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Subject: City of Rancho Cordova Climate Action Plan - Draft Vulnerability Assessment

1 INTRODUCTION

Global climate change is projected to exacerbate the impacts of certain hazards that the City of Rancho Cordova (City) is already exposed to under current conditions. These hazards include indirect impacts from wildfires and effects on air quality, extreme heat, heat wave events, long-term drought, and flooding. While many of these hazards have existed historically for the City, the frequency and intensity of these hazards will increase as a result of global climate change. This Vulnerability Assessment (VA) serves to identify and analyze impacts of climate change that will most directly affect the City. The VA includes a climate change vulnerability assessment and serves to inform development of adaptation strategies by analyzing the City's exposure to existing hazards, sensitivity to these hazards, potential climate-related impacts from these hazards, and the City's existing capacity to prepare and adapt for these impacts, known as adaptive capacity.

1.1 CLIMATE CHANGE MITIGATION AND ADAPTATION

The effects of climate change are already being experienced today. The combustion of fossil fuels, among other human activities, since the Industrial Revolution in the 19th century has introduced greenhouse gases (GHGs) into the atmosphere at an accelerated pace, intensifying the greenhouse effect and leading to a trend of warming of the Earth's climate, known as global climate change or global warming. Climate change has more recently become a priority on an international, national, and local scale as recent climate data reveal more extreme weather patterns, increased average global temperatures, and the rapid melting of the Earth's Artic and Antarctic poles and glaciers.

The Intergovernmental Panel on Climate Change (IPCC), the international body charged with compiling and interpreting the data surrounding climate change, estimates that global average temperatures will increase by 3.7 degrees Celsius (°C) (6.7 to 8.6 degrees Fahrenheit [°F]) by the end of the century unless additional efforts to reduce GHG emissions are made (IPCC 2014). A more recent IPCC report indicates that average global temperatures will likely increase by 1.5 °C (2.7 °F) between 2030 and 2052 if global GHG emissions continue their current rate (IPCC 2018). There is consensus among the scientific community that a 1.5 °C (2.7 °F) rise in global temperatures will likely cause catastrophic environmental disasters in certain locations including extreme heat, sea-level rise, and more severe and damaging precipitation events. These changes to Earth's climate would contribute to more frequent storms and flooding, the displacement of coastal and tropical populations, food and water insecurity, catastrophic wildfire events, economic hardships, loss of biological resources, increased spread of vector-borne diseases, and degraded ambient air quality (IPCC 2018).

In August 2021, IPCC released the Six Assessment report which assess scientific, technical, and socio-economic information concerning climate change. In this report, the IPCC states that observed increases in GHG concentrations in the atmosphere since around the year 1750 are unequivocally caused by human activities. As a result, Each of the last four decades has been successively warmer than any decade that preceded it since 1850 (IPCC 2021). The findings of highlight key new insights into the importance of global climate tipping points, thresholds in the global climate (e.g., global temperatures) that, when exceeded, can lead to large changes in the state of the climate system with one impact rapidly leading to a series of cascading events.

The Six Assessment report contains the body's strongest warnings yet on the causes and impacts of climate change. Importantly, the report notes that, in terms of solutions, "We need transformational change operating on processes and behaviors at all levels: individual, communities, business, institutions and governments. We must redefine our way of life and consumption (IPCC 2021)."

Efforts that focus on reducing the sources of climate change are termed climate change mitigation, GHG mitigation, or climate action. Efforts to reduce harm from the effects of a changing climate, are referred to as climate adaptation and resilience. Figure 1 illustrates the relationship between these two approaches. State law requires communities to address climate change mitigation in local planning and environmental review processes and climate adaptation in local long-range planning processes, such as general plans (CalOES 2020). Included below is a summary of the State requirements to address climate adaptation as part of the local planning process.

- Senate Bill 379 – This bill 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
- Assembly Bill 747 – Requires the safety elements for cities and counties to be reviewed and updated as necessary to identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios upon the next revision of a local hazard mitigation plan on or after January 1, 2022, or beginning on or before January 1, 2022 if a local jurisdiction has not adopted a local hazard mitigation plan.
- Senate Bill 99 - This bill requires cities and counties, upon the next revision of the housing element on or after January 1, 2020, to review and update the safety element to include information identifying residential developments in hazard areas that do not have at least 2 emergency evacuation routes.
- Senate Bill 1035 – This bill requires cities and counties to revise the safety element upon each revision of the housing element or local hazard mitigation plan, but not less than once every 8 years, to identify new information relating to flood and fire hazards and climate adaptation and resiliency strategies applicable to the city or county that was not available during the previous revision of the safety element.

Source: CalOES 2020, adapted by Ascent Environmental in 2021.

Figure 1 Relationship Between Climate Mitigation and Adaptation

1.2 GUIDANCE DOCUMENTS

This section provides a summary of the guidance documents and resources that were used to help develop the VA.

California Adaptation Planning Guide

The most recent version of the California Adaptation Planning Guide (APG) was released in March 2020. This guidance builds upon the first iteration of the APG released in 2012. The APG was developed by the California Office of Emergency Services (CalOES) and California Natural Resources Agency (CNRA). The APG provides guidance to local governments for adaptation and climate change resiliency planning. The APG includes a step-by-step process that communities may use to help 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 (CalOES 2020).

California's Fourth Climate Assessment

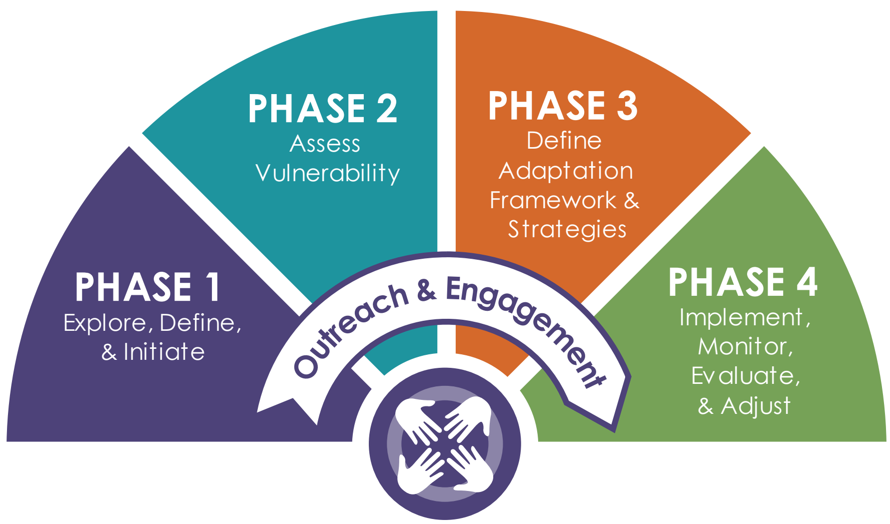
CNRA, the Governor's Office of Planning and Research (OPR), and the California Energy Commission (CEC) prepared California's Fourth Climate Change Assessment (Climate Assessment) in 2018. The Climate Assessment was designed to address critical information gaps that decisionmakers at the State, regional, and local levels need to close to protect and build the resilience of people, infrastructure, natural systems, working lands, and waterways from climate-related impacts. The Climate Assessment also includes regional reports which analyze and discuss the impacts to specific regions in the state. The regional report for the City and County is the California's Fourth Climate Change Assessment Sacramento Valley Region Report (Regional Report). The Climate Assessment and Regional Report are referenced throughout this VA to provide information regarding regional climate change impacts.

Safeguarding California Plan

Alongside the update to the Climate Assessment, CNRA released the Safeguarding California Plan in 2018 which provides a roadmap for State government action to build climate resilience. The Safeguarding California Plan identifies actions the State government will take to protect communities, infrastructure, services, and the natural environment from climate change impacts and includes strategies for use as local examples for climate adaptation.

1.3 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 their specific climate vulnerabilities and provides guidance on developing strategies to reduce climate change-related risks and prepare for current and future impacts of climate change.



Source: CalOES 2020, adapted by Ascent Environmental in 2021.

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, natural resources, and community assets. The vulnerability assessment is composed of four steps: exposure, sensitivity 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.
- Phase 4, "Implement, Monitor, Evaluate, and Adjust," the adaptation framework is implemented, consistently monitored, evaluated, and adjusted based on continual learning, feedback, or triggers. The adaptation planning process is intended to be cyclical in nature. Adaptation goals and strategieswill be included in the City's CAP which will contain a chapter that enumerates implementation planning policies. This section of the CAP will guide the implementation, monitoring, and evaluation of the adaptation policies.

The ultimate goal of the adaptation planning process is to improve community resilience in the face of a changing climate. A resilient community is one that is prepared for current and future hazardous conditions and experiences less harm when a disaster happens. Resilient communities can prepare for and recover from hazards with an understanding that the climate is going to continue to change in predictable and unforeseen ways. Ongoing learning and monitoring of strategy implementation allow for adjustments to be made in response to new information and opportunities.

2 VULNERABILITY ASSESSMENT

This section provides a comprehensive assessment of the City's vulnerabilities to climate change. It identifies and characterizes the climate-related hazards and other climate effects that are anticipated to affect the City. The vulnerability assessment 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 City and how changes in climate variables (e.g., average temperature, precipitation) are projected to affect these hazards. Existing hazards that can be worsened by the effects of climate change are identified and described, based on historical data from sources such as the City's Local Hazard Mitigation Plan.

Sensitivity and Potential Impacts: This step identifies a list of population groups and community assets that are sensitive to localized climate impacts. Climate-related hazards (e.g., flooding, wildfire) are generally projected to increase in severity, with the potential for climate change to 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 understand how sensitive populations and assets may be affected by climate impacts. Each hazard included in the VA is analyzed and given a qualitative score based on the criteria listed below in Table 1.

Table 1 Potential Impact Scoring

Score	Potential Impact
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: CalOES 2020.

Adaptive Capacity: The City, partner agencies, and regional organizations (e.g., Sacramento County, Sacramento Area Council of Governments) have already taken steps to build resilience and protect sensitive populations and assets from existing hazards. A full summary of partner agencies and regional organizations and their climate adaptation-related work is included in Section 2.6 "Adaptive Capacity". Thus, the purpose of this step is to identify the City's and partner agencies' current capacity to address future climate impacts, referred to as adaptive capacity. The ability of the City 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 ratings are described in Table 2.

Table 1 Potential Impact and Adaptive Capacity Scoring

Score	Adaptive Capacity
Low	The population or asset lacks capability to manage climate impact; major changes would be required.
Medium	The population or asset has some capacity to manage climate impact; some changes would be required.
High	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

Source: CalOES 2020.

Vulnerability Scoring: This step determines the City's priority climate vulnerabilities through a scoring process. 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. Table 3 presents the rubric used to determine the overall vulnerability scores based on the 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		

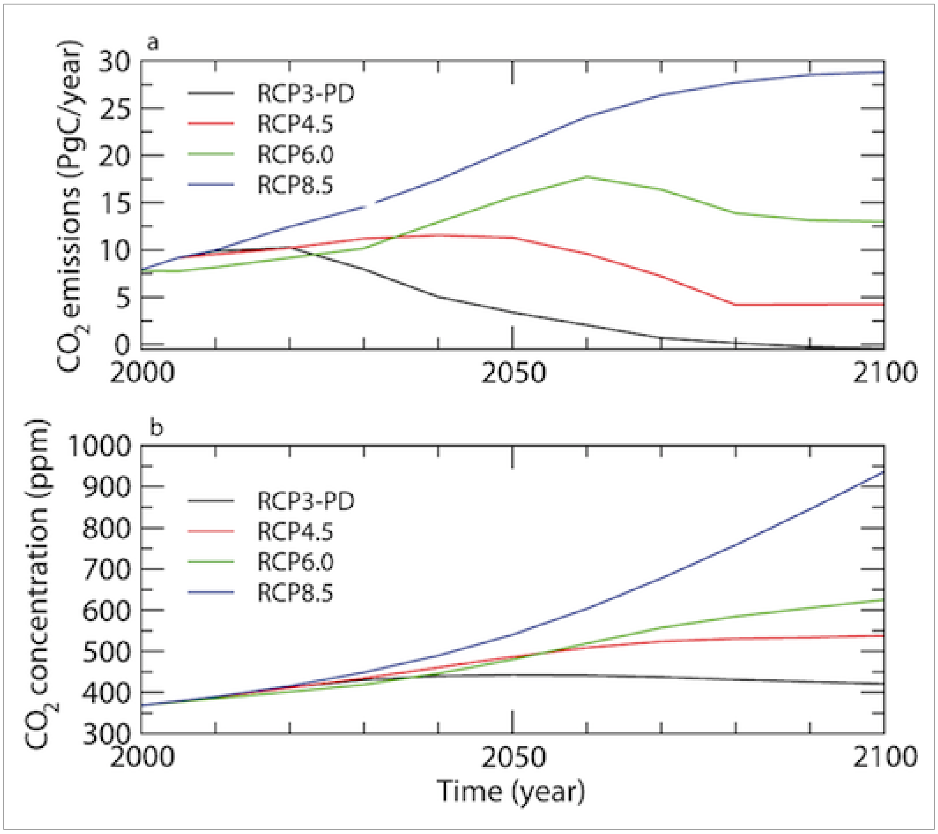
Source: CalOES 2020.

The vulnerability assessment helps the City understand which climate vulnerabilities are most urgent and should be prioritized during the adaptation strategy development phase as well as during strategy implementation.

Climate Change Impact Modeling and Projections

According to the work of IPCC and research conducted by the State alongside partner agencies and organizations, climate change is already affecting and will continue to affect the physical environment throughout California, including the City. To identify the local impacts of climate change in California, the CEC, and the University of California, Berkeley Geospatial Innovation Facility developed the scenario planning tool Cal-Adapt. The Cal-Adapt tool uses global climate simulation model data downscaled to a local and regional resolution to identify localized impacts from various climate metrics. Developers of the Cal-Adapt tool selected four priority global climate models to include in projections provided in the tool. This analysis uses the average of these four models to identify changes in temperature and extreme heat events.

The projected effects of climate change over the next century will vary depending on global GHG emissions trends. The Cal-Adapt tool includes global climate simulation model data from two emissions scenarios, known as Representative Concentration Pathways (RCPs), that were used in the IPCC's Fifth Assessment Report. The RCPs represent scenarios that estimate the level of global GHG emissions through 2099. The RCP scenarios used in the Cal-Adapt tool are the RCP 8.5 (High Emissions) scenario, which represents a business-as-usual future emissions scenario that would result in atmospheric CO_2 concentrations exceeding 900 parts per million (ppm) by 2100, and the RCP 4.5 (Medium Emissions) scenario, which represents a lower GHG emissions future and likely the best-case scenario for climate impacts, under which GHG emissions would peak in 2040 and then decline through the rest of the century, resulting in a CO_2 concentration of about 550 ppm by 2100. The RCP trends assumed in the analysis are illustrated in Figure 3. The emissions scenarios depend on global GHG emissions trends in the future and the efficacy of global GHG reduction strategies proposed by the international community. Because the efficacy of the GHG reduction strategies and the likelihood that a certain RCP scenario will occur are uncertain, a discussion of both emissions scenarios and their subsequent impacts are included in this analysis.



Notes: CO_2= carbon dioxide; ppm = parts per million; PgC = one billion metric tons of carbon; RCP = Representative Concentration Pathway.

Source: Goosse et al. 2010.

Figure 3 Representative Concentration Pathway Used in Global Climate Modeling

The State's *Adaptation Planning Guide 2.0* (CalOES 2020) provides guidance on choosing appropriate RCP scenarios to be included in the analysis. For analysis of impacts through 2050, the draft *Adaptation Planning Guide 2.0* suggests using a conservative approach based on the High Emissions scenario, but notes that impacts by 2050 under the Medium and High Emissions scenarios will vary based on local context.

The Cal-Adapt tool provides data on projected changes in annual average temperature and changes in the frequency and severity of extreme heat events. This analysis uses Cal-Adapt data to evaluate increases in annual average maximum temperatures, as well as shifts in the duration and frequency of extreme heat events in the future. The analysis also identifies at what point over the next approximately 80 years (2021–2099) changes in temperature and extreme heat events will begin to occur and at what magnitude. This exposure analysis uses the following time periods to analyze changes in climate variables under the Medium Emissions scenario for the near-term and midterm periods and Medium and High Emissions scenarios for the long-term period. 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 time periods or longer. This results in overlap among some time periods. Due to annual fluctuations in climate variables, climate data on shorter time periods may be less accurate and not reflect long-term averages (NOAA 2018). The three time periods are:

- near-term (2021–2050),
- midterm (2040–2070), and
- long-term (2070–2099).

2.1 COMMUNITY OVERVIEW

The City covers approximately 34.8 square miles of land, the majority of which historically consisted of flat grassland and oak woodlands. The City is generally bordered by the American River to the north, Hazel Ave and the boundary of the 100-year floodplain for the Consumnes River on the east, Jackson Highway on the south, and Bradshaw Road on the west.

Population Overview

The U.S. Census bureau estimates the City's population to be 75,086 persons as of July 2019 (U.S. Census Bureau 2021). Table 4 illustrates the City's demographics by sex, race, and age according to the U.S. Census. As shown, the majority of residents identify as white with those identifying as Hispanic being the second largest demographic group. In terms of youth and elderly populations, 42 percent of City residents are either under 18 years or over 65 years old, populations at increased risk from climate-related hazards. The City is highly educated: 88 percent of the population over 25 years old has at least a high school degree, and 29 percent of the population over 25 years old has a bachelor's degree or higher (U.S. Census Bureau 2021).

Table 4 City Demographics by Sex, Race, and Age

Demographic Characteristics	City of Rancho Cordova	Sacramento County
Population	47,459	1,552,058
Male	48%	49%
Female	52%	51%
White alone	42%	44%
Hispanic or Latino	23%	39%
Asian alone	14%	16%
Two or more races	9%	6%
Black or African American alone	10%	9%
American Indian and Alaska Native alone	0.4%	0.4%
Persons under 18 years	28%	23%
Between 18 and 64 years	59%	62%
Persons 65 years and older	13%	14%

Source: U.S. Census Bureau 2021.

2.2 TEMPERATURE AND EXTREME HEAT ANALYSIS

Existing and Future Temperatures and Extreme Heat

The City has a mediterranean climate characterized by mild winters and hot, dry summers. The wet season runs from October through April, though there is occasional light rainfall in the summer months. The annual temperature mean is 61.1 °F, with monthly means ranging from 45.8°F in December to 75.4 °F in July. Summer high temperatures are often moderated by the "delta breeze": which comes through the Sacramento-San Joaquin River Delta from the San Francisco Bay. The City experiences temperatures in excess of 100°F during the summer and fall months, reaching daily maximum temperatures of 105-115°F (Sacramento County 2021).

As discussed in *California's Fourth Climate Change Assessment Sacramento Valley Region Report*, changes in temperature and extreme heat events in northern California are anticipated to affect the Sacramento Valley Region (boundary defined in the Regional Report) (OPR et al. 2018). Changes for the Sacramento Valley region include more warming in the summer than the winter (with July–September increases of 2.7°F–10.8°F) and greater warming inland than in coastal regions (by as much as 7.2°F) (Pierce et al. 2018). Table 5 provides a summary of the projected temperature increases over the century for the City.

Future Changes in Temperature and Extreme Heat

As shown in Table 5, both annual maximum and minimum are projected to increase throughout the 21st century. The average annual maximum temperature in the City is projected to increase approximately six percent from 74.2°F historically (1961-1990) to 78.3°F in the near-term and increase approximately eight percent to 79.8°F in the midterm. The average annual maximum temperature is projected to increase eight to 12 percent to 80.2°F and 83.1°F in the late-century period under the medium and high emissions scenarios, respectively. The average annual minimum temperature in the City is projected to increase approximately five percent from 49.3°F historically (1961-1990) to 52.9°F in the near-term and increase approximately six percent to 54.1°F in the midterm. In the late-century period, average annual minimum temperature is projected to increase between seven and 11 percent to 54.3°F and 57.7°F under the medium and high emissions scenarios, respectively (CEC 2021a). Increased temperatures in the City will influence secondary climate effects, including extreme heat events, wildfire, and drought. Figure 4 below illustrate the changes in annual average maximum temperature in the City and the County, highlighting the variability in temperature increases across the County throughout the 21st century.

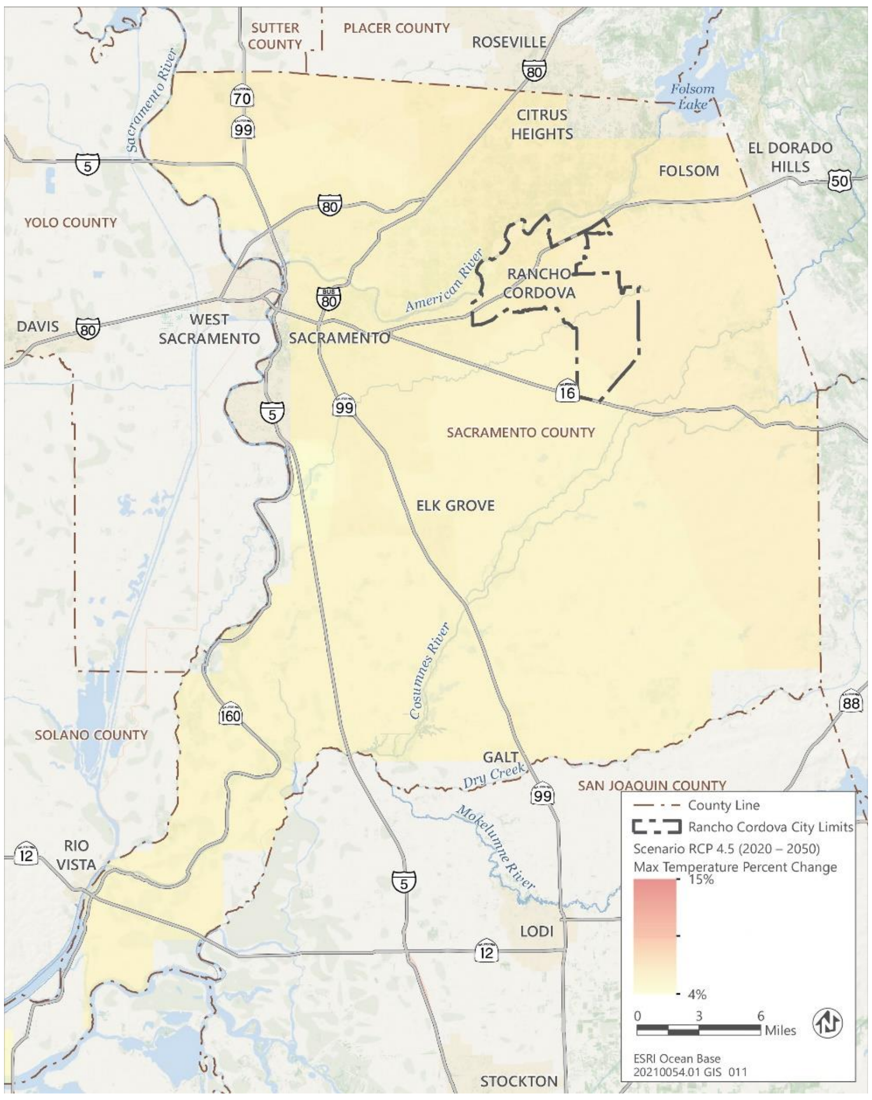
Table 5 Changes in Average Annual Temperature in the City of Rancho Cordova

Geography	Average Annual Temperature	Historic Average Annual Temperature (1961-1990)	Near-Term (2021-2050)	Midterm (2040-2070)	Late-Century (2070-2099)	
					Medium Emissions	High Emissions
City of Rancho Cordova	Maximum Temperature (°F)	74.2	78.3	79.8	80.2	83.1
	Minimum Temperature (°F)	49.3	52.9	54.1	54.3	57.7

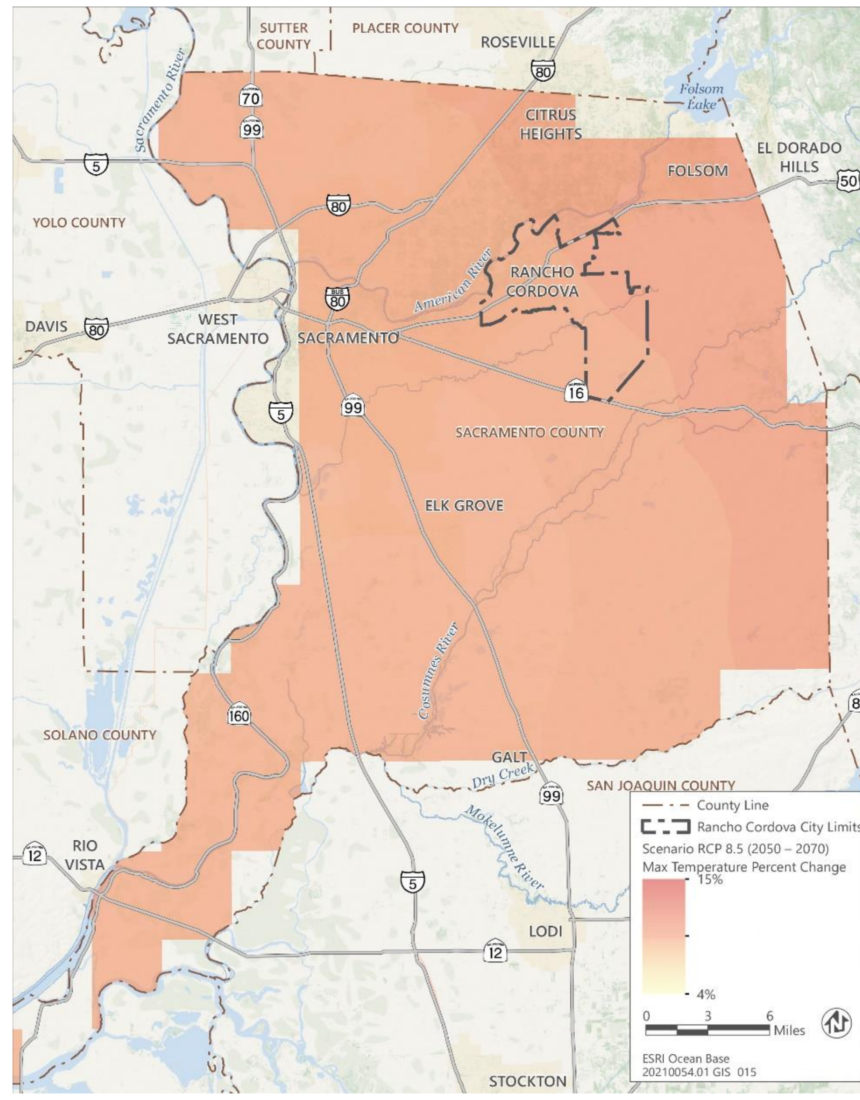
Notes: °F = degrees Fahrenheit.

Source: CEC 2021a.

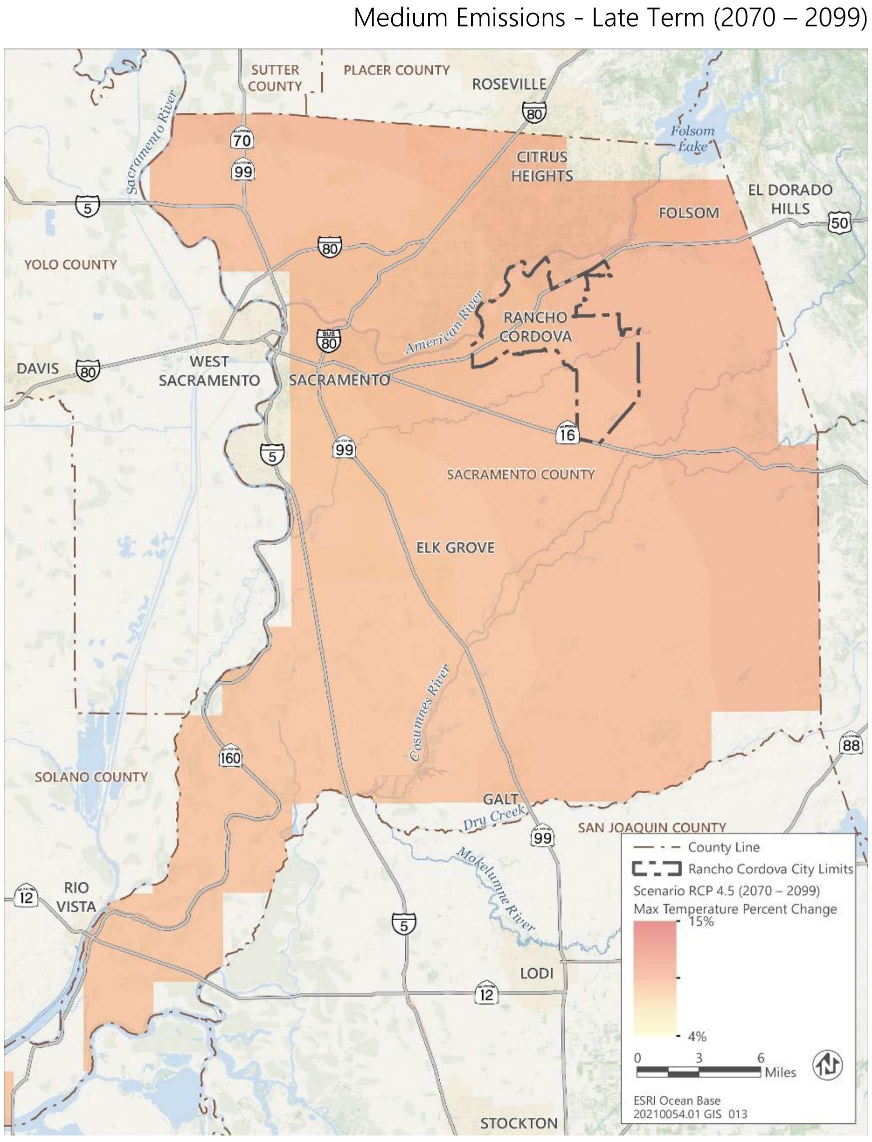
Near-Term (2021 – 2050)



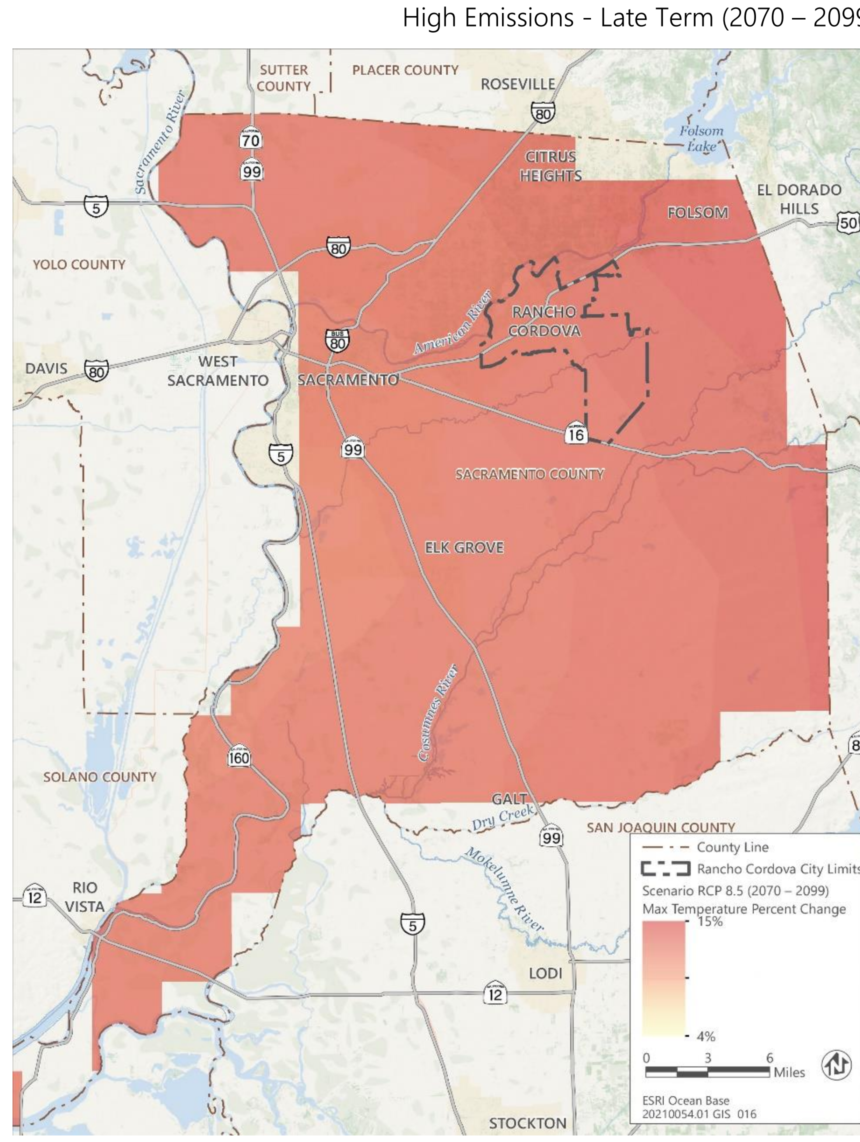
Midterm (2040 – 2070)



Medium Emissions - Late Term (2070 – 2099)



High Emissions - Late Term (2070 – 2099)



Source: Data downloaded from CEC and DWR in 2019.

Figure 4 Sacramento County Annual Average Maximum Temperature through 2099

Along with increases in annual average temperature, the City is anticipated to experience increases in the average number of extreme heat days per year, as well as increases in the frequency and duration of heat wave events. Based on the parameters set in Cal-Adapt and for the purposes of this analysis, an extreme heat day is defined as a day between April and October with a maximum temperature of 103.6°F or above. This threshold was chosen because it is the 98th percentile of historic maximum temperature for days in the historic period (1961–1990), meaning 98 percent of all recorded temperatures in this period were below 103.6°F. This is also the recommended threshold by the Extreme Heat tool in Cal-Adapt. For the purposes of this analysis, a heat wave event is defined as a series of 4 or more days above 103.6°F. Table 6 illustrates the projected changes in extreme heat events. In the historic period, the maximum duration of days above 103.6°F is 2.5 days, which does not qualify as a heat wave based on the heat wave threshold used. By the midterm period, the City will experience heat wave events that qualify based on the established threshold.

Table 6 Changes in Extreme Heat in the City of Rancho Cordova

Extreme Heat Event	Extreme Heat Event Metric	Historic (1961-1990)	Near-Term (2021-2050)	Midterm (2040-2070)	Late-Century (2070-2099)	
					Medium Emissions	High Emissions
Extreme heat days	Days above 103.6°F	4	19	32	29	48
Heat wave events	4-day period above 103.6°F	0.2	1.4	4.8	4.0	7.8
Heat wave duration	Consecutive days above 103.6°F	2.5	6.3	7.2	8.5	14.2

Notes: °F = degrees Fahrenheit.

Source: CEC 2021a.

As shown in Table 6, while heat waves have historically been infrequent in the City, with a historical average of less than one heat wave annually, climate change is expected to increase the frequency of heat waves. Under the high emissions scenario, the City is projected to still experience 19 extreme heat days in the near-term and 32 extreme heat days annually in the mid-term. By the late-century, the City will experience 29 extreme heat days per year under the medium emissions scenario and 48 extreme heat days per year under the high emissions scenarios.

In terms of heat wave events, the City is projected to experience approximately 1.4 heat waves per year in the near-term and 4.8 heat wave events in the midterm. By the late-century, the City is projected to experience 4 heat waves per year under the medium emissions scenario and 7.8 heat waves per year under the high emissions scenarios. The average number of days in the longest stretch of consecutive extreme heat days per year is also projected to increase. Historically, the longest stretch of consecutive extreme heat days lasted for an average duration of approximately two-and-a-half days. The longest stretch of consecutive extreme heat days is projected to increase significantly to 6.3 days in the near-term period and 7.2 days by the midterm period. By late-century, the duration is projected to increase to a maximum length of 8.5 days under the medium emissions scenario and 14.2 days under the high emissions scenario (CEC 2021b). The timing of extreme heat days is also projected to change over the 21st century with more extreme heat days and heat wave events occurring earlier in the year (April through May) and more severe events occurring in the historically hot months of September and October (CEC 2021b).

Extreme Heat Sensitivity and Impacts

This section provides an overview of the anticipated impacts on the City from the increases in temperature and extreme heat, discussed above, and subsequent secondary impacts. The impact discussion is organized around the three analysis time periods.

Based on the information included in the exposure analysis, the impact analysis is intended to identify and describe impacts on the City's built environment, vulnerable populations, and community functions anticipated to result from temperature increases and increases in the frequency and severity of extreme heat events. To help better understand how and when these impacts will occur, a series of threshold indicators are used to assess how various aspects of the City's normal functions are affected when temperature-related thresholds are exceeded.

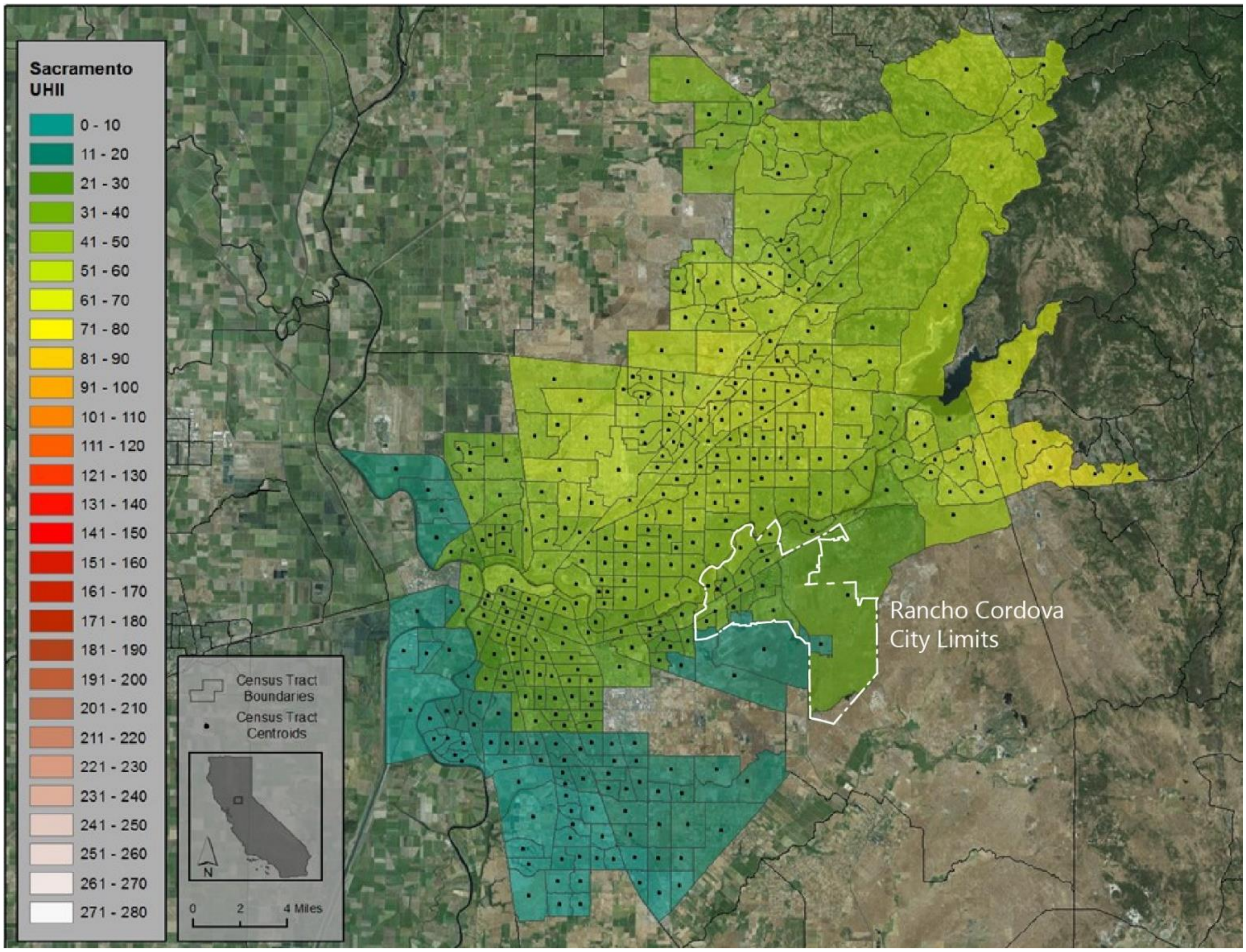
Existing Heat Sensitivities and Urban Heat Island Effect

Although the City's mediterranean climate includes high temperatures during summer and fall months, the City's urban land use patterns can intensify periods of extreme heat through the "urban heat island" (UHI) effect. The UHI effect is generally understood as the phenomenon of urban areas being significantly warmer than surrounding rural areas because of human activity and land use patterns in the built environment. Several factors contribute to the effect, with the primary cause being changes in land surfaces (EPA 2008). The albedo of a surface is the measure of the surface's ability to reflect or absorb solar radiation, with darker surfaces having a lower albedo and absorbing more solar radiation. As urban areas develop over time, resulting in the development of more land surfaces with low albedos (e.g., asphalt pavement, dark building surfaces), more solar radiation is absorbed in these materials causing increased ambient temperatures and warmer nighttime temperatures. Another factor contributing to the UHI effect is the loss of evapotranspiration in urban areas. Evapotranspiration, the movement of water to the air from sources such as the soil, plants, and bodies of water, reduces ambient air temperatures (EPA 2008). As cities grow and often reduce the extent of available vegetation that contributes to evapotranspiration, UHI effects are exacerbated. Additionally, waste heat from human activities involving machinery (e.g., vehicle traffic, using air conditioning, industrial activity) can also contribute to the UHI effect, with excess heat absorbed by surrounding surfaces (Sailor 2011; Zhu et al. 2017).

Sensitive Land Uses

Land use patterns and the design of the built environment in urban areas play a large role in an area's exposure to the UHI effect (Stone and Rodgers 2001; Solecki et al. 2005). Urban land uses with large, paved areas, low albedo, and less vegetation (e.g., commercial, industrial uses) tend to be subject to the UHI effect and have higher nearby ambient temperatures. Conversely, land uses with smaller percentages of paved surfaces and abundant vegetation (e.g., parks) tend to have lower average temperatures compared to other portions of urban areas. A study looking at the relationship between land use patterns and the UHI effect in Toronto, Canada found a statistically significant difference between average maximum temperatures for commercial and resource/industrial land uses and other surrounding land uses. The study also found the average low temperatures for parks, recreational land, and water bodies to be lower than those for surrounding land uses, likely because of increased evapotranspiration (Rinner and Hussain 2011). Additionally, areas that have higher concentrations of commercial and industrial land uses clustered together can have increased ambient and surface temperatures, with temperatures increasing relative to the size of these areas (Rinner and Hussain 2011). Increased temperatures in areas with concentrations of commercial and industrial land uses can also result in secondary impacts, including increased cooling demand for buildings, pavement deterioration, decreased air quality, and reduced stormwater quality from above-average-temperature runoff entering natural waterways and nearby ecosystems (Rinner and Hussain 2011).

The California Environmental Protection Agency has developed a UHI index (UHII) to assess the severity of the UHI effect in various urban areas throughout the state. The scores are based on the temperature difference over time between urban census tracts and nearby upwind rural reference points to demonstrate the relative difference in temperature caused by the urban environment (CalEPA 2019). Figure 5 shows the UHII effect for the County by census tract.



Source: CalEPA 2019.

Figure 5 Urban Heat Island Index for Sacramento County

As shown in Figure 5, compared to other urban areas in County, census tracts in the City being affected by the UHI effect but not as severely as other areas in the County. As discussed above, a number of factors contribute to the UHI effect. Factors that could be contributing to the City's relatively low UHII score include the presence of rural land uses surrounding the City, particularly to the south and east of the City's more urban areas. As the City continues to grow, developing medium and high-density transit-oriented land use patterns will be an important part of helping the City achieve its greenhouse gas emissions reduction targets included in the City's CAP. However, as this growth occurs, it is also important to consider how new development may contribute to the UHI effect and include strategies to mitigate the UHI effect from new development in the City.

Transportation System Heat Sensitivities

Transportation systems are designed and constructed to withstand certain variabilities in weather and temperature based on observations of historical weather trends for specific climate regions (Li et al. 2011). The performance of transportation assets may begin to decline when the severity of extreme heat periods exceeds historical ranges, for example, rail buckling at temperatures above 111°F. The characteristics of extreme heat events will affect different transportation assets differently. Provided below is a summary of the quantitative and qualitative thresholds used to assess the impacts of climate change on the City's transportation system. These thresholds were applied to the specific geography of the City using Cal-Adapt data and are presented in Table 7.

Pavement Deterioration

The effect of temperature on the performance and integrity of pavement depends on a variety of factors, including material type (asphalt versus concrete), the albedo of the material, details specific to the material mixing and placement, and soils and materials in the subbase of the roadway (Harvey et al. 2000). The performance of pavement also is dependent on the traffic volumes and types of vehicles using the roadway (Harvey et al. 2000). Based on the City's Standard Construction Specifications, based on Sacramento County Standards (Sacramento County 2016), roadways in the City use a binder within the asphalt mix with a Performance Grade of 64-16 means that roadways using this binder can withstand 7 consecutive days of pavement temperatures up to 64°C (147°F), after which point the heat can result in rutting along high-volume roadways and cause considerable safety issues. Based on guidance in the FHWA's *Vulnerability Assessment and Adaptation Framework* (FHWA 2017), this pavement temperature threshold can be translated into an ambient air temperature of 111°F. The UHI effect can increase ambient temperatures between 1.8°F and 5.4°F in urban areas compared to surrounding rural areas. Because the Cal-Adapt tool does not account for the added effects of the UHI effect in its projections, this analysis is conservative in setting a threshold for pavement impacts. As a result, the threshold used for widespread impacts on pavement in the City is a 7-day consecutive heat wave with a maximum daily temperature of 108°F. The analysis in roadways using this threshold is included below in Section 2.4.2.

Rail Buckling

During periods of extreme heat, rail lines can expand and result in "buckling" in which tracks come out of alignment, resulting in serious safety issue. However, the risk of buckling is managed by designing the rail neutral temperature at 95-110°F (35-45°C), with tracks designed and fit into infrastructure that assumes operations at those temperatures could occur (OFCM 2002, Transportation Research Board and National Research Council 2008). For this analysis, the threshold for increased risk from rail buckling is days in which the maximum daily temperature is 111°F or above.

Public Transportation Operations and Bridges

Research has found that when daily maximum temperatures reach 100°F, air conditioning units in buses are placed under increased stress and risk of failure (Cambridge Systematics 2015). For this analysis, the threshold for public transportation is days per year with maximum temperatures above 100°F.

Additionally, research indicates that bridges are at increased risk from thermal expansion during periods above 100°F. 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 and National Research Council 2008). The number of days above 100°F is also used as a threshold to determine impacts on bridges (Zimmerman 1996).

Heat Sensitive Populations

Certain vulnerable populations in urban areas are particularly vulnerable to extreme heat and related hazards. Vulnerable populations include persons over the age of 65, infants and children, individuals with chronic health conditions (e.g., cardiovascular disease, asthma), low-income populations, athletes, and outdoor workers (CDC 2019). Increased temperatures have been reported to cause heat stroke, heat exhaustion, heat syncope, and heat cramps, with certain vulnerable populations at increased probability of experiencing these effects (Kovats and Hajat 2008). Extreme heat can also worsen air quality, quickening the production of ozone in areas with increased concentrations of ozone precursors (i.e., oxides of nitrogen [NO_X] and reactive organic gases [ROG]) (Knowlton et al. 2004). This is of particular concern to the City because the Sacramento Valley Air Basin has high concentrations of ROG and NO_X emissions and is currently in nonattainment status for California ambient air quality standards for ozone (SMAQMD 2017).

Alongside populations with health sensitivities, residents with specific sociodemographic characteristics are at increased sensitivity to extreme heat events (CDC 2019). Research has found that low-income residents spend a larger proportion of their income on utilities, including electricity use for cooling, with these residents being disproportionally affected during extreme heat events (Voelkel et al. 2018). Additionally, research has found that low-income neighborhoods can often have less tree coverage and park space, further contributing to the disproportionate impact on low-income residents (Zhu and Zhang 2008). Unhoused individuals are also at increased risk from extreme heat events with, generally, less access to places to cool off and healthcare resources during these events. Additionally, decreased access to transportation services can further increase exposure and health risks from extreme heat events for the unhoused community (Ramin and Svoboda 2009).

Unlike thresholds for transportation assets, heat-related thresholds for populations in an urban area vary widely and depend on a number of factors, including the sensitivity of specific populations to heat (e.g., elderly, children). For this analysis, the California Heat Assessment Tool (CHAT) was used to identify how Heat Health Events (HHE) would increase in the future. An HHE, for the purposes of the tool, is defined as any event that results in negative public health impacts, regardless of the absolute temperature. The tool includes unique HHE threshold for locations throughout the state, specific to the climate and the historical sensitivity of people in that area to past extreme heat events. For this analysis, the CHAT tool and the projected increase in HHEs in the City is used as the threshold for this sensitivity. The heat wave event threshold, defined as a 4-day consecutive period with daily maximum temperatures above 103.1°F, is also used to identify various impacts from heat wave events.

Buildings and Energy Use

Changes in annual average temperature and extreme heat events are likely to effect buildings primarily through changes in energy use as well as disproportionate impacts on individuals residing in units that do not have air conditioning. 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 mean (the average of the high and low) 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 7 includes the relative shift in Cooling Degree Days and Heating Degree Days in the City through 2099.

Table 7 Summary of Potential Heat Impacts by Impact Area through 2099

Impact Area	Impact Type	Threshold Criterion	Historic (1961–1990)	Near Term (2021–2050)	Midterm (2040–2070)	Medium Emissions Long Term (2070–2099)	High Emissions Long Term (2070–2099)	Threshold Source
Built Environment impacts	Roadways and pavement	7 consecutive days above 108°F	0	0	0.1	0.1	0.5	DOT 2014
	Rail buckling	Days per year with maximum temperature of 111°F	0	2	3	3	9	OFCM 2002
	Bridges and bus operations	Days above 100°F	15	35	44	24	67	Zimmerman 1996, Cambridge Systematics 2015
	Building Energy Use	Percent increase in Cooling Degree Days	n/a	49%	48%	46%	74%	CEC 2021b
		Percent increase in Heating Degree Days	n/a	-25%	-44%	-50%	-81%	CEC 2021b
Vulnerable Population impacts	Heat wave events	4-day period above 103.6°F	0.2	1.4	2.5	2.6	5.4	CEC 2021b
	Heat wave duration	Consecutive days above 103.6°F	2.5	6.3	6.9	8.5	14.2	CEC 2021b
	Heat Health Events (HHE)	Range of potential HHEs per year	n/a	2.9	3.9	4.2	4.8	CEC 2018a

Note: NA = not available.
Source: See sources in "Threshold Source" column of table.

Near Term (2021–2050)

As shown in Table 7, during the near-term period, extended periods (7 consecutive days) of temperatures reaching above 108° would be unlikely; therefore, there would not be widespread impacts from pavement deterioration in the City. The City has experienced buckling of sidewalks due to extreme heat conditions, prompting repairs to avoid tripping hazards. As extreme heat continues to increase in severity and frequency in the future, this impact is likely to increase as well. Increased risk to rail from extreme heat days will increase slightly, with only 3 days over 111°F. However, there will be continued increases in risk from thermal expansion of bridges, with increases in days above 100°F from 15 historically to 44 during this period. An increase in the number of days above 100°F will also place increased stress on buses and their air conditioning systems, as well as result in potential declines in bus ridership because of the discomfort. During this period, the number of Cooling Degree Days will increase approximately 49 percent increase over historic levels, placing more demand on the electricity grid during heat wave events and increase electricity bills for residents. Conversely, the number of Heating Degree Days will decrease by approximately 25 percent and reduce energy demand for heating, resulting in cost savings for residents and businesses cooler months during those months. City staff have noted that extreme heat events have already begun to affect the homeless population in the City, prompting the need for cooling center to house the City's homeless population and other vulnerable populations. As extreme heat events continue to increase in frequency and severity, these impacts are likely to become more pronounced and demand for cooling centers as well as emergency services will increase.

During the near-term period, the City will also experience approximately 2.9 HHEs per year, with increased risk to populations particularly vulnerable to extreme heat, as discussed above. The frequency of extreme heat events will increase to 1.4 on average per year with the maximum duration of events increasing to 6.3 days during this period. These events will increase the risk of public health impacts on vulnerable populations and could result in increased burden on low-income residents because of the increased energy demand for cooling (Calkins et al. 2016).

Midterm (2040–2070)

During the midterm period, there would likely not be any extended periods (7 consecutive days) above 108°F during this period; therefore, there would not be widespread impacts from pavement deterioration in the City. Increased risk to rail from extreme heat days will be relatively minor, with only 2 days over 111°F. However, there will be noticeable increases in risk from thermal expansion of bridges, with increases in days above 100°F from 15 historically to 35 during this period. An increase in the number of days above 100°F will also place increased stress on buses and their air conditioning systems, as well as result in potential declines in bus ridership because of the discomfort. During this period, the number of Cooling Degree Days will increase approximately 49 percent increase over historic levels, placing more demand on the electricity grid during heat wave events and increase electricity bills for residents. Conversely, the number of Heating Degree Days will decrease by approximately 44 percent over historic levels and reduce energy demand for heating, resulting in cost savings for residents and businesses cooler months during those months.

During the near-term period, the City will also experience approximately 3.9 HHEs per year, with increased risk to populations particularly vulnerable to extreme heat. The frequency of extreme heat events will continue to increase to 2.5 on average per year with the maximum duration of events increasing to 6.9 days. These events will increase the risk of public health impacts on vulnerable populations and continue to disproportionately burden low-income residents because of the increased energy demand for cooling (Calkins et al. 2016).

Long Term (2070–2099)

During the long-term period, increases in the duration and frequency of heat wave events will place increased stress on transportation assets and could result in subsequent impacts on community functions. By this period, under the High Emissions scenario, there would be an average of 0.5 events per year with extended periods (7 consecutive days) above 108°F. There would be only 0.1 events per year under the Low Emissions scenario for this period. As discussed in Section 2.4.1, these events will result in much larger impacts on the performance of pavements in the City. Extensive rutting could occur, particularly on high-volume roadways, including Folsom Boulevard, Sunrise Boulevard, and International Drive, as well as on Caltrans facilities (i.e., SR-50).

During this period, there would be significant risk to rail infrastructure from extreme heat days, with approximately 9 days over 111°F per year under the High Emissions scenario, likely affecting Regional Transit light rail service when these events do occur. Risk of impacts on bridges from thermal expansion will also increase considerably, with the number of days above 100°F per year increasing from 12 historically to 24 under the Low Emissions scenario and 67 days under the High Emissions scenario. During the long-term period, the City will experience between 4.2 and 4.8 HHEs depending on future emissions, with increased risk to vulnerable populations. The increased frequency of HHEs will likely place increased demand on emergency services and emergency care facilities and could result in economic consequences from impacts on public health and work productivity (Paterson et al. 2014). The frequency and duration of heat wave events will increase considerably during this period, with the maximum duration of events increasing to 14.2 days under the high emissions scenario. These events will increase public health impacts on vulnerable populations, with increased levels of risk for elderly and youth populations, as well as individuals with chronic health conditions (Voelkel et al. 2018). By the end of the century, the number of Cooling Degree days will increase approximately 74 precent, under the high emissions scenario, resulting in more than 3 months of the year requiring increased energy demand for cooling. By this period, the number of Heating Degree Days will decrease by approximately 81 percent under the High Emissions scenario by 2099. Increases in energy demand for cooling during this period will also have larger impacts on the electricity grid, with increased stress on and risks to electricity generation facilities and transmission lines (DOE 2016).

<u>Potential Impact Score</u>
Based on this analysis, the potential impact score for Temperature and Extreme Heat is High.

2.3 PRECIPITATION AND FLOODING ANALYSIS

Existing and Future Flooding Conditions

Scientists, engineers, and planners all use a specific system to measure and plan for certain sizes of storm events and flood impacts associated with these events. These events are measured by the probability that they are likely to occur in a given year. The phrase “100-year storm,” for example, refers to a storm event with a 1-in-100 or one percent chance of occurring in any given year. The size and other aspects of these storms are identified to characterize the nature of the events based on historic data. The metrics are then used to plan and design stormwater management systems that can cope with storm events of these sizes. The Federal Emergency Management Agency (FEMA) uses certain larger storm events (i.e., 100-, 500-year storms) to identify flood hazard areas in the United States. FEMA administers flood insurance based on location and extent of impacts from these storm events, which influences land use patterns and development in cities. The following metrics are used in this analysis to discuss storm events and are included in projections from the Cal-Adapt tool:

- Intensity—The amount of rainfall that occurs over a certain period (e.g., 1 hour, 24 hours, 5 days) during storm events of different sizes (e.g., 100-year storm event, 2-year storm event)
- Duration—The longest stretch of consecutive days during a water year (October through September) with rainfall above a certain threshold
- Count—The number of days during a water year (October through September) with rainfall over a certain period (e.g., 1 hour, 24 hours, 5 days) above a certain threshold
- Timing—The timing during the year in which rainfall events exceeding a certain threshold occur

The City’s *Local Hazard Mitigation Plan* (LHMP), which was developed as an annex to *the Sacramento County Local Hazard Mitigation Plan* which is currently being updated with the public draft of the document available, includes summary of the existing natural and manmade hazards affecting the City have been analyzed to assess current risks levels for each hazard (Sacramento County 2021). The LHMP provides details on the planning process, risk assessment, and mitigation strategies for the City to address specific hazards including large flooding events and flood related hazards.

Historically, flooding from large storm events is a significant problem in the County and the City. Historically, the City has been at risk to flooding primarily during the winter and spring months when river systems in the County swell with heavy rainfall and snowmelt runoff. The City also experiences flooding challenges in the Morrison Creek watershed as well as obstructions to peak storm flow management with the Folsom South Canal which runs north-south through the City.

Storm floodwaters are typically managed by the City's stormwater management system, which is able to collect and divert stormwater runoff from smaller storm events. However, extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage. Major surface waters in the vicinity of the City include the American River, Folsom Reservoir, and Lake Natomas to the north. Other surface waters within the City include the Folsom South Canal, Cordova Creek, Deer Creek, and the Morrison Creek Stream Group (Morrison, Laguna, Elder, Gerber, Unionhouse, Florin, Buffalo, and Frye Creek, as well as Rebel Hill Ditch) which generally flow in a southwesterly direction southeast of the City. The topography within the City includes gently rolling terrain, such as that found in the eastern Great Central Valley interrupted by numerous seasonal creeks and streams. These creeks and streams are largely ephemeral and intermittent, which is typical of areas that experience dry summers and cool, wet winters, as in this part of the Central Valley.

The County and City have a large number of large-scale flooding events resulting in Federal and State disaster declarations. Table 8 includes a list of state and federal disaster declarations for the County since 1950.

Table 8 Changes in Average Annual Precipitation and 5-Year Storm Event in Sacramento County

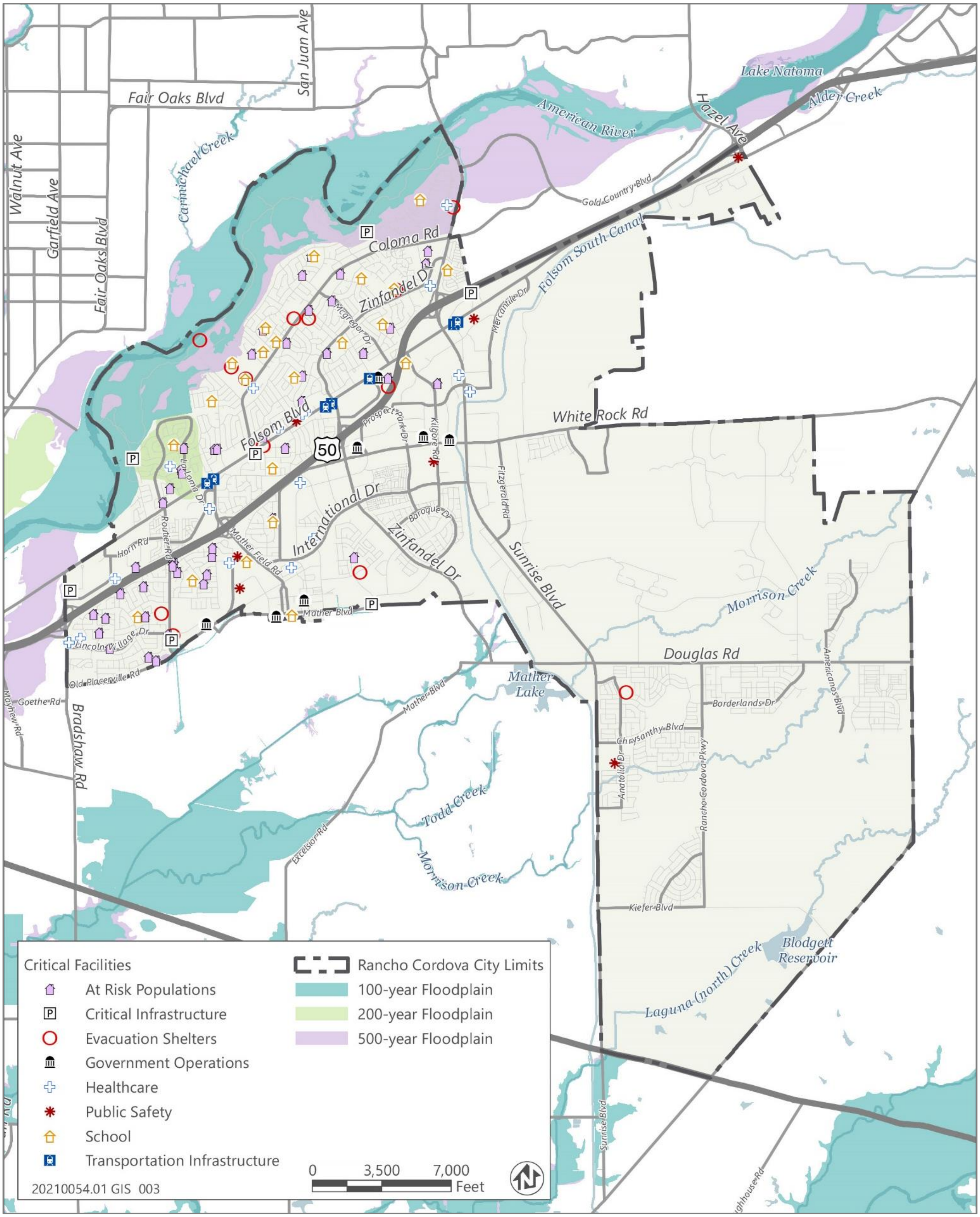
Type of Hazard Event	Federal Declarations		State Declarations	
	Count	Years	Count	Years
Flood (including heavy rains and storms)	19	1950, 1955, 1958 (twice), 1963, 1969, 1982 (twice), 1983, 1986, 1995 (twice), 1996, 1997, 1998, 2008, 2017 (three times)	14	1955, 1958, 1964, 1969, 1983, 1986, 1995 (twice), 1997, 1998, 2006, 2017 (three times)

Source: Sacramento County 2021.

As shown in Figure 6, small portions of the City are located within the FEMA floodplains for the 100- and 500-year storm events. Figure 6 also includes areas within the 200-year flood zone which were mapped as part of the City's GP updated process and used to comply with the requirements of Senate Bill (SB) 5, which requires cities in the Sacramento-San Joaquin Valley area to assess risk-levels and provide increased flood protection for properties in the 200-year floodplain. As shown in Figure 6, the northern boundary of the City is located along the American River, with this area of the City at the highest risk from flooding.

Based on information in the City's LHMP, there are 58 properties located in the 100-year flood zone valued at a total of $21.6 million. As part SB 5, jurisdictions in the Sacramento-San Joaquin Valley are required to identify properties located in the 100- and 200-year floodplains and implement development standards that prohibit new development in the 200-year floodplain unless the property achieves an Urban Level of Flood Protection (ULOP), defined in SB 5. To satisfy the requirements of ULOP, the City has developed a 200-yr floodplain map based on the proposed Folsom Dam improvements by the US Army Corps of Engineers. These improvements include the Joint Federal Project to improve the dam spillway and the future dam raise to increase flood storage. In conjunction with the new 200-yr map, the City has made changes to its General Plan and zoning code that will guide development within the 200-yr ULOP.

As illustrated in Figure 6, the 500-year floodplain also impacts the northern portions of the City along the American River with118 residential parcels located within this zone. The City has one critical facility located in the 100-year flood zone, six critical facilities in the 200-year flood zone, and 5 critical facilities in the 500-year flood zone. While portions of the City are within the 100- and 500-year flood zones, there have been no historical insurance claims for flood losses in the City (Sacramento County 2021).



Source: Sacramento County 2021 and data provided by City of Rancho Cordova staff.

Figure 6 Flood Zones and Critical Facilities in the City of Rancho Cordova

As shown in Table 9, there are several areas in the City with various land uses in the 100- and 500-year flood zone. As discussed above, the presence of the Laguna West Levee System near the Laguna West neighborhood is protecting 2,073 parcels from the 100-year flood event. Parcels located in the 100-year flood zone are located in flood zone areas surrounding Laguna Creek and Deer Creek. Alongside an analysis of land uses at risk of flooding, the City's LHMP also analyzed the number of essential service facilities, and at-risk populations that are located within the 100- and 500-year flood zones. Table 9 summarizes the number and type of critical facilities located within the 100- and 500-year flood zones.

Table 9 City of Rancho Cordova Properties by Land Use in FEMA Flood Zones

Land Use	100-Year Flood Zone	500-Year Flood Zone
Residential	19	1,118
Retail/Commercial	0	3
Office	0	2
Industrial	0	0
Care/Health	0	0
Church/Welfare	0	2
Recreational	1	0
Miscellaneous	35	11
Public/Utilities	0	2
Vacant	3	2
Total	58	1,145

Note: FEMA = Federal Emergency Management Agency.
Source: Sacramento County 2021.

Future Changes in Precipitation Patterns and Flooding

As discussed in the *Fourth Climate Change Assessment Sacramento Valley Report*, changes in precipitation patterns in northern California are anticipated to affect the Sacramento Valley region as well as adjacent regional watersheds which affect the Sacramento Valley (OPR et al. 2018). Projected shifts include increases in the intensity of large storms events, which could compromise the performance of the Sacramento Valley and Central Valley flood management systems (Pierce et al. 2018). Based on California's location next to the Pacific Ocean, the state is exposed to the atmospheric river phenomenon, a narrow corridor of concentrated moisture in the atmosphere. California is subject to precipitation from an atmospheric river that transports water vapor from as far south as Hawaii to the state. The presence of the atmospheric river contributes to the frequency of "wet years" in the state, when there is an above-average number of atmospheric river storms and above-average annual precipitation. While research indicates that the frequency of large storms events does increase in these wet years, the most severe flooding from atmospheric rivers may not be in wet years (Swain et al. 2018). The largest flooding impacts are caused by persistent storm sequences on sub-seasonal timescales (i.e., short time periods, typically 2 weeks to 3 months), which bring a significant fraction of annual average precipitation over a brief period. These are storms events similar to the Great Flood events of 1861–1862 which caused widespread damage throughout northern California (Swain et al. 2016). Based on current climate modeling, the frequency of these large storm sequences over short timeframes is projected to increase noticeably under the High Emissions scenario. It is estimated that a storm similar in magnitude to the Great Flood events is more likely than not to occur at least once between 2018 and 2060 (Swain et al. 2018). A storm of this size would likely compromise large portions of the flood control systems in the Sacramento and the Central Valleys (Swain et al. 2018).

Regional changes in precipitation over the century will subsequently result in local changes in both annual precipitation and changes in the characteristics of storm events in the City and the County more broadly. Table 10 includes the projected precipitation changes in the County through 2099. The precipitation changes included in Table 10 are illustrated in Figure 7.

Table 10 Sacramento County Precipitation Change (Historic to 2099)

Geographic Area	Historic (1961–1990)	Change in Annual Mean Precipitation (Inches)			
		Near Term (2021–2050)	Midterm (2040–2070)	Late-Century	
				Medium Emissions (2070–2099)	High Emissions (2070–2099)
Sacramento County	18.3	20.1	20.2	20.3	22.1
Percent Change from Historic Period	NA	10%	10%	11%	21%

Note: NA = not available.

Source: CEC 2021a.

As shown in Table 10, annual precipitation in the County is estimated to increase between 11 and 21 percent by 2099 under the medium and high emissions scenarios, respectively. As noted in the *Fourth Climate Change Assessment Sacramento Valley Report*, although annual precipitation is anticipated to increase in the region, California's climate oscillates between extremely dry and extremely wet periods with annual precipitation varying widely from year to year. Climate change is anticipated to exacerbate these seasonal extremes with dry periods becoming dryer and wet periods becoming wetter (OPR et al. 2018). As a result, the frequency and severity of large storm events are anticipated to increase as well. These oscillations between extremely dry and extremely wet periods, which have occurred historically in the state, are anticipated to become more severe with rapid shifts from dry to wet periods known as "whiplash events" (Swain et al. 2016). As Swain et al. note in their research, the recent 2012–2016 drought followed by the 2016–2017 flood events throughout the state serve as a good example of the type of whiplash events that will occur more frequently over the next century. These types of events are estimated to increase by approximately 25 percent in northern California, with increases in frequency occurring largely after 2050 (Swain et al. 2016).

Although annual precipitation is anticipated to increase in the City over the coming decades, the majority of the increase in precipitation is likely to occur during extreme precipitation events (Swain et al. 2018). As a result, it is important to understand how these shifts in extreme precipitation events will affect the City and regional watersheds which affect the stormwater management system and larger waterways within the City, though they begin outside the City boundaries. The Cal-Adapt Extreme Precipitation Event tool provides information on how the characteristics of extreme precipitation events will change over the century, including the ability to analyze changes at the watershed level.

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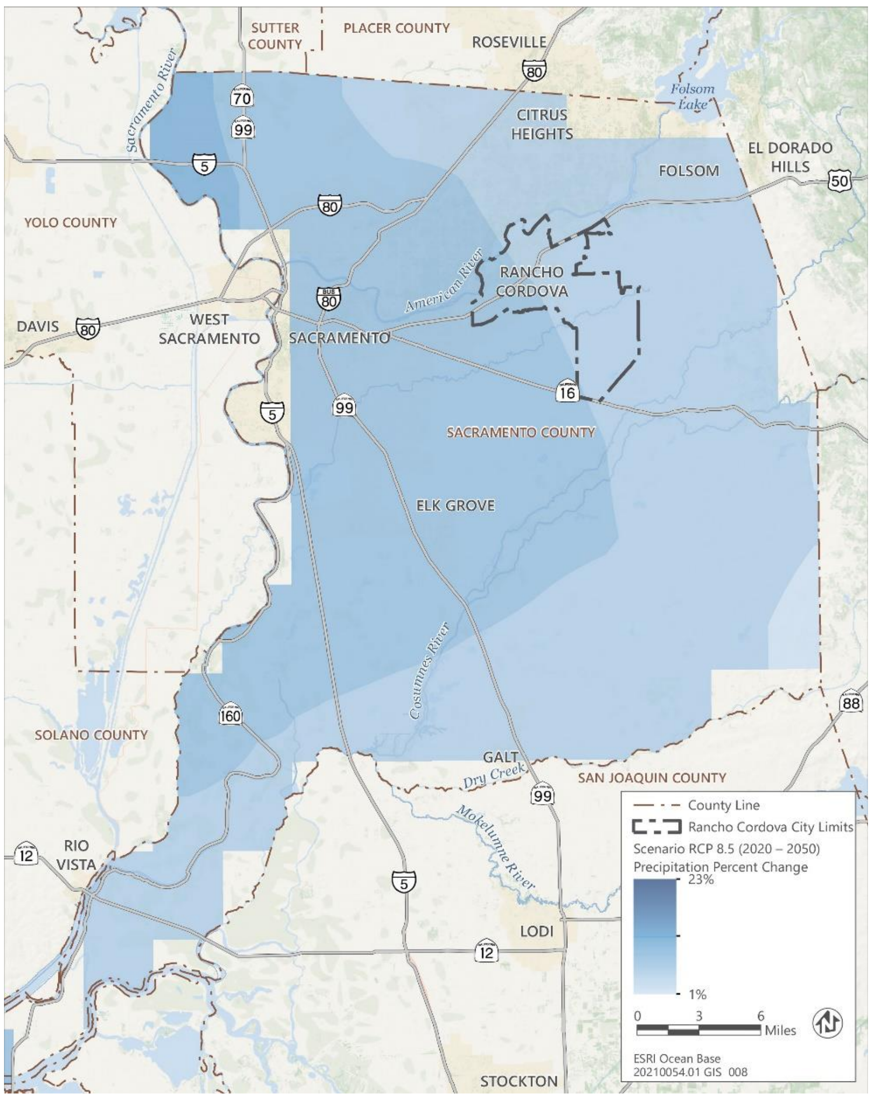
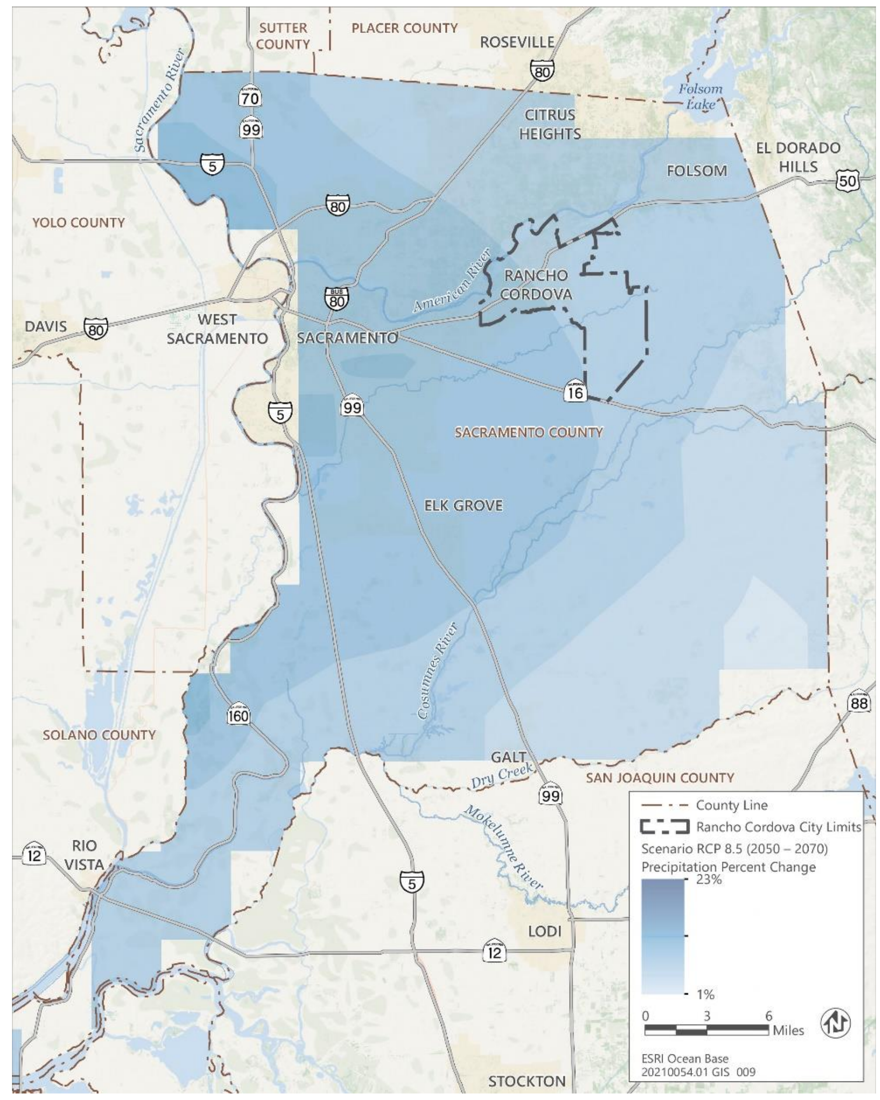
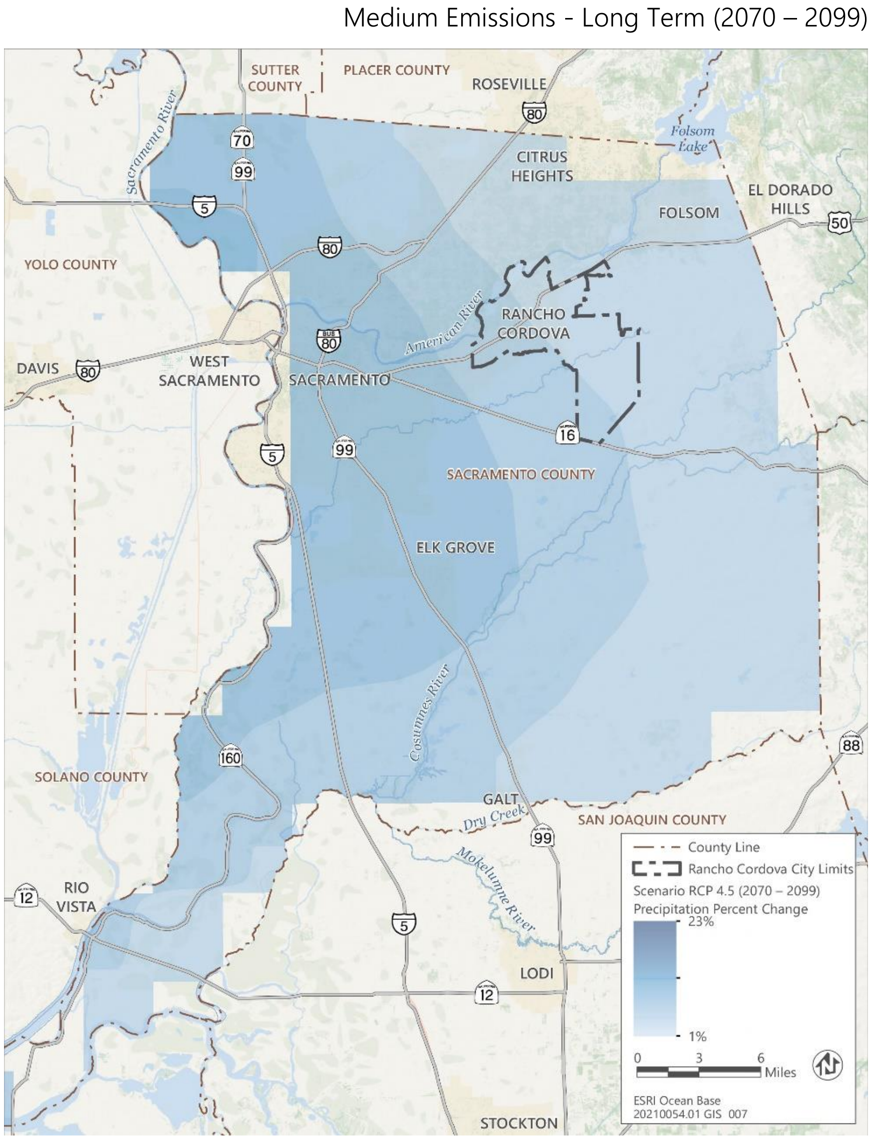
Near-Term (2021 – 2050)



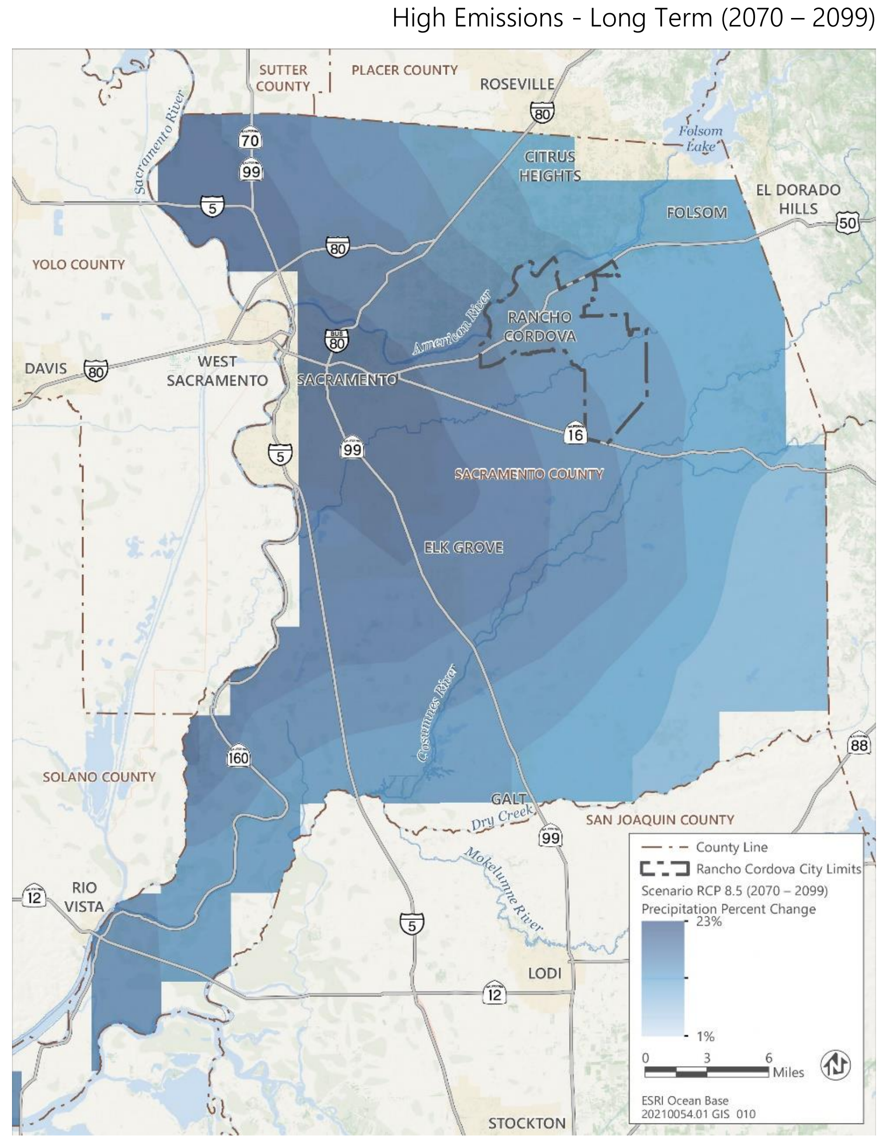
Midterm (2040 – 2070)



Medium Emissions - Long Term (2070 – 2099)



High Emissions - Long Term (2070 – 2099)



Source: Data downloaded from CEC and DWR in 2021.

Figure 7 Sacramento County Annual Average Precipitation through 2099

The characteristics of extreme precipitation events are what are most commonly used to model and design urban stormwater management systems to ensure the system can withstand the rainfall and stormwater runoff that occurs during these events. For the purpose of this analysis, the specific storm events chosen are consistent with three size storm events used to design the City's stormwater management system and are included in the *Sacramento County Drainage Manual*. These include the 2-, 10-, and 100-year storm events for rainfall over a 24-hour period. Table 11 summarize the changes in amount of rainfall projected to occur in American River watershed, the main watershed affecting the City for the 2-, 10-, and 100-year storm events through 2099 under the high emissions scenario.

Table 11 Changes in Rainfall During Extreme Precipitation Events

Watershed	Storm Event Size	Historic (1961–1990)	Change in 24-Hour Rainfall Period (Inches) for 100-Year Storm Event			
			Midterm (2035–2064)	Percent Change (Historic to 2064)	Long-term (2070–2099)	Percent Change (Historic to 2099)
American River Watershed	100	7.1	4.8	-32%	6.3	-11%
	10	3.5	2.9	-17%	3.5	0%
	2	2.1	2.0	4%	2.3	9%

Notes: This table shows estimated intensity (Return Level) of Extreme Precipitation events, which are exceeded on average once every 2, 10, and 100 years (Return Period). Extreme Precipitation events, defined here, are days during a water year (October through September) with 1-day rainfall totals above an extreme threshold set for each of the watersheds, which is based on the lowest annual maximum storm intensity in historic records.

Source: CEC 2021a.

As shown in Table 11, by midcentury, the American River watershed is projected to experience decreases in rainfall during the 100- and 10-year storm event and a slight increase in the 2-year storm event. By late century, the watershed will experience an 11 percent decrease in the intensity of the 100-year storm event, no change in the 10-year storm event, and a more nine percent increase in the 2-year storm events. Climate change is also projected to increase frequency and maximum duration of larger precipitation events. For the American River watershed, there is projected to be slight increase in number of larger precipitation events from five events historically by the late-century period. The maximum durations of these events will also increase from two days historically to 2.3 days by the late-century period.

Future Flood Impacts

Stormwater Drainage System

In current practice, the stormwater management systems in urban areas are modeled to manage large storm events based on characteristics of rainfall specific to the region from observed historical data. These characteristics in the intensity, duration, and frequency (IDF) of extreme precipitation events. These characteristics are described using IDF curves which are used to design various components of urban drainage systems including pipes, culverts, waterway channels, and detention ponds. Because climate change is anticipated to shift precipitation patterns during storm events, these changes could impact the performance of urban stormwater management systems (CEC 2018b). Increases or changes in the IDF curve can impact the integrity of stormwater infrastructure, particularly natural and engineered slopes such as levees (CEC 2018b). Based on current design standards, the City's drainage system has been designed based on the 2-, 10-, and 100-year storm events. Consistent with these standards, the primary sensitivity threshold for this precipitation and flooding impacts is the exceedance of the historic intensities of the 2-, 10-, and 100-year storm event for the 24-hour period. This threshold is developed from the understanding that the City's current stormwater management and flood protection system is designed based on historic observations for the size of flood events. If these historic storm intensities are exceeded, this would likely begin to disrupt, deteriorate, damage, or generally affect the performance of the City's stormwater management and flood protection systems (CEC 2018b). The analysis also considers the magnitude of the increase above the historic storm levels in the severity of the impacts that may occur.

Based on projections included in the Table 11 above, the City is not projected to experience larger increase in the size of these storm events and, therefore, not likely experience widespread flooding impacts from frequent but smaller storm events in the future. The small increases in the frequency and maximum duration of storm events are also not likely to have an impact on the City's stormwater management system.

Large Storm Events and Flood Protection

For this analysis the FEMA floodplain for the 100-year storm event is used as the sensitivity threshold for large storm events. Specifically, for future scenarios in which the intensity of the 100-year storm events is exceeded, parcels and roadways within these floodplains are seen to be at increased risk from large storm events. Based on information in Table 11, the City is not projected to experience increases in the intensity of the 100-year storm event and, therefore would likely not experience widespread flooding impacts from less frequent but larger storm events based on the Cal-Adapt data. However, as discussed above, California does experiment Atmospheric River events The presence of that contribute to the frequency of "wet years" in the state. While research indicates that the frequency of large storms events does increase in these wet years, the largest flooding impacts are caused by persistent storm sequences on sub-seasonal timescales (i.e., short time periods, typically 2 weeks to 3 months), which bring a significant fraction of annual average precipitation over a brief period (Swain et al. 2018). As noted in the *Fourth Climate Change Assessment Sacramento Valley Report*, climate change is projected to increase the intensity of "wet years" when they do occur and would likely have significant impacts on the County as well as the City.

Levee System Impacts

Increases in precipitation and particularly in the intensity and frequency of extreme precipitations due to climate change will have impacts on the integrity of levee systems (Jasim et al. 2017). Shifts in the IDF curve, particularly during multi-day events, can increase the risk of levee failure. A study which modeled the impacts of projected changes in IDF curves on the Elkhorn Levee in the County found that the probability of levee failure could increase between 3 and 12 percent during projected extreme precipitation events under the high emissions scenario when compared to the baseline scenario. Levee systems, particularly systems not maintained through the Federally protected levee system, are subject to other factors which can comprise their structural integrity including land subsidence and climatic conditions, which will be exacerbated by climate change (Jasim et al. 2017). The combination of land subsidence and specific climatic conditions including drought and severe flooding can further threaten the structural integrity of these aging levees (Robinson and Vahedifard 2016). There are currently two levees in the City which protect residential neighborhoods: Cordova Meadows Levee and Sunriver Levee. Based on the research referenced above, these levee systems will be at increased risk of failure due to increasingly intense storm events as well as increases in the frequency of these events.

<u>Potential Impact Score</u>

Based on this analysis, the potential impact score for Precipitation and Flooding is High.

2.4 DROUGHT AND WATER SUPPLY ANALYSIS

Existing and Future Drought Conditions

Long-term drought can have environmental, agricultural, health, economic, and social consequences. The County, along with larger areas of California, experiences periods of long-term drought that stress the ecosystem and water supplies; and subsequently, impact agriculture, public health, and the economy. The City relies on regional water supplies with the three primary water purveyors providing services within the City's planning area: Sacramento County Water Agency; Golden State Water Company; and California-American Water Company. The City's water supply is currently provided by a combination of ground and surface water resources. As discussed in the Natural Resources Chapter of the City's General Plan, future water supplies will be provided from a variety of sources, including: water from the Central Valley Project; appropriate water supplies; water transfer supplies; groundwater;

recycled water; surface water from the American River; SMUD transfer water; and Aerojet replacement water due contamination of the portion of the City's groundwater resources (City of Rancho Cordova 2006).

As noted in Appendix C – Water Supply Evaluation of the City's General Plan (City of Rancho Cordova 2006), it is likely that adequate water supplies would be available to meet the City's water demands associated with buildout of its current corporate limits. However, based on total known future supplies there would be a supply shortfall of approximately 51,089 acre feet per year to meet the City's total planning area demands. This shortfall would occur if development exceeded the total amount associated with buildout of the City's corporate boundaries. If water supplies are not available to meet buildout water demands, the City would either need to stop approving new growth within its jurisdiction or collaborate with regional water purveyors to investigate potential future water supply options within the context of the regional water supply planning environment (City of Rancho Cordova 2006). Additionally, the Water Supply Evaluation conducted as part of the City's General Plan does not consider future changes in water supply due to climate change. This analysis does not include a comprehensive assessment of the City's water demand and available supply but rather focuses on how future changes in precipitation, temperature, and drought conditions in the County are likely to affect the City overall.

Future Changes in Precipitation Patterns and Flooding

The City and larger Sacramento region are expected to experience slight overall increases in average annual precipitation in the long-term. However, projections show the Sacramento region will experience increased variability and volatility in precipitation events, such as droughts. California has a highly variable climate that is susceptible to prolonged periods of drought, and recent research suggests that extended drought occurrence (a "mega-drought") could become more pervasive in future decades (CEC 2021c). As discussed above in Section 2.3, precipitation patterns in California oscillate between extremely dry and wet periods. Climate change is anticipated to exacerbate these seasonal extremes with dry periods becoming dryer and wet periods becoming wetter (OPR et al. 2018). With the increased severity of oscillation between wet and dry periods and precipitation occurring over more intense but shorter periods in the year, this will reduce opportunities for groundwater recharge which ideally occurs during prolonged wet periods allowing for soil infiltration, deeper percolation, and the resulting groundwater recharge. While a unique long-term drought scenario would likely affect the City's overall water supply management practices, there is the potential for there still to be above average wet years within a long-term drought, as shown in Figure 8. These above average wet years have the potential to replenish water supplies in the City's reservoirs and help mitigate the impacts of long-term drought.

A substantial portion of the water resources supplied to the Sacramento region originates as rainfall and runoff from snowpack in the northern Sierra Nevada mountains and the surrounding foothills. Cal-Adapt uses data to model an extended drought scenario for all of California from 2051 to 2070. For this analysis, the extended drought scenario for El Dorado County rather than just the boundaries of the City, with tributaries in El Dorado County (i.e., the north fork and south fork of the American River) providing key water resources (e.g., Folsom Lake) to the Sacramento region. Due to increases in climate variability and rising temperatures, the state has already seen signs of decreased snowmelt in Northern California. Annual snowpack in the Sierra Nevada is expected to decline by as much as 33 percent by mid-century and 66 percent by the end of the century, relative to historic baseline snowpack (OPR et al. 2018). Further, rising temperatures have caused snowpack to melt faster and earlier in the year. These changes in snowmelt timing and streamflow availability will challenge local and regional water supply availability (OPR et al. 2018). Inadequate rainfall and reduced snowpack will result in decreased runoff to the reservoirs that supply water to the City, which will lead to less available water and more frequent water shortages.

As shown in Figure 8, El Dorado County's observed historical (1961-1990) average annual precipitation accumulation (i.e., rainfall and snowpack runoff) is 43.6 inches. Under the anticipated drought scenario between 2051 and 2070, the County's average annual rainfall accumulation would decrease to 37 inches (CEC 2021c), resulting in an approximately 15 percent decrease in annual average rainfall over a 20-year period.

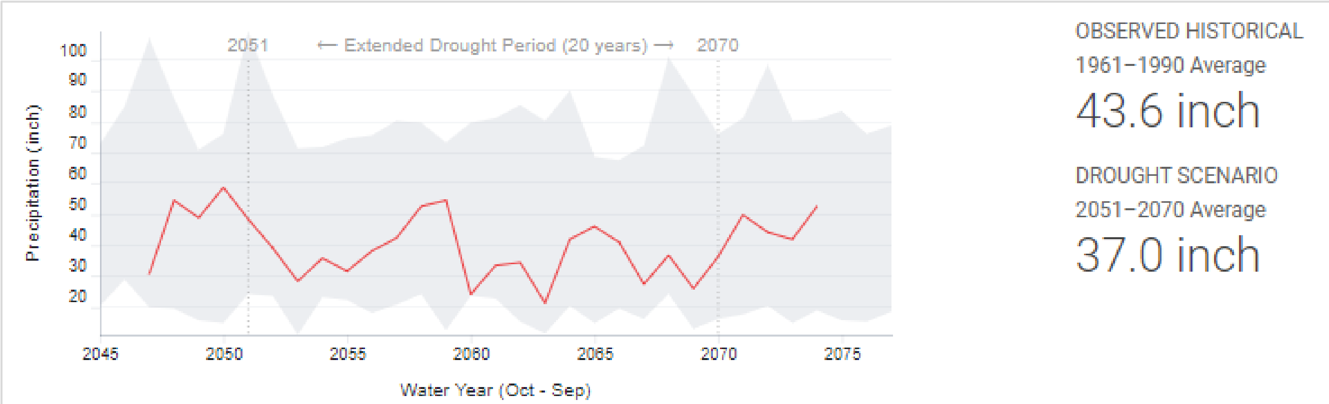


Figure 8 El Dorado County Long-Term Drought Scenario (2051-2070)
Source: CEC 2021c.

Drought Impacts

In the event of a severe and sustained drought lasting multiple years, water supplies provided to the City could be severely affected and result in the need for increased water conservation efforts to be implemented by jurisdictions in the Sacramento region. City residents may be encouraged to reduce household water demand, which may limit certain activities such as landscape irrigation. Each water purveyor that provides water resources to the City has an Urban Water Management Plan (UWMP), which includes a Drought Contingency Plan with specific actions to reduce overall water use by customers. The California Public Utilities Commission sets the rates and service terms for water utilities every three years after an exhaustive review, as required by state law. As a result, a long-term drought scenario would likely not result in rapid or unforeseen increases water costs for residents and businesses.

Droughts create cascading effects on community functions that may worsen in the future. The associated risks include adverse impacts on timber harvesting, reduction in native habitat and overall ecological function, increased forest fuels for wildfire, and economic consequences associated with decreases in tourism and recreation. More intense future droughts affecting the region could result in decreasing recreation opportunities on and surrounding Folsom Lake. Decreased recreation could have a direct impact on City business revenue from pass through visitors. Increased episodes of drought and increased water demand could result in water shortages for the region, endangering residents and ecological systems (e.g., flood control or sensitive habitat, recreational areas). Drought, as slow-moving disaster, can affect mental health if occurring over many years (Vins et al. 2015). While increasingly frequent and prolonged droughts directly affect residents, the built environment will not experience substantial direct impacts associated with this climate-related hazard.

A lack of soil moisture during long-term droughts can increase dust particle concentration, which can include harmful fungal spores and viruses, including Valley Fever (coccidioidomycosis) (OPR et al. 2018). The California Department of Public Health has highlighted the Sacramento Valley as a high-risk area for valley fever (OPR et a. 2018). Valley fever is found in disturbed, dry soil particles that must be inhaled. Symptoms of Valley Fever include chest pain, exhaustion, fever, coughing, joint and muscle pain, and difficulty breathing. Certain populations including pregnant women, the elderly, African, and Filipino Americans are particularly vulnerable to the severe cases of the disease (Brown et al. 2013).

<u>Potential Impact Score</u>

Based on this analysis, the potential impact score for Drought and Water Supply is Medium.

2.5 WILDFIRE ANALYSIS

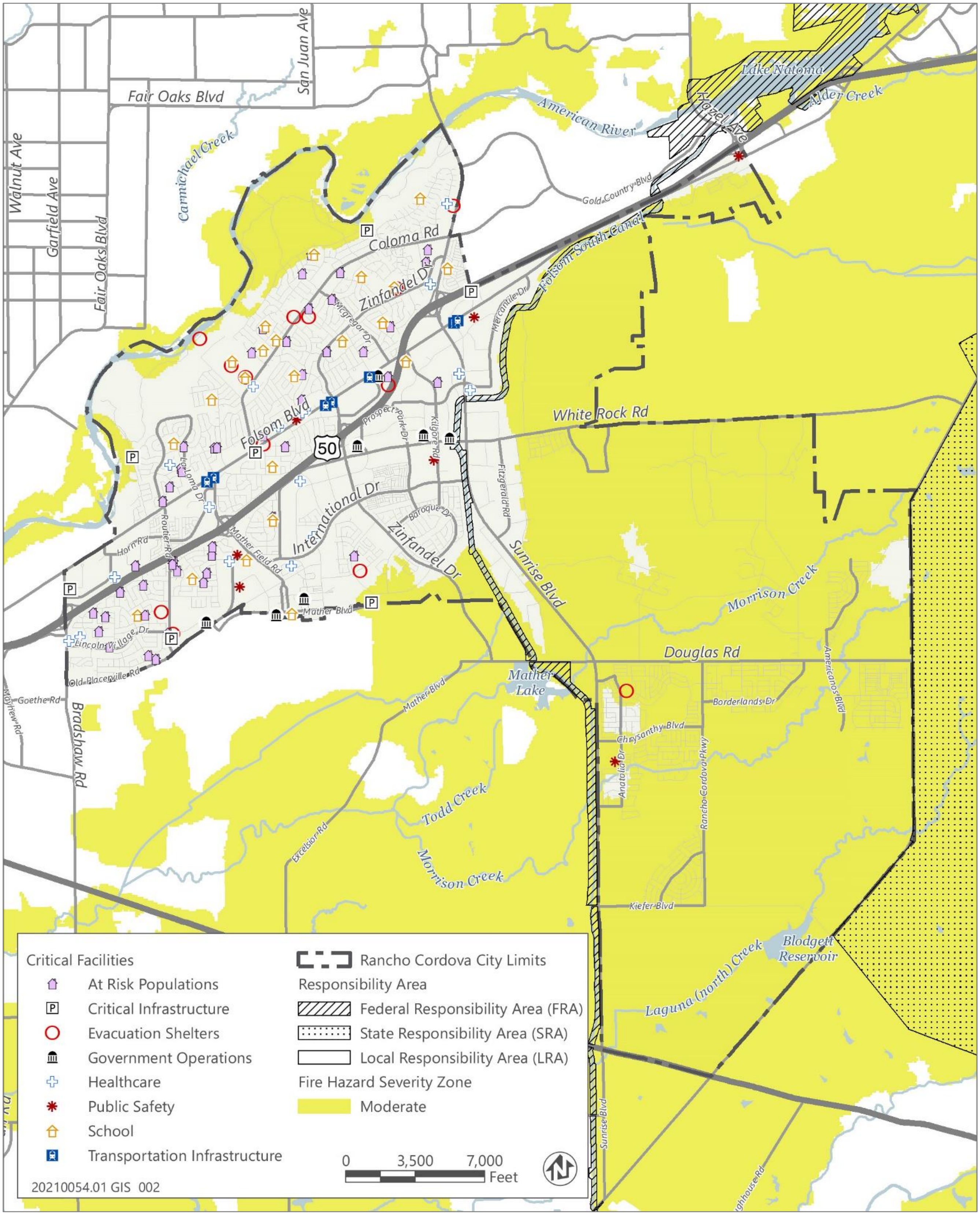
Existing and Future Wildfire Conditions

Wildfire behavior is dependent on several factors that, when identified and assessed, can help determine future wildfire characteristics. The three factors listed below contribute significantly to wildfire behavior and can be used to identify wildfire hazard areas:

- Topography: An area's terrain and land slopes affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases because heat from a fire tends to rise through convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- Fuel: Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuel sources are diverse and can include dead tree leaves, twigs, and branches of dead, standing trees; live trees; brush; and cured grasses. Buildings and other structures, such as homes and other associated combustibles, are also considered a fuel source.
- Weather: Components such as temperature, relative humidity, wind, and occurrence of lightning affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will ignite more readily and burn more intensely. Thus, during periods of drought, the threat of wildfire increases. Wind is one of the most significant weather factors in the spread of wildfires. The greater a wind, the faster a fire will spread and the more intense it will be.

The California Department of Forestry and Fire Protection (CAL FIRE) maps areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. These zones, referred to as Fire Hazard Severity Zones (FHSZ), are represented as Very High, High, or Moderate. The classification of a zone as a Moderate, High, or Very High FHSZ is based on a combination of how a fire would behave and the probability that flames and embers would threaten buildings. Wildfire risk is also determined by several factors, such as wind speeds, drought conditions, available wildfire fuel (i.e., dry vegetation), past wildfire suppression activity, and expanding wildland-urban interface (WUI) (i.e., places in and around forests, grasslands, shrub lands, and other natural areas) (Westerling 2018). Impacts from grass and brushfires in the City could result in evacuations of portions of the City as well as loss of property and impacts to critical facilities.

Based on data included in the City's LHMP Annex shown in Figure 9, large portions of the eastern and southern portions of the City are located in areas designated as Moderate FHSZ. Given the City's location and urban setting, there is relatively low risk of impacts from wildfires relative to areas northeast of the City in El Dorado and Amador County; however, the City is at increased threat of grass and brushfires. Although the majority of the City's developed areas are at lower fire risk, the City does include a few key areas with increase fires risk in undeveloped recreation areas along the American River. As a recreation area, there are limited roadways within these areas, making fire equipment access difficult. While threatened by fire risk along the American River, residents are also at risk from health impacts from poor air quality associated with wildfire smoke. Poor air quality can be generated in the City from wildfires occurring throughout northern California as has been experienced in recent years.



Source: Sacramento County 2021 and data provided by City staff.

Figure 9 Fire Hazard Severity Zones and Critical Facilities in the City of Rancho Cordova

Future Wildfire Risk

Increased Wildfire Risk in the Sacramento Valley

Climate change effects, including increased temperatures and changes to precipitation patterns, will exacerbate many of the factors that contribute to wildfire risk. Increased variability in precipitation may lead to wetter winters and increased vegetative growth in the spring, and longer and hotter summer periods will lead to the drying of vegetative growth and ultimately result in a greater amount of fuel for fires. This has already been seen across the state in recent years, with the area burned by wildfires increasing in parallel with rising air temperatures (OEHHA 2018). These factors, combined with intense wind conditions, cause fires to spread rapidly and irregularly, making it difficult to predict fires' paths and effectively deploy fire suppression forces.

Relative humidity is also an important fire-related weather factor; as humidity levels drop, the dry air causes vegetation moisture levels to decrease, which consequently increases the likelihood that plant material will ignite and burn. With an increase in hotter and drier landscapes, humidity levels may continue to drop and result in higher fuel levels, increasing the risk of wildfire (Schwartz et al., 2015).

Cal-Adapt provides projections for future annual mean hectares burned within the Sacramento Valley region, as defined in the California Fourth Assessment Report, when wildfires do occur. Because the City is not directly threatened by large-scale wildfires but is likely to be impacted by regional effects such as wildfire smoke, this analysis focuses on the Sacramento Valley region. As shown in Table 12, the total area burned annually by wildfire within the Sacramento Valley region is expected increase from the historic (1961-1990) annual average of 20,956 hectares to 23,942 hectares in the near-term and increase further in the midterm to 28,759 hectares. In the long-term, average annual area burned in the region is projected to increase to 31,670 hectares and to 41,784 hectares under the low and high emissions scenarios, respectively (CEC 2021e).

Table 12 Changes in Annual Average Area Burned in the Sacramento Valley Region

Average Annual Area Burned	Historic Modeled (1961-1990)	Near-Term (2021-2050)	Midterm (2035-2064)	Long-Term (2070-2099)	
				Low Emissions	High Emissions
Average Annual Area Burned (hectares)	20,956	23,942	28,759	31,670	41,784

Notes: Observed historical average annual area burned data was not available from Cal-Adapt; the modeled historical average annual area burned data under the low emissions scenario was available and used as proxy data.

Source: CEC 2021e.

Wildfire Impact Analysis

Increased temperatures and changes in precipitation patterns associated with climate change will lead to reduced moisture content in vegetation and soils during dry years. These conditions are expected to increase the amount of area burned by wildfires that will occur predominantly outside of the City boundaries but may have secondary impacts on the City from wildfire smoke, disruptions to transportation behavior, or the increased prevalence of Public Safety Power Shutoffs (PSPS).

Regional wildfires threaten energy generation and transmission infrastructure and have the capacity to damage facilities, create maintenance costs, and reduce transmission line efficiency (CAL FIRE 2020). Grid-supplied as well as locally generated electricity, which is the primary source of power for residences in the City, is provided by the Sacramento Municipal Utilities District (SMUD). Regional communications infrastructure can also be affected by wildfires, which is often located in remote locations, such as mountaintops, resulting in significant threat from wildfire. Regional wildfires may also generate impacts on transportation behavior in the City during emergency evacuation events. This could include potential route diversion and increases in traffic congestion due to road closures from wildfire impacts or post-wildfire runoff or landslide affected roadways. While fire causes relatively insignificant direct impact on roads and highways, cracking and degradation of pavement is not uncommon.

Although the City is not at a high risk from the direct impacts of wildfires, the City's location within the Sacramento Valley makes it susceptible to impacts of smoke from wildfires in the Sierra Nevada mountains and the coastal mountain ranges of northern California. Community public health factors that can increase the impacts of wildfire smoke include the prevalence of asthma in children and adults; chronic obstructive pulmonary disease; hypertension; diabetes; obesity; and percent of population 65 years of age and older. Additionally, socioeconomic characteristics such as poverty rates, educational achievement, and unemployment rates have all been linked to the increased prevalence of underlying health conditions including depression, obesity, hypertension, and diabetes, making populations in the City with these characteristics more vulnerable to wildfire smoke impacts (Kivimäki et al. 2020). Exposure to wildfire smoke, particularly exposure by vulnerable populations, can result in worsening of respiratory symptoms, increased rates of cardiorespiratory emergency visits, hospitalizations, and even death (Rappold et al. 2017). Increased annual average temperatures and the subsequent increase in the frequency and severity of wildfires in northern California are anticipated to result in impacts from wildfire smoke on the City's population and vulnerable populations in particular (OPR et al. 2018).

Specific populations including linguistically isolated households, senior citizens, and individuals with disabilities or those experiencing homelessness are particularly vulnerable during evacuation events, if wildfire evacuations were to occur in the City. Impacts affecting these populations include inability to access or receive and/or understand warning messages and evacuation notices, limited ability to evacuate due to lack of mobility, limited situational understanding from cognitive conditions, and reliance on medication or treatment devices. Wildfires in the larger Sacramento region can also result in secondary impacts affecting populations. A major consequence of wildfires is post-fire flooding and debris flow. The risk of floods and debris flows after fires increases due to vegetation loss and soil exposure. These flows are a risk to life because they can occur with little warning and can exert great force on objects in their path.

Public Safety Power Shutoffs

Due to a number of recent large-scale wildfires in Northern California caused by electricity infrastructure exposed to extreme heat and high-winds, utilities have begun to implement PSPS to avoid wildfire risk. PSPS events can result in communities experiencing no electricity for multiple days and prevent individuals from using prescribed medications and treatments that rely on electricity or refrigeration. PSPS events can also result in impacts to commerce and economic losses, particularly for businesses that rely on refrigeration such as grocery stores. Hazards such as landslides, wildfires, and flooding can also affect underground natural gas pipelines, exposing and/or damaging these pipelines. The damage resulting from climate change-related hazards on electricity and natural gas infrastructure can have a greater impact on disadvantaged populations, particularly communities that are low-income or individuals who have limited mobility or lack the financial means to make repairs to their property.

Major wildfires often result in the damage to transportation infrastructure and/or closure of roadways. Combined with reduced visibility from wildfire smoke, this leads to a disruption in normal transportation networks and accessibility. Congestion that starts during a mass evacuation can lead to additional traffic management problems, which can result in delays to emergency response, evacuation, and logistical support.

Potential Impact Score

Based on this analysis, the potential impact score for Wildfire is Medium.

2.6 ADAPTIVE CAPACITY

This section analyzes the City's current capacity to address and adapt projected increase in severity and frequency of climate-related hazards. The City and regional agencies have established plans, policies, and programs that address climate change impacts. These efforts, however, do not comprehensively identify strategies that will be taken by local and regional governments to address the full scope and magnitude of potential climate impacts. Climate change will increase the frequency and severity of climate-related hazards in the future, requiring updates to emergency response, land use planning, and strategic partnerships. A summary of the regional and local planning efforts to adapt to climate change and climate-related hazards are presented below.

Existing State and Regional Planning Efforts

California Department of Transportation

The Climate Change Branch in the California Department of Transportation (Caltrans) Division of Transportation Planning is responsible for overseeing the development, coordination, and implementation of climate change policies in all aspects of the Department's decision making. In 2013, Caltrans completed its first report intended to help reduce GHG emissions and adapt the State's transportation system to prepare for the impacts of climate change (Caltrans 2013), which includes a series of strategies to reduce the risk from various climate change impacts, including increasingly intense precipitation events.

Strategies outlined in the report include using vegetation to prevent erosion along roadways, assessing and resizing culverts to accommodate increased precipitation, coordinating with local jurisdictions regarding route closures as well as pursing individual projects included in the Caltrans District Vulnerability Assessments. In 2019, Caltrans completed the District 3 Vulnerability Assessment which provides an overview of potential climate impacts to the district's portion of the State Highway System. The District 3 Vulnerability Assessment is part of a larger adaptation process undertaken by Caltrans to assess risk to Caltrans assets in the district and prioritize adaptation strategies from various climate impacts. The District 3 Vulnerability Assessment includes projected climate change exposure from precipitation change, flooding, temperature change, wildfire, storm surge, and sea level rise.

Sacramento Area Council of Governments

The Sacramento Area Council of Governments (SACOG) is the Metropolitan Planning Organization for the six-county Sacramento region including the 22 cities within El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties. SACOG develops the region's long-range transportation plan which guides transportation and land use planning in the region. In 2015, SACOG adopted the Sacramento Region Transportation Climate Adaptation Plan to address how potential climate change impacts affect the region's transportation infrastructure. The plan highlights key impacts from climate change that could occur on the Sacramento region's transportation system in the future as well as a guiding action plan for future adaptation planning and implementation.

Sacramento County

The County completed a vulnerability assessment in 2015 that assessed the projected changes associated with climate change in the County (including the City of Rancho Cordova), including impacts from changes in precipitation patterns and increased flooding. The assessment highlighted the unique vulnerabilities of the County to climate change including projected increases in the frequency, intensity, and duration of extreme storm events as well as projected regional temperature increases leading to earlier and more rapid melting of the Sierra Nevada snowpack and subsequent increases in flow rate of surface waters in the County (Sacramento County 2021).

The County is currently working to conduct a study looking at current and future precipitation trends in the County under the influence of climate change. This work will inform an update to the County's Drainage Manual better prepare for future changes in precipitation. The County Drainage Manual is used by incorporated cities in the County to design and build drainage and stormwater infrastructure and inform development standards.

Sacramento Public Department of Health Services

As a division of the Sacramento County Department of Health Services, Sacramento County Public Health works to promote, protect, and ensure conditions for optimal health and public safety for residents and communities in the County. As part of its work in helping prevent health impacts from extreme heat, Sacramento County Public Health conducts community education related to public health and emergency preparedness. It also has developed plans with the Sacramento Office of Emergency Services on wildfire smoke and response plans. Sacramento County Public Health has also begun to research the impacts of climate change using available tools specific to extreme heat and public health.

Sacramento Office of Emergency Services

The Sacramento County Office of Emergency Services (Sacramento OES) provides support and resources for emergency preparedness through its Sacramento Ready Program and operates the county's Emergency Alerts Notification System. Sacramento, Yolo, and Placer County residents can use the Citizen Opt-In portal to receive critical and time-sensitive alerts regarding flooding, levee failures, severe weather, disaster events, unexpected road closures, missing persons, and evacuations of buildings or neighborhoods in specific geographic locations. Sacramento OES coordinates with police and fire departments in the incorporated cities in the county for emergency planning and responses purposes. In regard to heat-related events, Sacramento OES focuses on the immediate effects of events; near-term risks from these events, particularly fires, droughts, and air pollution. Sacramento OES also maintains the County's Emergency Operation Plan, which includes protocols for emergency operations during extreme heat events. Sacramento OES also develops and updates planning documents, including the County's *Evacuation Plan*, *Emergency Operations Plan*, *Mass Care and Shelter Plan*, and the County's LHMP and Annexes including the City. The City's Annex in the LHMP includes climate change as a hazard and discusses how climate change will impact other hazards in the City, rating the likelihood of occurrence high and vulnerability to climate change as high.

Sacramento Metropolitan Fire District

The Sacramento Metropolitan Fire District (SMFD) provides fire protection services, fire suppression, inspection, plan checking, emergency transportation and medical services, public education, advanced life support, and rescue services to the City as well as the unincorporated portions of the Planning Area and southern the County. SMFD encompasses approximately 417 square miles in the southern portion of the County and includes both urban and rural areas. SMFD is the largest district in the County and the seventh largest local fire agency in the State of California. SMFD has 42 fire stations with approximately 673 paid personnel on its staff. The District includes 39 engine companies, 5 truck companies, 12 medic transportation units, 8 historical fire apparatus, 5 crash/rescue units, and various watercraft response units. In the City's General Plan Planning Area, SMFD currently has seven fire stations.

Sacramento Metropolitan Air Quality Management District

The Sacramento Metropolitan Air Quality Management District (SMAQMD) is the agency responsible for monitoring air pollution in the Sacramento Valley Air Basin and for developing and administering programs to reduce air pollution levels below the health-based standards established by the State and Federal governments. SMAQMD is working to develop a UHI model to help identify sensitivities in the district to extreme heat and climate change, as well as develop and model the effects of mitigation strategies (e.g., green roofs, cool pavements). SMAQMD is also working to develop an update to the California Emissions Estimator Model and hopes to include an element to the tool that provides quantification of the benefits of climate adaptation strategies. The agency also works to provide funding from Assembly Bill 617 for the Clean Cars for All program, which provides increased access to electric vehicles for low-income residents. As part of the Plan development process, representatives from SMAQMD participated in the Heat Working Group and provided input on the development of this white paper.

Sacramento Municipal Utility District

SMUD is a publicly owned utility that provides electricity to the County and small portions of Placer County. In regard to climate change, SMUD has developed a sustainable communities program focusing on disadvantaged communities, as well as its Climate Readiness Assessment and Action Plan (SMUD 2016), which is intended to help the utility to adapt to and address climate change through community engagement, enterprise programs, capital projects, and operational initiatives. SMUD also works with the Sacramento Tree Foundation to operate the Sacramento Shade Program, which provides landscape assessments and free shade trees to SMUD customers. SMUD also operates Living Future Project Accelerator, which emphasizes sustainable commercial and residential building practices, and is beginning to work toward a land-based carbon storage program.

Sacramento Tree Foundation

The Sacramento Tree Foundation is a nonprofit organization that empowers people to plant, protect, and learn about trees in the Sacramento region. The organization has several programs that support its mission and provide services to cities and residents in the Sacramento region:

- Sacramento Shade Program – This program, in partnership with SMUD, provides free landscape assessments and up to 10 free shade trees that provide a host of benefits to the residents and the surrounding neighborhoods. The organization's work with SMUD emphasizes planting locations and tree varieties that reflect SMUD's goals for carbon sequestration.
- NeighborWoods Program – This program provides support to communities throughout the Sacramento region by offering expertise, training, tools, and advice to plant and protect trees in their neighborhoods.
- Urban Wood Rescue Program - This program works to preserve useful life of the trees by providing logging and milling services for trees which have reached the end of their life. This lumber is then sold, providing a second life for the trees while capturing carbon sequestered during their lifetime.

The organization also conducts community outreach campaigns, utilizing door to door canvassing and community meetings to promote the benefits of the urban forest.

Existing Local Planning Efforts

City of Rancho Cordova

In 2006, the City adopted its first General Plan. The General Plan includes a Safety Element which includes goals, policies, and actions to address a set of safety issues in the City including traffic hazards, airport safety, neighborhood policing, and flooding. The following list of Goals and corresponding policies in the Safety Element help address and mitigate impacts from climate-related hazards.

GOAL S.2: Reduce the possibility of a flooding or drainage issue causing loss of life or damage to property.

- Policy S.2.1: Support and encourage efforts to limit and reduce the potential for community flooding from the Cosumnes or American Rivers.
- Policy S.2.2: Manage the risk of flooding by discouraging new development located in an area that is likely to flood.
- Policy S.2.3: Discourage the creation of new parcels when the presence of easements, floodplain, marsh, or riparian habitat, and/or other features would leave insufficient land to build and operate structures. This policy shall not apply to open space lots specifically created for dedication to the City or another appropriate party for habitat protection, flood control, drainage, or wetland maintenance.
- Policy S.2.4: Ensure that adequate drainage exists for both existing and new development.

GOAL S.9: Reduce the probability of fire damage to all the City's structures.

- Policy S.9.1: Cooperate with the Sacramento Metropolitan Fire District (SMFD) to reduce fire hazards, assist in fire suppression, and ensure efficient emergency medical response.
- Policy S.9.2: Provide infill development with adequate off-site improvements to meet onsite fire flow requirements.
- Policy S.9.3: Consider establishing mitigation fees to fund adequate fire protection and emergency medical response facilities, if such fees are critical and necessary to meet the facility funding needs of SMFD and existing methods of financing are inadequate.

The City also has regulations within the Municipal Code, specifically, Chapter 23.716 "Landscaping," that provides guidance for landscaping and tree planting requirements for new development in the City. Title 19, "Trees," of the Municipal Code provides regulations regarding the preservation of public trees of local importance and mitigation of tree loss.

The City adopted their Emergency Operations Plan (EOP) in 2018. The EOP describes how the jurisdiction will manage and coordinate resources and personnel responding to emergency situations. It detailed information covering Emergency Operations Center procedures, documentation and reference and support information and includes response protocols for a comprehensive set of emergency situations including climate-related hazard events including flooding, wildland fire, and extreme heat. The document is continually evolving as the City grows with recommendations for improvement solicited and carefully considered for future revisions.

City of Rancho Cordova Public Works Department

The City's Public Works Department supports important activities and functions within the City, which have an impact on UHI, including designing, constructing, operating, and maintaining the City's road network and drainage systems. The Public Works Department is also responsible for the maintenance of roadways in the City as well as the City's Capital Improvements Program, which includes developing, upgrading and implementing the City's *Capital Improvements Program 5-Year Plan* – a list of improvement projects for various components of City operations.

City of Rancho Cordova Police Department

The Rancho Cordova Police Department is contracted through the Sacramento County Sheriff's Department to provide patrol, traffic enforcement, investigations, and administrative services to the City. Portions of the General Plan Planning Area outside the current City limits are within the Sacramento County Sheriff Department's jurisdictional boundaries.

Summary of Adaptive Capacity

Table 13 evaluates the specific climate change effects covered under each of the plans and reports discussed above. As shown in Table 13, multiple planning efforts have been made to address the climate change-related impacts that are expected to impact the City. Mitigation and adaptation measures for hazards including flooding, storms and extreme weather events, and wildfires and severe wind have been relatively well documented in assessments prepared previously. Other climate change hazards including impacts on human health, drought and available water supply, extreme heat and heat waves, landslides, and sea-level rise are noted in various regional planning efforts. However, these efforts do not analyze regional climate change effects consistently while developing adaptation strategies. 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 specific and targeted policies should be developed to address the resilience of the most vulnerable populations and assets in the City.

Table 13 Adaptive Capacity in Existing Plans and Reports

Plan or Report	Climate Change Hazard			
	Extreme Heat Events	Extreme Precipitation and Flooding	Drought and Water Supply	Wildfires
Sacramento County LHMP Annex	✓	✓	✓	✓
City's General Plan		✓	✓	✓
California's Fourth Climate Change Assessment Sacramento Valley Regional Report	✓	✓	✓	✓
Caltrans Climate Change Vulnerability Assessment District 3	✓	✓		✓
City Water Purveyor's Urban Water Management Plans		✓		
City's Emergency Operations Plan		✓	✓	✓

Source: Data compiled by Ascent Environmental in 2021.

Adaptive Capacity Scoring by Hazard

Based on a combination of the adaptation initiatives outlined in these documents and additional adaptive efforts that have been pursued, the City'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 rating indicates a community is unprepared and requires major changes to address hazards (CalOES 2020).

Increased Temperatures and Extreme Heat

Adaptive Capacity Rating: Low

The City does not generate its own electricity and may not be in a position to protect vulnerable populations from the impacts that will be caused by rising temperatures and a drastic increase in the number of extreme heat events. As rising temperatures and extreme heat lead to more frequent electricity outages, the lack of backup power sources for residents and business will expose more residents to risk of health impacts associated with extreme heat. While the LHMP does include extreme heat as a hazard, relevant information is limited. Impacts associated with increases in temperatures and extreme heat events are the largest potential impact for the City. This means that although the City may be adequately prepared to address extreme heat events currently, the vulnerabilities faced by the City including impacts to youth, seniors, and homeless populations as well as impacts on energy demand and services are likely to exceed to City's current capacity.

For these reasons, the adaptive capacity ranking for increased temperatures and extreme heat is Low.

Increased Wildfire Risk

Adaptive Capacity Rating: High

The County, State and regional agencies, and other partners are implementing a diverse array of policies and programs that address the design of structures, fire safety, community preparedness, and emergency response, decreasing the City's overall vulnerability to the threat of wildfire. However, as the threat of wildfire increases both locally and regionally, the City, in coordination with federal, state, and local agencies, will need to continue to adapt to projected impacts from wildfire. While the City is at relatively low risk from direct wildfire impacts, the affects from regional wildfires on the City through secondary impacts such as wildfire smoke and regional transportation route disruptions will continue to affect the City. Because these impacts have been increasing in intensity and severity in recent years and are somewhat novel, the City will need to make moderate changes to expand its capacity to address these types of impacts.

For these reasons, the adaptive capacity associated with wildfire is high.

Increased Extreme Precipitation and Flooding

Adaptive Capacity Rating: Medium

The City has adequately assessed its flood risk through the LHMP and other planning documents. The City and stakeholders have developed, adopted, and enforced several policies and programs that will serve to mitigate impacts from increasingly frequent floods in the future. While the City's populations and assets are not severely threatened by floods as identified in the LHMP, the City, the County and other regional and local agencies can continue to implement policies and programs that reduce the risks associated with significant flooding events. As noted in Section 2.3, the risk of a large-scale storm event similar to the Great Flood events of 1861–1862 is more likely than not occur at least once by 2060. This means that although the City is adequately prepared to address flooding events currently, an event such as this would result in widescale impacts on the City and potentially affect Folsom Dam.

Therefore, the adaptive capacity associated with increased extreme precipitation and flooding is medium.

Drought and Water Supply

Adaptive Capacity Rating: Medium

The City understands that a reliable water supply is essential. Each water purveyors that provide water resource so the City have UWMPs and Drought Contingency Plans, which will assist in building resilience to future drought conditions. The City is still somewhat vulnerable to these climate-related hazards, particularly in terms of the economic and related impacts (irrigation of recreation fields, constraints on future housing development) of generally dryer conditions, interannual precipitation variability, and reduced snowpack. These climate change effects will pose risks to tourism-related businesses that rely on pass-by visitors to Folsom Lake and the surrounding recreation areas when long-term droughts do occur.

Based on the reasons stated above, the adaptive capacity ranking for drought, water supply, and reduced snowpack is medium.

2.7 VULNERABILITY SCORING

The City's vulnerability to each identified climate change impact is assessed based on the magnitude of risk posed to populations and assets, and any existing measures in place to mitigate these impacts. Potential impacts and adaptive capacity are rated on a qualitative scale from Low to High based on guidance from the APG. A description of each qualitative rating for both factors is provided in Table 14.

Table 14 Potential Impact and Adaptive Capacity Scoring

Score	Potential Impact	Adaptive Capacity
Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capability to manage climate impact; major changes would be required.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

Source: CalOES 2020

After rating potential impacts and adaptive capacity, an overall vulnerability score is determined for each climate change impact. This scoring can help the City understand which effects pose the greatest threats and should be prioritized in future planning efforts. Table 15 presents the rubric used to determine the overall vulnerability scores based on the ratings for potential impacts and adaptive capacity.

Table 15 Vulnerability Scoring

<table>
<tr><td colspan="2"></td><td colspan="3">Vulnerability Score</td></tr>
<tr><td rowspan="3">Potential Impacts</td><td>High</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Medium</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>Low</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td colspan="3">Adaptive Capacity</td></tr>
</table>

Source: CalOES 2020.

Vulnerability scoring for each climate change effect identified and evaluated in Sections 2.2 through 2.6 is included in Table 16 below. The table shows that increased temperatures and extreme heat is assigned a vulnerability rating of 5 and therefore should be a high priority for the City. Impacts from increased precipitation and flooding was scored as a 4 while drought and water supply risks was assigned a vulnerability score of 3. These climate change effects are likely to have significant impacts on the City's populations, built environment, and community functions in the near-term, and although a variety of adaptive efforts related to both climate change effects are in place and underway, the magnitude of the risks posed by these hazards contributes to high vulnerability in the City. Increased wildfire risk is characterized as having a vulnerability rating of 2. This climate change effect will likely have lower priority impacts on the City and is currently being addressed adequately based on existing conditions, but additional adaptation and resilience planning will be required in the future to mitigate impacts and protect the City.

Table 16 Vulnerability Scoring Summary

	Vulnerability Score		
Climate Change Effect	Vulnerability Score		
	Adaptive Capacity	Potential Impact	Vulnerability
Temperature and Extreme Heat	Low	High	5
Precipitation and Flooding	Medium	High	4
Drought and Water Supply	Medium	Medium	3
Wildfire	High	Medium	2

Source: CalOES 2020; adapted by Ascent Environmental in 2021.

3 CLIMATE ADAPTATION STRATEGIES

CLIMATE ADAPTATION STRATEGY OPTIONS

The adaptation strategies included in this memo serve as an initial set of options to be considered for inclusion in the City's CAP. The strategies focus on helping the City prepare for the short-term (2021-2050) and more long-term (2050-2099) climate impacts that have been included in the vulnerability assessment portion of this memo. This set of adaptation strategies respond to the impacts from climate-related hazards discussed above and works to build upon the comprehensive set of plans and initiatives the City has already undertaken to reduce risk from natural hazards that will be exacerbated by climate change. As noted in the vulnerability assessment, climate change will affect and exacerbate natural hazards the City has experienced historically as well as create novel hazards. The set of resilience strategies is intended to respond to and help the City become more resilient to the projected increases in intensity and severity of existing hazards as well as help the City respond appropriately to novel hazards created by climate change. The strategies serve as an initial set of ideas for City staff to consider and further develop with Ascent and do not represent the final set of strategies that will be included in the City's CAP.

EQUITY CONSIDERATIONS FOR ADAPTATION STRATEGY

As the set of adaptation strategies is developed through City staff and community feedback, it is important to carefully consider how implementation of the strategies can be done in an equitable manner that addresses and prioritizes vulnerable populations and historically disadvantaged communities in the City. To help with these considerations, several types of equity can be used to guide this process and inform how successful implementation of the strategies is measured. Three types of equity that have been prioritized in the State's Adaptation Planning Guide (Cal OES 2020) are provided in Table 1. These considerations are included here to ensure that equity is incorporated early in the adaption strategies and CAP implementation process.

Table 1

TYPE OF EQUITY	EQUITY METRICS
Procedural Equity	▸ Create processes that are transparent, fair, and inclusive in developing and implementing any program, plan, or policy. ▸ Ensure that all people are treated openly and fairly. ▸ Increase the civic engagement opportunities of communities that are disproportionately impacted by climate change.
Distributional Equity	▸ Fairly distribute resources, benefits, and burdens. ▸ Prioritize resources for communities that experience the greatest inequities and most disproportionate impacts and have the greatest unmet needs.

TYPE OF EQUITY	EQUITY METRICS
Structural Equity	▸ Make a commitment to correct past harms and prevent future unintended consequences. ▸ Address the underlying structural and institutional systems that are the root causes of social and racial inequities. ▸ Include adaptation strategies to eliminate poverty, create workforce development, address racism, increase civic participation, protect housing availability, increase education, and provide healthcare.

Source: Cal OES 2019

ORGANIZATION OF THE ADAPTATION STRATEGIES

The climate adaptation strategies in the forthcoming CAP will be structured similar to the GHG reduction strategies and correspond to each of the climate-related hazard categories included in the element (i.e., flooding, drought, and extreme heat). Provided below is a brief explanation of each of the components that will be included for each of the hazards in the element.

- Strategy – An overarching statement that describes a desired strategy approach and/or a future condition or "end" state.
- Measure – A measure that helps implement specific components of an overarching strategy and guides a specific course of action for decision-makers to use during CAP implementation.
- Action – An action, procedure, program, or technique that carries out the measure or part of a measure.

The set of adaptation strategies included in this memo, once refined and finalized, will be incorporated in to and adaption chapter in the CAP that will include a summary of the vulnerability assessment and the final set of strategies, measures, and actions.

Adaptation Strategy 1: Increase community resilience and ensure equitable implementation of adaptation strategies

Measure 1.1: Prioritize historically marginalized communities and climate-vulnerable populations (e.g., elderly, youth, ethnic minorities, linguistically isolated communities) during implementation of climate adaptation strategies, ensuring that climate impacts and climate adaptation strategies do not lead to disproportionally adverse effects on vulnerable populations.

- Action 1.1.A Ensure community outreach and education opportunities focused on adaptation strategy implementation include multi-lingual options for both written materials and in-person engagement. Include demographic surveys as part of community outreach events to ensure that participants are representative of the demographic makeup (e.g., race, age, ethnicity) of the City's population as a whole.
- Action 1.1.B As adaptation strategies are implemented, ensure that the goal of the strategy aligns with community needs by providing opportunities for community organizations and other stakeholders to review strategy details before implementation. Use equity metrics included in the State's Adaptation Planning Guide, or similar metrics, to develop an Equity and Environmental Justice Project Checklist to be used during the design and development of City-led programs and capital improvement projects to ensure they are implemented equitably and, where appropriate, historically disadvantaged communities are prioritized in receiving the benefits of the project.

- Action 1.1.C Continue to use existing resources (listed below) that identify disadvantaged communities in the City and prioritize community outreach to these communities during implementation of relevant strategies.
  - California Department of Water Resources Disadvantaged Communities Mapping Tool
  - Public Health Alliance of Southern California's California Healthy Places Index
  - Environmental Protection Agency's Environmental Justice Screening Tool
  - Office of Environmental Health Hazard Assessment CalEnviroScreen Tool

Measure 1.2: Integrate regional collaboration into the City's climate adaption planning and implement a long-term strategy to increase City staff capacity to address climate change and implement adaptation strategies.

- Action 1.2.A During the City's next update of the Local Hazard Mitigation Plan and/or Emergency Operations Plan, incorporate climate projections and climate impact data from the vulnerability assessment into the planning process and analyze future staffing and resource requirements to adequately address the future frequency and intensity of climate-related hazards in the City.
- Action 1.2.B Begin the process of evaluating and updating the City's building and engineering standards to account for future changes in key climate variables (e.g., changes in the size of large storm events, maximum daily temperatures) that are likely to affect critical infrastructure. Use data from the vulnerability assessment, the Cal-Adapt tool, and supplemental climate projection data and research to inform the updates to the City's standards update process. Use a climate-informed adaptive management approach to continually monitor the performance of the updated building and engineering standards against the observed changes in climate variables, adjusting standards as need to match future changes in these variables caused by climate change.
- Action 1.2.C Assess existing infrastructure systems vulnerable to changes in key climate variables (e.g., flooding, extreme heat) and incorporate upgrades to critical infrastructure in the City's Capital Improvement Projects (CIP) planning process. Identify key pieces of existing infrastructure that are likely to be compromised by climate impacts and prioritize these upgrades as part of the City CIP process. Use data from the vulnerability assessment, the Cal-Adapt tool, and supplemental climate projection data and research to inform an appropriate list of infrastructure upgrades.

Measure 1.3: Develop a clean energy microgrid for essential City facilities to support resilient emergency operations.

- Action 1.3.A Conduct a feasibility study for developing a clean energy microgrid for key City facilities to provide clean back-up power during utility disruptions (e.g., Public Safety Power Shutoffs or other disruptions) as well as providing local solar power to City facilities non-emergency use during the day. Ensure that the feasibility study includes the following details to allow for the development of a City microgrid, if deemed feasible:
  - A review of regulatory and operational considerations
  - A conceptual shovel-ready design of the technical components for a fully connected microgrid and an islandable solar + storage system
  - A phasing strategy and procurement plan for implementation
  - An operational strategy that includes governance and cybersecurity
  - Key considerations for operation of the microgrid during short-term and long-utility disruptions

  Seek funding sources including the California Energy Commissions Electric Program Investment Charge (EPIC) Program to conduct a feasibility study.

Adaptation Strategy 2: Prepare for changes in annual average temperatures and increases in extreme heat events

Measure 2.1: Implement a Climate-Smart Urban Heat Strategy to mitigate the urban heat island effect and help community members prepare for extreme heat events.

- Action 2.1.A Develop and implement appropriate strategies for the City to use aspects of the built environment to mitigate the projected impacts from the urban heat island effect. This should include a strategy to maintain and enhance the City's urban tree canopy and other vegetative features to help reduce the urban heat island effect while accounting for the effect of shifting average minimum and maximum temperatures on sensitive tree species and vegetation. Strategies should also include potential updates to the City's development standards to reduce the urban heat island effect in new development. Strategies could include:
    - Review and update Section 23.716 "Landscaping Standards" in the City's Municipal Code and other design guidelines to incorporate strategies to increase shading of buildings and parking lots to mitigate the urban heat island effect.
    - Review and update City development standards, where appropriate, to include building and site design features that mitigate the urban heat island effect including reflective roofing, solar carports.
- Action 2.1.B Monitor and pilot cool pavement technologies that may reduce the urban heat island effect being generated from the City's pavement surfaces focusing on large surface parking lots. Identify urban heat island hotspots in the City using data from The Trust for Public Land and other sources regarding the urban heat island effect in the City and implement a cool pavement pilot project in key areas of the City to review results, including up-front capital costs and ongoing maintenance requirements. Research and adopt new standards for new development projects, as appropriate, to use high-albedo or cool pavements for surface parking lots.
- Action 2.1.C Work with community organizations, faith-based organizations, businesses, local government entities in including Sacramento County, and other institutions to develop a Community Cool Zone Network comprised of air-conditioned spaces conveniently located throughout the City that can be opened during heat wave events to help prevent heat-related illness for vulnerable populations (e.g., elderly, youth, homeless, residents without air conditioning). Support network participants to conduct energy efficiency and building decarbonization improvements. Prioritize opening cool zone locations in areas with identified heat-vulnerable populations and disadvantaged communities. Assess feasibility and efficacy of providing transportation options to the cooling network location to elderly residents and transit-dependent populations.

Measure 2.2: Integrate climate-smart natural resource management into City operations.

- Action 2.2.A Integrate climate projections regarding changes in average temperatures and extreme heat into updates of the City's natural resource planning documents. Integrate Climate-Smart Pest Management Practices into the City's parks and recreation operations with consideration of how climate change is going to affect pest control and invasive species.
- Action 2.2.B Conduct analysis on the impacts of extreme heat on the city trees and, if necessary, update the City's street trees list as part of the Urban Forest Management program to prepare for increases in minimum and maximum temperatures and extreme heat events and corresponding drought and fire risk. Identify which trees will be most vulnerable to climate impacts and which species will thrive during future increases in temperature. Ensure updated street trees List does not include highly combustible trees that increase fire risk in the City. Communicate the results of the analysis to help City residents prepare for impacts on trees on private property.

Measure 2.3: Incorporate projected changes in the annual average temperatures and extreme heat events into the design of the City's forthcoming building electrification and energy efficiency retrofit program.

- Action 2.3.A As part of the City's forthcoming building retrofit program, integrate climate resilience retrofit features to help residents prepare for the impacts of climate change (e.g., extreme heat, wildfires, and wildfire smoke). Incorporate projections on future energy demand associated with shifts in maximum and minimum temperatures as well as increase the frequency and severity of extreme heat events. This work should include conducting a gap analysis to identify portions of the City's housing stock that are not equipped with air-conditioning or other cooling systems to address the projected increases in temperature and extreme heat events. As part of the CAP building retrofit program, include proactive efforts (i.e., incentives, matching funds) to retrofit or assist with retrofitting the identified housing stock with climate resiliency features including but not limited to:
    - adequate climate control equipment (e.g., HVAC) and air conditioning heat pumps,
    - weatherization and energy efficiency improvements to address increases in extreme heat, annual average maximum temperatures, and wildfire smoke,
    - reflective roofing, green walls/roof, shade trees, and other features to reduce energy demand for cooling.

Adaptation Strategy 3: Increase community preparedness to changes in large storm events flooding

Measure 3.1: Prioritize climate-smart green infrastructure strategies for flood management in the City.

- Action 3.1.A To account for future changes in large storm events (50-, 100-, and 500-year storm events), prioritize the use of green infrastructure strategies (compared to grey infrastructure strategies) to manage future flood risk exacerbated by climate change. Work with public and landowners upstream of waterways passing through the City (e.g., Morrison Creek) to manage stormwater runoff through sustainable land conservation practices (e.g., conservation easements) that achieve multiple objectives for the City (e.g., carbon farming, land conservation, flood management).
- Action 3.1.B Incorporate the future climate-informed flood risk modeling into the City's Stormwater Quality Program using information from the Cal-Adapt Tool and the vulnerability assessment to account for future changes in precipitation patterns and flood risk. Coordinate with Sacramento County and their current work on climate-informed precipitation modeling to incorporate flood risk modeling in all flood management-related capital improvement projects in the city. As part of the update process, develop targets to offset the increase in stormwater runoff from existing residential and nonresidential land uses through green infrastructure approaches (e.g., rain gardens, rainwater catchment barrels, green stormwater infrastructure, permeable parking lots, and pavement) to help offset climate impacts on the City's stormwater management system from climate change.

Measure 3.2: Utilize redundancies in the City's flood management system to prepare for future increases in the size and frequency of storm of large storm events.

- Action 3.2.A Explore opportunities to add redundancy to the City's existing stormwater and flood management systems to mitigate impacts from increased storm intensities, as needed, using detention basins, green infrastructure (e.g., bio-swales, floodplain management through conservation easements). Considering the uncertainty in the timing of changes in large storm events, design flood management system redundancies to serve multiple purposes that add value to the community (e.g., detention basins that serve as parks or recreation areas).

Adaptation Strategy 4: Increase resilience to long-term droughts

Measure 4.1: Advocate for drought-proof water supplies including recycled water systems or indirect potable recharge.

- Action 4.1.A Continue to work with water suppliers to implement their set of Urban Water Management Plan, and Water Shortage Contingency Plan and support updates these plans, as needed, to account for future regulations and requirements. As part of the update of these plans, the City should support the development of an extended (20-year) drought scenario analysis to consider the effects on the City's water supply and water demand. As part of future updates to relevant Urban Water Management Plans, research the feasibility of developing a network of rainwater harvesting facilities to groundwater recharge.

Measure 4.2: Consider incorporation of water-efficient appliance retrofits as part of the City's forthcoming building retrofit program.

- Action 4.2.A Consider including options for water-efficient appliance retrofits as part of the City's forthcoming building retrofit program being implemented as part of the CAP. Work with the City's Public Works and Community Development Department to integrate current resources and programs regarding water conservation and energy-efficient appliance retrofits into the building retrofit program. The building retrofit program can also serve to highlight the energy conservation benefits of the reduced residential and commercial water use.

Measure 4.3: Establish a per capita water use reduction target to be achieved by 2028. Use education and outreach to promote water conservation practices and water efficiency retrofits for residential and nonresidential buildings.

- Action 4.3.A Using information in the City's Urban Water Management Plans, establish an per capita water use reduction target to be achieved by 2028 and track yearly progress on achieving the goal. Use a suite of existing and new strategies to achieve the target through water conversation education and financial incentives for water efficiency retrofits for residential and nonresidential properties. Water conservation strategies should include:
  - Continue the City's water suppliers to promote low-flow appliance retrofits including faucets, showerheads, and information on low water use appliances (e.g., dishwashers, washing machines)
  - Work with community organizations and contractors to educate the public about the benefits and water conservation potential of rainwater catchment systems and greywater systems
  - Conduct community outreach to educate citizens on current levels of water use by end-use in the City and water conservation tips to reduce household and business water waste
- Action 4.3.B Design and implement a "Cash for Grass" lawn replacement program to help residents and businesses reduce outdoor water use and promote native climate-smart landscaping improvements. Price lawn replacement on a square-footage basis that effectively attracts participants.

Adaptation Strategy 5: Increase community resilience to the local and regional impacts of wildfires

Measure 5.1: Develop and implement a Wildfire Smoke Protection Outreach Strategy.

- Action 5.1.A: Develop and implement a Wildfire Smoke Protection Outreach Strategy to help protect City's residents and visitors from poor air quality caused by wildfire smoke. Work with the Sacramento Air Quality Management District to conduct a comprehensive outreach campaign focused on educating residents on how to protect themselves and their homes from wildfire smoke impacts. Prioritize outreach campaigns to populations who are vulnerable to poor air quality and those who work with the population (e.g., elderly care nurses and assistances, teachers), conducting educational events at convenient locations for these residents. Specific topics could include:

- General tips to avoiding wildfire smoke impacts
- Education on the proper use of N95 respirators
- Publishing and sharing location of local Resilience Center with residence
- Preparing homes for wildfire smoke events and development of "clean rooms"
- Proper use of air conditioning and climate control during wildfire smoke events
- Behaviors to reduce indoor air quality impacts (e.g., avoid vacuuming, using gas-powered appliances)

The outreach strategy should also focus on supporting employers to maintain compliance with California Code of Regulations, title 8, section 5141.1, which applies to most outdoor workplaces where the current Air Quality Index (current AQI) for airborne particulate matter is 2.5 micrometers or smaller (PM2.5) is 151 or greater, and where employers should reasonably anticipate that employees could be exposed to wildfire smoke. Compliance requirements and training instructions are included in California Code of Regulations, title 8, section 5141.1

Measure 5.2: Increase opportunities for battery storage and energy independence for residence and businesses to mitigate impacts from Public Safety Power Shutoffs.

- Action 5.2.A: Through the City's Community Development Department, proactively provide information on funding resources and financing options for the installation of battery storage systems for existing residential and non-residential developments, prioritizing opportunities for essential services such as hospitals, grocery stores, pharmacies, and other essential businesses. Develop a streamlined permitting process, including appropriate CEQA exemptions, for the installation of small- and large-scale battery storage systems in existing residential and nonresidential development as well as providing applicants information on battery storage incentives provided through SMUD.

4 REFERENCES

Brown, C. J., Saunders, M. I., Possingham, H. P., and Richardson, A. J. 2013. Managing for interactions between local and global stressors of ecosystems. PloS one, 8(6), e65765.

California Environmental Protection Agency. 2019. Urban Heat Island Interactive Maps, Sacramento County.

CAL FIRE. *See* California Department of Forestry and Fire Protection.

California Department of Forestry and Fire Protection. 2020. 2020 Strategic Fire Plan. Accessed February 21, 2021.

California Department of Transportation. 2013 (February). Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs.

California Energy Commission. 2018a. California Heat Assessment Tool. Available: https://www.cal-heat.org/explore. Accessed October 18, 2019.

———. 2018b. Projected Changes in California's Precipitation Intensity-Duration-Frequency Curves.

———. 2021a. Cal-Adapt Annual Averages Tool. Available: https://cal-adapt.org/tools/annual-averages/ Accessed December 28, 2020.

———. 2021b. Cal-Adapt Extreme Heat Tool. Available: https://cal-adapt.org/tools/extreme-heat/ Accessed December 28, 2020.

———. 2021c. Cal-Adapt Extended Drought Scenario Tool. Available: https://cal-adapt.org/tools/extended-drought/ Accessed December 28, 2020.

———. 2021d. Cal-Adapt Snowpack Tool. Available: https://cal-adapt.org/tools/snowpack/#climatevar=swe&scenario=rcp45&lat=38.90625&lng=-120.03125&boundary=locagrid&units=inch Accessed December 28, 2020

———. 2021e. Cal-Adapt Wildfire Tool. Availablehttps://cal-adapt.org/tools/wildfire/ Accessed December 28, 2020.

Cal OES. See California Governor's Office of Emergency Services.

California Governor's Office of Emergency Services. 2020. California Adaptation Planning Guide. Available: https://www.caloes.ca.gov/HazardMitigationSite/Documents/APG2-FINAL-PR-DRAFTAccessible.pdf. Accessed February 12, 2021.

California Governor's Office of Planning and Research, California Energy Commission, and California Natural Resources Agency. 2018. *California's Fourth Climate Change Assessment Report: Sacramento Valley Region Report.* Available: https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-002_SacramentoValley_ADA.pdf. Accessed January 29, 2021.

California Office of Environmental Health Hazard Assessment. 2018. Indicators of Climate Change in California.

Cambridge Systematics. 2015. Central Texas Extreme Weather and Climate Change Vulnerability Assessment of Regional Transportation Infrastructure. Available: https://austintexas.gov/sites/default/files/files/CAMPO_Extreme_Weather_Vulnerability_Assessment_FINAL.pdf. Accessed February 11, 2021.

Calkins, M. M., T. B. Isaksen, B. A. Stubbs, M. G. Yost, and R. A. Fenske. 2016. Impacts of Extreme Heat on Emergency Medical Service Calls in King County, Washington, 2007–2012: Relative Risk and Time Series Analyses of Basic and Advanced Life Support. *Environmental Health.*

Caltrans. *See* California Department of Transportation.

CDPH. *See* California Department of Public Health.

CDC. *See* Centers for Disease Control and Prevention.

CEC. *See* California Energy Commission.

CEC and CNRA. *See* California Energy Commission and California Natural Resources Agency.

Centers for Disease Control and Prevention. 2019. Protecting Vulnerable Groups from Extreme Heat [website]. Available: https://www.cdc.gov/disasters/extremeheat/specificgroups.html. Accessed December 2, 2019.

City of Rancho Cordova. 2006. City of Rancho Cordova General Plan.

CNRA. *See* California Natural Resources Agency.

DWR. *See* California Department of Water Resources.

Federal Highway Administration. 2015 (August). *Climate Change Adaptation for Pavements*

———. 2017. Vulnerability Assessment and Adaptation Framework. Third edition.

FHWA. *See* Federal Highway Administration.

Goosse, H., P. Y. Barriet, M. F. Loutre, and V. Zunz. 2010. Introduction to Climate Dynamics and Climate Modeling. Centre de Recherche sur la Terre et le Climat Georges Lemaître-UCLouvain.

Harvey, J., A. Chong, and J. Roesler. 2000. Climate Regions for Mechanistic-Empirical Pavement Design in California and Expected Effects on Performance. University of California, Berkeley. Prepared for California Department of Transportation.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014 Synthesis Report. Available: https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf. Accessed February 11, 2021.

———. 2018. Global Warming of 1.5 Degrees Celsius: An IPCC Special Report. Available: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf. Accessed February 12, 2021.

———. 2021. Climate Change Six Assessment: Summary Report for Policy Makers. Available: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf Accessed September 5, 2021.

IPCC. See Intergovernmental Panel on Climate Change.

Jasim, F. H., F. Vehedifard, E. Ragno., A. AghaKouchak, and G. Ellithy. 2017. Effects of Climate Change on Fragility Curves of Earthen Levees Subjected to Extreme Precipitations. Geo-Risk 2017 Conference Paper.

Kivimäki, M., Batty, G. D., Pentti, J., Shipley, M. J., Sipilä, P. N., Nyberg, S. T., & Vahtera, J. 2020. Association between socioeconomic status and the development of mental and physical health conditions in adulthood: a multi-cohort study. The Lancet Public Health, 5(3), e140-e149.

Knowlton, K., J. E. Rosenthal, C. Hogrefe, B. Lynn, S. Gaffin, R. Goldberg, C. Rosenzweig, K. Civerolo, J.-Y. Ku, and P. L. Kinney. 2004. Assessing Ozone-Related Health Impacts under a Changing Climate. *Environmental Health Perspectives* 112(15):1557–1563.

Kovats, R. S., and S. Hajat. 2008. Heat Stress and Public Health: A Critical Review. *Annual Review of Public Health* 29:41–55.

Li, Q., L. Mills, and S. McNeil. 2011 (September 25). The Implications of Climate Change on Pavement Performance and Design. Submitted to the University of Delaware University Transportation Center.

National Oceanic and Atmospheric Administration. 2018. *What's the Difference Between Weather and Climate?* Available: https://www.ncei.noaa.gov/news/weather-vs-climate. Accessed February 8, 2020.

NOAA. *See* National Oceanic and Atmospheric Administration.

Office of the Federal Coordinator for Meteorological Services and Supporting Research. 2002. *Weather Information for Surface Transportation: National Needs Assessment Report*. FCM-R18-2002.

OPR, CEC, and CNRA. *See* California Governor's Office of Planning and Research, California Energy Commission, and California Natural Resources Agency.

OPR. *See* California Governor's Office of Planning and Research.

Paterson, J., P. Berry, K. Ebi, and L. Varangu. 2014. Health Care Facilities Resilient to Climate Change Impacts. *International Journal of Environmental Research and Public Health* 11(12):13097–13116.

Pierce, D., J. F. Kalansky, and D. R. Cayan. 2018. Climate, Drought, and Sea Level Rise Scenarios for California's Fourth Climate Change Assessment.

Ramin, B., and Svoboda, T. 2009. Health of the homeless and climate change. Journal of Urban Health, 86(4), 654-664.

Rappold, A. G., J. Reyes, G. Pouliot, W. E. Cascio, and D. Diaz-Sanchez. 2017. Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure. Environmental Science & Technology 51(12):6674-6682.

Rinner, C., and M. Hussain. 2011. Toronto's Urban Heat Island—Exploring the Relationship between Land Use and Surface Temperature. *Remote Sensing* 3(6):1251–1265.

Robinson, J. D., and F. Vahedifard. 2016. Weakening Mechanisms Imposed on California's Levees under Multiyear Extreme Drought. *Climatic Change* 137(1–2):1–14.

Sacramento County. 2016. Standard Construction Specifications. Available: https://saccountyspecs.saccounty.net/Documents/PDF%20Documents%202016/2016CompleteSpec.pdf Accessed September 14, 2021.

———. 2021. Draft Local Hazard Mitigation Plan. Available: https://waterresources.saccounty.net/Pages/Drainage--Draft-Local-Hazard-Mitigation-Plan-Report.aspx. Accessed September 14, 2021.

Sacramento Metropolitan Air Quality Management District. 2017. *Air Quality Pollutants and Standards – Ozone.* Available: http://www.airquality.org/air-quality-health/air-quality-pollutants-and-standards. Accessed November 6, 2019.

Sacramento Municipal Utility District. 2016 (November). Climate Readiness Assessment and Action Plan.

Sailor, D. J. 2011. A Review of Methods for Estimating Anthropogenic Heat and Moisture Emissions in the Urban Environment. *International Journal of Climatology* 31:189–199.

SMAQMD. *See* Sacramento Metropolitan Air Quality Management District.

SMUD. *See* Sacramento Municipal Utility District.

Schwartz, M. W., N. Butt, C. R. Dolanc, A. Holguin, M. A. Moritz, M. P. North, H. D. Safford, N. L. Stephenson, J. H. Thorne, and P. J. van Mantgem. 2015. Increasing elevation of fire in the Sierra Nevada and implications for forest change. Available: https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1890/ES15-00003.1. Accessed February 5, 2021.

Solecki, W. D., C. Rosenzweig, L. Parshall, G. Pope, M. Clark, J. Cox, and M. Wiencke. 2005. Mitigation of the Heat Island Effect in Urban New Jersey. *Global Environmental Change Part B: Environmental Hazards* 6(1):39–49.

Stone, B., Jr., and M. O. Rodgers. 2001. Urban Form and Thermal Efficiency: How the Design of Cities Influences the Urban Heat Island Effect. *Journal of the American Planning Association* 67(2):186–198.

Swain, D. L., D. E. Horton, D. Singh, and N. S. Diffenbaugh. 2016. Trends in Atmospheric Patterns Conducive to Seasonal Precipitation and Temperature Extremes in California. Science Advances 2(4): e1501344.

Swain, D. L., B. Langenbrunner, J. D. Neelin, and A. Hall. 2018. Increasing Precipitation Volatility in Twenty-First-Century California. Nature Climate Change 8:427–433.

Transportation Research Board and National Research Council. 2008. Potential Impacts of Climate Change on U.S. Transportation. Special Report 290. Washington, DC: The National Academies Press.

U.S. Census. 2021. Quickfacts: Rancho Cordova City, California. Available: https://www.census.gov/quickfacts/ranchocordovacitycalifornia. Accessed September 11, 2021.

Planning.

U.S. Department of Energy. 2016. Climate Change and the Electricity Sector: Guide for Climate Change Resilience Planning.

U.S. Department of Transportation. 2014. *Transportation Climate Change Sensitivity Matrix*.

U.S. Environmental Protection Agency. 2008. Reducing Urban Heat Islands: Compendium of Strategies

Vins, H., Bell, J., Saha, S., and Hess, J. J. 2015. The mental health outcomes of drought: a systematic review and causal process diagram. International journal of environmental research and public health, 12(10), 13251-13275.

Voelkel, J., D. Hellman, R. Sakuma, and V. Shandas. 2018. Assessing Vulnerability to Urban Heat: A Study of Disproportionate Heat Exposure and Access to Refuge by Socio-Demographic Status in Portland, Oregon. *International Journal of Environmental Research and Public Health* 15(4):10.3390/ijerph15040640.

Westerling, A. L. 2018. Wildfire Simulations for the Fourth California Climate Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate. University of California, Merced, California's Fourth Climate Change Assessment, California Energy Commission. Available: https://climateassessment.ca.gov/events/docs/20181210-Slides_Westerling.pdf. Accessed February 11, 2021.

Zhu, R., M. S. Wong, É. Guilbert, and P. W. Chan. 2017. Understanding Heat Patterns Produced by Vehicular Flows in Urban Areas. *Scientific Reports* 7:article number 16309.

Zhu, P., and Y. Zhang. 2008. Demand for Urban Forests in United States Cities. *Landscape and Urban Planning* 84(3–4):293–300.

Zimmerman, R. 1996. Global Warming, Infrastructure, and Land Use in the Metropolitan New York Area: Prevention and Response. *Annals of the New York Academy of Sciences* 790(1):57–83.