Appendix B

Climate Vulnerability Assessment

Climate Vulnerability Assessment

for the

County of Alameda

Community Climate Action Plan

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
ACFCD	Alameda County Flood Control and Water Conservation District
ACPWA	Alameda County Public Works Agency
ACRCD	Alameda County Resource Conservation District
APG	*California Adaptation Planning Guide*
ART Bay Area Report	*Adapting to Rising Tides, Bay Area: Regional Sea Level Rise Vulnerability and Adaptation Report*
BAAQMD	Bay Area Air Quality Management District
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	California Governor's Office of Emergency Services
Caltrans	California Department of Transportation
CCAP	Alameda County *Community Climate Action Plan*
CCHPR	*Climate Change and Health Profile Report: Alameda County*
CDPH	California Department of Public Health
CEC	California Energy Commission
CERT	Community Emergency Response Team
Clean Air Plan	*2017 Clean Air Plan: Spare the Air, Cool the Climate*
Climate Assessment	*California's Fourth Climate Change Assessment*
CNRA	California Natural Resources Agency
CWPP	*Community Wildfire Protection Plan 2015 Update: Alameda County*
District 4 Report	*Caltrans Climate Change Vulnerability Assessments: District 4 Technical Report*
EBMUD	East Bay Municipal Utility District
EBMUD UWMP	*Urban Water Management Plan 2020: East Bay Municipal Utility District*
EBMUD WSCP	*Water Shortage Contingency Plan 2020: East Bay Municipal Utility District*
EOP	*Alameda County Emergency Operations Plan*
FEMA	Federal Emergency Management Agency
FHSZ	Fire Hazard Severity Zone
FRA	Federal Responsibility Area
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
IRWMP	*San Francisco Bay Area Integrated Regional Water Management Plan*
LHMP	*2021 Alameda County Local Hazard Mitigation Plan*
LRA	Local Responsibility Area
NDMC	National Drought Mitigation Center
NFIP	National Flood Insurance Program
OPR	Governor's Office of Planning and Research
PG&E	Pacific Gas and Electric Company
$PM_{2.5}$	fine particulate matter measuring 2.5 micrometers or smaller
PSPS	Public Safety Power Shutoff

RCP	Representative Concentration Pathway
RPP	*Alameda and Contra Costa County Regional Wildfire Prevention Plan*
Safeguarding California	*Safeguarding California Plan: 2018 Update*
SB	Senate Bill
SCU	CAL FIRE's Santa Clara Unit
SFBA Report	*California's Fourth Climate Change Assessment: San Francisco Bay Area Region Report*
SFP	*CAL FIRE Santa Clara Unit: Strategic Fire Plan*
SRA	State Responsibility Area
Strategy	*California Climate Adaptation Strategy*
SVI	Social Vulnerability Index
VA	Vulnerability Assessment
WUI	wildland-urban interface
Zone 7	Zone 7 Water Agency
Zone 7 UWMP	*2020 Urban Water Management Plan: Zone 7 Water Agency*

1 INTRODUCTION

Climate change is projected to exacerbate the impacts of certain hazards that the unincorporated areas of Alameda County (hereafter referred to as "unincorporated county") is exposed to under current conditions. These hazards are wide-ranging, and while many of these hazards have historically posed a risk to the unincorporated county, the frequency, intensity, and duration of them will likely shift because of climate change. The Alameda County government (hereafter referred to as "County") has prepared this Vulnerability Assessment (VA) to identify and analyze climate change effects that will impact the unincorporated county. The primary effects of climate change include increased temperatures, changes in precipitation patterns, and sea level rise. These effects are expected to heighten and exacerbate risks posed by secondary climate change effects, including wildfires, extreme heat events, extreme precipitation and flooding, and drought. The level of impact from these climate change effects will vary across the unincorporated county due to variations in physical, social, and economic characteristics.

The goal of the adaptation planning process is to improve overall community resilience in the face of a changing climate. A resilient community is one that is more prepared for current and future hazardous conditions and experiences less societal disruption when disaster strikes. Resilient communities can better prepare for and recover from hazards with an understanding that the climate will continue to change. The VA is the first step in the County's adaptation planning process and will serve to inform the development of adaptation strategies. The purpose of the VA is to analyze the unincorporated county's exposure to existing hazards, to evaluate sensitivity to these hazards and identify potential climate-related impacts from these hazards, and to determine the County's existing capacity to prepare for and adapt to these impacts, known as adaptive capacity. The next step in the County's adaptation planning process will include the development of adaptation strategies. These strategies will be included in the County's *Community Climate Action Plan* (CCAP), which will provide the County with a roadmap to reduce its contributions to climate change while simultaneously preparing for its impacts.

1.1 CLIMATE CHANGE BACKGROUND

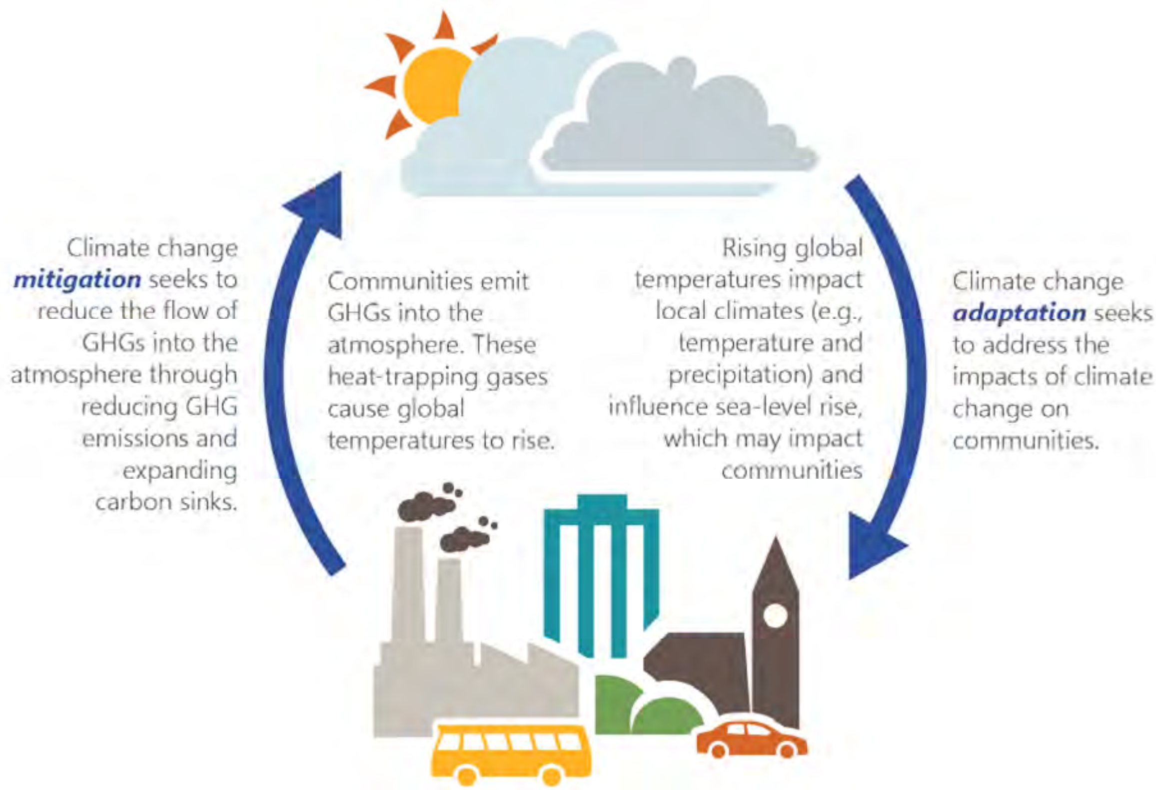
Since the beginning of the Industrial Revolution in the late 18th century, human activities—primarily the combustion of fossil fuels for electricity, heat, and transportation—have released an excessive amount of greenhouse gases (GHGs) into Earth's atmosphere. Significantly elevated levels of GHG emissions have intensified the greenhouse effect and have led to an unprecedented trend of human-caused (i.e., anthropogenic) warming of Earth's climate, among other climatic disruptions, known as climate change. There are many effects and associated impacts stemming from climate change that intersect with multiple facets of human society. Though it is a global issue, it is an issue that will be, and already is, experienced differently around the world. Over time, it has become an increasing priority to address climate change at multiple scales as weather patterns become more extreme, temperatures continue to rise, and polar ice caps continue to melt.

The average global surface temperature is expected to increase approximately 8 degrees Fahrenheit (°F) by the end of the century unless additional efforts are made to reduce GHG emissions (IPCC 2021). Depending on future GHG emissions scenarios, annual average maximum daily temperatures in California are projected to increase between 4.4 °F and 5.8 °F by 2050 and by 5.6 °F to 8.8 °F by 2100 (Pierce et al. 2018, cited in OPR, CEC, and CNRA 2018a). Temperature changes in the San Francisco Bay Area are expected to be consistent with California as a whole, with projected increases between roughly 5 °F and 8 °F by the end of the century (OPR, CEC, and CNRA 2018b). The state and the unincorporated county have already begun to experience extreme weather effects, the frequency and intensity of which have been worsened by climate change (OPR, CEC, and CNRA 2018a). Extreme weather effects such as precipitation volatility (i.e., dramatic changes over a short period of time), increased average temperatures, and increased frequency of extreme heat events have led to increases in the frequency and intensity of human health and safety hazards such as wildfires, droughts, and changes to water supply.

While it remains imperative to drastically reduce global GHG emissions, it is equally important for communities to engage in adaptation planning to prepare for and strengthen resilience to the adverse impacts of climate change. Local efforts are critical in building climate resilience—the capacity of a community to prepare for and withstand disruptions, to recover from shocks and stressors, and to adapt and grow from turbulent experiences related to climate change—and can lead to a greater understanding of climate risks and strategies to reduce their impacts. There are many plans, policies, and programs in place at the local and regional levels that address existing climate-related hazards. In some cases, these may be sufficient to address the potential for climate change to worsen existing hazards. In other cases, significant gaps exist, and new policies are needed. This VA intends to identify and address those gaps.

1.2 CLIMATE CHANGE MITIGATION AND ADAPTATION

Addressing climate change requires an integrated approach that targets both the sources of climate change and its effects. Targeting the sources of climate change is known as climate change mitigation and primarily involves reducing the flow of GHGs into the atmosphere. This can happen through the direct reduction of anthropogenic GHG emissions, or by enhancing carbon sinks (e.g., carbon sequestration), which capture and remove GHGs from the atmosphere, most notably carbon dioxide. The goal of climate change mitigation is to minimize significant human interference with the global climate. The extent to which climate change mitigation efforts are implemented today will likely determine the severity of climate change and its effects in the future. However, even in a scenario where anthropogenic GHG emissions were drastically and instantaneously reduced today, society will still have to endure some degree of climate change and its associated effects. Adjusting to the effects of climate change that are already occurring and preparing for those that are anticipated to occur in the future is known as climate change adaptation. Climate change adaptation planning aims to enhance the resilience of communities to climate change impacts through analyzing jurisdiction-specific climate-related vulnerabilities and developing strategies to respond to and prepare for current and future impacts. Figure 1 illustrates the relationship between climate change mitigation and climate change adaptation.



Source: Cal OES 2020; adapted by Ascent in 2022.

Figure 1 Relationship between Climate Change Mitigation and Adaptation

Climate change mitigation and adaptation are both crucial components of comprehensive climate change planning. While mitigation and adaptation are often separate planning efforts, it is important to consider both components within the overall climate action planning process. Many initiatives that focus on climate mitigation and reducing GHG emissions support climate adaptation objectives, and vice versa. These are referred to as 'co-benefits.' For example, renewable energy installations combined with battery storage systems will reduce reliance on fossil fuel-generated grid electricity, but they will also improve energy independence and resilience in the face of hazards exacerbated by climate change that threaten energy infrastructure; thus, this initiative will yield adaptation benefits as well as GHG emissions reductions. Similarly, building energy efficiency improvements, such as improving insulation in a home or structure, will help to combat extreme heat events and decrease risks to humans of heat-related illnesses, but it will also reduce cooling demands and thus save energy, reducing (i.e., mitigating) GHG emissions associated with energy consumption. Combining climate mitigation and adaptation in the climate action planning process is becoming an increasingly common approach taken by jurisdictions to address climate change.

1.3 REGULATORY SETTING

State law requires communities to address climate change adaptation through several planning processes, such as the development of general plans (Cal OES 2020). Specifically, Senate Bill (SB) 379 requires all cities and counties to include climate adaptation and resiliency strategies in the next update of their general plans beginning January 1, 2017. The update must include:

- A vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts;
- A set of adaptation and resilience goals, policies, and objectives based on the information specified in the climate vulnerability assessment for the protection of the community; and
- A set of feasible implementation measures designed to carry out the goals, policies, and objectives identified pursuant to the adaptation objectives.

This vulnerability assessment will serve to provide the framework for SB 379 compliance for the County's Safety Element Update.

1.4 GUIDANCE DOCUMENTS

Several key guidance documents and resources that were used to help develop the VA, developed by the State, are outlined in the following sections.

1.4.1 California Adaptation Planning Guide

The most recent version of the *California Adaptation Planning Guide* (APG) was released in June 2020 and was prepared by the California Governor's Office of Emergency Services (Cal OES). This update builds upon the first iteration of the APG that was released in 2012, and reflects the latest best practices, integrates recent updates to State plans, policies, programs, and regulations, and ensures that communities have guidance on using the best available science and information. The purpose of the APG is to provide guidance to local governments for climate change adaptation and resiliency planning, primarily through a step-by-step process that communities can use to plan for the impacts of climate change. The APG is designed to be flexible and guide communities through an adaptation planning process that is best suited for their needs (Cal OES 2020).

1.4.2 California's Fourth Climate Change Assessment

The Governor's Office of Planning and Research (OPR), the California Energy Commission (CEC), and the California Natural Resources Agency (CNRA) prepared *California's Fourth Climate Change Assessment* (Climate Assessment) in 2018.

The Climate Assessment was designed to address critical information gaps that decision makers at the State, regional, and local levels need to close to protect and build the resilience of people, infrastructure, natural systems, working lands, and waterways to the impacts of climate change. The Climate Assessment also includes regional reports, which analyze and discuss the impacts to specific regions in the state, including *California's Fourth Climate Change Assessment: San Francisco Bay Area Region Report* (SFBA Report), which encompasses the entirety of Alameda County. The Climate Assessment and SFBA Report are referenced throughout this VA to provide information regarding regional climate change impacts.

1.4.3 Safeguarding California Plan

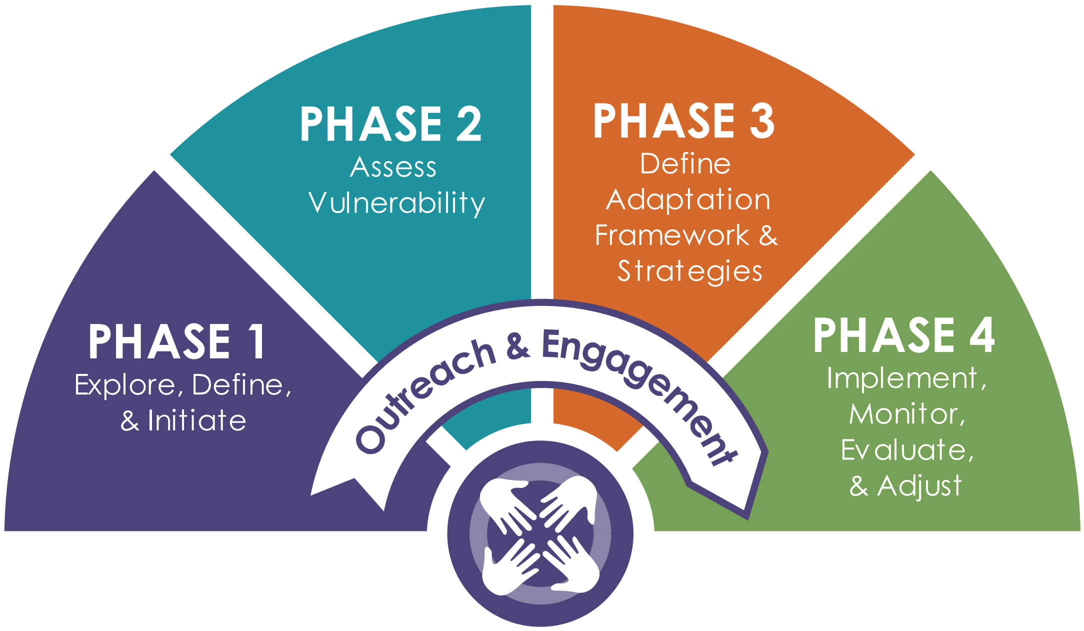
Alongside the update to the Climate Assessment, CNRA released the *Safeguarding California Plan: 2018 Update* (Safeguarding California), which serves as a roadmap for State government action to build climate change resilience. Safeguarding California provides a holistic overview of the State's current and planned efforts to address the ongoing and forthcoming impacts of climate change and identifies actions the State will take to protect communities, infrastructure, services, and the natural environment from climate change.

1.4.4 California Climate Adaptation Strategy

Every three years, California is required to issue an updated statewide climate adaptation strategy. In April 2022, CNRA, in partnership with OPR's Integrated Climate Adaptation and Resiliency Program, released the *California Climate Adaptation Strategy* (Strategy), which serves as an update to Safeguarding California. The Strategy is organized around six outcome-based priorities and integrates key elements from numerous state plans and strategies, including statewide climate action plans, sector-based strategies, regionally focused strategies, and State stewardship plans. Each outcome-based priority consists of several unique goals, and each goal is comprised of specific climate actions that can be taken towards achieving that goal. The Strategy also identifies success metrics and an implementation timeline for each action within the strategy. The Strategy reflects the State's commitment to integrating climate resilience into the work of all state agencies, and this collective, statewide effort will ultimately support local communities.

1.5 ADAPTATION PLANNING PROCESS

The APG provides guidance for communities throughout the state in planning for and adapting to the impacts of climate change. The APG includes a four-phase process, illustrated in Figure 2, which allows communities to assess locally specific climate vulnerabilities and develop strategies to reduce climate change-related risks.



Source: Cal OES 2020; adapted by Ascent in 2022.

Figure 2 Adaptation Planning Process

- Phase 1, "Explore, Define, and Initiate," includes scoping and defining the adaptation planning effort. Phase 1 also involves identifying key roles and stakeholders in the local government and throughout the community to contribute to the planning process. Potential climate change effects and important physical, social, and natural assets in the community are identified for further analysis.
- Phase 2, "Assess Vulnerability," includes an analysis of potential climate change impacts and adaptive capacity to determine the vulnerability of populations, built environment, and community functions. The vulnerability assessment is composed of four steps: exposure, sensitivities and potential impacts, adaptive capacity, and vulnerability scoring. Phase 2 also integrates stakeholder and public input to provide a comprehensive assessment of the community's sensitivity to climate change and its ability to adapt.
- Phase 3, "Define Adaptation Framework and Strategies," focuses on creating an adaptation framework and developing adaptation strategies based on the results of the vulnerability assessment. Adaptation strategies identify how the community will address the potential for harm based on the community's resources, goals, values, needs, and regional context. Community input is needed to prioritize adaptation strategies, identify co-benefits of strategies, and determine implementation steps.
- In Phase 4, "Implement, Monitor, Evaluate, and Adjust," the adaptation framework is implemented, consistently monitored and evaluated, and adjusted based on continual learning, feedback, and/or triggers.

2 VULNERABILITY ASSESSMENT

This section provides a comprehensive assessment of the unincorporated county's vulnerabilities to climate change. It identifies and characterizes the climate change effects and other related hazards that are anticipated to impact the unincorporated county. The VA follows the process outlined in Phase 2 of the APG and is composed of the following four steps:

Exposure: The purpose of this step is to understand existing hazards within the unincorporated county and how changes in climate variables (e.g., average temperature, precipitation) are projected to influence these hazards. Existing hazards that are likely to be exacerbated by the effects of climate change are identified and described based on historical data from sources such as the *2021 Alameda County Local Hazard Mitigation Plan* (LHMP). Climate projection data are used to develop forecasts for how existing hazards are expected to change within various timescales, including near-term (current-2050), midterm (2040-2069), and long-term (2070-2099).

Sensitivity and Potential Impacts: This step identifies the population groups and community assets that are sensitive to localized climate impacts. Hazards influenced by climate change (e.g., flooding, wildfire) are generally projected to increase in severity, and additionally, climate change may generate new impacts that communities have not experienced historically. Using historical data, research from regional and State reports on climate impacts, and input from stakeholders, this step seeks to assess the degree of sensitivity of the populations and assets based on the potential impacts of each exposure. Key populations and assets identified in the unincorporated county are organized into three overarching categories: populations, built environment, and community functions. Each hazard included in the VA is analyzed and assigned a potential impact score using the criteria in Table 1.

Table 1 Potential Impacts Scoring

Score	Potential Impact Scoring Description
Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.

Source: Cal OES 2020.

Adaptive Capacity: The purpose of this step is to identify the County's current capacity to address future climate impacts, referred to as adaptive capacity. The County, partner agencies, and regional organizations have already taken steps to build resilience and protect sensitive populations and assets from existing hazards. The ability of the County to adapt to each of the identified climate impacts is determined through a review of existing plans, policies, and programs, and through stakeholder engagement. Adaptive capacity scoring is described in Table 2. A summary of partner agencies and regional organizations and their climate adaptation-related work is included in Section 2.3, "Adaptive Capacity."

Table 2 Adaptive Capacity Scoring

Score	Adaptive Capacity Scoring Description
Low	The County lacks capacity to manage climate change effect; major changes would be required.
Medium	The County has some capacity to manage climate change effect; some changes would be required.
High	The County has high capacity to manage climate change effect; minimal to no changes are required.

Source: Cal OES 2020.

Vulnerability Scoring: This step characterizes the unincorporated county's vulnerability to each climate change effect. Vulnerability scores are based on several factors including the severity of projected climate impacts, how sensitive certain populations and assets are to anticipated climate impacts, and whether sufficient adaptive capacity exists to manage future climate impacts. Higher vulnerability scores (5 being the highest) indicate that a climate change effect should be prioritized earlier than those with lower scores (1 being the lowest). This scoring helps the County understand which climate vulnerabilities are most urgent and should be prioritized during the adaptation strategy development process. Table 3 presents the rubric used to determine the overall vulnerability scores, which is derived from ratings for potential impacts and adaptive capacity.

Table 3 Vulnerability Scoring

		Vulnerability Score		
Potential Impacts	High	3	4	5
	Medium	2	3	4
	Low	1	2	3
		High	Medium	Low
		Adaptive Capacity		

Source: Cal OES 2020.

2.1 EXPOSURE

This section includes the exposure analysis, which relies on existing planning documents and resources to understand the unincorporated county's current hazards, and climate modeling to identify how these hazards are projected to change in the future. To better contextualize the unincorporated county's exposure to these hazards, an overview of the county and a land acknowledgment are presented first.

2.1.1 County Overview and Land Acknowledgment

Alameda County is situated on the east side of the San Francisco Bay, where it is bounded by Contra Costa County to the north, San Joaquin County to the east, and Santa Clara County to the south. In fact, when Alameda County was founded in 1853, it was carved out of territory from previously established Contra Costa County and Santa Clara County. Alameda County includes 14 incorporated cities and 6 unincorporated communities and other rural areas, though the focus of this VA is on the unincorporated county. The unincorporated county encompasses approximately 425 square miles of beautiful and diverse landscapes for residents and visitors to enjoy, including rolling open spaces and densely vegetated hillsides with lakes and streams. Some notable features of the unincorporated county include Livermore Valley, which lies in the eastern portion of the unincorporated county, Amador Valley, which abuts the western edge of the Livermore Valley and continues west to the Pleasanton Ridge, and the ridges and valleys of the Diablo Range, containing the county's highest peaks, which cover the sparsely populated southeastern portion of the unincorporated county.

It should be noted that the unincorporated communities of Ashland, Cherryland, Hayward Acres, San Lorenzo, and Castro Valley, which contain 16 census tracts identified as "Priority Communities" for the forthcoming Environmental Justice Element of the General Plan, are located in the traditional Jalquin/Irgin territory of the Chochenyo-speaking Ohlone people. Ohlone is an umbrella term given to a collective of various tribes, bands, and territories of Indigenous people. Every member of these Priority Communities benefits from the use and continued occupation of this land. The County acknowledges the land, the history, and the presence of the Ohlone people whose connection to this land still exists, who still reside in the community, and to whom this land belongs. The County looks to work to correct the harms of the past, stands in solidarity with all Indigenous people and their right to self-determination and justice, and commits towards the healing of the generational trauma, theft, and dispossession native peoples have faced and continue to face.

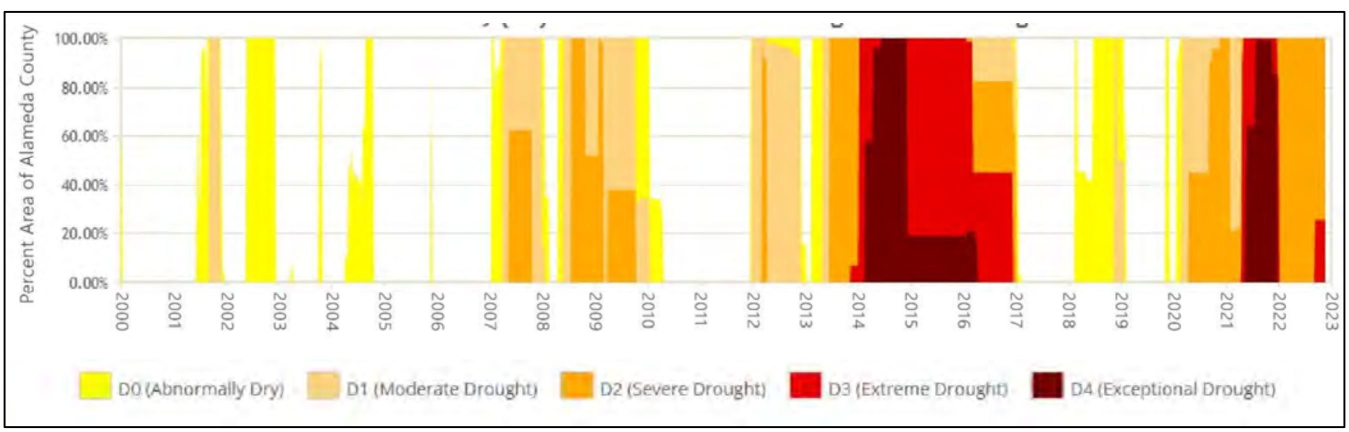
2.1.2 Existing Hazards

The LHMP, the *Alameda County Emergency Operations Plan* (EOP), and an array of additional plans and sources provide a comprehensive understanding of natural and anthropogenic hazards that have historically threatened the unincorporated county. Acknowledging the existence of this wide array of hazards, for the purposes of this VA, the focus will be on hazards that may be exacerbated by climate change. Some of the hazards linked to climate change that these documents evaluate include drought, flooding, and wildfire. The following sections discuss these existing hazards as evaluated by the County, drawing from other sources as needed, and are presented alphabetically—the order in which they are presented is not determined by level of importance, severity, or otherwise.

DROUGHT

In general, due to the multi-dimensional nature of droughts, they are difficult to define in exact terms and can pose difficulties in terms of comprehensive risk assessments (County of Alameda 2022a). However, according to the EOP, drought refers to "a prolonged period of dryness in which precipitation is less than expected or needed in a given geographic location or climate over an extended period of time" (County of Alameda 2012). As identified in the LHMP, droughts are often classified as one of four types: meteorological, hydrological, agricultural, and socioeconomic. Meteorological droughts solely refer to the degree of dryness, typically expressed as a departure in actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. Hydrological droughts are related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. Agricultural droughts are defined principally in terms of soil moisture deficiencies relative to the water demands of plan life, usually crops. Lastly, socioeconomic droughts associate the supply and demand of economic goods and services with elements of meteorological, hydrological, and agricultural droughts. In other words, a socioeconomic drought occurs when the demand for water exceeds the supply because of weather-related supply shortfall (County of Alameda 2022a).

Overall, the frequency and severity of droughts can vary. According to historical data prepared by the National Drought Mitigation Center (NDMC), Alameda County has experienced some level of drought in most years of the 21st century thus far (2022). Figure 3 displays a time series of the percent area of Alameda County classified within the five US Drought Monitor categories (i.e., D0 – Abnormally Dry, D1 – Moderate Drought, D2 – Severe Drought, D3 – Extreme Drought, and D4 – Exceptional Drought) since 2000. As displayed in the figure, the period from roughly 2012 to 2016 was a period of intense and prolonged drought, with much of the county experiencing multiple years of exceptional drought (i.e., D4). The drought during this period was one of the most severe droughts on record and it affected the entire state to the point where Governor Brown declared a statewide drought emergency in 2014, which was not lifted until 2017. The severity of any drought is dependent on numerous factors, including duration, intensity, geographic extent, and regional water supply demands by humans and vegetation (County of Alameda 2022a).



Source: NDMC 2022.

Figure 3 Alameda County Percent Area in US Drought Monitor Categories Since 2000

There are several ways in which drought differs from other natural hazards, but most notably, the onset and end of a drought are difficult to determine due to the slow accumulation and lingering effects of an event after its apparent end, as opposed to other hazards with a more visibly obvious and rapid onset and retreat (e.g., flooding) (County of Alameda 2022a). Within Alameda County, drought has proven to have an array of adverse impacts, ranging from public health and safety impacts to economic and environmental impacts. Drought impacts increase with the length of a drought, and the magnitude of these impacts are correlated directly with available water supplies and development densities. Additionally, drought often exacerbates, or is often accompanied by, an array of other hazards, including extreme heat, wildfire, and debris flows.

FLOODING

According to the EOP, flooding is "the accumulation of water where usually none occurs," and are natural events that are only considered hazards when they intersect with society (County of Alameda 2012). A flood occurs when the existing channel of a stream, river, canyon, or other body of water cannot contain excess runoff from rainfall or snowmelt, resulting in overflow onto adjacent lands. The LHMP states that there are four primary types of flooding that occur within Alameda County: coastal flooding, riverine flooding, localized flooding, and flash flooding. Coastal flooding in the county is generally caused by wave run-up, typically as a result of severe winter storms from November to February. The size and intensity of storm-generated waves depend on the magnitude of the storm, its sustained wind speeds, and the duration of the storm. It should be noted, however, that coastal flooding is not common in most of the unincorporated county, as there is only about one mile of coastline on unincorporated county land located in San Lorenzo. Riverine flooding, the most common type of flooding, occurs in narrow, confined channels in the steep valleys of hilly regions to wide and flat areas in plains and coastal regions. When riverine floods occur, the amount of water in the floodplain is a function of the size and topography of the contributing watershed, the regional and local climate, and the land use characteristics. Localized flooding may occur outside of recognized drainage channels or delineated floodplains due to a combination of locally heavy precipitation, increased surface runoff, and inadequate facilities for drainage and stormwater conveyance. Such events frequently occur in flat areas and urbanized areas with large amounts of impermeable surfaces. Lastly, flash flooding, which is the fastest moving type of flood, occurs when water falls too quickly on saturated soil or dry soil that has poor absorption ability (County of Alameda 2012, 2022).

Flooding is a dangerous hazard that has adversely affected Alameda County in the past and will likely continue to do so in the future. Floods can directly affect populations, property, critical facilities and other infrastructure, the environment, and the economy. Within the county, both 100-year floodplains and 500-year floodplains exist. A 100-year floodplain is one that has a 1 percent chance (i.e., a 1-in-100 chance) of experiencing a flood in any given year, whereas a 500-year floodplain is one that has a 0.2 percent chance (i.e., a 1-in-500 chance) of experiencing a flood in any given year. Figure 4 displays where the 100- and 500-year floodplains are located in the unincorporated county; almost seven square miles fall within the 100-year floodplain, and roughly 2.5 square miles fall within the 500-year floodplain, encompassing approximately 1.6 percent and 0.6 percent of the total area of the unincorporated county, respectively (County of Alameda 2022a). From 1953 to 2021, Alameda County, as a whole, experienced a total of 21 hazard events resulting in Major Disaster Declarations, five of which were flooding events (FEMA 2021). For context, a Major Disaster Declaration is any major disaster resulting from a natural event that the President of the United States determines has caused damage of such severity that it is beyond the combined capabilities of State and local governments to respond to. Major Disaster Declarations provide a wide range of Federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work. Figure 6 displays the types of each of these 21 Major Disaster Declarations that Alameda County has endured. Recently, and notably, Alameda County experienced a series of flooding events in January and February of 2017 caused by atmospheric rivers, which caused widespread damage throughout the county (County of Alameda 2022a).

WILDFIRE

The EOP defines a wildfire as "an uncontrolled fire spreading through vegetative fuels" and can be caused by human activities (e.g., arson, campfires) or by natural events (e.g., lightning) (County of Alameda 2012). There are three primary factors that significantly contribute to wildfire behavior: topography, fuel, and weather. Topography describes slope increases, which can directly influence the rate in which a wildfire spreads. Additionally, south-facing slopes are subject to more solar radiation than other slopes, and as such, they tend to be drier and serve as wildfire catalysts. It should be noted that the top of a slope (e.g., ridge tops) may mark the end of wildfire spread, as it is difficult for fire to spread downhill. The areas most susceptible to wildfire across the entirety of Alameda County are the hilly northwestern, central, and southeastern portions of the county, largely because of their topography. Fuel refers to the type and condition of vegetation, which plays a significant role in the occurrence and spread of wildfires. Certain plant types are more susceptible to burning or will burn with greater intensity, and dense or overgrown vegetation increases the amount of combustible material available as fuel. Lastly, the most variable factor influencing wildfire behavior is weather. Temperature, humidity, wind, and lightning can affect the odds for ignition and spread of wildfires. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often signal reduced wildfire risk and can provide easier containment if a wildfire were to ignite (County of Alameda 2012, 2022). Accounting for each of these factors helps to determine Fire Hazard Severity Zones (FHSZs), which are designated by the California Department of Forestry and Fire Protection (CAL FIRE). FHSZs represent areas in the county with varying degrees of fire hazard, ranging from "Moderate," "High," and "Very High." Figure 5 displays the unincorporated county's FHSZs.

There are many entities that have responsibility for wildfire protection within any jurisdiction, ranging from local and tribal organizations all the way to federal organizations. To address wildfire jurisdictional responsibilities, the State Legislature has designated Local Responsibility Areas (LRA), State Responsibility Areas (SRA), and Federal Responsibility Areas (FRA), which are all prevalent in Alameda County as a whole, though the unincorporated county only contains LRA and SRA. FRA encompasses fire-prone wildland areas that are owned or managed by a federal agency. SRA includes land in the state where CAL FIRE has legal and financial responsibility for wildfire protection, which includes forested lands, but does not include incorporated cities or federal lands. LRA includes land in cities, cultivated agricultural lands, and other lands that otherwise do not meet the criteria for SRA or FRA, inclusive of some unincorporated county land. In addition to the unincorporated county's FHSZs, LRA and SRA are also indicated on Figure 5.

Wildfires have proven to be costly and have put many elements of the unincorporated county at risk, including human lives, property, rivers and watersheds, open space, timber, recreation, wildlife habitats, historic and cultural assets, scenic assets, and local economies, among others. Of the 21 hazard events resulting in Major Disaster Declarations that Alameda County, as a whole, has experienced from 1953 to 2021, two of them were wildfire events, which are displayed in Figure 6 alongside the other types of Major Disaster Declarations the county has experienced (FEMA 2021). In addition to these two wildfire events, it should be noted that Alameda County has been notably affected by other wildfires that have resulted in Major Disaster Declarations, including the SCU Lightning Complex Fire in 2020, which burned over 396,000 acres in the county and was one of the largest wildfires in California history (County of Alameda 2022a). However, wildfires originating outside of the Alameda County's boundaries, such as the SCU Lightning Complex Fire, are not included in the county's count of hazard events resulting in Major Disaster Declarations.

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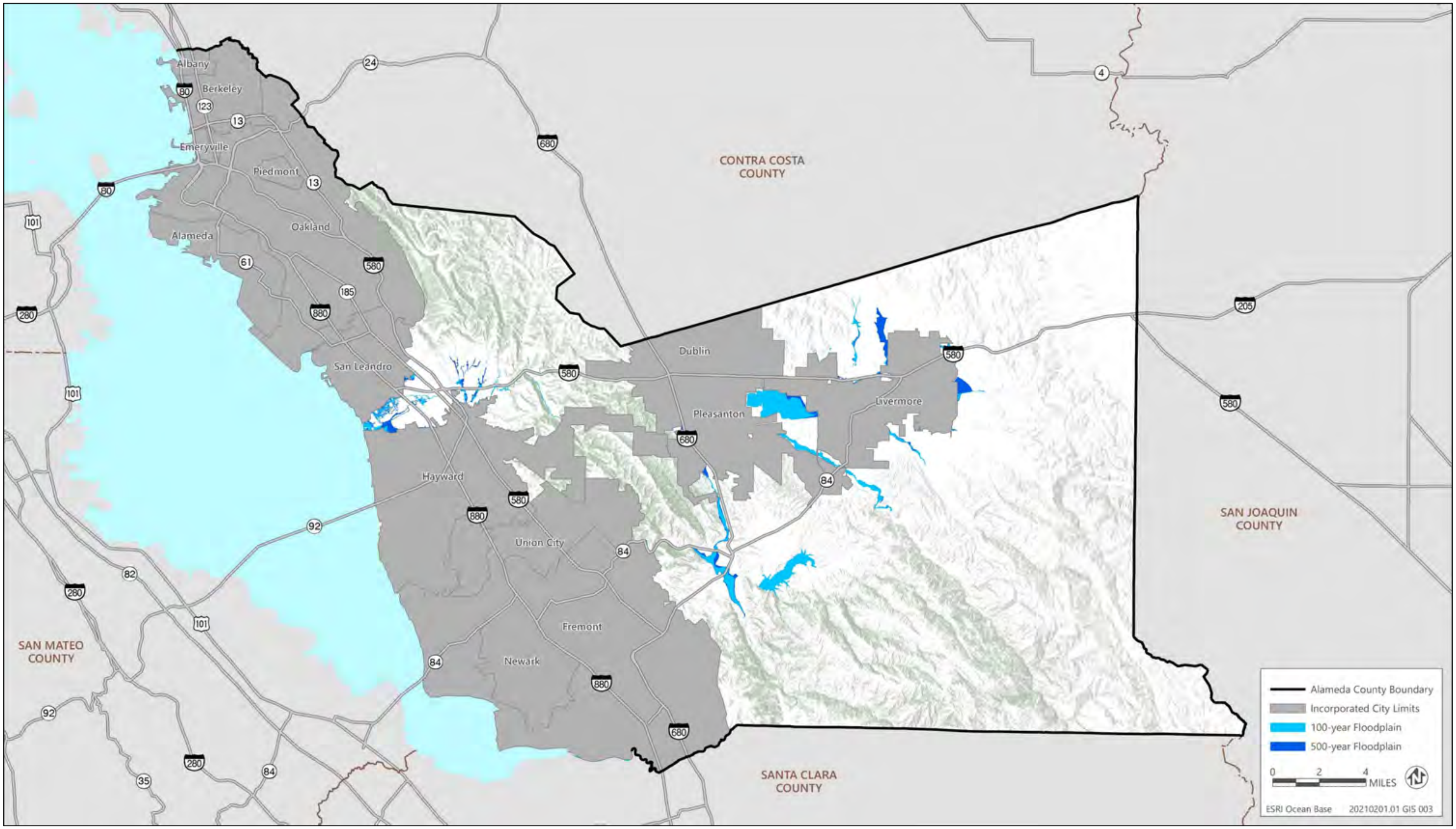
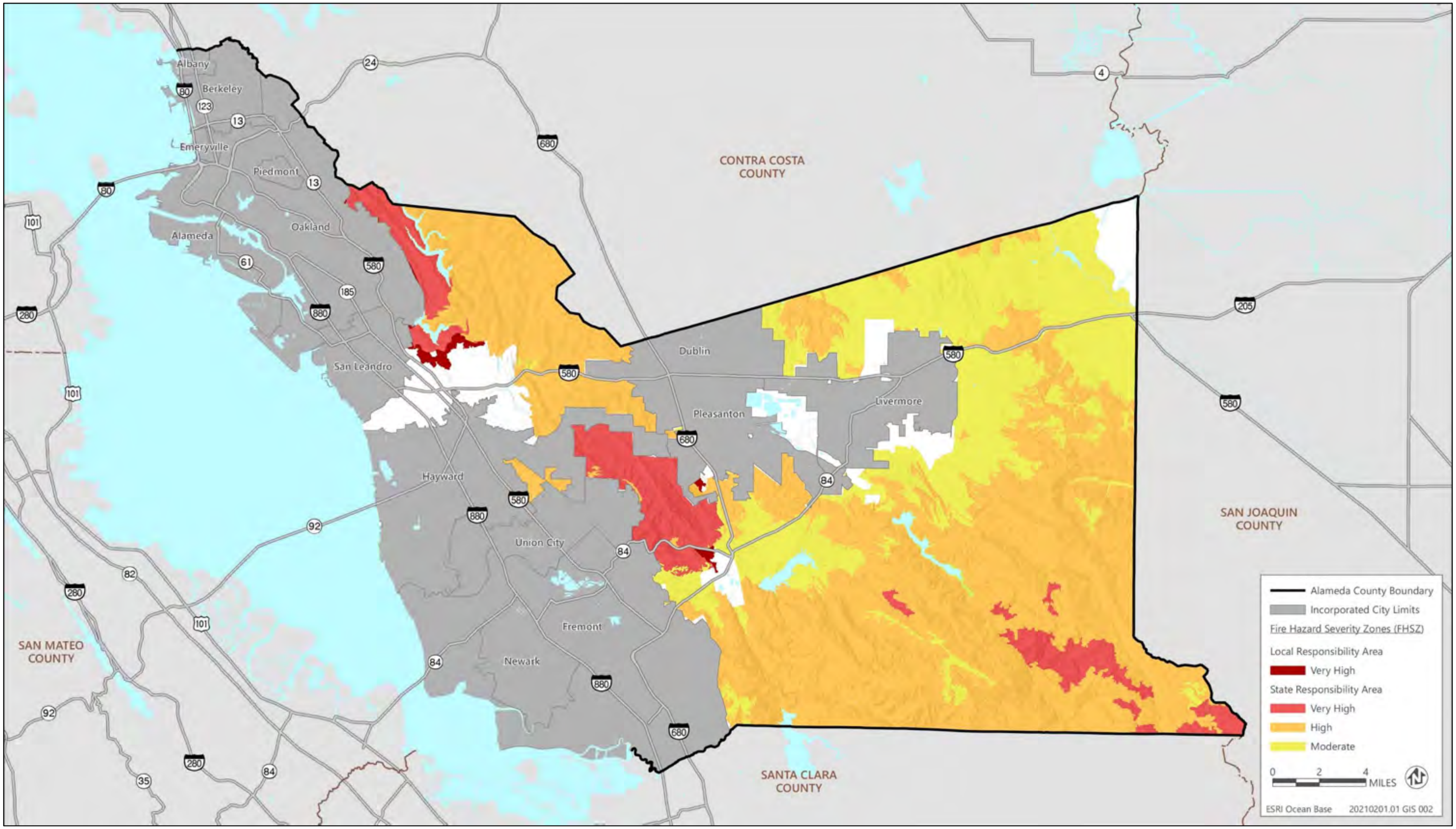


Source: Data downloaded from FEMA in 2022; adapted by Ascent in 2022.

Figure 4 Floodplains in Unincorporated Alameda County



Source: Data downloaded from CAL FIRE in 2022; adapted by Ascent in 2022.

Figure 5 Fire Hazard Severity Zones in Unincorporated Alameda County

Note: The data presented in this figure encompasses the entirety of Alameda County, rather than just the unincorporated county.

Source: FEMA 2021.

Figure 6 Alameda County Major Disaster Declarations (Federal) from 1953-2021

2.1.3 Climate Change Effects

Climate change effects are categorized as primary (direct) and secondary (indirect). Primary effects are those that are caused by the initial impacts of increased GHG emissions, from which secondary effects result. The primary climate change effects analyzed for the unincorporated county include increased temperatures, changes in precipitation patterns, and sea level rise. The secondary climate change effects, which can occur because of individual changes or a combination of changes in the primary climate change effects, include increased wildfire risk, increased frequency of extreme heat events, extreme precipitation and flooding, and drought and water supply.

Though the precise extent of future climate change effects is uncertain, historical climate data and forecasted GHG emissions can be used to project climate change effects through near-term (current-2050), midterm (2040-2069), and long-term (2070-2099) timescales, unless noted otherwise for individual climate change effects. The time periods are established as 30-year time intervals to gather accurate data on average changes in the climate, which is typically measured over 30-year periods or longer. This results in overlap among some time periods. Due to annual fluctuations in climate variables, climate data on shorter periods may be less accurate and not reflect long-term averages (NOAA 2020). To assess potential effects from climate change, the APG recommends using Cal-Adapt, a tool developed by the CEC and the University of California, Berkeley Geospatial Innovation Facility that uses global climate simulation model data to identify how climate change might affect various geographies in California. Cal-Adapt addresses the uncertainty in future GHG emissions by using Representative Concentration Pathways (RCPs) developed by the Intergovernmental Panel on Climate Change (IPCC). These RCPs depict two future emissions scenarios. RCP 4.5 represents a lower emissions scenario in which GHG emissions continue to rise through 2040 and then decrease to below 1990 levels by the end of the century. RCP 8.5 represents a high emissions scenario, or business-as-usual scenario, where GHG emissions continue to increase through the end of the century. As recommended by the APG, this VA evaluates near-term and midterm climate change effects and their associated impacts under the high emissions scenario, as this takes a conservative approach and assumes a worst-case scenario. Additionally, changes in climate variables for these timescales are similar under both the low and high emissions scenarios. Because long-term global GHG emissions trends are less certain and climate impacts vary more considerably between scenarios, a discussion of both the low and high emissions scenarios is included for this timescale (OPR, CEC, and CNRA 2018a).

Cal-Adapt downscales global climate models to local and regional resolutions using the Localized Constructed Analogs statistical technique. Four of the models included have been selected by California's Climate Action Team Research Working Group as priority models for research contributing to the Climate Assessment. The first model, CanESM2, represents an "average" simulation. The second model, CNRM-CM5, represents a "cooler/wetter" simulation. The third model, HadGEM2-ES, represents a "warmer/drier" simulation. The fourth model, MIROC5, represents a "dissimilar" simulation that is most unlike the other three to produce maximal coverage of possible future climate conditions. To analyze climate projections for the unincorporated county, the average of the downscaled data provided by these four models was used. The boundaries of the study area for this analysis are the geographic boundaries of Alameda County as a whole, unless otherwise noted. It is important to note that although incorporated areas of the county are included within this boundary, their inclusion does not affect the overall results of the analysis because the climate data associated with these regions are nearly identical to the data associated with the surrounding study area.

PRIMARY CLIMATE CHANGE EFFECTS

Increased Temperatures

Though average annual temperature varies depending on location within Alameda County, this analysis focuses on the county as a whole. According to Cal-Adapt, the historic (1961-1990) average annual maximum temperature for the county is 68.5 °F, and the historic average annual minimum temperature is 46.8 °F. As shown in Table 4, both are projected to increase throughout the century (CEC 2022a). The average annual maximum temperature in the county is projected to increase to 71.8 °F in the near-term and 73.5 °F in the midterm under RCP 8.5. The average annual maximum temperature is projected to increase to 73.5 °F and 76.2 °F in the long-term under RCPs 4.5 and 8.5, respectively. Figure 7 graphically displays the increase in average annual maximum temperature within the county through the end of the century (CEC 2022b). The average annual minimum temperature in the county is projected to increase to 50.0 °F in the near-term and 51.6 °F in the midterm under RCP 8.5. The average annual minimum temperature is projected to increase to 51.5 °F and 54.7 °F in the long-term under RCPs 4.5 and 8.5, respectively.

As noted, historic average annual temperatures, along with future projected temperatures across each timescale, vary slightly depending on location within the county. For example, the historic average annual maximum temperature in Oakland, an incorporated city along the San Francisco Bay, is 65.9 °F, whereas the historic average annual maximum temperature in Sunol, a slightly more inland unincorporated community, is 68.3 °F. However, the change in temperature across each timescale from the historic average is similar in jurisdictions across the county. For example, in the long-term under RCP 8.5, Oakland is projected to have an average annual maximum temperature of 73.1 °F, or an increase of 7.2 °F from its historic average. Similarly, Sunol is projected to have an average annual maximum temperature of 76.1 °F in the long-term under RCP 8.5, or an increase of 7.8 °F from its historic average. These respective increases in temperature of 7.2 °F and 7.8 °F are similar to the projected 7.7 °F increase across the county as a whole, which is shown in Table 4. Increased temperatures in the county will likely influence secondary climate change effects, including increased wildfire risk, increased frequency of extreme heat events, and drought and water supply.

Table 4 Changes in Average Annual Temperature in Alameda County

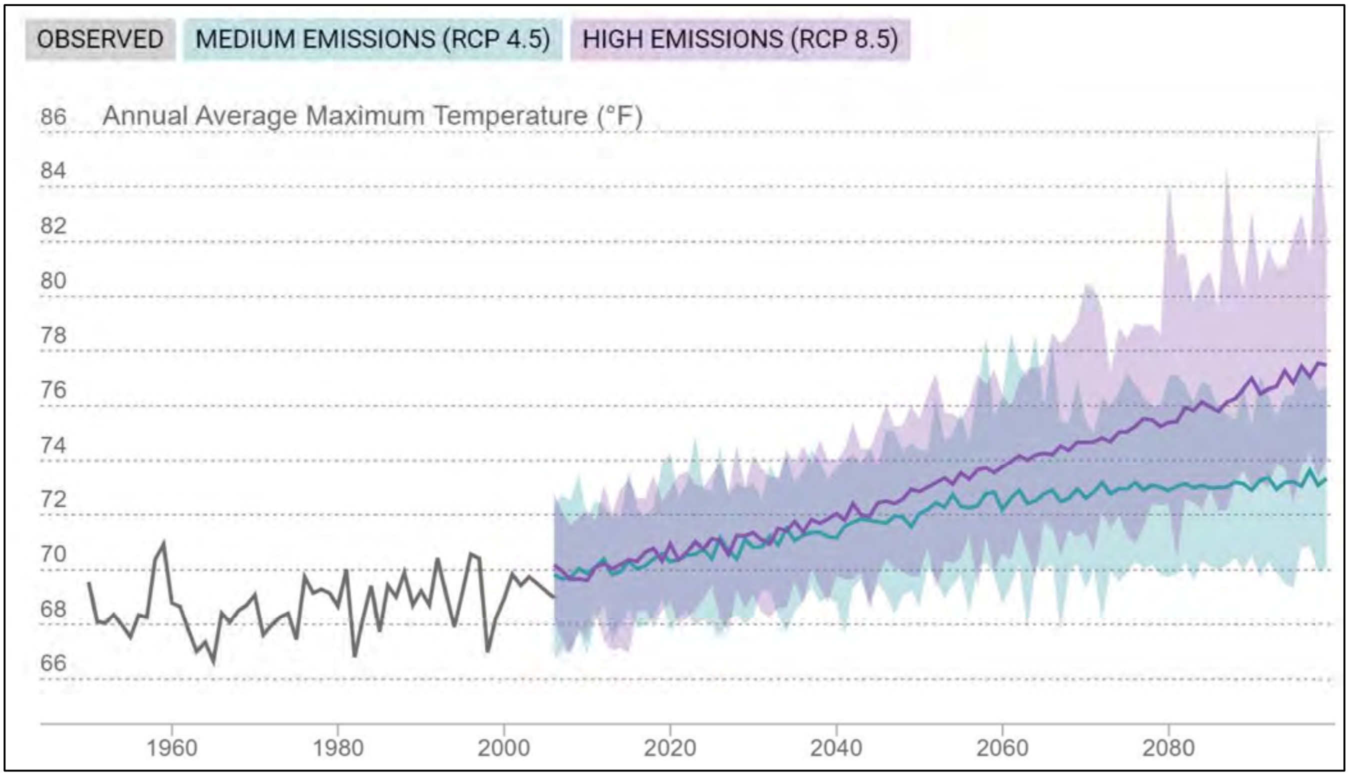
Average Annual Temperature	Historic (1961-1990)	Near-Term[1] (current-2050)	Midterm[1] (2040-2069)	Long-Term (2070-2099)	
				RCP 4.5	RCP 8.5
Maximum Temperature (ºF)	68.5	71.8	73.5	73.5	76.2
Maximum Temperature Difference from Historic (ºF)	N/A	+3.3	+5.0	+5.0	+7.7

Average Annual Temperature	Historic (1961-1990)	Near-Term[1] (current-2050)	Midterm[1] (2040-2069)	Long-Term (2070-2099)	
				RCP 4.5	RCP 8.5
Minimum Temperature (ºF)	46.8	50.0	51.6	51.5	54.7
Minimum Temperature Difference from Historic (ºF)	N/A	+3.2	+4.8	+4.7	+7.9

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; ºF = degrees Fahrenheit; N/A = not applicable; RCP = Representative Concentration Pathway.

1 Projections for the near-term and midterm timescales are based on RCP 8.5.

Source: CEC 2022a.



Note: Due to Cal-Adapt limitations, the data presented in this figure encompasses the entirety of Alameda County, rather than just the unincorporated county.

Source: CEC 2022b.

Figure 7 Alameda County Projected Increase in Average Annual Maximum Temperature through 2099

Changes in Precipitation Patterns

Similar to the previous analysis, this analysis focuses on the county as a whole, despite average annual precipitation varying dependent upon location within the county. According to Cal-Adapt, the historic average annual precipitation in the county is 18.0 inches. As shown in Table 5, the average annual precipitation in the county is projected to increase to 20.5 inches in the near-term and 20.4 inches in the midterm under RCP 8.5. In the long-term, average annual precipitation is projected to increase to 20.4 inches under RCP 4.5, and 22.6 inches under RCP 8.5 (CEC 2022a).

As noted, historic average annual precipitation, along with future projected average annual precipitation across each timescale, varies slightly depending on location within the county. Using the same examples as before (i.e., average annual maximum temperature), the historic average annual precipitation in Oakland is 22.1 inches, whereas the historic average annual precipitation in Sunol is 19.6 inches. The differences between these averages are not considered to be significant. Additionally, though the changes in precipitation across each timescale compared to the historic average vary slightly between Oakland and Sunol, and in jurisdictions across the county as a whole, the differences do not differ greatly from the countywide data, as displayed in Table 5.

While average annual precipitation in the county is projected to trend upward in future years, overall precipitation patterns are also projected to change, with precipitation variability expected to continue, and potentially increase, over time across the San Francisco Bay Area, inclusive of the county. Historically, precipitation in the San Francisco Bay Area exhibits "booms and busts," which refers to the existence of both very wet years and very dry years (OPR, CEC, and CNRA 2018b). The amount of precipitation that falls in any particular year is largely influenced by occurrences of large, discrete winter storms, which often provide a substantial fraction of the region's annual precipitation. When these storms happen, they will likely become more intense, and potentially more damaging, in the coming decades. In general, periods of precipitation are projected to be wetter, but on an annual basis, there will likely be fewer total days with precipitation. Further, climate projections show a likely increase in extreme dry events, which may result in severe and prolonged drought (OPR, CEC, and CNRA 2018b). Overall, the projected increase in average annual precipitation and changes in precipitation patterns through the end of the century will likely influence secondary climate change effects, including increased wildfire risk, extreme precipitation and flooding, and drought and water supply.

Table 5 Changes in Average Annual Precipitation in Alameda County

Average Annual Precipitation	Historic (1961-1990)	Near-Term[1] (current-2050)	Midterm[1] (2040-2069)	Long-Term (2070-2099)	
				RCP 4.5	RCP 8.5
Average Annual Precipitation (inches)	18.0	20.5	20.4	20.4	22.6
Average Annual Precipitation Difference from Historic (inches)	N/A	+2.5	+2.4	+2.4	+4.6

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; N/A = not applicable; RCP = Representative Concentration Pathway.

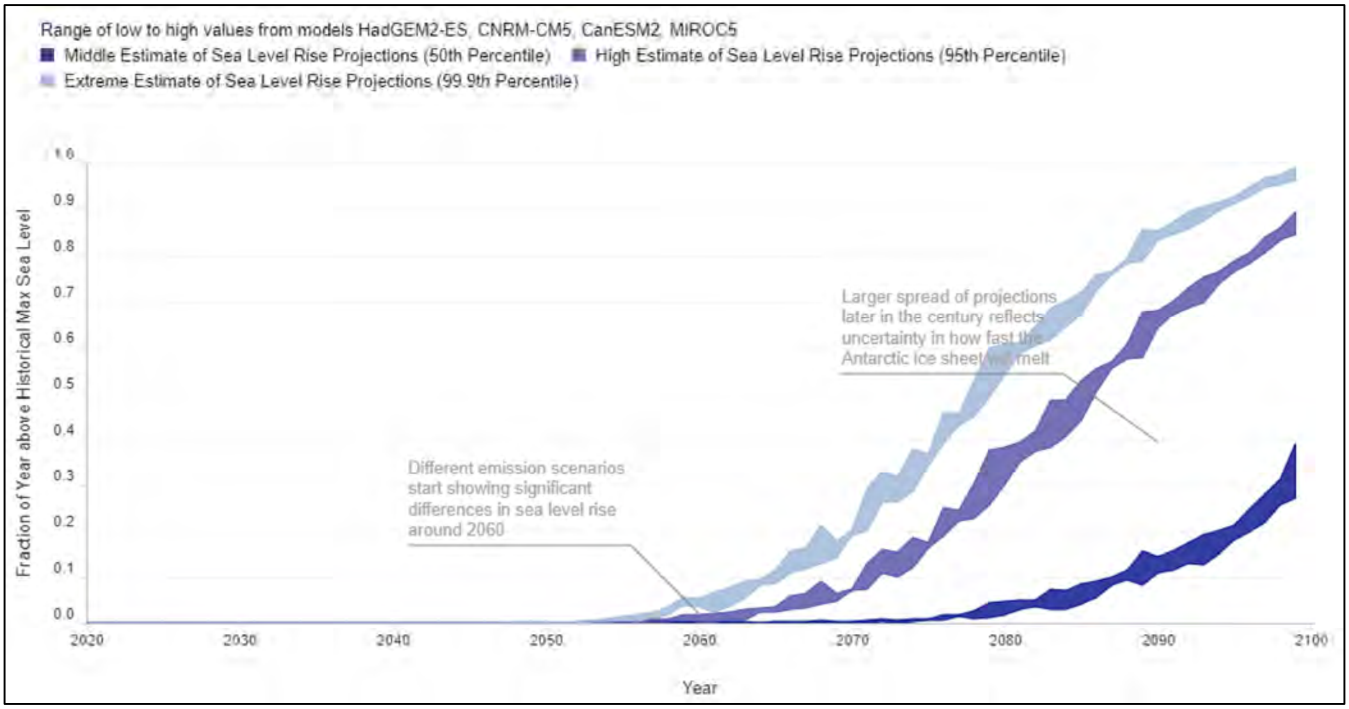
[1] Projections for the near-term and midterm timescales are based on RCP 8.5.

Source: CEC 2022a.

Sea Level Rise

Cal-Adapt provides probabilistic sea level rise projections for both RCPs 4.5 and 8.5, which incorporate estimates of components that contribute to global and regional sea level rise (e.g., thermal expansion of seawater, glacier ice melt, glacial isostatic adjustments, etc.). The sea level rise projections for RCP 8.5 also incorporate relatively recent scientific findings on the potential for rapid demise of the West Antarctic Ice Sheet, which could dramatically accelerate sea level rise in the latter decades of this century. The probabilistic framework is helpful because despite substantial advances in the science of sea level rise, significant uncertainty remains in mid- and late-century projections of sea levels. Probabilistic sea level rise projections provide a range of possible outcomes in a framework that enables decision-makers to choose a number that is appropriate for their level of risk tolerance. Sea level rise scenarios presented in Cal-Adapt include the 50th percentile (middle estimate), 95th percentile (high estimate), and 99.9th percentile (extreme estimate) (CEC 2022c).

According to Cal-Adapt, the historic maximum sea level at the San Francisco tide gauge station is 67 inches. The San Francisco tide gauge station was chosen for this analysis as it is the closest of the 11 gauge stations across the state in proximity to the county as a whole, and thus would provide the most relevant projections. Figure 8 displays the projected fraction of the year that sea level would be over the historic maximum sea level at the San Francisco tide gauge station under RCP 8.5 and each of the above noted sea level rise scenarios. As shown, it takes until roughly mid-century for each sea level rise scenario to start showing significant differences. Due to the inherent uncertainty in the rate of future sea level rise, the purpose of this analysis is not to project when and how much sea levels will rise, but rather, to emphasize that sea levels are rising and should be planned for accordingly. As noted previously in Section 2.1.2, there is only about 1 mile of coastline on unincorporated county land located in San Lorenzo, and thus, sea level rise is only a direct threat in this area. Though sea level rise will not impact most of the unincorporated county directly, it can indirectly impact more inland communities. For example, landward intrusions of seawater due to sea level rise can make groundwater levels rise, which could result in subsurface flooding of septic systems, basements, and other infrastructure, affecting the future suitability of land for commercial and residential use. Sea level rise, in general, can influence flooding (e.g., coastal flooding), one of the secondary climate change effects identified in this VA.



Source: CEC 2022c.

Figure 8 Projected Fraction of Year with Sea Level Above Historic Maximum at the San Francisco Tide Gauge Station Under RCP 8.5

SECONDARY CLIMATE CHANGE EFFECTS

Increased Wildfire Risk

Historically, attention to wildfire in the state has mostly focused on the Sierra Nevada region and Southern California, but recent large and destructive wildfires in the San Francisco Bay Area have rapidly shifted attention to the ongoing risks in this region, inclusive of Alameda County (OPR, CEC, and CNRA 2018b). Using a statistical model based on historical data of climate, vegetation, population density, and large (i.e., greater than 988 acres) fire history, Cal-Adapt provides projections for future average annual acres that are anticipated to burn within the county, as a whole, when wildfires do occur. It is important to note that Cal-Adapt does not account for current or planned wildfire management projects. Table 6 displays the projected change in average annual area burned within the county under RCP 8.5 for the near-term and midterm timescales, and under both emissions scenarios, RCPs 4.5 and 8.5, for the long-term timescale. The modeled historic average annual area burned in the county is 4,020 acres. The average annual area burned in the county is projected to increase to 4,516 acres in the near-term and 4,513 acres in the midterm under RCP 8.5. The average annual area burned is projected to increase to 4,534 acres in the long-term under RCP 4.5, and 4,193 acres in the long-term under RCP 8.5. As a worst-case scenario, the county has the potential to experience 6,659 acres in average annual area burned in the long-term under RCP 8.5 (CEC 2022d). While the worst-case scenario is unlikely to happen, it is important to consider for adaptation planning purposes. Though it is difficult to pinpoint the exact timing, location, duration, and severity of future wildfires, the areas most susceptible to wildfire are the central and southeastern portions of the unincorporated county, largely because of their topography, as also described in Section 2.1.2. See Figure 5 for the FHSZs in the unincorporated county.

Table 6 Changes in Average Annual Area Burned in Alameda County

Average Annual Area Burned	Modeled[1] Historic (1961-1990)	Near-Term[2] (current-2050)	Midterm[2] (2040-2069)	Long-Term (2070-2099)		
				RCP 4.5	RCP 8.5	RCP 8.5 Maximum[3]
Average Annual Area Burned (acres)	4,020	4,516	4,513	4,534	4,193	6,659
Average Annual Area Burned Difference from Historic (acres)	N/A	+496	+493	+514	+173	+2,639

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; N/A = not applicable; RCP = Representative Concentration Pathway.

1 Observed historical average annual area burned data were not available from Cal-Adapt; the modeled historical average annual area burned data under RCP 4.5 was available and used as proxy data.

2 Projections for the near-term and midterm timescales are based on RCP 8.5.

3 "RCP 8.5 Maximum" refers to the maximum modeled value (i.e., worst-case scenario) within the long-term timescale under RCP 8.5.

Source: CEC 2022d.

Increased Frequency of Extreme Heat Events

The Cal-Adapt tool provides estimates of future instances of extreme heat events. Extreme heat events include extreme heat days and heat waves. Cal-Adapt defines an extreme heat day as a day when the daily maximum temperature exceeds the 98th historical percentile of daily maximum temperatures based on observed data from 1961–1990 between April and October. Heat wave events are characterized as periods of sustained extreme heat and are defined by Cal-Adapt as four or more consecutive extreme heat days.

Extreme heat day thresholds vary significantly for different portions of the county due to various geographic, topographic, and climatological factors. However, to be consistent with exposure analyses of other climate change effects, the study area in Cal-Adapt was kept as the geographic boundaries of the entire county. The default extreme heat threshold for the county is 92.7 °F, meaning 98 percent of all recorded temperatures between the months of April and October from 1961 to 1990 were below 92.7 °F. Historically, the county experienced an average of 4.3 extreme heat days and 0.2 heat waves per year from 1961-1990. As a result of rising temperatures from climate change, the county is projected to experience 13.0 extreme heat days and 1.2 heat waves annually in the near-term, and 19.3 extreme heat days and 2.2 heat waves annually in the midterm under RCP 8.5. In the long-term, the county is projected to experience 18.7 extreme heat days and 2.0 heat waves annually under RCP 4.5, and 32.7 extreme heat days and 4.6 heat waves annually under RCP 8.5. As a worst-case scenario, the county has the potential to experience a maximum of 105.0 extreme heat days and 22.0 heat waves per year in the long-term under RCP 8.5 (CEC 2022e). While the worst-case scenario is unlikely to happen, it is important to consider for adaptation planning purposes. In addition to the increasing number of extreme heat days and heat waves on an annual basis, the length of consecutive extreme heat days is also projected to increase through the end of the century.

Table 7 below displays the data for extreme heat events in the county through the end of the century. Figure 9 provides a visual representation of the projected increase in the annual number of extreme heat days in the county through the end of the century using the four priority models previously described (i.e., CanESM2, CNRM-CM5, HadGEM2-ES, and MIROC5). Noting that the presented data is for Alameda County as a whole, and acknowledging that extreme heat is experienced differently across the county due to various factors (e.g., limited air conditioning in certain areas), a more in-depth discussion of heat-related sensitivities and potential impacts is presented in Section 2.2.5.

Table 7 Changes in Extreme Heat Events in Alameda County

Annual Averages	Historic (1961-1990)	Near-Term[1] (current-2050)	Midterm[1] (2040-2069)	Long-Term (2070-2099)		
				RCP 4.5	RCP 8.5	RCP 8.5 Maximum[2]
Number of Extreme Heat Days[3]	4.3	13.0	19.3	18.7	32.7	105
Number of Heat Waves[4]	0.2	1.2	2.2	2.0	4.6	22
Number of Days in Longest Stretch of Consecutive Extreme Heat Days	2.3	4.7	6.3	5.5	9.0	35

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; RCP = Representative Concentration Pathway.

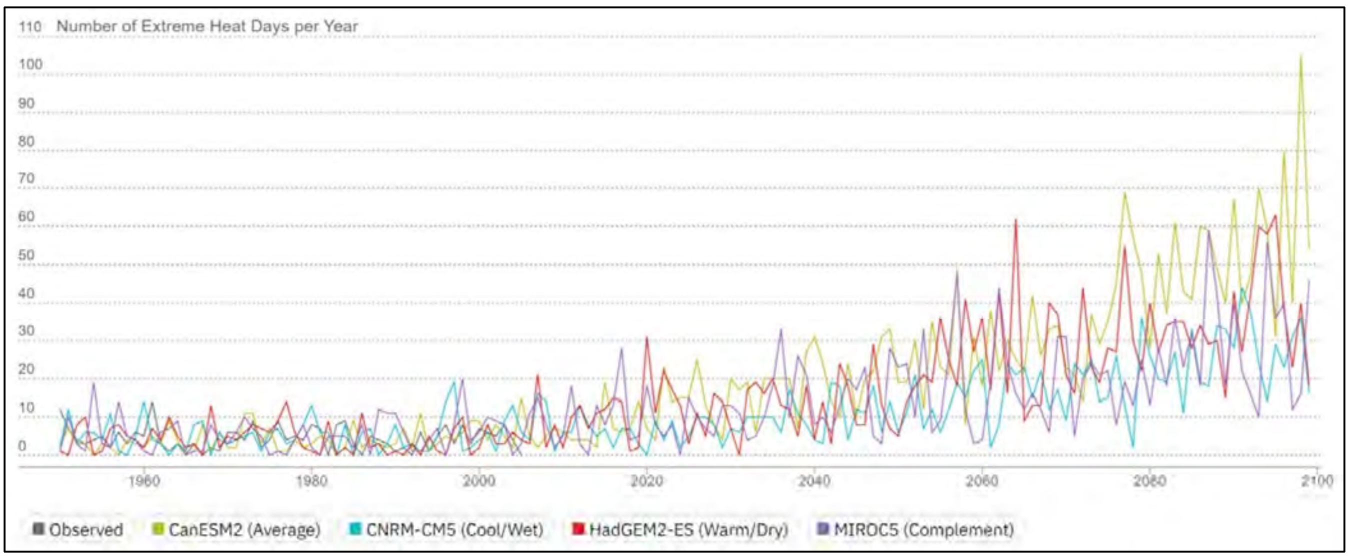
1 Projections for the near-term and midterm timescales are based on RCP 8.5.

2 "RCP 8.5 Maximum" refers to the maximum modeled value (i.e., worst-case scenario) within the long-term timescale under RCP 8.5.

3 The threshold for an extreme heat day in Alameda County is 92.7 °F.

4 A heat wave is characterized as a period of sustained extreme heat and is defined by Cal-Adapt as four or more consecutive extreme heat days.

Source: CEC 2022e.



Notes: Due to Cal-Adapt limitations, the data presented in this figure encompasses the entirety of Alameda County, rather than just the unincorporated county; the threshold for an extreme heat day in Alameda County is 92.7 °F.

Source: CEC 2022e.

Figure 9 Alameda County Projected Increase in Extreme Heat Days through 2099

Extreme Precipitation and Flooding

In the Cal-Adapt tool, extreme precipitation events are defined as events where 2-day rainfall totals are above an extreme threshold (i.e., days having precipitation at or exceeding the 95th percentile). For the county as whole, this threshold is approximately 0.9 inches over a 2-day period. Similar to extreme heat thresholds, extreme precipitation thresholds vary significantly for different portions of the county due to various geographic, topographic, and climatological factors. However, to be consistent with exposure analyses of other climate change effects, the study area in Cal-Adapt was kept as the geographic boundaries of the entire county. According to Cal-Adapt, the county has historically experienced an average of 1.5 extreme precipitation events per year from 1961-1990. Under RCP 8.5, the county is expected to experience 2.4 extreme precipitation events per year in the near-term and 2.9 extreme precipitation events per year in the midterm. In the long-term, the county is projected to experience 2.8 extreme precipitation events per year under RCP 4.5, and 4.4 extreme precipitation events per year under RCP 8.5.

Additionally, as a worst-case scenario, there is the potential to have as many as 14 extreme precipitation events per year in the long-term under RCP 8.5 (CEC 2022f). Changes in extreme precipitation events in the county are shown in Table 8. Though the table displays an increase in the average annual number of extreme precipitation events through the end of the century, it is important to note that the quantity of extreme precipitation events in the county may vary considerably year-to-year due to California's highly variable climate setting. However, as the climate continues to warm, atmospheric rivers, responsible for many of the extreme precipitation events across the state, will carry more moisture and may make extreme precipitation events more severe (Polade et al. 2017).

Table 8 Changes in Extreme Precipitation Events in Alameda County

Average Annual Number of Extreme Precipitation Events[1]	Historic (1961-1990)	Near-Term[2] (current-2050)	Midterm[2] (2040-2069)	Long-Term (2070-2099)		
				RCP 4.5	RCP 8.5	RCP 8.5 Maximum[3]
Average Annual Number of Extreme Precipitation Events	1.5	2.4	2.9	2.8	4.4	14
Average Annual Number of Extreme Precipitation Events Difference from Historic	N/A	+0.9	+1.4	+1.3	+2.9	+12.5

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; N/A = not applicable; RCP = Representative Concentration Pathway.

1 The threshold for an extreme precipitation event in Alameda County is 0.9 inches of precipitation over a 2-day period.

2 Projections for the near-term and midterm timescales are based on RCP 8.5.

3 "RCP 8.5 Maximum" refers to the maximum modeled value (i.e., worst-case scenario) within the long-term timescale under RCP 8.5.

Source: CEC 2022f.

As the potential increases for more extreme precipitation events to occur on an annual basis through the end of the century, the county may also experience an increase in the frequency and intensity of flood events. Though the occurrence of extreme precipitation events is a major source of flooding in the county, and will increasingly be so in the future, it is not the only source. Sea level rise is another major source of flooding across the entire county (i.e., incorporated and unincorporated areas) as rising seas will put new areas at risk of coastal flooding, but also increase the likelihood and intensity of floods in areas already at risk. Figure 10 displays projected flooding inundation across the entire county under four distinct sea level rise scenarios associated with a 100-year storm: 1.6 feet of sea level rise, 3.3 feet of sea level rise, 5.0 feet of sea level rise, and 6.6 feet of sea level rise. As noted previously, most of the unincorporated county will not experience direct impacts associated with sea level rise and associated flooding; the vast majority of the county that borders the San Francisco Bay is incorporated cities. However, there does exist some unincorporated county land in San Lorenzo that will directly experience sea level rise and associated flooding, as circled in red in Figure 10. Additionally, flooding induced by sea level rise can indirectly affect the remainder of the unincorporated county.

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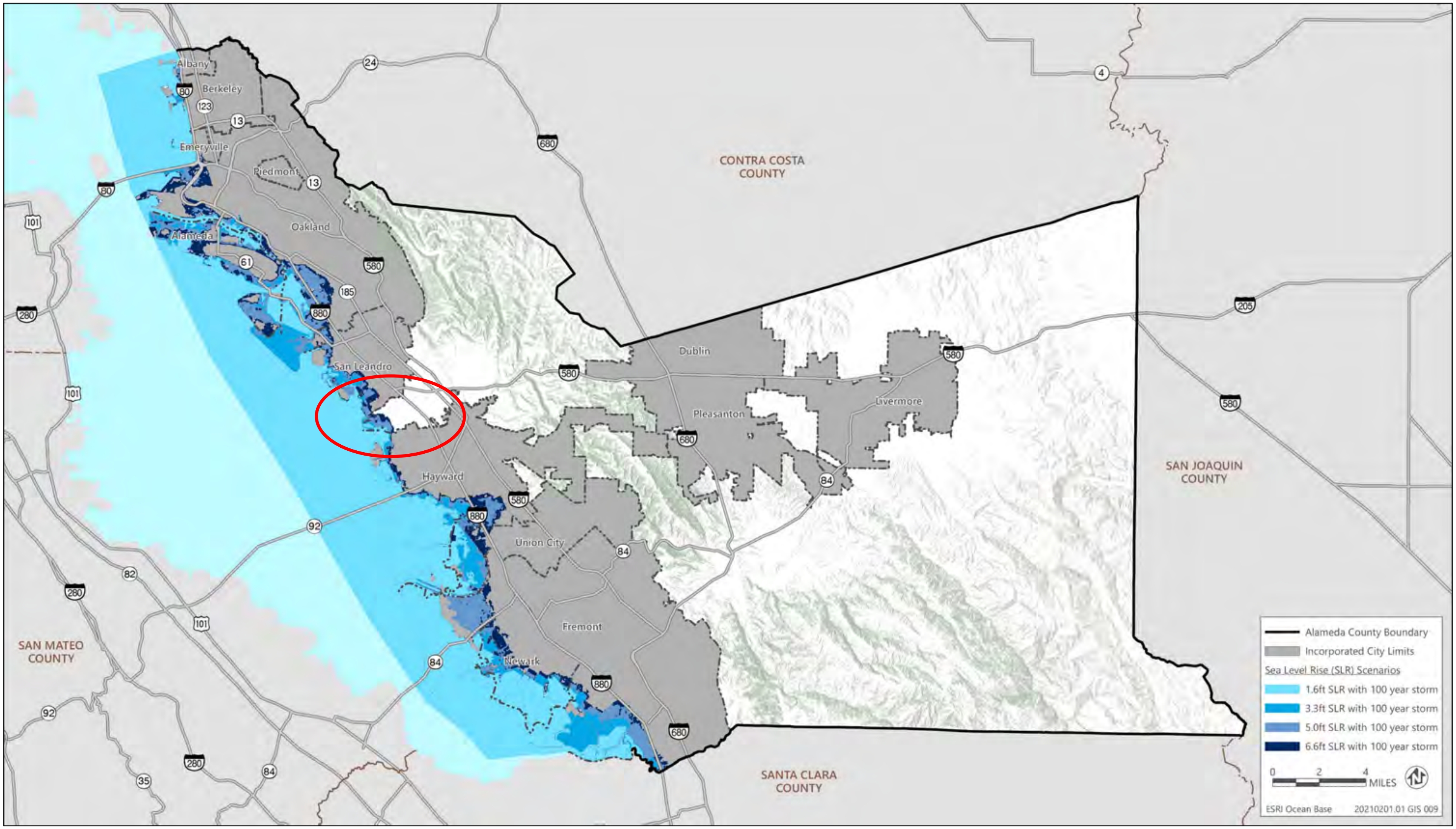


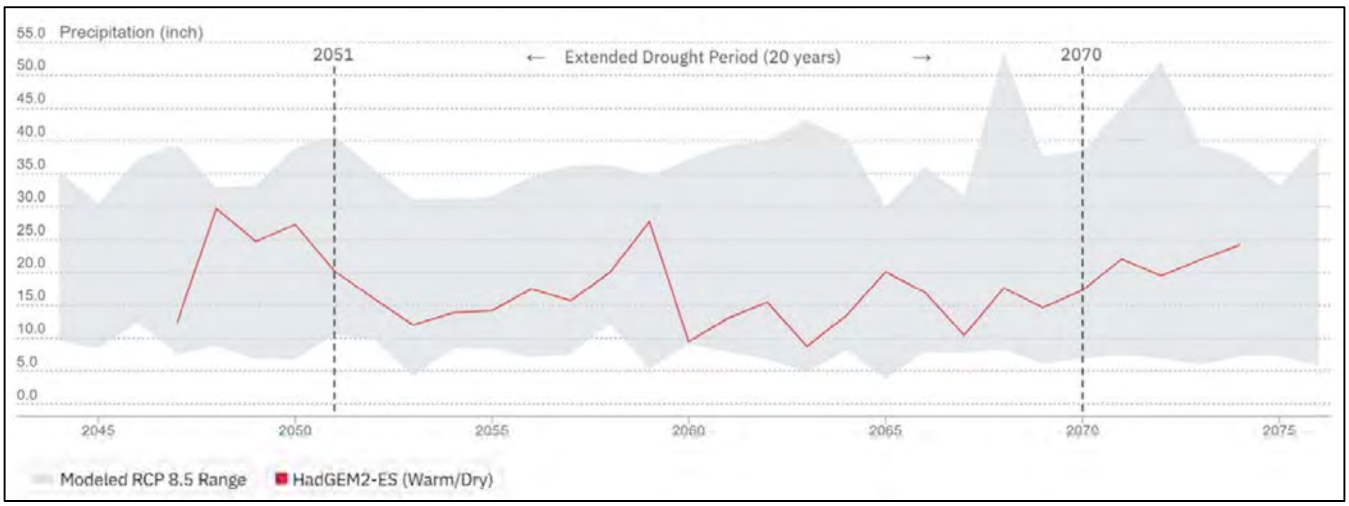
Source: Data downloaded from Our Coast Our Future in 2022; adapted by Ascent in 2022.

Figure 10 Alameda County Sea Level Rise Scenarios

Drought and Water Supply

As shown in Table 5 above, under both emissions scenarios, RCPs 4.5 and 8.5, the county is expected to experience slight overall increases in average annual precipitation in the long-term. However, in addition to these slight increases in average annual precipitation, overall precipitation patterns are projected to change, with precipitation variability expected to increase substantially. The county and state have a highly variable climate that is susceptible to prolonged periods of drought, and recent research suggests that extended drought occurrences (i.e., a "mega-drought") could become more pervasive in future decades (CEC 2022g).

Cal-Adapt uses data to simulate an extended drought scenario for all of California from 2051 to 2070 under RCP 8.5 and the HadGEM2-ES model. The extended drought scenario is based on the average annual precipitation over 20 years. This average value equates to 78 percent of the historical median annual precipitation averaged for the North Coast and Sierra California Climate Tracker regions. As shown in Table 5, the county's observed historic (1961-1990) average annual precipitation is 18.0 inches. Under the anticipated drought scenario between 2051 and 2070, the county's average annual precipitation would decrease to 15.7 inches, with some individual years falling below 10.0 inches of precipitation, as shown in Figure 11 (CEC 2022g). Though this analysis serves as a scenario rather than an actual projection or forecast, the county is predicted to experience extended drought periods like this as a result of climate change, and without effective adaptations, future droughts will challenge the management of the San Francisco Bay Area's water supplies, inclusive of the county (OPR, CEC, and CNRA 2018b).



Note: Due to Cal-Adapt limitations, the data presented in this figure encompasses the entirety of Alameda County, rather than just the unincorporated county.

Source: CEC 2022g.

Figure 11 Alameda County Average Annual Precipitation Projections During an Extended Drought Scenario between 2051 and 2070

2.2 SENSITIVITY AND POTENTIAL IMPACTS

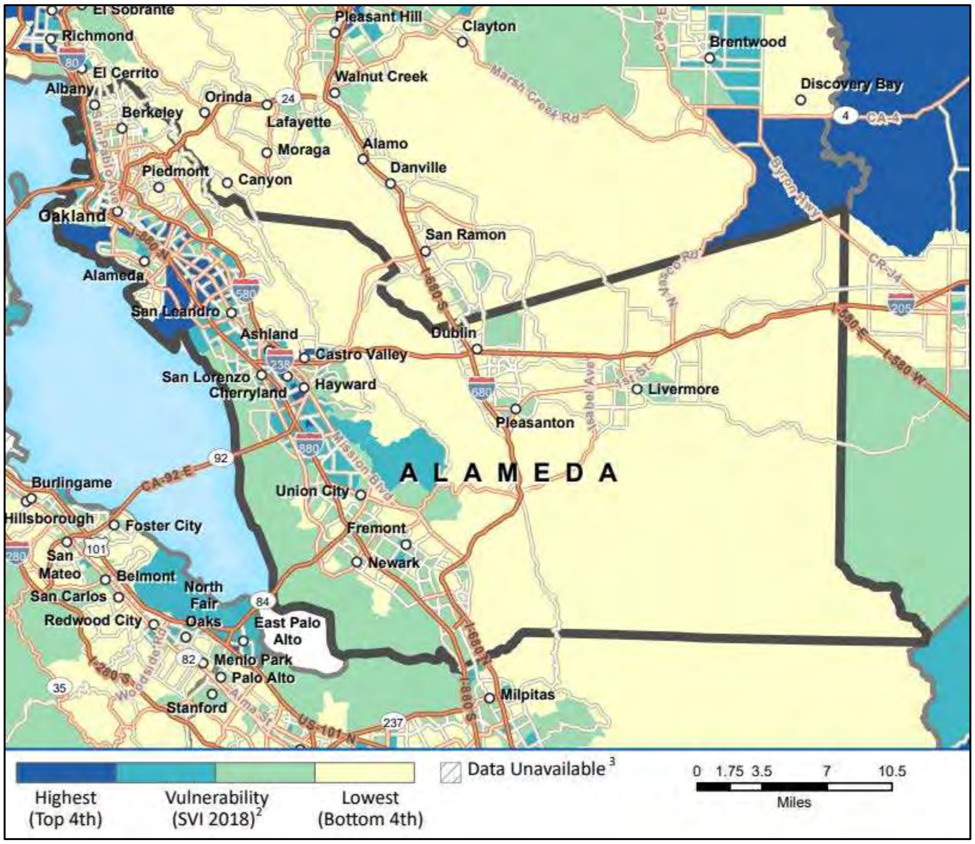
The second step of the VA process is conducting the sensitivity analysis and the analysis of potential impacts. The varying effects of climate change will impact the unincorporated county differently, such that some population groups and assets will be affected more severely than others. The first objective of this step is to identify which populations and assets may be sensitive to climate change effects. The second step is to determine the specific potential impacts that those populations and assets may face as a result of those climate change effects. Key populations and assets identified in the unincorporated county are organized into the following overarching categories: populations, built environment, and community functions. These categories are described in more detail below.

The climate change effects analyzed in this section include increased wildfire risk, increased temperatures and extreme heat, extreme precipitation and flooding, and drought and water supply. Climate change exposures at the local scale are inherently uncertain, but the potential ways in which climate change could impact specific populations and community assets within the unincorporated county are identified and discussed.

2.2.1 Populations

While all persons in the unincorporated county will experience impacts from climate change, some populations are more vulnerable to climate impacts due to a variety of factors. Vulnerable populations are those that "experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts" (OPR 2018). These disproportionate effects are caused by physical, social, political, and economic factors, which are exacerbated by climate impacts. Some of these factors include race, class, sexual orientation and identification, national origin, and income inequality, among others (OPR 2018). These factors can often be the result of historic inequitable planning processes (Lynn et al. 2011).

Within the county as a whole, there exists an array of populations vulnerable to the effects of climate change. The Social Vulnerability Index (SVI), developed by the Centers for Disease Control and Prevention, is a tool intended to assist local planners in better preparing for and responding to hazards by identifying and mapping areas where populations are most likely to need support before, during, and after a hazardous event, including those linked to or exacerbated by climate change. The SVI groups 15 distinct census-derived factors (e.g., poverty, lack of vehicle access, crowded housing) into four themes (i.e., socioeconomic status, household composition/disability, race/ethnicity/language, housing type/transportation) that summarize the extent to which an area is socially vulnerable to hazards. Figure 12 displays the county's SVI. As shown, the most vulnerable populations are primarily in the western portions of the county along the San Francisco Bay. These portions mostly consist of incorporated city limits, though vulnerable populations can be found throughout the county, including in the unincorporated areas (CDC 2018). For example, the forthcoming Environmental Justice Element of the General Plan identifies 16 unincorporated census tracts in Ashland, Cherryland, Hayward Acres, Castro Valley, and San Lorenzo as Priority Communities that have been historically and disproportionately burdened by environmental factors (e.g., pollution burden, greater health risks, low-income). Specific vulnerable populations in the county include, but are not limited to, children, pregnant people, the elderly, communities of color, linguistically isolated communities, individuals experiencing homelessness, low-income individuals, individuals with access and functional needs, workers in vulnerable occupations, and those with preexisting health issues. Though vulnerable populations do not represent the majority of the county's total population, it is important to plan for all groups that, for one reason or another, lack available resources or capacity to react or adapt to the impacts of climate change.



Note: The data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county.

Source: CDC 2018.

Figure 12 Alameda County Social Vulnerability Index

2.2.2 Built Environment

The built environment in the unincorporated county consists of a set of assets that are essential to the health and welfare of residents and visitors and are especially important during and following hazard events linked to or exacerbated by climate change. This ranges from residential and commercial buildings to an array of critical infrastructure, including essential facilities (e.g., fire stations, medical facilities, schools), transportation infrastructure (e.g., roadways, bridges, railroads), and utility infrastructure (i.e., energy, communications, and water and wastewater). Critical infrastructure, in general, refers to any structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause disruption of vital socioeconomic activities if it is destroyed, damaged, or functionally impaired.

2.2.3 Community Functions

Community functions are the resources, assets, operations, economic sectors, and services that are created or influenced by the interaction between populations and the built environment and allow day-to-day activities to continue in the unincorporated county. Some of the unincorporated county's community functions include, but are not limited to, agriculture, tourism and recreation, transportation and mobility, housing, essential and emergency services, energy delivery, and other utility (e.g., communications) operations. Increases in the frequency and/or severity of hazards linked to climate change will likely cause environmental, economic, and/or social impacts across these community functions, which are crucial to the integrity and resilience of the unincorporated county.

2.2.4 Increased Wildfire Risk

Under RCP 8.5, the average annual area burned in the county, as a whole, is projected to rise by over 500 acres in the near-term and midterm when compared to the historic (1961-1990) average annual area burned. In the long-term, the average annual area burned is projected to increase by approximately 500 acres and 200 acres under both emissions scenarios, RCPs 4.5 and 8.5, respectively. As a worst-case scenario, the average annual area burned in the county has the potential to experience an increase by approximately 2,600 acres in the long-term under RCP 8.5 (CEC 2022d). Regardless of the level of future GHG emissions, wildfire risk within the county is projected to increase as a result of climate change.

POPULATIONS

There are approximately 33,000 unincorporated county residents that are at risk of being directly affected by wildfire that reside within a "High" or "Very High" FHSZ (as determined by CAL FIRE)—almost 23,000 within the "High" FHSZ, and almost 10,000 within the "Very High" FHSZ, respectively representing 10 percent and 4.4 percent of the unincorporated county population (County of Alameda 2022a). The vast majority of FHSZs in the unincorporated county fall within the SRA, with the remainder being encompassed by the LRA. Though the FRA does exist within the county, it is all encompassed within incorporated city limits, and thus, is not discussed here. Additionally, related but separate from FHSZs are wildland-urban interface (WUI) areas, where three types exist within the county: interface, intermix, and influence. Interface areas are developed areas that have sparse or no wildland vegetation, but are in close proximity to a large patch of wildland. Intermix areas are areas where development (e.g., houses) and wildland vegetation directly overlap. Influence areas are areas where wildfire-susceptible vegetation is up to 1.5 miles from interface or intermix areas. Within the unincorporated county, there are over 25,000 residents residing in interface areas, over 4,000 residents residing in intermix areas, and over 31,000 residents residing in influence areas. Each represents approximately 11.1 percent, 1.8 percent, and 13.7 percent of the unincorporated county population, respectively (County of Alameda 2022a). A map of WUI areas across the entirety of Alameda County can be found in Figure C-21 of the LHMP. Communities located within WUI areas or FHSZs are at greater risk of wildfires, where direct exposure can lead to burns resulting in severe injuries or death.

In addition to the potential impacts associated with direct exposure to wildfires, there also exists indirect impacts like smoke and air pollution, which can be a severe health hazard. Smoke generated by wildfire contains visible and invisible emissions comprising of particulate matter (e.g., soot, tar), gases (e.g., carbon monoxide, carbon dioxide, nitrogen oxides), and toxins from burning structures and vehicles (e.g., formaldehyde, benzene), and inhalation of smoke can potentially lead to injuries or death (OPR, CEC, and CNRA 2018b; CDPH 2017). Further, wildfire-linked air pollution resulting in degraded air quality can result in cognitive impairment, premature births, and eye and respiratory illnesses, and can exacerbate other pre-existing conditions such as asthma, allergies, chronic obstructive pulmonary disease, and other cardiovascular and respiratory diseases (LAO 2022; CDPH 2017).

Wildfires can also create hazardous conditions even after they are suppressed. Most notably, destructive debris flows triggered by intense precipitation are one of the most dangerous post-fire hazards, and the risk of debris flows is directly correlated with the degree of vegetation loss and soil exposure after a wildfire (USGS 2018). Post-wildfire debris flows can adversely impact the county in different ways, but the deadly impact it can have on human lives is perhaps the most notable. The county, as a whole, is projected to have an increase in average annual area burned through the end of the century as a result of wildfire, and because debris flows in the county are primarily associated with wildfire burn scars, there may be an increase in intensity and frequency of deadly debris flows.

Overall, the entire population of the unincorporated county is vulnerable to the impacts of wildfire, both directly and indirectly, which may be exacerbated because of climate change. However, wildfires disproportionately impact vulnerable populations due to an array of factors, including health disparities, higher risk of job loss during economic downturns, and lower access to social resources, which is exacerbated by language barriers, lower levels of internet access, and unwillingness to contact authorities for undocumented individuals. When it comes to wildfire-related alerts and warnings, some communities in the eastern portion of the unincorporated county do not reliably or consistently receive these messages because of power, cell phone, and internet-related accessibility issues.

Additionally, renters and lower-income homeowners generally have lower financial or decision-making capacity to build or upgrade to fire-safe building codes and maintain defensible space, and have higher rates of uninsured or underinsured homes and belongings lost in fires (OPR, CEC, and CNRA 2018b). Further, people that hold specific occupations may be more vulnerable to the impacts of wildfire. First responders can be directly exposed to wildfire during fire suppression activities. Agricultural workers are particularly vulnerable to wildfire impacts because of the increased exposure to wildfire smoke while working outdoors, and the direct economic effects on the agricultural industry from wildfires, greatly diminishing their health and livelihoods. For residents residing in more rural or isolated areas, such as the eastern portion of the county, it is possible that they could become trapped without the option to evacuate during a wildfire, forcing them to shelter in place. Individuals with access and functional needs and those with certain medical issues residing in healthcare facilities are also inherently vulnerable during wildfires resulting in evacuations. Other vulnerable populations to wildfire impacts include children, the elderly, pregnant women, people with cardiovascular disease, and people with asthma or other respiratory diseases (EPA 2021).

BUILT ENVIRONMENT

Increased wildfire risk in the county poses significant threats to the unincorporated county's built environment, especially within WUI areas and the unincorporated county's FHSZs. Thousands of homes and dozens of critical facilities, including fire stations, medical facilities, schools, water and wastewater facilities, government facilities, communication facilities fall in or near WUI areas or FHSZs and are directly threatened by wildfires that may occur. Critical infrastructure made of wood frame construction are especially vulnerable during wildfire events. Energy production and distribution are also threatened by wildfires through loss of efficiency, generating capacity, and disruption or destruction of power lines, which are often associated with transmission poles made of wood (CDPH 2017).

Wildfires may also impact transportation infrastructure in the unincorporated county. For example, the California Department of Transportation (Caltrans) has identified portions of Interstate 580 within the unincorporated county at direct risk of wildfire exposure in future years, along with other transportation infrastructure within its jurisdiction (Caltrans 2018). While roadways and bridges typically sustain minimal to moderate damage during wildfire events, except in extreme scenarios, wildfires can create conditions that obstruct these assets through fallen trees, downed power lines, and other debris. This is particularly concerning for residents that are isolated in more rural areas that may not have many egress options during a wildfire-related evacuation. In addition to obstruction of these assets, the cracking and degradation of pavement is another risk related to wildfires.

COMMUNITY FUNCTIONS

The increased risk of wildfire through the end of the century has the potential to impact or disrupt an array of the unincorporated county's community functions. In smaller-scale periods during, or in anticipation of, heightened wildfire risk (e.g., high temperatures, high winds, low humidity), the California Public Utilities Commission states that electric utilities can de-energize if the utility "reasonably believes that there is an 'imminent and significant risk' to strong winds that may topple power lines or cause major vegetation-related damage to power lines, leading to increased risk of fire" (County of Alameda 2022a). In accordance with this, Pacific Gas and Electric Company (PG&E), who delivers power to the unincorporated county, has shown in the past, and has stated that continuing into the future, they may shut off power to electrical grids to reduce the chance of accidental fire ignition in high fire threat areas. These are known as Public Safety Power Shutoff (PSPS) events, and when these happen, power will remain out for as long as extreme and dangerous conditions pose a potential fire risk and until PG&E can inspect and repair power lines and equipment. Once PG&E deems it safe to do so, power will be systematically restored. While PSPS events are meant to prevent the ignition of potentially widespread, devastating wildfires, vulnerable populations without alternate power options (e.g., low-income individuals, individuals requiring electric-powered medical devices) may be adversely impacted by the PSPS event itself (e.g., loss of air conditioning during extreme heat conditions). Similarly, wildfire-induced loss of power affecting fire stations, police stations, and emergency dispatch and medical services, but not necessarily a purposive PSPS event, could diminish emergency dispatching, communications, and response capabilities, especially when coupled with evacuation-related traffic congestion.

Wildfires can also have severe economic impacts and other impacts on community functions within the unincorporated county. At a basic level, wildfires include the cost of fire suppression and disruptions to consumption and production of local goods and services. These costs are expected to increase in the future parallel to increased wildfire risk. Additionally, CAL FIRE's Santa Clara Unit (SCU) has identified values at risk from wildfire within its jurisdiction, which includes the unincorporated county. These values all relate to public health, public welfare, and the environment, and include ecosystem health, wildlife, recreation, and timber, among others (CAL FIRE 2022). Agriculture, a key economic sector in the unincorporated county, is also vulnerable to increased wildfire risk. Irrigation systems, equipment, crops, livestock, and stored commodities can all be lost during a wildfire, and wildfires can also diminish soil quality, which could reduce the viability of local agriculture. Wildfire smoke can also have negative impacts on crops, as smoke can lead to less sunlight reaching crops, causing them to develop more slowly and contributing higher disease loads. Exposure to wildfires, wildfire smoke, post-wildfire erosion, debris flows, and flooding can also adversely affect watersheds, specifically, their functions and associated ecosystem services (e.g., water quantity, water quality).

2.2.5 Increased Temperatures and Extreme Heat

Under RCP 8.5, the average annual maximum temperature in the county, as a whole, is projected to rise more than 3 °F in the near-term and roughly 5 °F in the midterm. In the long-term, the average annual maximum temperature is projected to increase between 5 °F to 8 °F, depending on the level of GHG emissions (CEC 2022a). Increased temperatures will likely lead to secondary climate change effects including increases in the frequency, intensity, and duration of extreme heat events in the county. As discussed previously in Section 2.1.3 the average number of extreme heat days and heat waves are projected to increase substantially in the midterm and in the long-term, with the greater number of extreme heat days and heat waves associated with RCP 8.5 (CEC 2022e). The potential impacts associated with increased temperatures and extreme heat are discussed below.

POPULATIONS

Increased temperatures and extreme heat exacerbated by climate change are one of the primary health concerns in the county, and the entire population of the unincorporated county will be exposed to this climate change effect. Across the state, with no exception to the San Francisco Bay Area and Alameda County, extreme heat ranks amongst the deadliest of all hazards (CNRA 2022). Increased temperatures that manifest in sustained periods of extreme heat can directly impact the unincorporated county's populations through heat stroke and other heat-related illnesses of varying severity, and can increase the risk of cardiovascular disease, respiratory disease, kidney failure, and preterm births (CDPH 2017; LAO 2022). Non-fatal heat stroke, specifically, can result in severe mental status changes, seizures, loss of consciousness, and abnormal cardiac rhythm (Cal EPA and CDPH 2013). Additionally, extreme heat can exacerbate other pre-existing conditions in certain vulnerable populations, such as the medically fragile and chronically ill. Increased temperatures and extreme heat may also heighten allergies and intensify the photochemical reactions that produce smog, ground-level ozone, and fine particulate matter measuring 2.5 micrometers or smaller ($PM_{2.5}$), which can be detrimental to human health (CDPH 2017). This correlation between extreme heat and heightened levels of pollutants is locally substantiated by data from the Bay Area Air Quality Management District (BAAQMD) (BAAQMD 2017).

In more densely populated areas of the unincorporated county, increased temperatures and extreme heat can contribute to the urban heat island effect, which makes these areas comparatively hotter than surrounding areas due to the higher density of heat-absorbing structures and lack of green space. In addition to the heightened temperatures in these areas, the urban heat island effect creates conditions more conducive to the production of smog, ground-level ozone, and $PM_{2.5}$. Heat-related deaths in more densely populated areas of the state are projected to at least double by mid-century (CNRA 2022). While there are other regions of the state that are comparatively hotter than the county as a whole, it has been estimated that heat-related illness and mortality may be higher in cooler regions of the state because the populations are less acclimated and prepared for extreme heat, including in more coastal areas of the county (LAO 2022). Air conditioning can alleviate some of the discomfort felt during periods of extreme heat and lower the risk of mortality, but many coastal areas across the San Francisco Bay Area, inclusive of areas within the unincorporated county, lack air conditioning due to historically lower temperatures.

Overall, when it comes to increased temperatures and extreme heat, vulnerable populations, such as the Priority Communities identified in the forthcoming Environmental Justice Element of the General Plan, will likely experience the worst impacts, as heat-related risk is associated with physical, social, political, and economic factors. Children, the elderly, pregnant people, and people with chronic illness can be especially sensitive to heat exposure. Combining these characteristics and existing health inequities with additional factors, such as poverty, linguistic isolation, housing insecurity, and the legacy of historic redlining policies can put individuals at disproportionately high risk of heat-related illness and death (CNRA 2022). Additionally, people that work long hours outdoors, such as those working in agriculture and transportation maintenance, among others, are at heightened exposure and risk to increased temperatures and extreme heat (Caltrans 2018).

BUILT ENVIRONMENT

Increased temperatures and extreme heat events are likely to affect the unincorporated county's built environment primarily through changes in energy use, as well as disproportionate impacts on individuals residing in units that do not have air conditioning, which is relatively common within western portions of the county. Cal-Adapt provides data on the shifts in Cooling Degree Days and Heating Degree Days, which are measurements used to assess the energy demand needed for cooling and heating buildings in different climate zones throughout California. A "degree day" does not equate to a single day of the year, but rather compares the average outdoor temperatures recorded for a location to a standard temperature (i.e., 65 °F). For example, if the average temperature for a day is 80 °F, the day has 15 Cooling Degree Days (80 – 65 = 15). Degree days are used in the State's Title 24 Building Energy Efficiency Standards to help design the energy demand needed for heating and cooling in the various climate zones throughout the state. To illustrate how climate change is likely to affect energy demand for heating and cooling in the future, Table 9 includes the relative shift in Cooling Degree Days and Heating Degree Days in the county, as a whole, through 2099. As displayed, the county is projected to have significant decreases in Heating Degree Days and significant increases in Cooling Degree Days through the end of the century, most notably with an almost 320 percent increase in Cooling Degree Days in the long-term under RCP 8.5 (CEC 2022h). These projections for the county correlate to an overall significant increase in cooling costs through the end of the century, with a slight decrease in heating costs. Additionally, apart from projected changes in building energy use, increased temperatures can add to the heat load of buildings in more densely populated areas of the county and can exacerbate existing urban heat islands, adding to the risk of extreme heat (CDPH 2017).

Table 9 Changes in Heating and Cooling Degree Days in Alameda County

Annual Averages	Historic (1961-1990)	Near-Term[1] (current-2050)	Midterm[1] (2040-2069)	Long-Term (2070-2099)	
				RCP 4.5	RCP 8.5
Number of Heating Degree Days	3,092	2,353	2,036	2,035	1,522
Percent Change in Heating Degree Days from Historic	N/A	-23.9%	-34.2%	-34.2%	-50.8%
Number of Cooling Degree Days	400	864	1,137	1,114	1,681
Percent Change in Cooling Degree Days from Historic	N/A	+115.8%	+184.0%	+178.2%	319.7%

Notes: Due to Cal-Adapt limitations, the data presented in this table encompasses the entirety of Alameda County, rather than just the unincorporated county; N/A = not applicable; RCP = Representative Concentration Pathway.

[1] Projections for the near-term and midterm timescales are based on RCP 8.5.

Source: CEC 2022h.

In addition to the impacts of increased temperatures and extreme heat on buildings and energy use, transportation systems will also be affected. Transportation infrastructure is designed and constructed to withstand certain variabilities in weather and temperature based on observations of historical weather trends for specific climate regions. The performance of transportation infrastructure may begin to decline when the severity of extreme heat periods exceeds historical ranges. For example, extreme heat may cause pavement discontinuities and deformation, increases the risk of buckling of highways and railroad tracks, and may cause premature deterioration of transportation infrastructure, decreasing transportation safety and creating higher maintenance costs (Caltrans 2018). Air conditioning units in buses are placed under increased stress and risk of failure when maximum daily temperatures reach 100 °F, which is a temperature threshold certain areas of the unincorporated county may exceed more frequently over time (Cambridge Systematics 2015). Further, while bridges are designed to expand during periods of extreme heat, projected increases in extreme heat events could go beyond design criteria, resulting in cracking and crushing of the roadway deck, as well as increased maintenance costs (Transportation Research Board 2008).

COMMUNITY FUNCTIONS

Increased temperatures and extreme heat may pose increase the risks to the unincorporated county's community functions. Similar to and connected with increased wildfire risk, increased temperatures and extreme heat can trigger a PSPS event by PG&E, which can adversely affect vulnerable populations without alternate power options (e.g., greater risk of the development of heat-related illnesses due to inaccessible air conditioning) and could potentially disrupt emergency dispatching, communications, and response capabilities. Agriculture in the unincorporated county could be significantly impacted by extreme heat, especially when coupled with drought. Higher temperatures can lead to increased evaporation rates of surface water and increased evapotranspiration in plants, resulting in decreased soil moisture content and increased demand for irrigation. Additionally, soils exposed to intense heat may erode quickly and enhance siltation of rivers and streams, which can then increase flood potential, harm aquatic life, and degrade water quality (County of Alameda 2012). Further, because western portions of the county have experienced historically temperate climates, increased temperatures and extreme heat could result in many residences, schools, and businesses needing to add air conditioning systems and remodel any outdoor facilities (e.g., playgrounds) with more heat-resistant materials, despite financial barriers that may exist (LAO 2022).

2.2.6 Extreme Precipitation and Flooding

The average number of annual extreme precipitation events in the county, as a whole, are projected to increase from the historical average of 1.5 events per year to 4.4 events per year by the end of the century under RCP 8.5, with the potential for up to 14 extreme precipitation events per year as a worst-case scenario. While it is uncertain exactly how climate change will affect flooding events in the unincorporated county and the region and to what extent, it is reasonable to assume that an average annual increase in extreme precipitation events, coupled with sea level rise, will likely lead to an increase in the frequency and intensity of flood events, which could result in adverse impacts to the unincorporated county's populations, built environment, and community functions.

POPULATIONS

The populations that will likely be most directly affected by extreme precipitation and flooding in the county are those that reside in the county's 100- and 500-year floodplains, where over 8,000 and 7,500 unincorporated county residents reside in each. This represents approximately 3.6 percent and 3.3 percent of the unincorporated county population, respectively (County of Alameda 2022a). Additionally, related but separate from the county's populations that reside in floodplains are the populations that are at direct risk of coastal flooding and inundation resulting from sea level rise. Depending on the amount of sea level rise through the end of the century, with scenarios considering sea level rise from anywhere between 3 and 6 feet, there are between approximately 500 and 2,000 unincorporated county residents residing in areas of San Lorenzo at direct risk and exposure of coastal flooding and inundation (County of Alameda 2022a). Depending on the severity of a flooding event, there is the potential for populations to be displaced and for people to lose their homes and livelihoods, in addition to the risk of injuries and even death. Flooding resulting in overflow of sewage systems or hazardous waste site infiltration may create conditions that release contaminants and promote water- and food-borne diseases, which can severely impact human health (CDPH 2017; OPR, CEC, and CNRA 2018b).

All residents and visitors of the unincorporated county may be sensitive to extreme precipitation and flooding. This notion is supported through feedback from the County's CCAP Kickoff Workshop, where attendees used words such as "helpless," "sad," "afraid," and "loss" to describe how they were feeling in the aftermath of the severe storms experienced across the state in the winter of 2022-2023. However, noting this, vulnerable population groups will likely face disproportionate negative impacts to extreme precipitation and flooding, especially in the context of climate change. In addition to lacking adequate shelter and protection from these events, individuals experiencing homelessness, along with some broader unincorporated county communities, may have limited access to warning messages and other pertinent information from the County and other public health and safety agencies. The elderly and individuals with access and functional needs may also face these challenges and are likely to have limited mobility and ability to react to and prepare for these events. For low-income individuals, risks of isolation and lost resources are elevated during flooding events. Because these residents have a lower rate of car ownership than the general population, they are heavily reliant on public transportation and frequently have limited mobility during extreme weather events and emergencies. (OPR, CEC, and CNRA 2018b). Other vulnerable populations to extreme precipitation and flooding in the unincorporated county include low-income individuals, communities of color, linguistically isolated communities, and children.

BUILT ENVIRONMENT

When it comes to flooding- and extreme precipitation-related impacts on the unincorporated county's built environment, residential property is notably at risk, especially homes that lie within the unincorporated county's floodplains or are at risk of sea level rise. Aside from residential property, much of the unincorporated county's critical infrastructure is at direct risk from flooding. Often, extreme precipitation events are followed by flash floods, landslides, mudslides, and debris flows. These hazards have significantly impacted roadways within the unincorporated county and have caused large traffic buildups in the past. In general, bridges and certain roadways often provide the only ingress and egress to some neighborhoods. Flooding-related disruption of the transportation network may reduce the capacity of individuals to evacuate or access hospitals and other health-related infrastructure in the event of an emergency, and can prevent emergency services providers from reaching vulnerable populations or making necessary repairs (OPR, CEC, and CNRA 2018b). Additionally, local bus routes and bus stops can be directly affected. Transportation infrastructure, along with other critical facilities (e.g., electric distribution lines, pipelines, public buildings, etc.), are also at direct risk of flooding-induced scouring, which is the removal of sediment, such as sand and gravel, caused by swiftly moving water and compromising the integrity of a structure. The projected increases in annual precipitation will increase the vulnerability of these structures in the future. Flooding-related disruptions can also occur within power and fuel distribution networks, as well as water delivery or wastewater treatment systems, which can create substantial risks to public health depending on the length of the disruption (OPR, CEC, and CNRA 2018b).

There are additional potential impacts associated with extreme precipitation and flooding on the unincorporated county's built environment. Flooding can cause underground utilities, along with water and sewer systems, to be damaged, or otherwise adversely affected via high inflow and infiltration. If drainage systems or culverts are backed up by floodwaters, pronounced localized flooding can occur. Sea water backflow resulting from coastal flooding can impair coastal sanitation drainage systems during flood events, requiring costly upgrades and alterations. Floodwaters may infiltrate drinking water supplies, causing contamination. Additionally, facilities that are known to manufacture, process, store, or use hazardous materials, such as fuel stations, could be damaged during flooding events. If damaged, these facilities, or containers holding these materials, could release chemicals that are carcinogenic, or otherwise detrimental to human health and the environment.

COMMUNITY FUNCTIONS

Heightened extreme precipitation and flooding can result in impacts to an array of community functions. Flooding may have adverse impacts on businesses (e.g., revenue loss due to closures) and public agency budgets. Increased direct and indirect costs associated with flood mitigation services, clean-up operations, and maintenance and replacement of damaged structures and infrastructure could put considerable strain on local and regional government budgets. If floods cause sustained closures of major roadways, in addition to limited transportation and mobility, there is an array of community functions that may result in limited access, including access to essential services (e.g., grocery stores) and emergency services (e.g., emergency response inhibited by damaged roads). These impacts can also persist, especially if funding for maintenance and repair is limited. Flooding events resulting in disruption of communications, utilities (e.g., energy, water, sewage), and related delivery of services, excessive expenditures for emergency response, and general disruption of the normal functions across the unincorporated county can result in severe economic losses. Additionally, recreation opportunities can be adversely affected by major flood events, as some popular destinations tend to overlap with the unincorporated county's floodplains and areas that are prone to sea level rise and coastal inundation. The agricultural sector is also at increased risk of flooding induced by extreme precipitation events, especially as these events become more common as a result of climate change.

2.2.7 Drought and Water Supply

Increased average temperatures and abnormally dry years have previously affected water supplies in the region and will continue to occur in the future, though the exact timing and duration of droughts are difficult to predict. However, assuming that droughts are a hazard that the unincorporated county will continue to face and will likely be exacerbated because of climate change, their potential impacts on the unincorporated county's populations, built environment, and community functions still need to be considered.

POPULATIONS

The entire population of the county is vulnerable to prolonged drought periods and may be affected in a variety of ways, primarily indirectly. Drought may increase exposure to health hazards, including extreme heat events, flash flooding, degraded water quality, and reduced water quantity. Dust associated with drought conditions have been linked to increased incidents of Valley fever, a fungal pathogen (CDPH 2017). Water shortages during periods of drought can affect access to safe and relatively affordable water, with notably substantial impacts on low-income individuals and communities otherwise burdened with environmental pollution. Drought can lead to disruptions or shortages in food and water supply, increased costs, and the promotion of food- and water-borne diseases, which, in turn, could lead to hunger, obesity, malnutrition, and food insecurity among particularly vulnerable populations in the county (CDPH 2017). Additionally, drought leading to increased soil erosion and risk of wildfire can lead to degraded air quality, causing respiratory health problems and likely increasing the number of patients at local hospitals and health clinics.

BUILT ENVIRONMENT

The built environment in the unincorporated county will not experience substantial direct impacts associated with drought. However, prolonged drought conditions in the future have the potential to cause secondary impacts. For example, heavy precipitation following periods of drought can cause intense flooding, debris flows, landslides, and mudslides, which pose risks to the unincorporated county's built environment. Recently, for example, the storms in February of 2017, which followed an extended drought period and resulted in a Major Disaster Declaration, triggered intense landslides and mudslides across the region (County of Alameda 2022a). Additionally, drought-induced wildfires can also affect residential property, critical infrastructure, and other aspects of the unincorporated county's built environment.

COMMUNITY FUNCTIONS

Perhaps the most significant potential impacts of drought on the unincorporated county will be on its wide array of community functions. For one, the unincorporated county's agricultural sector is especially vulnerable to drought conditions, with the most notable consequences directly related to water availability for crop irrigation. A decrease in water availability could greatly reduce crop yields and overall levels of production in the unincorporated county and across the San Francisco Bay Area, especially when coupled with extreme heat. Higher soil erosion exacerbated by drought can also decrease agricultural production, resulting from agricultural lands becoming less fertile. Particularly dry soil conditions resulting from low stream flow and groundwater levels can increase the risk of wildfires, another threat to agricultural production. The above factors can lead to higher consumer costs for agricultural products, loss of income for the supply chain, and can enhance regional food security issues.

In addition to agriculture, drought may affect other local businesses and economic sectors, both directly and indirectly. The most significant economic impacts will likely be on industries that use or depend on water for their business or sector. Any water-use restrictions during times of drought can directly impact smaller-scale businesses that provide water-related services (e.g., power-washing). Essential product costs that increase because of drought (e.g., agricultural and energy products) can potentially discourage and reduce discretionary consumer spending in other industries, such as entertainment, dining, and retail. Recreational activities in the unincorporated county can be diminished as a loss of aquatic species, lower stream flows, increased evapotranspiration, and reduced reservoir and lake levels flows lead to less fishing, kayaking, and hiking, among other activities. Overall shifts in the unincorporated county's economic sectors as a result of drought can lead to unemployment, increased risk for financial institutions, capital shortfalls, and loss of tax revenue.

Drought can also result in adverse environmental effects. Some effects are short-term, where conditions quickly return to normal following a drought, but others can be long-term, lingering for long periods of time or even becoming permanent. For example, wildlife habitat may be degraded as a result of drought through the loss of wetlands, lakes, and vegetation, but many species will eventually recover. However, the drought-induced degradation of landscape quality, including high levels of soil erosion, may lead to a more permanent loss of biological productivity. Additionally, drought can trigger holistic ecosystem impacts and system failures. For example, the California live oak, which is a keystone species, can trigger widespread, disproportionally adverse impacts on its surrounding environment if negatively influenced by a prolonged drought event. In general, drought can influence tree mortality and loss of tree canopy, which in more densely populated areas of the unincorporated county, can heighten the urban heat island effect. Low streamflow, higher temperatures, and degraded water quality during times of drought can affect aquatic ecosystems, as well as terrestrial wildlife that rely on surface water, floodplains, wetlands, marshes, and surrounding soil and vegetation.

2.2.8 Summary of Sensitivity and Potential Impacts

Based on guidance from the APG, potential impacts from each climate change effect are rated on a qualitative scale of Low, Medium, or High. A description of each qualitative rating for potential impacts is provided in Table 1 at the beginning of Section 2.

The potential impacts rating for each climate change effect that is anticipated to impact the unincorporated county is shown in Table 10. This evaluation is based on the exposure analysis and analysis of sensitivities and impacts discussed in the previous sections.

Table 10 Potential Impacts Summary

Climate Change Effect	Potential Impacts Rating
Increased Wildfire Risk	High
Increased Temperatures and Extreme Heat	High
Extreme Precipitation and Flooding	Medium
Drought and Water Supply	Low/Medium

Source: Ascent 2022.

2.3 ADAPTIVE CAPACITY

The third step in the VA process is to evaluate the adaptive capacity of the populations, built environment, and community functions to adjust to climate change effects and their associated potential impacts. Adaptive capacity refers to a community's current and future ability to address climate-related impacts. A review of the County's existing policies, plans, programs, and resources, as well as those from relevant regional and State agencies and organizations, informed this assessment of the County's current ability to minimize vulnerability to hazards and adapt to climate change over the long-term. While there is some level of existing adaptive capacity, these efforts do not comprehensively identify all strategies and actions that will need to be implemented by the County and other agencies to adequately address the full scope and magnitude of potential impacts from climate change. Climate change will increase the frequency and severity of some hazards in the future, requiring updates to emergency response and land use planning, new policies and programs, and new strategic partnerships.

2.3.1 Existing State, Regional, and Local Planning Efforts

This section summarizes current State, regional, and local planning efforts that address climate-related hazards. It should be noted that though this section is comprehensive, it is not all-encompassing, as additional policies, plans, programs, and resources may be available that address climate-related hazards within the unincorporated county. This section serves as a high-level overview, and the planning efforts that are reviewed and summarized are arranged alphabetically.

2017 CLEAN AIR PLAN: SPARE THE AIR, COOL THE CLIMATE

Prepared by BAAQMD and adopted in 2017, the *2017 Clean Air Plan: Spare the Air, Cool the Climate* (Clean Air Plan) encompasses the entire San Francisco Bay Area, inclusive of Alameda County, and focuses on two closely related goals, which includes protecting public health and protecting the climate. The Clean Air Plan describes a multi-pollutant strategy to simultaneously reduce emissions and ambient concentrations of ozone, $PM_{2.5}$, toxic air contaminants, as well as GHGs that contribute to climate change. Additionally, it describes a vision for a thriving region with clean air, a stable climate, a robust natural environment, and a prosperous and sustainable economy (BAAQMD 2017).

2020 URBAN WATER MANAGEMENT PLAN: ZONE 7 WATER AGENCY

The *2020 Urban Water Management Plan: Zone 7 Water Agency* (Zone 7 UWMP) assesses the availability and reliability of Zone 7 Water Agency's (Zone 7's) water supplies and current and projected water use to help ensure reliable water service under different conditions, which is critical in the context of climate change and further development and growth. The Zone 7 UWMP is required to be updated every 5 years under the Urban Water Management Planning Act. Specifically, Zone 7 is a water wholesaler, meaning it sells water to other agencies, known as retailers, who then sell it to individual water users (e.g., residents and businesses). Many of these individual water users are within the unincorporated county; Zone 7 serves unincorporated areas of eastern Alameda County adjacent to Livermore, Pleasanton, and Dublin (Zone 7 Water Agency 2021).

2021 ALAMEDA COUNTY LOCAL HAZARD MITIGATION PLAN

The development of the LHMP was a collaborative effort by the County, the Alameda County Fire Department, and the Alameda County Flood Control and Water Conservation District (ACFCD). The goal of the LHMP is to identify and profile the broad array of hazards (including those examined in this VA) that faces the entire county, inclusive of the unincorporated county, assess risks posed by those hazards, and to develop prioritized strategies to reduce those risks. The LHMP serves as an update to the 2016 version of the LHMP and meets the requirements of the Disaster Management Act of 2000 (County of Alameda 2022a).

ADAPTING TO RISING TIDES, BAY AREA: REGIONAL SEA LEVEL RISE VULNERABILITY AND ADAPTATION STUDY

Prepared in March 2020, *Adapting to Rising Tides, Bay Area: Regional Sea Level Rise Vulnerability and Adaptation Study* (ART Bay Area Report) presents a story of what consequences the San Francisco Bay Area may face as sea levels rise in the absence of coordinated, prioritized adaptation efforts. The ART Bay Area Report represents a commitment by many agencies to proactively manage the functionality and sustainability of critical regional assets in an uncertain future, and it speaks directly to the San Francisco Bay Area's most critical regional transportation and land use plan, *Plan Bay Area 2050* (ART 2020).

ALAMEDA AND CONTRA COSTA COUNTY REGIONAL WILDFIRE PREVENTION PLAN

The focus of the *Alameda and Contra Costa County Regional Wildfire Prevention Plan* (RPP), developed in conjunction with the Alameda County Resource Conservation District (ACRCD) and the Contra Costa Resource Conservation District with funding from the California State Coastal Conservancy, is to identify and prioritize projects at the landscape- or watershed-level to address forest health and wildfire risks in the region. The RPP is intended to complement other existing fire planning documents covering Alameda County and was informed by consultation and collaboration with over 160 stakeholders, including local governments, private businesses, nonprofit organizations, and community members (ACRCD and CCRCD 2022).

ALAMEDA COUNTY EMERGENCY OPERATIONS PLAN

The EOP, developed in 2012 by the County, provides an overview of the County's approach to emergency operations. It identifies emergency response policies, describes the response and recovery organization, and assigns specific roles and responsibilities to County departments, agencies, and community partners. The EOP has the flexibility to be used for all emergencies and has been used to facilitate response and recovery activities in an efficient and effective way. The overarching, operational priorities identified in the EOP are to save lives, protect public health and safety, protect property, and preserve the environment. Many of the hazards Alameda County faces, inclusive of the unincorporated county, are assessed in the EOP, inclusive of those examined in this VA (County of Alameda 2012).

CAL FIRE SANTA CLARA UNIT: STRATEGIC FIRE PLAN

The *CAL FIRE Santa Clara Unit: Strategic Fire Plan* (SFP), prepared in 2022, identifies and prioritizes pre-fire and post-fire management strategies and tactics meant to reduce the loss of values at risk within the SRA and Mutual Threat Zones within the jurisdiction of the SCU, which includes the unincorporated county. Additionally, the SFP provides planning information on a SCU-wide scale, recognizes the variation in fuels, weather, topography, and community/agency priorities present in each area the SCU serves, and recommends measures to reduce the ignitability of structures throughout the SCU's jurisdiction (CAL FIRE 2022).

CALIFORNIA'S FOURTH CLIMATE CHANGE ASSESSMENT: SAN FRANCISCO BAY AREA REGION REPORT

As described in Section 1.4.2, "California's Fourth Climate Change Assessment," the SFBA Report, published in January 2019, is one of a series of nine regional climate vulnerability assessments in California that provides an overview of region-specific climate science and anticipated climate-related changes, specific strategies to adapt to climate impacts, and key research gaps needed to safeguard the region from climate change. The SFBA Report breaks down regional vulnerability by ecosystems and biodiversity, water resources, and communities and provides adaptation strategies applicable to the unincorporated county (OPR, CEC, and CNRA 2018b).

CALTRANS CLIMATE CHANGE VULNERABILITY ASSESSMENTS: DISTRICT 4 TECHNICAL REPORT

The *Caltrans Climate Change Vulnerability Assessments: District 4 Technical Report* (District 4 Report) was developed in 2018 for Caltrans and summarizes the climate change-specific vulnerabilities of the portion of the State Highway System located in Caltrans District 4, which encompasses the unincorporated county. The report is divided into sections by climate stressor (e.g., wildfire, temperature, precipitation) and each section presents how that climate stressor is changing, the data used to assess State Highway System vulnerabilities from that stressor, and the methodology for how that data was developed. Additionally, the District 4 Report outlines a recommended framework for prioritizing projects that might be considered by Caltrans in the future (Caltrans 2018).

CLIMATE CHANGE AND HEALTH PROFILE REPORT: ALAMEDA COUNTY

Primarily produced by the California Department of Public Health (CDPH), the *Climate Change and Health Profile Report: Alameda County* (CCHPR) seeks to provide a county-level summary of information on current and projected risks from climate change and potential health impacts. The CCHPR represents a synthesis of information on climate change and health for communities based on recently published reports of State agencies and other public data. It is part of a suite of tools that is being developed by CDPH to support local, regional, and statewide efforts of the public health sector to build healthy, equitable, resilient, and adaptive communities ready to meet the challenges of climate change (CDPH 2017).

COMMUNITY WILDFIRE PROTECTION PLAN 2015 UPDATE: ALAMEDA COUNTY

The *Community Wildfire Protection Plan 2015 Update: Alameda County* (CWPP) was prepared by the Diablo Fire Safe Council. The CWPP provides a comprehensive, scientifically-based analysis of wildfire related to the hazards and risk in the wildland-urban interface areas of Alameda County, inclusive of the unincorporated county. The CWPP follows the standards for community wildfire protection plans that have been established by the federal Healthy Forest Restoration Act by identifying and prioritizing fuel reduction opportunities across Alameda County, addressing structural ignitability, and collaborating with stakeholders (DFSC 2015).

SAN FRANCISCO BAY AREA INTEGRATED REGIONAL WATER MANAGEMENT PLAN

The *San Francisco Bay Area Integrated Regional Water Management Plan* (IRWMP), most recently updated in October 2019, represents an outgrowth of a collaborative process that began in 2004, when regional and local organizations in the San Francisco Bay Area signed a Letter of Mutual Understandings to develop the IRWMP. This nine-county effort aims improve water supply reliability, protect water quality, manage flood protection, and protect habitat and watershed resources across the region, inclusive of the unincorporated county (IRWMP 2019).

URBAN WATER MANAGEMENT PLAN 2020: EAST BAY MUNICIPAL UTILITY DISTRICT

The *Urban Water Management Plan 2020: East Bay Municipal Utility District* (EBMUD UWMP) serves as the East Bay Municipal Utility District's (EBMUD's) commitment to managing water demand efficiently using its water supplies to protect both its customers and its water and natural resources, and to ensure that the appropriate level of water service reliability is met given varied water demands during normal, dry, and multiple dry years. Similar to the Zone 7 UWMP, the EBMUD UWMP is required to be updated every 5 years under the Urban Water Management Planning Act. The water service area for EBMUD encompasses incorporated and unincorporated areas of both Alameda and Contra Costa counties, including the unincorporated communities of Ashland, Cherryland, Hayward Acres, San Lorenzo, and Castro Valley (EBMUD 2020a).

WATER SHORTAGE CONTINGENCY PLAN 2020: EAST BAY MUNICIPAL UTILITY DISTRICT

The *Water Shortage Contingency Plan 2020: East Bay Municipal Utility District* (EBMUD WSCP), which is incorporated as an attachment in the EBMUD UWMP, provides a framework to help address water shortages that may occur in the future, especially in the context of climate change. The EBMUD WSCP considers a wide range of possible future scenarios considering aspects of water resources including supply and demand. It defines an orderly process for collecting information on water supply availability, assessing conditions, determining fiscal actions, allocating resources, enforcing water use restrictions, monitoring customer response, and planning and implementing drought communications. It also describes EBMUD's planned actions to manage supply and demand before and during a water shortage to ensure a reliable water supply (EBMUD 2020b).

SUMMARY OF EXISTING PLANS AND REPORTS

Table 11 identifies the specific climate change effects covered under each of the plans and reports presented above. As shown in the table, multiple planning efforts address the climate-related impacts that are expected to affect the unincorporated county. Most of the policies provided in existing plans are broad-based strategies to reduce risk from climate change. Thus, it is important to note that an emphasis on specific and targeted policies should continue to be developed to improve the resilience of the most vulnerable populations and assets in the unincorporated county.

Table 11 Summary of Existing Plans and Reports

Plan or Report	Prepared By	Climate Change Effects			
		Increased Wildfire Risk	Increased Temperatures and Extreme Heat	Extreme Precipitation and Flooding	Drought and Water Supply
2017 Clean Air Plan: Spare the Air, Cool the Climate	BAAQMD	✓	✓		✓
2020 Urban Water Management Plan: Zone 7 Water Agency	Zone 7			✓	✓
2021 Alameda County Local Hazard Mitigation Plan	County	✓	✓	✓	✓
Adapting to Rising Tides, Bay Area: Regional Sea Level Rise Vulnerability and Adaptation Study	BCDC			✓	
Alameda and Contra Costa County Regional Wildfire Prevention Plan	ACRCD and CCRCD	✓			✓
Alameda County Emergency Operations Plan	County	✓	✓	✓	✓
CAL FIRE Santa Clara Unit: Strategic Fire Plan	CAL FIRE	✓			✓
California's Fourth Climate Change Assessment: San Francisco Bay Area Region Report	OPR, CEC, and CNRA	✓	✓	✓	✓

Plan or Report	Prepared By	Climate Change Effects			
		Increased Wildfire Risk	Increased Temperatures and Extreme Heat	Extreme Precipitation and Flooding	Drought and Water Supply
Caltrans Climate Change Vulnerability Assessments: District 4 Technical Report	Caltrans	✓	✓	✓	
Climate Change and Health Profile Report: Alameda County	CDPH	✓	✓	✓	✓
Community Wildfire Protection Plan 2015 Update: Alameda County	DFSC	✓			✓
San Francisco Bay Area Integrated Regional Water Management Plan	Collaborative Effort; No Distinct Author			✓	✓
Urban Water Management Plan 2020: East Bay Municipal Utility District	EBMUD			✓	✓
Water Shortage Contingency Plan 2020: East Bay Municipal Utility District	EBMUD				✓

Notes: ACRCD and CCRCD = Alameda County Resource Conservation District and Contra Costa Resource Conservation District; BAAQMD = Bay Area Air Quality Management District; BCDC = Bay Conservation and Development Commission; CAL FIRE = California Department of Forestry and Fire Protection; Caltrans = California Department of Transportation; County = County of Alameda government; CDPH = California Department of Public Health; DFSC = Diablo Fire Safe Council; EBMUD = Easy Bay Municipal Utility District; OPR, CEC, and CNRA = California Governor's Office of Planning and Research, California Energy Commission, and California Natural Resources Agency; Zone 7 = Zone 7 Water Agency.

Source: Ascent 2022.

The following sections, organized by climate change effect, provide a snapshot of current adaptive efforts in place to address the impacts of climate change, and thus, may not represent the entirety of adaptive efforts. These evaluations serve to analyze and ultimately score adaptive capacity related to each climate change effect. Based on a combination of the adaptation initiatives outlined in the documents described above and additional adaptive efforts that have been pursued, the unincorporated county's adaptive capacity for each climate change effect can be rated "Low," "Medium," or "High." High adaptive capacity indicates that sufficient measures are already in place to address the points of sensitivity and impacts associated with climate change, while a Low score indicates a community is unprepared and requires major changes to address hazards. Adaptive capacity ratings are defined in Table 2.

2.3.2 Adaptive Efforts Related to Increased Wildfire Risk

Fueled by climate change, increased wildfire risk through the end of the century directly or indirectly threatens nearly all the unincorporated county's residents and visitors, buildings and infrastructure, and community functions. Three of the primary documents that highlight efforts to reduce the risk of wildfire in the unincorporated county are the RPP, the SFP, and the CWPP, which are discussed further below.

ALAMEDA AND CONTRA COSTA COUNTY REGIONAL WILDFIRE PREVENTION PLAN

The RPP identifies eight regional priorities to address forest health and wildfire risks within its focus area (including unincorporated areas of the county), which are based on stakeholder input (e.g., representatives from local governments, nonprofit organizations, private businesses, educational institutions, State agencies). The eight priorities are as follows: 1) equipment and personnel capacity building; 2) fundraising capacity building; 3) broadening prescribed burning capacity; 4) fire education and outreach; 5) fuel reduction project support; 6) long-term planning and management; 7) resource sharing; and 8) post-fire recovery planning and preparation. Within these priorities, the RPP has identified an array of new projects, along with hundreds of pre-existing project proposals from complementary stakeholder plans, that should be implemented over the coming years and sets forth an action plan in securing funding for these projects (ACRCD and CCRCD 2022).

CAL FIRE SANTA CLARA UNIT: STRATEGIC FIRE PLAN

The SFP identifies pre-fire management strategies, which refers to all activities undertaken by county land managers, property owners, agencies, and fire departments intended to reduce the risk of wildfire and resulting suppression costs and to minimize the resulting damage to lives, property, and the environment. These strategies include fire prevention, information and education, defensible space fuel treatment tactics, and resource management. Regarding fire prevention, the Fire Prevention Bureau of the SCU works diligently to determine the cause of all fires with the assistance of engine company officers. By understanding what the causes are, it allows the SCU to focus on education, enforcement, and patrol activities in a more efficient way. Regarding information and education, CAL FIRE's Fire Safety Education programs are spread throughout the jurisdiction of the SCU and come in the form of fair exhibits, school presentations, station tours, posters, flyers, radio and television announcements, community meetings, and social media, among others. The SCU makes it a priority that residents within their jurisdiction are informed to the dangers of wildfire. Regarding defensible space fuel treatment tactics, CAL FIRE has published guidelines that should be reviewed by homeowners within the jurisdiction of the SCU. Lastly, regarding resource management, CAL FIRE has several programs to assist private landowners, non-governmental organizations, and other agencies in the region to achieve their resource management goals, including the Vegetation Management Program, the Vegetation Treatment Program, the California Climate Initiative Fire Prevention Grant Program, and the California Climate Initiative Forest Health Grant Program, among others (CAL FIRE 2022).

COMMUNITY WILDFIRE PROTECTION PLAN 2015 UPDATE: ALAMEDA COUNTY

The CWPP is focused on four broad categories of wildfire mitigation: 1) information, education and collaborative planning priorities; 2) enhanced suppression capability and emergency preparedness priorities; 3) fuel reduction treatments around homes and on public lands and related priorities; and 4) improving survivability of structures priorities. Action plan summaries are provided within the CWPP for a selection of priority activities and identification of implementation steps, leads and partners, timeframes, and funding needs. Some of the priority activities include, but are not limited to, creating effectiveness awareness campaigns for residents (e.g., using existing communication campaigns and systems as models), evacuation planning, monitoring forest health (e.g., using remote sensing technologies to develop aerial photo imagery, making products available to fire departments to pinpoint locations of higher risk), volunteer projects on public lands, balancing fuel load management with biological resource protection, education and training on structure retrofits, and access and egress improvements by reducing road restrictions. To ensure long-term success of the CWPP, the Diablo Fire Safe Council and other project partners have agreed to roles in monitoring implementation of the plan and for updating the plan in future years.

OTHER EFFORTS

In addition to RPP, SFP, and CWPP as foundational wildfire planning documents, the County's LHMP also identifies numerous recommended wildfire mitigation actions to further boost the unincorporated county's resilience. Some of these actions include retrofitting existing critical facilities through ignition-resistant construction, creating both online and offline public outreach campaigns for Red Flag warnings, continuing implementation of the Defensible Space Fuel Reduction Program, developing a countywide structure ignition zone assessment program for homeowners where mitigation specialists visit interested homeowners to develop a comprehensive report that recommends mitigation actions to take, and expanding the "rent-a-goat" program to control vegetation to reduce fire fuels, among others. The Alameda County Fire Department offers a variety of trainings to provide community members with the tools and resources to become better prepared during a large-scale emergency or disaster, such as wildfires (ACFD 2022). These trainings include personal emergency preparedness workshops and Community Emergency Response Team (CERT) training. To better prepare residents and frequent visitors to the county, the County has a mass notification system that individuals can opt into known as "AC Alert," which is intended to share critical information quickly during unexpected events or emergencies, including wildfires. AC Alert can send alerts by voice, text, email, social media posts, and wireless alerts from the Federal Emergency Management Agency (FEMA) (County of Alameda 2022b). To address wildfire smoke and poor air quality, the *Alameda County Air Quality Communications Protocol* serves as an action guide for County agencies when Air Quality Index levels reach unhealthy levels to aid tracking and mitigation efforts (County of Alameda 2021).

ADAPTIVE CAPACITY RATING: HIGH

The County has a wide range of robust plans, programs, and tools established that are intended to reduce the risk of wildfires in the unincorporated county from a variety of standpoints, including prevention, preparedness, response, and recovery. Additionally, the County acknowledges that climate change may increase the risk of wildfires in the future and has developed plans and intends to implement additional mitigation actions in accordance with this. Though the potential impacts associated with wildfire in the context of climate change are severe, and there are certain limitations that are prevalent in existing plans, the County and partner agencies and organizations have demonstrated a high level of commitment in making the unincorporated county more resilient to wildfires and knows that implementation of related plans and programs must be consistently evaluated and revised, as needed. The high levels of stakeholder engagement that have been conducted, and are still ongoing, for current wildfire plans and programs displays the County's devotion and sense of responsibility towards protecting its citizens and visitors. The County should continue expanding this engagement and emphasizing equity to ensure that all populations are able to provide input to inform future iterations of plans and programs, including those who are most vulnerable and hard to reach, such as those who reside in the identified Priority Communities for the forthcoming Environmental Justice Element of the General Plan (i.e., 16 unincorporated census tracts in Ashland, Cherryland, Hayward Acres, Castro Valley, and San Lorenzo). Because of the reasons described, the adaptive capacity rating for increased wildfire risk is high.

2.3.3 Adaptive Efforts Related to Increased Temperatures and Extreme Heat

Increased temperatures and extreme heat can be particularly dangerous in the summer months, especially in the context of climate change. To provide relief from extreme heat, the County maintains a list of cooling centers, which are air-conditioned facilities such as libraries, senior centers, and community centers (County of Alameda 2022c). Residents and visitors that may not have other means to cool down can utilize this list to see when and where cooling centers are open. The County also maintains a heat vulnerability StoryMap that maps the social and environmental factors that contribute to extreme heat vulnerability across the entire county. The map is intended to be used by County agencies, planners, community organizations, and others to support their efforts to assess and respond to the impacts of extreme heat, with particular attention to neighborhoods and demographics that are disproportionately affected, such as those with access and functional needs, along with the built environment (County of Alameda 2022d). Within the LHMP, the County has identified a mitigation action to prepare an Environmental Justice Element for the General Plan, which will address the requirements of SB 1000, including environmental impacts related to climate change (e.g., extreme heat) and how they disproportionately impact Environmental Justice communities (County of Alameda 2022a). At the time of writing this VA, the development of the Environmental Justice Element for 16 Priority Community census tracts in the unincorporated areas of Ashland, Cherryland, Hayward Acres, Castro Valley, and San Lorenzo is currently in process. Additionally, the LHMP calls for an expansion of "Cooling Our Communities", a program of the Alameda County CDA Planning Department, Public Health Department, and General Services Agency Office of Sustainability. From 2019 to 2022, this pilot program developed an extreme heat adaptation pocket guide and planted free shade trees for residents and business owners in the unincorporated Eden Area, helping to reduce urban heat island effect and reducing energy bills over the life of the trees. The County worked with local community organizers to keep community engagement and local leadership development at the root of extreme heat preparedness and the free shade tree program. As part of this program, a diverse group of Eden Area residents was trained to participate as "Cooling Ambassadors," engaging in neighbor-to-neighbor outreach and encouraging extreme heat preparedness and participation in the free shade tree program (County of Alameda 2022e).

In addition to the above adaptive efforts to increased temperatures and extreme heat, the County provides an array of resources across its various websites that serve as reliable extreme heat-related information sources for residents and visitors, including information on heat stroke and other heat-related illnesses, how to prepare for and respond to extreme heat at the individual level, and a repository for an array of external sources. Additionally, while PSPS events were identified as a potential impact for increased temperature and extreme heat, especially to vulnerable populations, they are also a necessary adaptive effort during periods of sustained extreme heat and increased wildfire risk to reduce the risk of accidental wildfire ignition. PG&E provides updates in anticipation of and during a PSPS event regarding when power will be turned off and when power will be restored so affected individuals can plan accordingly. Similar to wildfire alerts, extreme heat alerts are issued through AC Alert, the County's mass notification system that residents and visitors can opt into.

ADAPTIVE CAPACITY RATING: MEDIUM

Through several programs, the County acknowledges and demonstrates its understanding of the risk increased temperatures and extreme heat presents, especially to its populations. Though portions of the unincorporated county have a historically temperate climate, increased temperatures as a result of climate change will present heat-related challenges that have not previously been felt at large scales. Community-driven programs, such as Cooling Our Communities (though this specific program is no longer being funded), along with the upcoming completion of the Environmental Justice Element of the General Plan, can help build resilience among populations that are particularly vulnerable to the impacts of extreme heat. However, extreme heat is a problem that will likely grow exponentially over time, and this is especially concerning for residents that may not have access to air conditioning (e.g., lack of air conditioning system, financial barriers) or awareness of nearby cooling centers, along with vulnerable buildings and infrastructure that are not constructed for higher temperatures and community functions that are particularly susceptible to the impacts of extreme heat (e.g., agriculture). Acknowledging the County's current efforts to address extreme heat, further efforts will be needed in the context of climate change, as current adaptive efforts may not be enough to address extreme heat in the future, not only to protect vulnerable populations, but also the unincorporated county's built environment and community functions. For these reasons, the County's adaptive capacity rating for increased temperatures and extreme heat is medium.

2.3.4 Adaptive Efforts Related to Extreme Precipitation and Flooding

Flooding in the unincorporated county is projected to be exacerbated by climate change, both due to extreme precipitation and sea level rise. The IRWMP serves as one of the San Francisco Bay Area's foundational plans, inclusive of unincorporated areas of the county, specifically dedicated to improving regional flood management. The IRWMP's goals include managing floodplains to reduce flood damages to homes, businesses, schools, and transportation; achieving effective floodplain management that incorporates land use planning and minimizes risks to health, safety, and property by encouraging wise use and management of flood-prone areas; and identifying and promoting integrated flood management projects to protect vulnerable areas (IRWMP 2019). The ART Bay Area Report also serves as one of the foundational plans for the region, particularly related to the risks posed by sea level rise, including coastal flooding. It provides an array of adaptation responses that require coordination by local and regional stakeholders, should be initiated by regional stakeholders or through a regional process, or consist of best practices for local jurisdictions to help address the common, regionally significant vulnerabilities identified with the report (ART 2020). Additionally, many of the water suppliers/wholesalers within the unincorporated county are engaged in an array of flood protection activities. For example, Zone 7 manages a 37-mile network of streams and flood channels that protects communities should storms strike. With ongoing implementation of their Flood Protection Program, Zone 7 is developing a more integrated approach to channel stormwater more effectively. The long-term vision is to replace the largely engineered arroyo system with a porous chain of lakes, allowing them to detain stormwater for other beneficial uses along with other conceptual projects to continuously improve levels of preparedness and resiliency.

In addition to the above, ACFCD, through the Alameda County Public Works Agency (ACPWA), administers flood control programs and services including the planning and delivery of projects, and maintenance and operations of flood control facilities across western portions of Alameda County, inclusive of unincorporated areas. Some of the core programs and services include the flood control major maintenance program, the flood control system enhancement program, the flood control environmental restoration program, and the flood control watershed planning program. The purpose of the flood control major maintenance program is to rehabilitate flood control infrastructure that cannot be repaired through minor routine maintenance efforts. The purpose of the flood control system enhancement program is to construct projects that improve or enhance the flood control system by increasing the containment and conveyance capacity of the system. Most system components, such as culverts, open channels, levees, floodwalls, and pump stations must be designed to meet current FEMA design criteria for containing 100-year storm events. The flood control environmental restoration program consists of projects that restore flood control infrastructure through bioengineering that return human-made channels to a more natural state, enhance the habitat of creek ecosystems or improve the water quality of creeks, remove barriers to migratory fish which depend on these creeks for spawning, and that implement new creek-side trails in urban areas. The flood control watershed planning program is designed to study and assess flood control infrastructure by performing hydrologic and hydraulic modeling of drainage networks and facilities, identifying deficiencies in ACFCD's open channels, closed conduit systems, and pump stations that could cause flooding (ACPWA 2022).

The County joined the National Flood Insurance Program (NFIP) in 1981, which aims to reduce the impact of flooding on residential and nonresidential buildings by providing insurance to property owners and encouraging communities to adopt and enforce floodplain management regulations. As part of the NFIP, the County enforces a floodplain management ordinance and participates in FEMA's Community Assisted Visits where FEMA audits the County's floodplain management program every 3-5years. Further, the LHMP identifies an array of recommended mitigation actions related to unincorporated county flooding, including installing passive floodproofing measures in critical facilities that cannot be elevated; developing and expanding an outreach program to educate property owners about the adjustments in flood zones due to levees; continuing to implement green infrastructure; continuing to repair and make structural improvements to storm drains, channels, levees, and pump stations; and establishing design standards, guidelines, and setback requirements for development on properties that abut creeks and waterways and require the replanting and restoration of riparian vegetation (County of Alameda 2022a). Also, similar to wildfire and extreme heat alerts, flood alerts are issued through AC Alert, the County's mass notification system that residents and visitors can opt into.

ADAPTIVE CAPACITY RATING: MEDIUM

The County has adequately assessed the risks of extreme precipitation and flood events. In general, the County and/or regional partners have developed, adopted, and enforced several robust plans, policies, and programs that will serve to mitigate impacts associated with increased intensity and frequency of floods in the future, and substantial flood mitigation operations are currently in place. Noting the County's current adaptive efforts and planned efforts in the future, the risk of flooding due to the increased frequency of extreme precipitation events, coupled with sea level rise, is notable, and many of these efforts may require modification in the future as a result of climate change, especially as it pertains to vulnerable populations and community functions. Because of the reasons described, overall, the County's adaptive capacity rating associated with extreme precipitation and flooding is medium.

2.3.5 Adaptive Efforts Related to Drought and Water Supply

Past drought conditions across the county, especially more recent severe and prolonged droughts, have highlighted the importance for the County to prepare for future droughts exacerbated by climate change that will likely affect water supply availability and result in other cascading effects. Water suppliers/wholesalers in unincorporated areas of the county, such as EBMUD and Zone 7, have developed urban water management plans and water shortage contingency plans to ensure that customers have sustainable and reliable water supplies, even in the context of climate change and the existence of prolonged regional droughts. The LHMP identifies and recommends several drought-related mitigation actions to be taken in the near future, such as replacing deteriorating water storage tanks and/or installing more water storage tanks to be available for use during periods of prolonged droughts and continuing to implement green infrastructure and low-impact development projects to capture stormwater and harvest rainwater. The development of the Environmental Justice Element of the General Plan, which is currently in process, will address environmental impacts related to climate change, such as drought, and how they disproportionately impact Environmental Justice communities.

Additionally, the County has enacted an array of measures to conserve water. For instance, equipment upgrades and new maintenance practices associated with the ACPWA have resulted in significant water use reduction, including the discontinued use of potable water for roadway median turf irrigation; reducing watering schedules for corporation yards, roadway medians, and parkway landscaping; and reducing washing of vehicles at corporation yards. The County has bolstered design standards and requirements for new construction projects, including requiring the use of water efficient irrigation methods, replacing turf landscaping with drought tolerant options, and ensuring that landscape elements are designed in accordance with the Water Efficient Landscaping Ordinance, as outlined in Chapter 17.64 to Title 17 of the Alameda County General Ordinance Code. The County has adopted multiple water conservation codes and ordinances related to its local government operations (County of Alameda 2022f). Further, the County provides an array of resources across its various websites that serve as reliable drought and water supply-related information sources for residents and visitors, including water conservation best practices. To supplement the County's efforts, StopWaste, a public agency, helps Alameda County businesses, residents, and schools use water and energy more efficiently.

ADAPTIVE CAPACITY RATING: MEDIUM

The County understands the implications of drought on water supplies and other associated impacts. The undertaking of urban water management plans, water shortage contingency plans, and other plans and programs will assist the County in building resilience to future drought conditions. These plans and programs have taken necessary steps to mitigate the risk of inadequate water supplies, although it will be important for the County to continue and increasingly plan for drought, as drought is likely going to be exacerbated by climate change in the future, and drought-related water supply issues can become even more pronounced in the context of a growing population. The potential impacts of drought, especially on community functions, can be severe and long-lasting. However, because of the County's plans and programs already in place, along with its demonstrated understanding of measures it can or should take in the future related to drought, the adaptive capacity rating for drought and water supply is medium.

2.3.6 Summary of Adaptive Capacity

Table 12 summarizes the County's adaptive capacity regarding each climate change effect. Like the potential impacts rating evaluation, the scoring of adaptive capacity allows the County to better understand priority areas where there are gaps in preparing for and adapting to climate change. Adaptive capacity scoring is described in Table 2 at the beginning of Section 2.

Table 12 Adaptive Capacity Summary

Climate Change Effect	Adaptive Capacity Rating
Increased Wildfire Risk	High
Increased Temperatures and Extreme Heat	Medium
Extreme Precipitation and Flooding	Medium
Drought and Water Supply	Medium

Source: Ascent 2022

2.4 VULNERABILITY SCORING

The final step in the VA is to characterize the unincorporated county's vulnerability to each climate change effect, which is based on the magnitude of risk to and potential impacts on populations, the built environment, and community functions, while considering the current adaptive capacity in place to mitigate these impacts. Based on the ratings of potential impacts and adaptive capacity, an overall vulnerability score on a scale of 1 to 5 can be determined for each climate change effect. As noted at the beginning of Section 2, higher vulnerability scores (5 being the highest) indicate that a climate change effect should be prioritized sooner than those with lower scores (1 being the lowest). This scoring can be used to inform the development and prioritization of adaptation strategies included in the CCAP, and it can also help the County understand which effects pose the greatest threats and should be emphasized in future planning efforts. Table 3 in Section 2 presents the rubric used to determine overall vulnerability scores based on the ratings for potential impacts and adaptive capacity.

Vulnerability scoring for each climate change effect identified and evaluated in Sections 2.1 through 2.3 is included in Table 13 below. Table 13 shows that increased temperatures and extreme heat is assigned a vulnerability score of 4, which means it should be a high priority for the County. Increased wildfire risk and extreme precipitation and flooding are both assigned a vulnerability score of 3, which means it should be prioritized next in the County's adaptation- and planning-related efforts. These climate change effects could potentially have significant impacts on the unincorporated county's populations, built environment, and community functions in the near-term to midterm, and although a variety of adaptive efforts related to both climate change effects are already in place, the magnitude or risks posed by these hazards contributes to higher vulnerability in the unincorporated county. Drought and water supply is characterized as having a vulnerability rating of 2-3. This climate change effect is currently being addressed adequately based on existing conditions, but as droughts potentially become more severe in future years and water supplies start to become less reliable, additional adaptation and resilience planning will be required in the future to mitigate potential impacts and protect the unincorporated county.

Table 13 Vulnerability Scoring Summary

Climate Change Effect	Vulnerability Score		
	Adaptive Capacity	Potential Impact	Vulnerability
Increased Wildfire Risk	High	High	3
Increased Temperatures and Extreme Heat	Medium	High	4
Extreme Precipitation and Flooding	Medium	Medium	3
Drought and Water Supply	Medium	Low/Medium	2-3

Source: Ascent 2022.

2.5 CONCLUSION

The County, regional and State agencies, and other stakeholder groups have already implemented a variety of initiatives to address climate change in the unincorporated county through existing plans, policies, programs, and actions. As climate change continues to exacerbate risks and impacts from wildfire, increased temperatures and extreme heat, extreme precipitation and flooding, and drought, it is critical that the County continues to develop and implement adaptation strategies to mitigate these risks. The County's CCAP includes adaptation and resilience strategies and measures that were developed based on the findings of this report. These initiatives serve to address the climate-related hazards identified throughout the adaptation planning process and prioritize strategies that will be effective, feasible, cost-appropriate, and include additional social, environmental, economic, and technological benefits.

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