses on directing development away from known geologic hazards and ensuring high-quality construction in areas at risk. The more hazardous areas of the county do provide opportunity for low-intensity uses such as agriculture and recreation, concentrating development in areas with lower risk.

Seismic and geologic hazards are risks caused by the movement of different parts of the Earth's crust, or surface. Seismic hazards include earthquakes and hazardous events caused by them. Geologic hazards are other hazards involving land movements that are not linked to seismic activity and are capable of inflicting harm to people or property.

The unique landscape in Solano County provides the necessary conditions for earthquakes, landslides, and other geologic dangers. These events threaten people and property within geologic hazard zones, and their unpredictability is the driving force behind the proposed policies and implementation programs. The County hopes to safeguard development by directing it away from the most hazardous areas to more secure areas.

Planning Context

Seismic Hazards

Seismic activity occurs along boundaries in the Earth's crust, called faults. Pressure along the faults build 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

Though Solano County is at risk from many natural and human-caused hazards, the event with the greatest potential for loss of life or property and economic damage is an earthquake. This is true for most of the San Francisco Bay Area, since damaging earthquakes affect widespread areas and can trigger many secondary effects that can overwhelm the ability of local jurisdictions to respond. The Bay Area lies within the active boundary between the Pacific and the North American tectonic plates. The Pacific Plate is constantly moving northwest past the North American Plate at a rate of about two inches per year. Earthquakes in the Bay Area result from the energy constantly accumulating because of this motion. The San Andreas Fault is the major plate boundary and has the potential to cause the strongest earthquakes.

The earthquake risk is very high in Solano County due to the presence of several active faults in the region. The county is crossed by a number of active faults where past movement in the earth's surface has caused rock fractures. Fault traces occur when these fractures become visible on the surface. Fault zones are the areas surrounding active faults, where future movement is likely to occur. It is in these zones where most earthquakes originate. Surface displacement along a fault would cause serious structural damage to any overlying building, transportation facility, main utility line, and/or aqueduct. Seismic shaking is by far the single greatest cause of earthquake damage.

Figure HS-8 shows the locations of regional faults. The major faults in Solano County include the Green Valley fault system, running north-south through the county; the Great Valley 06 (Midland) fault zone, which extends north-south through most of the western side of the county; the Great Valley 04b Gordon Valley; the Great Valley 05 Pittsburg–Kirby Hills; and the Franklin fault, which extends through most of the westernmost tip of the county. Other faults in and outside Solano County, such as the San Andreas and Hayward faults, may also be capable of generating significant earthquakes with damaging effects in the county.

A major earthquake along any of these five faults could result in substantial casualties and damage resulting from collapsed buildings, damaged roads and bridges, fires, flooding, and other threats to life and property. 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

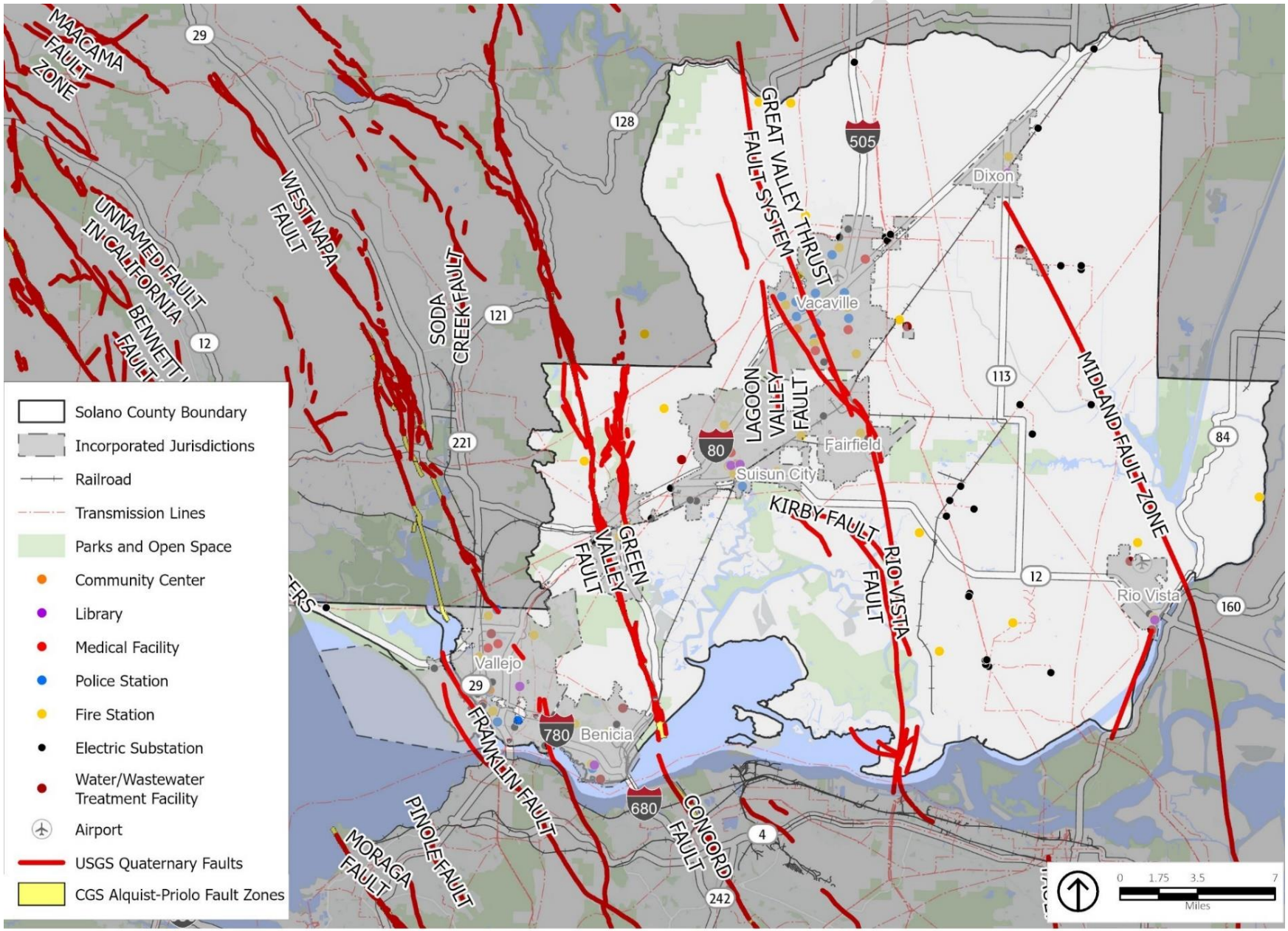
following damaging earthquakes. However, in Solano County, structures built prior to the enactment of these improved building codes have generally not been upgraded to current standards and are vulnerable in earthquakes. In Solano County, approximately 5,230 homes, or 63 percent of all housing in the county, was constructed prior to 1980.[9] The damage caused by the shaking of earthquakes may trigger secondary hazards, including urban fires, dam failures, and toxic chemical releases.

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 as well as property damage. There are a number of small-scale earthquakes that happen weekly and are barely felt or not felt at all, but larger-scale or catastrophic shaking is less likely. Property and human life in Solano County are at risk for a significant earthquake causing catastrophic damage and strains on response and mitigation resources.

Liquefaction

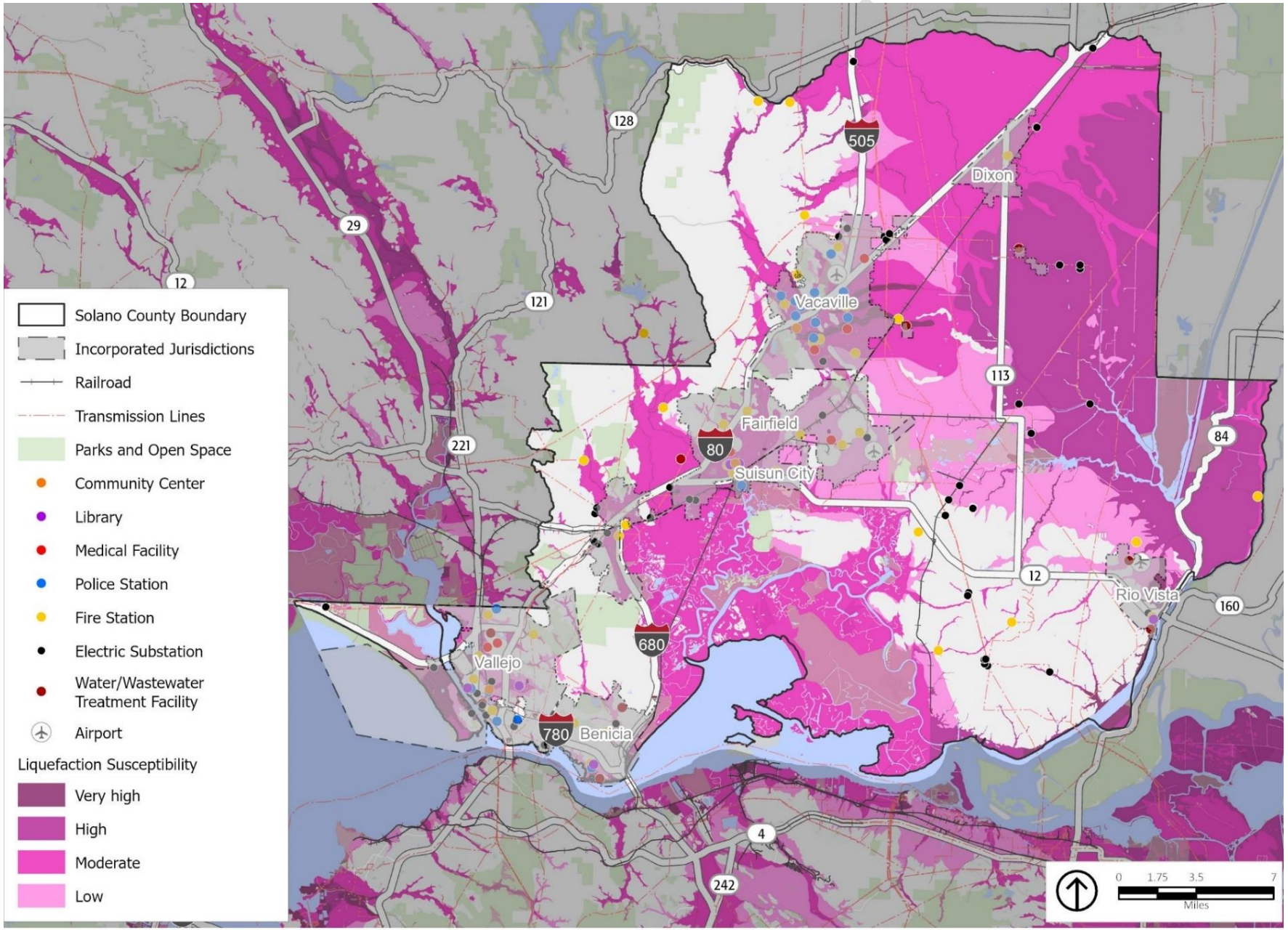
In addition to the direct physical damage that can result from the motion of the earthquake, damage can result from liquefaction. Liquefaction occurs where water-logged soils near the ground surface lose compaction during strong ground motion, causing the soils to lose strength and behave as liquid. This can cause building foundations to shift and can result in significant structural damage. Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. This change can cause ground failure and damage to overlying structures. Recent County efforts aimed at recharging the water table have been successful but produced the unforeseen consequence of increasing liquefaction potential in the central and eastern portions of the county. Areas with high liquefaction potential are shown on **Figure HS-9**. Lurching is the horizontal movement of ground next to slope faces, particularly in areas underlain by loosely consolidated soils, such as creek banks.

Figure HS-8: Regional Fault Lines



Source: USGS 2018, CGS 2017, PlaceWorks 2022, ESRI

Figure HS-9: Liquefaction Hazard Zones



Source: USGS 2006, PlaceWorks 2022, ESRI

Tsunamis

A secondary hazard of earthquakes are tsunamis, which have the potential to affect the shoreline areas of Solano County. Tsunamis are typically caused by earthquakes in subduction zones—that is, areas where ocean plates are forced down into the mantle by plate tectonic forces. This creates an enormous friction between the plates. When the energy is released, causing an earthquake, the sudden movement displaces a large volume of water, creating a tsunami.

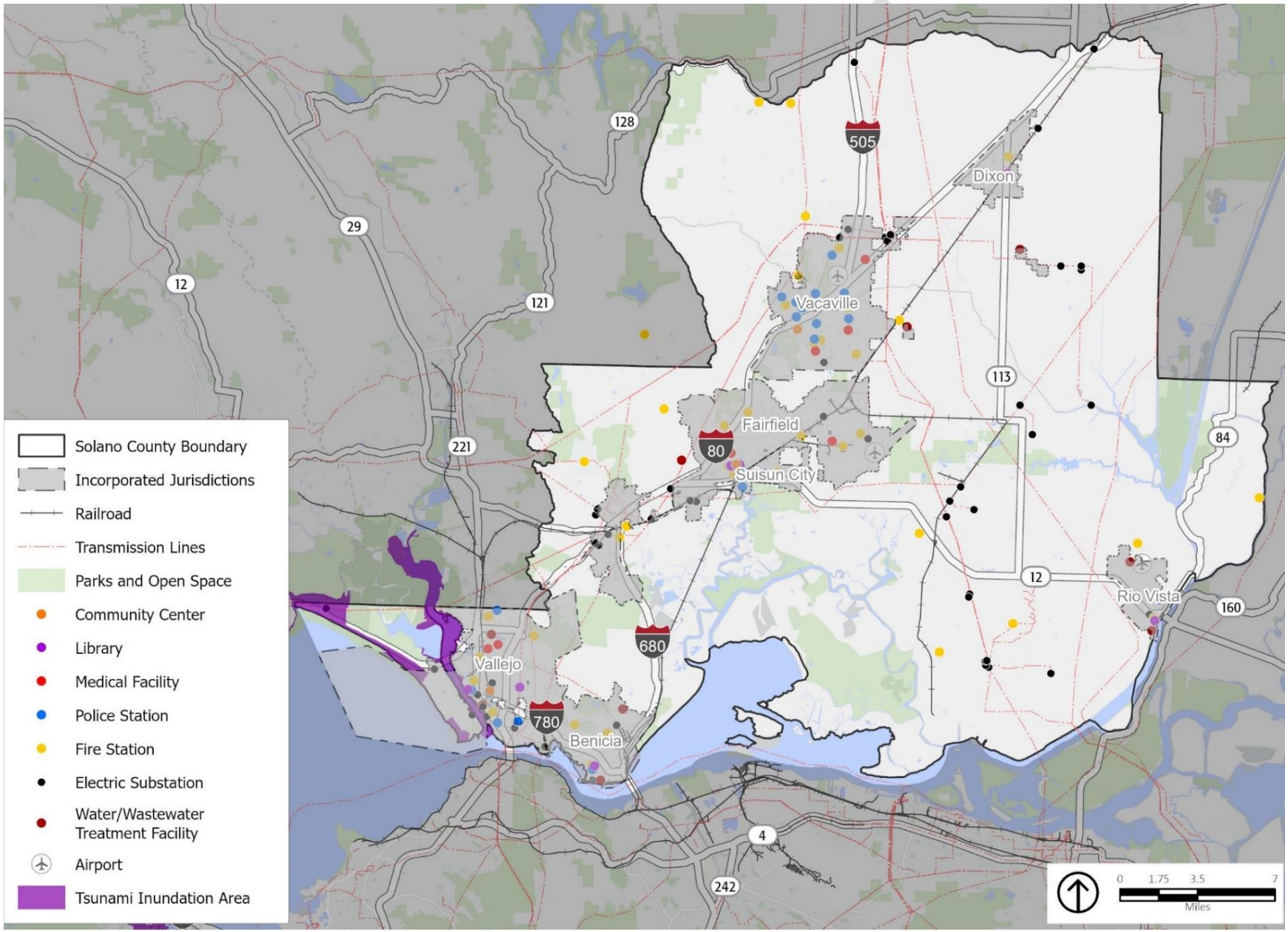
A tsunami travels across the ocean at speeds up to 700 miles per hour. The actual height of the wave in open water is generally only one to three feet, and it is often unnoticeable to people aboard ships. However, the energy of a tsunami passes through the entire water column to the seabed, unlike surface waves, which typically reach only to a depth of 30 feet or so. As the tsunami enters shallower water near coastal shorelines, it slows to about 20 to 30 miles per hour, and the wave can increase to a height of 90 feet or more as it approaches the coastline and the water column compresses. Tsunamis can result in severe property damages and loss of life to affected areas near the coast. They can also disrupt emergency services and transportation routes. Also, tsunami waves can diffract around land masses, and because they are not symmetrical, the wave may be much stronger in one direction than another, depending on the source and the surrounding geography.

Although earthquake magnitude is one factor that affects tsunami generation, there are other important factors to consider. The earthquake must be a shallow marine event that displaces the seafloor. Thrust earthquakes, such as those in subduction zones that cause up or down movements (as opposed to strike-slip earthquakes, which cause side-to-side movement) are far more likely to generate tsunamis, but small tsunamis have occurred in a few cases from large (i.e., greater than magnitude 8) strike-slip earthquakes.

Earthquakes with magnitudes below 6.5 are very unlikely to trigger a tsunami. Earthquakes of magnitudes between 6.5 and 7.5 do not usually produce destructive tsunamis. However, small sea level changes might be observed in the vicinity of the epicenter. Tsunamis capable of producing damage or casualties are rare in this magnitude range but have occurred due to secondary effects such as landslides or submarine slumps. Earthquakes of magnitudes between 7.6 and 7.8 might produce destructive tsunamis, especially near the epicenter. At greater distances, small sea level changes might be observed. Tsunamis capable of producing damage at great distances are rare in the magnitude range. Earthquakes of magnitude 7.9 and greater are typically destructive. Destructive local tsunamis are possible near the epicenter, and significant sea level changes and damage might occur in a broader region.

By the time a tsunami wave reaches the Carquinez Strait, much of its energy would have already dissipated. **Figure HS-10** illustrates the area that may be subject to inundation from tsunamis in Solano County. The only unincorporated areas of the county that would be subject to inundation by tsunamis is along Island No. 1 southwest of SR 37.

Figure HS-10: Tsunami Inundation Area



Source: CGS 2009, PlaceWorks 2022, ESRI

Geologic Hazards

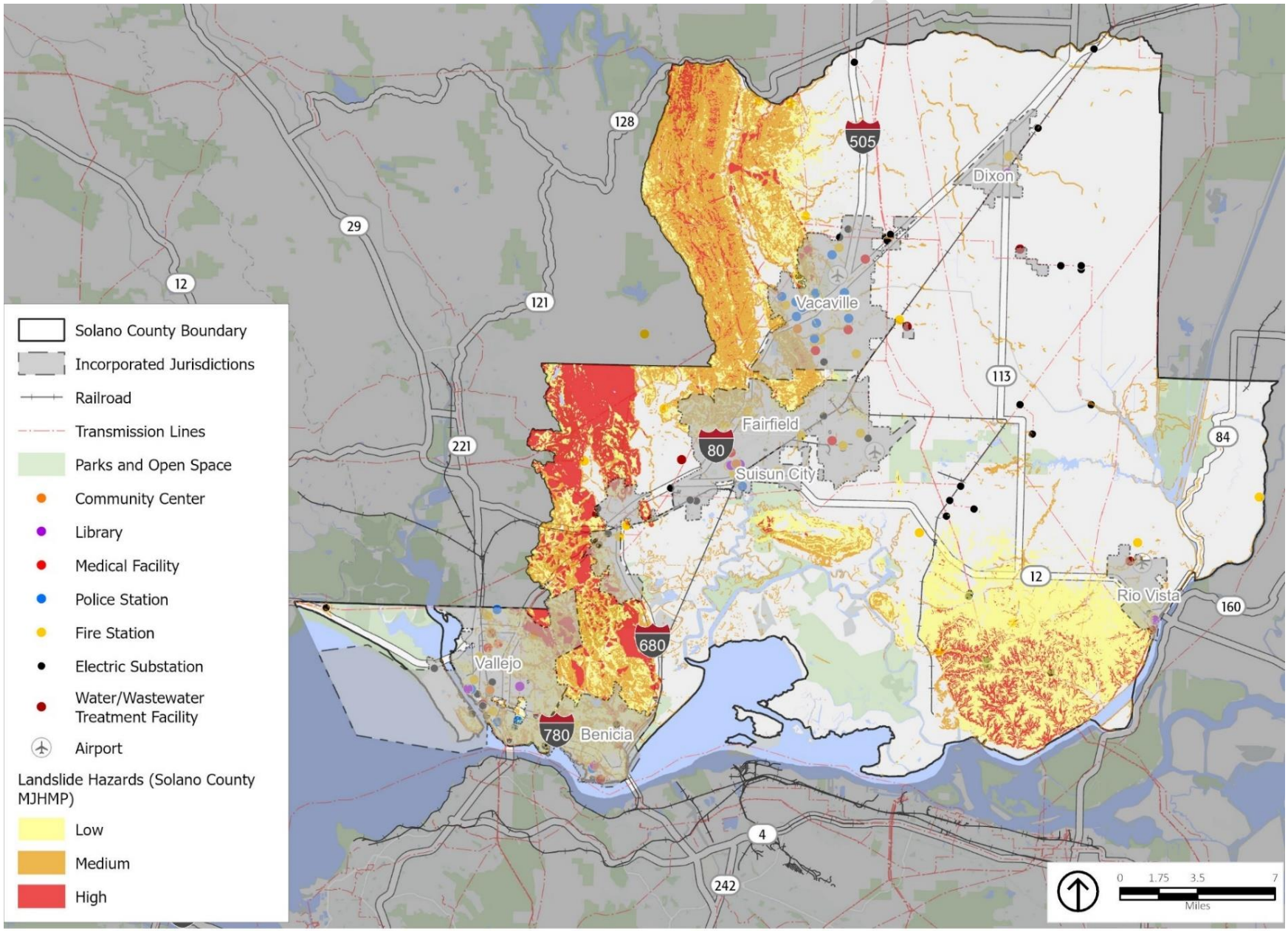
Geologic hazards, such as landslides and erosion, depend on the geologic composition of the area. Landslides and rock falls may occur in sloped areas, especially areas with steep slopes, and usually in areas of loose and fragmented soil. Landslides, rockfalls, and debris flows occur continuously on all slopes; some processes act very slowly, and others occur very suddenly, often with disastrous results. There are predictable relationships between local geology and landslides, rockfalls, and debris flows. Slope stability is dependent on many factors and interrelationships, including rock type, pore water pressure, slope steepness, and natural or human-made undercutting.

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so landslide frequency is often related to the frequency of these other hazards. The many types of landslides are categorized based on form and type of movement. They range from slow-moving rotational slumps and earth flows, which can distress structures over time but are less threatening to personal safety, to fast-moving rock avalanches and debris flows that are a serious threat to structures and have been responsible for most fatalities during landslide events. Many large landslides are complex and a combination of more than one landslide type.

In Solano County, landslides typically occur during and after severe storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. In Solano County, landslides and mudslides are a common occurrence and have caused damage to homes, public facilities, roads, parks, and sewer lines.

Upland areas of the county are susceptible to landslides, land slips, mudflows, and debris flows. Triggered by an earthquake, heavy rainfall, or changes in ground conditions caused by development activity, these events can send large volumes of land cascading down hillsides, destroying property along the way. Due to the differences in the physical characteristics of slope materials, some superficially similar areas may differ widely in terms of landslide hazard potential. For this reason, site-specific geotechnical analyses are considered essential to the accurate assessment of landslide hazard risk at a given location. While a majority of the county is within a low to medium landslide susceptibility class, several areas throughout the county are in high landslide susceptibility areas. **Figure HS-11** illustrates areas in Solano County that are susceptible to landslides.

Figure HS-11: Landslide Susceptibility

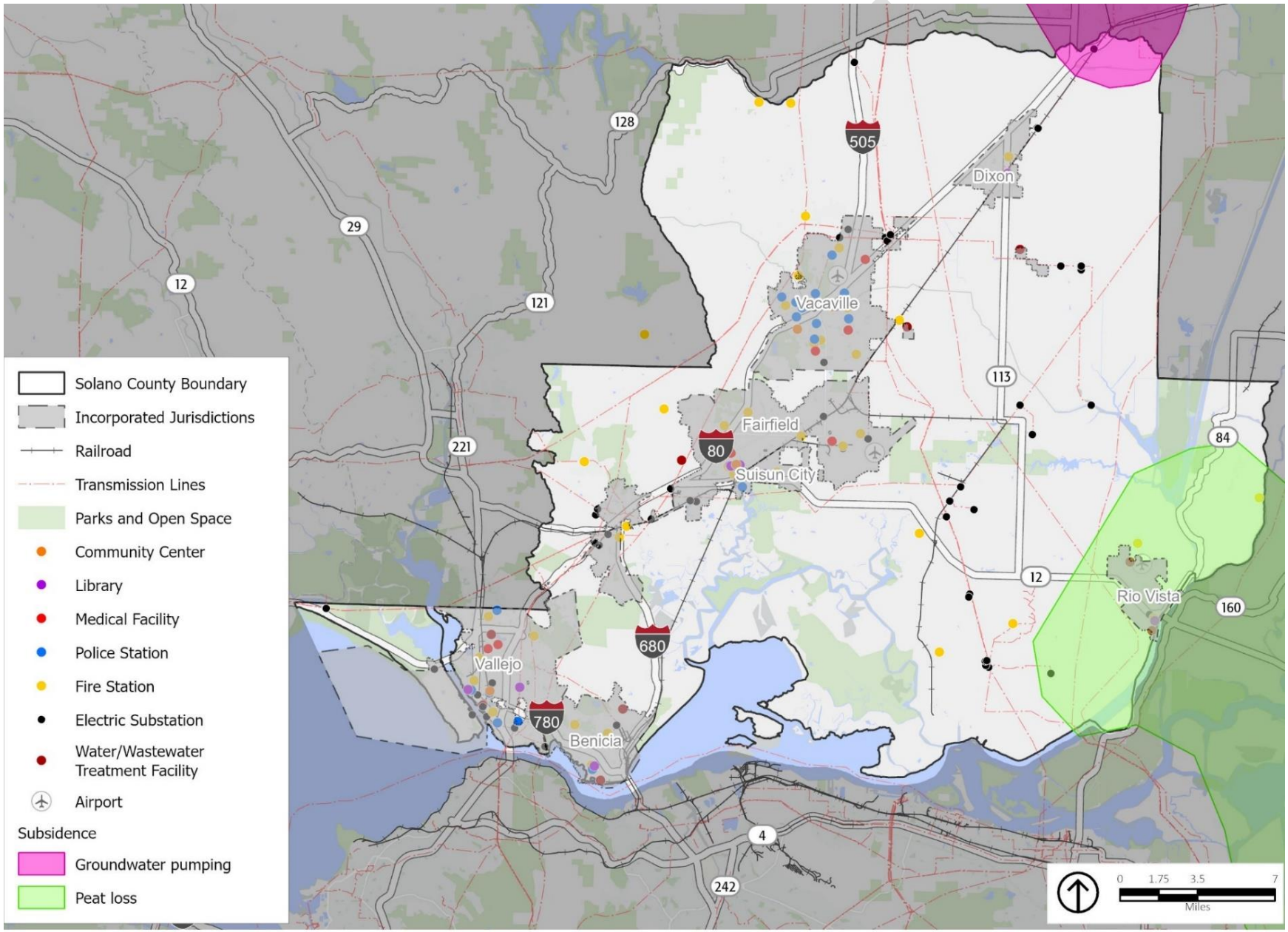


Source: Solano County 2021, PlaceWorks 2022, ESRI

Subsidence refers to the sudden sinking or gradual downward settling and compaction of soil and other surface material with little or no horizontal motion. It may be caused by a variety of human and natural activities, including earthquakes, water saturation, and groundwater pumping. Subsidence occurs when large amounts of groundwater have been excessively withdrawn from an aquifer. In Solano County, areas susceptible to subsidence are in the northeastern region, in an agricultural area that encompasses I-80 and the South Fork Putah Creek, as well as the southeastern region, in an area that encompasses Rio Vista, agricultural lands, and SR-12 and SR-84. In the northeastern region, these lands are susceptible to subsidence due to groundwater pumping whereas the southeastern region is susceptible to subsidence due to peat loss.

Areas identified as susceptible to subsidence are identified on **Figure HS-12**.

Figure HS-12: Subsidence Zones



Source: USGS 2022, PlaceWorks 2022, ESRI

Solano County is also susceptible to hazards related to erosion—the geological process in which earthen materials are worn away and transported by natural forces such as water or wind, causing the soil to deteriorate. Eroded topsoil can be transported into streams and other waterways. Water erosion is the removal of soil by water and transportation of the eroded materials away from the point of removal. The severity of water erosion is influenced by slope, soil type, soil water storage capacity, nature of the underlying rock, vegetation cover, and rainfall intensity and period. The impact of soil erosion on water quality can be significant, and highly erosive soils can damage roads, bridges, buildings, and other structures.

Shrink-swell soils contain large amounts of clay that swell when wet and shrink when dry. These clays will swell despite the heavy loads of large structures. Repetition of this shrink-swell cycle can cause building damage, including cracked foundations. **Figure HS-13** shows that a majority of the county is underlain by soils with a high shrink-swell potential. In most cases, removing the top layer of soil and/or preconstruction design and engineering are enough to prevent the costly problems associated with these soils. Land settlement is a gradual lowering of the ground surface caused by compression of fine-textured deposits like clays and silts. Compression can be caused by removing water from the soil—through agricultural pumping, for example—or by placing heavy loads on the soil. Many of the fine-textured bay mud deposits in and around the Napa River Delta are susceptible to settlement and present a potential hazard for road construction and development in southwestern Solano County.

Past Occurrences

Solano County is in a region of high seismicity with numerous local faults. A number of significant (more than magnitude 4.5) earthquakes have occurred in and near Solano County over the last 16 years. The South Napa earthquake, which occurred along the West Napa Fault on August 24, 2014, was the most recent earthquake near Solano County. Its epicenter was just north of Benicia, and with a recorded magnitude (M_w) of 6.0, it was one of the largest in the Bay Area in about 25 years. The South Napa earthquake caused extensive damage through both ground shaking and surface cracking in the affected region, resulting in one death and approximately 200 injuries. Ground shaking was also felt in the county.

The 1989 Loma Prieta earthquake was a M_w 6.9 earthquake which occurred on the San Andreas fault near Mt. Loma Prieta in the Santa Cruz Mountains, roughly 70 miles south of Solano County and 10 miles northeast of Santa Cruz. Statewide, 63 people were killed, 3,757 were reported injured, and 12,053 were displaced; 18,306 houses were damaged and 963 were destroyed; and 2,575 businesses were damaged and 147 were destroyed. The most notable damage included the collapse of

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.

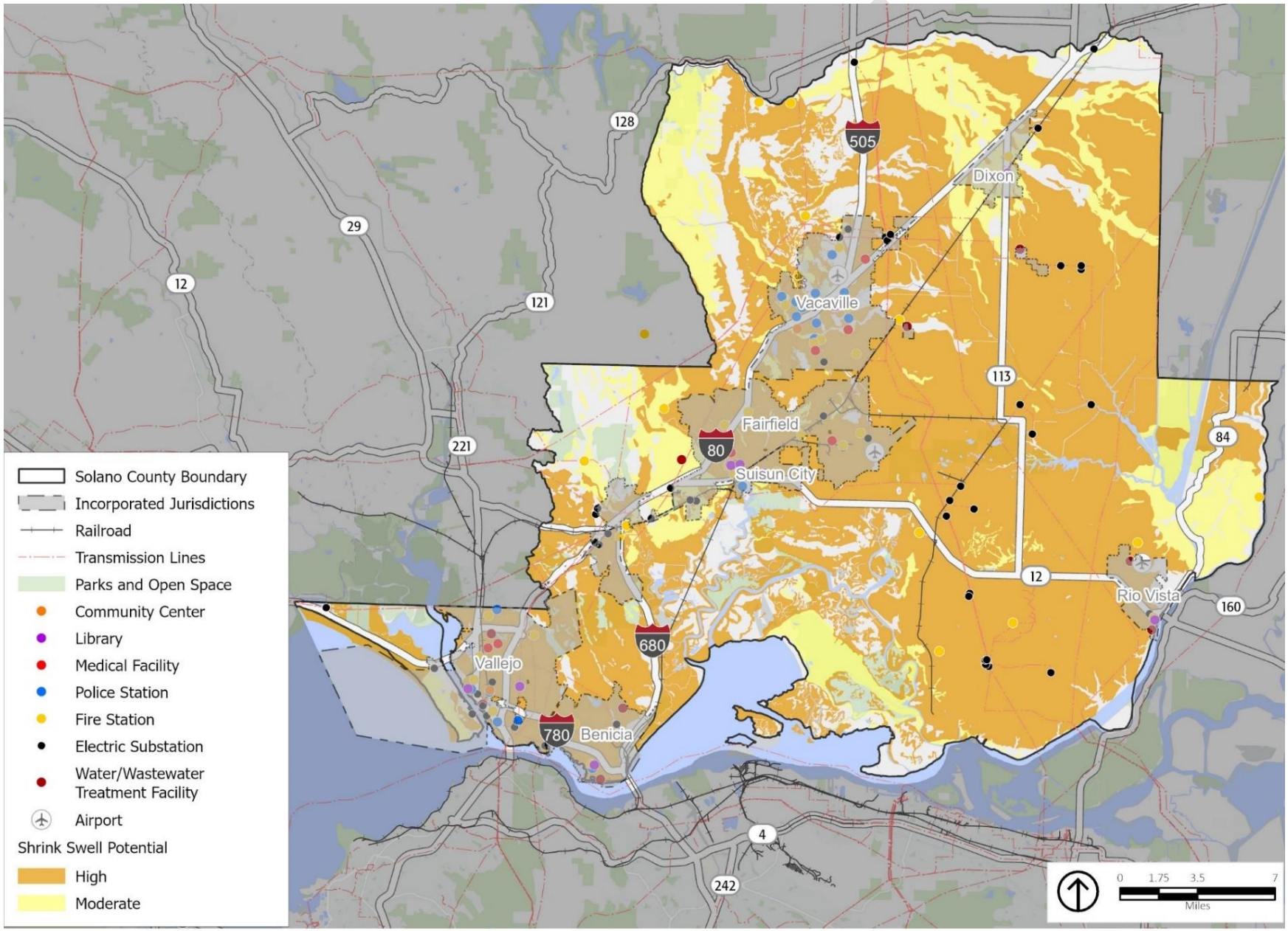
Source: Michigan Technological University, Earthquake Magnitude Scale, 2022, https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/magnitude/.

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. This earthquake resulted in an economic loss of approximately $10 billion and was felt as far away as San Diego and western Nevada. An earthquake equivalent to this strength in the Bay Area would produce strong shaking and ground failure throughout the region and likely cause significant damage in the area.

Major earthquakes are rare in Solano County but minor earthquakes occur often. Small landslides are a common occurrence on hillsides throughout the county, generally in winter during high precipitation years.

There have been no federally declared landslide events in Solano County. During the fall through spring rainy seasons of 1968 to 1969, 1972 to 1973, 1981 to 1982, 1997 to 1998, 2005 to 2006, and 2006 to 2007, landslides were widespread throughout the county. Between 1968 to 2007, 51 recorded historical damaging landslide events occurred in Solano County. Additionally, in 2006, a mudslide event in the county affected Clayton Road, Gibson Canyon, and Lynch Canyon. In 2005, a series of severe winter storms impacted the Bay Area and Solano County. These storms were responsible for flooding, mudslides, and landslides that resulted in two deaths and approximately $100 million in damage to businesses and homes.

Figure HS-13: Shrink-Swell Potential



Source: CASIL 1993/1996, SSURGO 2006, Solano County 2022, PlaceWorks 2022, ESRI

Potential Changes to Geologic and Seismic Risk in Future Years

Likelihood of Future Occurrence

Seismic Risk

Earthquakes are likely to continue to occur 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. According to the California State Hazard Mitigation Plan, earthquakes large enough to cause moderate damage to structures—those of M_w 5.5 or larger—occur three to four times a year statewide. Strong earthquakes of M_w 6.0 to M_w 6.9 strike on an average of once every two to three years. Major earthquakes of M_w 7.0 to M_w 7.9 occur in California about once every 10 years.

Major earthquakes are rare, but a possibility in the region. A major earthquake along any of the local faults could result in substantial casualties and damage, although the greatest risk in Solano County is from the Hayward-Rodger's Creek and the Concord-Green Valley faults due to their location and high potential to cause a severe earthquake. 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 seismic ground motion.

The Hayward-Rodger's Creek fault has the highest probability of an earthquake greater than M_w 6.7 in Solano County, with a greater than 10 percent annual probability. The Concord-Green Valley fault also has a greater than 10 percent annual probability of an earthquake. With a M_w 6.7 or greater earthquake, most parts of Solano County would experience very strong shaking, sufficient to cause major damage to structures and foundations that were not designed to resist earthquake forces. Based on historical data and the location of Solano County relative to active and potentially active faults, the county will likely experience a significantly damaging earthquake in the future, although such events are not expected to become more frequent in future years. Newer construction is in general more earthquake resistant than older construction because of improved building codes, and though liquefaction often causes severe damage to structures, structural collapse is uncommon. Furthermore, the risk to public safety is relatively low because structures can be protected from liquefaction with special foundations.

Geologic Risk

Geologic risks, such as small landslides, are common occurrences in Solano County. With significant rainfall, additional slope failures are likely in the community's landslide hazard areas, and minor to moderate landslides will likely continue to impact the area when heavy precipitation occurs, as they have in the past.

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). Total average annual rainfall may not change significantly, but rainfall may be concentrated in more intense precipitation events. Heavy rainfall could increase the number of landslides or make landslides larger than normal. Increased wildfire frequency can destabilize hillsides due to loss of vegetation and changed soil composition, which can contribute to greater runoff and erosion. 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.

Related Plans, Programs, and Agencies

California Building Standards Code

The State of California provides minimum standards for building design and construction through the California Building Standards Code, based on the International Building Code, which is used widely throughout the United States and has been modified for California conditions with numerous more-detailed and/or more-stringent requirements. The California Building Standards Commission is responsible for coordinating, managing, adopting, and approving building codes in the State of California. The California Building Standards Code was first established in 1953 and is updated regularly.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act requires the State Geologist to identify earthquake fault zones along traces of both recently active and potentially active major faults. Cities and counties that contain such zones must inform the public regarding the location of these zones, which are usually one-quarter mile or less in width. The main purpose of the act is to prevent the construction of buildings used for human occupancy on the surface fault rupture.

Seismic Hazards Mapping Act

Pursuant to the Seismic Hazards Mapping Act, the State Geologist compiles maps identifying seismic hazard zones. Development in seismic hazard areas is subject to policies and criteria established by the California Geological Survey. This act addresses earthquake hazards not related to surface ruptures, including liquefaction and seismically induced landslides, and states that cities and counties must require geotechnical reports defining and delineating any seismic hazard before approval of a project in a seismic hazard zone.

The law also requires that the State Geologist establish regulatory zones (known as earthquake fault zones) around the surface traces of active faults and issue appropriate maps showing those zones. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects subject to the act include all land divisions and most structures for human occupancy, except single-family wood-frame and steel-frame dwellings up to two stories that are not part of a development of four units or more. At their discretion, local agencies may be more restrictive than state law requirements.

Landslide Hazard Identification Program

The Landslide Hazard Identification Program requires the State Geologist to prepare maps of landslide hazards in urbanizing areas. According to Public Resources Code Section 2687(a), public agencies are encouraged to use these maps for land use planning and for decisions regarding building, grading, and development permits.

FIRE HAZARDS

Planning Context

This section describes a variety of actions that can prevent property damage and loss of life caused by wildfires. The County's wildfire planning and prevention strategy focuses on techniques that reduce wildfire potential, support firefighting in rural areas, and ensure use of fire-safe building methods by:

- Directing non-farm-related development to areas with low fire risk.
- Working with fire districts during development review and enforcing fire-safe site and building design standards.
- Promoting wildfire prevention measures such as grazing, disking, or plowing of agricultural lands.
- Requiring adequate on-site water supply for buildings lacking access to public water.

The County's fire safety policies and implementation programs were created to support the County's vision—specifically, the desire to develop in a way that supports the needs of both humans and the environment. Promoting natural fire ecology is good for the environment, but it can cause devastating damage to people and property. The County seeks a sustainable balance between these outcomes by directing development away from known fire hazard areas and buffering the effects of a wildfire away from developed areas.

Fire hazards include both wildfires and urban fires. The combination of complex terrain, Mediterranean climate, productive natural plant communities, and ample natural ignition sources has created conditions for extensive wildfires in and around Solano County. Wildfire is a hazard of high concern for Solano County. Historically, the fire season extended from early summer through late fall of each year,

during the hotter, dryer months, although increasingly, it can occur year-round. Fire conditions arise from a combination of high temperatures, low-moisture content in the air and plant matter, an accumulation of vegetation, and high winds.

Three types of fires are of concern to Solano County: (1) wildfires, (2) wildland-urban interface fires, and (3) structural fires.

Wildfires

Wildfires occur in open space areas, including forests, chaparral, and grasslands. Fuel, weather, and topography are primary factors that affect how wildland fires spread. In Solano County, grassland and woodland habitat provide highly flammable fuel that is conducive to wildfires. These plant species are capable of regeneration after a fire, making periodic wildfires a natural part of the ecology of these areas. The climate of Solano County keeps the grass dry and more readily combustible during fire season. Seasonal drought conditions exacerbate fire hazards.

The hilly and mountainous terrain on the north and west sides of the county strongly influence both wildland fire behavior and fire suppression capabilities. Wind is also a significant factor in the spread of fire, as wildfires spread faster and burning embers are carried with the wind to adjacent exposed areas. In densely populated areas, flying embers are the principal driver of wildfire. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread fire to adjacent structures.

Wildfire potential for Solano County is typically greatest in the months of August, September, and October, when dry vegetation coexists with hot, dry winds, known as Diablo winds. Diablo winds come from the north and northeast, carrying extremely dry air at a high velocity, usually in the San Francisco Bay Area. These hot, dry winds can quickly desiccate vegetation and other combustible materials and can push a fire down or up a slope at very high speeds. During these times, controlling a fire becomes far more difficult. Seasonal drought conditions exacerbate fire hazards. Areas adjacent to the county that are susceptible to wildfires are also of concern because these conditions could exacerbate vulnerabilities in the county.

Because areas of the county with natural vegetation are extremely flammable during late summer and fall, wildfire is a serious hazard in undeveloped areas and on large-lot home sites with extensive unirrigated vegetation. Grassland fires are easily ignited, particularly in dry seasons. These fires are relatively easily controlled if they can be reached by fire equipment, although after a fire, the burned slopes are highly susceptible to erosion and gullying. Brush lands are naturally adapted to frequent light fires, but fire suppression in recent decades has resulted in heavy fuel accumulation on the ground. Wildland fires, particularly near the end of the dry season, tend to burn fast and very hot, threatening homes and leading to serious destruction of vegetative cover. A wildland fire can generate a destructive crown fire, which is a fire that burns materials at the top of trees, spreading from treetop to treetop. They can be very intense and difficult to contain.

Many species of oaks are relatively tolerant to fire and are known to be part of California's fire-dependent ecosystem. In general, oak woodlands are well adapted to periodic fire in the landscape. However, fire suppression in the 20th century has led to an increase of ton per acre of various fuel types. The buildup of dense understories and higher density of small trees multiply the risk of high-severity fires under hot, dry, and windy conditions. The combustibility of the fuel depends on its moisture content, physical structure, and chemical content. The drier the fuel, the more flammable it will be. Regardless, all vegetation in the region reaches some degree of combustibility during the dry summer months and, under certain conditions, during the winter months.

In addition, tree mortality due to drought, sudden oak death, and forest pest (beetles) have increased densities of dead fuels and contributed to higher fire risk in the Bay Area. Sudden oak death is caused by the pathogen *Phytophthora ramorum*, which has been responsible for massive die-offs of true oak species and tanoak in coastal and inland regions of California and Oregon. These die-offs become a source of fuel and have consequently become an increasing concern for their potential to increase fire intensity throughout the region.

Under moderate drought conditions, oak woodlands generally present low fire risk, and treatments that remove ground fuels further reduce risk of high-severity fire. High-intensity fires increase the likelihood of a fire growing and spreading quickly. Furthermore, the production of burning embers carried through the wind can lead to spot fires beyond the immediate perimeter, and these are often the primary cause of ignition for structures. In Solano County, an oak woodland wildfire has the potential to spread rapidly due to the community's steep topography, and fuel load, and climatic conditions during the summer and fall make fire suppression challenging.

Potential Wildfire Areas

Solano County is threatened by both urban and rural fires with the potential to cause property damage, injury, and loss of life. The areas with the highest risk for wildfire are in western Solano County, in the foothills and mountainous watershed areas, as well as in grasslands throughout the county. Prior to the urbanization of nearby lowlands, the vegetation in these mountainous areas was naturally maintained by periodic wildfire. As nearby lands were developed, natural wildfires were suppressed, resulting in the buildup of fire-prone brush and woodlands.

Topography, weather, and native vegetation provide the conditions for destructive fires that can spread rapidly. In California, development in hazard areas has worsened the problem by placing people into hazard areas, disrupting natural fire processes, and allowing buildup of flammable brush and vegetation. Such development has also moved the urban-wildland interface (the area where human development meets undeveloped wildlands) closer to higher-risk wildfire hazard areas, increasing the number of people and buildings at risk. The rugged, rural terrain in the western hills of the county makes firefighting more difficult.

Wildfire Smoke

Increasing local and regional fire frequency can create recurring 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.

Wildland-Urban Interface Fires

The wildland-urban interface (WUI) is an area where buildings mix with areas of flammable wildland vegetation, allowing wildland fires to easily spread to buildings and structures. The WUI is subdivided into three zones: the intermix (where housing and wildland vegetation are closely mingled), the interface (where housing is adjacent to less-dangerous vegetation), and the influence (a buffer around intermix and interface zones). Hundreds of homes now border major forests and brush areas in California. According to a publication in the *International Journal of Wildfire*, the interface WUI in California contained 50 percent of the buildings destroyed by wildfire, but intermix WUI contained only 32 percent. The proportion of buildings destroyed by fires among classes was similar, though highest in interface WUI areas (15.6 percent). The results demonstrated that the interface WUI is where most buildings were destroyed in California, despite less wildland fuel.[10]

In the WUI, efforts to prevent ignitions and limit wildfire loss hinge on hardening structures and creating defensible space through a multifaceted approach that includes engineering, enforcement, education, emergency response, and economic incentive. Different strategies in the defense and threat zones of the WUI help to limit the spread of fire and reduce the risk to people and property.

Structural Fires

Solano County is also 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 exacerbate the damages associated with a structural fire. Structural fires are largely from human accidents, although deliberate fires (arson) may be a cause of some events. Older buildings that lack modern fire safety features may face greater risk of damage from fires. To minimize fire damage and loss, the County's Fire and Building Codes, based on the California Fire and Building Codes, set 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.

Fire Hazard Zones

The California Department of Forestry and Fire Protection (CAL FIRE) establishes Fire Hazard Severity Zones (FHSZ), designating each as moderate, high, or very high severity. Most unincorporated areas,

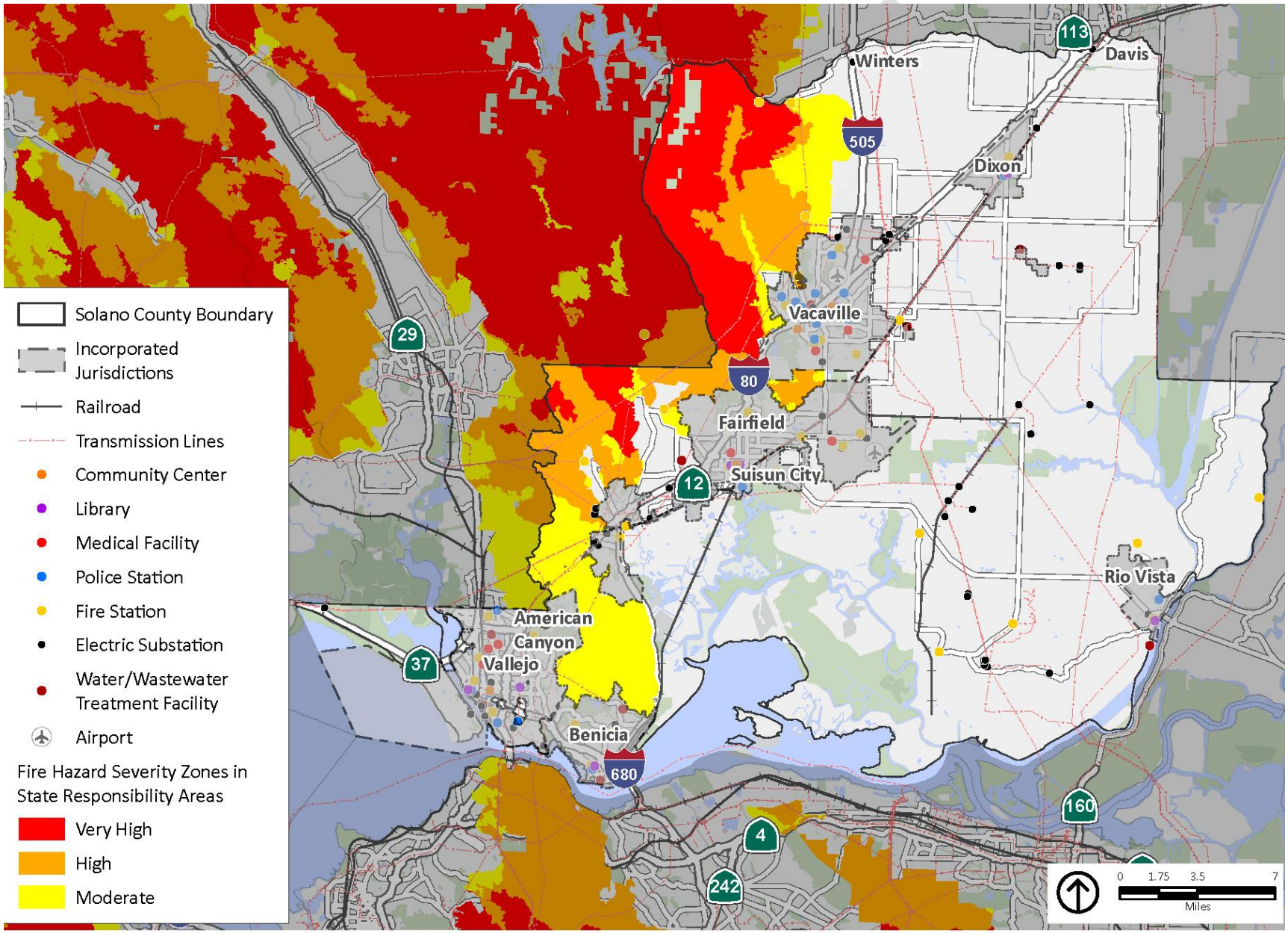
such as Solano County, are considered state responsibility areas (SRA) where CAL FIRE has responsibility for wildfire protection. CAL FIRE's Sonoma-Lake-Napa Unit is responsible for 93,820 acres of SRA lands in Solano County. All very high FHSZs in Solano County are in SRAs.

The areas currently at the highest risk for fires are in western Solano County in the foothills and mountainous watershed areas, and in grasslands throughout the county. Areas to the north of Benicia and to the west and north of Fairfield, primarily in the undeveloped hillsides, are in a moderate and high FHSZ. Additionally, areas along the Vaca Mountains, north of Fairfield and west of Vacaville, are in a moderate and high FHSZ; some of this land is in a very high FHSZ. Before nearby lowlands were urbanized, vegetation in these mountainous areas was naturally maintained by periodic fires. As nearby lands were developed, natural wildfires were suppressed, resulting in the buildup of fire-prone brush and woodlands. These efforts to suppress natural processes have resulted in larger, more damaging fires.

Areas in the WUI are vulnerable and, as a result of serious wildland fires throughout the state in recent years, are subject to stringent fire-prevention regulations on development. Residential development in the WUI has exposed more people to risks from wildfires. The introduction and proliferation of exotic species, accumulated fuel, and climate change–driven droughts and extreme heat events exacerbate the fire problem. Together, these factors result in more people, property, critical infrastructure, and natural resources in harm's way on a more frequent basis. Though large-scale wildfires do not occur every year, wildfire incidents driven by extreme weather conditions have repeatedly been difficult to contain.

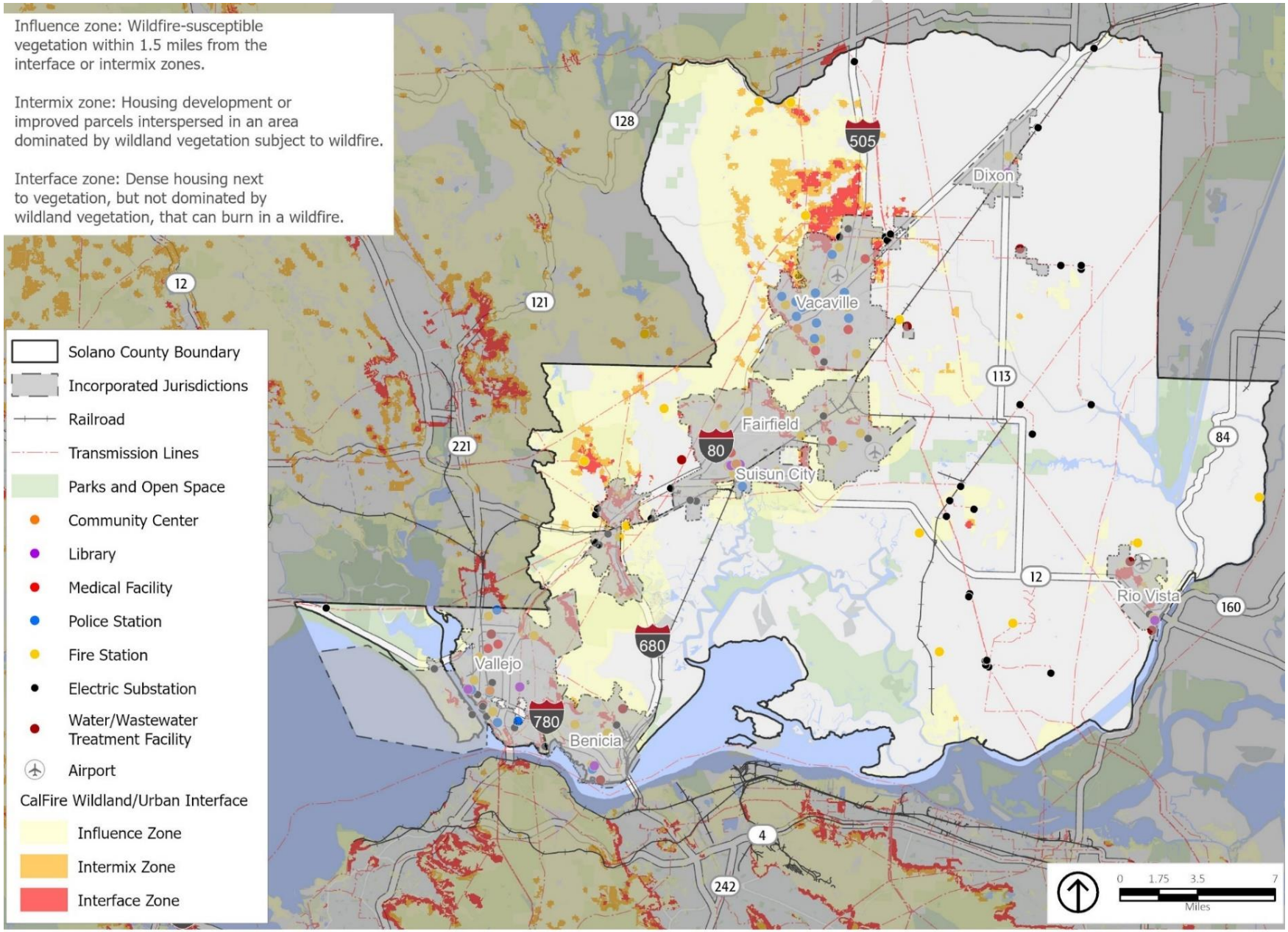
A combination of factors, including weather, topography, and vegetation, put Solano County, including both the High FHSZ and the WUI, at a high risk. **Figure HS-14** shows the wildfire hazard severity zones in and around Solano County, and **Figure HS-15** identifies the WUI.

Figure HS-14: Wildfire Hazard Severity Zones



Source: CalFire 2024, Solano County, PlaceWorks 2022, ESRI

Figure HS-15: Wildland-Urban Interface Zones



Source: CalFire 2015, PlaceWorks 2022, ESRI

Water Pressure and Supply

Insufficient water pressure and supply also contribute to wildfire danger. Most of the higher-risk wildfire areas in the county are not served by public water. Fire districts serving these areas are typically equipped with tank trucks. Properties designated for residential use in areas without public water service are required to maintain sufficient on-site water storage, and new development must show that it has sufficient water pressure for firefighting purposes.

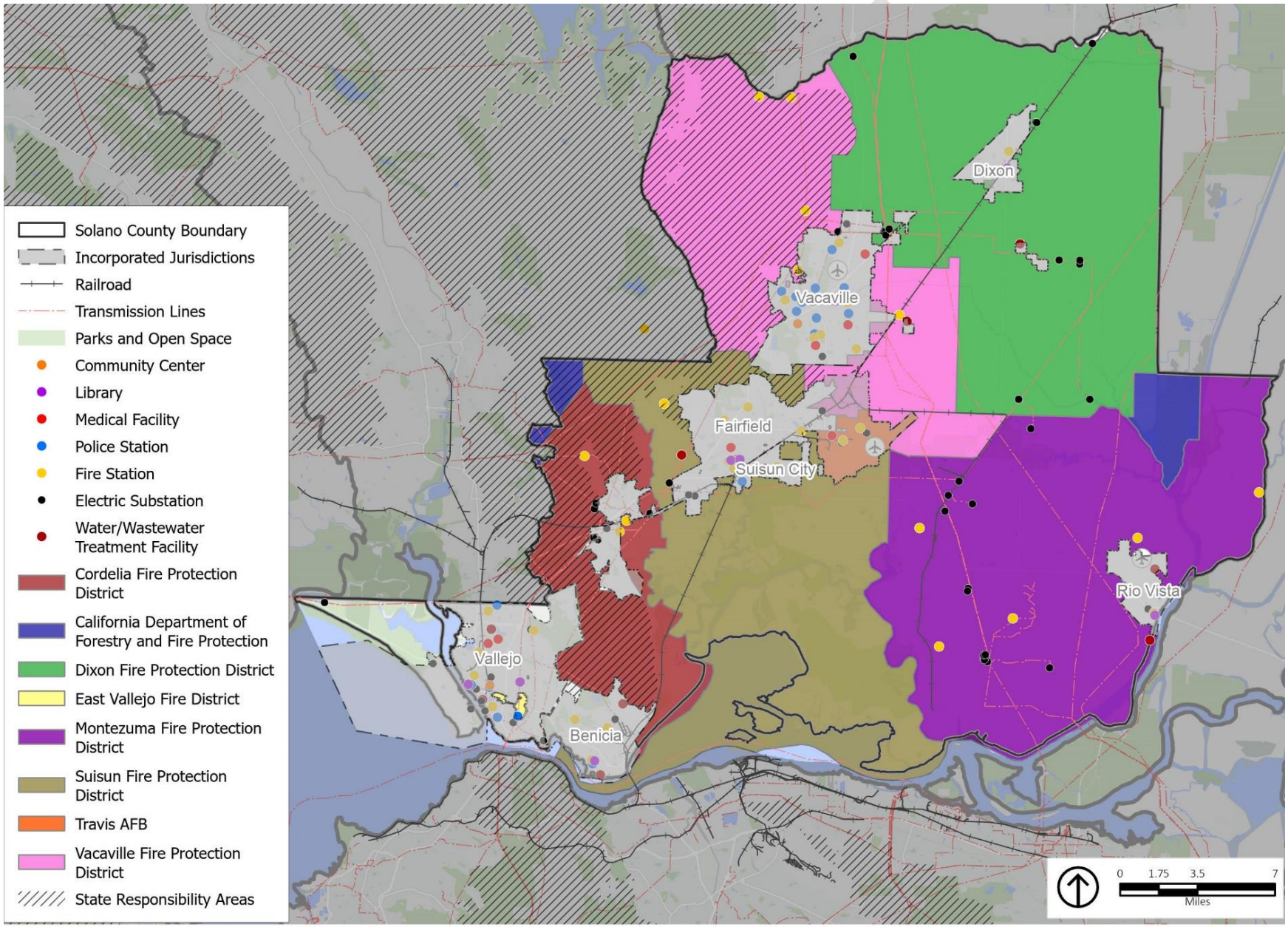
Fire Protection

Fire protection in unincorporated Solano County is provided by six fire protection districts—East Vallejo Fire District, Cordelia Fire Protection District, Suisun Fire Protection District, Vacaville Fire Protection District, Dixon Fire Protection District, and Montezuma Fire Protection District. The service area for each of the districts is equal to its boundary area. Similarly, each of the cities provides services within its boundaries. However, all agencies participate in mutual and automatic aid agreements to provide services outside of their bounds.

Other service providers include CAL FIRE, Travis Air Force Base Fire Department, and the United States Forest Service (USFS). Travis Air Force Base Department and the USFS do not overlap with the six districts mentioned above. CAL FIRE services are focused in wildland areas defined as state responsibility areas (SRAs). Fire protection districts in Solano County contain SRAs where CAL FIRE is responsible for wildland fires. These fire protection districts include the Dixon Fire Protection District, Vacaville Fire Protection District, Suisun Fire Protection District, and Cordelia Fire Protection District.

The jurisdictional boundaries for the fire protection districts are illustrated in **Figure HS-16**. CAL FIRE also provides technical support throughout the county in the form of specialized services such as fire suppression hand crews, dozers, and helicopters where necessary. No areas in unincorporated Solano County are currently lacking fire protection services.

Figure HS-16: Fire Protection Districts



Source: DWR DSOD 2021, PlaceWorks 2022, ESRI

Cordelia Fire Protection District

Cordelia Fire Protection District (CFPD) provides structural, wildland, and vehicle fire suppression; fire prevention services; hazardous materials assistance; public service assistance; and emergency medical services in the form of basic and advanced life support. In addition, the district provides specialized rescue services, such as response to boating accidents along the shoreline and low-angle rope rescue services. CFPD provides services to the unincorporated territory in the southwestern portion of Solano County. Services are provided by four full-time-equivalent personnel and 46 volunteers.

CFPD operates out of two stations:

- **Station 29** at 1624 Rockville Road, Fairfield
- **Station 31** at 2155 Cordelia Road, Fairfield

Dixon Fire Protection District

Dixon Fire Protection District (DFPD) provides structural, wildland, and vehicle fire suppression; fire prevention services; hazardous materials assistance; public service assistance; and emergency medical services in the form of basic and advanced life support. In addition, DFPD provides specialized rescue services, such as confined space rescue. All services are provided by the City of Dixon Fire Department through a contract. DFPD operates out of one station. It does not have any staff of its own; all services are provided by City of Dixon FD personnel. Dixon FD serves the most expansive area of 320 square miles (312 square miles of the district and 8 square miles of city territory).

DFPD operates out of one station at 205 Ford Way, Dixon.

East Vallejo Fire Protection District

East Vallejo Fire Protection District (EVFPD) provides structural, wildland, and vehicle fire suppression; fire prevention services; hazardous materials assistance; public service assistance; and emergency medical services in the form of basic and advanced life support. In addition, EVFPD provides specialized rescue services, such as swift water and low-angle rope rescue services. EVFPD does not have staff of its own, and all services are provided by the City of Vallejo Fire Department by contract. EVFPD receives services from seven stations; each station serves a very small area of about 8.3 square miles in the following seven noncontiguous areas, which are all either entirely surrounded by the city of Vallejo or immediately adjacent to the city's limits:

- A small pocket area off Springs Road.
- The sandy beach area to the south of the city.
- An area northwest of the city and west of SR-37.
- An area northeast of Vallejo, between Hiddenbrook Parkway and I-80.

- An area at the east end of Vallejo that borders Cordelia FPD and encompasses Lake Herman Road.
- Territory southeast of Vallejo that encompasses portions of both I-780 and I-80.
- Land northwest of Vallejo that includes a portion of SR-37 and borders the Napa River.

EVFPD operates out of seven stations:

- **Station 21** at 1220 Marin Street
- **Station 22** at 700 Fifth Street
- **Station 23** at 900 Redwood Street
- **Station 24** at 1005 Oakwood Avenue
- **Station 25** at 595 Mini Drive
- **Station 26** at 1335 Fulton Avenue
- **Station 27** at 1585 Ascot Court

Montezuma Fire Protection District

Montezuma Fire Protection District (MFPD) provides fire response, limited hazardous materials response, full vehicle extrication, and 24-hour basic life support services. MFPD performs fire code plan checks, inspection, and enforcement; participates in educational activities to increase community awareness of fire safety and prevention; and conducts fire investigations within its boundary area. MFPD is served by 32 firefighting staff. MFPD serves an extensive territory of 200 square miles of mostly farmland and pasture lands in southeastern Solano County. It operates out of four stations, each of which covers about 50 square miles.

MFPD operates out of these two stations:

- **Station 51** at 21 N. 4th Street, Rio Vista
- **Station 52** at 2151 Collinsville Road, Birds Landing

Suisun Fire Protection District

Suisun Fire Protection District (SFPD) provides structural, wildland, and vehicle fire suppression; some fire prevention services; hazardous materials awareness and operations; public service assistance; and emergency medical services in the form of basic life support. In addition, SFPD provides specialized rescue programs, such as water and boating accident rescue and low-angle rope rescue services. SFPD operates out of two fire stations. Services are provided by 39 firefighting personnel. SFPD is in the

southwestern portion of Solano County and surrounds the cities of Fairfield and Suisun City almost in their entireties.

SFPD operates out of these two stations:

- **Station 32** at445 Jackson Street, Fairfield
- **Station 33** at 4165 Clayton Road, Fairfield

Vacaville Fire Protection District

Vacaville Fire Protection District (VFPD) provides 24-hour response for emergencies. VFPD responds to all types of incidents, including wildland fires, structure fires, medical emergencies, vehicle accidents, activated alarms, technical rescues, hazardous materials, and public service assists. In addition, VFPD provides fire prevention and public education programs as well as ongoing training for all district staff. VFPD is in the northwestern portion of Solano County and surrounds Vacaville. VFPD is served by 77 firefighting staff. Although the overall number of firefighting personnel is the highest among the fire protection districts in the county, VFPD serves a large population, making its firefighting personnel ratio per capita of seven firefighters per 1,000 residents, the lowest of the fire districts.

VFPD operates out of five fire stations:

- **Station 64** at 420 Vine Street, Vacaville
- **Station 65** at 6080 A Street, Elmira
- **Station 67** at 4315 Cantelow Road, Vacaville
- **Station 68** at 4012 Canal Lane, Winters
- **Station 69** at 8684 Pleasants Valley Road, Winters

Travis Air Force Base Fire Department

Travis Air Force Base (AFB) is in the central part of Solano County and is bordered by Fairfield in the west, SFPD in the west and south, VFPD in the north, and MFPD in the southeast. Travis AFB occupies approximately 7,100 acres of land, with two 11,000-foot runways oriented along the northeast-southwest diagonal, away from existing housing developments. In 1995, the function of the base was expanded by the addition of air refueling assets from March AFB. The U.S. Department of Defense has been using the site for military operations since the early 1940s. Travis AFB Fire Department is a paid fire department that is a part of the federal government. It operates out of four stations and is staffed by 94 paid firefighters.

Travis AFB Fire Department serves territory on the air force base and responds to incidents related to AFB aircraft in other parts of Solano County.

California Department of Forestry and Fire Protection

CAL FIRE is a state agency responsible for protecting and maintaining privately owned wildland, providing emergency services, and responding to wildland fires throughout California. CAL FIRE also provides technical support throughout the county in the form of specialized services such as fire suppression hand crews, dozers, and helicopter services when necessary.

Solano County is served by the Sonoma-Lake-Napa Unit (LNU) of CAL FIRE. The unit was created in 1996 when the Sonoma Ranger Unit and the Lake-Napa Ranger Unit were merged. LNU has primary responsibility for more than 2.3 million acres of CAL FIRE's direct protection area (DPA), more than any other unit. It has the third largest population living within a CAL FIRE DPA and ranks the third in average number of annual fires.

The LNU is divided into 4 divisions and 10 field battalions. Solano, Yolo, and Colusa Counties make up the East Division, which has a single battalion. LNU's headquarters, including the Emergency Command Center and the South Division offices, are just north of St. Helena in Napa County. The headquarters for the East Division are in Delta Camp east of Suisun City.

United States Forest Service

The USFS also provides services in California, primarily in federal forests and grasslands. Areas that USFS services are defined as federal responsibility areas (FRA). There are only a few small areas that are considered FRAs in Solano County, all of which are in the western portion of VFPD.

Mutual Aid Agreements

All fire protection districts and agencies are a signatory to the California Mutual Aid Fire Protection System. This agreement was established to aid with major emergency incidents anywhere in the state. The fire protection districts maintain mutual aid agreements with several agencies, including the City of Benicia, City of Dixon, City of Fairfield, City of Rio Vista, and City of Suisun City. When major incidents occur, fire protection districts deploy their resources and depend on mutual aid agreements with neighboring jurisdictions.

All agencies, including CAL FIRE, the USFS, and Travis Air Force Base, participate in mutual and automatic aid agreements through which they can provide services outside of their boundaries. Mutual aid agreements help ensure adequate response times in the outlying areas. The County also has a contract with the State Office of Emergency Services.

Fire Safe Planning

Several site design and planning methods can be employed to minimize dangers to life and property in wildfire hazard areas. Methods advocated by County policies and programs include buffering, creating fuel breaks, clustering, and fire-safe construction.

Buffering for fire safety refers to the removal of combustible vegetation around a building within a given distance, usually 30 to 50 feet. This creates a fire-defensible space, which can limit fire from spreading to nearby buildings and provides better access to the property for firefighters.

Similarly, fuel breaks are large-scale buffers used to prevent fire from approaching communities or blocking roadway access for firefighting equipment. To create fuel breaks, small trees and light fuels within a 50-foot strip of land are removed. These fuels would otherwise allow fire to climb up to the treetops where firefighting is more difficult.

Clustered development for fire safety describes buildings that are placed closer to one another and closer to roads to decrease the amount of space fire districts must protect in the event of a wildfire and to increase access to that space. When homes are closer to one another, firefighters are able to maximize their resources, which is especially important in rural environments that lack public water sources.

Fire-safe construction incorporates fire-resistant materials into various parts of a house, including the roof, siding, vents, windows, and patios, to minimize the risk of burning. Particular attention is given to putting propane and oil tanks in protected locations.

Past Occurrences

There are four major factors that contribute to historical wildfire events:

1. Extreme vegetation diversity
2. Diverse fire weather and fire behavior
3. Dynamic fire history
4. Complex land use patterns

From 2005 to 2020, there were 15 wildfires in Solano County, some of which overlapped with neighboring counties, each burning over 100 acres in the region. Some burned considerably more acreage—most notably the 2017 Atlas Fire and the 2020 LNU Lightning Complex. These events are listed in **Table HS-1**.

TABLE HS-1: FIRE PERIMETER SIZES AND DATES (100 ACRES OR GREATER 2000–2020)

Date	Fire Name	Size in Acres
2005	Gordon	194
2000	Winters	404
2004	Cement	1,007
2002	128	188
2003	Sacket	192
2004	Mix	296
2006	Sky Valley	226
2008	Wild	4,102
2011	Beacon	703
2015	Wragg	8,049
2017	Timm	126
2017	Atlas	51,625
2018	Nelson	2,158
2019	American	527
2020	LNU Lightning Complex	160,260
Source: California Fire Incident Database.		

Atlas Fire

The Atlas Fire started on October 8, 2017; impacted Napa County and Solano County; and lasted approximately 123 days. The fire burned portions of these counties and extended to the east of the city of Napa. The fire killed six people, damaged 783 structures, and destroyed 120 structures, including residential homes, commercial, and other structures. The fire burned approximately 51,625 acres. According to CAL FIRE, this fire was California's 14th most destructive fire in history as well as the state's 15th deadliest fire.

LNU Lightning Complex and Hennessey Fire

The LNU Lightning Complex was a series of lightning-sparked fires that began in August and continued through October of 2020 in Northern California. Lightning struck California approximately 14,000 times over a three-day period and started more than 650 fires. The fires burned a total of 363,220 acres and were active for 47 days.

The Hennessey Fire, which started on August 17, 2020, formed part of the LNU Lightning Complex. It impacted Solano County along with Colusa, Lake, Napa, and Yolo Counties. The Hennessey Fire burned parts of northwestern Solano County west of Vacaville. In Solano County, the fires killed six people, injured five people, and destroyed 309 residential homes and 854 structures. The fire burned approximately 42,000 acres in the county.

Potential Changes to Fire Risk in Future Years

Likelihood of Future Occurrence

The wildfire season in Solano County historically lasts from June through November. Generally, Solano County faces annual wildland fire threats. Extreme weather conditions during periods of low humidity, low fuel moisture, and high winds also contribute to the severity of any potential wildfires. Fires occurring during these times typically burn hot and fast and are difficult to control unless initial suppression is immediate. Wildfire for Solano County is a high concern given its High and Very High FHSZs and WUI designations. The area's unique ecology—particularly the topography, climate, and vegetation—provides the setting for recurrent catastrophic wildfires. Moreover, the county consists of and is surrounded by undeveloped hillsides that extend from the north of Benicia to the Vaca Mountains, which makes these areas high risk for wildfire. 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. Wildfire will continue to be a high-risk hazard for personal safety and property damage in Solano County, and smoke impacts from local and regional wildfires are likely to continue to be problematic. The likelihood of structural fires in the county is low because these fires are usually associated with human accidents or mechanical issues in buildings that rarely happen.

Climate Change and Wildfire

Climate change is expected to increase the frequency and size of wildfires in California. Hotter, drier weather and prolonged drought will increase the accumulation of fire-prone vegetation, and stronger winds will continue to spread fires faster and farther than previously. This will expand the size of the urban-wildland interface because more residential communities will be within reach of wildfire activity. An expanded urban- wildland interface will require increased resources, planning, and funding to maintain and defend.

Changing climate conditions are expected to increase the fire risk in and around Solano County. The majority of past wildfire events in Solano County typically occurred from June through October. Warmer temperatures brought on by climate change are expected to begin earlier and end later in the year, exacerbating drought conditions and extending the wildfire season. Droughts can kill or dry out plants, creating more fuel for wildfires. Increased winds may result in more erratic fire behavior, making fires harder to contain.. Wildfires occurring later or earlier in the year are more likely to occur during Diablo wind events, which can cause wildfires to move more quickly and increase the likelihood of burning in the WUI areas.

HAZARDOUS WASTE AND MATERIALS

Planning Context

This section addresses actions that can be taken to prevent exposure to potentially dangerous materials during their use, storage, transportation, and disposal. Hazardous materials are used extensively every day—from agricultural fertilizers and pesticides to household cleaning products. Hazardous materials include corrosive, toxic, reactive, or flammable materials in our homes and businesses. These materials can be harmful to people, wildlife, and the environment. In Solano County they can be found in a number of products and locations, including hazardous waste sites, brownfield properties, and naturally occurring materials like asbestos, radon, and mercury.

Types of Hazardous Materials

Hazardous materials are materials from a variety of sources that pose a significant risk to public safety or human or environmental health. Some common categories are briefly discussed below to provide a framework for the policies and implementation programs proposed at the end of this section.

Hazardous materials 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 material storage tank). Hazardous materials can also be released accidentally during transportation as a consequence of vehicle accidents. This includes items such as used motor oil, batteries, solvents, poisons, chemicals, oil- and latex-based paints, and automotive fluids.

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. Damage to property could range from immediate destruction by explosion to permanent contamination by a persistent hazardous material.

Hazardous waste is subject to storage time limits, disposal requirements, and labeling requirements on containers. Most hazardous waste may be stored for only 90 days, with exceptions made for businesses that generate small quantities under certain circumstances. Hazardous wastes used by businesses are reported in an annual inventory of hazardous materials required by the Solano County Hazardous Materials Management Plan.

Naturally occurring hazardous materials in Solano County, such as asbestos, radon, and mercury, are also found throughout California. Asbestos is a mineral composed of long, thin, fibrous crystals and is often found in the mineral serpentine. Prior to 1978, asbestos was used in building materials because of its resistance to heat, chemical, or electrical damage. Inhaling asbestos fibers may cause various health issues, including lung cancer. For this reason, asbestos is being removed from building materials, and

studies continue to investigate the correlation between naturally occurring asbestos and the health of nearby residents.

Mercury is an element found in Solano County as a result of both natural processes and human activities. There are natural deposits of mercury near Sulfur Springs Mountain in Vallejo. Sources related to human activities include coal combustion and certain industrial and mining activities. Mines with mercury-producing ore are in the Sulfur Springs Mountain Range east of Vallejo. Humans are most often exposed through consumption of fish that have been exposed to methyl mercury.

Radon is a gas that forms during the decay of uranium and is naturally found in rock, water, and soil. It migrates to the surface through cracks or fractures in the earth's crust. Breathing air with elevated levels of radon gas increases the risk of developing lung cancer. Radon hazards are generally low in Solano County, although some tests near Vacaville did have significant results.

The County will continue to keep informed of these hazardous materials and will inform and educate residents on how to avoid the risks. Other sources of hazardous material in Solano County include agricultural spraying, such as herbicides and pesticides; leaking underground storage tanks; and airports, specifically Travis Air Force Base.

Brownfields

Brownfields are properties that are contaminated or thought to be contaminated. Many are in urban areas and are underused because of perceived remediation costs and liability concerns. Redeveloping brownfield properties optimizes the use of existing infrastructure, saving tax dollars and protecting natural resources. It also preserves agricultural and green spaces by slowing their conversion to residential, commercial, and industrial uses. Solano County maintains a list of all of the approximately 500 brownfield sites in the county and works with federal and State agencies to ensure their proper cleanup or maintenance.

Transportation of Hazardous and Toxic Materials

Land use hazards associated with the transport of hazardous cargo do exist in Solano County. A number of major, interstate transportation routes pass through the area, and a wide range of hazardous cargo is regularly transported along these routes. The most vulnerable areas are considered the on-/off-ramps and interchanges. Types of hazardous cargo regularly transported out of, into, and through Solano County by freeway or railroad include flammable liquids, corrosive materials, compressed and/or poisonous gases, explosives, and flammable solids.

Some potential exists for a highway or railway mishap that could cause hazardous cargo to spill, contaminating surrounding areas. If flammable liquids were to ignite, they could quickly spread fire and poisonous fumes that could cause human casualties and/or property damage. Spilled liquids could also drain into nearby streams or drainage facilities, spreading the effects of an accident over a much larger area. Since 1970, 5 railway and 78 roadway hazardous materials incidents have occurred in Solano County.

The County recognizes that the possibility of an accident involving hazardous cargoes and has established policies and implementation programs to minimize the likelihood and extent of such accidents. Certain provisions in the General Plan, primarily in response to noise and air quality issues, will also have a secondary effect of protecting developed lands near freeways and railroad alignments from casualties or property damage caused by hazardous cargo accidents. These provisions generally include increased development setbacks and berm techniques.

Agency Monitoring and Response

Hazardous materials and waste in Solano County are managed by the Certified Unified Program Agency (CUPA), a local administrative agency in the Solano County Department of Resource Management, Environmental Health Services Division. 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.

Several state agencies monitor hazardous materials/waste facilities. Potential and known contamination sites are monitored and documented by the Regional Water Quality Control Board (RWQCB) and the California Department of Toxic Substances Control (DTSC). A review of the leaking underground storage tank (LUST) list produced by the RWQCB's and the DTSC's EnviroStor database indicates hazardous waste sites throughout the county.

If a hazardous material spill poses an imminent public health threat, the County will support local regulating agencies in notifying the public. As sea levels rise, low-lying coastal areas become prone to flooding. Contaminated sites located near coastlines or in flood-prone areas may become submerged, allowing water to infiltrate the site. This inundation can directly mobilize contaminants by carrying them away from the site and potentially spreading them to surrounding areas. The transport of hazardous materials/wastes and explosives through the county is regulated by the California Department of Transportation (Caltrans). I-80, I-505, I-680, SR-12, SR-37, SR-84, and SR-113 are open to vehicles carrying hazardous materials/wastes. Transporters of hazardous wastes are required to be certified by Caltrans, and manifests are required to track the hazardous waste during transport. The danger of hazardous materials/waste spills during transport does exist and can potentially increase as transportation of these materials increases on freeways and railways. The Solano County Sheriff's Office, CAL FIRE, Solano County Office of Emergency Services, and Solano County Department of Resource Management, Environmental Health Services Division are responsible for hazardous materials accidents at all locations in the county. Depending on location, Solano County fire projection districts will also respond to hazardous materials accidents.

Potential Changes to Hazardous Materials Risk in Future Years

Likelihood of Future Occurrence

Although a hazardous material accident can occur almost anywhere, certain regions are more vulnerable. The potential for an accident increases in regions near roadways or railways that are frequently used for transporting hazardous material as well as those with agricultural or industrial facilities that use, store, handle, or dispose of hazardous material. Given that 83 hazardous materials incidents have happened in transport through the county in the past 50 years, it is likely that a hazardous materials incident will occur in Solano County every year. However, according to Caltrans, most incidents are related to releases of fluids from the transporting vehicles themselves and not the cargo, so the likelihood of a significant hazardous materials release in the county is more limited and difficult to predict.

Climate Change and Hazardous Materials

Climate change is unlikely to significantly affect hazardous materials transportation incidents. 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.

Related Plans, Programs, and Agencies

Safe Drinking Water and Toxic Enforcement Act of 1986

The Safe Drinking Water and Toxic Enforcement Act of 1986 was enacted as a ballot initiative in November 1986. It was intended to protect California citizens and the state's drinking water sources from chemicals known to cause cancer, birth defects, or other reproductive harm and to inform citizens about exposures to such chemicals. The act requires the governor to publish, at least annually, a list of chemicals known to the state to cause cancer or reproductive toxicity.

Oil Spill Contingency Plan

The Oil Spill Contingency Plan (California Government Code Section 8574.1) requires that regional and local planning agencies incorporate in their planning the state's effort to respond to marine oil spills and ensure the effective and efficient use of regional and local resources in the areas of traffic and crowd control, firefighting, boating traffic control, radio and communications control, and provision of medical emergency services.

Toxic Release Contingency Plan

The Toxic Release Contingency Plan (California Government Code Section 8574.16) requires that regional and local planning agencies incorporate within their planning the state's effort to respond to emergency toxic releases and ensure the effective and efficient use of regional and local resources in the areas of traffic and crowd control, firefighting, hazardous materials response and cleanup, radio and communications control, and provision of medical emergency services.

Hazardous Materials Release Response and InventoryProgram

The Hazardous Materials Release Response and Inventory Program (California Health and Safety Code Sections 25500 to 25520) establishes business and area plans for the handling and release of hazardous materials. Basic information on the location, type, quantity, and health risks of hazardous materials handled, used, stored, or disposed of in the state and that could be accidentally released into the environment is tracked by the local CUPA in each region for the use and awareness of hazardous materials responders, firefighters, emergency care providers, regulatory agencies, and other interested persons.

California Occupational Safety and Health AdministrationHazardous Substances Emergency Response Training

California Occupational Safety and Health Administration Hazardous Substances Emergency Response Training is required for all workers involved with the handling, disposal or emergency response to hazardous materials (Title 8, Section 5192). Various training levels are required depending on organizational level and responsibility level.

Hazardous Waste Management Plans

The Solano County Department of Environmental Management maintains hazardous materials management plans to address emergency response to incidents involving hazardous materials handled by a business over 55 gallons, 500 pounds, or 200 cubic feet of gas. These plans include an inventory of hazardous materials, which is updated annually.

The County also maintains the Hazardous Waste Management Plan (Tanner Plan) for the management of all hazardous wastes generated in the county and to address the siting of hazardous waste facilities for the disposal of those wastes. The County participates with the regional Hazardous Waste Management Facility Allocation Committee in addressing the Tanner Plan siting requirements. The Household Hazardous Waste Element of the County's Integrated Waste Management Plan addresses the safe collection, recycling, treatment, and disposal of hazardous wastes generated by households.

Certified Unified Program Agency

The Solano County Department of Resource Management is the CUPA for all cities and unincorporated areas in the county. The CUPA program was created to consolidate and make consistent the various environmental and emergency response regulations applicable in a jurisdiction to minimize the number of inspections and fees businesses must comply with. The Solano County CUPA:

- Conducts the permitting and inspection of businesses that handle certain quantities of hazardous materials/waste.
- Inspects businesses for compliance with the Hazardous WasteControl Act, in conjunction with the Hazardous Materials Business Plan Program.

- Responds to complaints of illegal disposal of hazardous waste.
- Addresses emergency response to incidents involving hazardous materials through the Hazardous Materials Management Plans.

EMERGENCY PREPARATION AND RESPONSE

Planning Context

Local Emergency Response

The Solano County Sheriff's Department and Solano County fire protection districts conduct emergency preparedness activities throughout the county. Solano County does not have its own fire department. Several individual fire protection districts serve the unincorporated county area. This includes the East Vallejo Fire District, Cordelia Fire Protection District, Suisun Fire Protection District, Vacaville Fire Protection District, Dixon Fire Protection District, and the Montezuma Fire Protection District. Certain fire protection districts may consist of full- or part-time firefighters, but most firefighters in the unincorporated county are volunteers.

Community Warning Systems

The County uses Alert Solano to notify residents and businesses within Solano County that are impacted by or in danger of being impacted by an emergency. The system provides basic information about incidents and what specific protective actions are necessary to protect life and health (shelter in place, lockdown, evacuate, avoid the area, etc.).

Alert Solano enables agencies in Solano County to provide residents with critical information quickly in a variety of situations, such as severe weather, unexpected road closures, missing persons, and evacuations of buildings or neighborhoods. In the event of an emergency, public safety officials, including local police and fire, send a message to those who have registered for Alert Solano about a potential safety hazard or concern, including severe weather alerts, road closures, and natural disasters. The Alert Solano emergency notification system allows users to provide customized information for the most efficient delivery of emergency information. Alerts can be sent to all devices registered with Alert Solano, maximizing the chances of alerting users in a timely manner.

Other systems include the Emergency Alert Systems (EAS) and the Emergency Digital Information System (EDIS). The EAS is a national public warning system commonly used by state and local authorities to deliver important emergency information, such as weather and AMBER alerts, to affected communities. EAS participants include radio and television broadcasters, cable systems, satellite radio and television providers, and wireline video providers. FEMA, the Federal Communications System, and the National Oceanic and Atmospheric Administration's National Weather Service (NWS) work collaboratively to maintain the EAS and Wireless Emergency Alerts, which are the two main components of the national public warning system and enable authorities at all levels of government to send urgent emergency

information to the public. The EDIS is a wireless emergency and disaster information service operated by the State of California Governor's Office of Emergency Services and is an enhancement to the EAS. These systems are available in multiple languages.

Weather-related emergency alerts are broadcast by the NWS and monitored by Solano County Sheriff's Dispatch. If the NWS posts a warning that would affect the Solano County Area, dispatch directly notifies the district's on-call battalion chief and the police department watch commander as well as the director and assistant director of Emergency Services and others as needed.

Emergency Evacuation

With advanced warning, evacuation can be effective in reducing injury and loss of life during a catastrophic event. **Figure HS-17** shows residential parcels with evacuation constraints. California Government Code Section 65302(g)(5), as codified by 2019's Senate Bill (SB) 99, requires that the Safety Element identify residential developments in hazard-prone areas that do not have at least two emergency evacuation routes. All of these parcels are at least a half mile from a major roadway and 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. **Figure HS-18** shows the potential evacuation routes throughout the county, although the recommended evacuation routes in any given situation will depend on the specifics of the emergency. Primary emergency access and evacuation routes include I-80, which runs across the county from southwest to northeast; I-680 between Benicia and Cordelia; I-505, which runs north from Vacaville; SR-12, which runs east-west across the length of the county; SR-37, which runs west from Vallejo; SR-84 and SR-113, which run north-south in the eastern region of the county; and other local roadways that connect to these primary evacuation routes. All evacuation routes in Solano County face a potential disruption from a flooding or earthquake event that may block roadways, damage the roadway surface, or collapse bridges and overpasses. In the event of widespread disruption to local evacuation routes, remaining evacuation routes may become congested, slowing down evacuation of a community or specific neighborhoods. This issue may be compounded since evacuation routes for Solano County will also likely serve as evacuation routes for surrounding communities, and so potential disruptions may have regional effects.

Disaster Preparedness

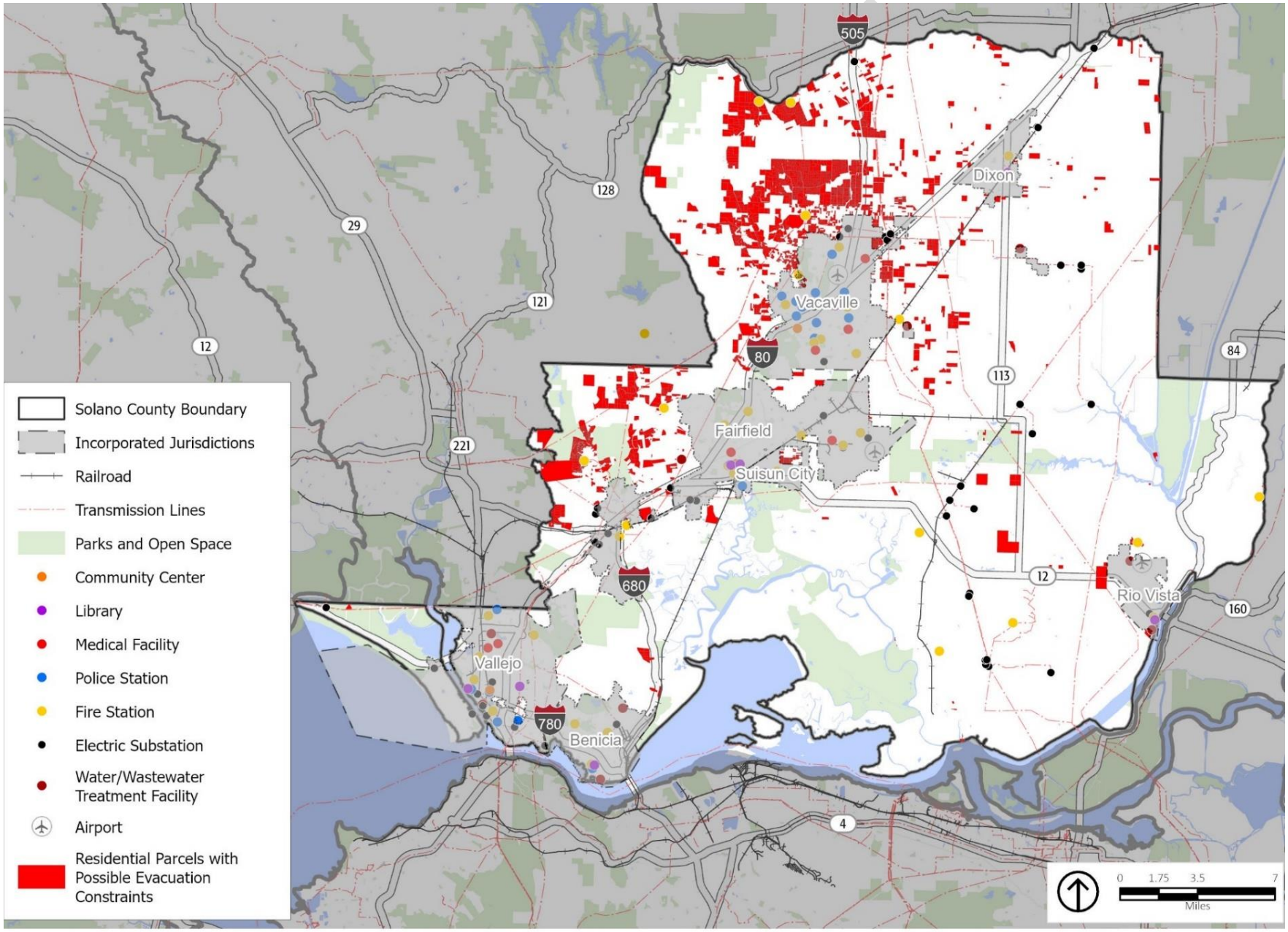
Disaster preparedness refers to coordinated efforts to respond to both natural and human-caused disasters. In recent years, the County has expanded its emergency preparedness planning. It is required under State law to prepare and maintain a SEMS multihazard functional plan. The California Governor's Office of Emergency Services (Cal OES) has extensive guidelines outlining the requirements of the Solano County SEMS.

The Solano County OES prepares disaster plans for the county and coordinates required emergency services and facilities from all agencies and levels of government to meet emergency and disaster needs. Though this Public Health and Safety chapter and the Public Facilities and Services chapter

overlap in some respects, the policies here are primarily related to disaster situations, whereas those in the Public Facilities and Services chapter address ongoing facility needs and service standards.

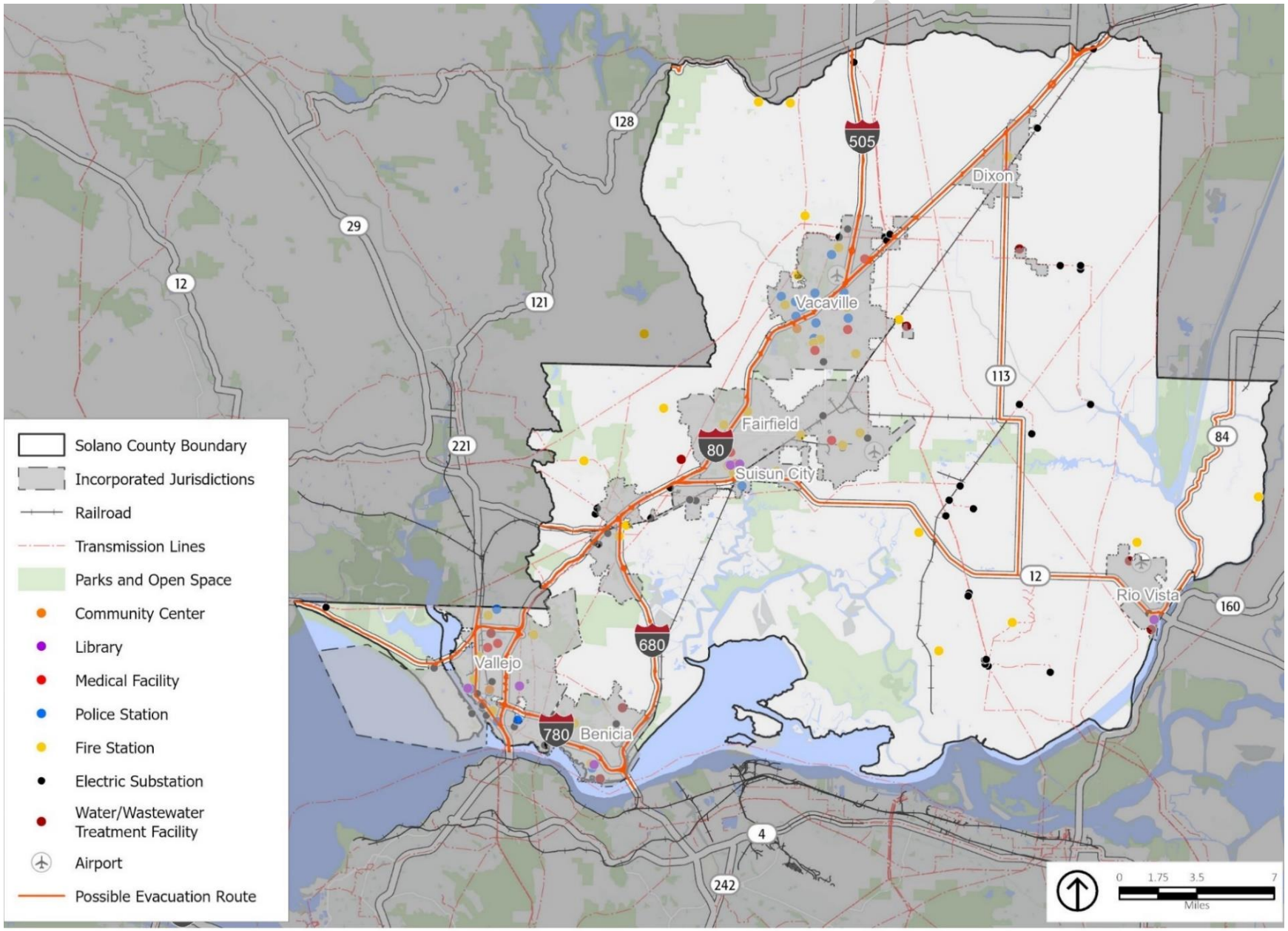
The Solano County OES offers Community Emergency Response Team (CERT) training to residents and members of the business community to increase disaster awareness and emergency response capability. The CERT program educates volunteers about disaster preparedness for the hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. CERT offers consistent volunteer training and organization that professional responders can rely on during disaster situations, allowing them to focus on more complex tasks.

Figure HS-17: SB 99 Evacuation Constrained Parcels



Source: Solano County, PlaceWorks 2022, ESRI

Figure HS-18: Evacuation Routes



Source: Solano County 2021, PlaceWorks 2022, ESRI

Related Plans, Programs, and Agencies

Solano County Office of Emergency Services

OES oversees the development, establishment, and maintenance of programs and procedures to protect lives and property of county residents from the effects of natural or human-caused disasters. The office must train for and properly respond to floods, earthquakes, major fires, storms, radiological or hazardous material incidents, aircraft accidents, mass casualty incidents, and other emergencies.

OES manages and coordinates disaster response, terrorism response, search and rescue missions, flood response, and other major emergencies within its sphere of influence. It works with city and county departments with fire suppression activities, evacuations, hazardous materials incidents, disaster exercises, planning, and use of resources through the SEMS/Incident Command System. Additionally, OES conducts emergency preparedness training and awareness presentations for citizens and various organizations so they better understand what they should do before, during, and after a disaster or major emergency.

AGRICULTURE AND ECOSYSTEM HAZARDS

Agricultural Pests

Agriculture uses are approximately 62 percent of the land in Solano County. Half of these lands are irrigated agriculture lands. The other half is used for dryland farming in Montezuma Hills and grazing/pasture throughout the county.

The county's top crop is almonds, with 18,000 acres planted in 2020. Other important crops include grapes, olives, prunes, tomatoes, and nursery products. Solano ranks as one of the top five counties in California for production of sheep and lambs, grain corn, Sudan grass hay, and safflower. Agricultural production and the related businesses continue to be a significant contributor to the county's economy, generating nearly $1.3 billion each year in gross output value. Agriculture provides 4,187 jobs directly employed on ranches and farms, plus 5,890 indirect jobs. Additional economic activity in agricultural infrastructure, processing, and handling of raw product and supporting industries can increase the County's overall economic output significantly.

Solano County's agricultural sector is threatened by a number of insect pests that can cause severe economic and environmental harm under the right circumstances. Insects of concern to plants and crops include the Asian gypsy moth, rosy moth, nun moth, Siberian silk moth, Asian citrus psyllid, European grapevine moth, glassy-winged sharpshooter, Japanese beetle, Mediterranean fruit fly, melon fly, and oriental fruit fly.

Aquatic Invasive Species

The introduction of nonnative species into County waters can cause significant and enduring economic and environmental impacts. One of the most widespread mechanisms for introduction of nonnative species is transport of ballast water in boats. Ballast water is taken on and released by a vessel during cargo loading and discharging operations to maintain the vessel's trim and stability.

Boats discharge ballast water that has been obtained from waters throughout the state, country, or elsewhere in the world. This water might include nonnative organisms, untreated sewage, and other contaminants. Once introduced, invasive species are likely to become a permanent part of an ecosystem and may flourish, creating environmental imbalances and wreaking economic havoc. Invasive species of concern in Solano County include the New Zealand mud snail, zebra mussel, and quagga mussel.

Potential Changes to Agriculture and Ecosystems in Future Years

Likelihood of Future Occurrence

As long as severe weather events continue, the potential for ecosystem and agricultural losses remain an ongoing concern for Solano County. The primary causes of agricultural losses are severe weather events such as drought, freeze, and insect infestations. These factors can also contribute to significant ecosystem loss, as can wildfire events.

The rate of aquatic invasive species discoveries continues to increase. Due to the high number of incidents of invasive species in the Sacramento-San Joaquin Delta, it is likely that future infestation of aquatic pests will occur in Solano County. The risk of aquatic invasive species exists and if a breakout occurs, there may be potentially large economic impacts.

Climate Change and Agriculture and Ecosystem Hazards

Many pests and organisms that carry diseases are most active during warmer months, so the threat of infection or infestation can be higher during this time of year. Temperatures are expected to get warmer earlier in the year and remain warmer until later in the year due to climate change, creating a wider window for pests and diseases to be active.

Climate change can also indirectly create a greater risk of agriculture and ecosystem pests and diseases. Many crop plants, trees, and livestock may be weakened by warmer temperatures and changes in precipitation. These weaker plants and animals may not be able to fend off infestations or infections as well as a stronger plant or animal, causing pests and diseases to affect more of the agricultural areas or ecosystem. These pests and diseases can inhibit plant and animal growth; damage plants and animals such that their products are less appealing and harder to sell; or lead to mortality. Moreover, excessive heat and prolonged dry conditions can impact agriculture by creating worker safety issues for farm field workers, severely damaging crops, and reducing availability of water and food supply for livestock.

Drought can reduce the amount of water available for crop irrigation, potentially reducing yield if farmers cannot find alternative supplies. Floods and severe weather can severely harm or kill crops and damage infrastructure, reducing agricultural yields and requiring costly repairs.

In aquatic ecosystems, climate change is expected to result in warmer water temperatures, altered streamflow patterns, increased salinization, and increased demand for water storage and conveyance structures. Due to these patterns, invasive aquatic species are expected to flourish because cold temperatures or winter hypoxic conditions are what have traditionally prevented the establishment and survival of these species in this climate.

CLIMATE RESILIENCE

Climate change refers to a change in the state of the climate that persists for an extended period due to natural processes or human-caused changes in the composition of the atmosphere or land use. For the purposes of this background report, climate change is a result of human activities that result in the release of greenhouse gases (GHGs), which trap heat in the atmosphere. GHGs include carbon dioxide, methane, nitrous oxide, and fluorinated gases. The human activities during which these gases are emitted include burning, manufacturing, and transportation-related combustion of fossil fuels. Livestock and solid waste activities also contribute to the buildup of GHGs.

The effects of climate change include increased global average temperature, subsequent altered precipitation patterns, thermal expansion of the ocean, and loss of polar and global sea ice. In Solano County, these changes would translate to sea level rise with possible coastal flooding, water and energy supply issues, and increased risk to wildfire. Global average temperature rise and indirect impacts associated with climate change could increase distribution of diseases or cause other public health problems; increase hazards such as flooding, storms, and wildfires; cause habitat loss and species endangerment and extinction; and negatively affect agricultural operations.

Drought

A drought is an extended period when precipitation levels are well below normal, but it 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, Solano County chronically experiences drought cycles. Drought impacts the county's water supply, and in severe instances, less water is 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 are more easily harmed by it. During drought events, the flow of water in creeks and streams is reduced, creating more slow-moving or standing water. Low water levels can concentrate sediment and toxins, causing harm to plants and animals. 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). According to the U.S. Drought Monitor, the most intensive drought conditions in recent years were during most of 2014, when all of Solano County was classified in "extreme" drought. More recently, from May 2021 through the end of the year, the county was also classified in "extreme" drought. As of December 2022, Solano County was classified as being in "extreme" drought. During severe drought conditions, water shortages are common and water restrictions may be imposed so as to meet essential community needs. Solano County's 2020 Water Shortage Contingency Plan contains actions to implement and enforce regulations and restrictions for managing a water shortage when it declares a water shortage emergency under the authority of the Water Code. Pursuant to Senate Bill 552, Solano County reconvened a standing drought task force in August 2022 to facilitate drought and water shortage preparedness for state small water systems (serving 5 to 14 connections), domestic wells, and other privately supplied homes. Solano County intends to prepare a drought resilience plan to assess potential drought and water shortage risk and develop interim and long-term solutions for state small water systems and domestic wells within the county.

The County's water supply is derived from the State Water Project, Solano Project, the Bay Delta/Sacramento River, local reservoirs, and groundwater. SCWA serves as a water wholesaler for the Solano Project and the State Water Project. The State Water Project is a collection of 700 miles of canals, pipelines, reservoirs, and hydroelectric power facilities that deliver water from the Sierra Nevada to the Central Valley, South Bay Area, and Southern California. The Upper Feather River Watershed is a major source of the state's water and provides nearly all the water delivered by the State Water Project. The Upper Feather River Watershed includes all waters tributary to the Feather River from the headwaters in the Sierra Nevada crest downstream to Lake Oroville. The Solano Project is a federal project with the Bureau of Reclamation that stores water in Lake Berryessa for delivery to users throughout Solano County. Roughly 83 percent of Solano County's water comes from Lake Berryessa, and the remaining 17 percent is diverted from the Sacramento-San Joaquin Delta. The North Bay Aqueduct delivers water from Barker Slough in the Delta to Solano agencies like the SCWA. Some municipalities and the Solano Irrigation District rely on groundwater sources for all or a portion of their water supplies, as do areas located outside of a water provider's service area.

Potential Changes to Drought in Future Years

Likelihood of Future Occurrence

Drought is different than many of the other natural hazards because 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 for commercial and domestic use is the most critical issue. As the population in the county 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. As demonstrated in the 2020 Urban Water Management Plan, the County shows adequate capacity to accommodate the demand through 2045 through a diversified and resilient portfolio that includes recycled water and conservation programs.

Based on historical information, the occurrence of drought in California, including Solano County, is cyclical, driven by weather patterns. Periods of actual drought with adverse impacts can vary in duration, and the period between droughts is often extended. Although an area may be in 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).

Climate Change and Drought

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 or even increase in some places. However, more years with extreme levels of precipitation, both high and low, are likely as a result of climate change. This is expected to cause more frequent and intense droughts compared to historical norms. Droughts 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. 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 fresh water available for communities throughout California, including the imported water supply for Solano County from the State Water Project and the Solano Project. A continued decline in the Sierra Nevada snowpack volume is expected, which may lead to lower volumes of available imported water. In the Upper Feather River Watershed area—the source of most of the water delivered through the State Water Project—the State projects that the snowpack levels in the spring are expected to decline from a historical average of 7.8 inches to as low as an average of 2.4 inches (a 69 percent decrease) by the middle of the century (2035 to 2064), and as low as an average of 0.7 inches (an 91 percent decrease) by the end of the century (2070 to 2099).

Climate change emissions are 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.

Extreme Heat

While there is no universal definition of extreme heat, California guidance documents define 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 Solano County, the average extreme heat threshold is 100.2°F. An event with five extreme heat days in a row is called a heat wave. According to Cal Adapt, Solano County has experienced a historical annual average of 3 extreme heat days. From 1990 to 2020, Solano County has experienced 20 years with a greater number of extreme heat days than the historical annual average. The annual

average of extreme heat days during this period is 6 extreme heat days per year, an increase from historic levels.

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, National Oceanic and Atmospheric Administration data indicate that about 175 Americans succumb to extreme 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 that an average of 702 deaths annually 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. Heat events are projected to become more frequent and last longer, so preparing for the public health challenges they pose is critical.

People exposed to extreme heat can suffer a number of heat-related illnesses, including heat cramps, heat exhaustion, and (most severe) heat stroke. As discussed in the Vulnerability Assessment, elderly persons, small children, chronic invalids, those on certain medications or drugs, and persons with weight and alcohol problems are particularly susceptible to heat reactions. The elderly and individuals below the poverty level are the most vulnerable to extreme heat. Nursing homes and elder-care facilities are especially vulnerable to extreme heat events if power outages occur and air conditioning is not available. In addition, individuals below the poverty level may be at increased risk from extreme heat if use of air conditioning is not affordable. Areas with lower extreme-heat thresholds are not necessarily at lower risk because persons and community assets used to cooler temperatures may be less prepared for extreme heat events.

Trees and other vegetation in the natural and urban environment 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.[11,12] Very high temperatures can harm plants and animals that are not well adapted to them, including natural ecosystems. 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 also 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 also 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.

The majority of homes in unincorporated Solano County are older homes. Approximately 5,230 homes, or 63 percent, were constructed prior to 1980, and some of these lack air conditioning and may lack effective insulation. Therefore, people living in these homes, especially vulnerable populations, are at higher risk for heat-related illnesses. To help provide relief from the heat, the County opens public libraries

during extreme heat days and heat waves. These air-conditioned community spaces provide essential cool spaces for vulnerable populations, especially those susceptible to heat-related illnesses.

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. Though the western portions of Solano County closer to San Francisco Bay generally experience cooler temperatures than the eastern portions, high temperatures in Solano County will continue to be common.

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 projects that the number of extreme heat days is expected to rise from a historical annual average of 3 to an average of 15 by the middle of the century (2035 to 2064) and an average of 29 by the end of the century (2070 to 2099), with some years experiencing many more extreme heat days.

Overall, Solano County is expected to see an increase in the average daily high temperatures. Depending on the future severity of climate change, the state Cal-Adapt database indicates the annual average maximum temperature is expected to increase from a historical annual average of 73.0°F to an average of up to 78.0°F by the middle of the century (2035 to 2064), and an average of up to 81.3°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, Solano County is expected to face increased risk of death from dehydration, heat stroke, heat exhaustion, heart attack, stroke, and respiratory distress caused by extreme heat.

Severe Weather

Severe weather is generally any destructive weather event, but usually occurs in Solano County as localized storms that bring heavy rain, hail, thunderstorms, and strong winds. Severe weather is usually caused by intense storm systems, although types of 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 often produces high winds and lightning that can damage structures and cause power outages. Lightning from these storms can ignite wildfires and 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.

A relatively common weather pattern that brings southwest winds and heavy rain to California 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. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow, often causing heavy rains that can lead to flooding and mudslides.

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains 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 tornado. However, tornadoes are uncommon in Solano County; only two have been recorded in the county since 1950.

High winds, often accompanying severe storms, 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 NWS, 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 be part of a seasonal climate pattern or related to other severe weather events, such as thunderstorms. Solano County experiences high wind on an annual basis. On January 11, 2021, strong and damaging winds developed across interior northern California, resulting in power outages, downed trees, downed power lines, and several small wildfires. Peak gusts ranged from 30 to 60 mph in the Central Valley, and generally between 40 and 80 mph for the mountains and foothills. Stronger winds were observed along the Sierra Crest. Solano County reported that high winds brought down several trees and power lines across the county. The report also stated that several vegetation and car fires were started due to wind damage and that 2,000 customers were without power from this event. Total damages were estimated at approximately $50,000. On October 11, 2021, Solano County reported 53 to 57 mph winds in the Fairfield area. The California Highway Patrol reported numerous downed trees, tree limbs, and power lines across the region.

Wind events can pose several different threats. By themselves, the 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. Winds may dry out brush and forest areas, increasing the fuel load in fire-prone areas. Winds may 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 rapid spread of wildfires and making them harder to control. This can affect the air quality in Solano County and may disrupt regional infrastructure networks.

Potential Changes to Severe Weather in Future Years

Likelihood of Future Occurrence

According to historical hazard data, severe weather is an annual occurrence in Solano County. Damage and disaster declarations related to severe weather have occurred and will continue to occur in the future. Heavy rain and thunderstorms are the most frequent type of severe weather in the county. Wind and lightning often accompany these storms and have caused damage in the past. However, actual damage associated with the primary effects of severe weather have been limited. It is the

secondary hazards caused by severe weather, such as floods and fire, that have had the greatest impact on the county. Thunderstorms, high winds, and lightning can each have localized impacts on infrastructure, properties, and public safety. Transportation, including freight shipping, faces increased congestion from severe storms.

Climate Change and Severe Weather

Climate change is expected to cause an increase in intense rainfall and strong storm systems. This means that Solano County 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. While 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.

APPENDIX A: VULNERABILITY ASSESSMENT RESULTS

The table o shows the results of the Vulnerability Assessment prepared for Solano County, in accordance with the requirements of Senate Bill 379. For each population or asset that may be vulnerable to each climate-related hazard, the population or asset is scored on a scale of zero to five:

0: Not vulnerable

V1: Minimal vulnerability

V2: Low vulnerability

V3: Moderate vulnerability

V4: High vulnerability

V5: Severe vulnerability

The vulnerability scores reflect both the severity of climate-related impacts and the ability of populations and assets to resist and recover from these effects.

	Populations and Assets	Hazard									
		Agricultural and Ecosystem Pests	Shoreline Flooding	Drought	Extreme Temperatures	Human Health Hazards	Inland Flooding	Landslides	Sea Level Rise	Severe Weather	Wildfire & Smoke
Populations	Children under 10	-	V2	-	V5	V3	V3	V2	-	V3	V4
	Cost-burdened households	-	V3	V3	V3	V3	V3	V3	V3	V3	V3
	Households in poverty	-	V5	V5	V5	V5	V5	V5	V4	V5	V5
	Immigrant communities	V5	V4	V5	V5	V4	V5	V4	-	V4	V4
	Linguistically isolated persons	-	V3	V2	V3	V3	V3	V2	-	V3	V3
	Low-income households	-	V3	V3	V3	V3	V4	V3	V3	V3	V3
	Low-resourced people of color	-	V4	V4	V5	V5	V4	V5	V4	V4	V4
	Outdoor workers	V4	V4	V4	V5	V5	V5	V4	V4	V5	V5
	Overcrowded households	-	V2	V1	V3	V4	V3	-	-	V2	V2
	Persons experiencing homelessness	-	V5	V3	V5	V5	V5	V5	-	V5	V5
	Persons living in mobile homes	-	-	V2	V4	V3	V4	-	-	V4	V2
	Persons living on single access roads	-	V5	V3	V2	V2	V5	V5	V5	V4	V5
	Persons with chronic illness and/or disabilities	-	V4	V3	V4	V5	V4	V4	-	V4	V5
	Persons without a high school degree	-	V3	V1	V2	V2	V3	V2	-	V2	V2
	Persons without access to lifelines	-	V3	V2	V4	V4	V5	V3	-	V4	V4
	Pollution burdened populations	-	V5	V5	V4	V5	V5	V2	V5	V3	V5
	Renters	-	V3	V1	V3	V2	V3	V2	V2	V3	V2
	Seniors (65+)	-	V3	V1	V4	V4	V4	V4	-	V3	V4
	Seniors living alone	-	V4	V2	V5	V5	V5	V5	-	V4	V5
	Unemployed persons	-	V3	V2	V3	V3	V3	V3	-	V3	V3
Infrastructure	Bicycling and pedestrian trails	V1	V1	V1	V2	-	V2	V2	V1	V2	V3
	Bridges	-	V4	-	V3	-	V4	V5	V3	V5	V4
	Communication facilities	-	V1	-	V3	-	V2	V3	V1	V4	V3
	Dams/Reservoirs	-	-	V2	V1	-	V2	V4	-	V2	V2
	Electrical transmission infrastructure	V2	V2	-	V5	-	V3	V4	V2	V5	V5
	Electric vehicle charging stations	-	-	-	V3	-	V2	V2	-	V2	V2
	Evacuation routes	-	V5	-	V3	-	V5	V5	V4	V3	V5
	Flood control infrastructure	-	V5	-	-	-	V5	-	V5	V3	V2
	Hazardous materials sites	-	V4	-	V2	-	V3	V4	V4	V4	V3
	Major roads and highways	-	V5	-	V3	-	V4	V5	V4	V3	V5
	Natural gas pipelines	-	V3	-	-	-	V2	V4	V1	-	V1
	Parks and open space	V3	V3	V3	V3	-	V3	V3	V2	V3	V3
	Power Plants	-	V2	-	V3	-	V2	V2	V1	V4	V2
	Railways	-	V5	-	V4	-	V5	V5	V5	V4	V5
	Solid waste facilities and closed landfills	-	V3	-	V2	-	V3	V3	V3	V3	V2
	Transit facilities	-	V2	-	V1	-	V1	V3	V1	V2	V1
	Water and wastewater infrastructure	-	V5	V3	V2	-	V5	V3	V5	V2	V3

Buildings	Community centers and libraries	-	V1	-	V1	-	V3	V1	V2	V2	V2
	Commercial businesses	-	-	-	V2	-	V2	V3	-	V3	V3
	Government buildings	-	V3	-	V1	-	V3	-	V2	V1	V1
	Historic buildings and museums	-	V4	-	V2	-	V3	V2	V2	V4	V2
	Homes and residential structures	-	V5	-	V3	-	V5	V5	V5	V5	V5
	Medical and care facilities	-	V3	-	V2	-	V2	V2	-	V3	V2
	Public safety buildings	-	V2	-	V1	-	V3	V3	V2	V2	V4
	Schools	-	V1	-	V3	-	V2	V2	V2	V3	V3
Economic Drivers	Agricultural land	V4	V5	V5	V5	V4	V5	V3	V5	V4	V5
	Livestock and grazing lands	V5	V5	V4	V5	V2	V4	V2	V4	V3	V3
	Education services	-	V2	V1	V3	V3	V3	V3	-	V2	V3
	Industrial facilities	-	V4	V3	V3	V3	V4	V3	V3	V3	V2
	Travis Air Force Base	-	V1	V1	V2	V2	V1	V1	-	V4	V2
	Major employers	-	V3	V3	V2	V3	V3	V2	V3	V3	V3
	Outdoor recreation	V2	V4	V4	V4	V2	V3	V4	V3	V3	V4
	Retail centers	-	V2	V2	V3	V3	V2	V1	V1	V3	V3
Ecosystems and Natural Resources	Grassland	V2	V2	V3	V2	-	V3	V1	V3	V1	V3
	Scrub/Chaparral	V3	V3	V3	V3	-	V2	V2	V2	V3	V4
	Oak Savanna	V4	-	V2	V2	-	V1	V1	-	V4	V2
	Oak woodland	V5	-	V3	V2	-	V1	V2	-	V5	V3
	Riparian areas	V3	V4	V4	V3	-	V3	V3	V4	V4	V3
	Marshland	V3	V5	V4	V5	-	V4	-	V5	V2	-
Key Services	Communications services	V2	V2	-	V3	-	V2	V4	V1	V4	V3
	Emergency medical response	-	V3	-	V3	V4	V3	V3	V3	V3	V3
	Energy delivery	V2	V3	V3	V5	-	V2	V4	V1	V5	V5
	Government administration & community services	-	V2	-	V1	V1	V2	V1	V3	V2	V2
	Public safety response	-	V3	-	V3	V3	V3	V3	V3	V3	V3
	Public transit access	-	V3	-	V4	V2	V4	V4	V2	V3	V4
	Solid waste removal	-	V4	-	V3	V3	V4	V3	V3	V3	V3
	Water and wastewater treatment, delivery, and collection	-	V5	V5	V2	-	V5	V4	V5	V3	V5

Page HS - 87

Endnotes

[1] Pacific Gas and Electric Company (PG&E), 2006, *The Pacific Energy Center's Guide to California Climate Zones*, https://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/toolbox/arch/climate/california_climate_zones_01-16.pdf.

[2] BestPlaces, n.d., "Climate in Solano County," https://www.bestplaces.net/climate/county/california/solano.

[3] Cal-Adapt, 2018, "Annual Averages," https://cal-adapt.org/tools/annual-averages.

[4] U.S. Census Bureau, 2020, "Age and Sex," Table S0101 of 2016-2020 American Community Survey 5-Year Estimate, https://data.census.gov/cedsci/table?q=solano%20county&t=Age%20and%20Sex&y=2020.

[5] Louise Bedsworth, Dan Cayan, Guido Franco, Leah Fisher, and Sonya Ziaja from the California Governor's Office of Planning and Research, Scripps Institution of Oceanography, California Energy Commission and California Public Utilities Commission, 2018, "Statewide Summary Report," in California's Fourth Climate Change Assessment, publication number: SUMCCCA4-2018-013.

[6] Ocean Protection Council, 2018, *State of California Sea-Level Rise Guidance*, https://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf.

[7] California Coastal Commission, 2018, *California Coastal Commission Sea Level Rise Policy Guidance: Science Update*, July, https://documents.coastal.ca.gov/assets/slr/guidance/2018/3_Ch3_2018AdoptedSLRGuidanceUpdate.pdf.

[8] San Francisco Bay Keeper, 2022, Sea Level Rise in California, https://baykeeper.org/shoreview/california-slr.

[9] United States Census Bureau, 2020, "Year Structure Built," in 2016–2020 American Community Survey 5-Year Estimates.

[10] Heather Anu Kramer, Miranda H. Mockrin, Patricia M. Alexandre, and Volker C. Radeloff, 2019, "High Wildfire Damage in Interface Communities in California," *International Journal of Wildland Fire*, 28 (9): 641, https://doi.org/10.1071/WF18108.

[11] J. Huang, 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.

[12] D. Kurn, 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.