# One Bay Area: Building a Sustainable, Resilient Region

*A Silicon Valley Case Study*

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# 1. Regional Blueprints: The Climate Connection

Tremendous post-World War II population growth pressures in urban regions throughout the country have translated into mostly lower-density, land and resource consumptive development patterns, with undesirable environmental side-effects, such as air and water quality degradation, deteriorating urban ecosystems, and increasing greenhouse gas emissions.

Driven by federal transportation funding mandates, state policies, and local desires for better, coordinated, and more sustainable regional growth, metropolitan planning organizations (MPOs)[1] throughout the country have undertaken "blueprint" visioning initiatives and developed a range of technical assistance tools to implement regional blueprints. These tools help communities understand and evaluate alternative growth scenarios, take steps to reduce the environmental footprint of future growth, spur economic development, and encourage more compact, mixed-use development forms that support transit, biking, and pedestrian activity.

Regional blueprints, if implemented locally, can have many sustainability, community health, climate mitigation, and community resiliency benefits. However, a consequence of successful regional blueprints that guide more future development and urban revitalization around transit-oriented centers and corridors is that more people, housing, commercial uses, and infrastructure investment (public and private) is concentrated in areas vulnerable to climate and non-climate related events (earthquakes, sea level rise storm surge, riverine flooding, urban wildfire, drought, extreme heat, etc.).

Regional growth coordination through blueprint-like strategies on the U.S. west coast, including California, have many similarities, and urban areas in west coast states have similar climate and non-climate vulnerabilities.

The combined population of west coast states in 2010 was nearly 48 million, or 15.5 percent of the total U.S. population. The most populated urbanized regions in these states (those with metropolitan populations of roughly two million or more), accounted for nearly 40.5 million of the combined population of these states (Table 1, next page). In California the largest MPO urban regions (greater Los Angeles area, San Francisco / Monterey Bay, San Joaquin Valley, and greater Sacramento area) account for about 35.2 million of California's approximately 38 million residents.

At risk in the west coast states, and their largest urbanized areas, is over $2.5 trillion in gross state domestic product, of which $2 trillion is California State GDP[2], and likely many times that amount in the total value of land, improvements, and other assets in these states.

## Regional Blueprints in California

An outcome of blueprint processes in California is that more future development is projected for higher density, mixed-use centers and corridors with access to high-quality transit (priority development areas [PDAs], transit priority areas [TPAs], or high-quality transit areas [HQTAs]), housing, services, and jobs in closer proximity to each other.

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[1] MPOs are federally mandated and federally funded transportation policy-making bodies in urban regions of 50,000 or more governed by representatives of local governments as the receiving entities for federal transportation funding.

[2] http://www.bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm

Table 1: Eight Largest West Coast Metro Area Populations[3]

| Urban Area | 2010 Population |
|---|---|
| Greater Los Angeles Region | 13,652,155 |
| San Francisco / Monterey Bay Region | 7,883,447 |
| Inland Empire (CA) | 4,224,851 |
| Puget Sound Region (Seattle-Tacoma) | 3,439,809 |
| San Joaquín Valley Región (excl. Stockton) | 3,286,354 |
| San Diego County | 3,095,313 |
| Greater Sacramento / Stockton Region | 3,073,065 |
| Portland / Vancouver (WA) Region | 1,789,580 |
| TOTAL METRO AREA POULATION | 40,444,574 |
| | |
| USA | 308,745,538 |
| Metro Area Population as a % of USA Population | 13.1% |

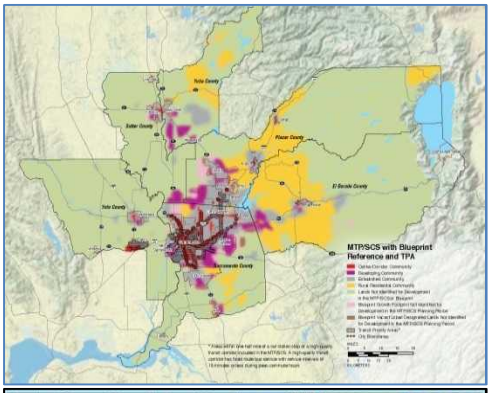
Blueprints for sustainable growth have many commonalities among California urban regions. Common blueprint principles include:

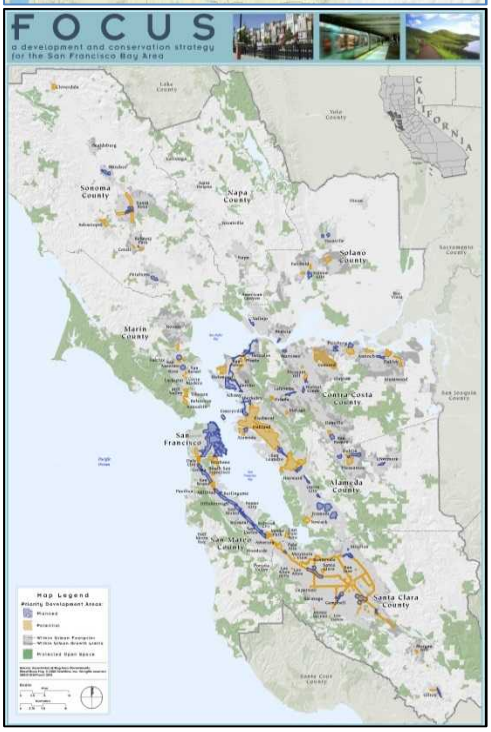
- Deliver efficient public infrastructure, with greater emphasis on redevelopment to better utilize existing infrastructure.
- Enhance regional mobility that reduces vehicle miles traveled through interconnected, multiple modes of travel, jobs and housing balance throughout the region, and placing commercial and residential development in closer proximity to each other to improve access to jobs and services.
- Better integrate local land use and regional transportation systems that incent development within transit corridors and mixed-use activity centers.
- Allocate housing on a "fair-share basis" throughout the region for all demographic and income groups and to meet housing needs through all stages of life.
- Ensure public health and safety, through transportation systems, community layout, and neighborhood design that promote physical activity and healthy living
- Invest in and revitalize existing communities, particularly older communities closer to core cities within the region.
- Support a prosperous regional economy that provides opportunities for all through balanced investments in infrastructure, transportation, education, and social systems.

[3] Greater LA Basin Urban Area = Los Angeles, Orange, and Ventura Counties; 11-County Greater SF Bay Area = San Francisco, Santa Clara, Alameda, Contra Costa, Sonoma, Solano, San Mateo, Napa, Monterey, Marin, and Santa Cruz counties; Inland Empire = Riverside and San Bernardino counties; Greater Sacramento / Stockton Urban Area = Sacramento, San Joaquin, Placer, Yolo, El Dorado, Yuba, and Sutter counties; and San Joaquin Valley Urbanized Area = Fresno, Kern, Stanislaus, Merced, Tulare, Madera, and Kings counties.

- Promote regional collaboration among government, business, education, civic, and community organizations and broad-based community outreach and information sharing.
- Strengthen the sense of community by preserving environmental, cultural, and historical assets, supporting diversity and social cohesion, and promoting town centers.
- Protect and enhance open space, the natural environment, and aesthetic values by reducing the urban footprint of future growth and connecting urban residents to rural resources (agriculture, water, open space, etc.) that sustain healthy urban regions.

Transit Priority / Priority Development Areas (SACOG, ABAG)




In 2008, Executive Order S-13-08 from the Governor directed the California Natural Resources Agency (CNRA) to provide land use planning guidance on climate change impacts and prepare a State Climate Adaptation Strategy (2009) and a California Sea Level Rise Assessment. These strategies are intended to help MPOs and their member communities consider vulnerability assessment and climate adaptation in regional planning and coordination efforts.

State legislation in 2009 (SB 375) requires metropolitan planning organizations (MPOs) to adopt sustainable community strategies (SCS)[4] as part of the transportation planning process to meet regional greenhouse GHG reduction targets for passenger vehicles and light trucks. These SCSs reflect the comprehensive plans of cities and counties, allocating land uses in the region (similar to the SACOG and other regional blueprints).

MPOs throughout California have either updated regional transportation plans (RTPs) and included sustainable communities strategies or are in the process of doing so. The four largest MPOs (Southern California Association of Governments [SCAG], Association of Bay Area Governments [ABAG], San Diego Association of Governments [SANDAG], and Sacramento Area Council of Governments [SACOG]) have adopted RTPs / SCSs that project regional growth through 2035 (SACOG, SCAG), 2040 (ABAG), or 2050 (SANDAG). Collectively, the four RTPs / SCSs are intended to guide most new housing and jobs toward PDAs, TPA, or HQTAs—centers and corridors within proximity to transit than can accommodate higher densities of development in mixed-use environments (Table 2, next page).

[4] The SCS is a required component of RTPs that addresses integration of land use and transportation planning through more detailed allocation of land uses in the RTP.

Table 2: Project Growth Within PDAs / TPAs[5]

| Metropolitan Planning Organization | Projected Growth[1] |
|---|---|
| Southern California Association of Governments (2035) | |
| *Housing*[2] | 1,511,000 |
| *In PDAs / TPAs / HQTAs* | *50% - 69% (est.)* |
| *Jobs* | 1,703,000 |
| *In PDAs / TPAs / HQTAs* | *52% (est.)* |
| Association of Bay Area Governments (2040) | |
| *Housing* | 652,600 |
| *In PDAs / TPAs / HQTAs* | *78%* |
| *Jobs* | 1,112,900 |
| *In PDAs / TPAs / HQTAs* | *62%* |
| San Diego Association of Governments (2050) | |
| *Housing* | 388,400 |
| *In PDAs / TPAs / HQTAs* | *79%* |
| *Jobs* | 502,000 |
| *In PDAs / TPAs / HQTAs* | *82%* |
| Sacramento Area Council of Governments (2035) | |
| *Total Housing* | 303,000 |
| *In PDAs / TPAs / HQTAs* | *30%* |
| *Jobs* | 361,100 |
| *In PDAs / TPAs / HQTAs* | *29%* |
| TOTAL PROJECT GROWTH | |
| Total Housing | 2,855,000 |
| *In PDAs / TPAs / HQTAs* | *50% - 60%* |
| Total Jobs | 3,679,000 |
| *In PDAs / TPAs / HQTAs* | *57%* |

[1]Rounded to the nearest 1,000

[2]SCAG growth projections based on households

## 2. Plan Bay Area: Strategy for a Sustainable Region

*Plan Bay Area* provides a vision for how to retain and enhance the qualities that make the Bay Area a great place to live, work and play. The planning scenarios and the land use and transportation investment strategies developed during the *Plan Bay Area* process seek to address the needs and aspirations of each Bay Area jurisdiction, as identified in locally adopted general plans and zoning

[5] SCAG, *Regional Transportation Plan / Sustainable Communities Strategy 2012- 2035*; ABAG, Plan *Bay Area: Strategy for a Sustainable Region;* SANDAG, *Our Region, Our Future: 2050 Regional Transportation Plan;* SACOG Metropolitan Transportation Plan / Sustainable Communities Strategy.

ordinances. The framework for developing these scenarios consisted largely of the Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs) recommended by local governments.

*Plan Bay Area's* distribution of jobs throughout the region is informed by changing trends in the locational preferences of the wide range of industry sectors and business place types in the Bay Area. The employment distribution directs job growth toward the region's larger cities and Priority Development Areas with a strong existing employment base and communities with stronger opportunities for knowledge-sector jobs.

Almost 40 percent of the jobs added from 2010 to 2040 will be in the region's three largest cities — San Jose, San Francisco, and Oakland. Two-thirds of the overall job growth is anticipated to be in PDAs throughout the region. Due to the strength of the knowledge sector, nine of the 15 cities expected to experience the greatest job growth are in the western and southern part of the region surrounding Silicon Valley. The 15 cities expected to experience the most job growth will account for roughly 700,000 jobs, or just over 60 percent of the new jobs added in the region by 2040.[6]

### Priority Development Areas – Risk and Vulnerability

Applications for over 100 PDAs were submitted to ABAG and the Metropolitan Transportation Commission (MTC). The areas nominated include most of the places in the Bay Area served by fixed transit, major bus corridors, or planned transit under MTC's guidance. These areas comprise about 115,000 acres of urbanized land, which represents less than five percent of the Bay Area's total land area. However, the proposed PDAs have the capacity to accommodate over half of the Bay Area's projected housing growth through 2035.[7]

ABAG is partnering with the Bay Conservation and Development Commission (BCDC) to assess the vulnerability of PDAs to sea level rise and develop strategies to address the vulnerabilities. The vulnerability assessment will be informed by the Adapting to Rising Tides (ART) project, which is mapping shoreline risks and vulnerabilities from sea level rise and storm surge.

ABAG and BCDC will identify which PDAs are vulnerable to sea level rise and evaluate the vulnerability and risk the exposed PDAs may experience due to sea level rise and the consequences on local communities and the region if this exposure was to occur.

ABAG is also conducting the Bay Area Housing and Community Multiple Hazards Risk Assessment project, which will include recommended strategies to decrease vulnerability and increase the region's resilience to natural hazards.

## 3. A Silicon Valley Case Study

Silicon Valley is home to roughly three million residents, and is the 4th most ethnically diverse and culturally rich community in the United States. It contains a multitude of working and natural landscapes, generates a gross domestic product closing on $200 billion, is the global model for innovation technology, and is the world's leading center for venture capital. While these and other conditions make the region a highly desirable place to live and conduct business, climate change presents a threat to Silicon Valley's communities' safety and prosperity. A coordinated response to climate change is needed to ensure that the region continues to thrive in the future.

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[6] This summary of *Plan Bay Area* was drawn from the Introduction.

[7] http://www.bayareavision.org/initiatives/prioritydevelopmentareas.html

Over the next century, increasing atmospheric greenhouse gas concentrations are expected to cause a variety of changes to local climate conditions including sea level rise, increased coastal and riverine flooding, and more frequent and higher temperature extreme heat wave events. Development and implementation of climate adaptation strategies will be important to protect the region's people, infrastructure, ecosystems, and vibrant economy. The Silicon Valley 2.0 Project is a regional effort, managed by the Santa Clara County Office of Sustainability and funded by the Strategic Growth Council, to minimize the anticipated impacts of climate change and reduce the generation of local greenhouse gas emissions. The project will use a risk management framework to A) evaluate the exposure of community assets (i.e., infrastructure, populations, and landscapes) to likely climate impacts, B) examine the potential consequences to the economy, society, and environment of this exposure, and C) develop preemptive adaptation strategies that improve community resiliency.

Using this framework, the project will prepare a strategic climate change adaptation plan that aims to facilitate and coordinate regional planning and implementation efforts in this area. The plan will identify assets within the region that are threatened by the anticipated climate change conditions and the magnitude of the potential economic, social, and environmental impacts that could result if no action is taken. The plan will also identify potential strategies to minimize these impacts. Ultimately, the plan will identify the region’s top priorities, and the near–term actions needed to implement an effective regional scale adaptation response.

The project will also develop a decision-support tool that will allow jurisdictions and other organizations to evaluate potential climate change impacts and strategies within their communities. The tool will contain a variety of user-interface dashboards and generate easy-to-understand output reports to facilitate decision making processes.

Climate change adaptation planning and greenhouse gas mitigation efforts are intertwined and interdependent. Consensus amongst climate scientists indicates that if humanity can reduce global emissions by approximately 80% below1990 levels by 2050, we can avoid the worst impacts of climate change. If not, adaptation and resilience will become increasingly difficult, costly, and potentially infeasible. The second phase of Silicon Valley 2.0 Project (which the County is currently seeking funding for) will establish a regional roadmap towards an ambitious 2050 emission reduction goal. The roadmap effort will identify potential pathways, technologies, strategies, and policy mechanisms needed to reduce regional emissions and make a fair-share contribution toward global climate protection efforts. The strategic document will identify near-term actions, areas for regional collaboration and leadership, and areas where State, federal, or utility initiative will be needed.

Together the components of the Silicon Valley 2.0 Project make it a comprehensive regional climate change adaptation and climate protection initiatives. The project, combined with the capacity of its public, private, and non-profit sector partners, has the opportunity to make a considerable contribution to these important challenges and demonstrate the region’s leadership.

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- evaluate the exposure of community assets (i.e., infrastructure, populations, and landscapes) to likely climate impacts;
- examine the potential consequences to the economy, society, and environment of this exposure; and
- develop preemptive adaptation strategies that improve community resiliency.

The goals of Silicon Valley 2.0 include:

- Prepare a strategic climate change adaptation plan that aims to facilitate and coordinate regional planning and implementation efforts for Silicon Valley.
- Identify assets within the region that are threatened by the anticipated climate change conditions and the magnitude of the potential economic, social, and environmental impacts that could result if no action is taken.
- Identify potential strategies to minimize these impacts.
- Develop a decision-support tool that will allow jurisdictions and other organizations to evaluate potential climate change impacts and strategies within their communities
- Ultimately, the plan will identify the region's top priorities, and the near–term actions needed to implement an effective regional scale adaptation response.

## Risk Assessment Framework

Understanding the level of risk with respect to climate impacts is a valuable part of decision-making and policy development for future adaptation, as it provides a basis for establishing priorities. Risk is the potential for an unwanted outcome resulting from an event, such as inundation from sea level rise. Conducting a risk assessment is the first step in climate adaptation planning, as it identifies those areas on which to focus the subsequent development of appropriate adaptation strategies. This second step centers on the creation of implementable actions aimed at reducing the prioritized climate risks. The adaptation framework proposed for Silicon Valley 2.0 is a multi-step process that can vary by scale and context. This memorandum discusses these elements in greater detail. Figure 1, below (next page) illustrates the Risk Assessment Framework.

### *Local Control*

Climate change has the potential to affect a wide range of sectors, from public health to water supply. The entities responsible for managing and adapting to the risks posed by climate change will vary by sector. For example, within the transportation sector, cities and counties are responsible for local road networks, while the California Department of Transportation (Caltrans) oversees state highways. For the Silicon Valley 2.0 project, the assessment of climate risks and the development of adaptation strategies focuses on those areas that local jurisdictions can control. In addition to local transportation infrastructure, this includes buildings and land use, economic development, community wellbeing, public health, drainage, and parks and open space. Areas that fall within the broader area of influence, where the majority of decision-making lies with state and federal agencies, special districts and private actors, include energy, water supply, flood control, agriculture, the greater economy, and federal and state policy. Figure 1, below (next page) illustrates this relationship.

There is overlap between the areas of broader influence and local control, and for the purposes of climate adaptation planning for Silicon Valley 2.0, it is important to focus on the potential for local action. For example, drought may create water supply shortages for Santa Clara County local jurisdictions, but Santa Clara Valley Water District (SCVWD) manages the majority of the water supply network. Local jurisdictions, however, can adapt to water supply shortages by implementing conservation actions or developing local sources, such as recycled water facilities. In the area of broader influence, it will be important to undertake adaptation planning along with key partners in the areas of broader influence, such as SCVWD and Caltrans. Figure 2, below (page 9), illustrates the climate change impact sectors, areas of influence, and local control.

FIGURE 1: SILICON VALLEY 2.0 RISK ASSESSMENT FRAMEWORK

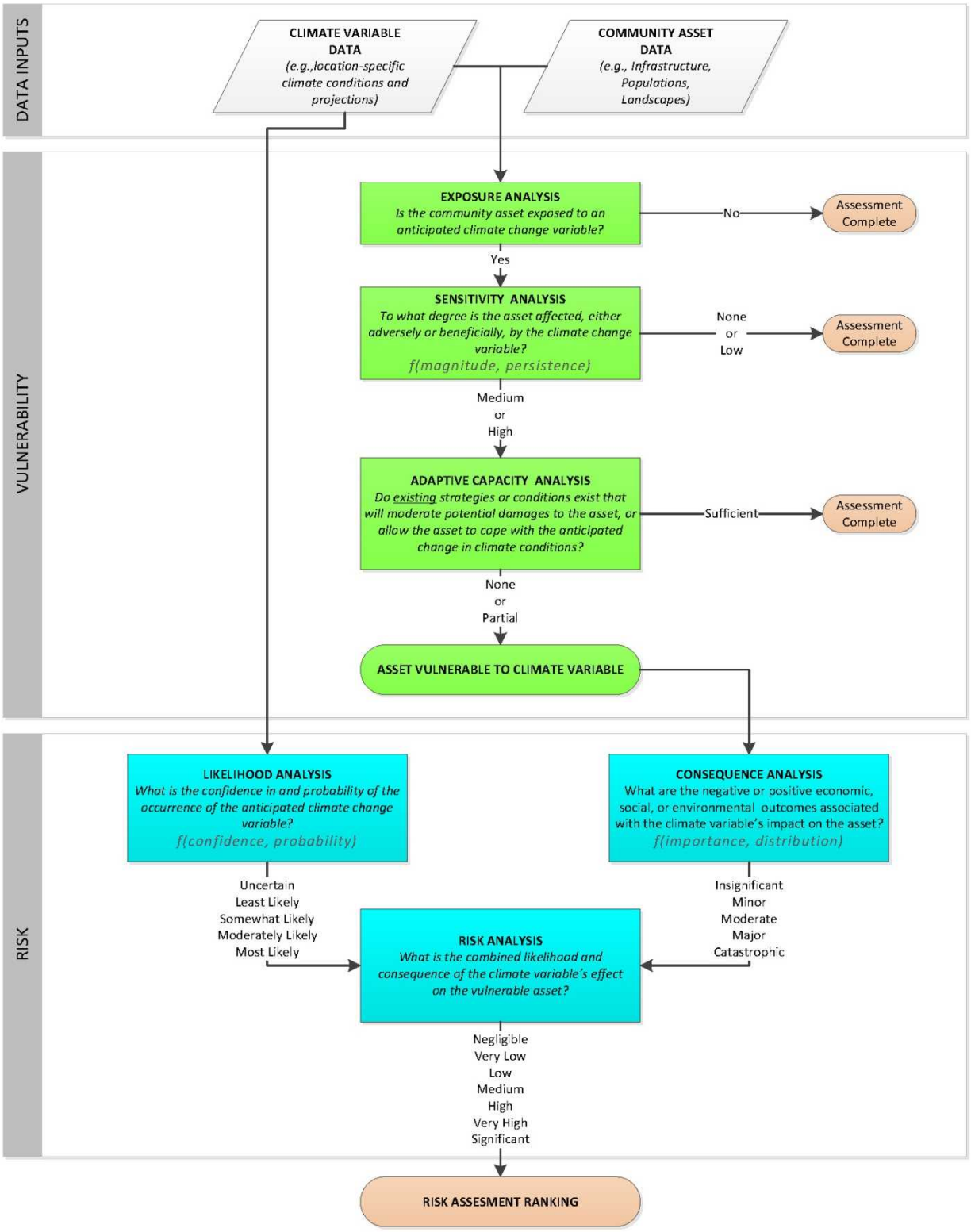
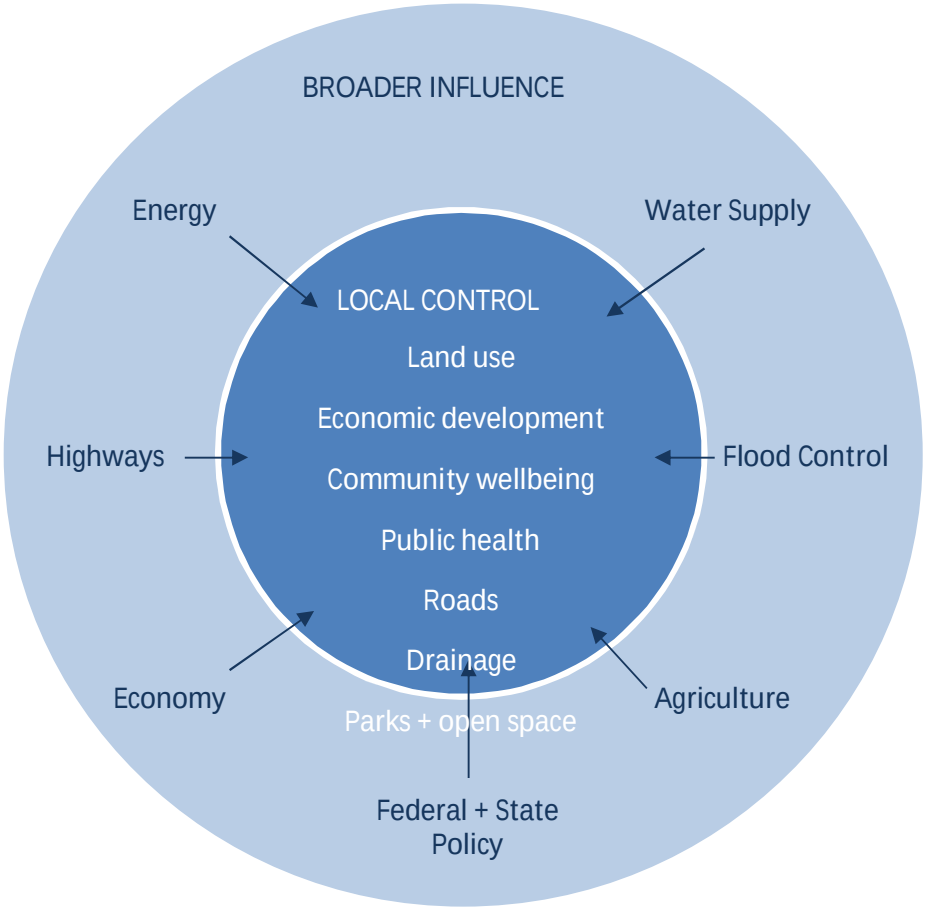


FIGURE 2: CLIMATE CHANGE SECTORS AND LOCAL CONTROL




### *Risk Assessment*

A climate risk assessment involves five sequential steps that evaluate exposure, sensitivity, adaptive capacity, likelihood and consequence. For each of these terms, this memorandum uses definitions provided by the Intergovernmental Panel on Climate Change (IPCC). Each of the steps in a climate risk assessment requires the development of criteria, and a subsequent rating scheme, in order to evaluate the risk level. These will be specifically tailored to Silicon Valley 2.0 as the project progresses. Example criteria are provided below for roads and sea level rise, following the definition of each term:

1. Exposure *"is the nature and degree to which a system is exposed to significant climatic variations."* For example, a roadway inundated by sea level rise at mid-century would be exposed to this climate variable, whereas a roadway not inundated would not.
2. Sensitivity *"is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli."* One criterion to evaluate the sensitivity of local roadways to sea level rise may be classification as an arterial. The more arterials exposed to sea level rise within a given area, the larger the magnitude of an adverse reaction. Alternatively, an arterial road flooded by over 1 foot of water becomes unusable and therefore, is sensitive to the inundation.

3. Adaptive capacity "*is the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities or cope with the consequences.*" One aspect of the adaptive capacity of local roadways to sea level rise may be the ability to divert traffic onto alternative routes.
4. Likelihood *"is a probabilistic estimate of the occurrence of a single event or of an outcome, for example, a climate parameter, observed trend, or projected change lying in a given range. Likelihood may be based on statistical or modeling analyses, elicitation of expert views, or other quantitative analyses."* For example, 16 inches of sea level rise is moderately likely to occur by mid-century, in the middle of a scale that ranges from remote to near certainty.
5. Consequence refers to the outcomes (e.g., economic, ecological, social) associated with a climate variable and can range from positive to negative.[8] For example, one economic consequence of inundation of arterials from sea level rise would be a reduction in goods movement, and one social consequence would be the isolation of a low-income community from local services.

The final step in a climate risk assessment is the assignment of an overall risk rating. While exposure, sensitivity and adaptive capacity provide context for a particular climate variable and sector, such as the impact of sea level rise on roadways, the risk rating is a function of likelihood and consequence. The rating helps prioritize and guide adaptation planning activities and decision-making and could be a score (1 through 6) or a rating (such as very low, low, medium, etc.). Figure 3, below, illustrates one example of a risk rating matrix that aggregates scores assigned to likelihood and consequence. The development of a risk rating approach for Silicon Valley 2.0 will be determined as the project progresses and will be specifically tailored to the project's needs.

FIGURE 3: RISK, LIKELIHOOD, AND CONSEQUENCE MATRIX

| | | Consequence | | | | |
|---|---|---|---|---|---|---|
| Likelihood | | 1 (very low) | 2 (low) | 3 (moderate) | 4 (high) | 5 (very high) |
| | 1 (Remote) | 2 | 3 | 4 | 5 | 6 |
| | 2 (Unlikely) | 3 | 4 | 5 | 6 | 7 |
| | 3 (Likely) | 4 | 5 | 6 | 7 | 8 |
| | 4 (Highly likely) | 5 | 6 | 7 | 8 | 9 |
| | 5 (Near certainty) | 6 | 7 | 8 | 9 | 10 |
| Risk | | Low | | Moderate | High | |

## Development of Risk Assessment Criteria

The climate risk assessment involves the development of criteria in order to be able to assign a rating to each. For some, the criteria will be binary (i.e., in/out of an inundation zone for Exposure), and for others, such as Consequence, there may be multiple criteria (social, economic and environmental) that will determine the ultimate rating (whether low, medium or high, or a numerical score).

[8] IPCC does not explicitly define consequence but includes it as an essential component in its climate risk management framework.

EXAMPLE – THE EFFECTS OF EXTREME HEAT EVENTS ON VULNERABLE POPULATIONS

- *Exposure: This might include the number of extreme heat days (above the* 98th historical percentile of maximum temperatures) *projected to occur in Santa Clara County by mid-century. The more days of extreme heat, the greater the Exposure.*
- *Sensitivity: This might include size of populations of the elderly (e.g., over 75 years of age) and the very young (under 5 years) throughout the county. The more of this demographic in a particular in an area, the more sensitive the population will be.*
- *Adaptive Capacity: This might include the availability of "cooling centers" (i.e., public facilities, such as libraries that may provide relief) or healthcare facilities in close proximity to vulnerable populations. If there are few places for the vulnerable to go, they will have lower adaptive capacity.*
- *Likelihood: This would identify the certainty assumed for that event (number of extreme heat days—using the risk rating matrix in Figure 2, this might result in a Likelihood rating of 3 (on a scale of 1 to 5, or "Likely").*
- *Consequence: might include increased incidence of heat-related illness or death (social consequence) and an increase in healthcare costs (economic consequence).*
- *Risk Rating: The overall risk of extreme heat for vulnerable populations would be Moderate (a combined score of 7 out of 10), based on an aggregation of Likelihood and Consequence. Figure 4, below, illustrates this outcome using the previous risk rating matrix. This risk assessment then sets the stage for the development of adaptation strategies to mitigate the risks of extreme heat for vulnerable populations, such as through the creation of additional cooling centers near vulnerable populations.*

FIGURE 4: RISK, LIKELIHOOD, AND CONSEQUENCE MATRIX – EXTREME HEAT EXAMPLE

| | | Consequence | | | | |
|---|---|---|---|---|---|---|
| Likelihood | | 1 (very low) | 2 (low) | 3 (moderate) | 4 (high) | 5 (very high) |
| | 1 (Remote) | 2 | 3 | 4 | 5 | 6 |
| | 2 (Unlikely) | 3 | 4 | 5 | 6 | 7 |
| | 3 (Likely) | 4 | 5 | 6 | 7 | 8 |
| | 4 (Highly likely) | 5 | 6 | 7 | 8 | 9 |
| | 5 (Near certainty) | 6 | 7 | 8 | 9 | 10 |
| Risk | | Low | | Moderate | | High |

In the above example, the climate risk assessment would be conducted with spatial information; however, the process can be applied qualitatively as well. For example, extreme heat can cause spikes in peak demand for electricity (for air conditioning), which can result in power outages. In this case, any facility that depends on the electric grid without backup power within the area exposed to extreme heat may be at risk. Although this information does not need to be mapped, the process of evaluating Sensitivity and Adaptive Capacity, followed by scoring Likelihood and Consequence to determine a risk rating and developing appropriate adaptation strategies to mitigate risk still applies.

# Appendix: Risk and Vulnerability Gaps Analysis for Silicon Valley

The purpose of this gap analysis is to: A) summarize existing policies, programs, and projects that when implemented could reduce vulnerability to and consequences of climate change in the Santa Clara County region and B) identify gaps where no current efforts exist, and C) identify key actors and decision makers related to climate change adaptation strategy development and implementation. The findings of the analysis will be used within the project's vulnerability assessment and in the adaptation strategy development process. Existing policies, programs, and project can improve the adaptive capacity of assets and asset sectors and therefore effectively reduce vulnerability and subsequent risk within the community. Existing initiatives can also provide the foundation for more robust future efforts to build on. Understanding current gaps and other weaknesses is essential to developing effective strategies that will ultimately improve the region's climate change preparedness.

## Memorandum Structure

The memorandum is organized into individual sector-specific gap analyses. Each sector chapter provides a review of the key climate change vulnerabilities relevant to a sector, identifies existing policies, programs, and projects that address these vulnerabilities, and recognizes key actors vital to the adaptation strategy development and implementation process. Each sector chapter concludes with a summary of the key strengths and weakness within the sector. The analyses identify both climate change-explicit initiatives and other relevant parallel initiatives. While climate change-explicit initiatives were the primary focus of this review, parallel initiatives that will be useful climate preparedness were also recorded.

## Research Methods

To complete this analysis the AECOM team (including Raimi & Associates for Public Health and Nelson/Nygaard for Transportation) conducted a literature search and targeted interviews with specific experts in each sector. After being reviewed, each initiative was classified as one of the following climate preparedness planning stages:

- Climate variable data development (and distribution);
- Vulnerability assessment;
- Risk assessment;
- Adaptation strategy development ;
- Adaptation strategy implementation;
- Overall climate change adaptation planning; or labeled as a,
- Parallel effort with climate change preparedness benefits.

After all initiatives were reviewed, the region's overall level of climate preparedness was analyzed for each sector and climate variable combination. The AECOM team used the following criteria to determine the rankings:

- None – no climate change specific initiative identified,
- Low – climate variable data development, vulnerability or risk assessment completed,
- Medium – adaptation strategy development completed
- High – adaptation strategy implementation completed

Key actors for each sector were identified if they have regulatory jurisdiction or operational control over the relevant assets or are involved in related planning processes.

## Buildings and Land Use

CLIMATE CHANGE VARIABLES / IMPACTS RELEVANT TO THE BUILDINGS / LAND-USE SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact |
|---|---|---|
| Changes in Precipitation Patterns | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels | - Loss of function due to temporary inundation<br>- Physical damage to property |
| Sea level rise and Storm Surge | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels | - Loss of function due to permanent inundation from long-term sea level rise, or short-term inundation from storm surge<br>- Physical damage to property |
| Wildfires | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels | - Loss of function<br>- Physical damage to property |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE BUILDINGS AND LAND USE SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Regional Climate Change Preparedness |
|---|---|---|---|---|
| Changes in Precipitation Patterns | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels | - Loss of function due to temporary inundation<br>- Physical damage to property | Yes | Very Low |
| Sea level Rise and Storm Surge | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels located near the coast | - Loss of function due to permanent inundation from long-term sea level rise,<br>- Loss of function due to short-term inundation from storm surge,<br>- Physical damage to property from storm surge | Yes | Very Low |
| Wildfires | All residential, commercial, industrial, mixed-use, and governmental/institutional parcels | - Loss of function<br>- Physical damage to property | No | None, but Parallel Efforts Exist |

## Telecommunications

CLIMATE CHANGE VARIABLES / IMPACTS RELEVANT TO THE TELECOMMUNICATIONS SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact |
|---|---|---|
| Changes in precipitation patterns (Riverine Flooding) | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage |
| Extreme and frequent heat events | All | - Temporary service interruption due to power outages |
| Sea Level Rise | All | - Loss of function due to permanent inundation of telecommunications infrastructure in coastal areas |
| Coastal Storm Surge | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage |
| Wildfires | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE TELECOMMUNICATIONS SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Changes in precipitation patterns | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage | No | None, but Parallel Efforts Exists |
| Extreme and frequent heat events | All | - Temporary service interruption due to power outages | No | None, but Parallel Efforts Exists |
| Sea Level Rise | All | - Loss of function due to permanent inundation of telecommunications infrastructure in coastal areas | No | None, but Parallel Efforts Exists |
| Storm Surge | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage | No | None, but Parallel Efforts Exists |
| Wildfires | All | - Physical damage to infrastructure<br>- Temporary service interruption due to power outages and/or physical damage | No | None, but Parallel Efforts Exists |

## Ecosystems

CLIMATE CHANGE VARIABLES / IMPACTS RELEVANT TO THE ECOSYSTEM SECTOR

| Climate Change Variable | Habitat Asset Affected | Nature of Impact |
|---|---|---|
| Sea Level Rise | - Grassland (near coastline)<br>- Riparian and Riverine<br>- Coastal Wetland<br>- Freshwater and Lacustrine<br>- Agricultural<br>- Developed Landscape (near coastline) | Permanent inundation of habitat assets near coastline, habitat loss, inability for upland habitat migration due to human-built environment, saltwater intrusion to freshwater systems, drinking water, freshwater supplies, loss of habitat (e.g. nest failure, burrow inundation, etc.). |
| Storm Surge | - Grassland (near coastline)<br>- Riparian and Riverine<br>- Coastal Wetland<br>- Freshwater and Lacustrine<br>- Agricultural<br>- Developed Landscape (near coastline) | Damage to coastal habitat assets from increased storm surge intensity and frequency, saltwater intrusion into freshwater systems, hydrology changes,, crop loss, food loss, loss of habitat (e.g. nest failure, burrow inundation, etc.). |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE ECOSYSTEM SECTOR

| Climate Change Variable | Habitat Asset Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Sea Level Rise | Coastal Habitat<br>Coastal Wetland | Permanent inundation of habitat assets near coastline, habitat loss, inability for upland habitat migration due to human-built environment, saltwater intrusion to freshwater systems, drinking water, freshwater supplies, loss of habitat (e.g. nest failure, burrow inundation, etc.). | Yes | Medium |
| Storm Surge | Coastal Habitat<br>Riparian and Riverine<br>Coastal Wetland<br>Freshwater and Open Water<br>Agricultural | Damage to coastal habitat assets from increased storm surge intensity and frequency, saltwater intrusion into freshwater systems, hydrology changes, impacts to infrastructure (levees, sea walls, buildings), crop loss, food loss, loss of habitat (e.g. nest failure, burrow inundation, etc.). | No | None |
| Precipitation Change (Riverine Flooding) | Chaparral and Scrubland<br>Riparian and Riverine<br>Freshwater Wetland and Open Water<br>Agricultural<br>Developed Landscape | Flooding on slopes leading to erosion, species composition, habitat loss, increase in sedimentation in aquatic habitats, impacts to fishes through loss of spawning habitat, egg loss and failure, loss of individuals, esp. juveniles, vegetation loss in all habitats affected, including agricultural, riparian loss, structural damage (related to habitat loss in built environment) | Yes | Low |

| Climate Change Variable | Habitat Asset Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Temperature Change (Shift to a Warmer Climate) | All Habitats | Heat stress leading to population loss, loss of populations/species dependent on cooler environments (e.g. redwoods), phenological changes, fuel loading supporting wildfire increase, landscape species composition changes, succession - gradual shift to grassland habitats as species move to higher elevations and cooler climates, increase in invasive species, freshwater availability loss and increased competition (incl. human environment) for aquatic resources, crop loss, loss of food supply | Yes | Low |
| Precipitation Change (Shift to a Drier Climate) | All Habitats | Drought, less summer precipitation, exacerbated effects to temperature change listed above, reduction in freshwater and ground water supplies, increase competition for water (including with human environment), vegetation loss leading to increases in wildfire and landslide/erosion, gradual habitat changes, phenological changes | Yes | Low |
| Wildfire | Coniferous Forest Hardwood Forest Oak Woodland Coastal Wetland Freshwater and Open Water Agricultural | Loss (potentially catastrophic) of populations and species, changes to natural habitat fire cycles, loss of carbon sinks, increase of carbon dioxide in atmosphere, habitat loss/change, shade loss, increase in sedimentation, reduced water quality, food loss | No | None, but Parallel Efforts Exist |

## Energy

CLIMATE CHANGE VARIABLES AND IMPACTS RELEVANT TO THE ENERGY SECTOR LEVEL OF CLIMATE CHANGE

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Relevant Utilities |
|---|---|---|---|
| Changes in precipitation patterns | Hydro-electricity generation | - Potential losses in hydroelectric power generation due to reduced snow-pack in the Sierra Nevada region | PG&E, CPAU, SVP |
| Extreme and frequent heat events | Overall electricity supply | - Increased average electricity demand due to air conditioning load | PG&E, CPAU, SVP |
| | | - Power outages due to excessive peak load | PG&E, CPAU, SVP |
| | Electric transmission and distribution lines | - Reduced efficiency and reliability of equipment | PG&E |
| Sea Level Rise | Sub-stations, electric transmission and distribution lines, power generation facilities | - Permanent inundation of coastal and low-elevation infrastructure | PG&E, CPAU, SVP |
| Storm Surge | Sub-stations, electric transmission and distribution lines, power generation facilities | - Loss of function of coastal and low elevation infrastructure due to temporary inundation and/or physical damage, resulting in power outage | PG&E, CPAU, SVP |
| Wildfires | Electric transmission and distribution lines | - Loss of function of electric transmission and distribution lines due to physical damage, resulting in power outage | PG&E |

PREPAREDNESS EFFORTS IN THE ENERGY SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness | Level of Climate Change Preparedness |
|---|---|---|---|---|
| Changes in precipitation patterns | Hydro-electricity generation | - Potential losses in hydroelectric power generation due to reduced snow-pack in the Sierra Nevada region | Yes | Medium |
| Extreme and frequent heat events | Overall electricity supply | - Increased average electricity demand due to air conditioning load | No | None, but Parallel Efforts |
| | | - Power outages due to excessive peak load | No | None, but Parallel |
| | Electric transmission and distribution lines | - Reduced efficiency and reliability of equipment | Yes | High(PG&E) Low(CPAU,SVP) |

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness | Level of Climate Change Preparedness |
|---|---|---|---|---|
| Sea Level Rise | Sub-stations, electric transmission and distribution | - Permanent inundation of coastal and low-elevation infrastructure | Yes | Low |
| Storm Surge | Sub-stations, electric transmission and distribution | - Loss of function of coastal and low elevation infrastructure due to temporary inundation and/or physical damage, resulting in | No | None, but Parallel Efforts Exist |
| Wildfires | Electric transmission and distribution lines | - Loss of function of electric transmission and distribution lines due to physical damage, resulting in power outage | No | No |

## Human Health

CLIMATE CHANGE IMPACTS TO HUMAN HEALTH

| Change in Climate Variable and Type of Health Effect | Confidence Based on Evidence[1] | Examples of Vulnerable Populations | Examples of the Potential Impacts on Health |
|---|---|---|---|
| Direct Impacts from Extreme Weather Events and Sea Level Rise | | | |
| Extreme heat days and heat waves | Very high | Infants and children; seniors; individuals with cardiovascular disease, diabetes, and mental illness; neighborhoods with high levels of impervious surfaces and minimal tree cover; no vehicle access; race and ethnicity; education level; poverty; immigration status; profession | Increased heat-related mortality and morbidity including, cardiovascular-related mortality, respiratory mortality, heart attacks, and renal disease. Lower birth weight infants. |
| Flooding and sea level rise | Very high | Low income individuals living adjacent to waterways and the Bay; uninsured | Increased injuries, illnesses, or death associated with flooding, higher emotional stress |
| Indirect Impacts from Changes in Temperature and Precipitation | | | |
| Air pollution – increased ozone levels | Very high | Children; individuals with lung disease, cardiopulmonary disease, and asthma; African Americans; women | Diminished lung function, increased frequencies of asthma attacks, sensitivity to allergens, and premature mortality |
| Allergens | High | Individuals with asthma, respiratory disease, or cardiovascular disease; pregnant women; smokers | Increased allergic sensitivity and asthma episodes |
| Wildfires | Very high | Firefighters and first responders, households in the wildland urban interface zone, individuals with asthma, allergic rhinitis, or atopic eczema; children; seniors; the immunocompromised; uninsured | Increased respiratory and cardiovascular hospital emissions, asthma attacks |
| Vector-borne infectious disease | High | Children; seniors; immunocompromised individuals; pregnant women | Increased incidences of specific diseases such as Lyme disease and West Nile Virus |
| Food- and waterborne disease | Medium | Children; seniors; immunocompromised individuals; pregnant women | Contaminated drinking water, food-borne illness |
| Food insecurity | High | Children; families with lower-incomes; children of immigrants; farmworkers | Greater micronutrient malnutrition, obesity, and mental health problems |

## Shoreline and Riverine Flooding

CLIMATE CHANGE VARIABLES AND IMPACTS RELATED TO SHORELINE AND RIVERINE FLOOD PROTECTION INFRASTRUCTURE

| Climate Change Variable | Assets/Services Affected | Nature of Impact |
|---|---|---|
| Changes in precipitation patterns | Levees, flood walls | - Temporary over-topping due to water level rise in creeks, resulting in flooding<br>- Loss of function due to physical damage, resulting in flooding |
| Sea Level Rise | Berms, wetlands, levees, flood walls | - Loss of function due to over-topping and permanent inundation, resulting in flooding |
| Sea Level Rise + Storm Surge | Berms, wetlands, levees, flood walls | - Loss of function due to over-topping and/or physical damage, resulting in flooding |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE SHORELINE AND RIVERINE FLOOD PROTECTION INFRASTRUCTURE SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Changes in precipitation patterns | Levees, flood walls | - Temporary over-topping due to water level rise in creeks, resulting in flooding<br>- Loss of function due to physical damage, resulting in flooding | No | None, but Parallel Efforts Exist |
| Sea Level Rise | Berms, wetlands, levees, flood walls | - Loss of function due to permanent inundation, resulting in flooding | Yes | Medium |
| Storm Surge | Berms, wetlands, levees, flood walls | - Loss of function due to physical damage, resulting in flooding | Yes | Low |

## Water and Wastewater

CLIMATE CHANGE VARIABLES AND IMPACTS RELEVANT TO THE WATER AND WASTEWATER SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Relevant Utilities |
|---|---|---|---|
| Sea Level Rise (Permanent Inundation and Wind Waves & Storm Surges) | Wastewater treatment plant and collection infrastructure; water supply plant and delivery infrastructure (e.g. pumps, pipes) | - Permanent or temporary inundation of coastal, low-lying treatment plants<br>- Inundation of below-ground pipes with corrosive saltwater | Cities of Sunnyvale, Palo Alto, and San Jose |
| | Stormwater infrastructure | - Loss of stormwater infrastructure capacity near the coast (impairment of gravity-fed systems) | City governments (Palo Alto, Mountain View, Sunnyvale, Santa Clara, San Jose) |
| | Groundwater Aquifers | - Saltwater intrusion into freshwater coastal aquifers | SCVWD; private entities |
| Storm events – localized flooding from increased intensity and duration rain events | Stormwater infrastructure | - Increased wear and/or damage to stormwater infrastructure from more turbidity / debris in floodwater | City governments |
| Warmer average temperatures (and extreme temperatures events such as heatwaves) coupled with seasonal precipitation change | Wastewater treatment plant and collection infrastructure | - Lower water volumes from warmer temperatures and shifts in precipitation means an effective increase in pollutant and waste concentrations | SCVWD; City governments |
| | Water supply plant and delivery infrastructure (e.g. pumps, pipes) | - Drier conditions as a result of warmer temperatures and precipitation shifts mean increased demand at the same time as a reduction in supply | SCVWD; City governments |
| | Reservoirs | - Increased temperature and evaporation causes greater net loss of stored water, coupled with lower supply / in-flow volumes | SCVWD |
| | Groundwater Aquifers | - Drier conditions as a result of warmer temperatures and precipitation shifts mean increased groundwater pumping and decreased recharge volumes, potentially resulting in land subsidence | SCVWD |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE WATER AND WASTEWATER SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Regional Climate Change Preparedness |
|---|---|---|---|---|
| Sea Level Rise and Storm Surge | Wastewater treatment plant and collection infrastructure; water supply plant and delivery infrastructure (e.g. pumps, | - Permanent or temporary inundation of coastal, low-lying treatment plants<br>- Inundation of below-ground pipes with corrosive saltwater | Yes | Medium |
| | Freshwater Aquifers | - Sea level rise-induced saltwater intrusion into coastal freshwater aquifers | No | None, but Parallel Efforts Exist |
| | Stormwater infrastructure | - Loss of stormwater infrastructure capacity near the coast (impairment of | No | None |
| Storm events | Stormwater infrastructure | - Increased turbidity and debris can tax and/or damage stormwater | No | None, but Parallel Efforts Exist |
| Warmer Average Temperatures, Extreme Heat Events, and Precipitation Changes (Annual and Seasonal) | Wastewater treatment systems | - Lower flows, and higher concentrations of water pollutants will require | No | None |
| | Water treatment systems | - Overall drier conditions, due to increased evaporation rates will increase demand for | No | None, but Parallel Efforts Exist |
| | Groundwater Aquifers | - Warmer temperatures and shifts in seasonal precipitation, may result in lower flows, increased | No | None, but Parallel Efforts Exist |

## Solid and Hazardous Waste

CLIMATE CHANGE VARIABLES AND IMPACTS RELEVANT TO THE SOLID AND HAZARDOUS WASTE MANAGEMENT

| Climate Change Variable | Assets/Services Affected | Nature of Impact |
|---|---|---|
| Changes in precipitation (riverine and localized flooding) | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to temporary inundation (open sites only)<br>- Deteriorated water quality due to leaked contaminants from sites (all sites) |
| Sea Level Rise | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to permanent inundation (open sites only)<br>- Deteriorated water quality due to leaked contaminants from sites (all sites) |
| Coastal Storm Surge | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to temporary inundation (open sites only)<br>- Deteriorated water quality due to leaked contaminants from sites (all sites) |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE SOLID AND HAZARDOUS WASTE MANAGEMENT

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Changes in precipitation patterns | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to temporary inundation<br>- Deteriorated water quality due to leaked contaminants from sites | No | None, but Parallel Efforts Exist |
| Sea Level Rise | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to permanent inundation<br>- Deteriorated water quality due to leaked contaminants from sites | No | None, but Parallel Efforts Exist |
| Coastal Storm Surge | Solid and hazardous waste facilities, Superfund sites, State response sites | - Loss of function due to temporary inundation<br>- Deteriorated water quality due to leaked contaminants from sites | No | None, but Parallel Efforts Exist |

## Transportation

CLIMATE CHANGE VARIABLES AND IMPACTS RELEVANT TO THE TRANSPORTATION SECTOR

| Climate Change Variable | Assets/ Services Affected | Nature of Impact |
|---|---|---|
| Sea Level Rise | All | Loss of function of multiple assets due to inundation, physical damage to multiple assets, corrosion/scouring of bridges, erosion of roads |
| Storm Surge | All | Loss of function of multiple assets due to inundation, physical damage to multiple assets, corrosion/scouring of bridges, erosion of roads |
| Changes in Precipitation (Riverine Flooding) | All | Physical damage to multiple assets, erosion of roads, temporary loss of function of bridges |
| Storm Events (Wind) | All | Temporary closure of roads, bridges, pedestrian/bike paths, airports, and rail services |
| Extreme Temperature Events | All | Buckling of rails, failure of electronic equipment, softening of road asphalt |

LEVEL OF CLIMATE CHANGE PREPAREDNESS EFFORTS IN THE TRANSPORTATION SECTOR

| Climate Change Variable | Assets/Services Affected | Nature of Impact | Existing Climate Change Preparedness Efforts? | Level of Climate Change Preparedness Efforts |
|---|---|---|---|---|
| Sea Level Rise | Multiple | Loss of function of multiple assets due to inundation, physical damage to multiple assets, corrosion/scouring of bridges, erosion of roads | Yes (for some Rail Transit) | Medium (for some Rail Transit)<br>Low (for all transportation types) |
| Storm Surge | Multiple | Loss of function of multiple assets due to inundation, physical damage to multiple assets, corrosion/scouring of bridges, | No | None |
| Changes in Precipitation (Riverine Flooding) | Multiple | Physical damage to multiple assets, erosion of roads, temporary loss of function of bridges | No | None, but Parallel Efforts Exist |
| Storm Events (Wind) | Multiple | Temporary closure of roads, bridges, pedestrian/bike paths, airports, | No | None |
| Extreme Temperature Events | Multiple | Buckling of rails, failure of electronic equipment, softening of road asphalt | Yes (for some Rail Transit) | Low |