CLIMATE VULNERABILITY IN THE CITY OF WEST SACRAMENTO

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Chapter 1. Introduction and Purpose

Climate change refers to changes in long-term, average weather patterns as well as impacts associated with those changing weather patterns, such as sea level rise (NASA 2020). While the earth's climate naturally changes gradually, over long timeframes, today's climate change is the result of human actions and is occurring much more rapidly than climatic changes seen in the past (NASA 2010).

Globally, climate change is already having or will have many adverse impacts, including:

- Sea level rise
- Changes in precipitation and other hydrologic patterns
- Changes in frequency and severity of drought
- Changes in frequency and severity of extreme heat and heat waves
- Increased hazards from wildfires due to increased size, severity, and frequency of wildfire in some areas (IPCC 2014).

In the Sacramento Valley, various climate impacts are already occurring, and many of these impacts are projected to worsen throughout this century. According to California's 4th Climate Change Assessment, Sacramento Valley Regional report (Houlton and Lund 2018), the Sacramento Valley will experience the following climate impacts:

- Higher temperatures and a greater average number of extreme heat days
- Decreased snowpack in the mountains, with implications for water supply
- More frequent and severe droughts
- Sea level rise, which will increase flood risk and push saltwater farther into the Delta (assuming no change in management actions)
- More intense floods (due to a combination of sea level rise and changes in precipitation patterns)
- Increased risk of wildfires and related air quality impacts.

The City of West Sacramento (City) will likely directly or indirectly experience impacts from the above climate effects. The City is projected to experience higher average and extreme temperatures over the course of this century (CEC 2020). Decreased snowpack and changing precipitation patterns in the Sacramento River watershed will threaten the City's water supply, while an increased risk of wildfires in other areas of the state could result in heightened air quality impacts in the City. While the City is not projected to experience an increased probability of flooding due to levee overtopping, flood risk due to levee failure may increase as sea level rise and an increased frequency of extreme storms increase stress on levees (DSC 2021d; City of West Sacramento and WSAFCA 2019). Chapter 3 will discuss in detail the climate stressors and hazards faced by the City.

While mitigating climate change by reducing greenhouse gas emissions is important, adapting to, or addressing, the impacts of climate change is essential, since certain impacts will occur even if humans stopped emitting greenhouse gases today—and climate change has already resulted in adverse impacts. Adaptation actions are also more within local control, whereas climate mitigation requires global, collective effort. The California Adaptation Planning Guide 2.0 defines climate adaptation as "the adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, and which moderates harm or exploits beneficial opportunities. Climate change adaptation is focused on long-term threats to human life, property, economic continuity, ecological integrity, and community function" (CalOES 2020).

The City of West Sacramento has taken action on climate change mitigation through its 2010 draft Climate Action Plan (currently being updated) as well as its participation in the Mayors' Commission on Climate Change, which produced a final report laying out strategies for achieving net-zero carbon emissions in Sacramento and West Sacramento by 2045. Beyond mitigation, the City must plan for climate adaptation in order to safeguard residents and critical City assets from climate hazards. Under Senate Bill 379, all California cities and counties must assess vulnerability to climate hazards in their jurisdiction and associated risk from those hazards, and develop associated adaptation and resiliency goals, policies, and objectives to address those risks (Cal. Gov. Code section 65302). The purpose of this report is to better understand vulnerability to climate change in the City of West Sacramento, specifically by investigating the vulnerability of City residents and assets to flooding, extreme heat, and wildfire—hazards that will be exacerbated by climate change during this century. The information in this report can help inform SB 379 implementation, creating a basis from which to develop climate adaptation and resiliency policies and strategies that the City can incorporate into its general plan safety element.

Geographic and Demographic Setting

The City of West Sacramento is located in eastern Yolo County, bordering the Sacramento River, and located within the greater Sacramento area and the Sacramento Valley (**Figure 1**). The City is also located at the northernmost border of the legal Sacramento-San Joaquin Delta (Delta), a hub for the state's water supply and a diverse region that includes rural and urban areas, productive agriculture, and important wetland ecosystems that provide habitat for many plant and animal species. Water bodies surround the City on its northern, eastern, and western sides, with the Sacramento River, the Sacramento River Deep Water Ship Channel, and Yolo Bypass and Sacramento Bypass (flood bypass channels that are intermittently flooded). The official elevation of the City is 20 feet above sea level; total land area in the City is 22.8 square miles (Yolo County et al. 2018).

As of January 2020, the City has a population of approximately 54,328 (California Department of Finance 2020). Chapter 4, Existing Conditions, provides a more detailed overview of the City's demographics, as well as important assets that should be considered when assessing future climate hazards.

Chapter 2: Planning and Regulatory Setting

A number of relevant tools, efforts, and plans exist at the state, regional, and local levels that can help guide the City in assessing climate vulnerability and planning for adaptation. Additionally, statutory requirements mandate that California cities and counties undertake climate change vulnerability assessments and develop associated adaptation goals, policies, and objectives, as well as develop goals and policies to address environmental justice—an issue that will be exacerbated by climate change. The following section explains the resources and statutory requirements most relevant to the City of West Sacramento and that have guided the preparation of this report.

2.1 Relevant State Tools, Efforts, and Plans

The state of California produces a variety of tools and resources related to climate research, climate vulnerability, and adaptation planning. The California Climate Change Assessments assess climate impacts and risks in the state and provide resources usable by state, regional, and local agencies for climate adaptation planning (State of California 2018). Climate projection data from the assessments can be visualized and downloaded on the online Cal-Adapt website (CEC 2020a). The California Climate Assessments produce regional reports to discuss projected climate impacts in each of 9 regions of California; the Sacramento Valley Regional Report serves as a useful source of information for the City of West Sacramento (Houlton and Lund 2018). Included as part of California's 4th Climate Change Assessment, the California Heat Assessment Tool (CHAT) provides a tool for jurisdictions to examine projected heat events that will have local public health impacts, as well as to identify high-priority census tracts for heat mitigation efforts (CEC 2020b).

In addition to climate data, the state produces various plans and planning guides that can serve as a guide for local climate adaptation efforts. The Safeguarding California Plan: 2018 Update is the state's climate adaptation plan, laying out how the California state government is taking action to address climate change (CNRA 2018). Safeguarding California is currently being updated in 2021. The 2018 California State Hazard Mitigation Plan (SHMP), which addresses climate hazards, is another climate planning resource for local jurisdictions, which are statutorily required to align their local hazard mitigation plans (LHMPs) with the SHMP (CalOES 2018). The California Adaptation Planning Guide (APG 2.0), which is produced by the California Office of Emergency Services (CalOES), serves as a guide for local, tribal, and regional governments on climate change adaptation planning (CalOES 2020).

The APG 2.0 lays out four phases of adaptation planning: 1) Explore, define, and initiate, 2) assess vulnerability, 3) define adaptation framework and strategies, and 4) implement, monitor, evaluate and adjust (CalOES 2020) (Figure 1). This report is intended to inform Phases 1 and 2, which include identifying potential climate change effects, identifying important community assets, and assessing vulnerability of people and assets to those climate change effects.

Figure 1: Adaptation Planning Process from the California Adaptation Planning Guide

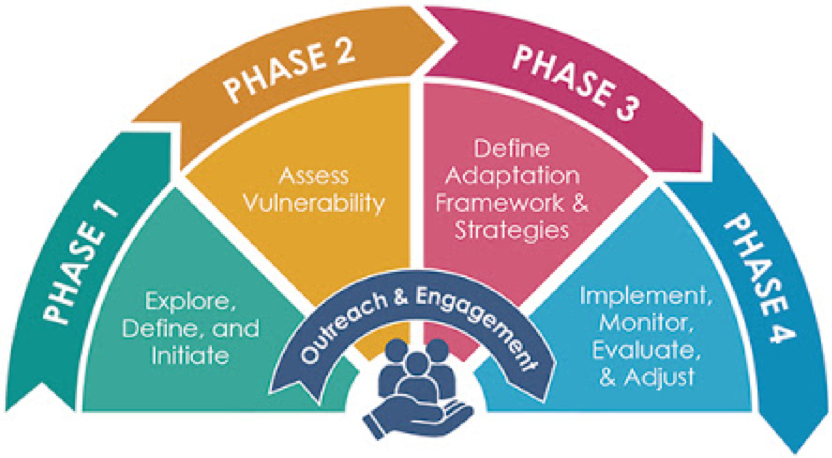

***Figure 1**, from the California Adaptation Planning Guide 2.0, shows the four phases of the adaptation planning process. Image credit: California Office of Emergency Services (2020).*

In addition to the adaptation planning resources mentioned above, the California Governor's Office of Planning and Research (OPR) produces the state Adaptation Clearinghouse, a centralized source of information and resources to guide adaptation planning in state, regional, and local jurisdictions. OPR also produces the State of California General Plan Guidelines, which include guidance on updating general plan safety elements to address climate adaptation (OPR 2017).

The California Ocean Protection Council (OPC) periodically produces sea level rise guidance for jurisdictions to aid in sea level rise planning. OPC's 2018 Sea Level Rise Guidance Update summarizes sea level rise projections, presents various risk-based scenarios, and presents guidance for sea level rise planning (OPC 2018).

2.2 Relevant Statutory Requirements for Local Jurisdictions

SB 379 requires cities and counties to review and update as necessary the safety element of their general plan to include climate adaptation and resiliency policies. The safety element must include "a set of goals, policies, and objectives based on a vulnerability assessment, identifying the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, and specified information from federal, state, regional, and local agencies" (Cal. Gov. Code section 65302).

SB 1000 requires cities and counties to include an environmental justice element in their general plan, or to include environmental justice policies in other elements of the general plan. This involves identifying *disadvantaged communities*[1] and identifying "objectives and policies to

[1] SB 1000 defines disadvantaged communities as "an area identified by the California Environmental Protection Agency pursuant to Section 39711 of the Health and Safety Code or an area that is a low-income area that is disproportionately affected by environmental pollution and other hazards that can lead to negative health effects, exposure, or environmental degradation" (Cal. Gov. Code section 65302).

reduce the unique or compounded health risks in disadvantaged communities…" among other requirements (Cal. Gov. Code section 65302). The City's General Plan includes environmental justice policies, which will be supplemented as needed to comply with SB 1000 as part of the General Plan Housing Element update.

Although SB 1000 does not explicitly require jurisdictions to identify the risks climate change poses to disadvantaged communities, climate change impacts will disproportionately affect disadvantaged communities (Shonkoff et al. 2011) and thus a holistic treatment of environmental justice should include identifying objectives and policies to reduce climate-related risks to disadvantaged communities. This report identifies City populations most vulnerable to climate impacts due to socioeconomic and health factors, as well as the overall *most vulnerable populations* to climate impacts—identified by highlighting areas of the City with high social vulnerability that will also be exposed to climate impacts. This information should help inform the City's climate change vulnerability assessment pursuant to SB 379, specifically by informing an assessment of the disproportionate impacts that climate change will have on the City's socially vulnerable communities. OPR's General Plan Guidelines and the APG 2.0 recommend that local governments consider vulnerable communities and environmental justice when planning for climate change (OPR 2017; CalOES 2020).

It is important to note that the vulnerable communities identified by the social vulnerability index (SVI) prepared in this report are not equivalent to 'disadvantaged communities' as defined in SB 1000, because the SVI does not consider pollution burden. The SVI is discussed in detail in Section 5.3.

2.3 Regional Plans and Efforts

The Delta Stewardship Council's (Council) ongoing **Delta Adapts: Creating A Climate Resilient Future** (Delta Adapts) initiative is a two-phase process including a climate change vulnerability assessment and adaptation plan for the Sacramento-San Joaquin Delta and Suisun Marsh. Delta Adapts will provide strategies and tools that state, regional, and local governments can use to help communities, infrastructure, and ecosystems in the Delta region adapt to climate change. Some of the analyses presented in this report for the City of West Sacramento use information and results from the Council's vulnerability assessment; in some instances, analyses were replicated to apply methods used in the Delta-wide vulnerability assessment to examine vulnerability in the City. Certain analyses in this report differ in methodology from the Delta Adapts initiative.

For the greater Sacramento area, the Sacramento Metropolitan Air Quality Management District (SMAQMD) and the Local Government Commission recently completed the **Capital Region Urban Heat Island Mitigation Project**, which developed an urban heat island index specific to the Capital region, evaluated the effectiveness of a variety of heat-mitigation strategies, and identified priority areas for heat mitigation efforts (SMAQMD and LGC 2020). The project also produced resources useful for jurisdictions to use in heat-related climate adaptation planning. The Sacramento Area Council of Government's (SACOG) **Sacramento Region Transportation Climate Adaptation Plan** (2015) and **Vulnerability and Criticality Assessment** (2020) provide useful information that can be used to help assess vulnerability of City transportation assets to climate impacts.

2.4 County Plans and Efforts

The Yolo Operational Area Multi-Jurisdictional Hazard Mitigation Plan (LHMP) was updated in 2018 (Yolo County et al. 2018). The LHMP considers climate change as a separate hazard while also addressing hazards that climate change may exacerbate, including flooding, drought, wildfire, extreme heat, and other severe weather events. However, the LHMP did not quantify future climate change-related hazards.

The Yolo County Climate Action Plan: A Strategy for Smart Growth Implementation, Greenhouse Gas Reduction, and Adaptation to Global Climate Change (2011) includes explanations of projected climate impacts in Yolo County as well as a set of adaptation measures and mitigation (GHG-reduction) measures by sector (Yolo County 2011).

The City of West Sacramento is part of the Yolo Climate Compact, an affiliation of cities and special districts in Yolo County as well as the University of California, Davis. Chaired by Yolo County Supervisor Don Saylor, the Yolo Climate Compact serves as a forum for exchanging information on greenhouse gas emissions reduction. The City is also a member of the Yolo Resiliency Collaborative (YRC), a collaborative of Yolo County jurisdictions' staff that aims to increase climate resilience throughout Yolo County and beyond. YRC has produced a draft Resiliency Planning Toolbox, which includes example planning language, policies, and actions for heat planning and implementation. The Toolkit will also include resources for wildfire planning and implementation (currently under development).

2.5 City and Inter-City Efforts

The City participated in the Mayors' Commission on Climate Change, a commission organized by the City of West Sacramento and City of Sacramento mayors that aimed to reach net zero greenhouse gas emissions in both cities by 2045. On June 29th, 2020, the Commission adopted its final report: Achieving Carbon Zero in Sacramento and West Sacramento by 2045 (Mayors' Commission on Climate Change and Local Government Commission 2020).

The City is currently updating its 2010 draft Climate Action Plan, which inventories the city's greenhouse gas emissions and includes emission reduction targets (City of West Sacramento 2010). The updated CAP will include a high-level overview of climate risks in the City, aiming to begin a dialogue about local impacts and how to address impacts in the City. A comprehensive climate change vulnerability assessment and associated adaptation strategies for the City will be prepared as part of the general plan safety element update pursuant to SB 379.

Chapter 3. Climate Stressors and Hazards

3.1 Climate Change Science

The earth's climate is changing at a much faster rate than rates seen in past, natural climatic changes, which occurred much more gradually than the climate changes occurring today (NASA 2010). The rapid climate changes seen today are the result of human actions, including the burning of fossil fuels, which increase the atmospheric concentration of greenhouse gases (GHGs), primarily carbon dioxide, methane, nitrous oxide, and ozone. GHGs exist naturally in the atmosphere and create what is known as the *greenhouse effect*: allowing energy from the sun to pass through the atmosphere but trapping some of the heat from the earth's surface as it radiates back into space (NASA 2020). As human-caused emissions have increased GHG concentrations in the atmosphere, the earth's average temperature has increased (IPCC 2014). These rapid climate changes have resulted in a number of other global impacts, including melting glaciers and ice sheets, reduced snowpack, changing precipitation patterns, sea level rise, an intensification of storm events, and increases in frequency and severity of drought and wildfires (Jay et al. 2018; US EPA 2016; IPCC 2014). Figure 2 illustrates the greenhouse effect (image credit US EPA 2012).

Figure 2: The Greenhouse Effect

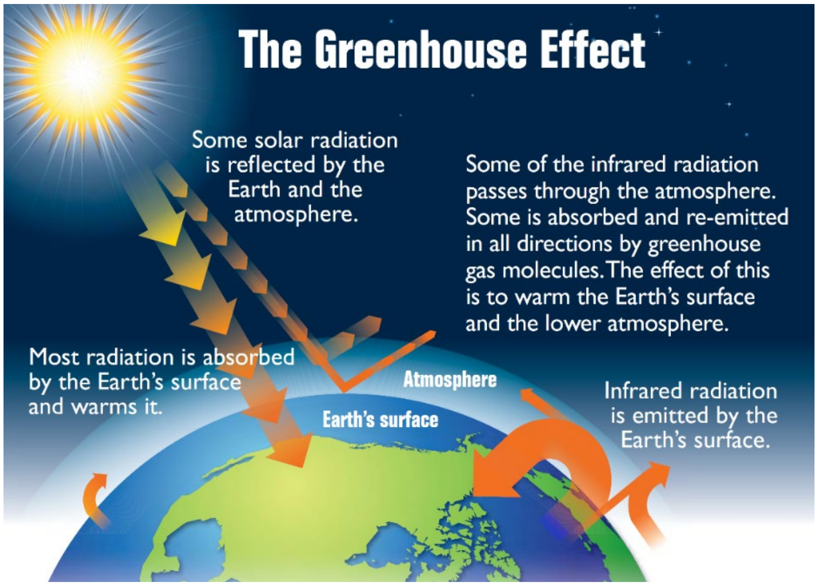

***Figure 2**, above, illustrates how the greenhouse effect works. Image credit: US EPA (2012).*

Statewide and regional climate assessments show that California and the Sacramento Valley will experience similar climate impacts (Barnett et al. 2008; Williams et al. 2015; Fritz et al. 2011; Kunkel et al. 2013; Pierce and Cayan 2013; and Dettinger 2016). The Sacramento Valley will likely experience the following climate impacts:

- Higher temperatures and a greater average number of extreme heat days
- Decreased snowpack in the mountains, with implications for water supply
- More frequent and severe droughts
- Sea level rise

- More intense floods (due to sea level rise and changing precipitation patterns)
- Increased risk of wildfires (Houlton and Lund 2018).

These climate impacts will likely intensify during the next century (Jay et al. 2018). In this report, both climate *stressors* and climate *hazards* will be considered: climate stressors refer to long-term environmental changes that result from climate change, while climate hazards are distinct events that pose a physical hazard to human and natural systems resulting from—or exacerbated by—climate stressors (United States 2020). The following climate stressors and hazards are considered:

Stressors:

- Air temperature
- Sea level rise
- Precipitation

Hazards:

- Flooding
- Extreme heat
- Wildfire

Modeling Climate Change: Applying Global Models to the Regional and Local Scale

While it is impossible to predict future GHG emissions with certainty, the Intergovernmental Panel on Climate Change (IPCC) has developed a range of Representative Concentration Pathways (RCPs)—possible pathways for future GHG emissions and associated atmospheric conditions (IPCC 2013). In this report, two RCPs are considered: RCP 4.5 and RCP 8.5. RCP 4.5 represents a moderate scenario in which GHG concentrations peak at mid-century at 550 parts per million (ppm) and then stabilize, while under RCP 8.5—known as the "business as usual" scenario and the trajectory that society is currently on track for—GHG concentrations exceed 900 ppm by 2100 (van Vuren et al. 2011). RCP 4.5 and RCP 8.5 are commonly used by jurisdictions for climate planning.

RCP scenarios are used as inputs for General Circulation Models (GCMs), which integrate emissions scenarios and associated warming to model resulting climate conditions, such as temperature and precipitation (IPCC 2013). While GCMs produce relatively course-scale projections of climate variables, model results can be statistically *downscaled* to create finer-resolution results that can be used at the regional and local scales. For the City of West Sacramento, climate projections used in this report have been downscaled through a process called Localized Construction Analogs (LOCA) (Pierce et al. 2014). The state Cal-Adapt tool provides LOCA-derived projections for jurisdictions in California, including temperature and precipitation projections, among other climatic variables.

3.2 Climate Stressors

Three climate stressors are considered in this report: air temperature, sea level rise, and precipitation patterns. These three stressors are described in detail below.

3.2.1 Air Temperature

Global climate projections show with a relatively high level of certainty that average temperatures will increase in the future (IPCC 2013). Climate change will likely lead to increases in both average temperatures and high temperature extremes across the United States (CDC 2011) (**Figure 3**). In California by 2100, average temperatures will likely increase by 3.6 to 7.2 °F (2-4 °C) under RCP 4.5 and by 7.2 to 12.6 °F (4-7 °C) under RCP 8.5 (Pierce et al. 2018).

Figure 3: Extreme Heat Events in the United States

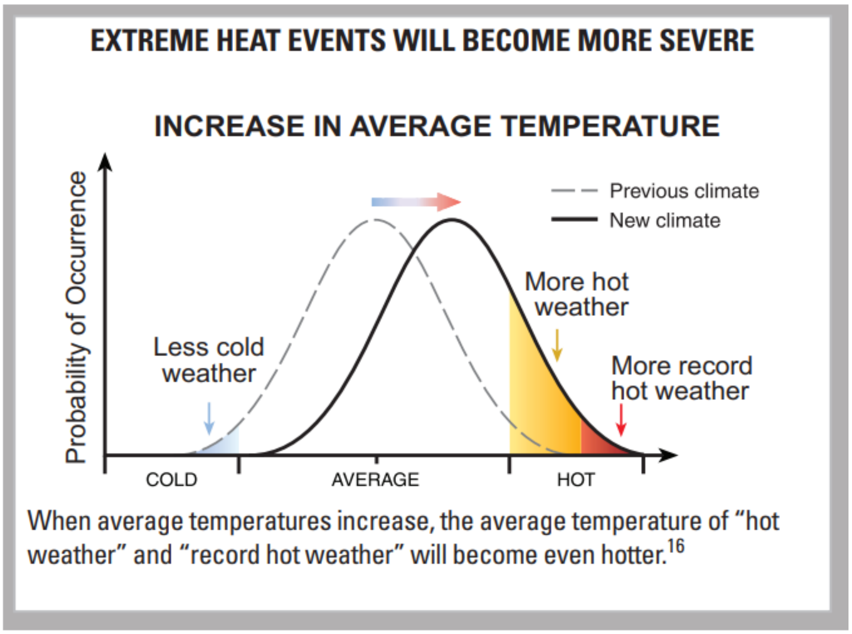

***Figure 3**, above, shows how both average temperatures and high temperature extremes will increase in the future with climate change. Image credit: U.S. Centers for Disease Control and Prevention (CDC 2011).*

The City of West Sacramento is characterized by a warm-summer Mediterranean climate, with hot, dry, and sunny summers in which temperatures are often in the low 90s °F but can exceed 100 °F (Yolo County et al. 2018). The City's summer temperatures usually cool overnight into the 60s (°F) due to effects from the Delta breeze.

Between 1961 and 1990—the historical baseline considered here—average daily maximum temperature in the City was 74°F. Temperatures are projected to increase throughout this century under both the medium emissions (RCP 4.5) and high emissions (RCP 8.5) scenarios (CEC 2020a). By mid-century, average daily maximum temperatures for the City will likely range from 78.2 °F to 79.2 °F (an increase of 4.2 to 5.2 °F above the historical baseline), and by end-of-century will likely range from 79.6 to 82.4 °F (an increase of 5.2 to 8.4 °F above the historical baseline) (**Table 1**). Average daily minimum, or nighttime, temperatures are projected to increase as well, though with less of an increase as maximum temperatures, with projected increases of 3.6-4.6 °F above the historical baseline by mid-century, and increases of 4.8 to 8.1°F above the historical baseline by end-of-century (Table 2).

Increasing air temperatures contribute to various climate hazards, including heightened urban heat island effects and increased extreme heat events, and droughts (SMAQMD and LGC 2020). Extreme heat and urban heat island hazards are discussed below in the Climate Hazards section.

Table 1. Projected Changes in Average Daily Maximum Temperature for City of West Sacramento

Emission Scenario	Historical Baseline (1961-1990)	Mid-Century (2035-2064)	End-of-Century (2070-2099)
RCP 4.5	74.0°F	+4.2°F (78.2°F)	+5.6°F (79.6°F)
RCP 8.5	74.0 °F	+5.2°F (79.2°F)	+8.4°F (82.4°F)

Table 1*, above, shows projected changes in average daily maximum temperature for the City of West Sacramento, for mid- and end-of-century under the RCP 4.5 and RCP 8.5 emissions scenarios. Projections shown are from Cal-Adapt LOCA-derived precipitation projections using the 4 priority models: HadGEM2-ES (warm/drier); CNRM-CM5 (cooler/wetter); CanESM2 (average); and MIROC5 (complement) (CEC 2020a).*

Table 2. Projected Changes in Average Daily Minimum Temperature for City of West Sacramento

Emission Scenario	Historical Baseline (1961-1990)	Mid-Century (2035-2064)	End-of-Century (2070-2099)
RCP 4.5	48.4°F	+3.6°F (52.0°F)	+4.8°F (53.2°F)
RCP 8.5	48.4°F	+4.6°F (53.0°F)	+8.1°F (56.5°F)

Table 2*, above, shows projected changes in average daily minimum temperature for the City for mid- and end-of-century under the RCP 4.5 and RCP 8.5 emissions scenarios. Projections shown are from Cal-Adapt LOCA-derived precipitation projections using the 4 priority models: HadGEM2-ES (warm/drier); CNRM-CM5 (cooler/wetter); CanESM2 (average); and MIROC5 (complement) (CEC 2020a).*

3.2.2 Sea Level Rise

A global impact of climate change is sea level rise, due to both the melting of land ice as a result of increased temperatures and the thermal expansion of ocean water (IPCC 2014). Rates of sea level rise vary by region due to a variety of factors, including land uplift and subsidence, wind patterns, and ocean circulation patterns (OPC 2018). The City of West Sacramento is located where the Sacramento River flows into the Delta; Delta water levels are in part determined by water levels in the San Francisco Bay, and thus the Delta and the City are affected by sea level rise. Sea levels most relevant to the City are recorded at the San Francisco Bay tide station, where the Delta's waters flow into the San Francisco Bay. Average sea level has increased at the San Francisco Bay tide station by about 8 inches since the mid-1850s (NOAA 2020). Sea levels will likely continue to increase this century (Church et al. 2013).

Table 3 shows sea level projections from OPC's 2018 Sea Level Rise Guidance Update for the San Francisco tide station (OPC 2018). These projections indicate that there is a 66% probability that sea level at the San Francisco tide station will increase from current levels between 0.6 to 1.1 feet by 2050. There is a 0.5% likelihood that sea level will increase by 1.9 feet. By 2100, sea level is likely to increase by between 1.2 to 3.4 feet (with a 0.5% chance of an increase of up to *6.9 feet*). The "H++" scenario shown in the table, which represents the most extreme scenario, would see up to 10.2 feet of sea level rise by 2100 (OPC 2018). The OPC guidance presents a range of sea level rise projections to use for planning, based on low, medium-high, and extreme risk aversion (**Table 3**). OPC recommends planning for sea level scenarios using RCP 8.5 scenarios through 2050.

Delta Adapts incorporates both sea level rise and projected changes in hydrology, consistent with the OPC guidance, to model flooding due to levee overtopping in the Delta and Suisun Marsh. The results of this flood analysis will be used to identify assets and residents exposed to flooding under the various scenarios for the City of West Sacramento. Methodology for the flood modeling is discussed in more detail in Section 5.2.

Table 3. Sea Level Rise Projections (in Feet) for the San Francisco Tide Station from OPC 2018 Sea Level Rise Guidance Update

		Median	Likely Range		1-in-20 chance	1-in-200 chance	
		50% probability sea level rise meets or exceeds	*66% probability sea level rise is between*		*5% probability sea level rise meets or exceeds*	*0.5% probability sea level rise meets or exceeds*	H++ Scenario
Emission Scenario	Year	N/A	N/A	Low risk aversion	N/A	Medium-high risk aversion	Extreme risk aversion
RCP 8.5	2030	0.4	0.3	0.5	0.6	0.8	1.0
RCP 8.5	2050	0.9	0.6	1.1	1.4	1.9	2.7
RCP 4.5	2070	1.3	0.8	1.7	2.1	3.2	5.2
RCP 8.5	2070	1.4	1.0	1.9	2.3	3.5	
RCP 4.5	2100	1.8	1.2	2.7	3.5	5.8	10.2
RCP 8.5	2100	2.5	1.7	3.4	4.4	6.9	

***Table 3,** from the Delta Adapts Vulnerability Assessment, shows a range of sea level rise projections and corresponding probabilities for the San Francisco tide station, as presented in OPC's 2018 Sea Level Rise Guidance Update (DSC 2021d). The Delta Adapts flood modeling incorporates a range of sea level rise scenarios along with a range of future hydrology scenarios. Information in this table is from OPC (2018).*

In the City of West Sacramento, long-term sea level rise in combination with altered precipitation patterns will likely increase stress on levees and reduce levee effectiveness (Yolo County 2011; City of West Sacramento and WSAFCA 2019).

3.2.3 Precipitation and Runoff Patterns

While more uncertainty exists for climate projections of precipitation patterns than for projections of temperature, models indicate that California will likely see an increase in both the number of dry years and the maximum amount of precipitation for a single day (Pierce et al. 2018). The state will also likely experience fewer wet days, drier spring and fall seasons, and wetter winters (*Ibid*). Many projections indicate that total annual precipitation in the state will not change significantly by the end of this century (CEC 2020a).

Climate projections for the state indicate that precipitation will increasingly fall as rain rather than snow, and that snow will melt earlier in the spring—meaning runoff will be the highest earlier in the winter and spring (Fritze et al. 2011). While California's Mediterranean climate has historically been defined by large variability in precipitation patterns—with dry summers and wet winters—climate change may increase this variability, making dry water years drier and wet water years wetter, and increasing the variability and intensity of storms (Dettinger et al. 2016). Climate change may also shift precipitation patterns such that maximum precipitation and runoff will occur during a shorter time period in winter months (Swain et al. 2018), during which stormwater drainage infrastructure already experiences its heaviest load (City of West Sacramento and WSAFCA 2019). These shifts in precipitation patterns and increased variability could stress the state's water supply and flood protection infrastructure—much of which is already vulnerable to existing stresses—in addition to causing other statewide impacts (Swain et al. 2018; Mount et al. 2018). Shifts in precipitation, snowpack, and runoff patterns in the Sierra Nevadas due to climate change have implications for the City of West Sacramento, including potential reductions in water supply from the Sacramento River, increased flooding, and decreased soil moisture in the summer (Yolo County 2011).

Precipitation patterns at the local scale are more difficult to predict, and certain locations are projected to see an increase in precipitation intensity and/or frequency while other locations are expected to see a decrease in intensity and/or frequency (Sacramento County 2017). Local precipitation patterns affect localized, stormwater-related flooding in the City as well as groundwater levels. An increase in extreme rainfall events could stress the City's existing stormwater drainage system (City of West Sacramento and WSAFCA 2019).

The City typically gets most of its precipitation in the winter months from November to March (Yolo County et al. 2018). Between 1961 and 1990, the City averaged 17.8 inches per year of precipitation (CEC 2020a). Table 4 shows the projected changes in average annual precipitation for the City for mid- and end-of-century under the RCP 4.5 and RCP 8.5 emissions scenarios (CEC 2020a). Note that the table shows *modeled* historical precipitation, rather than observed historical, to allow for better comparison between the historical and modeled, future precipitation rates. Under both emissions scenarios, the City is projected to see an increase in annual average precipitation, with an increase above the historical baseline of 1.8 - 2 inches/year in mid-century to 1.9 - 4.0 inches/year by end-of-century (CEC 2020a).

Table 4: Projected Changes in Average Annual Precipitation for the City of West Sacramento

Emission Scenario	Modeled Historical (1961-1990) (inches/year)	Mid-Century (2035-2064) (inches/year)	End-of-Century (2070-2099) (inches/year)
RCP 4.5	18.4 in	+1.8 in (20.2 in)	+1.9 in (20.3 in)
RCP 8.5	18.4 in	+2.0 in (20.4 in)	+4.0 in (22.4 in)

Table 4*, above, shows projected changes in average annual precipitation, in inches per year, for the City for mid- and end-of-century under the RCP 4.5 and RCP 8.5 emissions scenarios. Projections shown are from Cal-Adapt LOCA-derived precipitation projections using the 4 priority models: HadGEM2-ES (warm/drier); CNRM-CM5 (cooler/wetter); CanESM2 (average); and MIROC5 (complement) (CEC 2020a).*

3.4 Climate Hazards

Here, three climate hazards are assessed for the City of West Sacramento: flooding, extreme heat, and wildfire.

3.4.1 Flooding

In the Sacramento Valley, climate change will likely result in an increased frequency of severe storms, increasing stress on levees and resulting flood risk (Houlton and Lund 2018). As previously mentioned, sea level rise in combination with changing precipitation patterns may contribute to increased flood risk in the Sacramento Valley, including in the City of West Sacramento (*Ibid*).

The ongoing risk from flooding is a major safety concern in the City (City of West Sacramento 2016b). The 2018 Yolo Operational Area Multi-Jurisdictional Hazard Mitigation Plan, West Sacramento Community Profile (Community Profile) ranked riverine and tidal flooding as the top hazard for the City. The Community Profile ranks hazards according to probability of occurrence and geographic extent and potential magnitude of the hazard in the City. Flooding was given a "likely" probability, and the geographic extent and potential magnitude was identified as catastrophic. Levee failure was classified as unlikely, but if levee failure should occur, it would result in catastrophic consequences. Dam failure was deemed to be an unlikely hazard but would result in critical consequences.

The City lies within the Sacramento River's natural floodplain and is bound by bodies of water including the Sacramento River and the Sacramento River Deep Water Ship Channel. Located at the confluence of the Sacramento River and the American River, the City is protected from flooding by levees and the Yolo and Sacramento Bypasses, through which flood waters are diverted around the City. Floods in the City could occur from a 100-year flood event (meaning a flood with a 1% annual chance of occurrence) or greater flood event, as well as from dam or levee failure and from localized drainage problems (Yolo County et al. 2018).

Flood risk will likely increase with climate change due to both sea level rise and increased frequency of severe storm events, which will increase stress on levees and increase the risk of riverine flooding (Houlton and Lund 2018). In addition, urban development—which tends to increase impervious surface cover—can increase flood magnitudes. Impervious surface cover plays a significant role in flooding: A recent study indicates that an increase of impervious cover by one percentage point increases annual flood magnitude by 3.3% (Blum et al. 2020). Thus, in addition to impacts from climate change, urban development and a resulting increase in impervious surface cover in the City could exacerbate future flood events. Additionally, as mentioned above, an increase in extreme storm events could stress the City's stormwater drainage system, increasing the likelihood of stormwater-related flooding.

The Delta includes over 1,000 miles of levees, many of which are aging and already vulnerable to existing stressors (Luoma et al. 2015). The Council's Delta Adapts initiative modeled future flooding in the Delta, incorporating various scenarios for sea level rise and changing precipitation patterns (DSC 2021d). Of note is that the Delta Adapts analysis examined areas at risk of flooding due to levee *overtopping,* but did not evaluate flooding due to levee failure, as that was beyond the scope of the analysis. Flood model results indicate that the City of West Sacramento maintains a less than 0.5% annual chance of flooding due to levee overtopping through 2085, indicating that it will maintain low flood exposure. An area adjacent to the City's southern border will experience a 0.5-1% annual chance of flooding due to levee overtopping by 2085. Chapter 6 presents results of the Delta Adapts flood analysis for the City and discusses impacts of flooding on each asset category.

3.4.2 Urban Heat Island Effect and Extreme Heat

Increased temperatures will exacerbate extreme heat impacts by increasing the frequency, magnitude, and duration of extreme heat events in the state (SMAQMD and LGC 2020). Extreme heat has negative impacts on people, infrastructure, and natural ecosystems. Along with rising air temperatures, the urban heat island (UHI) effect—or the elevated temperatures seen in urban areas compared to non-urban areas—contributes to extreme heat events in urban areas (SMAQMD and LGC 2020). The Sacramento region, including the City, already experiences high summer temperatures and a high number of extreme heat days (here defined as days exceeding the 98th percentile for historical daily maximum temperature from 1961-1990 between April and October; for the City of West Sacramento, an extreme heat day is a day when maximum temperature exceeds 103.4 °F) (CEC 2020a). Correspondingly, the Sacramento region experiences a high level of health impacts due to heat; the number of heat-related deaths and hospital visits in the Sacramento region is above the statewide average (SMAQMD and LGC 2020).

Urban Heat Island Effect in the Sacramento Region and the City of West Sacramento

The UHI effect refers to the phenomenon in which urban and suburban areas experience higher temperatures than comparable rural or natural areas, and heat from an UHI can transfer to surrounding areas (SMAQMD and LGC 2020). Higher temperatures in an UHI extend to after sunset. Urban areas in the United States experience daytime temperatures on average 1 to 6°F higher than comparable rural or natural areas, and minimum (nighttime) temperatures in urban areas can be 22° F higher than comparable rural or natural areas (CalEPA and Altostratus Inc. 2015). Many factors contribute to the UHI effect, including the built environment, population density and associated increased levels of equipment, vehicles and buildings, and a lower level of vegetation compared with rural or natural areas (SMAQMD and LGC 2020). The Sacramento region already experiences a significant UHI effect (CalEPA and Altostratus 2015; SMAQMD and LGC 2020).

The California Environmental Protection Agency (CalEPA) created a UHI index (UHII) showing existing urban heat island effects in urban areas of the state, at the census tract scale (CalEPA and Altostratus Inc. 2015). The UHII is calculated as the difference in temperature over time between an urban census tract and a nearby, rural reference point, and is reported in values of degree-hours per day. The degree-hour measure reflects both the magnitude and duration of the UHI effect: For example, a one-degree temperature increase over an eight-hour period would equal eight degree-hours; a two-degree increase over a four-hour period would also equal eight degree-hours (CalEPA and Altostratus Inc. 2015).

Figure 4 shows the UHII results in degree-hours per day (in °C) for the City of West Sacramento and the surrounding Sacramento area. The City experiences a lower UHI effect than other parts of the Sacramento area; UHII values in the City range from 6.58 to 30.38 degree-hours per day, with the strongest UHI effects experienced in census tract 6113010101, an area that includes the Lighthouse and Washington neighborhoods as well as portions of the Broderick/Bryte and Iron Triangle neighborhoods. This means that tract 6113010101 on average experiences a temperature 2.38 °F higher than that of a nearby rural area. This temperature differential is lower than other parts of the Sacramento area, where temperature differentials can be as much as 5.68 °F above nearby rural areas.

Note that the UHII does not include all City of West Sacramento census tracts.

Figure 4: Existing Urban Heat Island Effects in the City of West Sacramento and the Sacramento Area

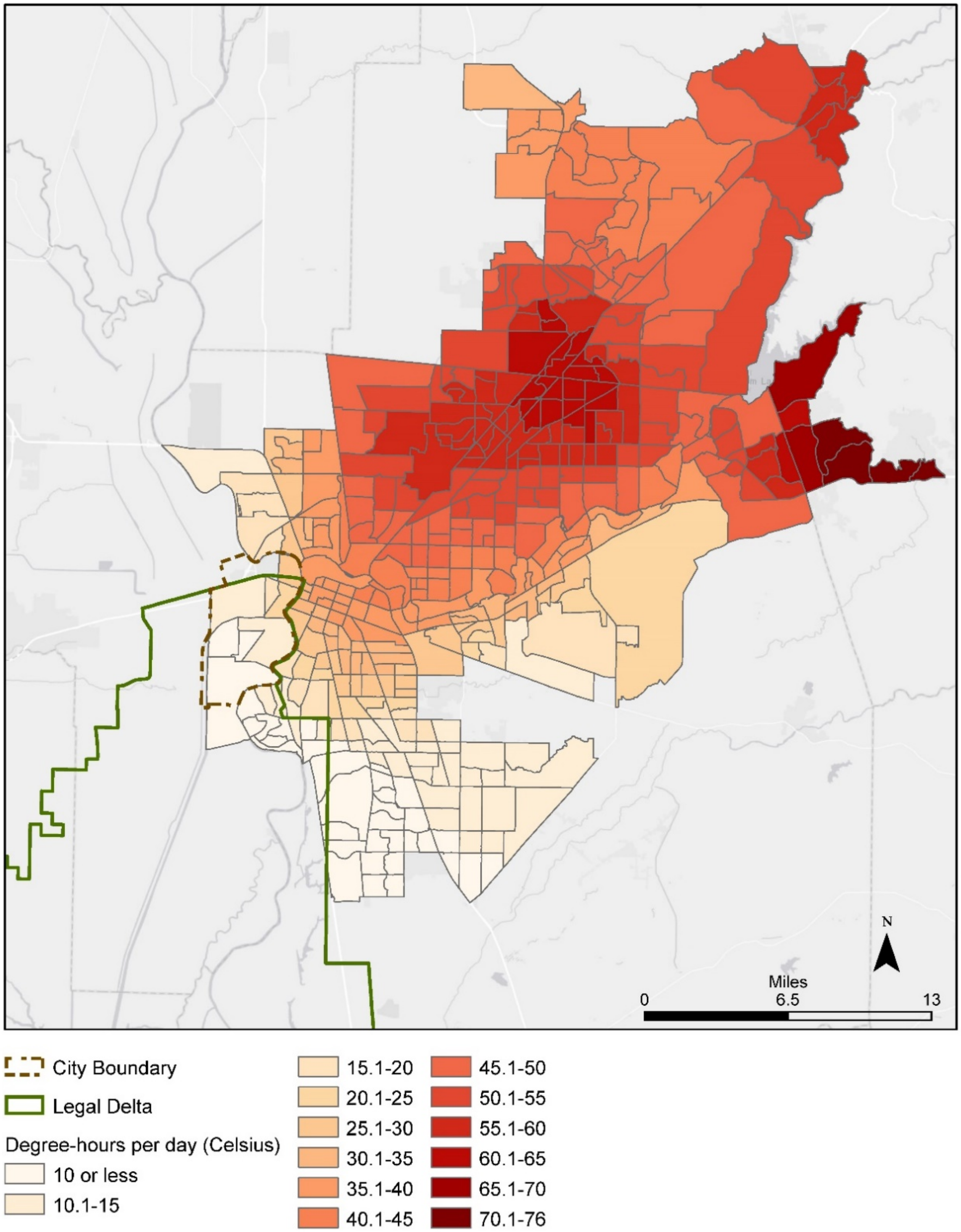

Figure 4*, above, shows UHII values, in degree-hour-days, for the City and other parts of the Sacramento area. While the City experiences a lower UHI effect than other parts of the Sacramento area, certain parts of the City experience up to 30.38 degree-hours per day, meaning that portion of the City experiences on average a 2.38 °F higher temperature than that of a nearby rural area.*

Climate change will exacerbate the UHI effect and thus worsen public health impacts due to extreme heat in urban areas (CalEPA and Altostratus Inc. 2015). Along with rising temperatures, future population growth and urbanization/land use changes could also worsen the UHI effect (SMAQMD and LGC 2020). While CalEPA's UHII did not model future UHI effects due to climate change, a recent project led by the Sacramento Metropolitan Air Quality Management District and the Local Government Commission modeled both existing and projected future UHI effects in the Sacramento region, incorporating various climate change, population growth, and land use and urbanization scenarios (SMAQMD and LGC 2020). Results showed that the UHI effect increased under both the RCP 4.5 and RCP 8.5 scenarios, with the RCP 8.5 scenario showing a stronger UHI effect (*Ibid*).

Extreme Heat Events

Extreme heat events can have significant public health and other impacts. (For an overview of health impacts of extreme heat and populations most vulnerable to extreme heat, see Section 6.1.2). While the UHI effect contributes to extreme heat conditions in urban areas, it is useful to assess the number of extreme heat events, as it is these discrete events that result in the most heat-related deaths and other health impacts (CDC 2011). As previously mentioned, an extreme heat day is here defined as a day in which maximum temperature exceeds the 98th percentile for historical daily maximum temperature from 1961-1990 between April and October (CEC 2020a). When extreme heat lasts for several days, it is known as a heat wave. For the City of West Sacramento, an extreme heat day is when maximum temperature exceeds 103.4 °F.

From 1961 to 1990, the City experienced an average of 4 extreme heat days per year; by mid-century, the City is projected to experience an average of 18 extreme heat days (under RCP 4.5) to 24 extreme heat days (under RCP 8.5) (Table 5) (CEC 2020a). By end-of-century, the City is projected to experience 25 extreme heat days under RCP 4.5 and 43 extreme heat days under RCP 8.5. When defining a heat wave as four consecutive days of extreme heat, the City is expected to experience on average 2.1 to 3.1 heat waves per year by mid-century and 3.2 to 6.4 heat waves per year by end-of century, under RCP 4.5 and RCP 8.5 emissions scenarios, respectively (CEC 2020a). From 1961 to 1990, the City experienced an average frequency of 0.1 heat waves per year, so the future projections indicate that the frequency of heat waves will increase significantly.

Table 5: Projected Changes in Average Extreme Heat Days Per Year in the City of West Sacramento

Emission Scenario	Historical (1961-1990)	Mid-Century (2035-2064)	End-of-Century (2070-2099)
RCP 4.5	4 days	+14 days (18 days)	+21 days (25 days)
RCP 8.5	4 days	+20 days (24 days)	+39 days (43 days)

Table 5 *shows projected changes in the average number of extreme heat days per year in the City of West Sacramento for mid- and end-of-century under the RCP 4.5 and RCP 8.5 emissions scenarios. An extreme heat day in the City is when temperature exceeds 103.4°F. Data source: Cal-Adapt LOCA-derived extreme heat projections (CEC 2020a).*

Heat Health Events: The California Heat Assessment Tool

Heat events can have public health impacts at varying temperatures and event durations depending on location. The California Heat Assessment Tool (CHAT) allows users to explore projections of heat health events—heat events that result in local public health impacts regardless of absolute temperature—at the census tract scale (CEC 2020b). CHAT has the option of visualizing a number of different variables related to heat health events, including but not limited to the projected number of events and average event duration. CHAT uses statistical relationships between local increases in emergency room visits and the absolute and relative maximum and minimum temperatures and duration of heat events in order to determine the characteristics of heat events that result in the highest increase in local emergency room visits. Using this identified local threshold for a heat health event, CHAT incorporates various downscaled climate change projections in order to project the average annual number of heat health events under various climate scenarios (Steinberg et al. 2018).

In addition to projecting various characteristics of heat health events, CHAT includes the Heat Health Action Index (HHAI), which assesses overall heat vulnerability by census tract. The HHAI identifies priority census tracts for heat mitigation on both a countywide and statewide basis by identifying census tracts that have the highest vulnerability to heat health events. Figures 5, 6, and 7 below show the projected average annual number of heat health events for the City of West Sacramento and surrounding areas, for the time periods 2011-2030, 2051-2070, and 2081-2099. CHAT projections of the future frequency of heat health events together with the HHAI priority census tracts can identify the City populations most vulnerable to extreme heat hazards as a result of climate change.

Figure 5: Projected Average Annual Number of Heat Health Events (under RCP 8.5) in the City of West Sacramento and Surrounding Areas, 2011-2030

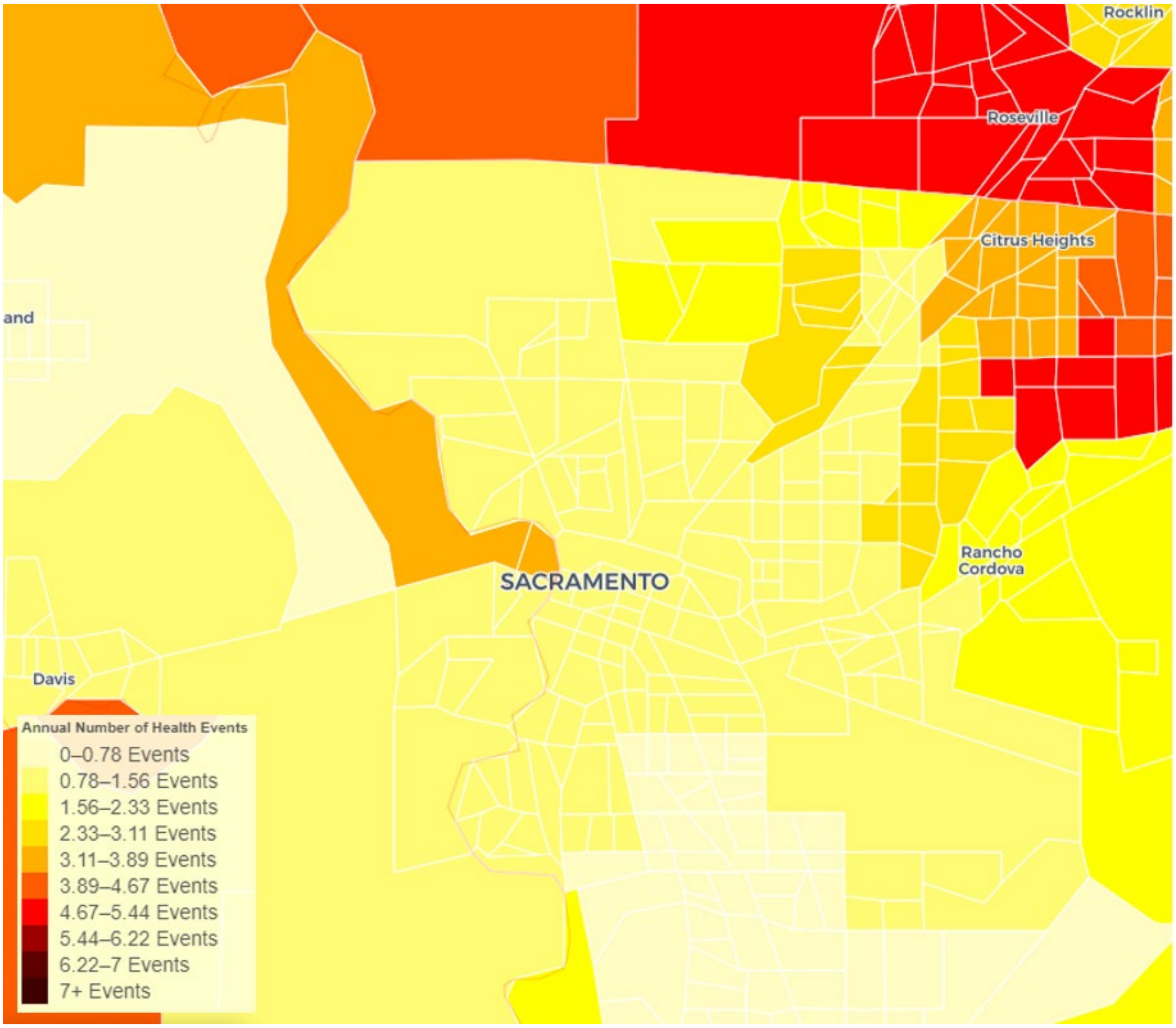

Figure 5*, above, shows the projected average annual number of heat health events (HHEs) for the City of West Sacramento and surrounding areas, for 2011-2030, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 0.9 (under RCP 4.5) to 0.95 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience* ***2.3 to 2.55 HHEs per year.*** *Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Figure 6: Projected Average Annual Number of Heat Health Events (under RCP 8.5) in the City of West Sacramento and Surrounding Areas, 2051-2070

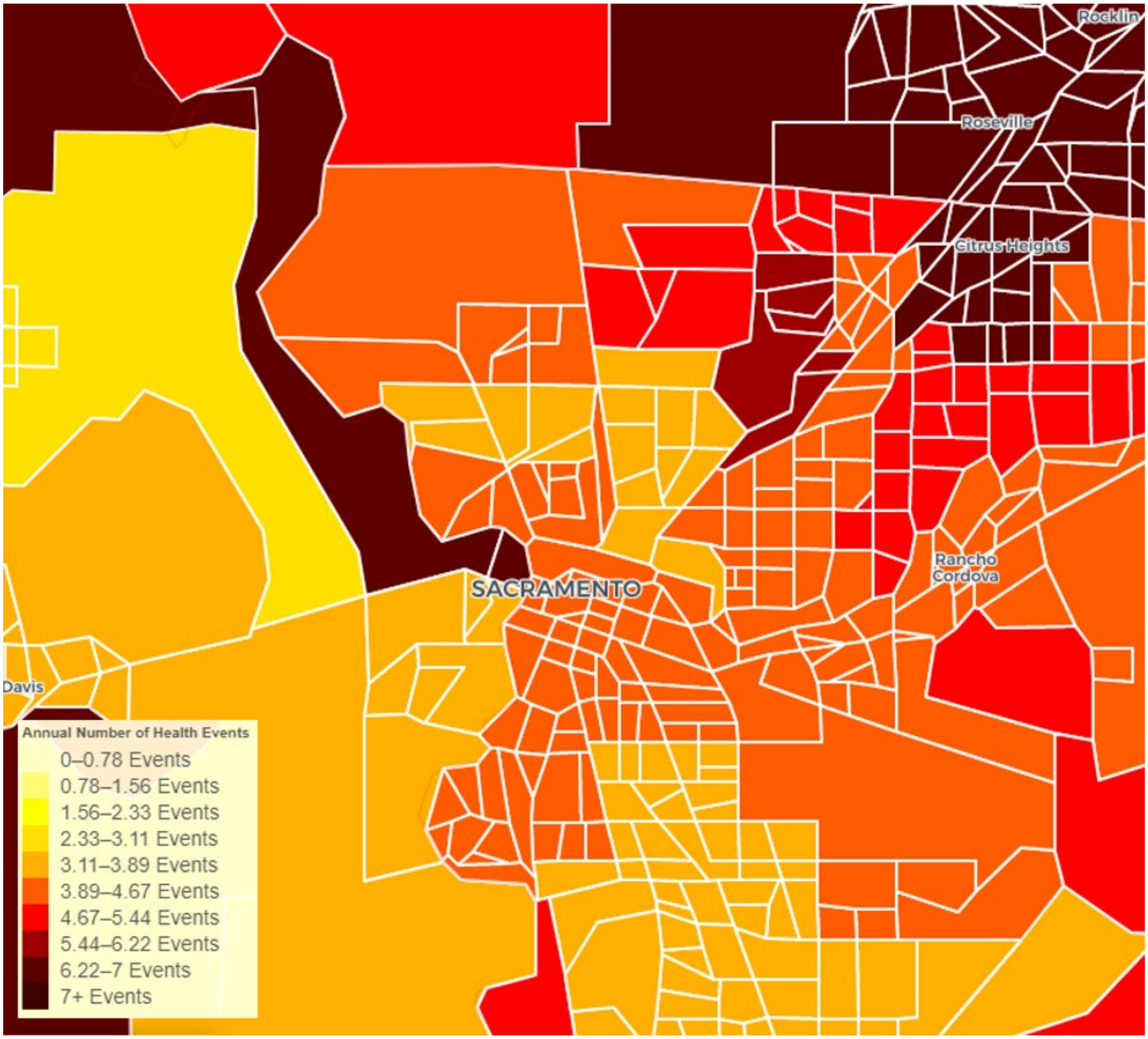

***Figure 6**, above, shows the projected average annual number of HHEs in the City of West Sacramento and surrounding areas, for 2051-2070, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 2.85 (under RCP 4.5) to 3.75 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience **4.3 to 5.7 HHEs per year**. Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Figure 7: Projected Average Annual Number of Heat Health Events (under RCP 8.5) in the City of West Sacramento and Surrounding Areas, 2081-2099

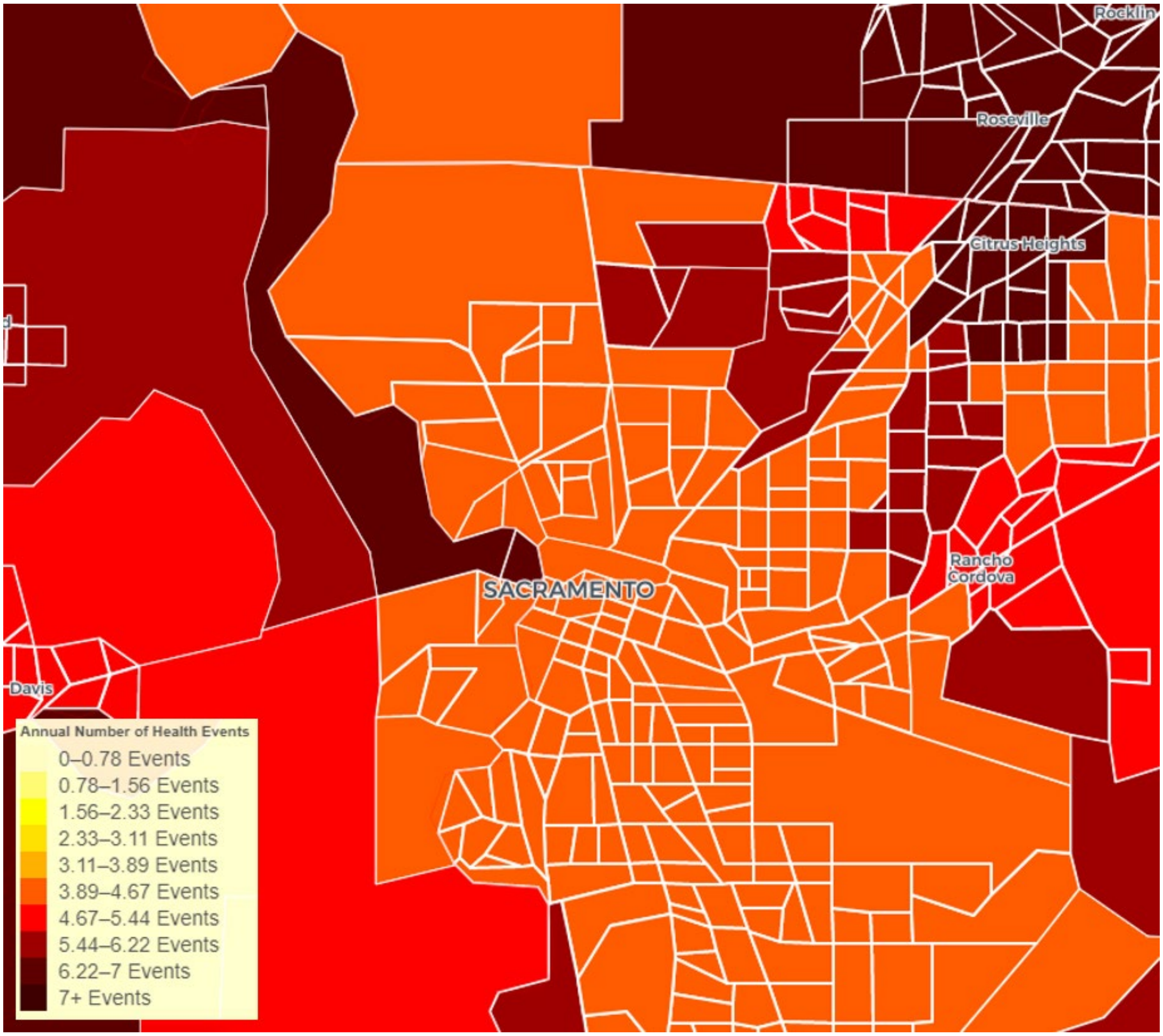

***Figure 7** shows the projected average annual number of HHEs in the City of West Sacramento and surrounding areas for 2081-2099, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 3.5 (under RCP 4.5) to 4.2 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience **5.2 to 6.35 HHEs per year**. Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Note that Section 6.1.2 will discuss in more detail the City populations most vulnerable to extreme heat events and the impacts of extreme heat on City assets.

3.4.3 Wildfire

Climate change, along with over a century of fire-suppression policies and other factors, has increased the frequency, severity, and size of wildfires in California (Steel et al. 2015; Williams et al. 2019). The length of the wildfire season is also increasing in California (CalFIRE 2019). In addition to directly threatening human lives and property, wildfires can have many secondary effects, including public health impacts from wildfire smoke.

The California Department of Forestry and Fire Protection (CalFIRE) prepared an assessment of existing community vulnerability to wildfire across the state. The vulnerability assessment used both wildfire risk and socioeconomic indicators to identify communities most vulnerable to wildfires (CalFIRE 2019), and the assessment found that West Sacramento has low vulnerability to wildfire relative to other areas of the state *(Ibid*). CalFIRE also produces maps of wildfire hazard severity zones, which assess existing fire hazard severity (using zones of moderate, high, and very high fire hazard severity) using factors including fuel, slope, and fire weather (CalFIRE 2020). The City of West Sacramento, which is not located in or near a forested or mountainous area and thus is not located in a wildland-urban interface, does not contain any fire hazard severity zones, but other nearby communities including Folsom and El Dorado Hills are located in Moderate Fire Hazard Severity Zones. If wildfires do occur in the City, these would most likely take the form of grass fires (Yolo County et al. 2018).

Wildfires in other areas of the state can reduce air quality in the City. Northern California experiences some of the highest levels of particulate matter due to wildfires (Rappold et al. 2017). Air quality impacts due to wildfire smoke will likely be exacerbated by climate change, as climate change will likely continue to increase the frequency and severity of wildfires in other parts of the state (Westerling and Bryant 2006). Statewide, annual land area burned by wildfires is projected to increase; wildfire risk is projected to increase this century for certain parts of California (CEC 2020a). Annual average acres burned by wildfires in the Sacramento Valley are projected to increase under both RCP 4.5 and RCP 8.5 (Table 6). Table 6 shows projections for wildfire acres burned for the Sacramento Valley Region under RCP 4.5 and RCP 8.5 at mid- and end-of-century, under a central population growth, and using the four priority models: CanESM2 (average), HadGEM2-ES (Warm/Drier), CNRM-CM5 (Cooler/Wetter), MIROC5 (Complement) (CEC 2020a). Acres burned in the Sacramento Valley region are projected to increase significantly, ranging from an increase of 22.5% to 37.3% at mid-century to an increase of 51% to almost 100% by the end of the century (Table 6). Note that the wildfire simulation model used only includes areas within combined state and federal fire protection responsibility areas (CEC 2020a).

Table 6: Projected Wildfire Acres Burned for the Sacramento Region for Mid- and End-of-Century

Emission Scenario	Modeled Historical (1961-1990) Annual Average Acres Burned	Mid-Century (2035-2064) Annual Average Acres Burned	End-of-Century (2070-2099) Annual Average Acres Burned
RCP 4.5	51,783.2	*22.5% increase* (63,458.6)	*51.1% increase* (78,257.8)
RCP 8.5	51,763.6	*37.3% increase* (71,066)	*99.5% increase* (103,249.8)

***Table 6** shows projected annual average acres burned by wildfires in the Sacramento Valley Region, under a central population growth scenario, for mid- and end-of-century under RCP 4.5 and RCP 8.5. Four priority models are used: CanESM2, CNRM-CM5, HadGEM2-ES, MIROC5. Wildfire projections are from Westerling 2018. Source: Cal-Adapt Wildfire Scenario Projections (CEC 2020a).*

Chapter 6 discusses impacts of wildfires and wildfire smoke on City residents and assets. For some asset categories, wildfire hazard vulnerability is not assessed because it is not applicable.

Chapter 4. Existing Conditions

This section explores current conditions in the City of West Sacramento, describing and mapping important City assets.

4.1 Asset and Resources Inventory

4.1.1 Inventory Process

To identify and map important City assets, various data sources were used. The Community Profile, General Plan 2035 and associated general plan background report chapters, and the Southport Levee Improvement Project (SLIP) Draft Environmental Impact Report provided information on certain city assets and asset locations for the various asset categories. Several GIS data layers from the City's online Open Data Hub were used. The Council's Delta Adapts asset database served as a starting point for data for many of the asset categories. This database includes GIS data of assets throughout the Delta and Suisun Marsh, pulling from external data sources. The data layers in this database are clipped to the Legal Delta and Suisun Marsh. Where additional data was needed to ensure coverage for entire City of West Sacramento area, original data sources were re-downloaded and used where possible.

Appendix 1 provides a full list of data sources used for each asset map.

4.1.2 Organization of Assets and Resources for Vulnerability Assessment

This report identifies key City assets, organizing assets into several overarching categories. These asset categories include important buildings and infrastructure within the City of West Sacramento—both city-owned and non-city owned—as well as City residents. Asset categories mapped include:

- People and Communities
- Cultural and Historic Resources
- Critical Facilities (e.g., police stations, fire stations, acute care facilities)
- Parks and Recreation Facilities
- Agriculture
- Energy Infrastructure
- Transportation Infrastructure
    - Major transportation infrastructure
    - Public transit and bike/pedestrian infrastructure
- Flood Management Infrastructure
- Water Supply Infrastructure.

4.1.3 Asset Descriptions

4.1.3.1 People and Communities

Photo Credit: Department of Water Resources

The City of West Sacramento has a population of approximately 54,328; the population increased by over 50% between 2000 and 2019 (California Department of Finance (DoF) 2020; DoF 2019). In that time, average educational attainment levels and income have increased as well: According to the 2018 American Community Survey 5-year estimates, approximately one-third of City residents have a bachelor's degree, and median household income is estimated to be $64,664 as of 2018 (US Census Bureau 2018). 57.9% of resident are between the ages of 18 and 59, an important population characteristic because this age class represents the bulk of the labor force *(Ibid*).

Socially Vulnerable Communities

Although average income and educational attainment have increased in the last two decades, approximately 36% of residents lived below 200% of the federal poverty level in 2018 (U.S. Census Bureau 2018). The City contains disadvantaged communities as defined by California Government Code section 65302, meaning the City contains communities disproportionately burdened by and vulnerable to environmental pollution and other hazards relative to other California communities. Figure 8 shows variations in social vulnerability across the City, showing which communities have higher concentrations of socially vulnerable populations relative to others. The map shows results of the social vulnerability index applied to the City as explained in Section 5.3.

Figure 8: Socially Vulnerable Communities by Census Block Group

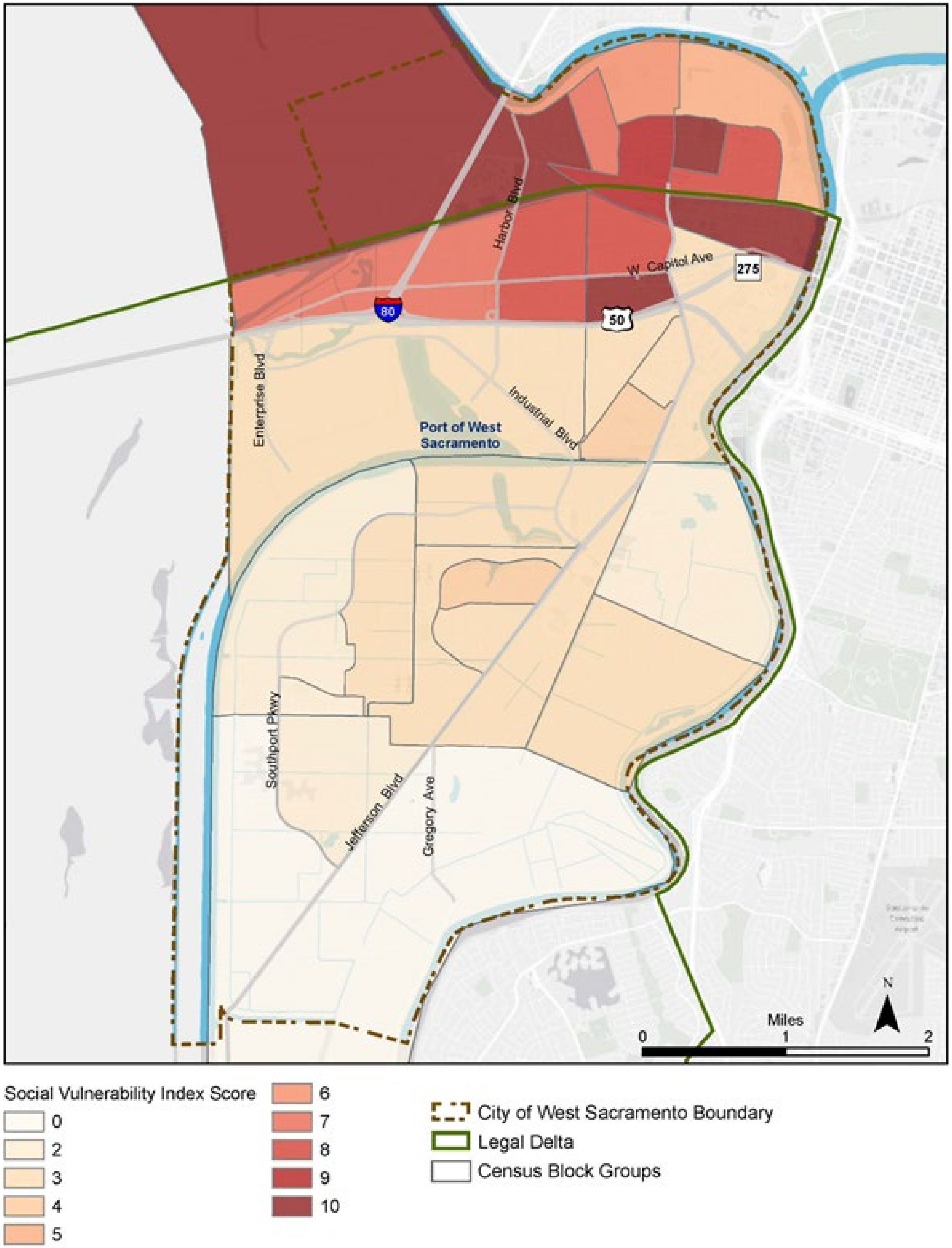

Figure 8 *shows results from the social vulnerability index for the City of West Sacramento, discussed in Section 5.3. Census block groups with higher scores are more likely to have higher sensitivity and lower adaptive capacity to the climate hazards of flooding, extreme heat, and wildfire smoke.*

4.1.3.2 Places

4.1.3.2.1 Cultural and Historic Resources

West Sacramento has various historic sites and buildings and has a rich Native American heritage (GP 2035 NCR element). The Background Report (2009) for General Plan 2035 lists 78 cultural and historic resources found in a 2007 survey of historic and cultural resources in Yolo County; however, the City did not verify the existence or determine significance of the identified resources. For simplicity, in this analysis, only resources listed or eligible to be listed on the National Register of Historic Places (as of 1/8/2020) were included[2]. Additionally, the Stone Lock Flood Gate was included because the 2035 General Plan Natural and Cultural Resources Element includes a policy stating that the City will consider developing and maintaining the Stone Lock Flood Gate as a point of historical interest.

The City has one listed site under the National Register of Historic Places (NRHP): Washington Firehouse, alternately known as the West Sacramento Fire House (NPS 2019). Located near the corner of 3rd and C Streets and next to the I Street Bridge, the Washington Firehouse was built in 1940 and served as a fire station for most of its life but also served as a police station for a time, and is now leased as a restaurant space. NRHP-listed sites listed under the City of Sacramento of interest to West Sacramento include the I Street Bridge and Tower Bridge, discussed further in Section 4.1.3.3.3. The Sacramento Weir, discussed further in the Flood Management Infrastructure asset category section, is eligible to be listed on the NRHP (NPS 2019).

The future California Indian Heritage Center State Park is planned to be located at the previously City-owned "East Riverfront" property in the Broderick Bend area, adjacent to the Sacramento River (California State Parks 2021). In June 2019, the City completed the transfer of the 43-acre East Riverfront parcel to California State Parks. The future State Park will feature a new museum and cultural heritage center. Site design and development are currently underway. Although the California Indian Heritage Center State Park does not yet exist, it will become an important cultural asset in the future and the City may want to consider how climate hazards could affect the site. Figure 9 shows the locations of these historic and cultural resources.

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[2] Note that the First Pacific Coast Salmon Cannery Site used to be listed on the NRHP but was removed from the list in 2004. Washington Firehouse, I Street Bridge, Tower Bridge, and the First Pacific Coast Salmon Cannery Site are also listed on the California Register of Historical Resources.

Figure 9: Major Historic and Cultural Resources

***Figure 9** shows the locations of NRHP listed or eligible sites in the City, the Stone Lock Flood Gate, and the planned, future site of the California Indian Heritage Center State Historic Park.*

4.1.3.2.2 Critical Facilities

The City has many critical city facilities that serve a variety of important functions and are thus considered key city assets. These assets include fire stations, police stations, acute care facilities, schools, and other major assets including the Community Center/Transit Center, Public Works buildings, Civic Center, and the Recreation Center (which can be used as an evacuation center). **Table 7** lists the various categories of critical facilities and **Figure 10** shows the locations of these facilities. Note that certain other City facilities are discussed in other asset categories (such as the Club West Teen Center).

Table 7: Critical Facilities in the City of West Sacramento

Facility Type or Name	Additional Information
Fire Stations	The West Sacramento Fire Department operates five fire stations in the City.
Police Stations	The West Sacramento Police Department operates one police station in the City located at 550 Jefferson Boulevard.
Schools	Washington Unified School District serves over 7,000 students and includes seven elementary schools, a high school, an alternative high school, independent study program, and an adult education program. At least one more elementary school is planned for the future.
Acute Care Facilities	One acute care facility exists in the City: West Sacramento Urgent Care, located at 2455 Jefferson Blvd. Various medical centers and medical groups exist in the City, but only acute care facilities are included in the analysis of City assets.
Community Center/Transit Center	Located at 1075 West Capitol Avenue.
Public Works Buildings	Public Works facilities perform critical functions in the City, including sludge dewatering. Various public works facilities are located at 1951 and 1991 S. River Road. A new corp yard is under construction at 4300 West Capitol Avenue that will replace the facilities on South River Road.
Civic Center	Located at 1110 West Capitol Ave, Civic Center serves as an event space that can be rented out.
Recreation Center	Located at 2801 Jefferson Blvd, the Recreation Center can be used as an evacuation center.

Figure 10: Critical Facilities

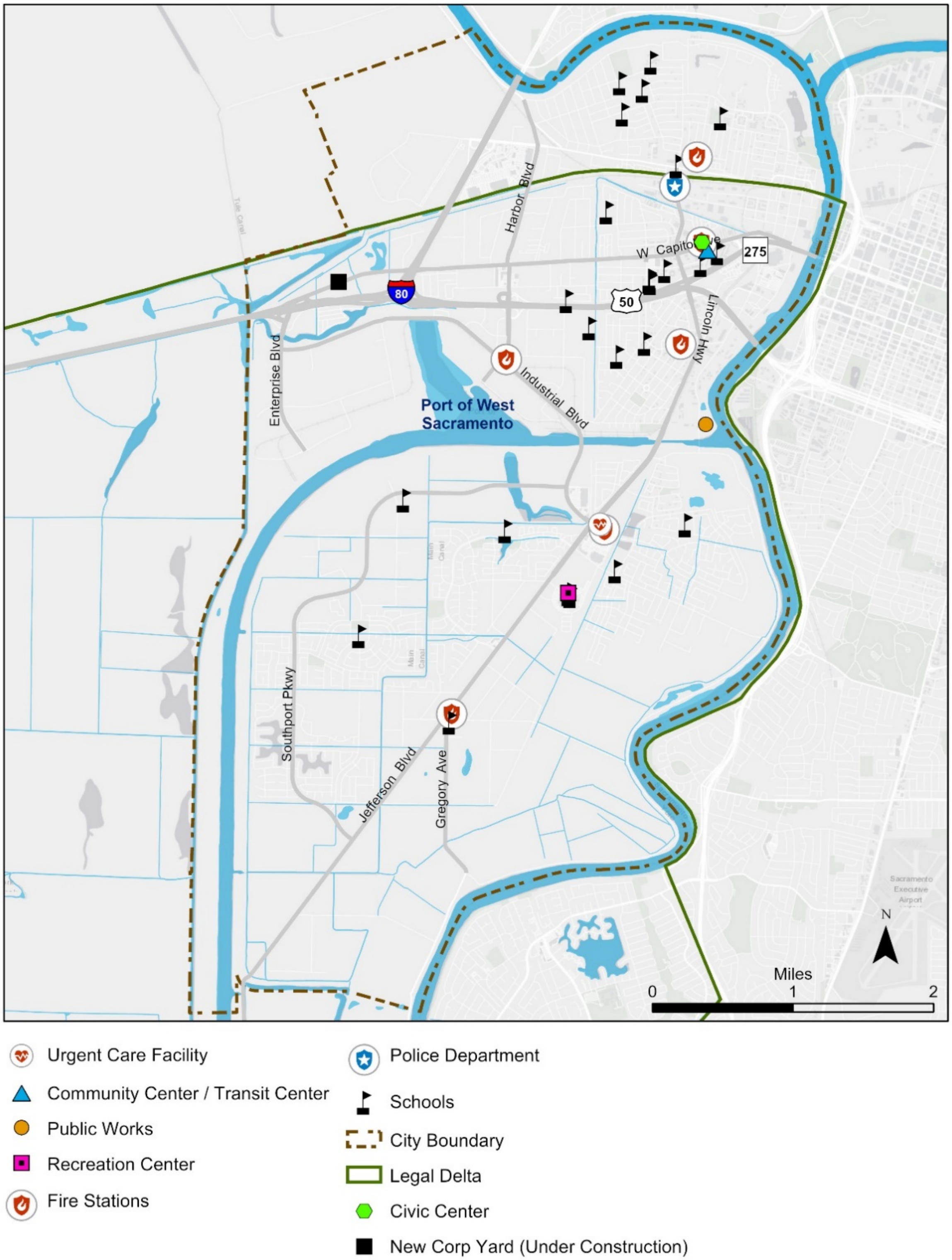

***Figure 10**, above, shows the locations of critical facilities in the City of West Sacramento, including acute care facilities, fire stations, police stations, schools, as well as the Civic Center, Community Center/Transit center, and public works facilities.*

4.1.3.2.3 Agriculture

Climate change will have various impacts on agriculture throughout the state. The City of West Sacramento contains agricultural lands, primarily in the southern, more rural portion of the City. Agricultural lands also border the City to the west and south. The principal agricultural crops grown in the City include wheat, alfalfa, and various fruits and vegetables. The Farmland Mapping and Monitoring Program (FMMP) ranks farmland according to soil quality and irrigation status. The best quality farmland is referred to as prime farmland. As of 2016, approximately 16.2% of City land area was classified as higher-value farmland, including prime farmland, farmland of statewide importance, farmland of local Importance, and unique farmland. Of these four categories, farmland of local importance makes up the highest percentage at 12.66% of total City land area (**Table 8**). **Figure 11** shows these farmland categories in the City, as well as land in the "other land" category, which includes land not suitable for agriculture and not urban or built-up land. **Table 8** shows all FMMP categories in the City as of 2016 and the land area in acres of each category, as well as the percentage of total acreage for each land use category.

Figure 11: FMMP Important Farmlands (2016)

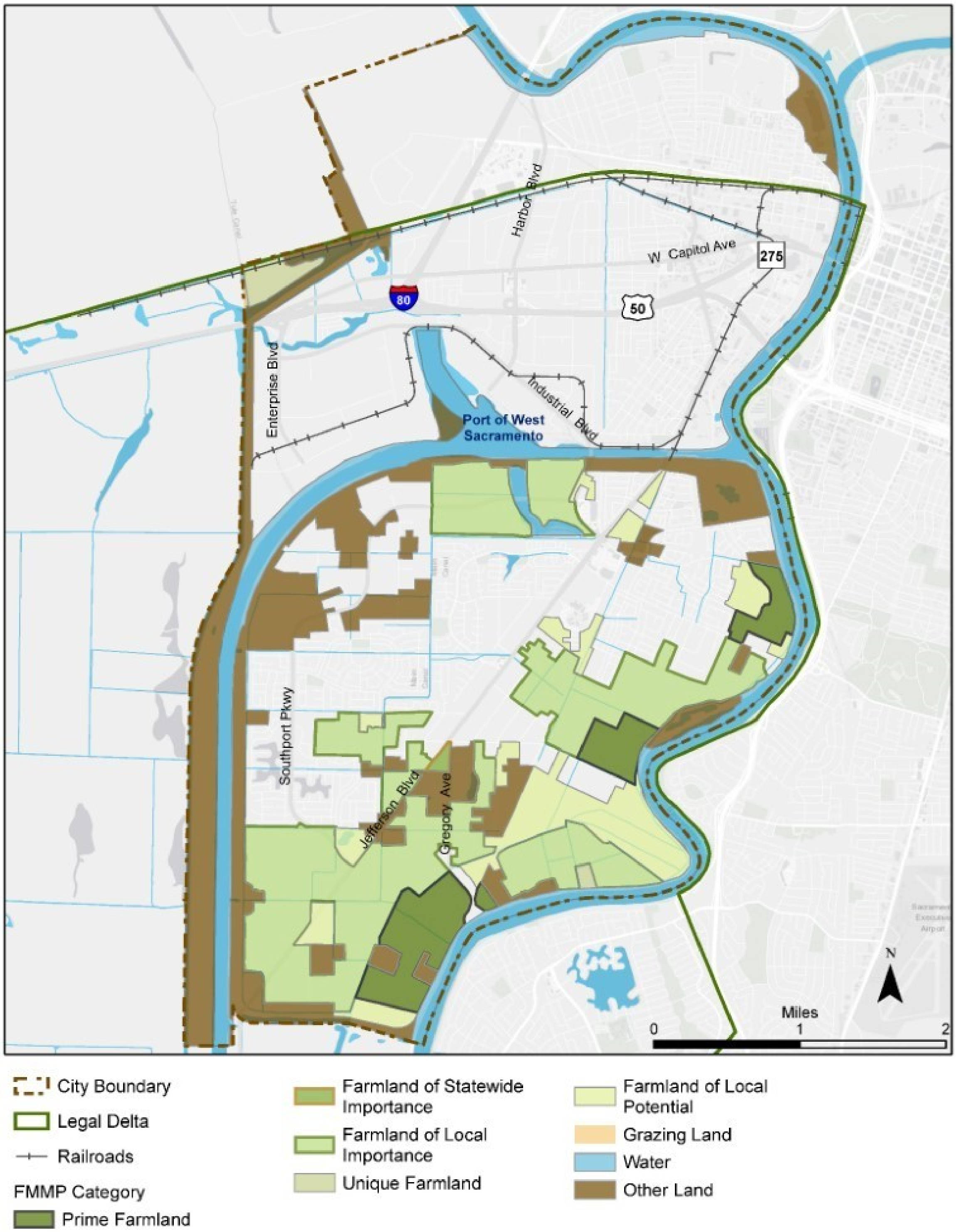

***Figure 11**, above, shows the Farmland Mapping and Monitoring Program (FMMP) Important Farmlands within the City. The City contains productive agricultural land, including prime farmland, the highest quality-rated farmland.*

Table 8: FMMP Land Use Categories for the City of West Sacramento (2016)

Land Use Categories	Definition	Acres (2016)	Percentage of total acreage
Prime Farmland	Best quality farmland with qualities to produce highest sustained yields	424.69	2.89%
Farmland of Statewide Importance	Similar to prime farmland but has minor shortcomings	12.51	0.09%
Farmland of Local Importance	Land of importance to the local economy. Cultivated farmlands that meet criteria for Prime or Statewide but the land is not currently irrigated, and other non-irrigated farmland.	1859.97	12.66%
Unique Farmland	Farmland of lesser quality soils used for the production of the state's leading agricultural crops	77.27	0.53%
Farmland of Local Potential	Land not presently cultivated or irrigated that if cultivated, would contribute to the local economy	583.08	3.97%
Grazing Land	Land on which the existing vegetation is suited for livestock grazing	6.54	0.04%
Urban and Built-Up Land	Developed land with a building density of at least one unit per 1.5 acres	8561.29	58.29%
Water	Perennial water bodies with an extent of at least 40 acres	1215.58	8.28%
Other Land	Land not included in any other mapping category	1945.40	13.25%

***Table 8** shows all FMMP land use categories and corresponding acreage in the City of West Sacramento. Categories highlighted in green are the agricultural areas of highest value in the FMMP rating system. Approximately 16.2% of land area in the City is prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. Note that the minimum mapping unit for the FMMP is 10 acres. Data Sources: California Department of Conservation, Farmland Mapping and Monitoring Program (FMMP) (2016).*

Approximately 857 acres are currently designated for agriculture under General Plan 2035, while much of the agricultural lands described above are designated for other uses, including low-, medium-, and high-density residential, neighborhood mixed-use, rural estate, business park, water related industrial, public-quasi public, recreation and parks, and open space. While agriculture is not designated to remain in much of this area, active agricultural operations are protected until development is imminent (City of West Sacramento 2016b).

4.1.3.3 Infrastructure

4.1.3.3.1 Parks and Recreation Facilities

The City has various parks and recreational facilities that provide important benefits to residents. The City has 35 existing parks, with two future parks planned (Figure 12). The City also has several other major recreational facilities, including the Recreation Center, Club West Teen Center, and the Bridgeway Lakes Boathouse and Concession Stand. Two privately-owned marinas also exist in the City: the Sherwood Harbor Marina and the Sacramento Yacht Club. The Yolo Bypass Wildlife Area and Sacramento Bypass Wildlife Area, located in flood bypass channels, provide many recreational opportunities.

Figure 12: Parks and Recreational Facilities

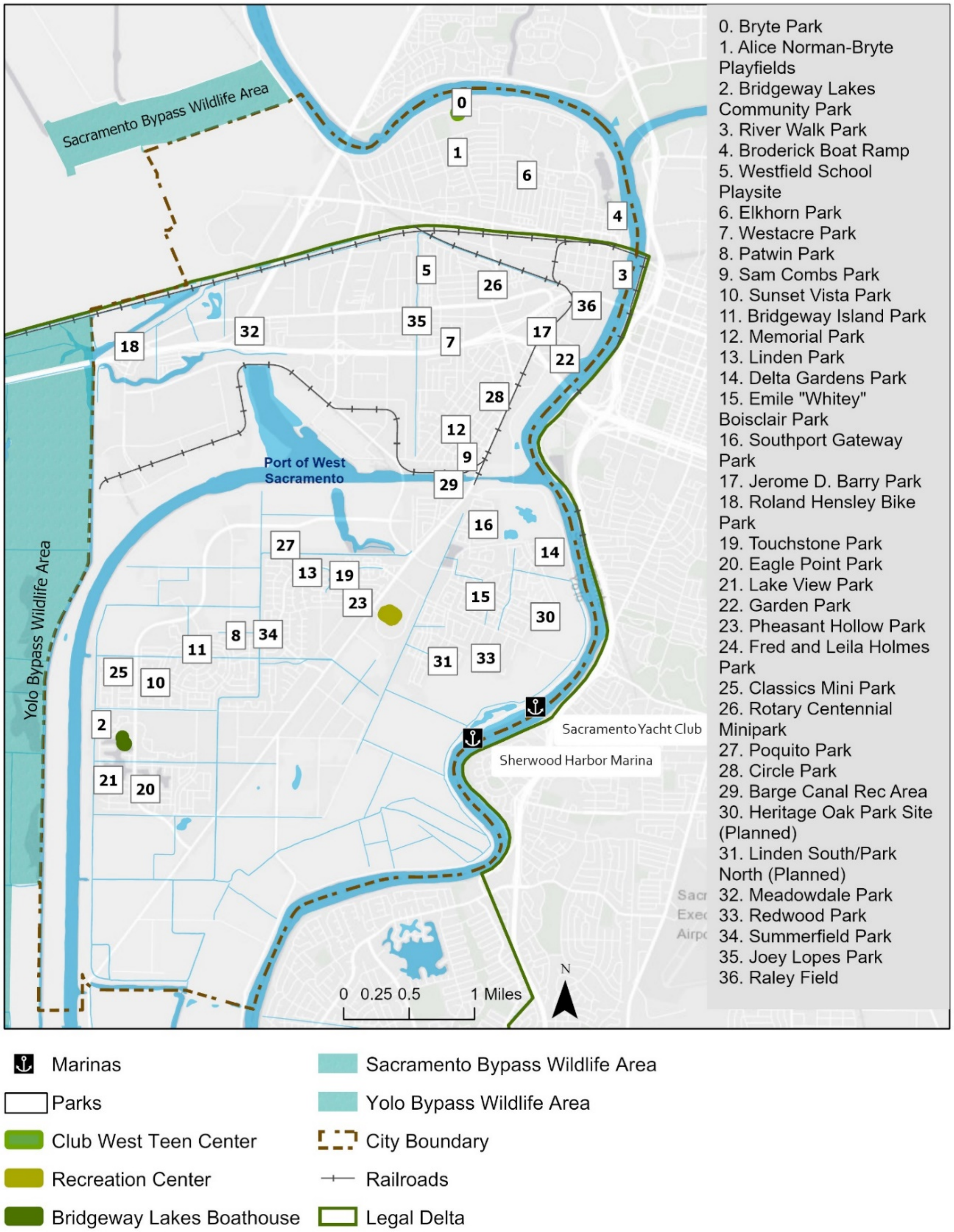

Figure 12 *shows parks and major City recreational facilities, including the Club West Teen Center, Bridgeway Lakes Boathouse, Recreation Center, and the two marinas: Sherwood Harbor Marina and Sacramento Yacht Club. The map also shows the locations of Yolo Bypass Wildlife Area and Sacramento Bypass Wildlife Area, which are adjacent to City borders.*

4.1.3.3.2 Energy Infrastructure

Energy infrastructure provides critical functions, and climate change will threaten this infrastructure. As such, it is important to identify potential impacts of climate change on energy infrastructure. In the City of West Sacramento, electrical and natural gas service is provided by Pacific Gas and Electric Company (PG&E). PG&E provides electricity and natural gas distribution, electricity generation, transportation and transmission, natural gas procurement, transportation, and storage (City of West Sacramento 2009). Three electrical transmission lines supply electricity to the City, and there are three electrical distribution substations: The Oak Street substation (located at 900 Oak St.), the Deep Water substation (adjacent to the Southport Industrial Park) (Yolo County et al. 2018), and the Sacramento Mail substation.

Two natural gas pipelines transport natural gas in the City: the SMUD pipeline and the PG&E pipeline. Three PG&E-owned natural gas stations are located within the City. Three pipelines transport liquid petroleum in the City (the Kinder-Morgan Pipeline, Chevron Pipeline, and Wickland Pipeline)[3]. **Figure 13** shows the locations of this infrastructure (excluding oil pipelines and oil fields)[4].

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[3] Note that oil pipelines are not mapped here because the data on oil pipelines cannot be reproduced due to safety reasons.
[4] Figure 13 only shows natural gas pipelines and natural gas stations within the legal Delta. Data for the rest of the City was unavailable.

Figure 13: Energy Infrastructure (Excluding Oil Infrastructure)

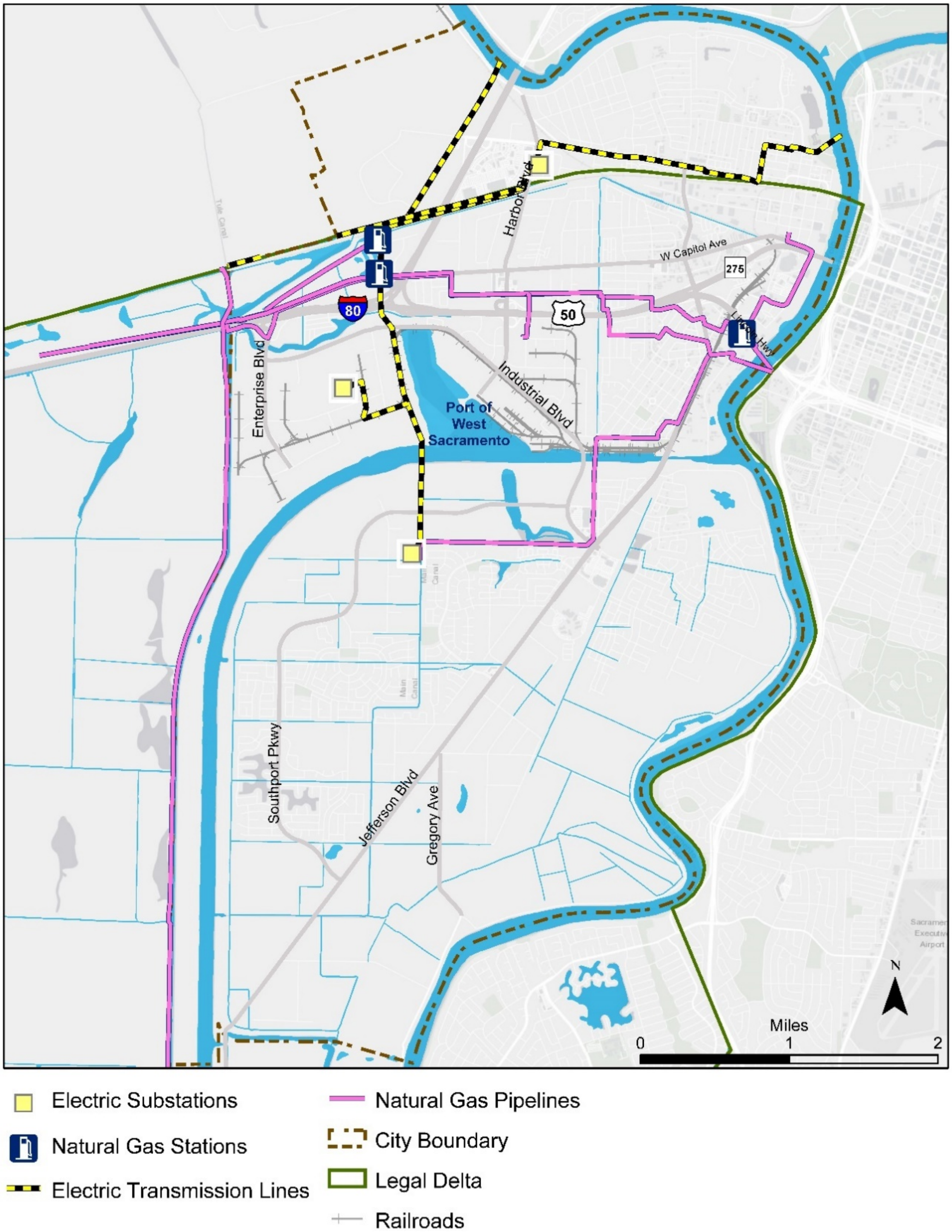

Figure 13*, above, shows major energy infrastructure in the City, including natural gas stations and pipelines, electric substations, and electric transmission lines. Natural gas pipelines and stations beyond the legal Delta are not shown due to a lack of available data.*

4.1.3.3.3 Transportation Infrastructure

Flooding and extreme heat can result in transportation asset damage and transportation system delays. At the same time, the transportation network is essential for emergency response during flood events and other hazards. As such, it is important to consider transportation assets in assessing the impact of climate hazards. The City contains various key transportation infrastructure, including major freeways and highways, bridges, railroad lines, and shipping ports. The Sacramento River Deep Water Ship Channel, which runs through City limits, provides international shipping access for the City by connecting the City with the San Francisco Bay and Pacific Ocean (Yolo County et al. 2018). **Table 9** lists key transportation assets along with a brief description of each; **Figure 14** shows the locations of these assets. Asset descriptions were obtained from the 2018 Yolo Operational Area LHMP West Sacramento Community Profile; locations of assets and GIS data were obtained from the City's Open Data Portal, U.S. Major Roads layer (Esri and Tom Tom North America), and the Department of Water Resources National Waterway Network (2013).

Table 9: Major Transportation Infrastructure in the City of West Sacramento

Key Transportation Assets	Additional Information
Major Roadways	
Interstate 80 and U.S. Highway 50/Interstate 80 Business	I-80 runs east to west through the City.
Jefferson Blvd.	Jefferson Boulevard serves as the primary north-south road through the City.
Interstate 5 (I-5)	While I-5 is across the river in the City of Sacramento, it is an important part of the larger transportation system of which the City is a part.
Bridges	Three main bridges connect the City with the City of Sacramento to the east.
I Street Bridge	A two-level bridge, with cars travelling on the upper two-lane level and the Union Pacific railroad tracks on the lower level. The I Street Bridge was built in 1911.
Tower Bridge	Built in 1934, the Tower Bridge is a four-lane car bridge.
Pioneer (U.S. Highway 50/Interstate 80 Business) Bridge	A multi-lane highway bridge.
Railroad Lines	
Sierra Northern Railroad	Local freight operator in the City.
Union Pacific Railroad	Provides long haul service to and from the City. Operates main lines in Sacramento that run from the Northwest U.S. to the Southwest U.S. In the City, operates a double-track,

	main line that runs east to west through the city from Oakland to Salt Lake City.
Burlington Northern Santa Fe Railroad (BNSF)	Provides long haul service to and from the City. Operates main lines in Sacramento that run from the Northwest U.S. to the Southwest U.S.
Shipping Ports	
Port of West Sacramento	The Port of West Sacramento, located where Industrial and Stone Boulevards meet the Deep Water Ship Channel, provides international shipping access for the City. The Deep Water Ship Channel connects the City to the San Francisco Bay and Pacific Ocean.

Figure 14: Key Transportation Assets

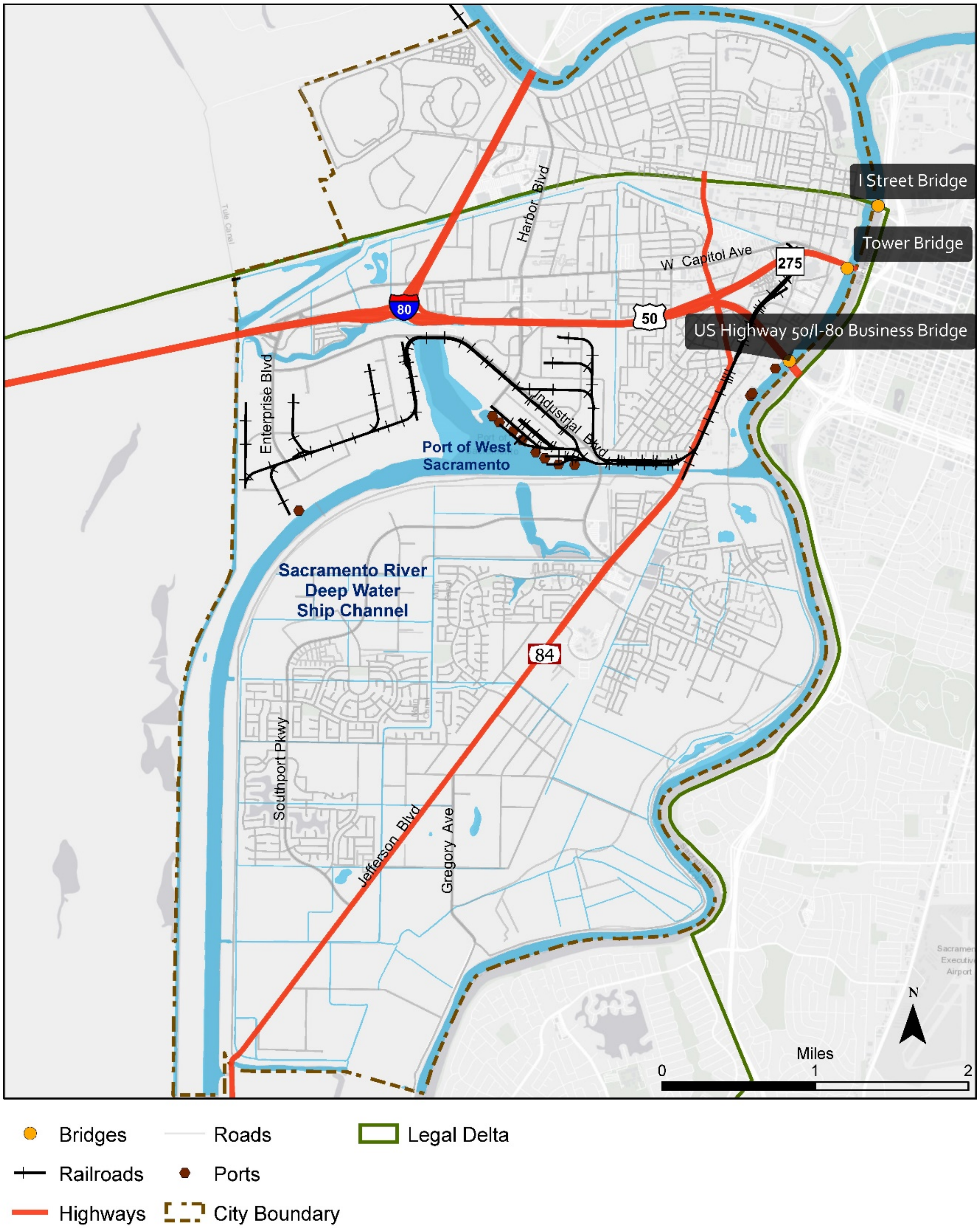

***Figure 14**, above, shows major transportation assets in the City of West Sacramento, including highways and freeways, bridges, railroad lines, and shipping ports and routes.*

Public Transit, Bicycle and Pedestrian Infrastructure

In addition to transportation assets like bridges and roads, public transportation infrastructure is a key part of the City's transportation system. The City is served by Yolobus, Yolo County's bus system, which connects the City to other cities in Yolo County. There are also four local Yolobus lines in the City. The City also contains assets for non-motorized transportation such as bicycle lanes and bicycle/pedestrian trails and routes. Figure 15 shows bus stops, multi-use bicycle and pedestrian trails, and bike lanes and routes in the City.

Figure 15: Bus Stops, Multi-Use Bicycle and Pedestrian Trails, Bike Lanes and Routes

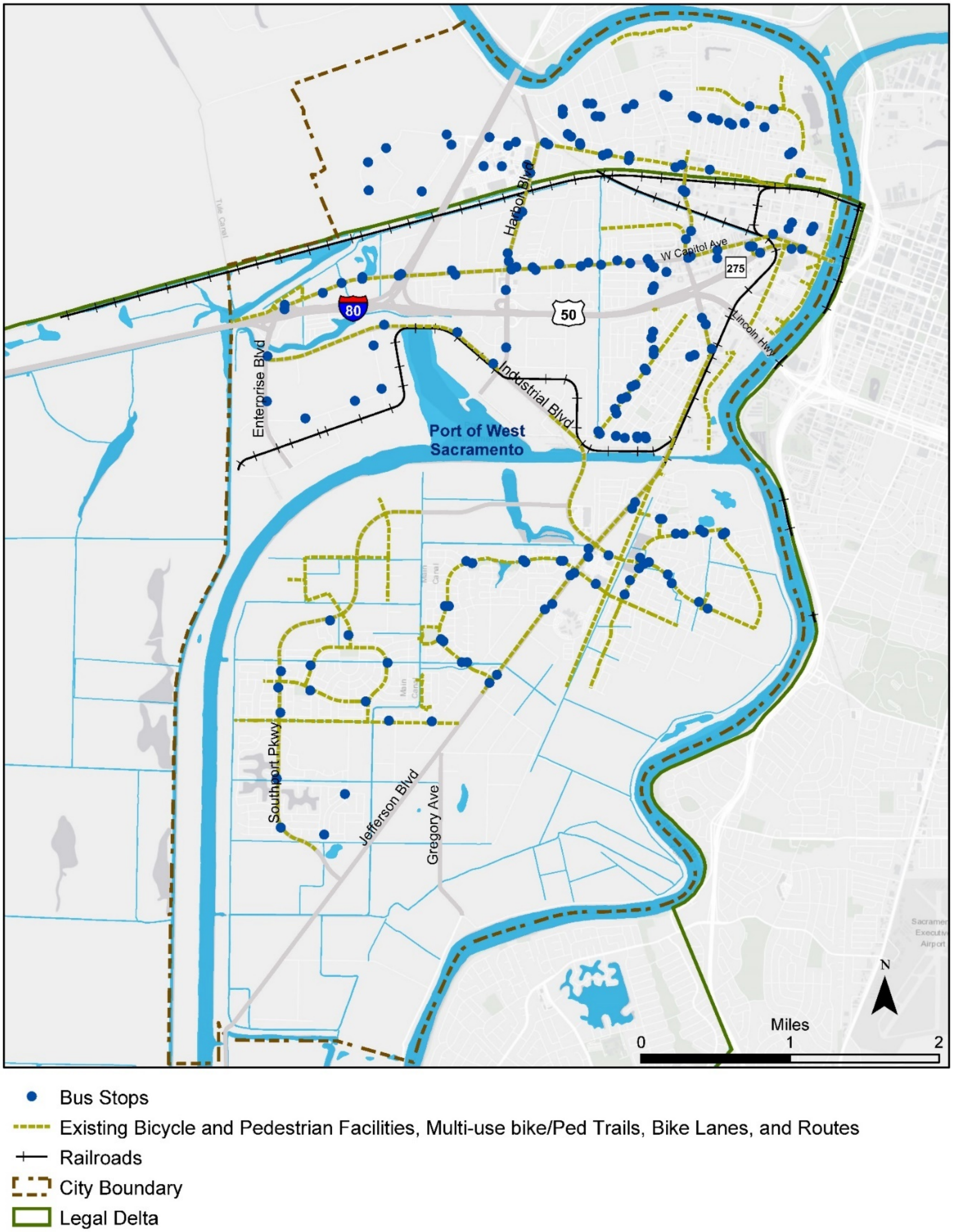

***Figure 15**, above, shows bus stops in the City as well as existing multi-use bike and pedestrian trails, and bike lanes and routes.*

4.1.3.3.4 Flood Management Infrastructure

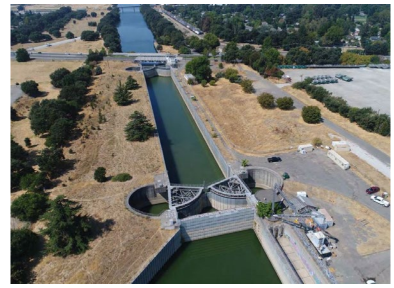

Photo Credit: City of West Sacramento

As discussed in the Climate Hazards section, flooding in the City could occur from a 100-year or greater flood event, from dam or levee failure or levee overtopping, or from localized drainage issues within the City. A comprehensive flood control system protects the City from flooding, consisting of dam, levees, overflow weirs, drainage pumping plants, and flood control bypass channels (nearest to the City, these bypass channels include the Yolo Bypass and Sacramento Bypass, which divert flood waters away from the City). In addition to protecting the City's residents, it is estimated that flood protection infrastructure in the City protects 13,000 acres of property with a $4.2 billion value (City of West Sacramento 2020a).

In order to meet new state standards for Urban Level of Flood Protection, levees protecting the City must protect against a 200-year (or 2% annual chance) flood event (Senate Bill 5). In order to achieve this level of protection, levees must be maintained and improved. The West Sacramento Project (Federal Project) was authorized in the 2016 Water Infrastructure Improvements for the Nation Act. Since 2008, and in advance of Federal Project, the City, the West Sacramento Area Flood Control Agency (WSAFCA), and the State of California invested over $200 million in advanced construction to immediately reduce flood risk to the City's 54,000 residents. The City and WSAFCA are actively pursuing federal appropriations for construction to improve the remaining levee segments and achieve 200-year level of flood protection.

Primarily consisting of residential and commercial areas, the northern portion of the City has a piped storm drain system. The southern, more rural portion of the City has a combination of piped storm drain and earth-lined drainage channels. The City and local reclamation district operate fifteen storm pump stations as part of the drainage management system (Yolo County et al. 2018) system. It is important to examine how future climate hazards may impact pump stations, because localized stormwater-induced flooding could be an issue if pump stations are adversely affected by climate hazards and cannot function properly.

The Sacramento Weir diverts flood waters from the Sacramento and American Rivers to the west through the Sacramento Bypass to the Yolo Bypass. The Sacramento Weir includes 48 flood gates and is 1,920 feet long; it is put into use when water level at the I Street gage reaches 27.5 feet and is continuing to rise (DWR 2010). The Sacramento Weir is only occasionally used; the last time it was used was January 2017. The US Army Corp of Engineers is currently designing an expansion of the Sacramento Weir approximately 1,000 feet to north that will significantly increase diversion of flood waters through the Sacramento Bypass into the Yolo Bypass. Construction is expected to commence in 2022. Additionally, the Stone Lock/Flood Gate protects against flooding in the Deep Water Ship Channel from the Sacramento River. The City is investigating flood protection alternatives for the Stone Lock/Flood Gate that will meet the needs of the authorized Federal Project and also align with the City's recreational and environmental objectives for the Barge Canal.

Table 10 lists important flood protection infrastructure within or adjacent to the City and **Figure 16** shows the locations of this infrastructure. Asset information was obtained from the Community Profile. Storm pump station locations were derived from the Storm Water Discharge Permit Implementation Level map.

Table 10: Flood Management Infrastructure in the City of West Sacramento

Asset	Type of Infrastructure	Description
Levees (approx. 50 miles)	Levees	Levees exist along all waterbodies surrounding and going through the City: along the Sacramento River, Sacramento River Deep Water Ship Channel, and Yolo and Sacramento Bypasses.
Storm Pump Stations	Storm drain pump stations	15 storm pump stations operate as part of the drainage management system.
Sacramento Bypass	Flood Control Bypass Channel	Located adjacent to the City's northwest boundary along Tule Jake Road, the mile-long Sacramento Bypass diverts flood waters west to the Yolo Bypass.
Sacramento Weir	Weir	Located along the Sacramento River at the Sacramento Bypass.
Stone Lock/Flood Gate	Flood Gate	Flood gate that protects against flooding in the Deep Water Ship Channel and protects Southport from flooding from the Sacramento River.
Yolo Bypass	Flood Control Bypass Channel	Adjacent to most of the City's western boundary, the Yolo Bypass diverts floodwaters away from the city.

Figure 16: Flood Management Infrastructure

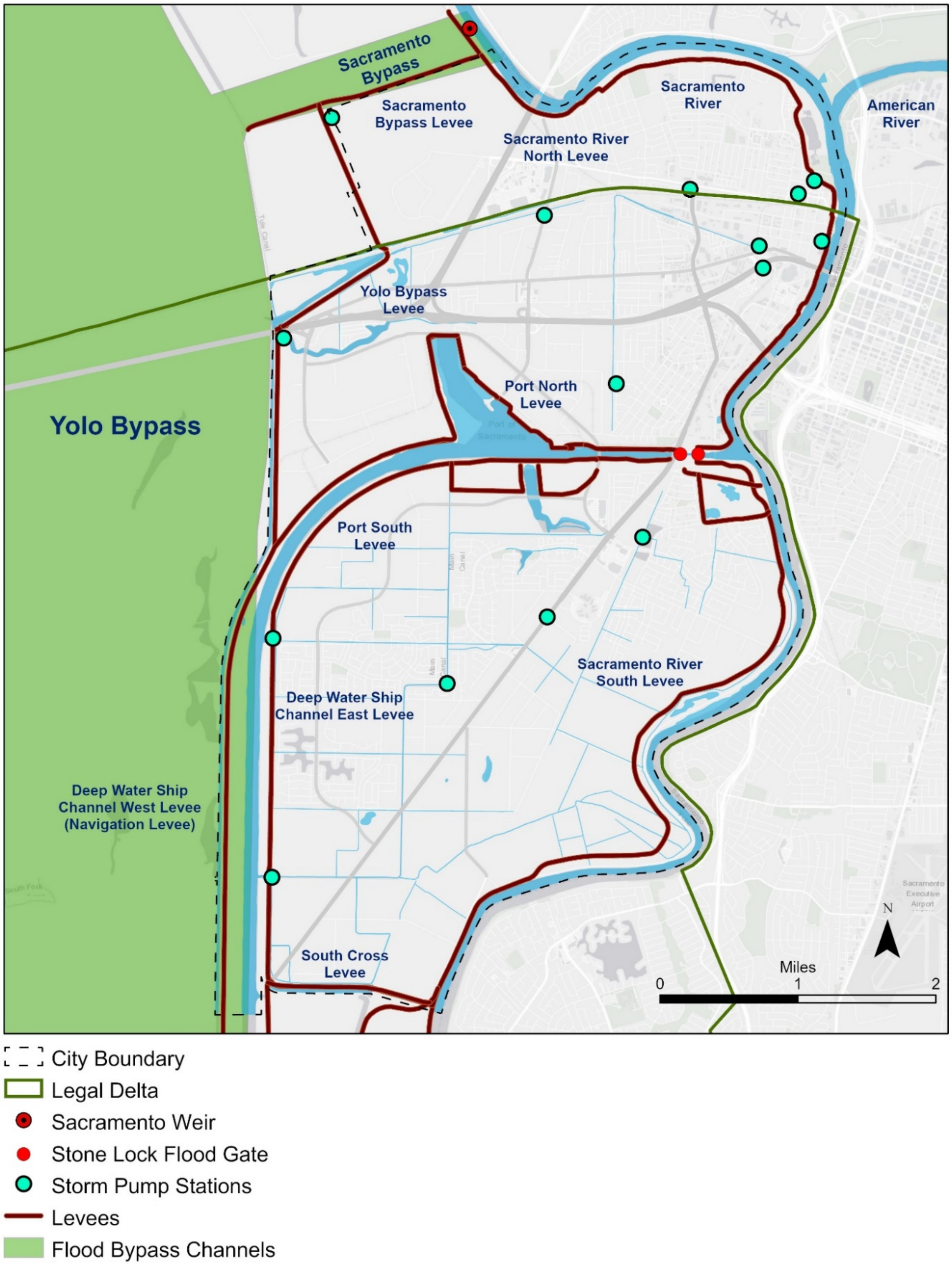

***Figure 16**, above, shows flood management infrastructure in the City of West Sacramento, including storm pump stations, flood gates and weirs, and levees. The Yolo and Sacramento Bypasses are shown for context.*

4.1.3.3.5 Water Supply and Wastewater

Photo Credit: City of West Sacramento

As discussed in the Climate Hazards section, shifting precipitation patterns and increased precipitation variability, in addition to other climate stressors and hazards, could stress the state's water management system including water supply and flood protection infrastructure—much of which is already vulnerable to existing stresses (Swain et al. 2018; Mount et al. 2018). Precipitation and runoff patterns, and the variability in these patterns, have important implications for the City of West Sacramento, which gets most of its water from the Sacramento River. The Sacramento River watershed comprises 17% of the land area in the state and forms part of the larger San Francisco Bay-Delta watershed (U.S. EPA, n.d.). The Sacramento River is fed by melting snowpack and rainfall in its watershed; thus, changing precipitation and runoff patterns and reduced snowpack pose a risk to the City's water supply.

The City owns and manages its water supply system. All of the water serving West Sacramento residents is from the Sacramento River; this surface water is treated at the George Kristoff Water Treatment Plant (City of West Sacramento 2009). The City's water rights include a maximum of 18,350 acre-feet of surface water annually, which is available at no cost to the City during the months of September to June through a State Water Resources Control Board (SWRCB) permit. In the months of July and August, and any other time that Term 91 restricts use of SWRCB permit water, surface water is purchased by the City through a contract with the U.S. Bureau of Reclamation (USBR). The City is also located within the boundaries of the North Delta Water Agency, which has a contract with the state stipulating that the state must ensure a reliable water supply for municipal, industrial, and agricultural uses (*Ibid*). These three sources—the SWRCB permit, USBR contract, and NDWA contract—serve as the City's water supply assets (City of West Sacramento 2016a).

Figure 17 shows water treatment facilities in the City, including the George Kristoff Water Treatment Plant, PSIP Water Treatment Plant, and the Bryte Bend Fluoride Facilities. Asset locations were obtained from the City's Open Data Hub, LHMP Community Profile and the General Plan Background Report. The City's water supply system also includes pump stations and water storage tanks; these were not mapped due to a lack of available data.

Figure 17: Water Treatment Facilities

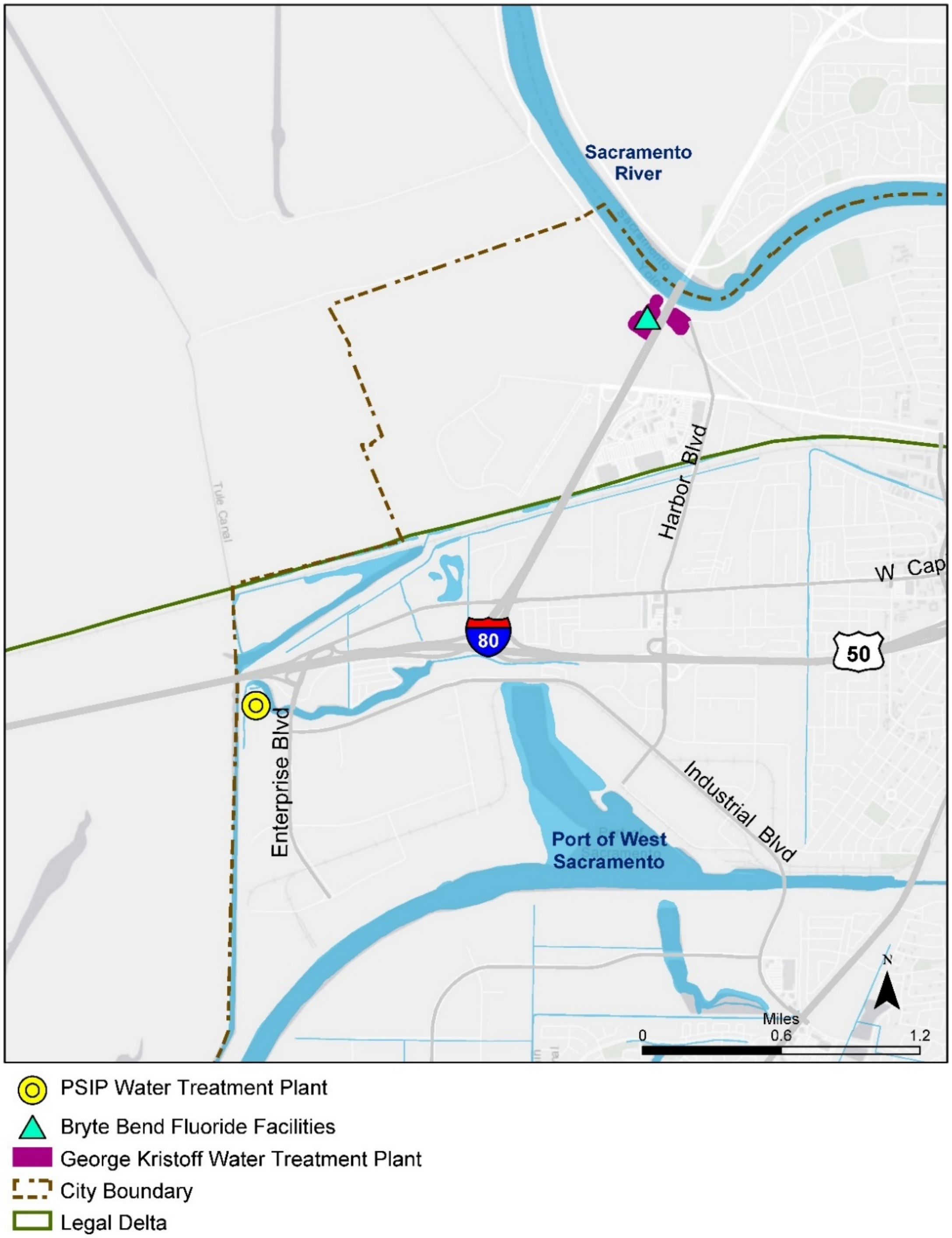

***Figure 17**, above, shows water treatment facilities in the City of West Sacramento.*

The City provides sanitary sewer collection for all residential, commercial, and industrial areas in the City. The Sacramento Regional Sanitation District's (SCRSD) wastewater collection and treatment system collects and treats the City's wastewater. The City's sewer system consists of pipelines, 12 sewer lift (pump) stations, and the SCRSD wastewater treatment plant. The Lower Northwest Interceptor (LNWI)—a 19-mile long pipeline—delivers sewage in the City to the SCRSD treatment plant. Wastewater treatment infrastructure in the City was not mapped due to a lack of available data.

Chapter 5. Vulnerability Assessment Methods

5.1 Assessment Framework

Vulnerability is defined as the interaction of *exposure* to a climate hazard, *sensitivity* to that hazard, and *adaptive capacity*, or the ability to respond to and recover from an event (OPR 2018; IPCC 2014) (**Figure 18**).

Figure 18: Conceptual Model of Vulnerability

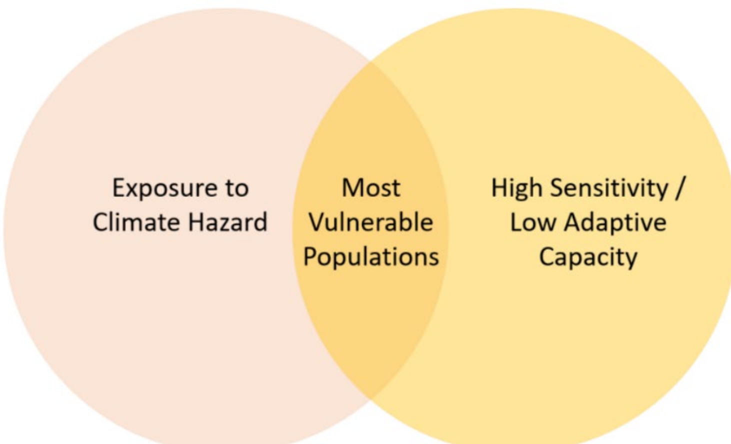

***Figure 18**, above, from the Delta Adapts Equity Technical Memorandum, shows the conceptual framework for vulnerability used in this report (DSC 2021b). Following guidance from the State and the IPCC, vulnerability is defined here as the interaction of exposure, sensitivity, and adaptive capacity to climate hazards (OPR 2018; IPCC 2014). Figure credit: DSC 2021b*.

Phase 2 of the adaptation planning process recommended by the Adaptation Planning Guide 2.0 includes four steps: exposure, sensitivity and potential impacts, adaptive capacity, and vulnerability scoring (CalOES 2020). This report covers *exposure* of residents and assets, *sensitivity and potential impacts* to residents and assets, and vulnerability of residents (by combining exposure information with the SVI and CHAT tool, which incorporate sensitivity and adaptive capacity). While this report does not cover adaptive capacity for the City overall, next steps will include an assessment of the City's adaptive capacity, or its current ability to address the impacts and sensitivities identified in this report.

City residents most vulnerable to extreme heat are identified using CHAT projections of heat health events and identified priority census tracts. Because exposure to wildfire smoke is assumed to be uniform, residents most vulnerable to wildfire smoke are those with the highest

SVI scores. As results of the Delta Adapts flood analysis indicate, exposure to flooding due to levee overtopping is uniform throughout the City, so residents most vulnerable to flooding are also those that live in areas with the highest SVI scores.

While spatial analyses are done to identify the most vulnerable City residents, the discussions of asset sensitivity and potential impacts are qualitative and not spatially-explicit. These discussions pull from existing literature, including existing vulnerability assessments and adaptation plans.

5.2 Flood Hazard Analysis

The Delta Adapts flood analysis evaluated flood hazards in the Delta at three future planning horizons: 2030, 2050, and 2085. The flood analysis assumed current conditions, meaning future levee improvements, changes in regulations, and continued changes in subsidence were not incorporated. The flood analysis incorporated both sea level rise and changes in riverine inflows projected for each planning horizon. The analysis looked at flooding due to levee overtopping only (flooding due to levee failure was not assessed). The flood analysis included both *probabilistic* and *deterministic* scenarios. The probabilistic scenarios show the likelihood of flooding due to levee overtopping at each time period, while the deterministic scenarios show flooding due to levee overtopping at each time period under a specific set of sea level rise and inflow conditions. Table 11, from the Delta Adapts Vulnerability Assessment (DSC 2021d), shows the four probabilistic scenarios.

Table 11. Probabilistic Flood Hazard Mapping Scenarios

Planning Horizon	Sea Level Rise Distribution	Watershed Hydrology (TDI Distribution)
Current Conditions	N/A	Historical
2030	RCP 8.5 2030	Historical
2050	RCP 8.5 2050	Mid-Century (2035-2064) RCP 8.5
2085	RCP 8.5 2085	End-of-Century (2070-2099) RCP 8.5

In addition to the probabilistic scenarios, the Delta Adapts flood hazard analysis included four additional mapping scenarios. These deterministic scenarios show flooding due to levee overtopping under a defined level of sea level rise, watershed hydrology, and a 100-year storm event. Table 12, from the Delta Adapts Vulnerability Assessment, shows the five deterministic mapping scenarios (DSC 2021d).

Table 12: Deterministic Flood Hazard Mapping Scenarios

Mapping Scenario	Planning Horizon	Sea Level Rise	Watershed Hydrology	Storm Event
0	Existing	0"	Historical	100-year water level
1	2030	6"	Historical	100-year water level
2	2050	12"	Mid-century (2035-2064) RCP 8.5	100-year water level
3	2050	24"	Mid-century (2035-2064) RCP 8.5	100-year water level
4	2050+	42"	End-of-century (2070-2099) RCP 8.5	100-year water level

For detailed information about the Delta Adapts flood modeling methodology, see the Delta Adapts Vulnerability Assessment (DSC 2021d) and the associated Flood Hazard Assessment Technical Memorandum (DSC 2021c).

Figure 19 shows the probabilistic scenario maps and **Figure 20** shows the deterministic scenario maps.

Figure 19: Probabilistic Scenario Maps

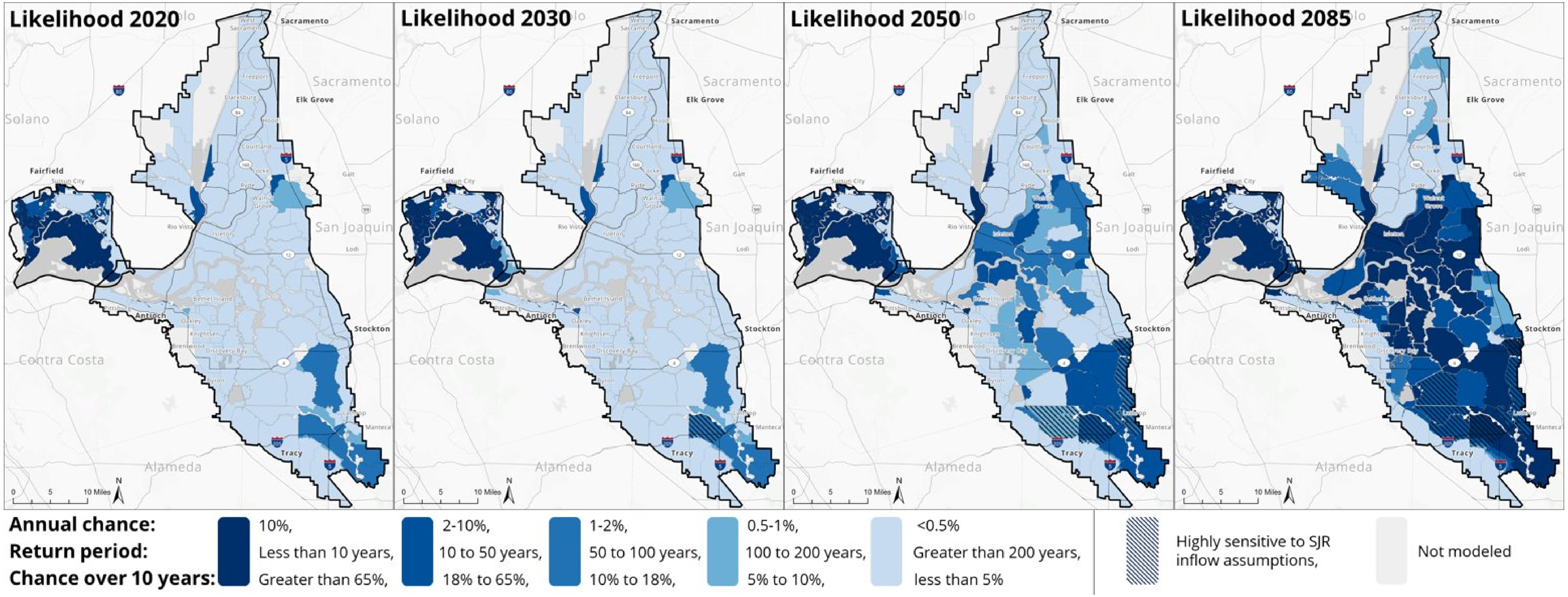

***Figure 19**, above, shows the likely (or probabilistic) frequency of a storm event that would cause flooding due to levee overtopping within areas of Suisun Marsh and the Delta (accounting for the combined effects of changes in riverine inflow to the Delta, tides, storm surge and sea level rise) under the following conditions: Current hydrology and sea level, 2050 hydrology and sea level, and 2085 hydrology and sea level. For each time period, the City of West Sacramento maintains a less than 0.5% annual chance of flooding due to levee overtopping. Figure is from DSC 2021d.*

Figure 20: Deterministic Scenario Maps

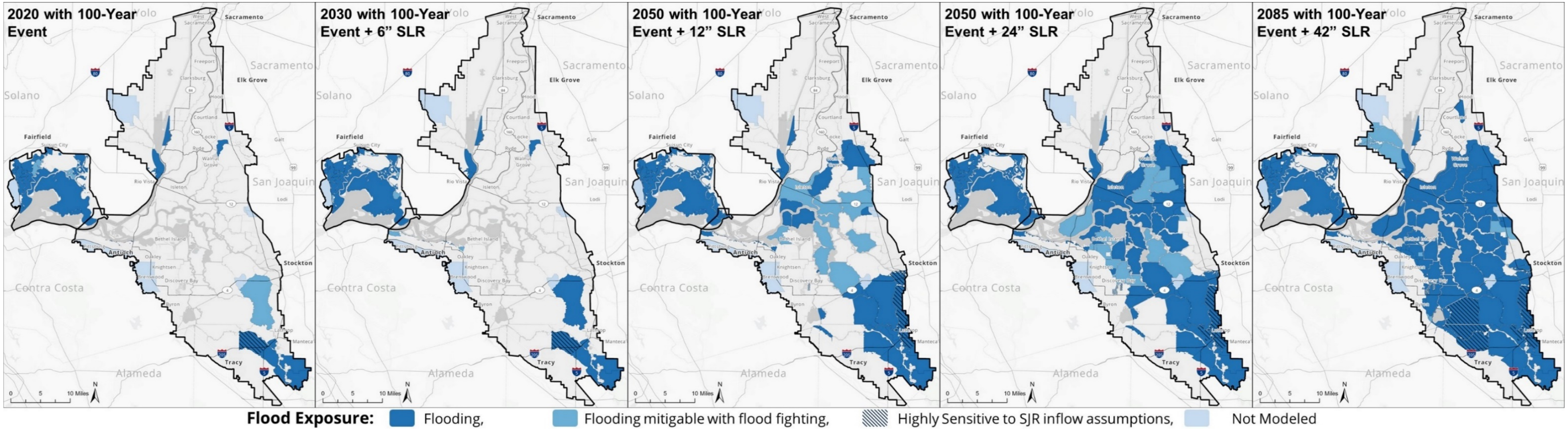

Figure 20*, above, shows areas within the Suisun Marsh and the Delta that may be exposed to flooding due to levee overtopping (accounting for the combined effects of changes in riverine inflow to the Delta, tides, storm surge and sea level rise) under the following conditions: Current hydrology and sea level; 2030 with a 100-year (1% annual chance) storm event and 6 inches of SLR; 2050 with a 100-year storm event and 12 inches of SLR; 2050 with a 100-year storm event and 24 inches of SLR; and 2085 with a 100-year storm event and 42 inches of SLR. For each scenario, the City of West Sacramento does not experience flooding. Figure is from DSC 2021d.*

While the Delta Adapts flood analysis indicates that the City of West Sacramento will maintain a less than 0.5% annual chance of flooding through 2085, and thus has low exposure, it is important to note that the Delta Adapts analysis looked at probability of flooding *due to levee overtopping only*. Because other forms of levee failure are not included in the analysis, **the flooding likelihood shown in these maps may underestimate the likelihood of flooding due to other kinds of levee failure**.

5.3 Social Vulnerability Analysis

This report developed a social vulnerability index (SVI) based on methods from the Council's Delta Adapts vulnerability assessment. For detailed information on development of the Council's SVI, see the Council's Equity Technical Memorandum for Delta Adapts (DSC 2021b); in this report, the same indicators and method are used, but the analysis only includes City of West Sacramento census tracts and block groups rather than all block groups and census tracts in the legal Delta and Suisun Marsh. The SVI developed for the City of West Sacramento identifies census block groups likely to have *higher sensitivity* and *lower adaptive capacity* to climate change hazards, relative to other City block groups.

Indicator Selection

The SVI uses 14 indicators (**Tables 13 and 14**) commonly used in other vulnerability indices to measure sensitivity and adaptive capacity to climate change hazards. Nine of these indicators are at the census block group scale (**Table 13**), while five indicators are only available at the census tract level (**Table 14**). Many of the indicators use data from the American Community Survey (ACS) (US Census Bureau 2017); most of the ACS data available at the census tract level is also available for census block groups. All indicator data used is free and publicly available for download.

Table 13. ACS Indicators Available at the Block Group Scale

Indicator	Metric	Data Source	Scale
Children	% population under 5	2017 ACS, Table B01001	Census block group
Disability	% households with 1 or more persons with a disability	2017 ACS, Table B22010	Census block group
Educational attainment	% adults over 25 without a high school diploma or GED	2017 ACS, Table B15003	Census block group
Linguistic isolation	% households that are limited English speaking households	2017 ACS, Table C16002	Census block group
Older adults living alone	% households that have 1 member, age 65 years and over	2017 ACS, Table B11007	Census block group

Poverty	% of households with income less than 200% of the federal poverty level	2017 ACS, Table C17002	Census block group
Race and ethnicity	% households with 1 or more persons that are Hispanic and/or non-white	2017 ACS, Table B03002	Census block group
Renters	% of housing units that are renter-occupied	2017 ACS, Table B25003	Census block group
Vehicle access	% households without a vehicle	2017 ACS, Table B25044	Census block group

Table 14. Health Indicators Available at the Census Tract Scale

Indicator	Metric	Data Source	Scale
Health Insurance	% of individuals without health insurance coverage	2017 ACS, Table B27001	Census tract
Asthma	Age-adjusted rate of emergency department visits for asthma per 10,000	CalEnviroScreen 3.0	Census tract
Cardiovascular Disease	Age-adjusted rate of emergency department visits for heart attack per 10,000	CalEnviroScreen 3.0	Census tract
Low Birth Weight	Percent low birth weight	CalEnviroScreen 3.0	Census tract
Food Insecurity	At least 100 households are more than ½ mile from the nearest supermarket and have no access to a vehicle; or at least 500 people or 33 percent of the population live more than 20 miles from the nearest supermarket	US Department of Agriculture (USDA) Food Access Research Atlas	Census tract

Weighting Scheme

An individual block group or tract was assigned a score based on the number of indicators for which it is in the 70th percentile or higher. Separate scores were calculated based on indicators available at the block group level (**Table 12**) and indicators available at the tract level (**Table 13**). A combined score was also calculated by assigning tract-level scores to the block groups they contained using a spatial join.

Analysis Area

For this analysis, all but one census tract and one block group that intersect with the City of West Sacramento boundary were included. Note that the 9 census tracts and 28 block groups included in the City of West Sacramento analysis generally align with the planning area in the General Plan 2035 Background Report public review draft (2009), which includes portions of two census tracts (6113010102 and 6113010402) that extend northwest and south, respectively, beyond city limits.

Census tract 6113010401 and block group 61130104012 were excluded from the social vulnerability analysis because the portion of this census tract and block group that is within City limits—which consists only of land adjacent to the Sacramento River and the Deep Water Ship Channel Levees—does not contain any residential areas. Figure 21 shows the 2035 General Plan Background Report planning area and regional setting for reference.

Figure 21: General Plan 2035 Draft Background Report Planning Area and Regional Setting

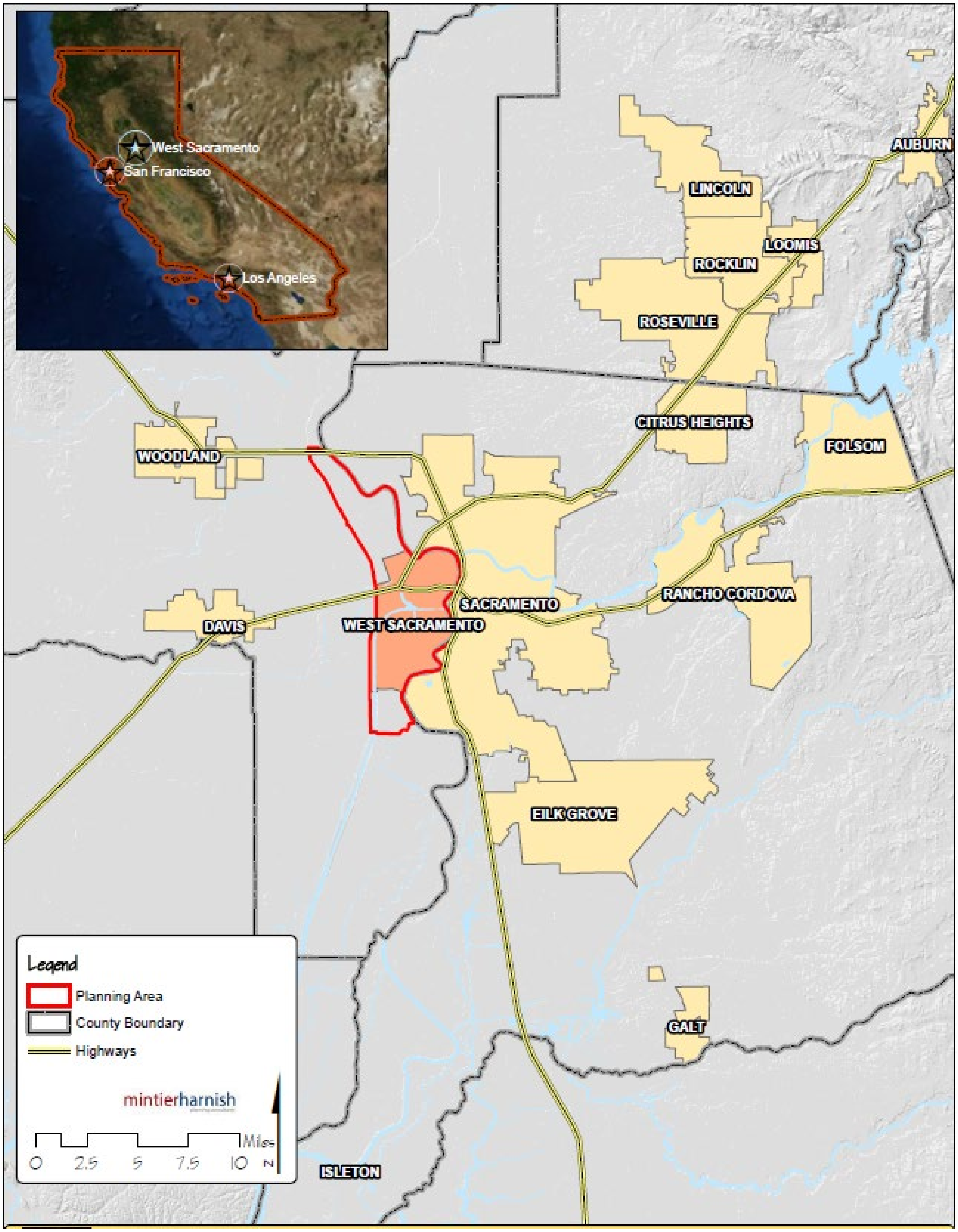

Figure 21 *shows the General Plan 2035 Draft Background Report planning area, which includes portions of two census tracts (6113010102 and 6113010402) that extend northwest and south, respectively, beyond city limits. Map Source: General Plan 2035 Draft Background Report.*

Social Vulnerability Index Results

SVI scores ranged from 0 to 10, meaning the block groups scoring the highest—or the *most socially vulnerable* block groups—scored in the 70th percentile for 10 of the 14 total indicators (Figure 22). Table 15 shows the breakdown of scores for each of the 28 block groups.

Figure 22: Social Vulnerability Index Results

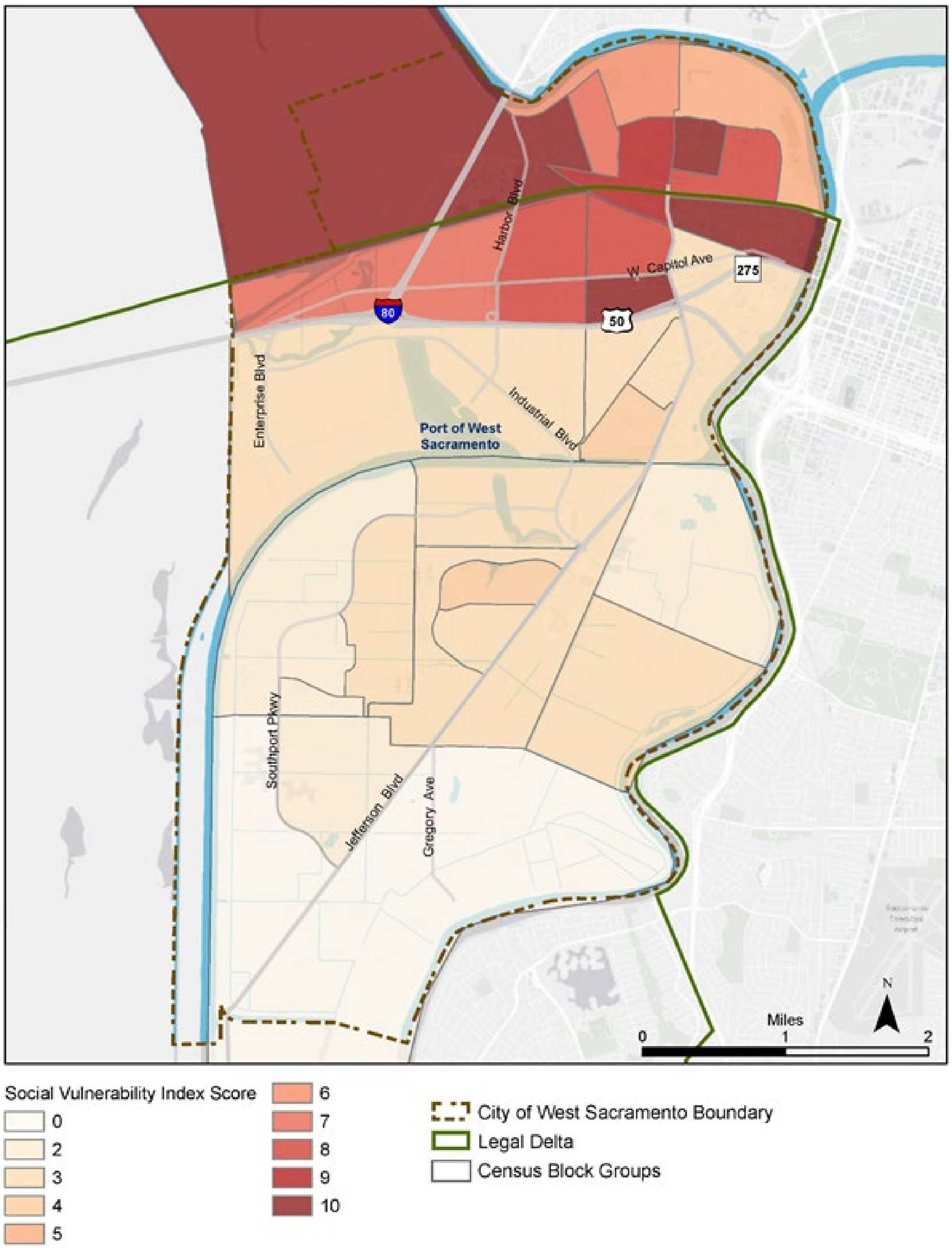

***Figure 22** shows results from the social vulnerability index for the City of West Sacramento. Block groups with higher scores are in the 70th percentile for a greater number of indicators. A higher score indicates a higher level of social vulnerability to climate hazards.*

Table 15: Social Vulnerability Index Scores and Frequencies

Score (Number of Indicators for which Block Group Is in 70th Percentile)	Number of Block Groups with Score	Block Group ID Numbers 6113010...
10 indicators in the 70th percentile	4	1012 1014 1021 2042
9 indicators in the 70th percentile	1	1024
8 indicators in the 70th percentile	4	1013 2032 2033 2041
7 indicators in the 70th percentile	2	1022 2031
6 indicators in the 70th percentile	1	1023
5 indicators in the 70th percentile	1	1011
4 indicators in the 70th percentile	2	2012 3122
3 indicators in the 70th percentile	8	2011 2034 2043 3021 3022 3102 3121 3123
2 indicators in the 70th percentile	4	3023 3101 3103 4022
0 indicators in the 70th percentile	1	4021

Analysis

Four block groups score in the 70th percentile for 10 of the 14 total indicators:

- Block Group 611301**01012**
- Block Group 611301**01014**
- Block Group 611301**01021**
- Block Group 611301**02042**

These blocks groups are all located north of U.S. Highway 50 and include the Riverside/CHP and Riverpoint neighborhoods as well as portions of the Broderick/Bryte, Iron Triangle, Washington, and S. West Capitol to I-80 neighborhoods. All four block groups scored in the 70th percentile for the following indicators, due to the following population characteristics:

- 14% to 26% of households are limited English speaking
- 60% to 77% of households are below 200% of the federal poverty level
- 26% to 41% of adults over age 25 do not have a high school diploma or GED.

Three out of the four highest-scoring block groups (61130101012, 61130101021, and 61130102042) scored in 70th percentile for the disability indicator, ranging from 35% to 43% of households with 1 or more persons with a disability.

Three out of the four highest-scoring block groups (61130101014, 61130101021, and 61130102042) scored in the 70th percentile for the tenancy indicator, ranging from 68% to 98% of housing units that are renter-occupied.

Health Condition and Health Disparities Indicators (Census Tract Level)

In addition to the above characteristics, three out of the four highest-scoring block groups (61130101012, 61130101014, and 61130101021) are located in census tracts that score in the 70th percentile for the asthma indicator, ranging from 72.99 to 80.98 age-adjusted rate of emergency department visits for asthma per 10,000. This indicator data is from CalEnviroScreen 3.0, which calculates percentiles for each indicator, by census tract, based on values for all census tracts across California; the City of West Sacramento census tracts named above scored in the percentiles of 81% and 86% (out of 100%) for asthma emergency department visits. In other words, *the rate of asthma-related emergency department visits in these census tracts is higher than 81% of census tracts in California.*

These same block groups (61130101012, 61130101014, and 61130101021) are located in census tracts that score in the 70th percentile for the cardiovascular disease indicator, with values of 12.04 and 13.37 for age-adjusted rate of emergency department visits for heart attack per 10,000. These census tracts are in the 89th and 94th percentile for the CalEnviroScreen 3.0 cardiovascular disease indicator, meaning *the rate of emergency department visits for cardiovascular disease in these census tracts is higher than 89% of census tracts in California.*

Three out of the four highest-scoring block groups (61130101012, 61130101014, and 61130102042) are located in census tracts that score in the 70th percentile for the low birth weight indicator, with 5% low-weight births (averaged over 2006 to 2012). These census tracts are in the 54th and 55th percentiles for the CalEnviroScreen 3.0 low-birth weight indicator, meaning percent low birth weight in these census tracts is higher than 54% of the census tracts in California.

Finally, one of the four highest-scoring block groups (61130101021) is located within a census tract with an overall CalEnviroScreen 3.0 percentile of 90-95% (out of 100%), meaning that census tract is also experiencing a high pollution burden relative to other census tracts in

California. Although CalEnviroScreen 3.0 was designed to identify communities disproportionately vulnerable to and burdened by pollution in order to help jurisdictions identify disadvantaged communities pursuant to SB 1000 (OEHHA 2018)—and thus was not designed specifically to capture populations most vulnerable to climate hazards—it is useful to compare CalEnviroScreen results with the social vulnerability index results in order to highlight areas of the City with both a high pollution burden and high social vulnerability to pollution and climate hazards. **Figure 23** shows CalEnviroScreen 3.0 percentiles for the City.

Figure 23: CalEnviroScreen 3.0 Overall Percentiles

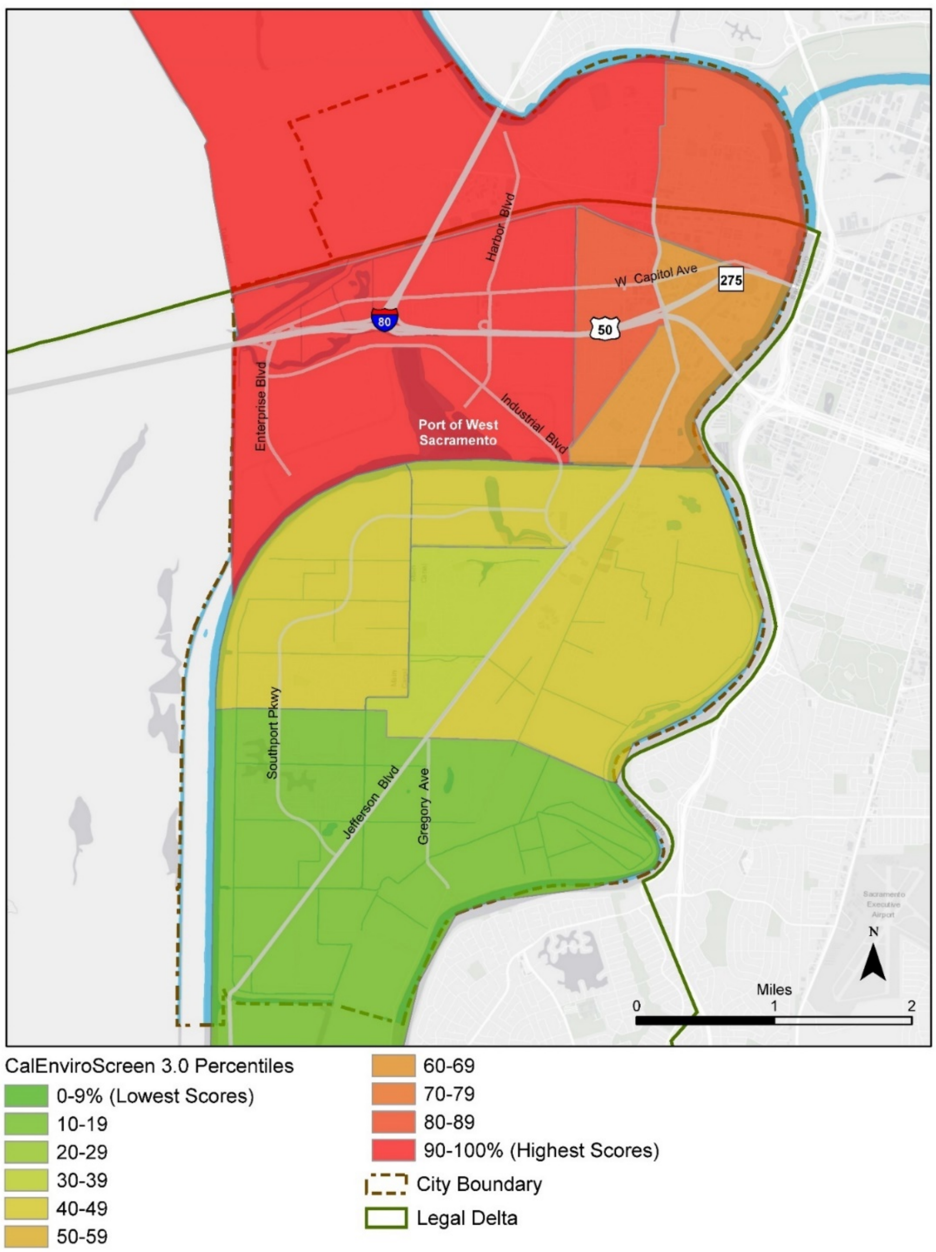

***Figure 23** shows CalEnviroScreen 3.0 results for City of West Sacramento census tracts. Tracts in the City range from 15-20% to 90-95% (out of 100%). Tracts with higher scores are more vulnerable to and burdened by pollution.*

One block group—61130101024—scores in the 70th percentile for 9 of the 14 total indicators. This block group includes the southeastern portion of the Bryte and Broderick neighborhood as well as the western portion of the Iron Triangle neighborhood. This block group is highly socially vulnerable due to various characteristics, including:

- 63% of households have 1 or more persons that are Hispanic and/or non-white
- 44% of households have 1 or more persons with a disability
- 37% of adults over age 25 do not have a high school diploma or GED
- 16% of households are limited English speaking households
- 10% of residents do not have health insurance
- The age-adjusted rate of emergency department visits for asthma is 70.99 per 10,000 – and that rate is higher than the rates in 81% of the census tracts in California (OEHHA 2018).
- The age-adjusted rate of emergency department visits for heart attack per 10,000 is 12.04 – higher than 89% of the census tracts in California (OEHHA 2018).

Additionally, 48% of households in this block group have an income below 200% of the federal poverty level, which is very close to the 70th percentile for all City of West Sacramento block groups (48.4%). (On average, 36.5% of all City households have an income below 200% of the federal poverty level (ACS 2017)).

This block group is also located in a census tract (6113010102) that scores 90-95% on CalEnviroScreen 3.0, so this block group is also experiencing a high pollution burden.

Chapter 6. Vulnerability Assessment Findings

Climate-related extreme heat, flooding, and wildfire hazards pose a variety of risks to City residents, services, and assets. Some example vulnerabilities and potential impacts discussed in this chapter include:

Asset Category	Example Vulnerability
People	Residents in census tracts 6113010101, 6113010102, and 6113010203 are identified as having the highest vulnerability to extreme heat (Figure 26). Extreme heat will have a variety of public health impacts.
	While *exposure* to flooding and wildfire smoke is projected to be uniform throughout the City, communities in portions of the Riverside/CHP, Riverpoint, Broderick/Bryte, Iron Triangle, Washington, and S. West Capitol to I-80 neighborhoods are identified as having the highest social vulnerability to flooding and wildfire smoke impacts.
Critical Facilities and Services	Extreme heat, flooding, and wildfire events can disrupt key services, including medical and emergency services, by damaging critical facilities, disrupting power supplies, and causing public health impacts that result in increased demand for medical care and emergency service calls.
Transportation	One of the greatest risks to transportation infrastructure is from impacts of extreme heat on roadways, railways, and bridges (Figure 28).
	Portions of I-5—outside of City boundaries—will be exposed to flooding due to levee overtopping by mid-century, with potentially significant impacts to the wider transportation network that the City is a part of.
	Extreme heat and wildfire smoke will also have important impacts on public transit ridership and active transportation, by posing health impacts to those who depend on those modes of transportation.
Energy	Extreme heat poses significant risks to energy infrastructure due to the potential to decrease efficiency of electrical transmission lines, reduce power supply, stress electrical infrastructure and lead to power outages.
	Rising temperatures and increasing frequencies of extreme heat events will likely result in increased electricity demand, further stressing the electricity grid. Future population growth and urbanization will likely also increase energy demands (unless mitigated by increases in energy efficiency), placing additional stress on electrical infrastructure.
	Increasing wildfire frequency and severity in California will further stress electrical infrastructure, potentially decreasing electrical transmission line efficiency and increasing electricity maintenance costs.

A Note on Flood Exposure

The Delta Adapts flood hazard analysis indicates that under each of the deterministic scenarios considered, the City of West Sacramento is not projected to be exposed to flooding from levee overtopping under expected climate change conditions in the future (see Section 5.2.2).

Additionally, the City is expected to maintain a less than 0.5% annual chance of flooding due to levee overtopping through 2085. Thus, the Delta Adapts vulnerability assessment indicates that the City will have relatively low flood exposure through 2085. The low flood exposure seen in the North Delta, including the City, is partly a result of historical levee improvements in the area. However, it is important to note that the Delta Adapts analysis looked at probability of flooding due to levee overtopping only. Because other forms of levee failure were not included in the analysis, the flooding likelihood shown in the Delta Adapts flood maps may underestimate the likelihood of flooding due to levee failure.

Because exposure to flooding from levee overtopping is projected to be uniform throughout the City, in this chapter, the sensitivity discussions for each asset category will include brief discussions of the potential impacts of flooding on that asset category. In some cases, results from an existing vulnerability assessment are used to identify vulnerable assets (e.g. results from SACOG’s 2020 Vulnerability and Criticality Assessment). Because flood exposure is projected to be uniform, the residents most vulnerable to flood impacts are those that live in communities with high scores on the SVI (indicating a high sensitivity and low adaptive capacity to flood hazards).

In this chapter, findings for each hazard are presented by asset category.

6.1 People

6.1.1 Flooding

Flooding can result in direct impacts such as death or injury and property and infrastructure damage, as well as a host of indirect impacts on people and communities. Those most vulnerable to flooding include people with greater flood exposure, including homeless individuals and emergency response workers (OPR 2017). Other groups highly vulnerable to flooding include those who cannot evacuate safely from a flood event, which can include those individuals with a disability, those without access to a vehicle, young children, older adults living alone, and people living in institutions and homes (including nursing homes and prisons), who are less likely to be able to evacuate without assistance (Bell et al. 2016; OPR 2017; Roos 2018).

Other highly vulnerable groups include those who do not receive adequate warning in time to evacuate (*Ibid*). Linguistically isolated households are less likely to receive adequate warning information and are less likely to understand flood risks (Bell et al. 2016). Other groups are vulnerable to flooding due to heightened sensitivity, including those with existing medical conditions such as cancer, cardiovascular disease, diabetes, and respiratory conditions, who are more likely to experience more severe health impacts due to flooding (Bell et al. 2016; Paterson et al. 2018). Older adults, low-income people, people of color, and individuals experiencing homelessness are more likely to have existing medical conditions, making them more sensitive to flood hazards (Bell et al. 2016; OPR 2017).

Some groups are vulnerable to flooding because they have lower adaptive capacity to recover from the aftermath of flooding, including those without health insurance, LGBTQ individuals, and immigrants, who are less likely to receive adequate treatment for flood-related health impacts (McCall 2018; OPR 2017b). Mobile home residents are more vulnerable to flood hazards both because mobile home structures are not as resilient to flooding and because those who live in mobile homes are more likely to be low-income and thus have reduced capacity to recover from flood impacts (Cutter et al. 2000; Fothergill and Peek 2004; Kusenbach et al. 2010). Homeownership is also associated with the ability to recover from flood events: Renters are less likely to have adequate resources to relocate to temporary or permanent new housing or to repair flood damage (Cutter et al. 2003). People of color are also less likely to be able to access resources for flood recovery, such as flood insurance (Elliott et al. 2020).

Flooding can also result in significant damage to communities and infrastructure, which can disrupt key social and economic services, such as businesses and education, and displace households (Bell et al. 2016).

Delta Adapts flood model results indicate that the City of West Sacramento will maintain low flood exposure due to levee overtopping through 2085, with a less than 0.5% annual chance of flooding for each time period assessed (see Section 5.2.2). **Because flood exposure is uniform throughout the City, the communities most vulnerable to flood impacts are those identified as having the highest social vulnerability to flooding—the communities with the highest SVI scores (see Section 5.3).** The communities with the highest SVI score of 10 include block groups 61130101012, 61130101014, 61130101021, and 61130102042. These blocks groups are all located north of U.S. Highway 50 and include the Riverside/CHP and Riverpoint neighborhoods as well as portions of the Broderick/Bryte, Iron Triangle, Washington, and S. West Capitol to I-80 neighborhoods.

6.1.2 Extreme Heat

Extreme heat events have can have serious public health consequences. Climate change will exacerbate existing extreme heat impacts, increasing the number of extreme heat events and thereby increasing heat-related health impacts and increasing the risk of heat-related mortality (Steinberg et al. 2018; Ostro et al. 2011; Hoshiko et al. 2010). The Sacramento region experiences a high level of health impacts due to heat; the number of heat-related deaths and hospital visits in the Sacramento region is above the statewide average (SMAQMD and LGC 2020).

Extreme heat can cause a number of health impacts, including heat exhaustion, heat stroke, cramps, and fainting, as well as heat-related mortality due to cardiac failure, suffocation, and kidney failure (McCall 2018). Extreme heat events can also lead to increased hospitalizations for other health conditions, such as diabetes, pneumonia, respiratory diseases, and stroke (McCall 2018).

Groups most sensitive to extreme heat impacts include older adults, children and infants, and those with existing health conditions including respiratory diseases, diabetes, cardiovascular diseases, asthma, and mental illnesses (medications taken by some persons with a mental illness can increase sensitivity to extreme heat) (Hajat et al. 2007, Knowlton et al. 2009, Kovats et al. 2004, McCall 2018, Gamble et al. 2016, OPR 2017). Extreme heat disproportionately impacts low-income communities and people of color due to a variety of factors, including existing health disparities disproportionately experienced by these groups, which increase sensitivity to extreme heat. Low-income communities and people of color also tend to face increased exposure to extreme heat, as these communities disproportionately live in areas that experience a strong urban heat island (UHI) effect due to a smaller urban tree canopy and higher proportions of impermeable surfaces (Shonkoff et al. 2011). Outdoor workers, including farm workers and construction workers, also experience high exposure and heightened sensitivity to extreme heat (Gamble et al. 2016). Individuals experiencing homelessness tend to experience a high level of exposure to extreme heat (OPR 2017); immigrants, LGBTQ individuals, and individuals without health insurance are at higher risk during extreme heat events because these groups may be less able to access adequate care for heat-related conditions (OPR 2017; Fowler et al. 2010).

Other highly vulnerable groups include those who cannot afford to use air conditioning or who lack air conditioning, and groups who are unable to go to a cooling center during an extreme heat event; this includes incarcerated populations, because correctional facilities often do not provide sufficient air conditioning (Motanya and Valera 2016; OPR 2017). Low-income communities, renters, and African American and Latino individuals are more likely to lack air conditioning (Shonkoff et al. 2011; OPR 2017). In addition to facing increased exposure, homeless individuals are more at risk of heat-related impacts because they are often unable to go to a cooling center or use air conditioning (OPR 2017). Transportation access is also an important factor in heat vulnerability, as those without access to a vehicle or another means of transportation may not be able to evacuate to a cooling center (Shonkoff et al. 2011; OPR 2017; SMAQMD and LGC 2020). Those who are dependent on public transit or active transportation are more exposed to extreme heat and can face disproportionate impacts from heat as a result (SMAQMD and LGC 2020).

Identifying the Populations Most Vulnerable to Extreme Heat

Various studies, indicators, and tools have been developed to project future extreme heat events and identify the communities most vulnerable to extreme heat (e.g. Cal-Adapt; California Heat Assessment Tool). For example, a recent study by UC Davis graduate students prepared for the Delta Stewardship Council found that the City of West Sacramento is highly vulnerable to extreme heat hazards relative to other Delta communities (UC Davis EPM and DSC 2019).

Various tools have also been created to examine heat vulnerability across the state. In this report, the California Heat Assessment Tool (CHAT) is used to assess future extreme heat events likely to have public health impacts in the City of West Sacramento, under various emissions scenarios and time periods. The CHAT tool is used rather than the SVI because CHAT was designed specifically to identify populations most vulnerable to extreme heat. Priority census tracts identified by CHAT's Heat Health Action Index (HHAI), along with the projected frequencies of heat health events, are used to identify the City residents *most vulnerable* to extreme heat.

As discussed in Chapter 3, CHAT models "heat-health events"—any heat event that results in local public health impacts, regardless of absolute temperature (Steinburg et al. 2018). The CHAT tool and the HHAI are at the census tract scale. The HHAI identifies priority census tracts for heat mitigation efforts by identifying tracts in which residents are most vulnerable to extreme heat. The HHAI uses some of the same socioeconomic and health indicators used in the SVI, but it also incorporates the percent of outdoor workers as well as a number of environmental variables known to exacerbate extreme heat impacts and/or health impacts of extreme heat. These environmental indicators include:

- Concentration of PM 2.5,
- Ozone exceedance,
- Percent impervious surfaces,
- Projected change in development by 2050 (percent change in unpaved to paved land area due to development between 2001 and 2050), and
- Percent no tree canopy (Steinberg et al. 2018).

Figures 24, 25, and 26 show the projected number of HHEs per year as well as priority census tracts for the City of West Sacramento and surrounding areas, for the time periods 2011-2030, 2051-2070, and 2089-2099, under the RCP 8.5 emissions scenario.

Figure 24: Projected Annual Average Number of Heat Health Events (under RCP 8.5) and Priority Census Tracts in the City of West Sacramento and Surrounding Areas, 2011-2030

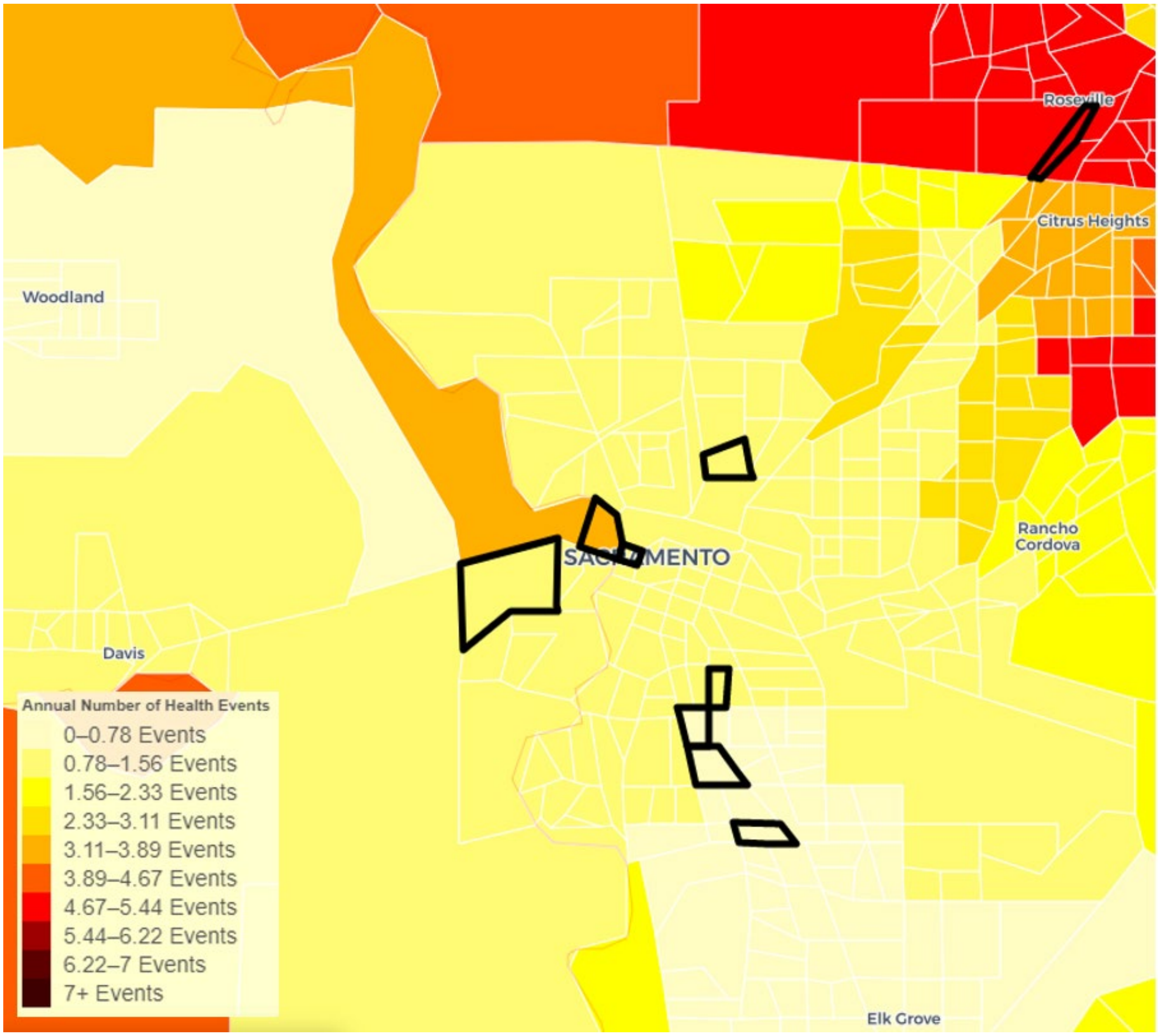

Figure 24 *shows the average annual number of Heat Health Events (HHEs) and priority census tracts (outlined in black) in the City of West Sacramento and surrounding areas, for 2011-2030, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 0.9 (under RCP 4.5) to 0.95 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience* ***2.3 to 2.55 HHEs per year.*** *Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Figure 25: Projected Annual Average Number of Heat Health Events (under RCP 8.5) and Priority Census Tracts in the City of West Sacramento and Surrounding Areas, 2051-2070

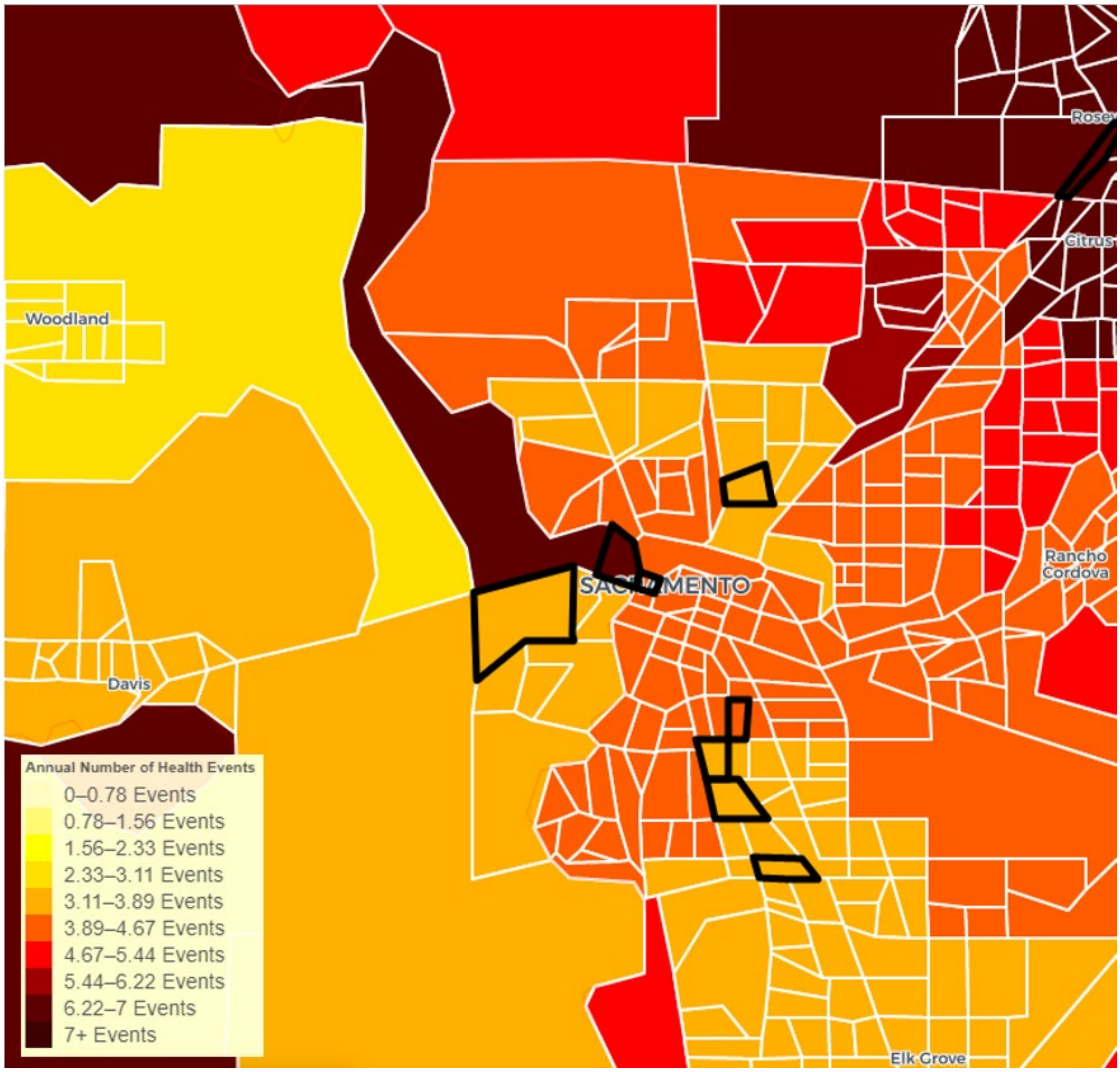

***Figure 25** shows the average annual number of Heat Health Events (HHEs) and priority census tracts (outlined in black) in the City of West Sacramento and surrounding areas, for 2051-2070, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 2.85 (under RCP 4.5) to 3.75 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience **4.3 to 5.7 HHEs per year**. Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Figure 26: Projected Annual Average Number of Heat Health Events (under RCP 8.5) and Priority Census Tracts in the City of West Sacramento and Surrounding Areas, 2081-2099

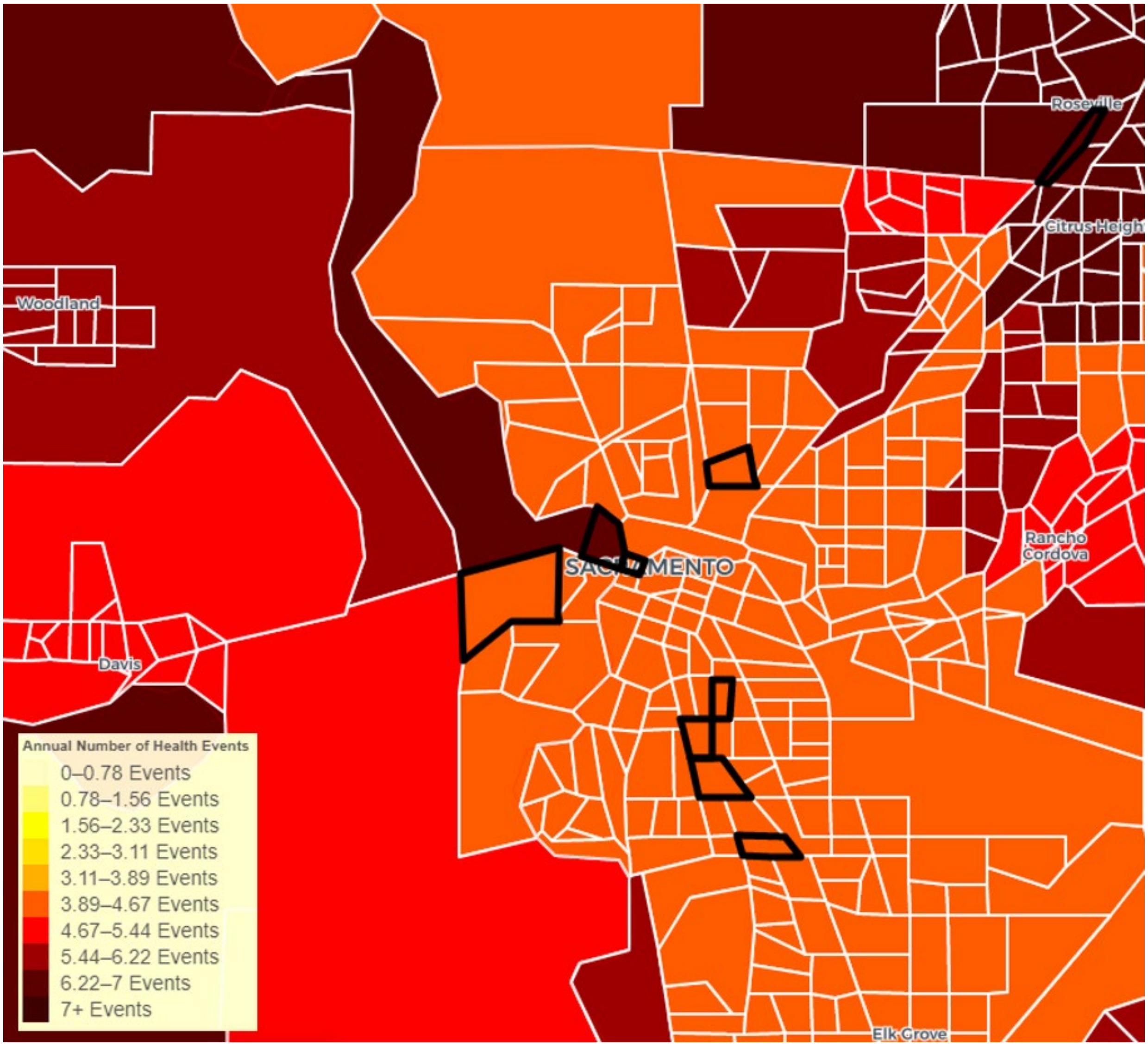

Figure 26 *shows the average annual number of Heat Health Events (HHEs) and priority census tracts (outlined in black) in the City of West Sacramento and surrounding areas, for 2081-2099, under the RCP 8.5 emissions scenario. In this time period, most census tracts in the City will experience 3.5 (under RCP 4.5) to 4.2 (under RCP 8.5) HHEs per year. Tract numbers 6113010102 and 6113010101 (the northernmost portion of the City) will experience* ***5.2 to 6.35 HHEs per year****. Map source: California Heat Health Assessment Tool (CHAT) (California Energy Commission 2018).*

Highest-Priority Block Groups

HHAI overall vulnerability scores for City census tracts ranged from 22.32 to 55.57 (out of a total of 100, with 100 representing highest vulnerability). The statewide average score was 37.3, indicating that portions of the City of West Sacramento are more vulnerable to extreme heat events than the average California census tract. Based on these scores, the City has two priority (high-heat vulnerability) census tracts: tract number 6113010101 and tract number 6113010203, which include the Lighthouse and Washington neighborhoods as well as portions of Iron Triangle and Broderick/Bryte. Tract 6113010101 was identified as a high-priority tract for Yolo County and a tract that should be monitored by the state, while tract 6113010203 was identified as a high-priority tract for Yolo County and as a priority census tract for the state. In addition to having high scores on socioeconomic and health indicators also used in the SVI, these census tracts are highly vulnerable to extreme heat due to various environmental factors. Individual indicators from CHAT show that these tracts are highly vulnerable because:

- 87% to 92% of land area has no tree canopy cover (percent area with no tree canopy cover is as high as 96% in other parts of the City),
- 54% to 65% of the land area in these census tracts is made up of impervious surfaces, and
- In census tract 6113010203, 22% of employed people over the age of 16 are outdoor workers (CEC 2018).

Several block groups that have high scores on the SVI are located within the two priority HHAI census tracts: Two census block groups within tract 6113010101 (block groups 61130101012 and 61130101014) scored the highest—10 out of 10—on the SVI. Two block groups within tract 6113010203 (block groups 61130102032 and 61130102033) scored an 8 out of 10 on the SVI. Thus, results from both indices show that the two HHAI priority census tracts for heat mitigation also contain several block groups with high sensitivity and low adaptive capacity to other climate hazards.

Future HHE Events

Beyond the HHAI priority census tracts, census tracts 6113010102 and 6113010101 will experience the highest frequency of HHEs in the City for all time periods considered. Together, these two census tracts include the Riverside/CHP, Riverpoint, Broderick/Bryte, Lighthouse, Iron Triangle, and Washington neighborhoods. Furthermore, tract 6113010102 also scored a 49.24 on the HHAI (close to the score of 51.64 in tract 6113010101, one of the two HHAI priority census tracts in the City). Thus, block groups located in tract 6113010102 are also likely to be highly vulnerable to future heat events.

Table 16 shows the average annual number of HHEs projected under RCP 4.5 and RCP 8.5 for the three time periods considered, for City block groups located within the two HHAI priority census tracts *or* in a tract with the highest projected frequency of HHEs. By end-of-century, block groups in tracts 6113010101 and 6113010102 will likely experience *5.2 to 6.35* heat-health events, while block groups in tract 6113010203 will experience *3.5 to 4.2* heat-health events (Table 16). **Residents in these three census tracts likely have the highest vulnerability to future climate-related extreme heat hazards.** City neighborhoods in the three high heat-vulnerability census tracts are shown in Figure 26.

Table 16: Most Heat-Vulnerable Block Groups: Projected Average Annual HHEs, HHAI Vulnerability Scores, and SVI Scores

Block Group *6113010…*	Projected Number of HHEs (RCP 4.5), 2051-2070	Projected Number of HHEs (RCP 8.5), 2051-2070	Projected Number of HHEs (RCP 4.5), 2081-2099	Projected Number of HHEs (RCP 8.5), 2081-2099	HHAI Vulnerability Score (out of 100)	SVI Score (10 is highest)
1011	4.3 events	5.7 events	5.2 events	6.35 events	51.64	5
1012						10
1013						8
1014						10
1021	4.3 events	5.7 events	5.2 events	6.35 events	49.24	10
1022						7
1023						6
1024						9
2031	2.85 events	3.75 events	3.5 events	4.2 events	55.57	7
2032						8
2033						8
2034						3

Figure 27: Neighborhoods in High Heat-Vulnerability Census Tracts

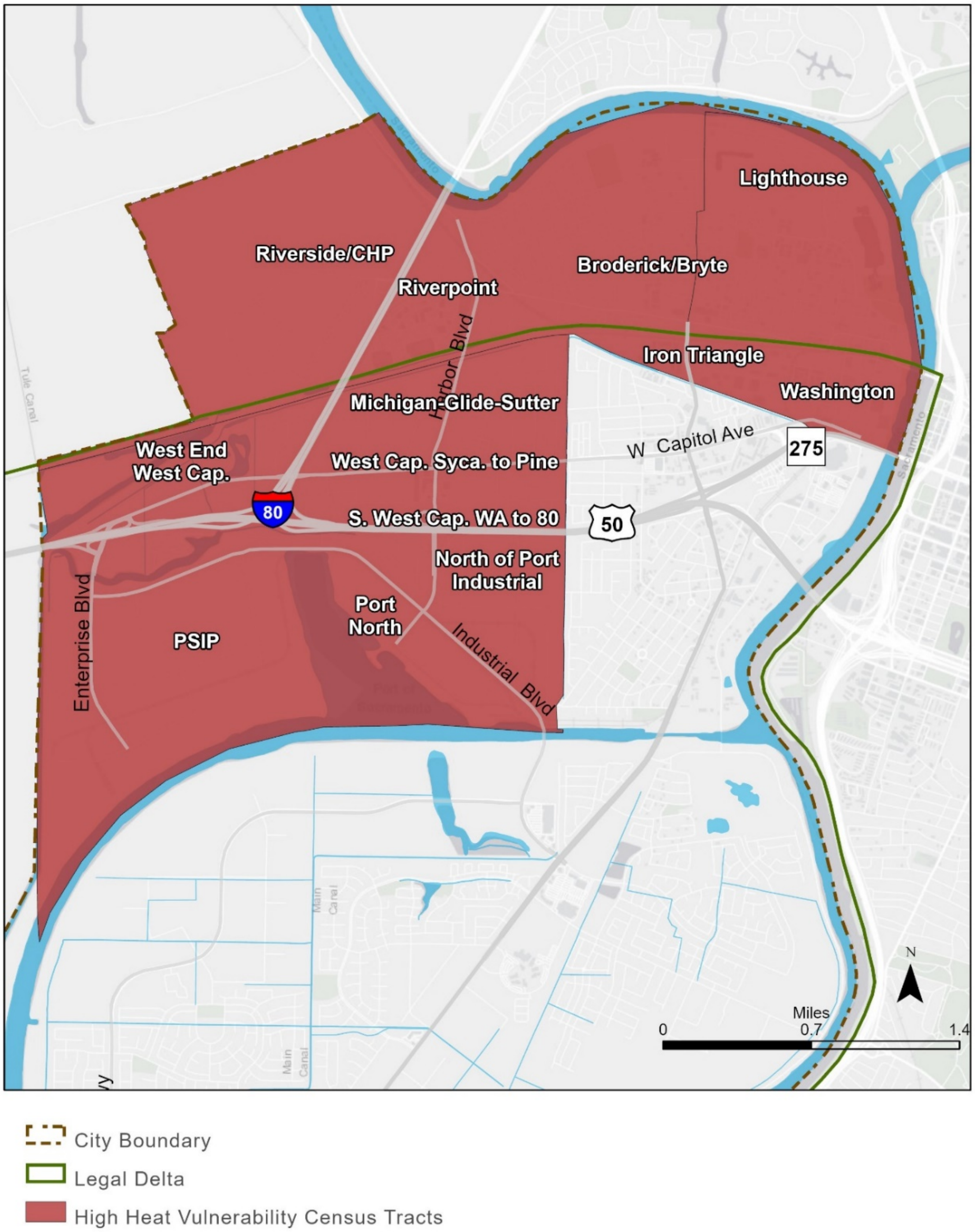

Figure 27 *shows City neighborhoods located in the three census tracts with highest vulnerability to future extreme heat hazards, as determined using the CHAT tool.*

CHAT Limitations

While CHAT provides a useful first step in identifying residents most vulnerable to extreme heat, it has certain limitations. For instance, it is at a relatively course scale for a city, so it lacks specific, household-level data on individual behaviors and household characteristics that can increase household-level vulnerability to extreme heat. A recent study using data from 823 phone calls with Stockton residents, for example, found that certain household-level behaviors and characteristics such as blackout curtains, air-conditioning, and exterior shade on a building are important factors in reducing a household's vulnerability to extreme heat (INDICIA Consulting 2020). A similar project could be done to more precisely identify the residents most vulnerable to extreme heat in West Sacramento.

6.1.3 Wildfire

Smoke from wildfires can significantly reduce air quality (Cooley et al. 2012). Although wildfire smoke can contain many compounds that have adverse health effects, it is believed that the most significant health impact from short-term exposure to wildfire smoke is from exposure to particulate matter (Lipsett et al. 2008). Certain groups are more sensitive to the health impacts of wildfire smoke and may experience more severe short- and long-term health impacts. Most of these groups consist of individuals with existing medical conditions that can be aggravated by wildfire smoke. While most of the information on the effects of particulate matter exposure on these groups is from studies of exposure to urban particulate matter, several studies on the impacts of smoke exposure indicate that wildfire smoke likely affects these groups in a similar way (*Ibid*).

Groups that are more sensitive to the health impacts of wildfire smoke include (from Lipsett et al. 2008):

- Those with asthma and other respiratory diseases
- Those with airway hyperresponsiveness
- Those with chronic obstructive pulmonary disease (COPD)
- Those with cardiovascular disease
- The elderly
- Children
- Pregnant women
- Smokers.

Children are more vulnerable to wildfire smoke for several reasons: their lungs are still developing, they tend to have increased exposure because they typically spend more time outdoors and engage in more vigorous activity than adults, and they breathe in more air per pound of body weight than do adults (*Ibid*). One study examining birth outcomes after the 2003 Southern California wildfires found that birth weights were lower in the babies of mothers who had been exposed to wildfire smoke during pregnancy (Holstius et al. 2012). A separate study on these same wildfires also concluded that pregnant mothers' exposure to pollution from wildfire smoke may lower birth weight (Breton et al. 2011). Smokers can be more vulnerable to wildfire smoke, both because they believe they will not be affected by smoke and so may expose themselves more to wildfire smoke, and because smokers' lungs are already compromised (Lipsett et al. 2008).

It is important to note that people from low-income communities and people of color tend to have higher rates of health conditions like asthma and heart disease due to a variety of cumulative factors (OPR 2017). Therefore, people of color and people from low-income communities may be more vulnerable to the health impacts of wildfire smoke. Other socioeconomic factors may increase vulnerability to adverse health impacts from wildfire smoke. For example, a lack of health insurance, among other factors, can lead to more severe health complications from air pollution (Cooley et al. 2012).

For the purposes of this report, exposure to wildfire smoke in the City of West Sacramento is assumed to be uniformly distributed. Thus, the communities most vulnerable to wildfire smoke are those that have the highest social vulnerability, as measured by the SVI (see Section 5.3). The communities with the highest SVI score of 10 include block groups 61130101012, 61130101014, 61130101021, and 61130102042. These blocks groups are all located north of U.S. Highway 50 and include the Riverside/CHP and Riverpoint neighborhoods as well as portions of the Broderick/Bryte, Iron Triangle, Washington, and S. West Capitol to I-80 neighborhoods.

6.2 Places

6.2.1 Cultural and Historic Resources

Flooding

The historic I Street Bridge and Tower Bridge could be damaged in a flood event; as discussed later in Section 6.3.2, riverine bridges tend to be vulnerable to failure during flood events (Pregnolato et al. 2020). Higher water levels and higher peak flows can increase scour effects on bridges, which reduce bridge safety and bridge strength and may necessitate costly repairs or reconstruction (SACOG 2015). Older buildings tend to be made of materials and electrical components that are highly sensitive to floodwaters (DSC 2021d); the City has one NRHP-designated historic building, the Washington Firehouse, built in 1940.

As currently constructed, the Sacramento Weir—eligible for listing under the NRHP—is not designed to meet modern flood threats. However, as discussed in Chapter 4, the U.S. Army Corps of Engineers is planning to expand the Sacramento Weir so that it will provide sufficient flood protection in the future (USACE 2021).

Extreme Heat

Higher temperatures and extreme heat can impact historic buildings and infrastructure, posing structural challenges and increasing maintenance needs and challenges (Historic England 2020; JK Industries, Inc. 2017). In the City, the historic I Street Bridge and Tower Bridge could be affected by extreme heat through bridge expansion and contraction, which affects expansion and contraction allowances for bridge joints, and by increased maintenance requirements (SACOG 2015). Roadways on both bridges may experience asphalt cracking and softening; the Union Pacific railway on the lower level of the I Street Bridge could experience rail expansion and buckling *(Ibid*). Extreme heat may also affect degradation of historic buildings and create maintenance challenges: For example, older roof shingles can become brittle under extreme heat conditions, increasing susceptibility to breaking due to decay (JK Industries, Inc. 2017).

Wildfire

Wildfire impacts to cultural and historic resources were not evaluated.

6.2.2 Critical Facilities

Flooding

Even a small chance of flooding can pose a significant risk to critical facilities and services, since the services these facilities provide are so important (United States 2020). Flooding can result in death or injury and property and infrastructure damage, leading to disruption of medical services and other key services. Death and injury from flood events can increase demand for medical services, while at the same time, ambulance service may be disrupted by flood damage to roads and other infrastructure. Power outages resulting from flood events can disrupt medical services and other key services; for example, power outages can lead to increased emergency medical service calls and emergency department visits from people who depend on electrically-powered medical devices (Lane et al. 2013).

If a fire station or police department is unable to operate due to flooding, it is customary for the next closest station to cover that service population. This would increase emergency response times and reduce capacity of staff and facilities, as they would have to cover a wider service area (DSC 2021d).

Depending on a building's compliance with modern building codes as well as flood depth, older buildings may be more sensitive to flooding if they have electrical equipment on the ground floor that would get damaged if exposed to floodwaters (DSC 2021d). Hospitals may be more sensitive to flooding because they house patients who may have existing health conditions that make them highly sensitive to equipment or operational failure caused by flood events. Hospitals are also sensitive to flooding because hospital patients are less able to evacuate without assistance (DSC 2021d). The City has one acute care facility, West Sacramento Urgent Care. Sensitivity of critical facilities can be reduced by elevating or floodproofing electrical and other equipment, and/or by employing backup power sources.

Schools are generally sensitive to flooding because flood events put students and staff at risk. In the event of exposure to flooding, a school would likely have to close until the building is safe to occupy. According to the Delta Adapts Vulnerability Assessment, "schools have moderate adaptive capacity because students could be temporarily or permanently redistributed to neighboring districts, use temporary trailers, or use remote learning capabilities to continue their education. School buildings could also be retrofitted with flood proofing techniques to withstand temporary flood events" (DSC 2021d).

Extreme Heat

Extreme heat can have serious impacts on critical facilities as well as public health services and governance in a community (Williams et al. 2020). Heatwaves, which occur when extreme temperatures last several days and/or temperatures remain high at night, can result in extreme stress on infrastructure and key services, such as medical and emergency services (SMAQMD and LGC 2020; Curtis et al. 2017; Williams et al. 2020). Extreme heat and other extreme weather events can disrupt health services in various ways, including by impacting physical infrastructure and the operation of healthcare systems, and by increasing demand for medical services (Curtis et al. 2017). Extreme heat events can disrupt and reduce hospital functionality by affecting medical equipment and the ability to store medicines effectively, and by reducing patient and staff comfort due to high temperatures (*Ibid*). Medical services can be overwhelmed if an extreme heat event results in high numbers of hospitalizations and deaths. Extreme heat can cause power outages and other disruptions to the electrical grid (Burillo et al. 2018); as such, heat-related power outages can disrupt key services including medical services.

Extreme heat can significantly impact other emergency services, including fire department and police services in a city (Williams et al. 2020). Extreme heat has been shown to be associated with increases in violent crime and aggressive behavior; because extreme heat can result in reduced cognitive function and poor sleep quality in individuals, extreme heat may increase driving errors and traffic accidents and increase injuries in the workplace *(Ibid*). All of these heat-related impacts could indirectly affect emergency services in the City. For example, a study that assessed the impacts of extreme heat on emergency services in Boston, Massachusetts, found that extreme heat events were associated with an increased demand for police, medical, and fire services, with the highest increase in demand seen for the fire department (*Ibid*).

Wildfire

By causing direct health impacts to humans, wildfire smoke can impact public health services in a community. For example, wildfire smoke events can lead to increased respiratory hospital admissions and emergency department visits; with climate change, respiratory hospital admissions due to wildfire smoke are projected to increase in the western U.S. (Liu et al. 2016).

Wildfire smoke can also disrupt schooling by forcing schools to close to protect student and staff health. For example, on November 15, 2018, classes were cancelled for more than 1 million school children in California, due to both direct wildfire impacts and wildfire smoke impacts—the single-day record for school closure due to wildfires in the U.S. (as of September 2020) (Holm et al. 2020). With climate change, such school closures may become more frequent as wildfire frequency and severity increases. Schools can install improved air filtration systems to better protect schoolchildren from wildfire smoke.

Remote wildfires can also indirectly impact key City services and critical facilities through impacts to the City's power supply. As is discussed in Section 6.3.1, wildfires can threaten electrical infrastructure by decreasing electrical transmission line efficiency and capacity, and wildfires can also cause power outages (Sathaye et al. 2011). The City has low wildfire risk, but wildfires in other parts of the state can affect the City's power supply since it depends on a network of electrical infrastructure that may cross areas where wildfires are projected to increase in frequency and severity. Wildfire-related power outages and other disruptions to the electrical grid can disrupt key services including medical services and schools.

6.2.3 Parks and Recreation Facilities

Flooding

Flooding can impact parks and recreation in various ways. Recreational assets such as parks tend to have low to moderate sensitivity to flooding; for instance, intermittent, minor flooding may cause little damage and only result in temporary park closure, while repeated or more significant flooding could damage park facilities and necessitate repairs (DSC 2021d). In some cases, parks and open space areas can be designed to flood when necessary, reducing flood risk in areas next to the park (*Ibid*). Parks can be designed to reduce stormwater flooding by collecting, infiltrating, and storing stormwater through features such as permeable pavement (Esri 2021).

Parks and recreational trails can also be located along levees, combining flood protection and recreational uses. The City has several parks and trails located on top of levees, such as River Walk Park and the River Walk Trail.

Flooding can also impact City recreational buildings, including the Recreation Center, Club West Teen Center, and Bridgeway Lakes Boathouse. As discussed in Section 6.2.2, depending on a building's compliance with modern building codes and flood depth during a flood event, older buildings can be highly sensitive to flooding if they contain electrical equipment and other materials on the ground floor that are damaged by exposure to floodwaters (DSC 2021d).

Extreme Heat

Extreme heat can impact recreation in the City in various ways. For example, extreme heat may make outdoor recreation—such as hiking, running, and playing sports—more uncomfortable or dangerous for residents (Sacramento County 2017). Extreme heat events can pose health risks for residents while recreating, as heat-related health impacts can be exacerbated when an individual is engaging in physical exertion (*Ibid*). Individuals who live in areas with a lower urban tree canopy and/or other factors that result in a heightened UHI effect are more vulnerable to health impacts of heat while recreating (SMAQMD and LGC 2020). One of the biggest climate-related threats related to parks and recreation is the increased health risks to children due to climate change, including heat-related health impacts (Dolesh 2017). Children are a highly vulnerable group to extreme heat, both due to heightened sensitivity and because they are more likely to engage in physical activity outdoors and are less likely to recognize signs of dehydration or overheating (OPR 2018).

These impacts of extreme heat on recreational use could result in indirect impacts in the City. For example, if reduced recreational use results in a decrease in demand for recreational equipment, facilities, and services, this could result in decreased revenue for recreation-related businesses (e.g. a business that sells and rents recreational equipment) (Sacramento County 2017). On the other hand, extreme heat could increase demand for indoor, air-conditioned recreation spaces such as indoor soccer fields and basketball courts.

Wildfire

Similar to hazards posed by extreme heat, hazardous air quality conditions due to wildfires across the state can make outdoor recreation more uncomfortable or dangerous for City residents. Hazardous air quality conditions could increase demand for indoor recreation spaces with effective air filtering capacity.

6.2.4 Agriculture

Climate change will threaten California agriculture, a significant driver of the state's economy and a major producer of the vegetables, fruits, and nuts in the U.S. (Pathak et al. 2018). The agricultural sector is vulnerable to changes in climate conditions: Climate change will impact agricultural productivity and diversity throughout the state by altering precipitation and runoff patterns; leading to hotter, longer summers; decreasing winter chill hours needed for certain crops; decreasing soil moisture; increasing soil salinity; increasing atmospheric CO2 concentrations, and by increasing the frequency and intensity of extreme events such as floods and droughts (Houlton and Lund 2018; Medellín-Azuara et al. 2018).

The principal agricultural crops grown in the City include wheat, alfalfa, and various fruits and vegetables (City of West Sacramento 2016). Field crops such as wheat and alfalfa are generally lower-value, while permanent crops like orchards are higher-value and more profitable (Pathak et al. 2018). Because permanent crops grow for long periods of time and may take years to reach maturity, growers of permanent crops should be especially cognizant of climate impacts on these crops.

Only about 857 acres—less than 6% of the land area within City limits—are currently designated for agriculture under General Plan 2035 (City of West Sacramento 2016b). Although active agricultural operations are protected until development is imminent, much of the agricultural land within City limits is planned to transition to urban development over time.

Altered Precipitation Patterns and Flooding

Under both RCP 4.5 and RCP 8.5, the City is projected to see a small increase in annual average precipitation, with an increase above the historical baseline of 1.8 - 2 inches/year in mid-century to 1.9 - 4.0 inches/year by end-of-century (CEC 2020a). However, local projections of precipitation have greater uncertainty than projections for the state. As discussed in Chapter 3, California is projected to experience increasing precipitation variability, with drier dry years and wetter wet years, and increased variability and intensity of storms (Dettinger et al. 2016). Additionally, climate change may shift precipitation patterns such that maximum precipitation and runoff will occur during a shorter time period in winter months

(Swain et al. 2018). These shifts in precipitation and storm patterns could stress California agriculture, including in the City. For instance, unanticipated storms and winter atmospheric river events could disrupt agricultural schedules (DSC 2021d). Consecutive rainfall events on soil that is already saturated could result in additional soil nutrient loss and erosion, and extreme storm events later in the spring could damage fruit trees by washing away pollen during flowering (*Ibid*).

Perennial crops—including alfalfa and orchards—tend to be more vulnerable to winter flooding. Inundation of floodwaters reduces crop survival and yields, increasing crop vulnerability to disease and nitrogen loss (DSC 2021a). According to the Delta Adapts Crop Yield and Agricultural Production Technical Memorandum, "earlier spring flooding may ruin furrows, waterlog and deplete oxygen in soil, lose nutrients and soil to runoff, delay crop plantings, and shorten the growing season, thus reducing yields (DSC 2021a)."

Extreme Heat

Rising temperatures can impact agricultural productivity and operations in various ways. Temperature affects crop photosynthetic rates and metabolic processes, which control important crop characteristics including plant growth, flowering and pollination times, leaf development, nutritional quality, and fruit production (Cavagnaro et al. 2006). Extreme heat, along with other extreme events such as floods, will likely lead to crop yield losses throughout the state (Deschenes and Kolstad 2011, Pathak et al. 2018). Increasing air temperatures—in combination with altered precipitation patterns—will likely increase crop susceptibility to pests and disease by increasing plant stress (Pathak et al. 2018). These effects may be somewhat tempered by increased availability of atmospheric carbon dioxide and resulting yield increases; however, these increases are not expected to be significant (Blanc and Reilly 2017).

One study that modeled yield changes in common Central Valley field crops under various climate change scenarios indicated that wheat yields, along with cotton and sunflower yields, will decrease under both medium-high and low emission scenarios by 2050, while other field crops including alfalfa, maize, and rice were not projected to experience yield declines (Lee et al. 2011). By end-of-century, yields for all of the field crops considered except for alfalfa saw significant declines under both medium-high and low emission scenarios (*Ibid*). Alfalfa crop yields in Yolo County are projected to increase under high- and low- emission scenarios through 2050 (Pathak et al. 2018).

Rising temperatures and decreased winter chill hours will likely reduce fruit tree yields: with 2 degrees Celsius of warming, yields of table grapes will be reduced by more than 5% in all growing regions of California, while under 4 C of warming most other fruit crops will likely see yield declines of more than 5%—with some regions seeing up to 40% yield reductions (Zilberman and Kaplan 2017).

Wildfire

Impacts of wildfire on agriculture were not assessed.

6.3 Infrastructure

6.3.1 Energy Infrastructure

Flooding

Energy infrastructure typically includes electrical and mechanical components that are highly sensitive to flood damage (DSC 2021d). Significant flood events can damage pipelines and transmission lines which provide power and heat. For example, flooding can cause scour or lead to removal of sediment around pipelines, damaging pipelines or reducing pipeline support (DSC 2021d). Exposure to saline floodwaters can corrode some transmission pipes, necessitating replacements. Flooding of electrical infrastructure can result in power outages, which in turn disrupt core services and facilities (such as schools and traffic lights).

PG&E supplies electricity and natural gas to the City of West Sacramento. Flood impacts to PG&E assets outside of City boundaries can impact the City's electricity and natural gas supply. PG&E's Climate Change Vulnerability Assessment (2016) assessed the exposure of its critical electric and natural gas assets to flooding, using FEMA 100-year and 500-year floodplains. The assessment notes that the 100-year and 500-year flood events will likely become more frequent in the future due to climate change. The assessment indicates that, of the company's electric assets, 26% of substations, 14% of transmission lines, 9% of distribution lines, and 6% of distribution transformers are within the FEMA 100-year flood zone. Of the company's natural gas assets, 28% of transmission pipes, 25% of storage fields, 13% of transmission stations, 9% of distributions regulating stations and CNG/LNG stations, 7% of distribution mains, and 4% of distribution services are within the 100-year flood zone.

One major PG&E asset that will be exposed to flooding is the McDonald Island natural gas storage facility in the Delta, PG&E's largest natural gas storage facility. The McDonald Island storage facility primarily supplies natural gas to the greater Sacramento and Stockton urban areas in times of peak demand (Sathaye et al 2011). The Delta Adapts flood analysis indicates that this facility will be exposed to flooding due to levee overtopping by 2085 (with a 2-10% annual chance of flooding due to levee overtopping by 2085) (DSC 2021d). Land surface elevations on McDonald Island are 10 feet or more below sea level. While the compressor and well-head controls at this facility are designed to be able to operate under 20 feet of water, flooding events leading to deeper water depths could negatively impact this facility, potentially impacting natural gas supply in California and in the City of West Sacramento (Sathaye et al. 2011).

Extreme Heat

The California Public Utilities Commission (CPUC) recommends that energy utilities use the RCP 8.5 (business-as-usual) emissions scenario when assessing and planning for risks to energy utilities infrastructure (CPUC 2020). Under RCP 8.5, the City of West Sacramento is projected to experience an increase in the frequency of extreme heat days and heatwaves, or prolonged periods of extreme heat, with a projected 24 extreme heat days by mid-century and 43 extreme heat days by end-of-century (CEC 2020a).

Increasing temperature thresholds and a higher number of extreme heat events can have various negative impacts on energy infrastructure and systems, resulting in system delays and disruptions and reduced performance. Rising temperatures and increasing frequencies of extreme heat events will likely result in increased electricity demand, and will increase peak electricity demands (Burillo et al. 2018). Electricity demand will likely increase because use of air conditioning—and resulting energy demand—will increase as temperatures increase (*Ibid*). Extreme heat, along with increases in electricity demand, put stress on electrical grid infrastructure and can decrease electricity transmission and supply. Extreme heat and increased electricity demand make it more likely that electrical grid infrastructure will fail, increasing the risk of power outages *(Ibid).* Power outages can exacerbate public health impacts of extreme heat events, leaving those who rely on electrical power for medical devises highly vulnerable to extreme heat events. Extreme heat events and higher temperatures can also reduce efficiency of electrical infrastructure, and prolonged periods of high temperatures may make it necessary to replace or modify electrical infrastructure so that it can function under a higher temperature threshold (PG&E 2016).

Different types of electrical grid infrastructure can be more vulnerable to extreme heat impacts. For example, a UCLA and ASU study that assessed the vulnerability of LA County's power generation plants, transmission lines, and substations to future extreme heat due to climate change found that extreme heat reduced the generation capacity of powerplants (in one scenario, during a 'severe heat wave' at mid-century, powerplants experienced generation capacity losses of up to 240 megawatts) (Burillo et al. 2018). Transmission line capacity and substation load capacity were also found to decrease due to extreme heat (*Ibid*).

Along with rising temperatures, the City of West Sacramento is projected to experience future population growth and development. The City's population is projected to reach 81,480 by 2035 (an approximately 50% increase from the current population of 54,328) (City of West Sacramento 2016c). The General Plan 2035 Draft Environmental Impact Report identifies portions of the Southport area to accommodate future development, suggesting that this area will absorb a large portion of the City's future growth (City of West Sacramento 2016c; Yolo County et al. 2018). Development and population growth will likely increase energy demands, further stressing electrical grid infrastructure on top of stresses from extreme heat (Burillo et al. 2018). As energy efficiency of buildings and facilities play a significant role in energy demand, the types of buildings used in the City's future development will impact future energy demands and resulting system outages or disruptions.

Various aspects of temperature and extreme heat conditions can affect different aspects of natural gas infrastructure and operation. For instance, the number of days exceeding a given temperature threshold is important when considering worker safety for operation and maintenance (Bruzgul et al. 2018). Extreme heat conditions can also result in increased demand for natural gas because demand for electricity typically increases during high heat periods, and increased electricity demand will require increased natural gas use to generate electricity (*Ibid*). Prolonged periods of extreme temperatures, especially in which minimum (nighttime) temperatures do not cool down below a certain threshold, can impact natural gas compressor stations because temperatures may be too high at night to achieve adequate cooling—increasing cooling needs the following day (*Ibid*). Extreme heat conditions—along with rising water temperatures—decrease the thermal efficiency of electricity generation from natural gas and other sources of energy (US DOE 2013). As a result of this reduced generation efficiency, power plants may require more fuel and will not be able to deliver as much power (Larsen et al. 2017).

Wildfire

Energy infrastructure in California and the City of West Sacramento will be impacted by increasing wildfire frequency and severity across the state. It is projected that climate change will increase the risks that wildfires pose to electrical transmission and distribution lines in northern California (Dale et al. 2018). While the City has low wildfire exposure, wildfires in other parts of the state can affect the City's power supply because it depends on a network of transmission and distribution lines that may cross parts of the state where wildfires are projected to increase in frequency and severity.

Wildfires can cause power outages, but it is more common for wildfires to result in decreased electrical transmission line efficiency and increased electricity maintenance costs (Sathaye et al. 2011). Even if a wildfire does not damage the physical structure of electrical infrastructure, heat, smoke, and particulate matter from wildfires can reduce electrical transmission line capacity (*Ibid*). Wildfires are more likely to destroy smaller electrical distribution lines, which are usually built with wooden poles, rather than larger transmission lines (*Ibid*). As weather conditions that increase fire risk—known as "red flag warning" conditions—become more frequent in the future, preventative public safety power shutoffs may be used more frequently (DSC 2021d). Wildfires also increase the risk of landslides and erosion, which can cause further damage to energy infrastructure (PG&E 2016).

6.3.2 Transportation

SACOG's Sacramento Region Transportation Climate Adaptation Plan, adopted in 2015, assessed high-level vulnerability of transportation assets in the Sacramento region to various climate hazards—extreme temperature, precipitation, wildfire, and landslides—including an assessment of both the likelihood and magnitude of impacts (SACOG 2015). Results from SACOG 2015 are used along with other literature to inform the following discussions of transportation asset sensitivity and exposure to flooding, extreme heat, and wildfire. **Figure 28** shows the relative likelihoods and magnitudes of impacts—from the three climate hazards relevant to West Sacramento—to transportation assets in the Sacramento region. Based on SACOG's analysis, out of the climate hazards assessed, the greatest risks to transportation infrastructure in the Sacramento Region are from impacts of extreme heat on roadways, railways, and bridges.

Figure 28: Impacts of Climate Hazards (Likelihood and Consequences) on Transportation Infrastructure in the Sacramento Region (from SACOG 2015)

	Extreme Temperature	Precipitation	Wildfire
Roadways	Asphalt-concrete cracking and curling, rutting/softening	Asphalt stripping, concrete corrosion, subbase erosion, washouts	Rutting/softening
Railways	Rail track buckling, expansion of catenary wires, slower speeds and forced delays, derailments	Substructure erosion, forced delays, inundation	Blocked routes, forced delays
Bridges	Expansion joint buckling, increased maintenance	Increased scour, decreased safety (visibility, traction), possible inundation	Weakening of steel bridge material
Walking & Biking	Decreased comfort, health risks	Decreased safety (visibility, traction), decreased comfort	Decreased air quality, health hazards
Drainage	Little/No consequence	Drainage overflows, clog drains with leaves	Increased debris flow and clogged drainage systems
Traffic Flow	Vehicles overheating, congestion and network delays	Slowdowns, increased accidents	Reduced visibility and whiteouts, route closures, slowdowns and congestion
Public Transit	Decreased comfort, transit vehicles overheating, network delays	Decreased comfort, delays	Route closures, trip delays
Buildings & Facilities	Load shedding and power outages, construction and maintenance forced to halt or slow down	Inundation of electrical boxes/equipment	Construction forced to halt
Traffic Controls	Power outages to signals	Power outages to signals, reduced sign visibility	Power outages to signals, reduced sign visibility

High likelihood or Damage
Moderate likelihood or Deterioration
Medium likelihood or Disruption
Low likelihood or No Consequences

Figure 28 *shows the likelihood and consequences of the evaluated climate hazards in SACOG's 2015 report, along with impacts of the hazard on vulnerable transportation assets. Landslide impacts were omitted in this figure as landslides are not an applicable hazard to West Sacramento. Figure credit: SACOG 2015.*

Flooding

Flooding can negatively impact transportation infrastructure in various ways. Flooding can damage bridges, pavement, and the substructure of rail lines. Flooding on roadways can damage pavement by stripping—in which exposure to water causes the aggregate in pavement to separate from the asphalt binder that holds them together—or by water seeping into the pavement and becoming trapped in between asphalt layers (SACOG 2015). When vehicles drive over pavement in which water is trapped, the pressure created results in physical scour of the asphalt. Flooding can also damage transportation-related electrical equipment, which would disrupt traffic signals and other infrastructure. Flooding can lead to public transit service disruption, causing delays and increasing travel time for riders (He et al. 2020). Inundation of bike paths and trails (such as the River Walk Trail) from a flood event impacts bicycle-dependent residents.

Riverine bridges are especially vulnerable to flooding, as they tend to be vulnerable to failure during flood events (Pregnolato et al. 2020). Higher water levels and higher peak flows can increase scour effects on bridges, which reduce bridge safety and bridge strength and may necessitate repairs or reconstruction (SACOG 2015). Bridges have high reconstruction costs, so flood damage to bridges would likely have significant consequences (Pregnolato et al. 2020).

Ports are generally vulnerable to flooding because they are difficult to relocate, and they depend on the waterfront (DSC 2021d). Temporary flooding can lead to service disruptions, impacting the shipping economy. Port infrastructure is typically designed for long lifetimes, meaning the infrastructure may have been designed for climate conditions of the past and is not designed for future climate conditions (Becker et al. 2013).

SACOG's Vulnerability and Criticality Assessment (2020) identified transportation infrastructure in the greater Sacramento region most vulnerable to flooding. A portion of I-80 west of the City, between Davis and West Sacramento, was identified as vulnerable to certain sea level rise and storm surge scenarios (note that the SACOG analysis used a different methodology than the Delta Adapts flood model, and it considered different sea level rise and storm surge scenarios). Although this segment was identified as having lower exposure than other roadways in the Sacramento region, it was identified as having high criticality, increasing its overall vulnerability score. The assessment notes that the high vulnerability score may be because the analysis did not capture road elevation at a sufficiently high resolution; however, the assessment notes that if flooding does occur to this section of I-80, the consequences would be significant, with impacts to the transportation network affecting the City and the wider region.

The Delta Adapts flood analysis indicates that portions of I-5, outside of City boundaries, will be exposed to flooding by mid-century (DSC 2021d). I-5 is an important transportation corridor connecting major cities along the West Coast of the U.S., including Sacramento and Stockton. Flooding of portions of I-5 would likely have significant impacts to the wider transportation network that the City of West Sacramento is a part of.

Extreme Heat

The discussion below primarily pulls from SACOG's Transportation Climate Adaptation Plan (2015), SACOG's Vulnerability and Criticality Assessment (2020), and the Capital Region Transportation Sector Urban Heat Island Mitigation Plan (SMAQMD and LGC 2020), which provide information on the impacts of extreme heat on transportation infrastructure and systems and asses the heat vulnerability of transportation assets and systems in the Sacramento region.

The transportation sector is both impacted by extreme heat and the UHI effect and contributes to urban heat islands. Impermeable surfaces—namely, asphalt and concrete--in transportation assets, including highways and roads, are one of the most significant factors contributing to the UHI effect (SMAQMD and LGC 2020). In addition to the effect of impermeable surfaces, elements of transportation systems are also contributing factors to the UHI effect, such as the waste heat emitted from cars. Use of public transit can reduce the UHI effect: buses and subway systems emit less waste heat and use less fuel per passenger do than single-occupancy vehicles (*Ibid*).

Extreme heat can cause serious damage to transportation infrastructure, such as by deteriorating pavement, leading to higher maintenance costs. These negative impacts affect transportation systems, resulting in delays and disruptions. According to the Capital Region Transportation Sector Urban Heat Island Mitigation Plan, extreme heat impacts on transportation assets and systems that are exacerbated by the UHI effect include both physical impacts on infrastructure and impacts on users of the transportation system (ridership).

Ridership impacts include disruptions and delays due to heat impacts on physical transportation infrastructure, as well as decreased comfort for riders of public transit. Among transportation system users, those most exposed to extreme heat include those who rely on walking or biking or who are dependent on public transportation (SMAQMD and LGC 2020). These individuals may be forced to avoid travel during an extreme heat event or must experience uncomfortable or dangerous conditions if they do have to travel. Extreme heat can result in decreased use of public transit and decreased use of active transportation (*Ibid*). This likely happens because individuals who are dependent on public transportation often live in areas with a heightened UHI effect, and so traveling to a transit stop can be dangerous during an extreme heat event. Extreme heat makes waiting for a bus or train uncomfortable or dangerous at stops/stations without adequate shade or shelter.

Rising temperatures and an increasing frequency of extreme heat events will stress physical transportation infrastructure, which often was designed to withstand historical temperatures and may not function properly under higher temperature thresholds due to climate change (*Ibid*). Major impacts of extreme heat on physical transportation infrastructure most relevant to the City of West Sacramento include:

- Impacts on Pavements: Pavements are designed to withstand certain temperature thresholds. Temperatures exceeding that threshold can cause cracking and distortion in pavements, which can lead to buckling and rutting on roads.
- Impacts on Railways: Railways are also designed to function within a certain temperature range, and temperatures that exceed those thresholds can cause rails to warp and expand. This can cause train derailments, and to reduce stress on rails, trains must operate at slower speeds (SMAQMD and LGC 2020).

Extreme heat can also impact electric vehicles and battery electric buses by increasing energy use of these vehicles and decreasing range, and by impacting reliability and cost of these vehicles (SMAQMD and LGC 2020). As a result of state legislation which mandates the use of electric transportation modes to reduce GHG emissions, many communities throughout California are implementing battery electric bus fleets; thus, jurisdictions should consider and plan for the potential impacts of extreme heat on electric vehicles *(Ibid*).

SACOG's Sacramento Region Transportation Climate Adaptation Plan (2015) laid out high-level risks—or the probability of hazards as well as the consequences of those hazards—that extreme heat poses to transportation infrastructure in the Sacramento region (see Figure 28). Of the assets considered in the SACOG analysis, roadways, railways, and bridges have the highest risk of damage from extreme heat. Asphalt and concrete on roadways can crack and soften, while rails can expand and buckle, which can result in slower train operation speeds and system delays as well as train derailments (SACOG 2015). Bridges can experience expansion, join buckling, and will likely require increased maintenance.

Moderate risks are posed to pedestrians and cyclists, due to impacts of extreme heat on decreased comfort and increased health risks. Moderate risks are also posed to public transit and active transportation modes, because extreme heat can result in public transit system delays and overheating of vehicles as well as reduced comfort to public transit riders and pedestrians (*Ibid*). For instance, temperatures over 100°F have been found to increase stress on, and increase the risk of failure for, air conditioning units on buses (Ascent Environmental 2020). Traffic flow and traffic controls face medium likelihood or disruption due to the potential for overheating of vehicles, traffic congestion and network delays, and power outages affecting traffic signals. Transportation-related buildings and facilities could experience disruptions due to power outages and load shedding, and extreme heat conditions could force construction crews to slow down or stop maintenance work.

SACOG's Vulnerability and Criticality Assessment (2020) identified several public transit stops in the northern portion of the City of West Sacramento as having relatively high vulnerability to extreme heat. The high vulnerability scores given to these transit stops is in part because the vulnerability scores incorporate CalEnviroScreen 3.0 scores of the census tract in which the asset is located, with the rationale that transportation assets in highly disadvantaged communities should be prioritized.

Extreme heat events can affect the operation of shipping ports by posing health risks to workers. Extreme heat events can force operation and maintenance of ports to stop or slow down during the event to protect worker safety (United Nations 2018). Additionally, transportation system delays due to heat-induced impacts on roadways or bridges (e.g. roadway rutting or softening; rail track buckling) can affect shipping operations by affecting connections and access to ports (*Ibid*).

Wildfire

SACOG's Sacramento Region Transportation Climate Adaptation Plan (2015) assessed the risks that wildfire poses to transportation infrastructure in the Sacramento region (**Figure 28**). All asset categories considered, besides railways, were deemed to have medium risk from wildfires, while railways were identified as facing moderate risks due to the potential for wildfires to block rail routes or delay trains. Wildfires can result in transportation network disruptions by blocking roads and railways, forcing the closure of roads and halting of rail service, and reducing visibility (SACOG 2015). The poor air quality resulting from wildfire smoke creates unhealthy air conditions for pedestrians and cyclists, and for public transit users waiting at transit stops. Wildfires can also disrupt power supplies for traffic signals and rail lines.

The City of West Sacramento has low wildfire risk relative to other parts of the Sacramento region and the state (CalFIRE 2019; CEC 2020a), so its transportation network is more likely to be impacted by wildfires in other areas. However, grass fires can occur near and in the City, such as in 2015, when a grass fire burning near Ikea forced Union Pacific to halt train service due to the thick smoke generated.

SACOG's Vulnerability and Criticality Assessment (2020), which assessed wildfire vulnerability of roadways and transit stops throughout the Sacramento region, gave a high wildfire vulnerability score to a segment of I-80 between Davis and West Sacramento. The high vulnerability score is in part due to the high criticality of I-80. The assessment also gave high vulnerability scores to various transit stops (Yolobus stops) in the southeastern portion of the City, as well as one stop in the northeastern portion of the City (SACOG 2020b).

6.3.3 Flood Management Infrastructure

Flooding

Sea level rise and changing hydrologic conditions due to climate change will likely increase stress on the City's flood management infrastructure, including upstream reservoirs and levees protecting the City. In particular, sea level rise will likely increase stress on the levees that protect the City and reduce levee effectiveness (Yolo County 2011; City of West Sacramento and WSAFCA 2019). Although the Delta Adapts flood analysis indicates that the City will maintain a less than 0.5% annual chance of flooding due to levee overtopping through 2085, flooding due to levee overtopping is still possible. Because only levee overtopping was included in the Delta Adapts analysis, the flooding likelihood shown in the Delta Adapts analysis may underestimate the likelihood of flooding due to other kinds of levee failure.

As discussed in Section 4.1.3.3.4, the City has made substantial levee improvements since 2008. The Delta Adapts flood analysis shows lower flood exposure in the North Delta, including in the City, relative to other areas included in the analysis; the Delta Adapts flood analysis talks about how this is partly a result of historical levee improvements in the area. The City and the West Sacramento Area Flood Control Agency (WSAFCA) are actively pursuing federal appropriations for construction to improve the remaining levee segments and achieve the required 200-year level of flood protection.

Flood events can damage stormwater pump stations, which could increase vulnerability to local rainfall flooding if pump stations are not repaired (DSC 2021d). Reduced snowpack and changing precipitation patterns due to climate change may increase stream runoff in the winter—when drainage infrastructure typically already experiences its heaviest load—further stressing drainage infrastructure (City of West Sacramento and WSAFCA 2019).

The Delta Adapts flood analysis evaluated which climate change influences—sea level rise, riverine flow, or both—most strongly influenced flood risk throughout the Delta. Results indicate that flood risk due to levee overtopping in the City of West Sacramento is driven primarily from changes in riverine inflow, meaning that future adaptation actions to reduce flood vulnerability should include adaptation actions in the contributing watersheds that result in reduced riverine inflows (DSC 2021c).

Extreme Heat

Extreme heat can negatively impact the operation of stormwater drainage pump stations in the City, which will require more energy to cool as temperatures rise (Heyn and Winsor 2015). In the Southwest, for example, utilities have had to redesign and reconstruct pump station cooling systems to ensure adequate cooling in the face of higher temperatures (Heyn and Winsor 2015). Power outages and increasing electricity demands due to extreme heat conditions can threaten worker safety and halt or delay operation and maintenance of flood protection infrastructure (SACOG 2015).

Extreme heat and rising temperatures in the Sierra Nevadas will indirectly impact flood protection infrastructure in the City through associated changes, including reduced snowpack and changing precipitation patterns. As discussed above, these changes may increase stream runoff in the winter, further stressing drainage infrastructure during a time when it already experiences its heaviest load (City of West Sacramento and WSAFCA 2019).

Wildfire

Wildfire impacts to flood management infrastructure were not assessed.

6.3.4 Water Supply and Wastewater

General Climate Risks to Water Supply

Climate change may pose risks to the City's water supply. As discussed in Section 4.1.3.3.5, the City has three main water supply sources (City of West Sacramento 2016a):

- A SWRCB appropriative water rights permit (Permit 18150) to divert Sacramento River surface water, typically during only the months of September to June (due to a Term 91 condition, discussed below);
- A contract with USBR for both a permit supplying a base supply (Permit 18150) and Central Valley Project (CVP) water derived from Shasta Reservoir storage; and
- A contract between the NDWA and Department of Water Resources (DWR), which ensures delivery of water to the NDWA service area—of which part of the City of West Sacramento falls within—under all conditions.

The SWRCB water rights permit is subject to Term 91, "a special water right condition that allows the state to limit or eliminate the City's ability to use this water in certain hydrological and regulatory conditions" (City of West Sacramento 2016a). Term 91 conditions apply when the CVP and State Water Project must release stored water in excess of natural flow—termed *supplemental project water*—in order to meet Sacramento Valley in-basin uses and export demands (City of West Sacramento 2016a). Permittees with a Term 91 condition cannot use their water under the given permit when supplemental project water is released.

A study assessing the impacts of climate change on future Term 91 curtailments found that climate change will likely increase the *frequency* of Term 91 curtailments as well as the *duration* of these curtailments (in other words, the length of the season in which Term 91 permittees cannot use the water)—assuming operation of the CVP and the conditions under which Term 91 apply remain the same (Schwarz 2015). The study also found that years in which no supplemental project water needs to be released—a rare occurrence historically—will be even rarer in the future due to climate change (*Ibid*). The study found that Term 91 curtailments would occur in 90% of years during mid-century (2030-2059), with a duration of about 95 days—around 20% longer than historical durations (*Ibid*). During end-of-century (2070-2099), curtailments would occur in 92% of years, with an average duration of 107 days (26% longer than historical durations) *(Ibid*). Thus, climate change will likely make it much more common for Term 91 curtailments to occur, increasing the importance of alternative water supply sources to meet the City's water supply needs.

The USBR contract includes both base water supply under the SWRCB permit discussed above and CVP Project Water derived from Shasta Reservoir storage (City of West Sacramento 2016a). This CVP Project Water can be reduced based on USBR's Municipal and Industrial Shortage Policy. Before 2015, the City's CVP Project Water supply had never been reduced to less than 75% of the three-year average use, but due to severe drought conditions of 2015, this water supply was reduced to 25% of three-year average use. Although the City was able to use alternative water supplies (including NDWA contract water) to meet its water supply needs in 2015, the projected increase in the frequency, severity, and length of droughts due to climate change could potentially result in more reductions such as the reduction seen in 2015—increasing the importance of having a diverse portfolio of water supply sources (Houlton and Lund 2018; USBR 2014).

The City uses NDWA contract water supplies as back-up supplies under certain hydrological and regulatory conditions (City of West Sacramento 2016a). In the past, the City has only used NDWA supply when the City's water supply needs could not be met using other supplies—such as during the 2014-2015 drought, during which the SWRCB permit and USBR CVP water supplies were severely reduced. The City plans to continue using NDWA contract supplies as back-up supplies to supplement other water supply sources. Delta water quality is impacted by sea level rise, which forces salinity intrusion eastward into the Delta from San Francisco Bay; to counteract salinity intrusion and ensure sufficient water quality for Delta water exports, releases of stored water from reservoirs must be increased, and/or export pumping from the Delta must be reduced (DSC 2021e). While some in-Delta water users that that are further southwest can be vulnerable to increases in Delta water salinity, the City of West Sacramento, located at the northernmost portion of the Delta and the NDWA service area, is less likely to be impacted by salinity-related water quality issues.

Specific impacts of flooding and extreme heat on water supply and wastewater infrastructure are discussed below.

Flooding

Flooding can disrupt utility services, including water and sewer. For instance, pump stations used in the City's water supply and wastewater systems can be impacted by flooding. Pump stations contain electrical and mechanical components that are sensitive to flooding, and pump stations can be damaged by high velocity flood flows, scour, and inundation (DSC 2021d). To reduce pump station sensitivity to flooding, sensitive electrical and mechanical portions of pump stations can be floodproofed or elevated to withstand higher water levels (*Ibid*).

Flooding can also result in the release of sewage if wastewater treatment plants are inundated or sewage pipelines severed (Sacramento County 2017).

Extreme Heat

As with other types of infrastructure, power outages due to extreme heat conditions—and resulting increases in electricity demands—can affect the operation of water supply and water utilities infrastructure by affecting worker safety and halting or delaying operation and maintenance work (SACOG 2015). The City of West Sacramento charges rates for water and sewage services; periods of power outages can result in reduced revenues from water and sewage services because the City must shoulder increased maintenance and repair costs for equipment which can be damaged by power outages

(Sacramento County 2017). As with stormwater drainage pump stations, extreme heat can negatively impact the operation of sewer and water pump stations in the City, which will require more energy to cool as temperatures rise (Heyn and Winsor 2015). Rising air temperatures, along with reduced snowpack and earlier snowmelt, can result in increased stream temperatures, which in turn could exacerbate corrosion of water supply and wastewater treatment infrastructure (Heyn and Winsor 2015). Corrosion of this infrastructure can result in water main breaks (*Ibid*).

Along with other climate impacts, higher temperatures can exacerbate existing water quality issues. Artificial surfaces such as pavement and rooftops can have very high temperatures; runoff on these surfaces can then result in higher temperatures of stormwater runoff, impairing water quality when released back into water bodies (U.S. EPA 2019). According to the U.S. EPA, runoff that flows through urban areas can be as much as 25ºF warmer as the initial rainfall (*Ibid*).

Wildfire

Wildfire impacts to water supply infrastructure were not assessed.

Chapter 7. Conclusion and Next Steps

This report is intended to help the City of West Sacramento advance its efforts to prepare for and adapt to changing climate conditions. Although we can't know with certainty exactly how or when climate impacts will occur, it is clear that climate change will have significant impacts on the City's residents and assets. The impacts described in this report underscore the need to begin planning for climate resilience now—and adaptation strategies and investments must be targeted to the City's most vulnerable populations.

Recommended next steps include assessing the City's adaptive capacity, or its current ability to address the sensitivities and vulnerabilities identified in this report. This can be done by reviewing existing City policies, programs, plans, and resources that relate to the three climate hazards (see the Adaptation Policy Gaps Memo, prepared for the City by the consultant team). Results from the adaptive capacity review together with information in this report can then be used to develop adaptation goals, policies, and strategies to address the identified vulnerabilities. Where possible, adaptation strategies should provide multiple benefits and complement the greenhouse gas reduction strategies identified in the City's Climate Action Plan.

Chapter 8. References

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Chapter 9 Appendices

Appendix 1: List of Data Sources for Asset Maps

For All Maps

- Legal Delta boundary: Department of Water Resources
- City of West Sacramento boundary: City of West Sacramento Open Government Hub, "Cities"
- Railroads: City of West Sacramento Open Government Hub, "Railroads"
- Major Roads and Highways: Esri and Tom Tom North America ("U.S. Major Roads"). Updated 2019.

Individual Asset Maps

- *People*:
  - U.S. Census Bureau (2017), TIGER/line shapefiles, Census Block Groups
  - Custom social vulnerability index (SVI) results – underlying data sources:
    - U.S. Census Bureau, American Community Survey (2017).
    - California Office of Environmental Health Hazard Assessment (OEHHA), CalEnviroScreen 3.0. Updated June 2018.
    - U.S. Department of Agriculture (USDA) Food Access Research Atlas
- *Cultural and Historic Resources*:
  - Stutts, M. 2014. National Register of Historic Places. National Register properties are located throughout the United States and their associated territories around the globe. Accessed at https://www.nps.gov/subjects/nationalregister/data-downloads.htm
  - GreenInfo Network. 2020. California Protected Areas Database (CPAD). https://www.calands.org/cpad/
- *Critical Facilities*:
  - City of West Sacramento Open Government Hub, "City Facilities" layer
  - Esri and Tom Tom North America (U.S. Major Roads). Updated 2019. https://www.arcgis.com/home/item.html?id=871852b13b53426dabdf875f80c04261
  - Sacramento Area Council of Governments (SACOG) Open Data Portal. 2019. "Schools 2019". http://data.sacog.org/datasets/schools-2019
- *Parks and Recreation Facilities*:
  - City parks and facilities sources: City of West Sacramento Open Government Hub, "Parks" layer and select assets from "City Facilities" layer (Club West Teen Center, Recreation Center, Bridgeway Lakes Boathouse)
  - Marinas: CA Department of Water Resources, via David Ford Consulting Engineers, 2013. Marinas in the Delta.

  - Yolo and Sacramento Bypass Wildlife Areas: California Protected Areas Database (CPAD) 2019.
- *Agriculture*:
  - California Department of Conservation. 2016. Farmland Mapping and Monitoring Program (FMMP) Important Farmlands. Yolo County.
- *Energy Infrastructure*:
  - California Energy Commission (CEC). 2018). "California Electric Substations"
  - CEC. 2020. "California Electric Transmission Lines"
  - CEC. 2020. "California Power Plants."
  - CEC Energy Assessments Divisions. 2016. "Natural Gas Stations" and "Natural Gas Pipelines"
- *Transportation Infrastructure*:
  - Roads, railroads, bridges, ports:
    - Esri and Tom Tom North America ("U.S. Major Roads"). Updated 2019.
    - California Department of Water Resources via David Ford Consulting Engineers (2013) (Ports Database)
    - City of West Sacramento Open Government Hub, "Railroads"
  - Public transit and active transportation:
    - SACOG Open Data Portal. "Regional and Existing Bike Facilities 2019" and "Bus Stops" (updated 2020).
- *Flood Management Infrastructure*:
  - City of West Sacramento Storm Water Discharge Permit Implementation Level map (2015)
  - USACE National Levee Database. Downloaded 07/2020.
  - SACOG Open Data Portal, "Flood Bypasses" (2018).
- *Water Treatment Facilities*:
  - City of West Sacramento Open Government Hub, "City Facilities" layer
  - 2018 Yolo Operational Area Multi-Jurisdictional Hazard Mitigation Plan, West Sacramento Community Profile