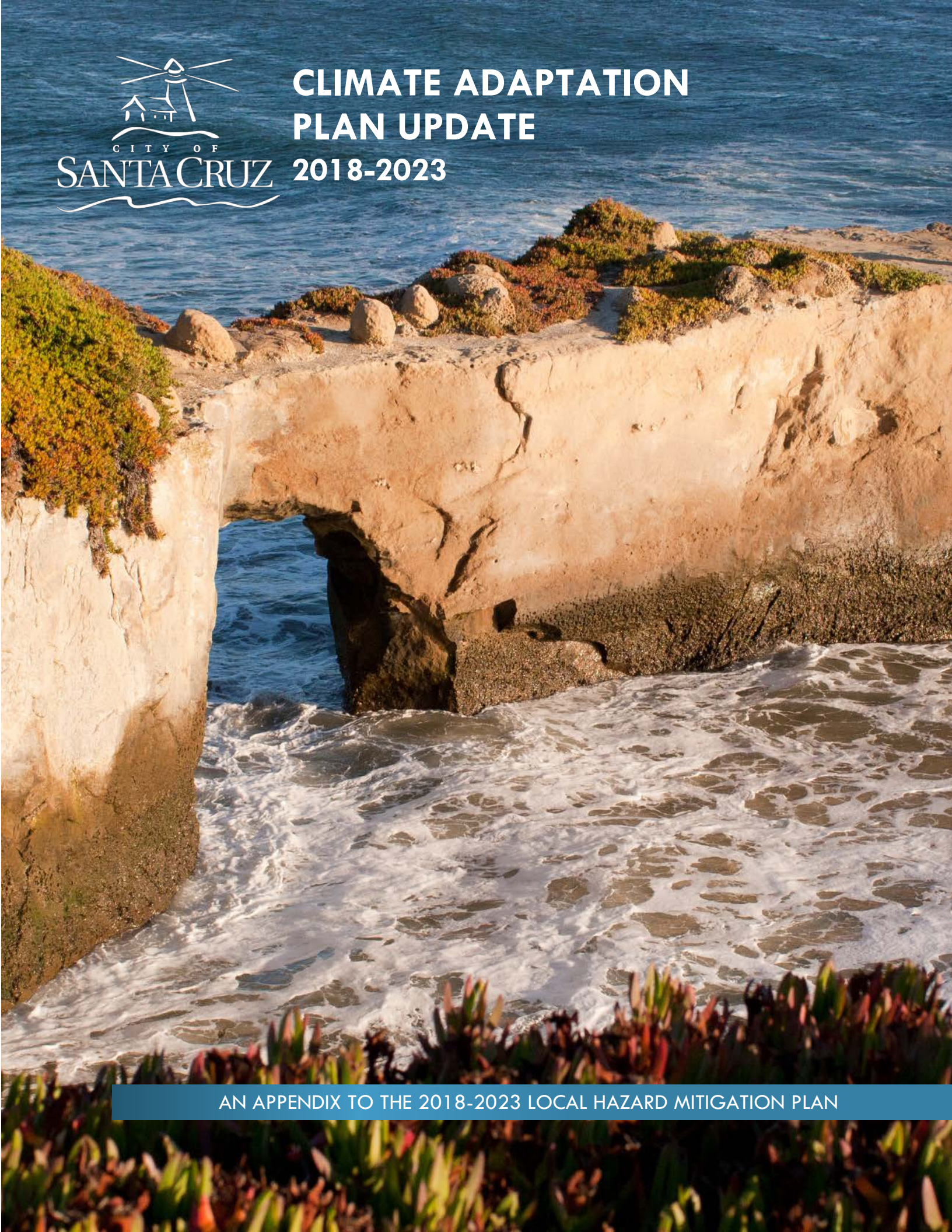
CITY OF SANTA CRUZ

CLIMATE ADAPTATION PLAN UPDATE 2018-2023



AN APPENDIX TO THE 2018-2023 LOCAL HAZARD MITIGATION PLAN

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CITY COUNCIL ADOPTION

RESOLUTION NO. _____

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF SANTA CRUZ ADOPTING THE LOCAL HAZARD MITIGATION PLAN FIVE YEAR UPDATE (2018–2023) AS APPROVED BY THE FEDERAL EMERGENCY MANAGEMENT AGENGY (FEMA) & THE 2018-2023 CLIMATE ADAPTATION PLAN UPDATE

WHEREAS, the City of Santa Cruz has experienced a number of devastating natural hazards prior to and since its incorporation in 1866, including floods, drought and the 1989 Loma Prieta Earthquake; and

WHEREAS, the City of Santa Cruz having developed a Local Hazard Mitigation Plan Five Year Update meeting the requirements of Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (as amended April 2013), and Section 322 (Mitigation Planning; 42 U.S.C. 5165) of the Disaster Mitigation Act of 2000; (DMA 2000) and

WHEREAS, the DMA 2000 requires all cities, counties, and special districts to adopt a Local Hazard Mitigation Plan, and to update that plan at least every five years as a condition of future funding for disaster mitigation from multiple FEMA pre- and post-disaster mitigation grant programs; and

WHEREAS, the City of Santa Cruz seeks to maintain and enhance both a disaster-resistant and resilient city reducing the potential loss of life, property damage, and environmental degradation from natural disasters, while accelerating economic recovery from those disasters; and

WHEREAS, City of Santa Cruz desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the City of Santa Cruz Local Hazard Mitigation Plan;

WHEREAS, the Climate Adaptation Plan Update builds upon the foundation, objectives and actions of the initial 2011 Climate Adaptation Plan and is consistent with the Emergency Operations Plan, the adopted Climate Action Plan and the 2030 General Plan Update; and

WHEREAS, the Climate Adaptation Plan Update has been reviewed by all relevant departments, boards and commissions, and is included as an appendix of the 2018 - 2023 Local Hazard Mitigation Plan approved by the California Emergency Management Agency and FEMA; and

WHEREAS, the draft Climate Adaptation Plan Update was reviewed by the City Council and the community at a City Council meeting on August 8, 2017 and was available for public comment and review between that date and September 1, 2018; and

WHEREAS, the Climate Adaptation Plan Update will contribute to building a more resilient Santa Cruz.

NOW, THEREFORE, BE IT RESOLVED that the City of Santa Cruz does hereby adopt the City of Santa Cruz Local Hazard Mitigation Plan Five Year Update (2018–2023) as an official plan in accordance with the federal Disaster Mitigation Act of 2000, thereby meeting the continued eligibility requirements for the potential receipt of hazard mitigation grant funds; and

BE IT FURTHER RESOLVED that the Santa Cruz City Council does hereby adopt the 2018 – 2023 Climate Adaptation Plan Update as both as appendix to the Local Hazard Mitigation Plan Five Year Update and as a stand-alone living document, pursuant to California Senate Bill 379.

BE IT FURTHER RESOLVED, that the City of Santa Cruz will submit this Adoption Resolution to Federal Emergency Management Agency Region IX Mitigation Division IX officials to enable the plan's final approval.

I HEREBY CERTIFY that the foregoing resolution was introduced, read and adopted at a regular meeting of the City Council on the 9TH day of August, 2018 by the following vote

Passed and adopted this __th day of _____, by the following vote:

AYES:

NOES:

ABSENT:

DISQUALIFIED:

APPROVED: _____
Mayor

ATTEST: _____
City Clerk

ACKNOWLEDGEMENTS

Santa Cruz City Council

David Terrazas, Mayor ▪ Martine Watkins, Vice Mayor
Sandy Brown ▪ Chris Krohn ▪ Cynthia Matthews
Richelle Noroyan ▪ Cynthia Chase

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EXECUTIVE SUMMARY

The scientific community has reached a strong consensus that the climate is changing, as identified in the City's first Climate Adaptation Plan (2011)[1]. Climate change impacts include threats not only to our infrastructure but to our health, safety and to the economic vitality of our community. Climate scientists agree that there are only three approaches to addressing the impacts of climate change: retreat, resist or ignore. There are different costs associated with each of these paths.

Incorporating climate resilience planning into all that we do as a city allows us to address some of these difficult decisions in advance and take advantage of potential opportunities to protect our residents, infrastructure and economic well-being. This Update to the City of Santa Cruz Climate Adaptation Plan (CAP Update) creates a framework for decision makers to build a more resilient and sustainable community, one that is informed by the most current climate science. The CAP Update is intended to remain a living document and assist the City of Santa Cruz in reducing the impacts of climate change by identifying and characterizing vulnerabilities, resources, information, and strategies for adaptation. Specifically, the CAP Update includes focus on:

- modeling and economically quantifying the impacts of sea level rise (SLR) at years 2030, 2060 and 2100;
- the addition of a social vulnerability score and related mapping;
- updated and improved data sources for the projection of other climate hazards and their impacts;
- describing progress made on adaptation strategies identified in original Plan;
- tailoring adaptation strategies around three time scenarios/time horizons; and
- identifying concrete next step actions that improve the utility of the CAP Update in increasing resiliency.

Surrounded by a greenbelt of open space areas and the Pacific Ocean, Santa Cruz is a compact, vibrant beach community that preserves the diversity and quality of its natural and built environments, creates a satisfying quality of life for its residents and attracts visitors from around the world. Its unique geography, from exposed Pacific Ocean cliffs to sheltered Monterey Bay beaches and coastal river running through its downtown and tourist-serving areas, is a part of its appeal, yet these features also increase its vulnerability to the impacts of climate change. Every aspect of the city — its economic prosperity, social and cultural diversity, scenic beauty and historical character — is threatened by potential impacts of climate change. While the exact time

[1] "Adaptation Planning — What U.S. States and Localities are Doing." *PEW Center on Global Climate Change.*

frame and severity of potential climate change impacts are uncertain, climate scientists agree that they will be significant.

The City of Santa Cruz has long been a leader in environmental sustainability and disaster recovery. Santa Cruz has extensive experience in preparing for and responding to disasters such as earthquakes, floods and drought. The community has come back from each experience stronger and better prepared for what lies ahead. We have not only recovered from these hazards but have strengthened our city by taking steps to avoid the impacts of these hazards should they occur again. As an example, our downtown corridor along Pacific Avenue was nearly destroyed by the 1989 Loma Prieta earthquake. The community rebuilt downtown to standards that make each building and the whole of downtown better prepared should another earthquake event occur. Hazard mitigation planning contributes to the protection of lives, property and the economic vitality of our city. The 1989 earthquake was devastating but it was also an opportunity to create a safer and more disaster resistant city. The elevation of our downtown area, visitor-serving facilities, neighborhoods and vital municipal infrastructure are within a few feet of sea level. Awareness of potential climate change impacts, especially SLR, and planning for such impacts, is critical for the future of Santa Cruz.

HISTORY OF ADAPTATION PLANNING

Climate change mitigation and adaptation planning was identified as a critical action item in the City's 2007 Local Hazard Mitigation Plan (LHMP, 2007). The Federal Emergency Management Agency (FEMA) reviews and approves LHMPs and requires an update on a five-year cycle in order to be eligible for certain hazard mitigation funding. In 2011, the LHMP was updated and included the 2011 Climate Adaptation Plan as an appendix. While both documents remain stand-alone living plans to be reviewed and progress updated annually, the CAP Update is also an appendix in the latest LHMP Update. Doing so, and integrating climate adaptation language, ensures the LHMP meets the requirements of California Senate Bill 379 (adopted in 2015).

The intent of this CAP Update is to identify and quantify our most significant potential climate change risks and vulnerabilities, and to revise our action plan in guiding current and future decision makers in protecting our natural and built environment, our residents and visitors, our economic base, and our quality of life. Having a well-researched CAP Update that draws on the latest science and condition of the City creates the opportunity for the City to apply for FEMA and other funding sources to address next step studies and identified adaptation priorities.

In 2011, FEMA grant funding was used to contract Dr. Gary Griggs, Director of the Institute of Marine Sciences, and Dr. Brent Haddad, Professor of Environmental Studies and Director of the UCSC Center for Integrated Water Research, to co-author the first Climate Adaptation Vulnerability Study. That study, City of Santa Cruz Climate Change Vulnerability Assessment, identified climate change impacts for which the community should prepare.

In 2017, vulnerability assessments[2] were updated by city staff (for the non-coastal impacts) and Central Coast Wetlands Group (CCWG) was contracted to conduct the City's first Sea Level Rise

[2] See Appendices D and E.

Vulnerability Analysis. CCWG's three key objectives were intended to further City planning for the likely impacts associated with sea-level rise (SLR) by:

1. Identifying critical coastal infrastructure (municipal, residential and commercial) vulnerable to SLR and estimating when those risks may occur;
2. Identifying specific hazards (coastal flooding, sea level rise, erosion) that pose risks to various infrastructure and the cost of potential infrastructure loss, and
3. Defining appropriate strategies for these risks.

Moreover, in a new and innovative piece to this CAP Update, the City partnered with the American Geophysicist's Union Thriving Earth Exchange to connect with Dr. Juliano Calil to assess social vulnerability to climate change. Dr. Calil worked with the City to compile social vulnerability scores and mapping for census blocks in the City. The social vulnerability scores, when overlain with the SLR impact hazard zones provide greater insight into appropriate adaptation strategies for those areas based on the drivers of social vulnerability in addition to geography. The concept of sustainability includes a community's environmental, social and economic health, infrastructure function, as well as disaster resilience. Traditionally, disaster resilience is viewed as preparation for sudden hazard events such as earthquakes or floods. This CAP Update expands disaster resilience to include climate change impacts which may occur now, gradually, or in the future as well as the public's exposure to these impacts. While the City is experiencing climate change right now, because many impacts are more gradual and longer term, we have the opportunity to prepare and to take advantage of opportunities to incorporate climate adaptation into our actions. The original Plan established specific Goals and Objectives for the City of Santa Cruz to adapt to climate change impacts while maintaining the community's environmental, social and economic health; those goals and remain current and unchanged. >>>

CLIMATE ADAPTATION GOALS

1. Protect the unique character, scenic beauty and culture in the natural and built environment from being compromised by climate change impacts
2. Support initiatives, legislation, and actions to respond to climate change
3. Build resilience into all programs, policies and infrastructure
4. Encourage climate change resilience planning and actions in private companies, institutions, and systems essential to a functioning City of Santa Cruz
5. Encourage community involvement and public-private partnerships to respond to potential climate impacts
6. Ensure that Santa Cruz remains a safe, healthy and attractive place with a high quality of life for its residents, businesses and visitors

Ten new objectives were developed for the Climate Adaptation Plan Update as presented in Chapter 4. City Council's strategic two-year work plan (FY 18 and FY 19) informs and supports the goals and objectives presented in the CAP Update. Moreover, the CAP Update is included in the City Council Work Plan as a featured Programs and Operations Spotlight focus area.

GENERAL PLAN GOALS RELATED TO CLIMATE ADAPTATION

General Plan Natural Resources and Conservation (NRC) Goal 4: Effective leadership and action in reducing and responding to global warming

NRC 4.3 Support initiatives, legislation and actions for reducing and responding to climate change.

NRC 4.4 Encourage community involvement and public-private partnerships to reduce and respond to global warming.

NRC 4.5 Minimize impacts of future sea level rise.

NRC 4.6 Take early action on significant and probable global warming, land use and development issues, including those that arise after 2025.

The City is also working to prepare an Administrative Draft of the Local Coastal Program (LCP) Update to include SLR policies and submit to the California Coastal Commission. Proposed policies relating to climate change and sea level rise are expected to be updated from the existing LCP policies reflecting more recent mapping, more current SLR assumptions, and incorporating statewide guidance for these topics. The LCP update will also seek to implement many of the Climate Adaptation strategies identified herein. The vulnerability assessment scenario analysis and adaptation strategies defined herein are consistent with the California Coastal Commission's Sea Level Rise Guidance (adopted in 2015 and updated in 2018)[3]. The LCP Update will also be consistent with this document and the California Coastal Commission's Draft Residential Sea Level Rise Guidance.

SUMMARY OF VULNERABILITY ASSESSMENT FINDINGS

While the magnitude of total damage cannot be quantified with this vulnerability assessment for any of the planning horizons, this assessment does identify the 2016 property and infrastructure "in harm's way," which will serve as the foundation for adaptation planning purposes. Within the combined hazard zones, coastal storm flooding is the primary hazard placing property and infrastructure at risk. Although armoring may prevent impacts associated with coastal erosion, in many areas the models suggest this infrastructure will not protect property from wave overtopping during coastal storm events.

For the baseline year of 2010, it is estimated that 63 existing buildings, including several critical City facilities, are vulnerable to the combined hazards of sea level rise and another 128 are managed or protected by current infrastructure. Moreover, over ½ mile of existing roadways, sanitary sewer, storm pipes and water mains are vulnerable. Substantial existing wetlands, habitat, coastal trails and access points and beaches are also vulnerable to the combined effects of sea level rise. For instance, SLR will result in a "coastal squeeze," causing beaches and other habitats to be squeezed and eventually lost as sea levels rise if armoring and other development

[3] In preparation for the LCP Update recertification, the City's progress on addressing SLR in LCPs per the Coastal Commission's SLR Guidance is as follows: steps 1 through 3 are complete, steps 4 and 5 are in progress, and step 6 is pending submission and recertification.

act as barriers to the natural inland migration of these habitats. A majority of California's coastal habitat area, like beaches, rocky intertidal, and estuarine marshes, are highly vulnerable to sea level rise since they exist in narrow bands at the land-sea interface, and will be strongly affected by the potential for shoreline retreat. Many patches of these coastal habitats will not be able to move inland in response to sea level rise, due to topography or the presence of the built environment (e.g., roads and other development).[4]

Furthermore, the "coastal squeeze" will have significant impacts on public resources such as access points to, and recreation at, beaches in Santa Cruz. A rise of two feet in sea level will start to have impacts on the sea wall to the rear of Cowell and Main beaches. Over 30 access points within city limits are exposed and vulnerable to sea level rise, and approximately 20 surf breaks, located within city limits, are projected to be impacted by rising sea levels. Cowell Beach is threatened by accelerated loss of sand; West Cliff by loss of surf quality and accelerated loss of cliffs; and East Cliff by accelerated loss of cliffs and loss of coastal access point. It is possible that the location of Cowell Beach surf break will migrate shoreward at a rate commensurate with rising sea levels since it overlies a sandy bottom; however, this likelihood decreases as rates of SLR increase. It further decreases as human interventions detrimentally impact natural coastal processes (e.g., shoreline stabilization prevents upland migration of beach environment and reduces sediment replenishment in the nearshore). In the case of Steamer Lane and many other breaks along West Cliff—which overly hard rock reef—the potential for break migration is very low. As such, these surf breaks face a high risk of extinction due to SLR, projected to occur between 2030 and 2060.

While sea levels are modeled to reach specific levels in the following three time horizons evaluated, these time horizons serve to create an envelope of impacts and should only be used as general guidelines for planning purposes. As SLR rates continue to increase and models become more accurate, SLR should be periodically monitored and observed, and projected changes should be incorporated into future Plan Updates.

2030 PLANNING HORIZON (OR 4 INCHES OF SLR)

Cumulative risks of coastal climate change on City of Santa Cruz public and private infrastructure for 2030 are projected to be significant. More than 70 buildings are projected to be at risk of impact (many from periodic coastal flooding) and more than 40% of these properties are private residences. Approximately 0.6 miles of roadway is projected to be at risk of flood and erosion damage as well as more than 2 miles of water, wastewater and storm drain pipe infrastructure. More than three times as many buildings (214) are protected or managed from predicted hazards by levees, water control structures, and storm pumps. Some critical City facilities are projected to be vulnerable and one of the three emergency services buildings are identified to be at risk from coastal climate change through 2030.

- Most of West Cliff and East Cliff are protected by sea walls and rip rap, mitigating much of predicted erosion hazards.

[4] Heady, Walter et al. *Conserving California Coastal Habitats: A Legacy and a Future with Sea Level Rise*. The Nature Conservancy and Coastal Conservancy.

- New sea walls may need to be constructed for portions of West Cliff and East Cliff where no structures currently exist if maintaining the same level of service (auto, bike and pedestrian) along the coast is a priority.
- Storm flooding is predicted in the socially vulnerable Beach Flats area (which includes the Boardwalk) due to waves overtopping the coastal infrastructure on Beach Road, but impacts are assumed to be managed by current storm water pumps along the San Lorenzo River levee.
- SLR over this century will directly impact the Santa Cruz Beach Boardwalk which is adjacent to Cowell and Main Beaches
- Parklands on Bethany Curve are projected to be prone to storm flooding.
- Acreage and tidal duration of availability of City beaches is projected to decrease.

2060 PLANNING HORIZON (OR 28 INCHES OF SLR)

Initially, for the purposes of this assessment and to identify the potential magnitude of impacts, it was assumed for the 2060 planning horizon that coastal armoring and water control structures will no longer function as designed without upgrades or replacement. However, as the Planning Team evaluated the findings of the Vulnerability Assessment, it was determined that a second 2060 scenario should be included that assumed that coastal armoring and water control structures will be upgraded to function as intended through the 2060 planning horizon.

By 2060 275 buildings are projected to be vulnerable to climate hazards within the City. An additional 28 properties (including 24 homes) are projected to be vulnerable to erosion if maintenance and management of existing protective structures is not maintained. Approximately 250 more buildings would be vulnerable if existing levees and storm pump infrastructure failed to function. Many of the 275 buildings that remain vulnerable are at risk of impacts from coastal flooding that current coastal structures are not designed to guard. More than 5 miles of roadways are projected to become vulnerable as well as 11 miles of water, wastewater and storm drain pipes. Additional park lands are projected to be at risk as well as 28 coastal access locations.

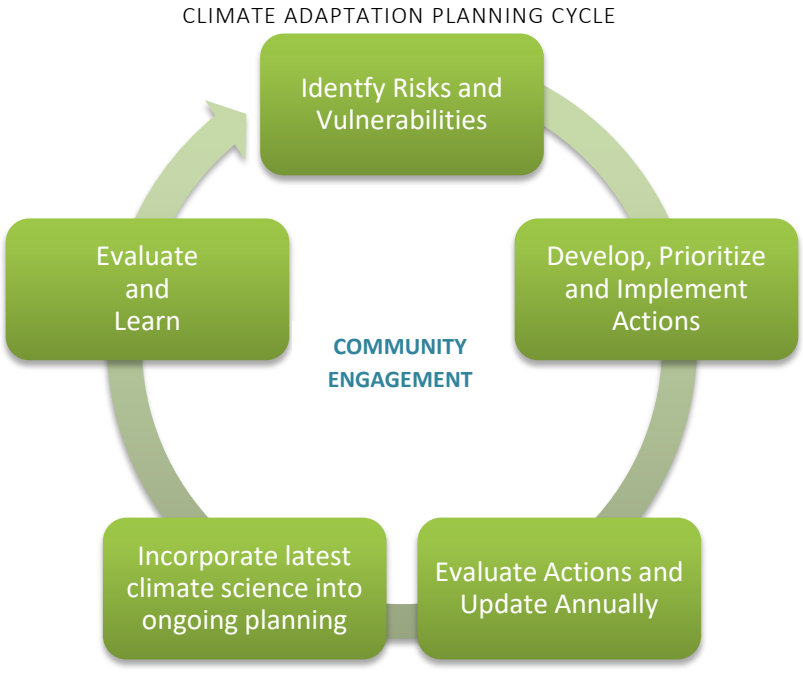
2100 PLANNING HORIZON (OR 68 INCHES OF SLR)

While 2100 is a distant time horizon, as noted in *Rising Seas in California, an update on sea-level rise science* (Griggs *et al*, 2017), it is increasingly important to plan for long range sea level rise. "Consideration of high and even extreme sea levels in decisions with implications past 2050 is needed to safeguard the people and resources of coastal California" (Griggs *et al*, April, 2017). By 2100, 390 residential and 65 commercial properties within the City of Santa Cruz are located within the hazard zones for predicted coastal climate change. Whether current or upgraded coastal protective structures can be built to protect these structures is uncertain. More than 500 additional buildings are within hazard zones currently protected or managed by storm water pumps and levees. Almost 7 miles of roadway and 16 miles of water, wastewater and storm drain pipes are at risk, and larger portions of all other land uses are projected to be vulnerable to climate change by 2100. More than 50 public buildings, 26 coastal access locations and 58 acres of sensitive habitat are projected to be at risk by 2100.

The SLR vulnerability assessment confirms that coastal erosion along West Cliff and East Cliff will be a continuing challenge for the City of Santa Cruz. Much of the most vulnerable coastal infrastructure is owned and operated by the City. Establishing sound coastal adaptation and protection policies early will likely best enable the long-term implementation of these policies and ensure long term sustainability for the community. The economic exposure of current residential, commercial and municipal buildings and infrastructure are contained in Chapter 3.

CLIMATE ADAPTATION STRATEGY

Climate adaptation requires ongoing actions by individuals, businesses, and government. This CAP Update identifies 41 Climate Adaptation strategies originally developed in 2011 and further refined in 2017 to adapt our community infrastructure, businesses and neighborhoods to potential climate change impacts, and to prepare for changes to natural resources that impact our community. The City's overall strategy will be a mix of hard infrastructure, green-grey infrastructure, and policies tailored to prepare residents to plan for and mitigate impact severity. It is crucially important that while the City continues its focus on climate adaptation that we also continue to aggressively reduce greenhouse gas emissions that cause climate change and provide strong encouragement and incentives to the community to do so.



CHAPTER 1
INTRODUCTION

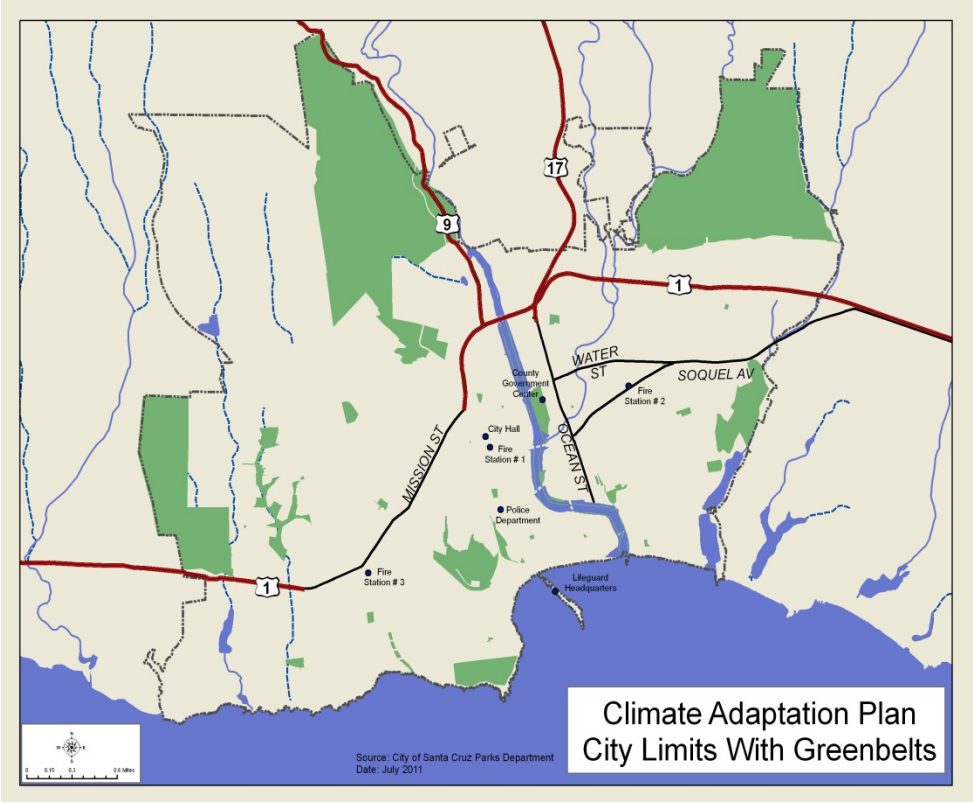
BACKGROUND, DEVELOPMENT TRENDS, COMMUNITY PROFILE AND CRITICAL STRUCTURES

People and property in Santa Cruz are at risk from a variety of hazards that have the potential to precipitate widespread loss of life as well as damage to property, infrastructure and the environment. Some hazards are natural and unpredictable, such as earthquakes. Whereas others are natural hazards exacerbated by land use decisions, such as building along cliff edges and development within floodplains. Natural hazards can inflict damages and hardships for an entire community for many years following the event.

Significant flooding, drought, earthquakes, storm induced landslides, and cliff erosion have occurred in the City within the last fifty years.

Earthquakes have caused the greatest amount of damage in the recent past. However, one of the greatest emergent threats to our community, first identified in the 2007 LHMP, are those impacts related to climate change.

FIGURE 1.1: CITY LIMITS WITH GREENBELTS



Climate change impacts include sea level rise (SLR) — which will exacerbate coastal storm events, cliff erosion, and flooding — drought, ocean acidification, extreme storms, extreme heat, saltwater intrusion, and increased risk of wildfire. The science surrounding climate change continues to improve and the impacts of unabated anthropogenic emissions are imminent. The City of Santa Cruz reaffirms its commitment to both reduce its emissions to mitigate climate

change and to build adaptive capacity into policies, plans, programs and infrastructure as well as incorporating systems to view decisions through a climate lens.

FIGURE 1.2: CITY LOCATION WITHIN CALIFORNIA

Efforts to address changing climate conditions generally fall into two categories: *mitigation* and *adaptation*. Mitigation refers to actions that reduce the overall magnitude or rate of long-term climate change by reducing the concentration of greenhouse gases in the atmosphere. Primary sources of greenhouse gas emissions include the combustion of fossil fuels and deforestation. Adaptation refers to actions that lessen the impacts or protect people and nature from the impacts of climate change.[5] For the purposes of this document, *climate resilience*, or the ability of communities to predict, prepare, and respond to change in a positive manner, is used interchangeably with adaptation.

The purpose of hazard mitigation is to implement and sustain actions that reduce vulnerability and risk from hazards, or reduce the severity of the effects of hazards on individuals, communities, and property. Mitigation actions include both short-term and long-term actions that reduce exposure to and/or impacts of hazards through various means including preparedness, policy and infrastructure decisions, and response and recovery measures. Effective mitigation planning will also reduce the adverse impacts and cost of impacts from other future disasters.

The purpose of adaptation in mitigation of climate change impacts is to anticipate the adverse effects of climate change and take appropriate action to prevent or minimize subsequent damage. Adoption of adaptation policy will also allow governments to capitalize on mitigation they can implement, and take advantage of opportunities that may arise. Well-planned, early adaptation action saves money and lives. Some examples of adaptation measures include: increased conservation of scarce water resources; adoption of building codes that can accommodate future climate conditions and extreme weather events; building flood defenses such as raising dikes; developing drought-tolerant crops; selection of tree species and

[5] Geos Institute. 2018. *Climate Ready Communities: A Practical Guide to Building Climate Resilience.*

implementation of forestry practices that decrease vulnerability to storms and wildfire; and setting aside land corridors to help species migrate.

The original Climate Adaptation Plan (2011) was drafted as an update to the 2007 LHMP and references strategies that plan to reduce or prevent risks as hazard mitigation actions. To maintain consistency with current terminology used in discussion of climate change issues, we reference such actions as *climate adaptation strategies*.

The City of Santa Cruz developed the 2007 LHMP to create a safer and more sustainable community. This Climate Adaptation Plan Update is a continuation of that commitment through an analysis of the projected hazards and the steps necessary to reduce the risks from climate change impacts. The CAP Update serves as a guide for decision-makers as they commit resources to building a climate resilient community.

COMMUNITY VISION

The City of Santa Cruz General Plan 2030 Safety Element provides the direction and resources to help reduce death, injuries, property and environmental damage, as well as direction and resources to reduce the economic and social dislocation resulting from natural hazards — including impacts of climate change. The General Plan informs the 2018-2023 LHMP Update, the Climate Action Plan (adopted in 2012), the Local Coastal Plan Update (currently underway), and this CAP Update. These Plans are intended to work in unison to support the broader vision and values of the community as reflected in the vision statement for the General Plan.

COMMUNITY BACKGROUND AND DEVELOPMENT TRENDS

Because most of the City is urbanized and has limited vacant parcels, it can be a challenge to completely curtail development within areas threatened by floods or SLR. The core of the downtown and visitor serving areas are both located in a flood plain and are low-lying in relation to sea level. While we may not be able to fully retreat to a location that is not threatened by the impacts of climate change (including SLR) we can incorporate climate science into development decisions that build resilience to current and future climate related impacts.

Santa Cruz is the largest city in Santa Cruz County and serves as the County government seat. Since its founding, the City has been the urban center of the County, providing employment and commercial, governmental, social, educational and cultural services to the larger area. Additionally, the establishment (1964) and growth of the University of California at Santa Cruz has reinforced the City's role as a major social, scientific and cultural center.

Santa Cruz is a compact city with an urban central core, circumscribed by designated open space and endowed with a diverse natural and built environment. Located between the Pacific Ocean and the Santa Cruz Mountains, the City is bounded to the south by the Monterey Bay. Public and privately-owned agricultural, natural areas, parks, and coastal recreation areas form a greenbelt of open space along the City's western, northern and eastern boundaries. These areas give definition to the City and serve as barriers to the further expansion of urbanization.

The City limits enclose approximately 12 square miles. At present, the City's population is nearly 65,000 residents. Employment is expected to rise from 37,076 to 42,546 jobs between 2010 and

2030. The City exercises zoning control and provides public services including refuse, parks, police and fire protection, as well as water and wastewater treatment services to City residents with some services covering populations in the surrounding area. Decisions impacting infrastructure along with water and wastewater services and infrastructure impact City residents as well as 30,000 to 60,000 additional customers outside City limits.

To preserve and build upon the City's sense of place and environmental character, the General Plan 2030 stipulates that growth will be accommodated by densification of residential, commercial and industrial development on lands within existing City boundaries. The Pacific Ocean and publicly-owned open space as well as agricultural and natural areas will be preserved to define and contain urban development.

The General Plan 2030 map (Appendix F) of land use designations includes the location and intensity of uses throughout the city's planning area. Land use designations for these areas include ground floor commercial with upper residential and densities ranging from 20.1 to 40 units per acre and up to 55 units per acre if certain conditions are met. In addition to land within the city limits, the planning area includes park land and agricultural/grazing land north of the City in the unincorporated area.

The General Plan 2030 envisions residential and commercial intensification along the major street corridors (Water Street, Soquel Avenue, Mission Street and Ocean Street) through private and public redevelopment of opportunity sites. The Plan also encourages intensification in the downtown area, including the Front Street corridor and lower Pacific Avenue. Post-recessionary economic recovery is on the rise with the development trend for the City increasing.

Employment and population projections prepared by the Association of Monterey Bay Area Governments (AMBAG) for the City estimate a 2030 population of 73,375. Most, if not all, growth will occur via infill development of vacant and underutilized parcels throughout the City.

COMMUNITY PROFILE

The city is nearing 65,000 residents in population and is the county seat. Situated as the northern edge of the Monterey Bay, it is about 32 miles south of San Jose and 75 miles south of San Francisco. Santa Cruz is known for its moderate climate, natural environment, coastline, and redwood forests. It is also home to the University of California Santa Cruz (UCSC), a premier research institution and educational hub, as well as the Santa Cruz Beach Boardwalk, an oceanfront amusement park operating continuously since 1907. Santa Cruz's parks, beaches, recreation, historic and cultural attractions make Santa Cruz a prime tourist destination. As home to the Monterey Bay National Marine Sanctuary, UCSC's Long's Marine Lab and the new Marine Science Campus, the bay, beaches and coastline are appreciated by the community and visitors alike as valuable natural and key economic resources. Proximity to the coast also increases exposure and vulnerability to the impacts of climate change and extreme storm events. Further evaluation of climate change's impact on tourism and other beach loss is a near-term next step to enhance the scope of this Plan Update.

COASTAL GEOLOGICAL SETTING

The City of Santa Cruz has two primary types of ocean front geologic features: coastal bluffs and coastal lagoons. Coastal bluffs include the exposed bluffs along West Cliff Drive and the bluffs of Seabright Beach, subtended by a wide beach created by completion of the Harbor jetties. Coastal Lagoons include low-lying area where waterways meet the ocean. The largest of these is Main Beach, formed by the San Lorenzo River Mouth. The Harbor is another coastal lagoon. According to the Coastal Commission's shore development typology groups[6], the City's development can be classified as urban bluff-top and urban beachfront.

NATURAL HAZARDS

Natural hazards that have affected Santa Cruz in the past may impact the community in the future, can be identified with a high degree of probability. These include erosion, flooding, landslides, and protracted drought. With a lower frequency, Santa Cruz has also experienced damage from wildfire, earthquake and tsunami. In 2011, climate change was added to the list of potential hazards that threaten Santa Cruz. Building a resilient community in the face of climate change requires acceptance of a certain degree of uncertainty in both the timing and severity of those hazards. With this CAP Update, the City takes a great step forward in placing some geographic and temporal boundaries around that uncertainty. Yet, as a community it is important that we consider the range of potential impacts from climate change on our services, infrastructure and quality of life. Flooding, drought, earthquakes, cliff erosion and beach loss have all occurred in the City within the past thirty-five years and will continue to occur in the future. These impacts will generally be exacerbated by changes to the climate.

Given our current understanding of climate science and awareness of our own history, we know that climate change impacts are occurring and will continue to occur whether anthropogenic emissions are mitigated or not. While in the 2011 Plan, information was incomplete on the timing and severity of potential impacts, this latest CAP Update, and associated SLR vulnerability assessment use California Coastal Commission guidance to project impact hazard zones at a baseline year (2010) and three time horizons (2030, 2060 and 2100). In addition to the geographic extent and timing of these climate-induced hazards, we also identify *who* may be impacted by these hazards through social vulnerability scoring. This method of hazard characterization improves policy and investment decision-making, allowing us to ensure equitable resilience building across all sectors and for our community. Additionally, through the social vulnerability scoring, we are prioritizing climate justice (as outlined in the Safeguarding California Plan: 2018 Update) by deepening our commitment to addressing the systemic burdens that the City's most vulnerable populations bear, especially as climate change exacerbates these burdens. According to the Safeguarding California Plan, climate justice entails ensuring that the people and communities who are least culpable in the warming of the planet, and most vulnerable to the impacts of climate change, do not suffer disproportionately as a result of historical injustice and disinvestment.[7]

[6] California Coastal Commission. 2017. *Draft Residential Adaptation Policy Guidance*.
[7] California Natural Resources Agency. 2018. *Safeguarding California Plan: 2018 Update. California's Adaptation Strategy.*

This CAP Update is part of an ongoing process to evaluate climate-related risks to Santa Cruz and to establish an ongoing community dialogue to identify the most important steps to pursue in order to reduce our community's vulnerability to climate change impacts, based on the best scientific information available. The CAP Update team strongly advises city staff to annually update City Council and other stakeholders on the progress achieved on the CAP Update adaptation strategies, and when new scientific or economic evaluation has been completed.

HEALTH AND SAFETY

Public safety and well-being is a core goal of the current City Council. In addition to the more obvious threats of SLR and flood, the availability of water, energy, and food must also be considered when looking at potential climate impacts. For example, the Water Department has identified water portfolio diversification as a key action for building resiliency into City services. The City is continually exploring ways to reduce energy consumption and increase local renewable energy resources as well as stimulating similar actions in the private sector. Food availability is also a critical aspect of our community's long-term resilience.

Our vulnerable populations, the economically disadvantaged, homeless, non-English speaking, elderly and the infirm may have less adaptive capacity to climate impacts. The innovative social vulnerability scoring feature of this CAP Update will assist in engaging vulnerable populations with education and assistance in climate awareness and adaptation planning. The LHMP will also reference this piece as it plans for equitable distribution of services and emergency response.

ECONOMIC WELL BEING

There are fiscal costs associated with implementation of adaptation measures. Climate awareness and timely long term planning allow us to take advantage of subsidies and opportunities for cost effective implementation of adaptation measures that maintain services to our community. Proactive adaptation policy can also stimulate and subsidize public-private partnerships that build adaptive capacity. As a near term next step to this CAP Update, City staff are proactively seeking funding to conduct a comprehensive cost benefit analysis of the herein short and long term adaptation strategies versus a business as usual scenario.

The City's mild weather, proximity to several northern California metropolitan centers, along with its scenic and recreation resources make it a popular day and extended-stay recreation area. As a result, the population is subject to large seasonal variations due to an influx of visitors during summer months and other peak recreational periods. The City recognizes that climate change will impact coastal and City resources that visitors rely upon and may change the quantity and demographics of those visiting the City. Planning for potential impacts of climate change in Santa Cruz allows us to address the impacts on our visitor population as well as residents, student population, and workers within the community.

INFRASTRUCTURE AND CRITICAL STRUCTURES

The City of Santa Cruz and community members, with the guidance of scientists and state and federal resources, are working to continually refine the characterization of the risks posed by climate change and other threats to our natural and built environment. This CAP Update is intended to reframe and guide City planning, policy and investments with current scientific

information and regulatory guidance. In addition, adaptation strategies identified in this CAP Update can be implemented through the current Local Coastal Program update.

The built environment is comprised of many elements including infrastructure such as roadways and bridges, energy systems, water mains, sewer pipes, storm drains, flood control and buildings. Infrastructure based strategies which may include raising levees, relocating roadways, managed retreat of public lands, and vegetation management, are critical components in building resiliency. This CAP Update examines the resilience of our infrastructure such as our Wastewater Treatment Facility, roads and bridges, residential, commercial and municipal buildings—particularly in relation to SLR. Other climate hazards are also evaluated in this context in a less detailed fashion.

TYPES AND NUMBERS OF EXISTING BUILDINGS, FACILITIES AND INFRASTRUCTURE

City of Santa Cruz-owned infrastructure consists of the following elements:

- Wastewater Treatment Facility and sanitary sewer system
- Water Treatment Plant and North coast water intakes, other wells and water distribution system
- Loch Lomond Reservoir
- Bay Street Reservoir
- River levees
- Roads, alleys, curbs, paths
- Retaining walls
- Storm drains
- San Lorenzo River
- Creeks, open channels and culverts
- Water Street Bridge
- Soquel Avenue Bridge
- Laurel Street Bridge
- Highway 1 Bridge
- City Hall and related buildings
- Civic Auditorium
- Police station (serves as backup Emergency Operations Center)
- Fire stations (3)
- 25+ parks
- Extensive network of street trees
- 8 Solar Photovoltaic renewable energy systems
- Municipal Wharf including Marine Safety and Lifeguard Headquarters

FIGURE 1.3: STATE HIGHWAYS AND MAJOR ROADS

The City of Santa Cruz owns or leases approximately forty buildings. These buildings are used for various municipal purposes, including City government administration, providing essential and emergency services, recreation, cultural and performing arts. A list of City facilities is contained in Appendix B.

A large portion of the downtown developed urban core is located within the historic flood plain of the San Lorenzo River. In 2000-2001 the U.S. Army Corps of Engineers constructed a series of levee height increases which are designed to protect the City's downtown from flooding and eventually lead to FEMA certification. A future FEMA certification will allow the lifting of the mandatory flood insurance requirements in downtown. During the interim period FEMA has

designated downtown in its Flood Zone A-99 which allows continued construction but requires the purchase of flood insurance on all properties with federally insured loans. Following FEMA accreditation that the improved levees can protect the downtown and beach areas from a 100 year flood, the purchase of flood insurance becomes optional for the property owner. The improvements constructed by the U.S. Army Corps of Engineers are part of an overall City planned effort to protect the City from flooding and improve the habitat and environmental value of the San Lorenzo River. See the 2018-2023 LHMP Update[8] for more details. For reference, FEMA flood plain mapping is contained in Appendix D.

As identified in the 2011 Vulnerability Study and 2017 Sea Level Rise Vulnerability Assessment (Appendix D), the downtown area is threatened by SLR, particularly increased coastal storm events in conjunction with rising tides. Climate scientists predict more frequent, more severe storm events which have the potential for significant structural and financial losses. Structures in the existing FEMA mapped 100-year flood plain (excluding SLR impacts) include the following:

- 2,100 Structures (2,269 parcels)
- Central Fire Station
- Police Station
- City Hall
- Lifeguard and Marine Safety Headquarters
- County Government Center
- 40 schools and day care centers

CRITICAL STRUCTURES WITHIN THE COMMUNITY

Critical structures within the community include hospitals, County government buildings, post offices, City structures such as police and fire stations, and the Wastewater Treatment Facility. A full list is contained in Appendix A. The CAP Update includes evaluation of the potential impacts that climate change might have on these structures and the expected consequences of that impact. This allows us to make decisions that incorporate climate change science when investing in infrastructure projects. It also allows us to better react to climate events that are exacerbated by SLR such as extreme storm events. Maps in Appendix D show potential SLR and potential projected losses.

There are only four bridges across the river connecting the two sides of the community. Past experience has demonstrated that losing even one of these bridges in a disaster presents significant problems to emergency management services and traffic congestion. Most essential bridges have recently been replaced. However, the Highway 1 Bridge is in need of replacement. This bridge is the most critical to regional transportation and, as a debris catching obstacle, is considered a significant flood risk. Replacement of the Highway 1 Bridge has been identified as a very high priority.

[8] City of Santa Cruz. 2018. *Local Hazard Mitigation Plan: Five Year Update (2018-2023).*

ECONOMIC IMPACTS OF EXPOSED INFRASTRUCTURE

While this assessment includes an estimate of the potential dollar losses that might occur as a result of vulnerability to the impacts of climate change in Chapter 3, a critical next step to this CAP Update is a cost benefit analysis of the dollar losses that might occur under a business-as-usual scenario as compared to losses resulting from the implementation of the adaptation strategies identified. Coastal erosion and wildland fires have the potential to cause significant losses but the greatest threat to the community in terms of potential dollar loss is combined flooding and SLR. The Wastewater Treatment Facility appears to be the highest potential dollar loss when evaluated using current climate science. Portions of the downtown and tourist serving beach areas (including the beach itself) are also at significant risk.

CHAPTER 2
THE PLANNING PROCESS

PLAN DEVELOPMENT AND BACKGROUND

This Climate Adaptation Plan Update is intended to remain a living document and assist the City of Santa Cruz in reducing the impacts of climate change by identifying and characterizing vulnerabilities, resources, information, and strategies for adaptation. In addition, specific adaptation policies identified herein can be incorporated into the LCP which would then build those policies into all new development on a project by project basis through the coastal permitting process. Building on a tradition of progressive planning and sustainability efforts the City of Santa Cruz Climate Adaptation Team set out to update the Climate Adaptation Plan by focusing on:

- Updating all background, program, policy and infrastructure conditions from 2011.
- Updating the Plan along the same timeline as the 2018-2023 LHMP Update and ensuring both Plans are integrated on potential climate change impacts and mitigation/adaptation strategies.
- Conducting a Sea Level Rise (SLR) vulnerability assessment to identify and characterize the geographic and temporal extent of SLR impacts through mapping and quantification of potential loss.
- Conducting a social vulnerability analysis to identify socially vulnerable populations of the City and the drivers of their vulnerability.
- Identifying progress on adaptation strategies proposed in 2011.
- Identifying new adaptation strategies as informed by the SLR vulnerability assessment, social vulnerable analysis and other known hazard zones.
- Prioritizing all adaptation strategies and putting in action next steps for technical analysis and planning to implement the very high priority strategies
- Providing a framework for current and future decision makers to build adaptive capacity into all policies programs and infrastructure investments for the purpose of creating a resilient community informed by the best available scientific information.

CLIMATE ADAPTATION UPDATE TEAM

The Climate Adaptation Update Team included department heads and key staff from departments that would be responsible for identifying and implementing actions to build adaptive capacity. The CAP Update Team also serves as the LHMP Update Team, with the updates occurring concurrently. The City Manager's Office took the lead managing the CAP Update project and was assisted by the Public Works Department, Planning Department, Water Department, Fire Department, Economic Development Department, Parks and Recreation Department and Geographic Information Systems (GIS Division/Information Technology). The Team brings experience and builds consistency between the LHMP and the Climate Adaptation Plan Updates. The Team identified several external technical and stakeholders advisors to serve

as technical reviewers of the draft CAP Update, including local planning staff and SLR planning staff from the Coastal Commission.

FOUNDATIONS OF THE CLIMATE ADAPTATION PLAN UPDATE

In 2011, Drs. Griggs and Haddad reviewed the latest climate science to develop the City's first Vulnerability Assessment. This study provided a thorough background and snapshot of climate-induced vulnerabilities in a qualitative fashion. This study became the basis upon which the City developed its 2011 Climate Adaptation Plan. Responsible departments were actively involved in the development of the *goals, objectives* and *strategies* which, in turn, were based on potential risks identified in the Vulnerability Study. Where possible, actions were built upon departmental efforts already underway. Potential actions, including information related to required resources, environmental concerns and timelines, were defined and vetted by all departments and prioritized by Department Heads.

In 2016 the CAP Update Team identified the need for the most current climate science information on risks and vulnerabilities upon which to update the Climate Adaptation Plan along with a process to review and update information on climate change as it became available. Because new modeling techniques were available, a SLR vulnerability assessment was identified as the first requirement and the City contracted with Central Coast Wetlands Group at Moss Landing Marine Labs to perform the work. The Team leaders were also interested in incorporating environmental justice and social justice into the CAP Update and were connected through the American Geophysicist's Union Thriving Earth Exchange to Dr. Juliano Calil, an expert in coastal adaptation. Both groups conducted their work in close collaboration with the City between January and June, 2017. The timeline for the project is contained in Appendix I.

After completing both studies, the City compiled successful programs, projects and policies that were called for in the 2011 Plan as noted in Appendix H. The City also evaluated and incorporated recommended adaptation strategies. Prioritization of adaptation strategies was also informed by the Team's utilization and completion of FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental dimensions (STAPLEE) evaluation. During the final review process, it was determined that several strategies identified essentially similar measures, such as protecting infrastructure. Therefore, several strategies were combined and expanded to limit repetition. The 2011 list of strategies is available along with the 2017 STAPLEE evaluation in Appendix G. The final list of prioritized actions is provided in Chapter Four.

PUBLIC OUTREACH AND COMMUNITY PARTICIPATION

Public input during the development of the Climate Adaptation Plan Update included several modes of outreach. First, prior to beginning the Update process, the City conducted public information events and a community survey on the 2011 Climate Adaptation Plan and resident's experience with and preparedness for climate change related impacts. Appendix I contains the full project outreach details and the results of that survey where nearly 400 residents responded. This input assisted in shaping the CAP Update's strategies. Second, the draft CAP Update was made available to internal and external stakeholders for review and comment between June and July, 2017. Those comments were integrated into the Final Plan Update. Third, the draft CAP Update progress, including the findings from the SLR vulnerability

assessment and social vulnerability analysis, was presented to community members through a series of Advisory Body (commission and task force) meetings taking place in July through September, 2017 and then at a City Council meeting on August 8, 2017. The City Council meeting was broadcast live on Santa Cruz County Community Television.

Since the draft Plan Update was made public in the fall 2017, City staff presented the draft CAP Update progress to community groups and solicited feedback at over 50 public events. Public comments received throughout the process were incorporated into the final document. Strategy feedback from public outreach is included in Chapter 4, and the details of the Climate Adaptation Plan Update public involvement in bringing the draft Plan Update to finalization are included in Chapter 5.

COORDINATION WITH OTHER PLANS AND POLICIES

Implementation and monitoring of the CAP Update includes tracking the identified strategies that are to be implemented, as well as changes in day-to-day City operations, and continued refinement and updates to the Climate Adaptation Plan Update based on the best available scientific information.

The 2011 Climate Adaptation Plan was informed by the General Plan, the Climate Action Plan, Emergency Operations Plan, Urban Water Management Plan, the Santa Cruz Water Department's Water Conservation Plan, various City ordinances, zoning and building codes and the Capital Improvement Program (CIP). Staff involved in the 2018 CAP Update were asked to provide feedback as to continued consistency between these plans, programs and policies. Senate Bill 379 requires climate adaptation integration into the general plan process. Pursuant to SB 379, the City must integrate its vulnerability assessment, adaptation goals, policies, objectives and feasible implementation measures into the Safety Element of the General Plan and the Local Hazard Mitigation Plan by January 1, 2022. The Climate Adaptation Plan Update was prepared concurrently with the LHMP Five Year Update, yet there are separate climate adaptation and hazard mitigation strategies listed in each Plan Update. Thus a "crosswalking" was prepared to establish linkages and alignment between the two Plan Updates. The crosswalk matrix is included in Appendix J. Pursuant to the regulatory recommendations of the Coastal Commission, the climate adaptation policy strategies identified in this document and the LHMP can be incorporated into the current LCP update and then implemented on a project by project basis through the coastal permitting process.

CHAPTER 3
VULNERABILITY ASSESSMENT UPDATES & PROJECTED IMPACTS

BACKGROUND OF RISK ASSESSMENT AND VULNERABILITY

It is important for a community's risk assessment, adaptation and preparedness efforts to be founded on the most current climate science available, in order to determine the types and scale of potential climate impacts which may threaten the community. In the 2011 Climate Adaptation Plan, this section contained descriptions of those risks and vulnerabilities which may occur as a result of climate change and which are identified as potential threats to Santa Cruz. Other threats (not directly related to climate change) are identified in the 2017 LHMP Update and remain accurate, with the stipulation that flooding, wildland fires, drought and coastal erosion threats will all be exacerbated by climate change. These potential increased risks are addressed in this CAP Update with particular focus on the impacts of SLR and the concept of social vulnerability to climate related hazards. The Local Hazard Mitigation Plan and the Climate Adaptation Plan Updates together address all identified risks to the community and provide potential hazard mitigation actions and climate adaptation strategies that might be taken by the community to reduce those risks.

To update this Plan with the best available scientific data, the CAP Project Team added a SLR vulnerability assessment and social vulnerability analyses. Along with the impacts of non-coastal hazards from the 2011 Vulnerability Assessment, these analyses supply the foundation upon which we can continue to build our efforts to understand Santa Cruz's climate risks and vulnerabilities, and to identify potential actions that might be implemented to increase climate resiliency into our physical, ecological, and economic base. The following is a list of the potential impacts of climate change in our area. Each impact is further discussed below.

- SLR
- flood
- severe storm/weather events
- coastal erosion
- drought
- increased wildfires
- ocean acidification
- salt water intrusion
- increasing temperature
- food and fuel/energy availability
- coastal habitat loss
- altered ecosystems
- altered coastal access
- altered public trust resources

IMPACTS OF CLIMATE CHANGE

The 2011 Vulnerability Study and additional research by staff identified vulnerabilities related to the direct and indirect impacts of climate change. In Santa Cruz, SLR combined with changing precipitation patterns, including increased severe storm events and drought, are the greatest threats that we face as a community. In combination with changing temperatures and shifting seasons, these direct impacts lead to increased risks for wildfire, coastal erosion, and damages to community infrastructure, economy, human health and safety, and local ecosystems. Additional but less understood potential impacts include ocean acidification, salt water intrusion, and food and fuel availability. For the SLR scenarios evaluated, the closer the time period is to the present, the more accurate the projections. Less certainty is available for projections further into the future. Hence we have a fairly accurate understanding of the impacts to the City of Santa Cruz in 2030 but our understanding of potential impacts in the year 2100 is more uncertain.

SEA LEVEL RISE IMPACTS

Santa Cruz's coastal zone resources include the Santa Cruz Harbor, publicly owned and accessible beaches via dozens of coastal access locations, and valuable wetlands[9].

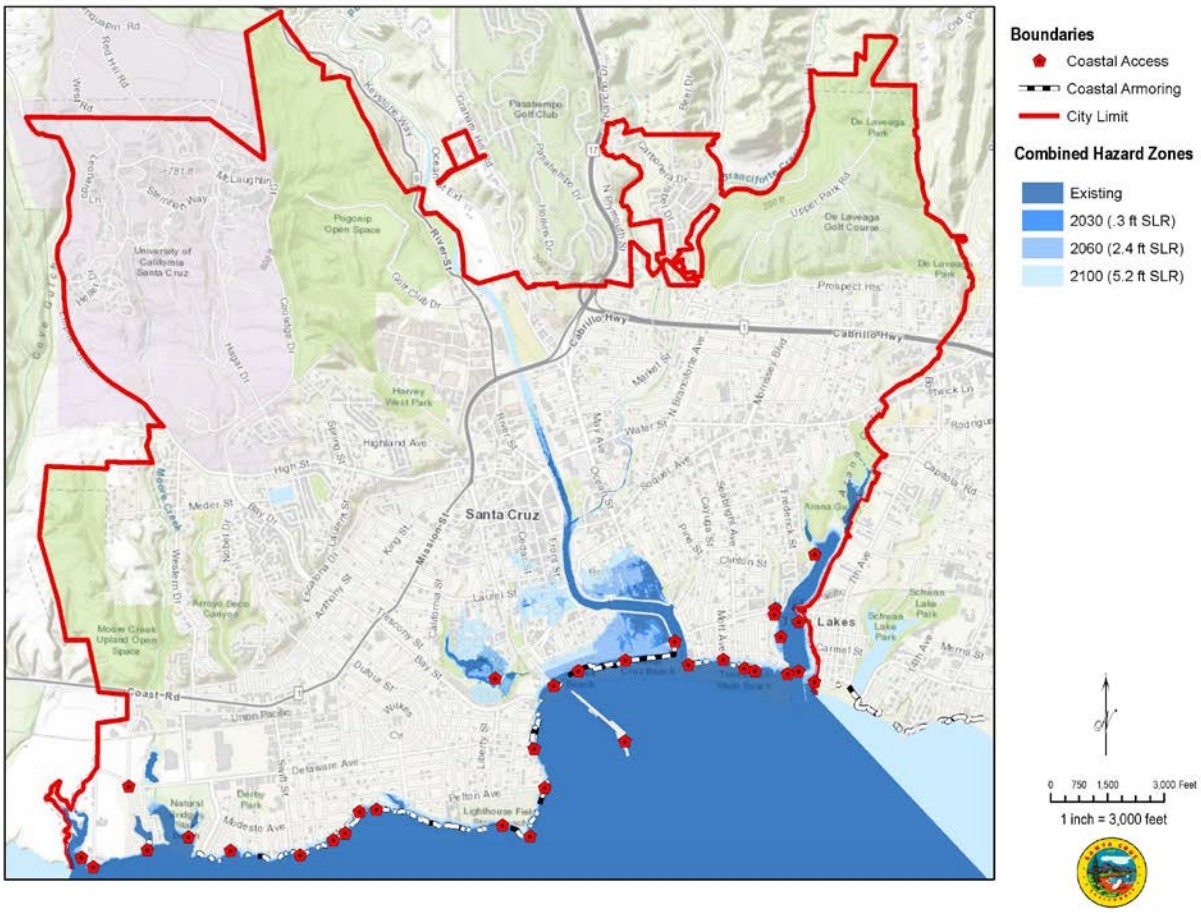
FLOOD AND SEVERE STORM EVENTS

Flooding and extreme storms pose similar risks in the City of Santa Cruz. Both are predicted to occur more frequently as a result of climate change and can combine synergistically with SLR. An increase in the intensity and amount of rainfall over short time periods can concentrate runoff and lead to more frequent or larger flood flows. Extreme coastal storms can create storm surge that increases tidal elevations and coastal flooding. Details of intense storm events combined with predicted SLR scenarios are described in the 2011 Vulnerability Study and at greater length in the 2017 LHMP. Intense storms are also associated with high winds, lead to soil saturation that exacerbates flooding, erosion, and tree fall. Sea level rise may currently contribute to rising and fluctuating groundwater at the Wastewater Treatment Facility.

Figure 3.1 depicts the coastal storm flood hazard zones (i.e., 100 year storm) for the 2010 baseline year as well as for the 2030, 2060 and 2100 planning horizons. It is important to note that the impact of river storm flows was not analyzed in the City's SLR assessment, thus impacts are likely underestimated; however, analyzing, integrating, and mapping climate-influenced hydrology is currently underway. Figure 3.1 also depicts how flooding impacts coastal access points.

[9] California Coastal Commission. 2016. *Statewide Sea Level Rise Vulnerability Synthesis*. Appendix A. County Snapshots. Santa Cruz County.

FIGURE 3.1: COASTAL STORM FLOOD HAZARD ZONES (HAZARD ZONES INCLUDE AREAS THAT ARE CURRENTLY MANAGED BY PUMPS OR PROTECTED BY LEVEES)



COASTAL EROSION

Santa Cruz has experienced significant coastal erosion in the past. An increase in coastal storm frequency and/or magnitude are associated with increased wave forcing that can lead to high rates of beach and coastal bluff retreat and ensuing damage to oceanfront property and infrastructure.

Coastal armoring limits sand supply to beaches and winter storms resupply sand to pocket beaches through natural erosion processes. However, in Santa Cruz, the majority of beach sand comes from river sediment and not coastal bluffs. A 2005 meta-analysis of the interactions between beaches and coastal armoring structures[10] concluded while seasonal dynamics shift beach width throughout the year, in general active erosion had negligible difference in beach profiles between those protected by coastal armoring structures and those without. Instead, the study pointed to passive erosion as the primary problem that is inherent to California's coastal dynamics: beaches are eroding in front of armoring structures because the coastline is fixed at

[10] US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuaries Division. (2005). The Impacts of Coastal Protection structures in California's Monterey Bay National Marine Sanctuary.

that spot while adjacent beaches with no armoring structures are migrating landward. The 2011 Vulnerability Assessment describes the history and potential impacts as a result of this climate change impact on City of Santa Cruz cliff and beach frontage.

A large part of the City of Santa Cruz' economy is based on coastal recreation and tourism. There is also significant private property and municipal infrastructure at or near sea level. The City has a highly developed coastline that contains significant City-owned infrastructure including roadways, bicycle paths, parks, park facilities and a City museum. Private development along the ocean frontage includes private residences, hotels, and an amusement park.

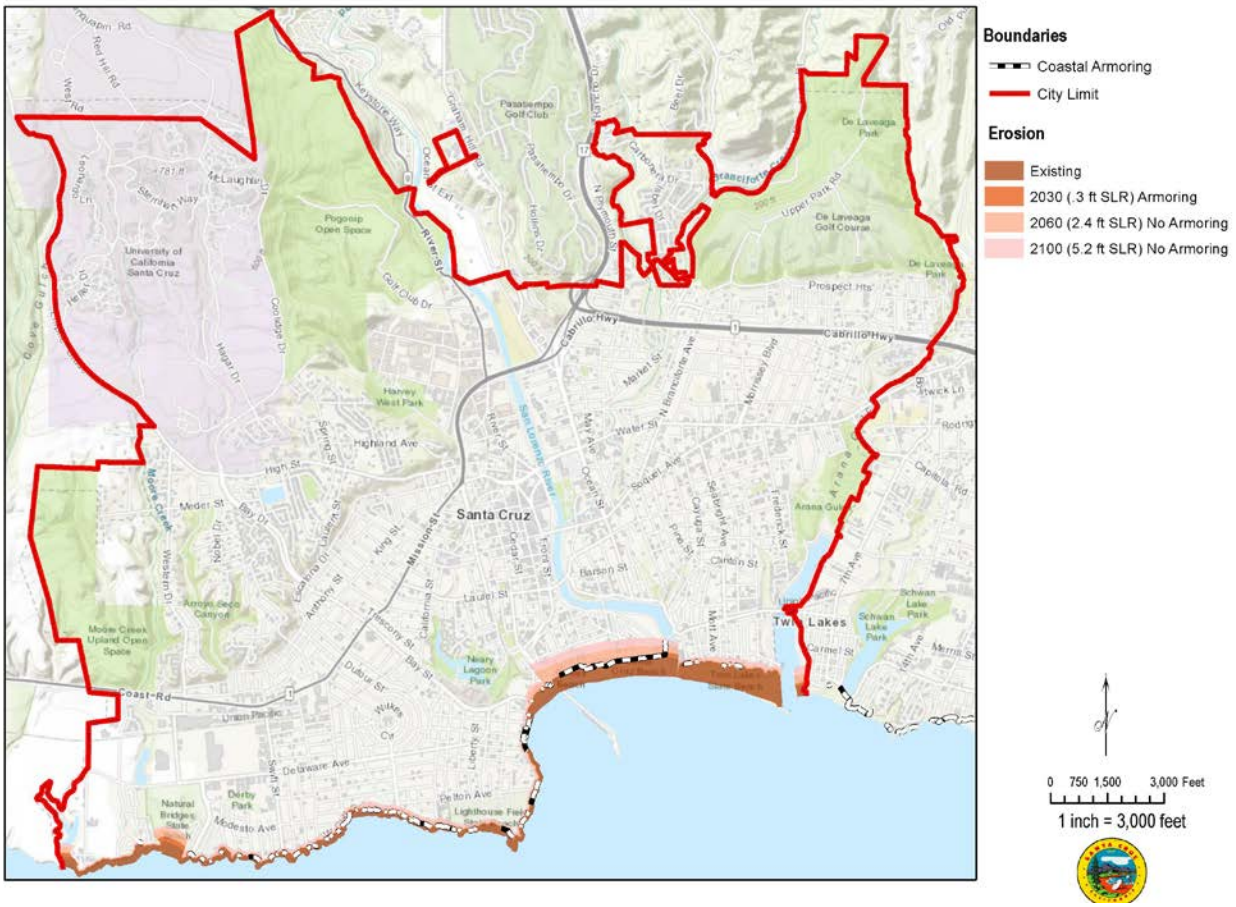
The Santa Cruz Harbor, beach frontage, and cliff frontage near the mouth of the San Lorenzo River are frequently subjected to erosion which is expected to be exacerbated by climate change. Protecting the natural resources of the area and preserving or relocating existing infrastructure, such as the lighthouse and bicycle path, are high priority objectives[11]. Main Beach in Santa Cruz is a principal recreational and tourism center. It is backed by a continuous concrete sea wall which protects the adjacent infrastructure. While coastal armoring along bluffs to prevent erosion contributes to loss of beach over time by restricting or limiting sand supply, it is unclear whether the sea wall's orientation to the beach does the same. Similarly, pocket beaches along West Cliff are protected by rip rap and sea walls; although this armament protects the eroding cliffs and infrastructure, it may contribute to loss of coastal access and beaches during the winter season. However, these beaches return in the summer months.

Localized, accelerated erosion that might occur because of interactions between armoring structures [including seawalls and riprap] and waves is referred to active erosion. This type of erosion includes scour at the base of a protection structure or on adjacent segments of shoreline, and changes in overall beach morphology.[12] Although, there is a perception that seawalls initiate active erosion and are detrimental to coastal environments, recent investigations have found that active erosion may not be as prolific as a problem as was once thought.[13] For instance, a recent study found that reflection of wave energy off of coastal armor generally does not cause changes in beach profiles or scour in front of the armor.[14] In addition, it was discovered that beach profiles in front of armoring retained the same amount of sand as non-armored beaches during storm events.[15] Furthermore, an eight-year study by Dr. Griggs on armored and non-armored beaches around northern Monterey Bay found that there were no significant differences in beach profiles in front of seawall versus rip rap. And, in contrast to the

[11] Protecting natural resources and preserving or relocating existing infrastructure along West Cliff will be further evaluated, the public consulted and will result in a West Cliff Drive Shoreline Adaptation and Management Plan (to be complete in 2020) to guide long term management of these assets and resources.
[12] U.S. Department of Commerce, Marine Sanctuaries Division. *The Impacts of Coastal Protection Structures in California's Monterey Bay National Marine Sanctuary*. February, 2005
[13] Ibid.
[14] Ibid.
[15] Ibid.

general sentiment that coastal armoring causes excessive erosion, there was no appreciable long-term active erosion caused by seawalls or riprap on the Monterey beaches.[16]

FIGURE 3.2: EROSION HAZARD ZONES



2018 SLR VULNERABILITY ASSESSMENT

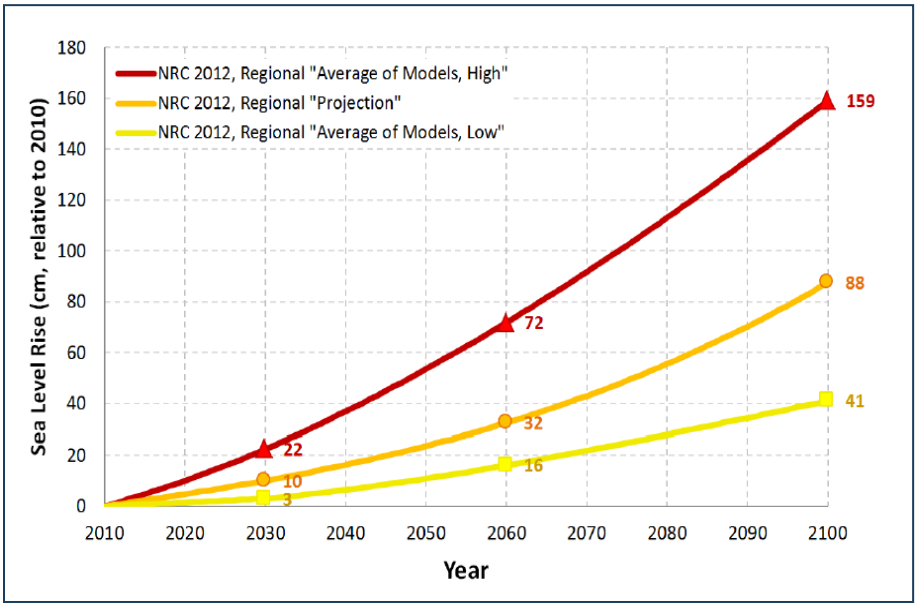
SLR projections are typically presented in ranges due to several sources of uncertainty such as the magnitude of future emissions and loss of sea ice among other sources. The *California Coastal Commission Guidance Document*[17] recommends evaluation of SLR impacts using a "scenario-based analysis." This method seeks to understand how SLR and other drivers interact to threaten health, safety, and resources of coastal communities. Briefly, "the best available science (currently the 2012 NRC report) is used to identify a range of sea level rise scenarios including high, low, and intermediate projections." Regional factors such as El Niño and extreme storm events that affect ocean levels, precipitation, and storm surge are then added to the

[16] U.S. Department of Commerce, Marine Sanctuaries Division. *The Impacts of Coastal Protection Structures in California's Monterey Bay National Marine Sanctuary*. February, 2005

[17] "California Coastal Commission Sea Level Rise Policy Guidance: Interpretative Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits." *California Coastal Commission*, 12 Aug. 2015.

model (Figure 3.3). For clarity, the SLR analysis focuses the hazard analysis on a subset of those scenarios, recommended by local and state experts (Table 3.1). Resulting sea levels are overlaid on geographic data including coastal elevation, infrastructure, and population information to produce hazard zones[18].

FIGURE 3.3: SEA LEVEL RISE SCENARIOS FOR EACH TIME HORIZON (FIGURE SOURCE: ESA PWA 2014)



The coastal climate vulnerability maps used for this study identify hazard zones for each climate scenario for the three planning horizons (2030, 2060, & 2100) under three different regional emissions scenarios (High, Medium, and Low). The resulting model allows planners to understand the range of impacts that may be expected and build an understanding of the overall risk posed by SLR.

The Coastal Commission recommends all communities evaluate the impacts of the highest water level conditions that are projected to occur in the planning area. Local governments may also consider including higher scenarios (such as a 6.6 ft. [2m] scenario) where severe impacts to Coastal Act resources and development could occur from SLR. In addition to evaluating the worst-case scenario, planners need to understand the minimum amount of SLR that may cause impacts for their community, and how these impacts may change over time.

CCWG's SLR hazard evaluation is intended to provide a predictive chronology of future risks to benefit local coastal planning and foster discussions with state regulatory and funding agencies. Estimates of the extent of assets at risk of various climate hazards were made using best available regional data. This approach allows planners to understand the full range of possible impacts that can be reasonably expected based on the best available science, and build an understanding of the overall risk posed by potential future SLR.

[18] SLR hazard zones were originally prepared by ESA through funding by the California Coastal Conservancy.

TABLE 3.1: SEA LEVEL RISE SCENARIOS SELECTED FOR ANALYSIS

Time Horizon	SLR Scenario	Notes
2030	med (10 cm or 4 in)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm)
2060	high (72 cm or 28 in)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)
2100	high (159 cm or 63 in)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)

The OPC's *State of California Sea-Level Rise Guidance Document* (Guidance Document)[19], initially released in 2010 and first updated in 2013, also provides guidance to state agencies for incorporating SLR projections into planning, permitting, investment, and other decisions. The 2013 Guidance Document was referenced in the City's Sea Level Rise Vulnerability Assessment. The *2018 Guidance Document Update*[20] was released after the completion of the City's Sea Level Rise Vulnerability Assessment and thus was not integrated into the CAP Update. The *2018 Guidance Document Update* reflects advances in SLR science and addresses the needs of state agencies *and* local governments as they incorporate SLR into their planning, permitting, and investment decisions.

One of the major changes made to the *2018 Guidance Document Update* is providing probabilistic SLR projections versus the scenario-based SLR projections of the 2013 OPC Guidance Document, as presented in Table 3.2. According to the *2018 Guidance Document Update*, the 2013 OPC Guidance was based on scenario-based sea-level rise projections from the 2012 National Research Council report, which produced a set of three scenarios (low, central, and high), with greater weight given to the central scenario. These scenario-based projections were partially but not fully tied to specific emissions scenarios presented in the Intergovernmental Panel on Climate Change's Fourth Assessment Report and do not include a likelihood of occurrence.

Subsequently, in 2013, the IPCC Fifth Assessment Report adopted a probabilistic approach and produced estimates of the likely range of global sea-level rise under different emission scenarios, where 'likely' covers the central 66% of the probability distribution (i.e., the sea levels that fall within the range created by the value that is 17% likely to occur and the value that is 83% likely to occur). The IPCC Fifth Assessment Report did not estimate sea-level rise outside these central 66% probability ranges or produce local projections for California. The *2018 Guidance Document Update* thus incorporates probabilistic sea-level rise projections, which associate a likelihood of

[19] State of California Ocean Protection Council. *State of California Sea-Level Rise Guidance Document*. March 2013 Update.
[20] Ibid.

occurrence (or probability) with sea-level rise heights and rates, and are directly tied to a range of emissions scenarios. However, the probabilistic projections may underestimate the likelihood of extreme sea-level rise (resulting from loss of the West Antarctic ice sheet), particularly under high emissions scenarios. Therefore, the *2018 Guidance Update* also includes an extreme scenario called the H++ scenario[21]. The probability of this scenario is currently unknown, but its consideration is important, particularly for high-stakes, long-term decisions.

Table 3.2 compares SLR projections (used for the CAP Update) from the 2013 Guidance Document (as noted above), and the *2018 Guidance Document Update.* Moreover, Table 3.2 distinguishes the differences between the scenario-based SLR projections of the California Coastal Commission guidance document and the probabilistic SLR projections of the 2018 Guidance Document Update. The probabilistic projections for Santa Cruz are based on a tide gauge located in Monterey, as this is the nearest tide gauge used in the *2018 Guidance Document Update.*

TABLE 3.2: COMPARISON OF OPC 2013 GUIDANCE DOCUMENT AND 2018 UPDATE'S PROJECTED SLR PROJECTIONS[22]

Time Horizon	**SLR Scenario-based projections**	**2018 Update Probabilistic SLR Projections**			
		Emissions Scenario	**Likely Range*** 66% probability SLR is between…	**1-In-200 Chance**** 0.5% Probability SLR meets or exceeds…	**H++ Scenario*****
2030	Med (4 in)	high	3.6 – 6in	9.6in	12in
2060	High (28 in)	low	6 – 14.4in	27.6in	45.6in
		high	8.4 – 16.8in	31.2in	
2100	High (63 in)	low	10.8 – 27.6in	66in	121.2in
		high	18 – 39.6in	82.8in	

Notes:*Low risk aversion projection**Medium-high risk aversion projection***Extreme risk aversion projection

KEY FINDINGS

Within the combined hazard zones as depicted in Figure 3.1, coastal storm flooding is the primary hazard placing property and infrastructure at risk. Although armoring may prevent impacts associated with coastal erosion (Figure 3.2), in many areas the models suggest this infrastructure will not protect property from wave overtopping during coastal storm events.

[21] The H++ extreme high SLR projections recommended for scenario analysis by the California 4th Climate Assessment were not evaluated in the coastal climate change analysis as CCWG's modeling and data sets utilized predate the H++ scenario development. The extreme H++ scenario has an unknown probability but could lead to SLR exceeding 10 feet in California by the end of the century.

[22] According to the *2018 Update* of the OPC SLR Guidance Document, probabilistic projections for SLR are shown in Table 2, along with the H++ scenario (depicted in the far right column), as first presented in the Rising Seas Report (Griggs *et al*. 2017). The H++ projection is a single scenario and does not have an associated likelihood of occurrence as do the probabilistic projections. Probabilistic projections are with respect to a baseline of the year 2000, or more specifically the average relative sea level over 1991 - 2009. High emissions represents Representative Concentration Pathways (RCPs) of 8.5; low emissions represents RCP 2.6.

While Figures 3.1 and 3.2 illustrate where vulnerabilities exist currently and in future time horizons, it does not distinguish between areas that are managed or protected because the effects of protective structures are not equally effective in addressing each individual hazard (erosion, coastal storm flooding and rising tides).[23]

For the baseline year of 2010, it is estimated that 63 existing buildings, including several critical City facilities and 5 buildings designated in the National Historic registry, are vulnerable to the combined hazards of sea level rise and another 128 are managed or protected by current infrastructure. Moreover, over ½ mile of existing roadways, sanitary sewer, storm pipes and water mains are vulnerable. Substantial existing wetlands, habitat, coastal trails and access points and beaches are also vulnerable to the combined effects of sea level rise.

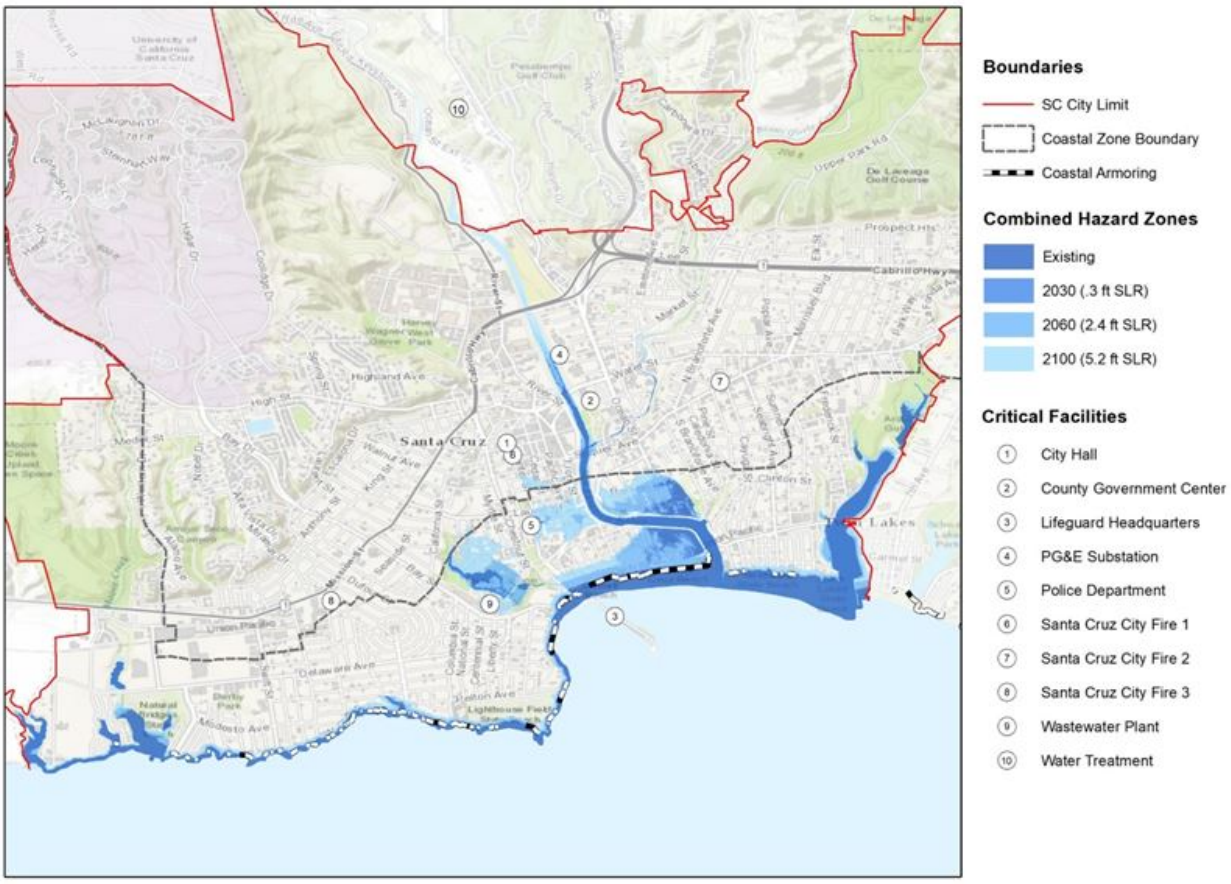
Key findings from the SLR vulnerability assessment for the City of Santa Cruz for the three future planning horizons include:

2030 PLANNING HORIZON (OR 4 INCHES OF SLR)
Cumulative risks of coastal climate change on City of Santa Cruz public and private infrastructure for 2030 is significant. More than 70 buildings are at risk of impact (many from periodic coastal flooding) and more than 40% of these properties are private residences with 8 properties designed on the National Historic registry. Approximately 0.6 miles of roadway will be at risk of flood and erosion damage as well as more than 2 miles of water, wastewater and storm drain pipe infrastructure. More than three times as many buildings (214) are protected or managed from predicted hazards by levees, water control structures, and storm pumps. Some critical City facilities are vulnerable and one of the three emergency services buildings are identified to be at risk from coastal climate change through 2030.

- Most of West Cliff and East Cliff are protected by sea walls and rip rap, mitigating much of predicted erosion hazards.
- New sea walls will need to be constructed for portions of West Cliff and East Cliff where no structures currently exist if maintaining the same level of service (auto, bike and pedestrian) along the coast is a priority.
- Storm flooding is predicted in the socially vulnerable Beach Flats area due to waves overtopping the coastal infrastructure on Beach Road, but impacts are assumed to be managed by current storm water pumps along the San Lorenzo River levee.
- Parklands on Bethany Curve are projected to be prone to storm flooding.
- Acreage and tidal duration of availability of City beaches is projected to decrease.

[23] To view areas managed by pumps or protected by levees for coastal storm flooding or rising tides, view those specific figures within Appendix D.

FIGURE 3.4: CUMULATIVE RISKS OF COASTAL CLIMATE CHANGE ON PUBLIC & PRIVATE INFRASTRUCTURE[24]

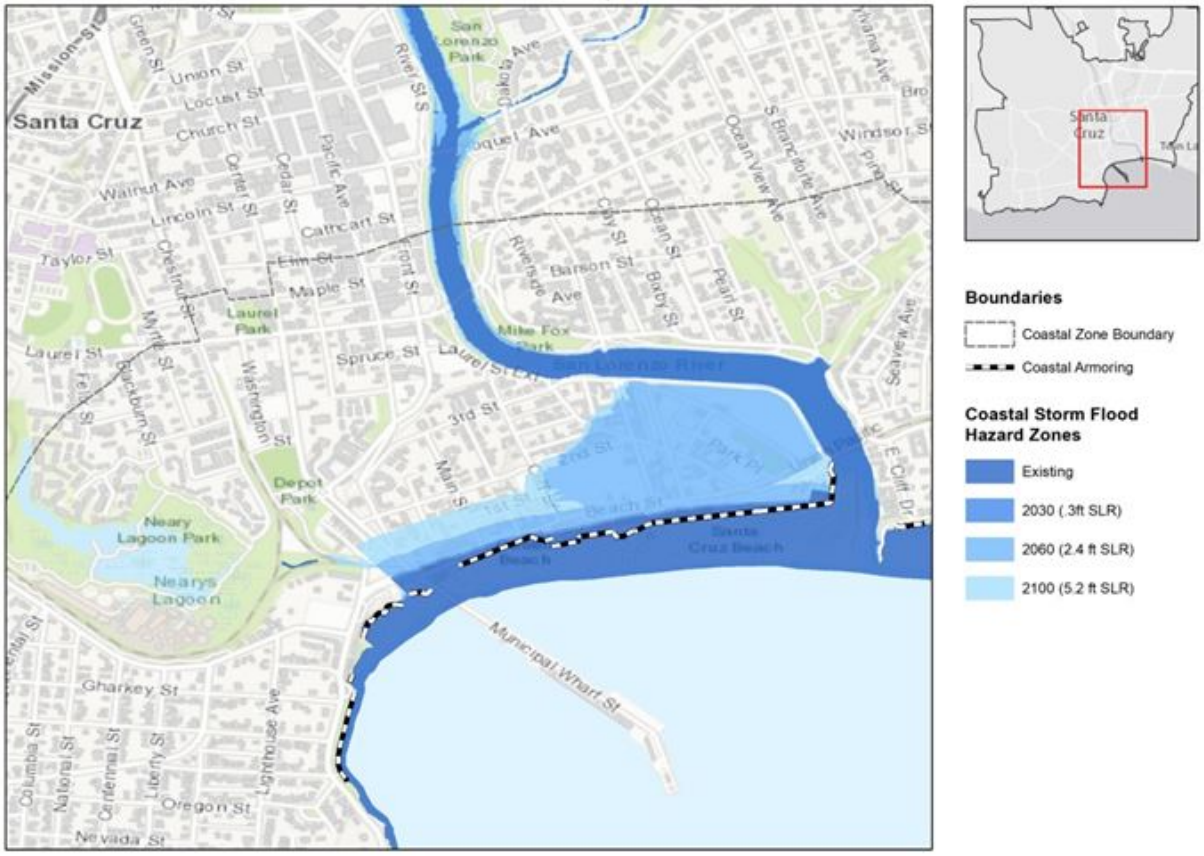


Eighty-four acres of parks land (including beaches designated as parks), 58% of coastal access points and 27% of current coast trail infrastructure are projected to be at vulnerable to periodic flooding or impacted due to sea level rise. Over half of Santa Cruz's coastal wetlands are projected to be vulnerable to the impacts of future coastal climate change. Sensitive habitat is projected to be minimally impacted, with only 4% of current sensitive habitat classified as vulnerable. As illustrated in Figure 3.5, as early as 2030, storm flooding is predicted in the socially vulnerable Beach Flats area due to waves overtopping the coastal infrastructure on Beach Street causing water to flow down Beach Street to low lying areas resulting in a short term flood condition. According to Public Works staff, current pump infrastructure can completely manage this hazard for all scenarios within 10 hours[25].

[24] It is important to recognize that a key assumption in the SLR models and on all maps projecting the combined coastal climate hazards or coastal storm flooding only is that erosion will occur *first* and then the area up to the erosion line will flood.

[25] The volume of water from rising tides within the Lower Ocean, Beach Flats and downtown neighborhoods can be accommodated by existing infrastructure to pump flood water from these areas for all scenarios over the three time horizons within 10 hours The 10 hours to pump down the storm surge assumes no power outages and that there is not a significant rain event during the 10 hours (S. Wolfman, Senior Associate Civil Engineer, *personal communication,* May, 2017).

FIGURE 3.5: EROSION & COASTAL STORM FLOOD HAZARD ZONES – BEACH FLATS (2030, 2060, AND 2100) [HAZARD ZONES EXCLUDE AREAS CURRENTLY MANAGED BY PUMPS OR PROTECTED BY LEVEES]



2060 PLANNING HORIZON (OR 28 INCHES OF SLR)

The 2060 combined hazard zones presented previously in Figure 3.4 highlights the areas vulnerable to the combined effects of coastal climate change without protective structures (i.e. coastal armoring). Initially, for the purposes of this assessment and to identify the potential magnitude of impacts, it was assumed for the 2060 planning horizon that coastal armoring and water control structures will no longer function as designed without upgrades or replacement. However, as the Planning Team evaluated the findings of the SLR Vulnerability Assessment, it was determined that a second 2060 scenario should be included that assumed that coastal armoring and water control structures will be upgraded to function as intended through the 2060 planning horizon. Figures 3.6, 3.7, and 3.8 illustrate the difference in the extent of projected vulnerability from coastal hazards both with and without the protection afforded from coastal armoring and water control structures.

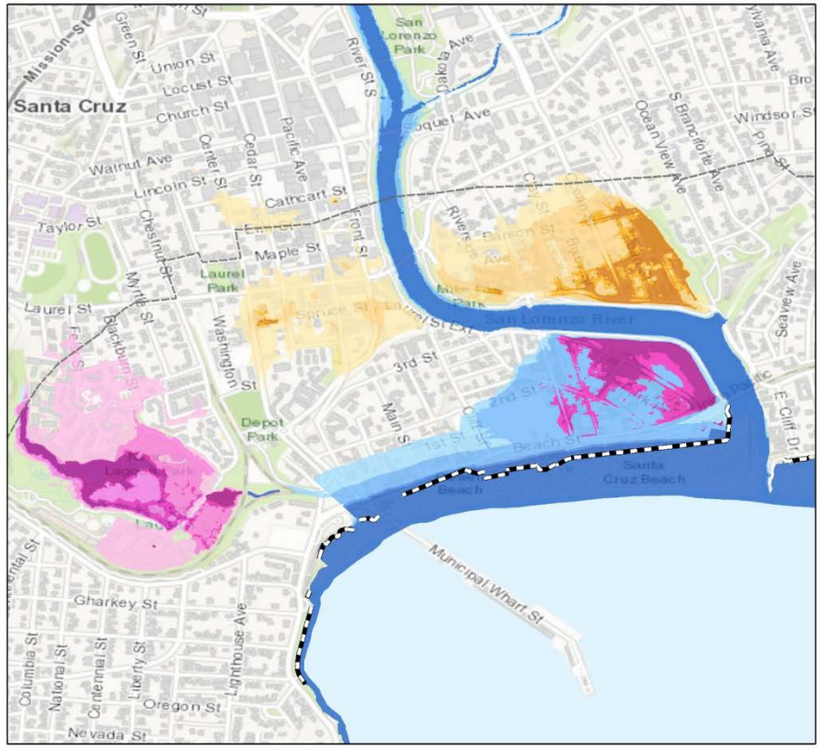
By 2060, 275 buildings are projected to be vulnerable to climate hazards within the City with 12 designated on the National Historic registry. An additional 28 properties (including 24 homes) are projected to be vulnerable to erosion if maintenance and management of existing protective structures is not maintained. Approximately 250 more buildings would be vulnerable if existing levees and storm pump infrastructure failed to function. Many of the 275 buildings that remain vulnerable are projected to be at risk of impacts from coastal flooding that current coastal

structures are not designed to guard. More than 5 miles of roadways are projected to become vulnerable as well as 11 miles of water, wastewater and storm drain-pipes.

These underground piping systems may be subject to potential backflow conditions, destabilization and breakage due to erosion and flood induced landslides, and disruption of service. As illustrated in Figure 3.8, unprotected portions of West Cliff are projected to be vulnerable to coastal erosion, threatening the road and subterranean utilities. Additional park lands are projected to be at risk as well as 28 (78%) coastal access locations. As illustrated in Figures 3.6, 3.7, and 3.8 pocket beaches along West Cliff are predicted to be lost due to higher tides and protected back shores. Over 66% of wetlands and about 4% of sensitive habitat are projected to be vulnerable to sea level rise impacts.

FIGURES 3.6 & 3.7: EROSION/COASTAL STORM AND RISING TIDES HAZARD ZONES – BEACH FLATS

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COASTAL STORM FLOOD HAZARD ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



Boundaries
- Coastal Zone Boundary
- Coastal Armoring

Coastal Storm Flood Hazard Zones

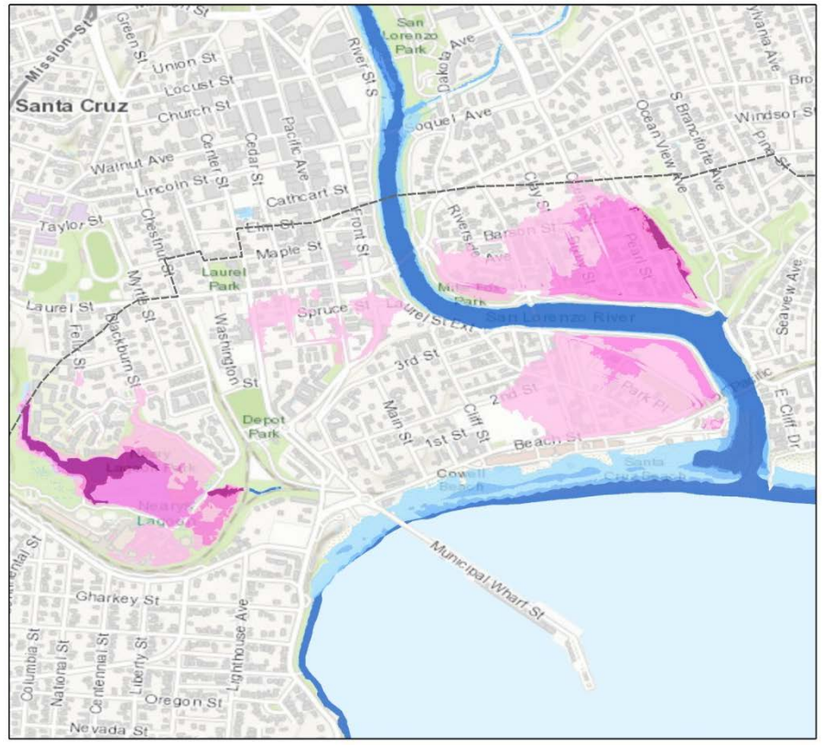
Existing
- Vulnerable
- Managed
- Protected

2030 (.3ft SLR)
- Vulnerable
- Managed
- Protected

2060 (2.4 ft SLR)
- Vulnerable
- Managed
- Protected

2100 (5.2 ft SLR)
- Vulnerable
- Managed
- Protected

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
RISING TIDES HAZARD ZONES
(hazard zones include areas that are currently managed by pumps)



Boundaries
- Coastal Zone Boundary

Rising Tides Hazard Zones

Existing
- Vulnerable
- Managed

2030 (.3ft SLR)
- Vulnerable
- Managed

2060 (2.4 ft SLR)
- Vulnerable
- Managed

2100 (5.2 ft SLR)
- Vulnerable
- Managed

As illustrated in Figure 3.4, all of Main Beach is projected to be vulnerable to the combined effects of SLR, with over half Main Beach projected to be reduced by rising tides alone (Figure 3.7). As illustrated in Figures 3.6 and 3.7, the first block inland of Beach Street is vulnerable to erosion and storm flooding. Projected vulnerabilities from rising tides to areas of Lower Ocean, parking lots in Beach Flats, and natural areas of Neary Lagoon are assumed to be managed by current storm water pump infrastructure. As illustrated in Figure 3.8, infrastructure and houses along West Cliff between Woodrow and Lighthouse Point are vulnerable to coastal erosion; coastal armoring currently protects much of the West Cliff coastline but the condition and lifetime of these structures vary and it is unclear what level of protection will exist by year 2060. The West Cliff Drive Shoreline Adaptation and Management Plan will include a conditional inventory of coastal armoring structures and offer recommendations for long term management approaches.

FIGURE 3.8: COASTAL EROSION HAZARD ZONES – LIGHTHOUSE POINT
[2060 TIME HORIZON WITH ARMORING COMPARED TO 2060 WITHOUT ARMORING]

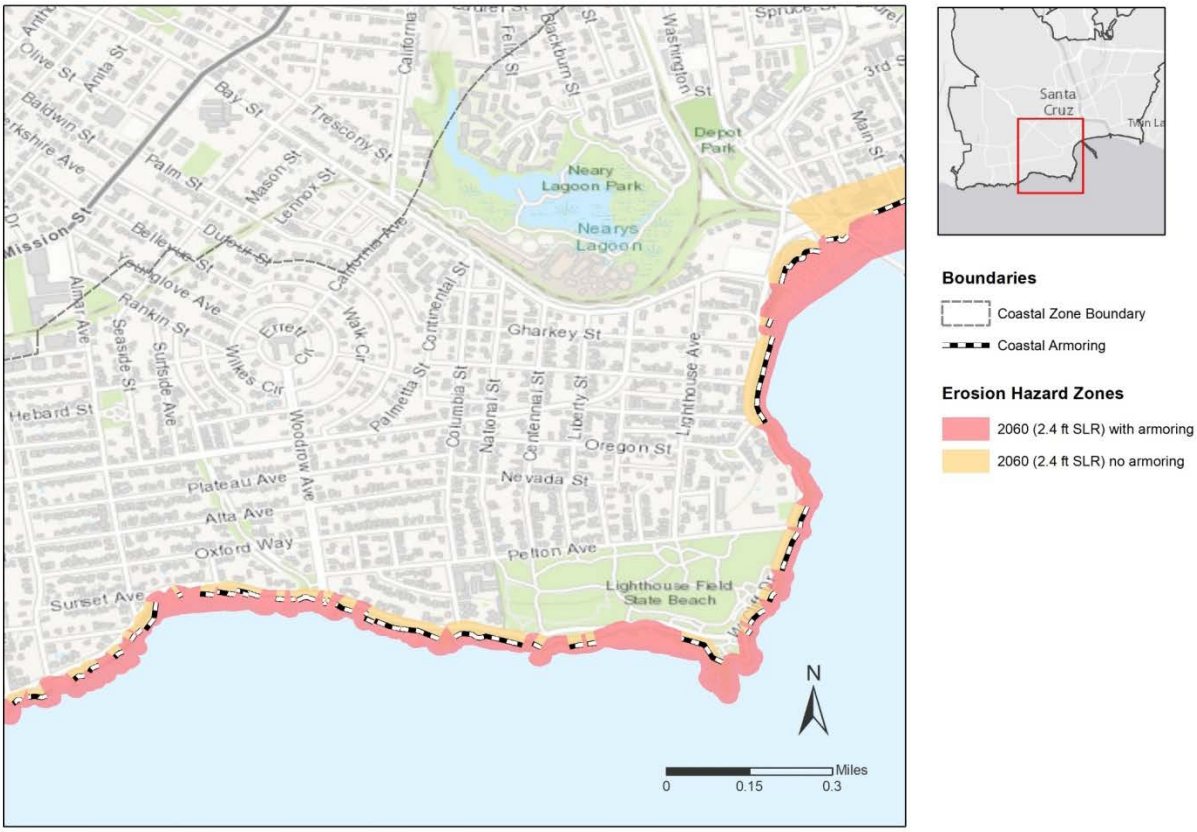
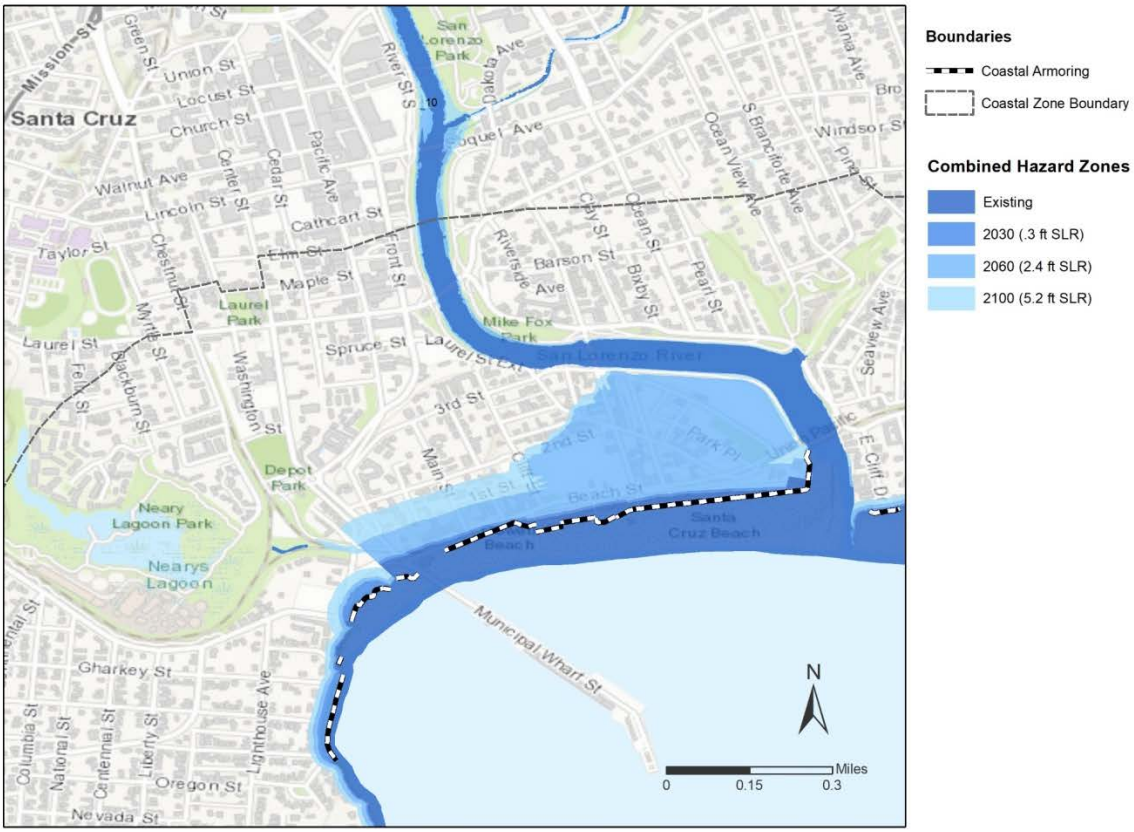


FIGURE 3.9: COMBINED COASTAL HAZARD ZONES (2030, 2060, AND 2100) – BEACH FLATS (HAZARD ZONES EXCLUDE AREAS CURRENTLY MANAGED OR PROTECTED)



2100 PLANNING HORIZON (OR 68 INCHES OF SLR)

By 2100, 390 residential and 65 commercial properties (15 on the National Historic registry) within the City of Santa Cruz are located within the hazard zones for predicted coastal climate change. Whether current or upgraded coastal protective structures can be built to protect these structures is uncertain. More than 500 additional buildings are projected to be within hazard zones currently protected or managed by storm water pumps and levees. Almost 7 miles of roadway and 16 miles of water, wastewater and storm drain pipes are projected to be at risk, and larger portions of all other land uses will be vulnerable to climate change by 2100. More than 50 public buildings, 26 coastal access locations and 58 acres of sensitive habitat will be at risk by 2100.

The SLR vulnerability study confirms that coastal erosion along West Cliff and East Cliff, as depicted in Figures 3.2 and 3.8, is projected to be an ongoing challenge for the City of Santa Cruz. Much of the most vulnerable coastal infrastructure is owned and operated by the City. It is important to note that while the study projects impacts to assets over the 2030, 2060 and 2100 time horizons, the City acknowledges that the current distribution of assets is not necessarily representative of future conditions and distribution. Establishing sound coastal adaptation and protection policies early will likely best enable the long-term implementation of these policies and ensure long term sustainability for the community. Table 3.3 outlines the specific City assets projected to become vulnerable to the combined impacts of SLR. The designation of assets/areas

as "SV" in Table 3.3 indicates that the asset or area is located in a socially vulnerable census block group.

TABLE 3.3: SPECIFIC ASSETS PROJECTED TO BE VULNERABLE TO SEA LEVEL RISE[26]

ASSET/AREA	TYPE	COASTAL HAZARD IMPACT	IMPACT THRESHOLD
Long Marine Lab	Coastal Trail	Erosion	2060
	Salt Water Supply System	Erosion	2060
Natural Bridges State Park	Park, Visitor Serving	Erosion	2060
DeAnza Trailer Park[SV]	Road	Erosion	2030
	Homes	Erosion	2060
West Cliff Drive	Road — Isolated sections	Erosion	2030
	Bethany Curve Greenway	Coastal Storm Flooding	2030
	Pocket Beaches	Rising Tides	2060
	Homes — Areas without armor	Erosion	2060
	Homes along Bethany Curve	Coastal Storm Flooding	2060
Lighthouse Point/West Cliff	Bike and walking path	Erosion	2030
	Lighthouse	Erosion	2060
Wharf Entrance	Road	Erosion	2030
Cowell/Main Beach[SV]	Beach	Erosion Rising Tides	2030 2060
Beach Street[SV]	Road and Visitor Serving	Erosion	2060
	Visitor Serving	Coastal Storm Flooding	2030
East Cliff Drive	Road	Erosion	2030
	Homes — Areas without armor	Erosion	2060

[26] An asset vulnerability table has also been prepared by asset type using FEMA's flood zone maps rather than the SLR projected hazard zones developed through this analysis. This map and table can be found in Appendix E.

ASSET/AREA	TYPE	COASTAL HAZARD IMPACT	IMPACT THRESHOLD
Twin Lakes State Beach	Beach	Erosion	2030
Crow's Nest & Adjacent Complex	Commercial	Erosion	2060
Harbor[27]	Parking and visitor serving	Coastal Storm Flooding	2060
Beach Flats Clinic[SV]	Clinic	Coastal Storm Flooding Rising Tides (managed)	2060 2100
Neary Lagoon[SV]	Habitat	Rising Tides (managed)	2030
	Trails	Rising Tides (managed) Coastal Storm Flood (managed)	2060 2060
	Wastewater Treatment	Rising Tides (managed) Coastal Storm Flood (managed)	2100 2100

Figures 3.10 and 3.11 quantify the number of buildings and feet of roadway, respectively, that are projected to be vulnerable to the combined SLR hazards. Electricity, natural gas and other utilities are excluded from the analysis. Appendix D includes details on impacted assets disaggregated by the three specific SLR impacts of coastal storm flooding, rising tides and erosion. It is important to note that a large number of assets are out of harm's way due to management or protective infrastructure; it is assumed that infrastructure in place to manage or protect assets must be upgraded and maintained in order to provide protection as noted in Figures 3.10 and 3.11.

[27] Future studies will strive to answer the question of what happens to the Harbor when jetties are overtopped by storm surge. Will large storm surge deposit additional sand in the Harbor entrance and could a large storm surge enter the Harbor?

FIGURE 3.10: NUMBER OF BUILDINGS VULNERABLE TO COMBINED SLR HAZARDS

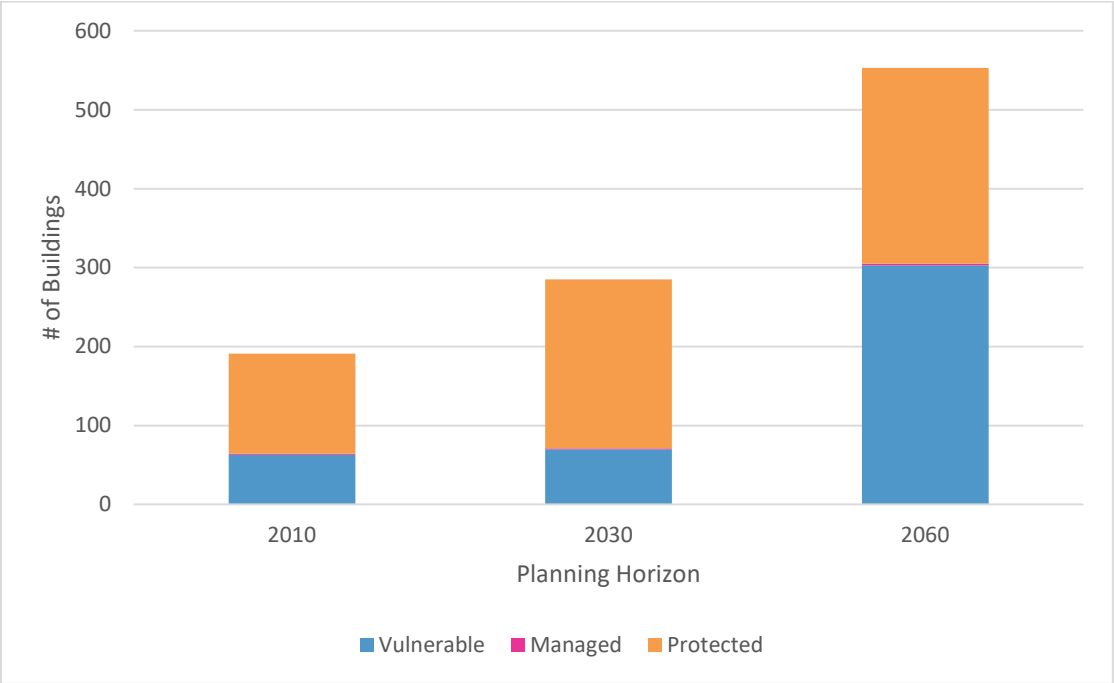


FIGURE 3.11: FEET OF ROADWAY VULNERABLE TO COMBINED SLR HAZARDS

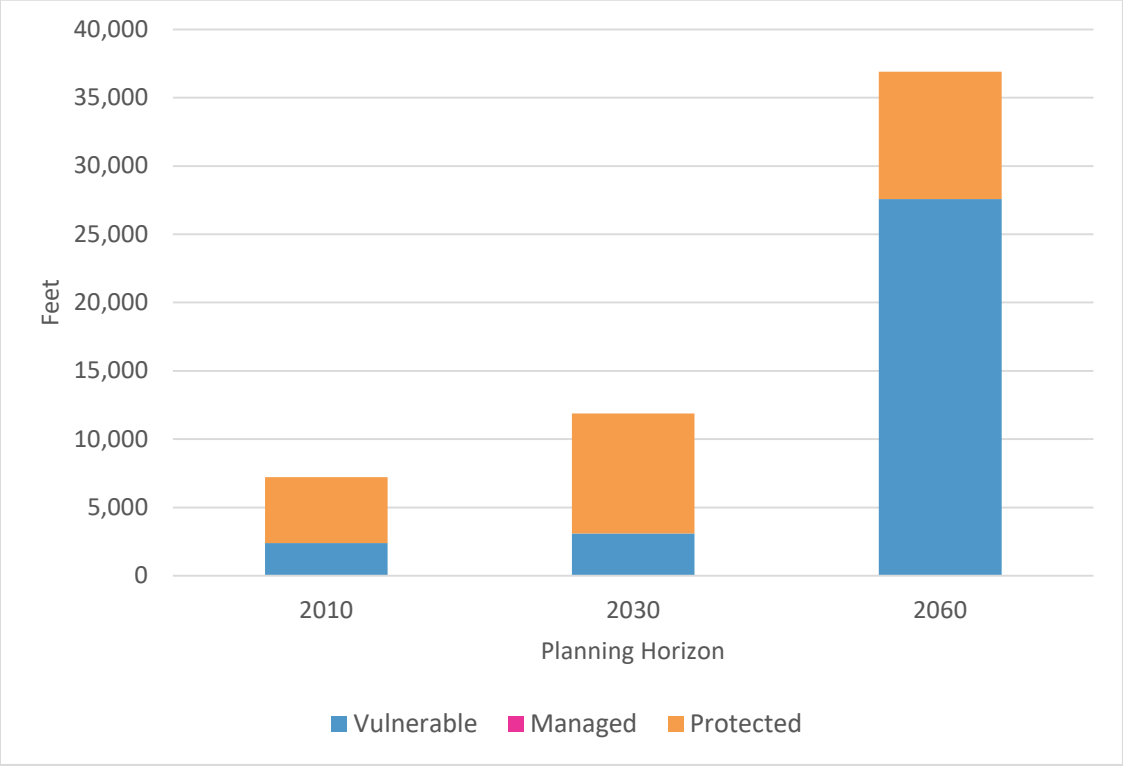


Table 3.4 summarizes which City facilities are projected to be vulnerable, managed, or protected from specific SLR impacts over the study time horizons.

TABLE 3.4: CITY FACILITIES PROJECTED TO BE VULNERABLE TO SEA LEVEL RISE

Key: Vulnerable Managed Protected

FACILITY	2030 mid	2060 high	2100 high
Beach Flats Clinic		Coastal Storm	Rising Tides
Police Department			Coastal Storm
Wastewater Plant			Rising Tides Coastal Storm

POTENTIAL ECONOMIC IMPACTS OF SEA LEVEL RISE

It is important to emphasize that the economic impacts of sea level rise represents only the present day valuation of current (2016) property and infrastructure assets that are vulnerable[28]. It does not include inflated costs, changes in land use, or the value of power system infrastructure, ecosystem services, recreation and tourism, etc. Currently $136 million in property and infrastructure are vulnerable to the combined hazards of coastal climate change within the City of Santa Cruz (Table 3.5). A significant number of properties are currently being protected from flooding and storm damage by a substantial set of structures including levees, storm drains, pump stations, and sea walls.

By 2030, the total value of vulnerable properties and infrastructure (not protected behind current structures) increases to $148 million. By 2030, $22 million (17% of the total value of vulnerable properties) in residential properties are at risk. About $44 million in commercial properties alone (34% of the total value of vulnerable properties) are vulnerable to 2030 hazards. More than half of the total property value at risk in 2030 is public property and infrastructure totaling over $64 million. This estimate does not include the Wastewater Treatment Plant.

The value of vulnerable property and infrastructure within the 2060 coastal climate hazard zone increases to over $622 million assuming that existing coastal armoring is replaced and new structures are constructed to protect against the hazards of sea level rise. In a comparative scenario, the value of vulnerable property and infrastructure within the 2060 coastal climate hazard zone is just over $1 billion if it assumed that existing coastal armoring is not replaced and new structures are not constructed to protect against the hazards of sea level rise. To note, in 2060, vulnerable property and infrastructure at risk is valued at over $33 million and consists of public buildings, roads and utilities.

[28] The values depicted represent the current value of the entire asset quantity (e.g., linear foot, etc.) that is exposed and the City recognizes that in the case of failure, a portion, and not the entire asset quantity, may need to be repaired or replaced.

TABLE 3.5: CUMULATIVE VULNERABLE ASSET VALUATION FOR VARIOUS TIME HORIZONS

ASSET	VALUE PER UNIT	2010 WITH ARMOR	2030 WITH ARMOR	2060 WITH ARMOR	2060 NO ARMOR
Buildings and Structures					
Residential	$960,000	$22,080,000	$26,880,000	$204,480,000	$437,760,000
Commercial	$2,600,000	$44,200,000	$49,400,000	$140,400,000	$218,400,000
Public	$4,000,000	$40,000,000	$40,000,000	$88,000,000	$108,000,000
Specific Municipal structures	$0	$24,288,000	$24,288,000	$140,653,100	$140,653,100
Valuation of vulnerable properties		*$130,568,000*	*$140,568,000*	*$573,533,100*	*$904,813,100*
Parks[29]					
Parklands	$1,873,080	$119,887,120	$119,877,120	$142,354,080	$151,719,480
Transportation					
Roads	$500	$1,193,500	$1,548,000	$13,790,000	$33,969,500
Highway	$4,000	$0	$0		$28,000
Rail	$237	$255,200	$293,900	$857,900	$1,854,300
Transportation infrastructure value		*$1,448,700*	*$1,841,900*	*$14,647,900*	*$35,851,800*
Water and Utility Infrastructure[30]					
Storm Drain pipeline	$600	$1,619,400	$1,893,600	$8,469,600	$19,870,200
Wastewater pipeline	$400	$1,250,800	$1,500,000	$7,482,000	$17,705,200
Drinking Water pipeline	$610	$1,724,500	$2,376,000	$17,497,200	$43,070,000
Utility Infrastructure value		*$4,595,000*	*$5,770,000*	*$33,449,000*	*$80,645,700*
Total Combined Infrastructure Asset Value		**$136,611,000**	**$148,179,000**	**$615,542,700**	**$1,021,311,000**

Many of the properties at risk during future time horizons are vulnerable to multiple hazards (i.e., erosion and coastal flooding). Depending on the engineering complexity and costs of replacing coastal protection structures, protecting all vulnerable properties is likely cost prohibitive.

[29] The value of parks is estimated to be about $1,873,080/acre based on a June 20, 2018 appraisal of Frederick Street Park and 1,853 acres of parks.

[30] Infrastructure costs are: $600/ft for storm drains/pipes, $400/ft for sewer, $610/ft for water, and $280/linear ft for roads. Impacts of road and utility infrastructure were only tallied for erosion impacts (temporary flooding was assumed to pose little in replacement costs).

A cost-benefit analysis must be undertaken by the City to evaluate adaptation options, which may include a managed retreat strategy for some public and private infrastructure, as well as evaluating coastal armoring and additional flood protection measures.

As an example, very preliminary 2017 cost estimates for a new 2.8 mile West Cliff Drive could cost as much as $145 million to construct, based on high estimates, and the cost for new revetment or armoring that would protect private homes within the hazard zone could cost $36 million.

This vulnerability study does not include estimated costs of other flood or infrastructure measures that might be considered as part of a broader City-wide strategy. All of these alternatives would need to include a thorough environmental analysis for potential impacts.

This preliminary economic evaluation highlights the need for constructive discussions between city decision makers, residents, and private property owners to establish protection and adaptation policies that fairly allocate costs and weigh public and private property concerns equitably.

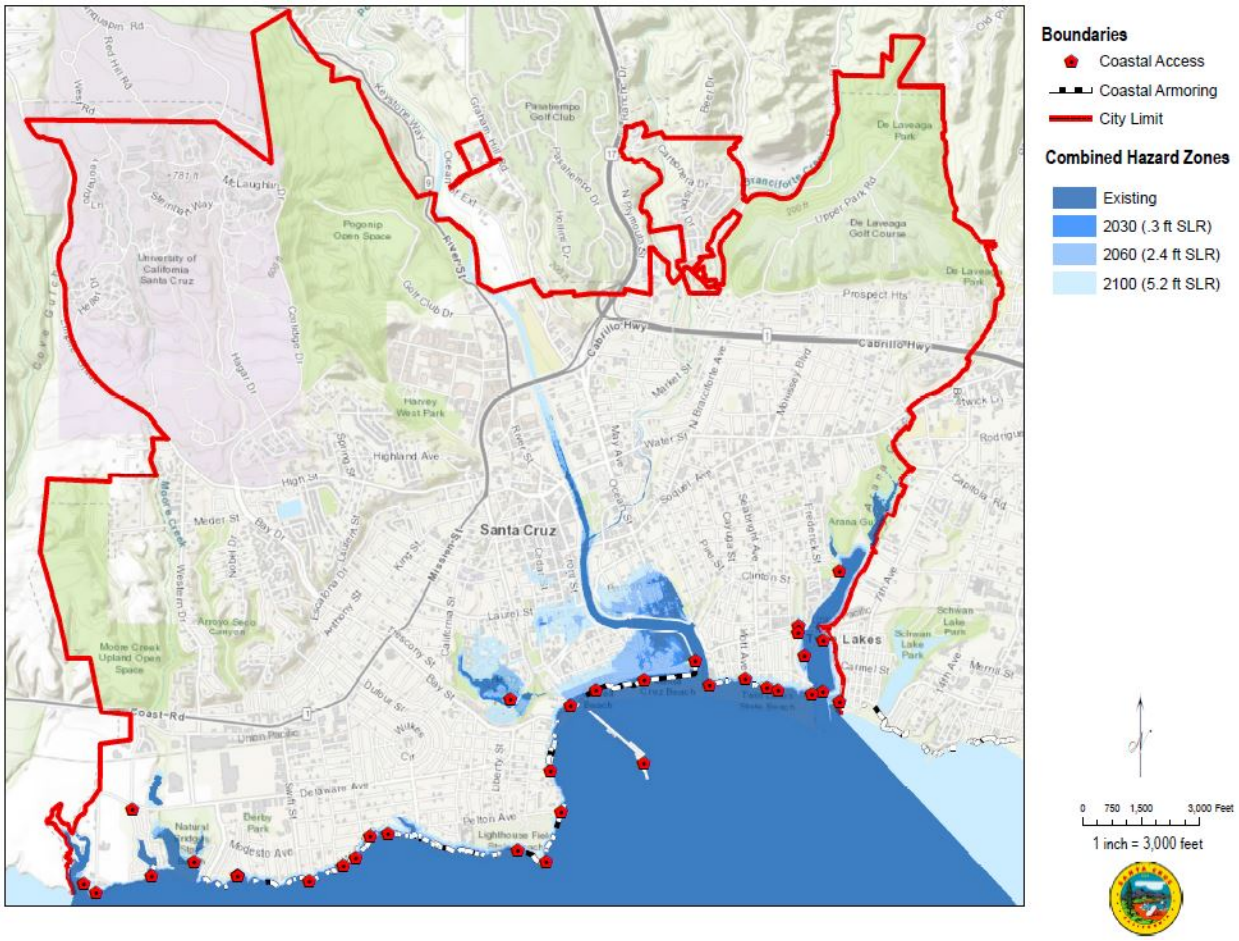
A more comprehensive economic analysis that accounts for relative scale of property damage for each projected hazard (i.e. temporarily flooded or total loss of property) is possible with the current data but is beyond the scope of this study. Using the compiled hazard and vulnerability data generated by this project, coastal armor construction costs and the secondary environmental and economic impacts resulting from constructed structures, one can compare relocation costs and losses associated with abandoning vulnerable structures. These data can inform temporal cost/benefit/consequence scenarios for each section of coastline and time horizon.

POTENTIAL IMPACTS OF SEA LEVEL RISE ON PUBLIC RESOURCES

PUBLIC ACCESS

The projected rise in sea level will have a major impact on public access and recreation since at least a million visitors use these beaches annually, most in the summer months and to a lesser extent in the winter months. Several options are being discussed to mitigate this impact on an interim basis. A rise of two feet in sea level will start to have impacts on the sea wall to the rear of Cowell and Main beaches. Figure 3.12 depicts the impact of SLR on access points at City of Santa Cruz beaches. Over 30 access points within city limits are exposed and vulnerable to sea level rise.

FIGURE 3.12: COASTAL ACCESS POINTS AND COMBINED COASTAL CLIMATE CHANGE HAZARD ZONES (HAZARD ZONES INCLUDE AREAS CURRENTLY MANAGED BY PUMPS OR PROTECTED BY LEVEES)



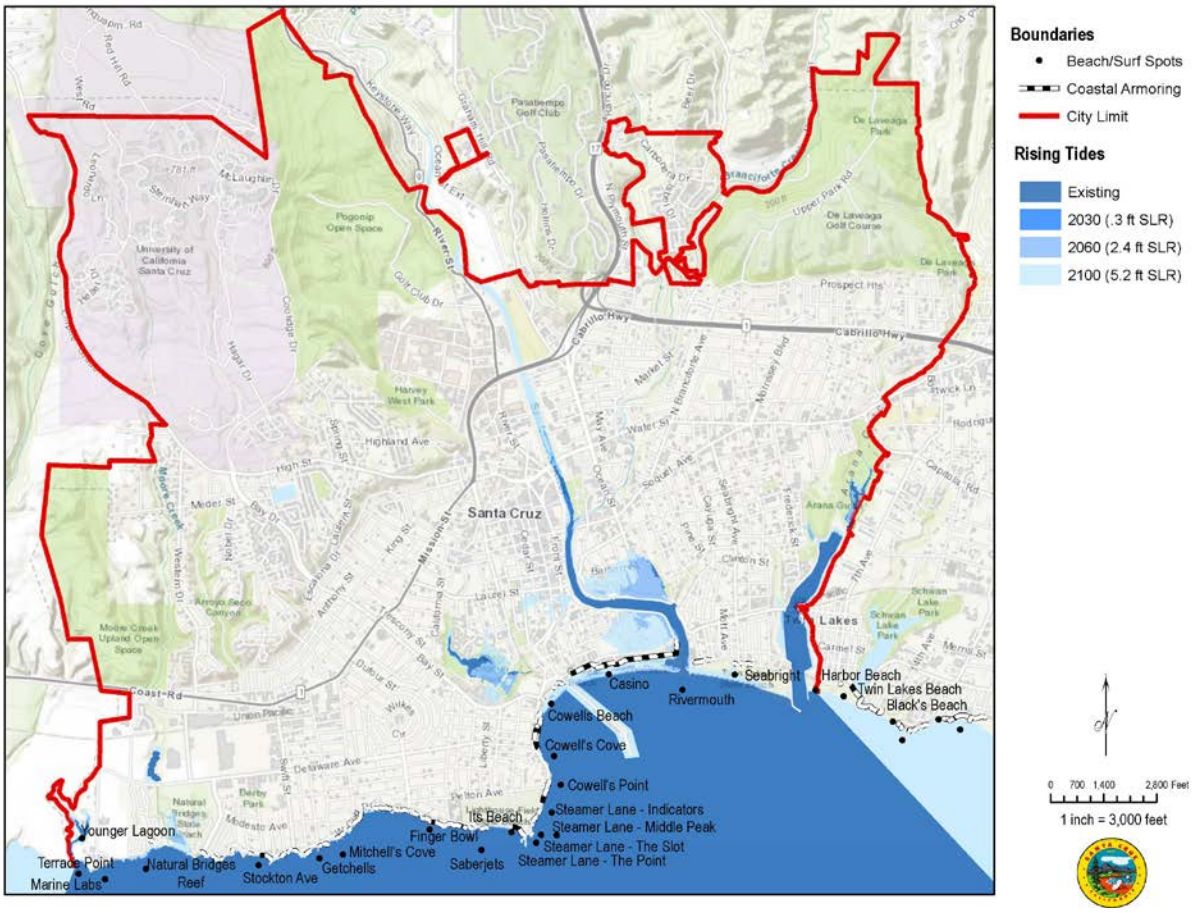
RECREATION & CULTURAL RESOURCES

Beaches within the city limits are used for a variety of recreational activities such as beach volleyball, sunbathing, picnicking, running/walking, swimming and surfing. Surfing is embedded in Santa Cruz culture, and two prominent surf spots—Steamer Lane and Cowell Beach—are located within city limits as depicted on Figure 3.13. Steamer Lane is one of Santa Cruz's most famous surf breaks, and hosts several surf contests throughout the year which attract surfers and tourists from all over the world. According the article *Using local knowledge to project sea level rise impacts on wave resources in California*[31] by Dr. Dan Reineman, "Sea level rise will have significant impacts on many coastal resources. Waves are an important resource in California, where they support the recreation of 1.1 million surfers who inject millions of dollars into local economies. The impacts of sea level rise on wave resource quality, however, are unknown." Breaking waves are a key element of California's intertidal ecosystems, and are central to the views and experiences of tens of millions of people who live on and visit the California coastline each year. Moreover, breaking waves enable surfing—one of the most iconic, as well as culturally and recreationally significant, activities in coastal California. According to Dr.

[31] Reineman, Dan et al. *Using local knowledge to project sea level rise impacts on wave resources in California*. Ocean & Coastal Management Journal. January 2017.

Reineman, "more than one-third [of California surf spots] are vulnerable to impacts from sea level rise… [however] surf-spot vulnerability is clearly not distributed evenly along the coast. San Francisco, Santa Cruz, Ventura, and San Diego counties in particular each have very high proportions of vulnerable surf-spots."

FIGURE 3.13: SURF BREAKS AND RISING TIDES



Based on another report by Dr. Reineman titled *Projected Sea Level Rise Impacts for Santa Cruz, CA*[32], Steamer Lane and Cowell Beach will be drowned at 0.4 and 0.66 meters of SLR, respectively, which are projected to occur between the 2030 and 2060 time horizons. These two breaks currently experience their best conditions at the lower end of the present day tide range. SLR will increase the water depth over these breaks such that as the lower levels of present day tide range are sequentially drowned; the best conditions will only occur during future lower and lower tides. This will continue until such time as the tide is never low enough (*i.e.*, the water is no longer ever shallow enough) during any part of the tide range and the surf break effectively "drowns." To reach this conclusion, the report assembled and analyzed data from interviews and secondary sources, then presented results on projected impacts of SLR on wave resources in the

[32] Report Prepared by Dr. Dan Reineman, Environmental Science & Resource Management, California State University Channel Islands.

City of Santa Cruz. Overall, approximately 20 surf breaks, located within city limits, are projected to be impacted by rising sea levels.

According to the *Santa Cruz World Surfing Reserve Stewardship Plan* (Stewardship Plan)[33], "in April 2012, Santa Cruz was officially dedicated as a World Surfing Reserve (WSR), globally recognized for its quality surf, unique environmental characteristics, strong surfing heritage, and local conservation leadership… however, there are some key challenges that continue to affect this coastline, including water quality, trash/marine debris, and sea-level rise." With regards to sea level rise, the WSR identifies three key areas within the city that are threatened by rising sea levels: Cowell Beach, West Cliff, and East Cliff. Based on the Stewardship Plan, Cowell Beach is threatened by accelerated loss of sand; West Cliff by loss of surf quality and accelerated loss of cliffs; and East Cliff by accelerated loss of cliffs and loss of coastal access points. Thus, some strategies and actions called out by the WSR to combat these threats include the following: investigating beach nourishment strategies, quantifying economic contributions associated with Santa Cruz's quality surf environment, supporting County ordinance to protect surf resources, and influencing Local Coastal Policy decision making. As such, their recommended actions include undertaking a "surfonomics" economic valuation study, investigating feasibility, costs, benefits, and consequences of beach nourishment programs within the WSR, and introducing a Santa Cruz County ordinance to safeguard the local surfing resources in sea-level response planning.

It is possible that the location of the Cowell Beach surf break will migrate shoreward at a rate commensurate with rising sea levels since it overlies a sandy bottom; however, this likelihood decreases as rates of SLR increase. It further decreases as human interventions detrimentally impact natural coastal processes (*e.g.*, shoreline stabilization prevents upland migration of beach environment and reduces sediment replenishment in the nearshore). In the case of Steamer

[33] Save the Waves Coalition. 2015. *Santa Cruz World Surfing Reserve Stewardship Plan*. World Surfing Reserves: A Program of Save the Waves Coalition.

Lane and many other breaks along West Cliff—which overly hard rock reef—the potential for break migration is very low. As such, these surf breaks face a high risk of extinction due to SLR.

In terms of other cultural resources, the City completed its *Cultural Resources Background Report Update*[34] in July 2018. These data are used to determine when an archaeological study would be required prior to issuing a permit for a development project. It identifies known prehistoric, historic and multicomponent archaeological sites as well as areas that are likely to contain such sites. While excluded from the scope of this Plan Update, this study will become a consideration of future, more location-specific climate adaptation studies.

COASTAL VISITOR SHIFTS

Human behavior patterns change in response to temperature and more broadly, weather patterns. Santa Cruz's climate relative to the rest of California creates the conditions for potential increases and decreases to coastal visits. Populations continue to migrate coastward and the greater Bay Area is no exception. The Bay Area is a large and growing population center. The inland region of the Bay Area has high temperatures while the adjacent coast, including Santa Cruz, has much more moderate temperatures. This temperature differential is forecasted to become greater and will promote increased coastal visitorship. It is unclear if public infrastructure (law enforcement, restrooms, parking, and transportation) is prepared to accommodate the projected increase. It is likely significant investment in public and private infrastructure will be necessary to accommodate this increase in visitorship.

According to the City of Santa Cruz *AB 691 Sea-Level Rise Assessment*[35], coastal visitation and recreation could also likely decrease as the City experiences the impacts of climate change and SLR processes. These impacts include a near total loss in beach acreage in the City by year 2100[36] and the assessment estimated the non-market value of such a loss to the City. Several approaches were evaluated in order to ascertain the non-market value of recreation in the beach areas within city limits, creating a potential range of impact associated with climate change and SLR. The first approach was based on similar work completed in San Diego[37]and found that the loss of the City's beaches would result in an annual loss of around $37 million for the City (one million visitors' at $37 per person a day).

The second approach utilized local statistics. According to the Santa Cruz Visitor's Council, the average visitor to Santa Cruz County spends $151 per day. It is assumed that a day at the beach is free, and as such, this expenditure should be reduced by at least half to $75 per person a day (to include parking, food, etc). Utilizing this higher local figure, the "day at the beach" economic

[34] Dudek. 2018. *Cultural Resources Background Report Update with Policies, Programs, and Maps*. City of Santa Cruz, CA.

[35] City of Santa Cruz. 2018. *AB 691 Sea-Level Rise Assessment. City of Santa Cruz Tide and Submerged Lands 1969 Grant. Santa Cruz Municipal Wharf*. Revised and Resubmitted July 17, 2018.

[36] The value of parklands, including beaches characterized as parks, is included in Table 3.5.

[37] DANIEL K. LEW & DOUGLAS M. LARSON. 2005. *Valuing Recreation and Amenities at San Diego County Beaches*. Coastal Management, 33:1, 1-86, DOI: 10.1080/08920750590883079

valuation ranges from $37 to $75 per person per day. Thus, a reasonable valuation would be the mid-point between these two figures which would establish a "day at the beach value" of $56 per day or $56 million annually spent by the one million Santa Cruz beach visitors.

The third and final approach was based on a March 2016 study by the Nature Conservancy for the California State Coastal Conservancy, titled: *Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay*[38]. Through strategies including coastal user counts and intercept surveys, the study found that beaches provide substantial non-market goods and services such as recreational value as well as significant ecological functions; and according to the study, economists measure the non-market value of beach recreation by beach-goers' willingness to pay to recreate at a beach. Using the Southern Monterey Bay statistics from the study as well as the local beach goer estimate of one million visitors annually, it is projected that a loss of the City's beaches would result in an annual loss of $30.8 million. As such, based on these three approaches, it is projected that between 2060 and 2100, approximately $30.8 to $56 million in 2018 dollars may be lost annually in the local economy due to climate change and sea level rise impacts on beaches. Anecdotally, according to advisors to this project, this range likely underestimates the value for projected beach loss.

POTENTIAL IMPACTS TO PUBLIC HEALTH

According to the *Climate Change and Health Profile Report: Santa Cruz County*[39], "through sea level rise, salt water may intrude into coastal aquifers thus reducing quality and quantity of water supply. Coastal erosion can contribute to the loss of recreational venues and pose a variety of hazards to infrastructure and public safety. Water intrusion into buildings can result in mold contamination leading to indoor air quality problem… In 2010, approximately 16,876 residents lived on coastal blocks that were at risk of inundation from a 100-year flood. With an additional 55 inches of sea level rise… the inundation zone would potentially include 39,377 residents. This is likely an underestimate as more recent climate change models indicate that California may see 66 inch (167 cm) rise [or more] in sea level within this century."

POTENTIAL IMPACTS TO HABITAT AND ECOSYSTEMS

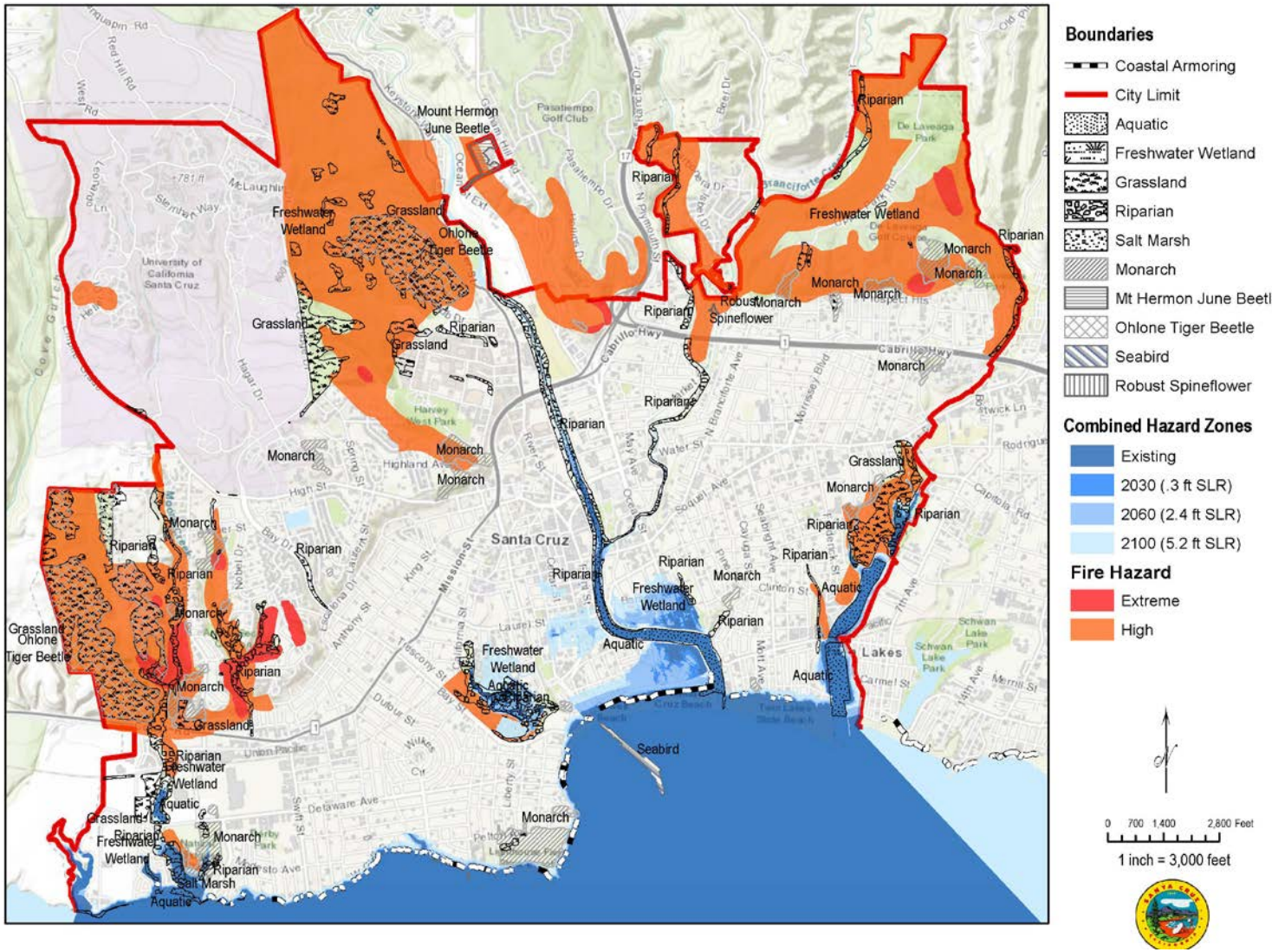
Flooding and erosion from sea level rise could cause coastal habitats to be converted from one type to another and generally reduce the amount of nearshore habitat, such as sandy beaches and rocky intertidal areas.[40] A majority of California's coastal habitat area, like beaches, rocky intertidal, and estuarine marshes, are highly vulnerable to SLR since they exist in narrow bands at the land-sea interface, and will be strongly affected by the potential for shoreline retreat. Many species are found only within California's coastal habitats and nowhere else in the world, and many patches of these coastal habitats will not be able to move inland in response to sea level rise, due to topography or the presence of the built environment (e.g., roads and other

[38] The Nature Conservancy. *SCC Climate Ready Grant #13-107 Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay.* March 2016.
[39] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*
[40] California Coastal Commission. 2016. Santa Cruz County Coastal Zone Fact Sheet.

development).[41] As such, SLR impacts are projected to be greatest for biota and functions of the upper shore zones of all beaches.[42]Five feet of sea level rise will have dramatic impacts on coastal habitats, biodiversity, and protected lands along California's coast. A majority of the area for several key coastal habitats are highly vulnerable, including: 58% of rocky intertidal habitats, most of which is located in the North Coast and Central Coast eco-regions; 60% of upper beaches statewide; 58% of regularly-flooded estuarine marshes.[43] Specifically, the City's SLR vulnerability assessment concludes that 5 acres of sensitive habitat are currently exposed and vulnerable to SLR increasing to up to 15 acres by year 2100.As such, the threat of rising sea levels may require adaptation strategies such as developing and implementing new conservation and management practices, and ensuring that our existing conservation lands are maintained and managed for resilience. A complete review of these impacts and strategies is beyond the scope of the CAP Update, but will be addressed in the upcoming West Cliff Drive Shoreline Adaptation and Management Plan development.

[41] Heady, Walter et al. *Conserving California Coastal Habitats: A Legacy and a Future with Sea Level Rise*. The Nature Conservancy and Coastal Conservancy.
[42] Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.
[43] Heady, Walter et al. *Conserving California Coastal Habitats: A Legacy and a Future with Sea Level Rise*. The Nature Conservancy and Coastal Conservancy.

FIGURE 3.14: SENSITIVE HABITAT/SPECIES, FIRE HAZARD ZONES & COMBINED COASTAL HAZARD ZONES (WITH AREAS CURRENTLY MANAGED BY PUMPS OR PROTECTED BY LEVEES)



As depicted in Figure 3.14, a variety of sensitive habitat/species - avian and aquatic species as well as monarch butterflies - are located along the coast and within city limits[44]. Between 2011 and 2014 a study was conducted to document the abundance and behaviors of birds located near the Wharf relative to a wind turbine[45]. According to the report, *Monitoring the Impacts of a Vertical Axis Wind Turbine on Avifauna at the Santa Cruz Wharf: Final Report*[46],

> "From February 2012 to February 2014, a total of 61 bird species were detected on 60 on-site avian surveys. Only 24 of those species were detected with any regularity (≥ 5% of the time) at any plot in their appropriate season of occupancy at the Wharf… This demonstrates the small composition of species that are regularly present at this site, and how diversity at the Wharf is significantly influenced by passage migrants and other local transient species."

Furthermore, the study found "over the course of the on-site surveys, four species were confirmed to be breeding on the Wharf. Because of these species' regular presence and interaction with the Wharf during an important stage in their life cycle, they are assessed to be species potentially at risk from anthropogenic effects of Wharf operations." These four species include the following: Pelagic Cormorant (*Phalacrocorax pelagicus*), Western Gull, Pigeon Guillemot *(Cepphus columba),* and Rock Pigeon (a non-native, introduced species that is present year-round in high abundance). Cormorants were observed roosting underneath the Wharf, Pigeons were perching underneath the Wharf near nest sites, and Rock Pigeons preferred to nest underneath the Wharf. With the advent of SLR, it is likely that this area of the Wharf will be impacted, potentially displacing the birds that roost, perch, and nest under the Wharf. However, no California state or federally listed endangered or threatened bird species were detected during on-site surveys. Although three species listed as California Bird Species of Special Concern were detected once each: Brant (*Branta bernicla*), Black Swift (*Cypseloides niger*), and Vaux's Swift (*Chaetura vauxi*).

As stated previously, a complete review of these impacts is beyond the scope of this plan, and will be addressed in the upcoming West Cliff Drive Shoreline Adaptation and Management Plan development. Future studies should also assess how climate change will affect migrating birds that frequent Neary Lagoon and the San Lorenzo River. Green or natural infrastructure solutions are also being considered that have the benefit of providing protection from SLR and increasing habitat space and connectivity.

[44] A full list of endangered, sensitive and threatened plant and animal species is included in the General Plan 2030 under Natural Resources.

[45] Notably, this wind turbine is the only offshore wind turbine permitted by the Coastal Commission off the coast of California. A three year monitoring study and resulting report were a condition of the Coastal Commission development permit. The findings of the report supported the Coastal Commission's discontinuation of the monitoring condition going forward.

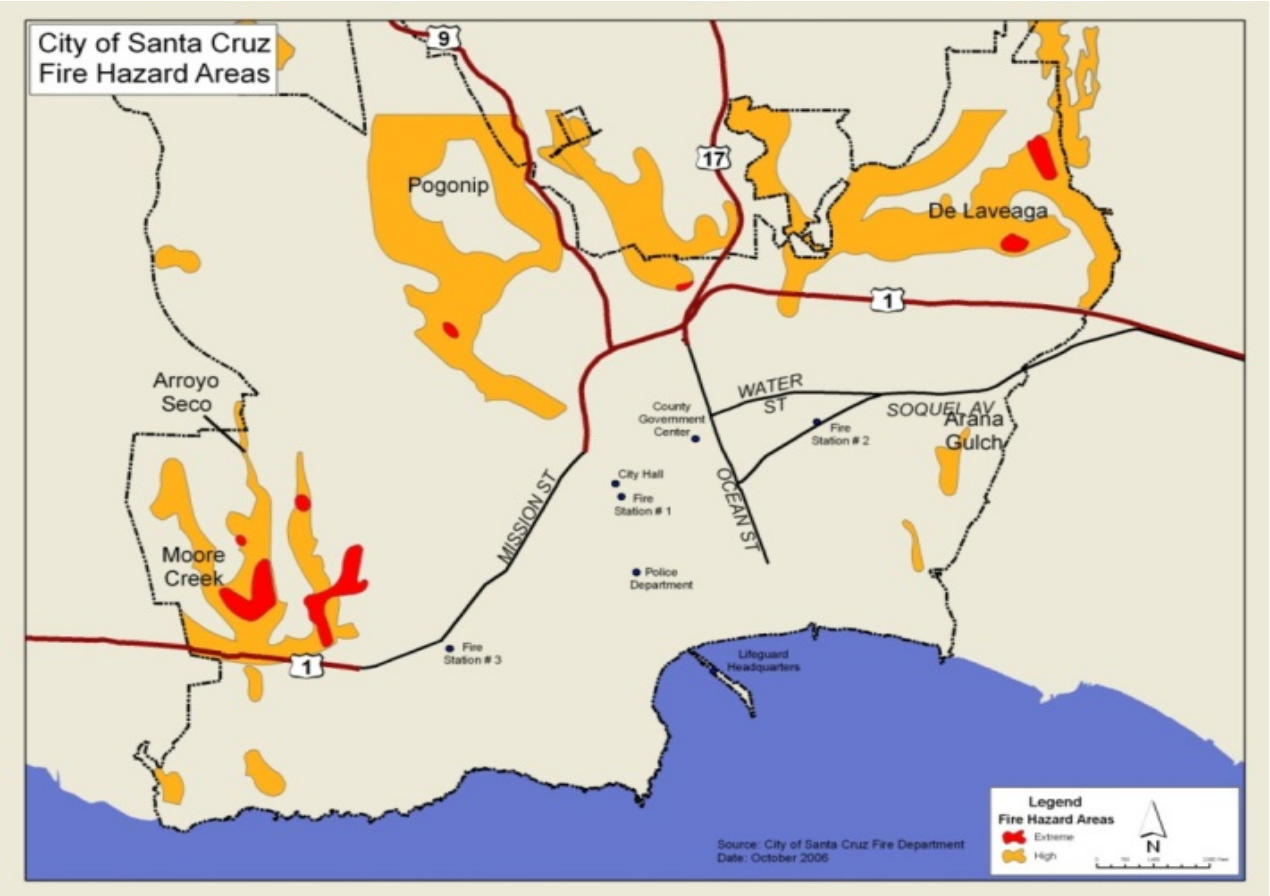
[46] Wise-West, Tiffany and Rinkert, Alex. *Monitoring the Impacts of a Vertical Axis Wind Turbine on Avifauna at the Santa Cruz Wharf: Final Report.* UC Santa Cruz. The Center for Sustainable Energy and Power Systems (CENSEPS). July 2014.

NON-SEA LEVEL RISE IMPACTS OF CLIMATE CHANGE

INCREASED WILDFIRE THREAT

Wildland/urban interface fires are a significant threat to the City of Santa Cruz. Climate change impacts through increased temperatures and changing precipitation patterns (shorter more severe winters and prolonged, hotter, dryer summers) will exacerbate the risk of wildfires and decrease the fire return frequency.[47] For example, models suggest temperature rise under the moderate warming scenario, increases risk of large wildfires in California by up to 55 percent, twice the estimated risk if temperatures remain in the lower warming range.[48] In addition to the increased risk of wildfires in the region, post-recovery time may be lengthened, and fire spread following ignitions will be enhanced, leading to a complex impact on fire regimes. Furthermore, expansion into wildland urban interface will continue to increase fire risks to human communities.[49]

FIGURE 3.15: URBAN/WILDLAND FIRE HAZARD AREAS



[12] Mann, Michael L., et al. "Incorporating Anthropogenic Influences into Fire Probability Models: Effects of Human Activity and Climate Change on Fire Activity in California." *PLOS ONE*, Public Library of Science, 28 Apr. 2016.

[48]Cal_Adapt. "Exploring California's Climate Change Research." Accessed August 17, 2017.

[49] Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.

Within the City of Santa Cruz there are five wildland/urban interface areas including three that are designated as *mutual threat zones* as illustrated in Figure 3.15. Mutual threat zones are those areas where a wildfire would threaten property within the Santa Cruz fire protection district as well as property covered by another fire protection service. Between 2015 and 2017 about 3 acres were lost to wildfire. According to Fire Department staff, fires cost Californians $60 annually per person.

Also according to Cal-Adapt, the annual average area burned by wildfires in Santa Cruz is projected to increase between the historical time period (1961 – 1990) from 78 acres to 87.2 to 91.2 acres in the projected time horizon (2070 to 2099), depending on the emissions scenario, assuming a moderate population increase.

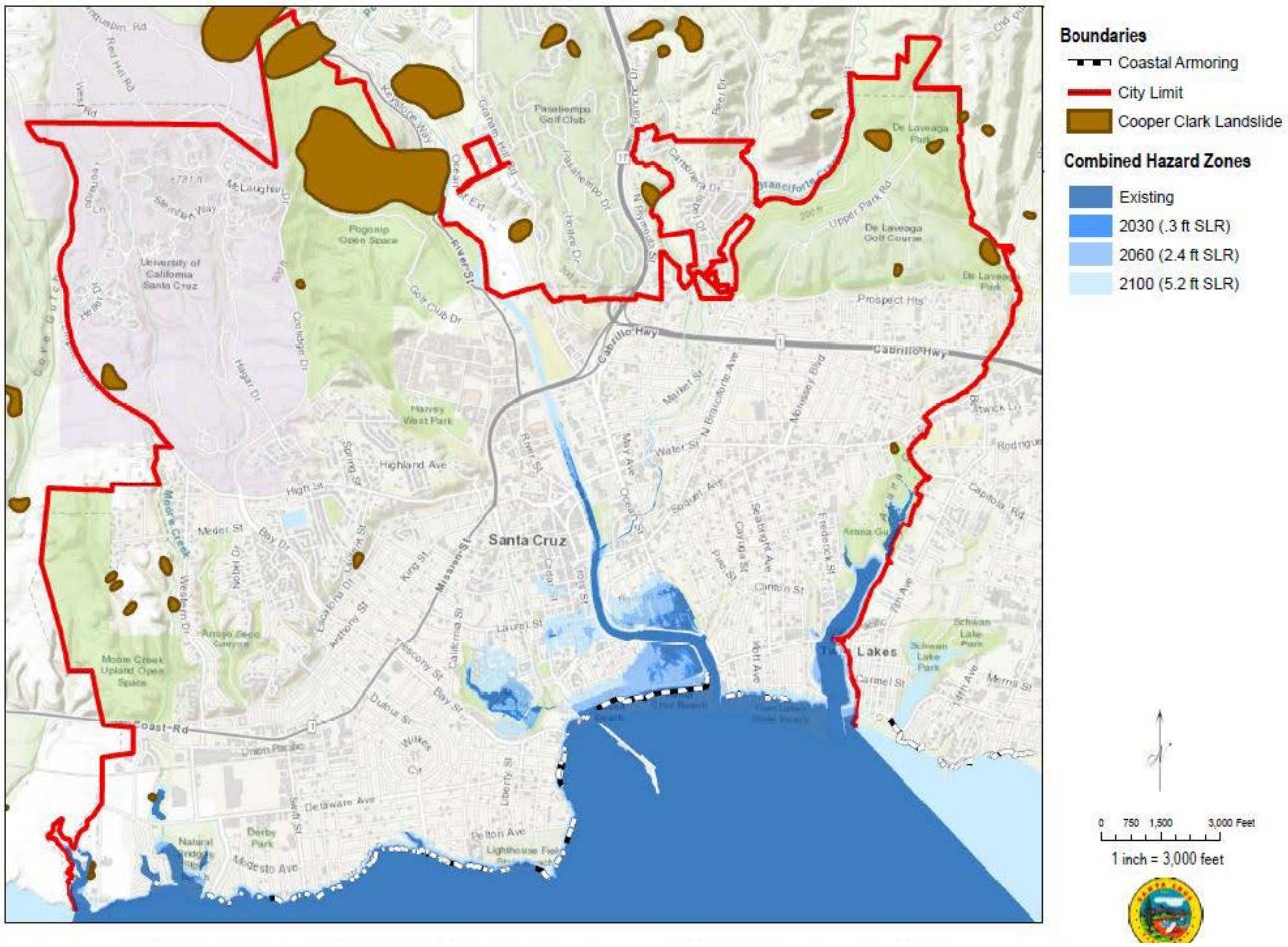
For major emergencies that require more resources than can be provided by a single agency, the City of Santa Cruz, Santa Cruz County, University of California at Santa Cruz and the State of California have an extensive mutual aid and emergency coordination system. Developed and managed in cooperation with the Governor's Office of Emergency Services (CalOES), this system allows departments and districts to share personnel and equipment as needed to address and control emergencies.

Wildland fires present a risk to open space areas within the City of Santa Cruz and adjacent to residential homes — the urban interface. It should also be noted that there are City of Santa Cruz water service areas and water infrastructure areas located outside the City limits and they are also potentially threatened by wildland fires. Wildland fires also present a risk to public health. According to the *Climate Change and Health Profile Report: Santa Cruz County*[50], *"*wildland fires impact watersheds and increase the risk of landslides or mudslides [see Figure 3.16], and sediment in run-off that reduce water quality. In addition to fire-related injuries, local and regional transport of smoke, ash, and fine particles increases respiratory and cardiovascular risks." Furthermore, extreme heat events in drought-ridden, low-humidity conditions in areas with significant vegetation vulnerable areas at high risk for wildfires. It is estimated that 24 percent Santa Cruz County is characterized by these conditions.[51] Santa Cruz County is also designated as being high or very high in the Fire Hazard Severity Zone map, with heat wave events expected to rise in number and duration over the twenty-first century.

[50] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*

[51] Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.

FIGURE 3.16: COOPER CLARK LANDSLIDE DATA AND COMBINED COASTAL HAZARD ZONES



DROUGHT

Santa Cruz does not import external water supplies. The amount of water available from local sources changes from year to year as a function of rainfall and runoff. The San Lorenzo River provides the largest portion of the City's water and Loch Lomond Reservoir is the primary storage reservoir. Climate model simulations and tree ring studies suggest that droughts lasting several years to decades have occurred in California. While a drying trend is unclear, even small changes will seriously challenge the region's stressed water supplies.[52] For example, water supply shortages, already common during drought, will be exacerbated, and impacts to the region would include increases in: water use for agriculture and landscaping, rates of saltwater intrusion and groundwater extractions. In addition, lower surface flows will lead to higher pollutant concentrations. Some adaptations include flooding agricultural fields for irrigation and groundwater recharge, increasing use of recycled water, and establishing drought reserves.[53]

[52]Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.
[53] Ibid.

Climate change can significantly alter precipitation patterns affecting the *quantity*, *quality, and distribution* of water available to the City. Reduction in precipitation is the primary concern, directly reducing our water supply. Precipitation on average is expected to increase by a relatively small amount, but the variability increases substantially by the end of the century. Across the central coast region, projections show that the wettest years will become wetter, and the driest years will become drier relative to historical conditions.[54] Other factors such as predicted increases to the intensity winter precipitation can result in higher runoff, decreased percolation, and lower summer base flows. High intensity rainfall over short periods decreases the time window during which water can be diverted from streams and reduces aquifer recharge. High sediment loads associated with elevated winter flows can also limit diversions and impact pumping and treatment operations. This in turn impacts water storage capability and availability during the long dry season. Tree fall and landslides associated with extreme weather events frequently damage water distribution infrastructure which can cause interruption of water services to residents.

Drought can also negatively impact public health because is decreases the availability and quality of water for humans. This also means a reduction in water availability to fight wildfires. Furthermore, according to the *Climate Change and Health Profile Report: Santa Cruz County,* drought may increase exposure to health hazards including wildfires, dust storms, extreme heat

[54] Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.

events, flash flooding, degraded water quality, and reduced water quantity. Dust storms associated with drought conditions have been associated with increased incidents of Valley fever, a fungal pathogen.[55]

OCEAN ACIDIFICATION

Ocean acidification has been identified as a future climate change impact concern for Santa Cruz. It is progressively affecting the structure and function of entire ecosystems and is a threat to the local economy, particularly the shellfish and fisheries sectors. Ocean acidification is further described in the 2011 Vulnerability Study. The scientific community has limited understanding of ocean acidification impacts, yet local and other researchers continue to monitor and evaluate them in the Monterey Bay National Marine Sanctuary.

Monterey Bay National Marine Sanctuary includes 276 miles of California coastline and is one of the most rich and biodiverse areas in the world. Ocean circulation ("upwelling") brings nutrient-rich waters to the surface at certain times of the year, catalyzing productivity. Microscopic photosynthetic plankton, the base of the ocean food web, support Monterey Bay's biologically rich and biodiverse ecosystem and provide at least 1 of 2 breaths of oxygen we breathe.[56]

The Sanctuary also acts as a carbon sink. Globally, the ocean absorbs twenty-five percent of our carbon dioxide emissions.[57] When this excess carbon dioxide is absorbed in seawater, a series of chemical reactions lower pH and increase ocean acidity. These changes, called "ocean acidification," have serious implications for our coastal ecosystems, altering the way marine life behave and develop.

Increased acidity interferes with the process by which calcifying organisms like crab[58], oysters, mussels, and certain types of plankton[59] build their shells. Species like crab, mussels, rockfish and its fisheries play a big role in the coastal economy. Complex modeling projects a 41% decline in Dungeness crab biomass and 30% loss in economic revenue the next 50 years due to ocean acidification.[60] Chemical changes in the ocean may also negatively affect some juvenile

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[55] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*

[56] Sekerci, Yadigar and Sergei V. Petrovskii. "Mathematical Modelling of Plankton-Oxygen Dynamics Under the Climate Change." *Bulletin of mathematical biology* 77 12 (2015): 2325-53.

[57] Le Quéré C, Andrew RM, et al. (2016) Global Carbon Budget 2016. Earth System Science Data, DOI:10.5194/essd-8-605-2016. https://www.earth-syst-sci- data.net/8/605/2016/

[58] Miller JJ, Maher M, Bahaboy E, Friedman CS, McElhany P (2016) Exposure to low pH reduces survival and delays development in early life stages of Dungeness crab (*Cancer magister*). Marine Biology 163:118

[59] Davis, C. V., Rivest, E. B., Hill, T. M., Gaylord, B., Russell, A. D., & Sanford, E. (2017). Ocean acidification compromises a planktic calcifier with implications for global carbon cycling. *Scientific Reports*, *7*, 2225. http://doi.org/10.1038/s41598-017-01530-9

[60] Marshall KN, Kaplan I, Hodgson E, Hermann A, Busch DS, McElhany P, Essington TE, Harvey CJ, Fulton EA (2017) Risks of ocean acidification in the California Current food web and fisheries: ecosystem model projections. Global Change Biology 23:1525-1539

rockfish[61], a key marine prey for many species of seabirds and marine mammals and several kinds of fishes in California's marine ecosystem. Rockfish are the most diverse group of fishes living on the west coast, with 65 different species that support important recreational and commercial fisheries.

Continued monitoring is needed to better understand how marine species will react to continued changes to ocean chemistry and how we can reduce stress on marine life while we work to mitigate our local and global CO_2 emissions. Efforts like NOAA's Monterey Bay National Marine Sanctuary 's Plankton Science Monitoring Program, in which citizens study both the temporal and spatial plankton populations along the coast, help to better understand issues like ocean acidification and how it relates to the marine food web and humans. Involvement of the public in these programs reflects collective responsibility in managing and protecting our shared natural heritage.[62]

SALT WATER INTRUSION

Rising sea levels will increase salinity in estuaries, wetlands, and groundwater aquifers. Saltwater intrusion can threaten the quality and reliability of the major fresh water supplies such as that pumped from the southern edge of the Sacramento/San Joaquin River Delta.[63]

Local impacts are less understood but no less severe. Some City ground wells that could be impacted through a combination of SLR, diminished surface flows and lowered aquifer levels. Salt water intrusion can raise coastal groundwater levels and lead to localized flooding, infiltrate storm drain systems, and require additional pumping including those along the lower San Lorenzo River. While there is no evidence of this condition in the City, saltwater intrusion can also adversely impact vegetation, trees and any coastal agriculture.

CHANGING TEMPERATURES

According to most recent Cal-Adapt projections[14], overall temperatures are expected to continue to rise throughout the century. By aggregating and averaging downscaled global climate models, scientists predict a temperature increase of between 5.2 and 8.3 degrees Fahrenheit between the historical time period (1961 to 1990) and projected time period (2070 to 2099) in our area. This suggests that average overall temperature could shift from the historical average of 61.9 degrees Fahrenheit to 67 (under the low emissions scenario) or 70.1 degrees Fahrenheit (under the high emissions scenario) for the 2070 to 2099 time period. These projections differ depending on the time of year and type of measurement (highs vs. lows), all of which have

[61] Hamilton SL, Logan CA, Fennie HW, Sogard SM, Barry JP, Makukhov AD, et al. (2017) Species-Specific Responses of Juvenile Rockfish to Elevated pCO2: From Behavior to Genomics. PLoS ONE 12(1): e0169670. doi:10.1371/journal. pone.0169670

[62] The City is grateful to Lisa Uttal (Monterey Bay National Marine Sanctuary), Alexandra Golikov (MBNMS), and John Ryan (Monterey Bay Aquarium Research Institute) for their major contribution to the Ocean Acidification section.

[63] Cal_Adapt. "Exploring California's Climate Change Research." Accessed August 17, 2017.

different potential effects of water use and availability, energy demand, human and environmental health, fire risk, and agricultural production.

As temperatures rise there will be a direct impact on the water supply, proliferation of pests, potential outbreak of diseases and overall quality and quantity of produce.[64] Climatic changes alter the range, biogeography, and growth of microbes and the vectors of food, water, and vector-borne illnesses. This includes the changes in aquatic environments that could increase harmful algal blooms and lead to increases in foodborne and waterborne illnesses.

Heat waves are associated with increased mortality rates and disproportionately affect older persons. This is compounded by shifting demographics to an aging population. According to the *Climate Change and Health Profile Report: Santa Cruz County,* increased heat also intensifies the photochemical reactions that produce smog and ground level ozone and fine particulates (PM2.5), which contribute to and exacerbate respiratory disease in children and adults.[65] Increased heat and carbon dioxide enhance the growth of plants that produce pollen, which are associated with allergies; and increased temperatures can also lead to increase energy consumption for climate control and refrigeration. Maintaining a healthy tree canopy and other vegetation can help buffer rising temperatures.

FOOD, FUEL & ENERGY AVAILABILITY

As the impacts of climate change intensify, food and energy availability will become more important. Climate change is expected to have global impacts on food production and distribution systems, which can cause food prices to increase, thereby making food less affordable. This in turn increases food insecurity, obesity, and malnutrition in economically constrained households. While no community food assessment comparing food availability across neighborhoods has been conducted, it is clear that community gardens, personal gardens and local agriculture feed many in our community. Maintaining access to locally produced food is of high importance. The community is fortunate to have abundant local, and frequently organic, food producers within Santa Cruz County. Regional climate and soils are conducive to a wide range of crops. The City and County have several local farmers' markets and many supermarkets in the area feature local produce. A community goal of "buying local" supports local farmers and producers so that they are able to continue farming, creating the opportunity for long term food availability and reduced fuel consumption in transport of foods. The City recognizes that supporting our local food producers contributes to the economic vitality of our community as well as its long-term sustainability. Increased temperatures and decreased water availability stress the food production system, including farm workers, creating an environmental justice

[64] Ibid.

[65] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*

issue. Climate change may require adaptive measures to protect workers and crops from high heat and ensure access to high quality locally produced food.

Also, with increasing temperatures, the energy grid will continue to be strained by its users' cooling needs. Without action, this stress creates an unreliable power source. The City recognizes it needs to continue to find ways to reduce imported energy consumption and support efforts in the private sector to do the same through energy conservation and distributed, local renewable energy generation.

FIGURE 3.17: LOCAL FARMERS' MARKET PRODUCE

IMPACTS TO HABITAT AND ECOSYSTEMS

Local ecosystems face significant multiple threats from climate change ranging from changes in sea levels (discussed previously), water, temperature, fire frequency, disease, phenology, range shifts, food web disruptions, reduction in buffering capacity, and extinction risks (see Figure 3.14). With continued climate change, many species may be unable to adapt or to migrate to suitable climates, particularly given the influence of other factors such as land use, habitat alteration, and emissions of pollutants. A complete review of these impacts is beyond the scope of the CAP Update, but will be addressed in the upcoming West Cliff Drive Shoreline Adaptation and Management Plan development.

Warming ocean conditions—another effect of climate change—is causing certain species to expand and/or change their range in response to rising ocean temperatures. For example, a species of nudibranch sea slug is expanding its range northward along the California coast in response to warming ocean conditions. Historical surveys of nudibranch populations along the California coast show a 210 kilometer (km) northward shift in the range for *Phidiana hiltoni* (*P. hiltoni*) since the mid-1970s. Until 1975, *P. hiltoni's* most northern location was on the Monterey Peninsula. Beginning in the late 1970s, its range expanded north across Monterey Bay to Santa Cruz County. By 1992, it had spread another 110 km up the coast into the San Francisco Bay area as far north as Duxbury Reef. Following its initial spread, *P. hiltoni* has persisted at each of these sites to the present day.[66] This is significant since the habitats of nudibranchs overlap with commercially important organisms, including abalone, crab, and lingcod. Although changes in the ranges of small, short-lived marine organisms such as nudibranchs may seem inconsequential, the nudibranch's response to ocean warming may foretell larger ecological changes that may already have been set in motion by climate change; and the expansion of marine organisms into new territories can have negative biological impacts on resident

[66] Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2018). *Indicators of Climate Change in California*.

organisms, similar to those of invasive species.[67] In addition to the impacts of local marine organisms, there would be potential impacts to coastal habitats and ecosystems. For example, warming temperatures can have a strong influence on some of the processes affecting fog formation, which is prevalent in Santa Cruz. Fog plays a vital role in coastal ecosystems, and according to the *Central Coast Regional Report* [68],"coastal zone flora can get up to 1/3 of their water from intercepted fog water." Plants in fog-filled forests can take in water through their leaves, supplying lifesaving "fog drip" to salmonids in low flow coastal streams that would otherwise dry out during the late summer dry season. In addition, shade from summertime fog and low clouds cools coastal systems, reducing the rate of plant evapotranspiration and plant uptake of subsurface water reserves, leaving more water in the system.[69] Furthermore, the disappearance of fog in late summer can exacerbate the climatic water deficit for entire watersheds, leading to fire-ready tinder conditions.

Climate change would also rearrange coastal and valley vegetations of the Central Coast, altering the habitats of wildlife. Among the changes of greatest concern are shifts in plants found nowhere else in the world (Central Coast endemics) or found only in the Central Coast and other parts of California (California endemics). According to the *Central Coast Regional Report*, "to conserve all species as these changes in location are unfolding, we want to protect species where they are now, where they will be in the future, and we want to know the connecting paths that can get them from where they are now to where they will be." The mountains of Santa Cruz also present complex mosaics of urban and wildlands, little of which is conserved on a scale meaningful for plant responses to climate change. As such, all of these areas are high priority for additional protection to facilitate native plant movements to climate change. Prioritizing these areas for conservation and managing lands to provide substantial areas in natural condition will facilitate movements of the Central Coast's native plants in response to climate change.[70]

One of the hallmarks of the Central Coast region is the multitude of microclimates created by topography, aspect, slope and proximity to the Pacific Ocean. In Santa Cruz, sandstones from the Miocene have created sand islands in the Santa Cruz Mountains that harbor numerous sensitive species. The sensitivity of such abrupt ecotones to climate change are not well understood, but should be a priority for monitoring.[71]

Healthy ecosystems generally exhibit high biodiversity and have ecological redundancy. They provide valuable ecosystem services that benefit crop production, water systems, and moderate heat, reduce disease, reduce flooding, offer recreation and enhance public wellbeing. Ecological resiliency is best promoted through an ecosystems approach, which relies on preserving core

[67] Ibid.
[68] Langridge, Ruth. (University of California, Santa Cruz). 2018. *Central Coast Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-006.
[69] Ibid.
[70] Ibid.
[71] Ibid.

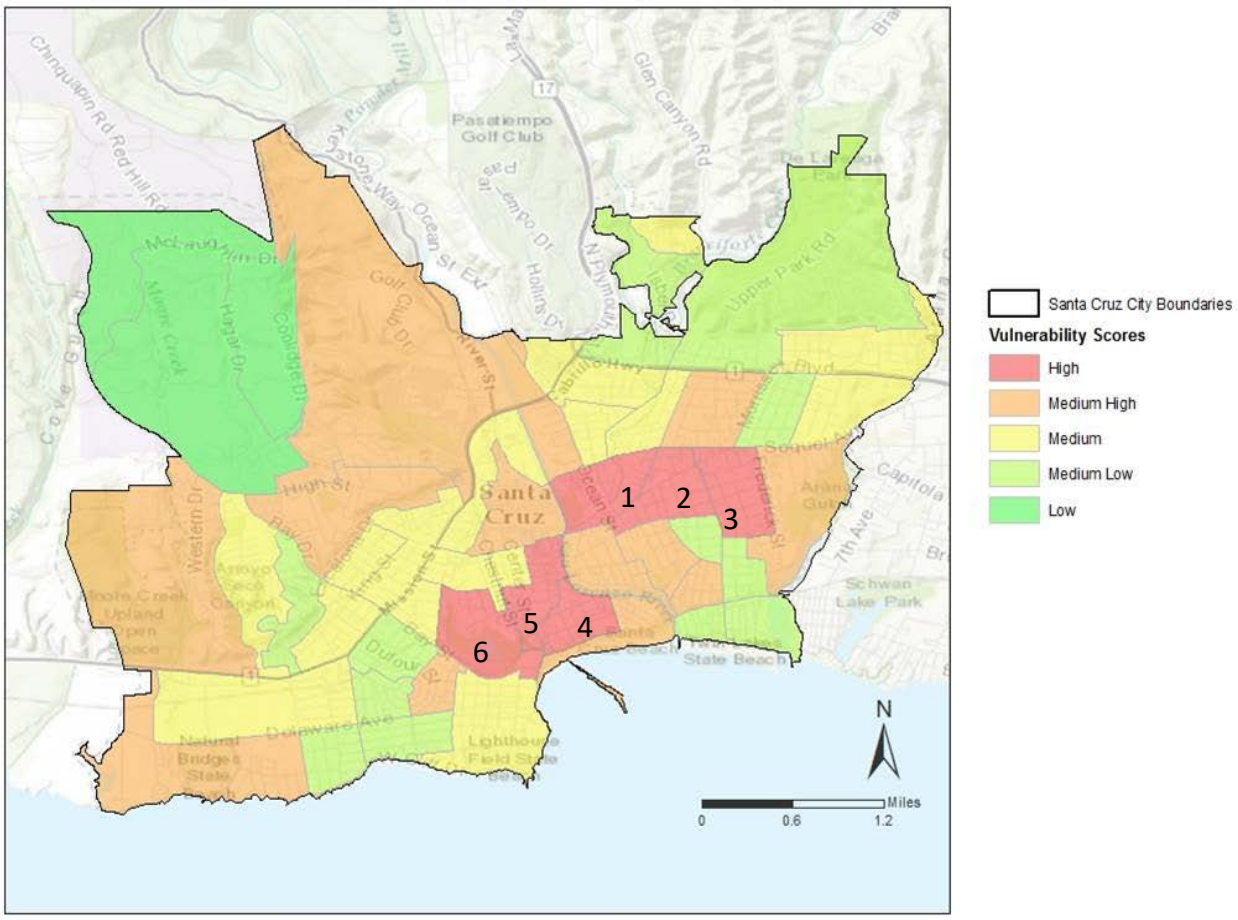
ecosystem components rather than focusing on single species. "... Such ecosystem-based approaches are thereby not simply about saving ecosystems, but rather about using ecosystems to help "save" people and the resources on which they depend."[72] Since ecosystems and their component species do not recognize political boarders, integration of local, regional, statewide, and federal efforts are important in increase ecosystem resiliency. Some ecological changes will require follow up restoration to backfill vacancies in the landscape; this process requires the practice of ecological restoration.

[72] Burgiel, Stanley W., and Adrianna A. Muir. "Invasive Species, Climate Change and Ecosystem-Based Adaptation: Addressing Multiple Drivers of Global Change." *Global Invasive Species Programme (GISP)*, Sept. 2010.

SOCIAL VULNERABILITY

The objective of the Social Vulnerability to Climate Change Hazards Assessment was to evaluate the geographic scale and drivers of social vulnerability. Taking place at the city block group level, several local indicators were compiled to form a social vulnerability score for each block group. The indicators of social vulnerability include 1) an income below the median income (based on HUD home income limits), 2) elderly (>65 years of age), 3) language limitations, 4) disability, and 5) crime incidence (violent and property crimes). The methodology used to determine social vulnerability scores for each city block group is contained in Appendix E.[73] Figure 3.18 displays the results of the social vulnerability scoring and is followed by descriptions of the six blocks determined to be highly social vulnerable.

FIGURE 3.18: SOCIAL VULNERABILITY SCORES BY CITY BLOCK GROUP



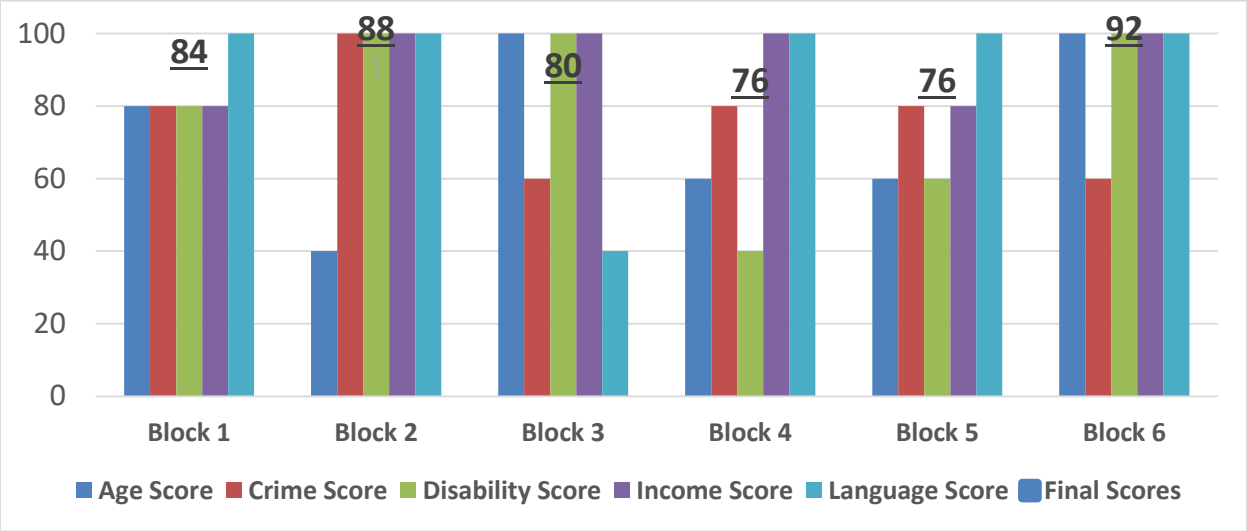
[73] Appendix E also contains maps of the individual social vulnerability indicator scores.

High Social Vulnerability Block Group Descriptions

1 = Lower Ocean (San Lorenzo River to Branciforte; Water to Soquel)
2 = Lower Soquel (Ocean to Seabright; Water to Broadway)
3 = Seabright (Water to Windham; Frederick to Seabright)
4 = Beach Hill (Beach to Front/San Lorenzo River, Riverside)
5 = Downtown/South of Laurel (Soquel to Laurel including Front, Pacific, Cedar; Laurel to West Cliff until Chestnut)
6 = Laurel and Neary Lagoon (Chestnut to California; Bay to Laurel)

Figure 3.19 illustrates the individual social vulnerability score for the six high social vulnerable block groups as well as the driving indicators of social vulnerability that contribute to these blocks' high scores.

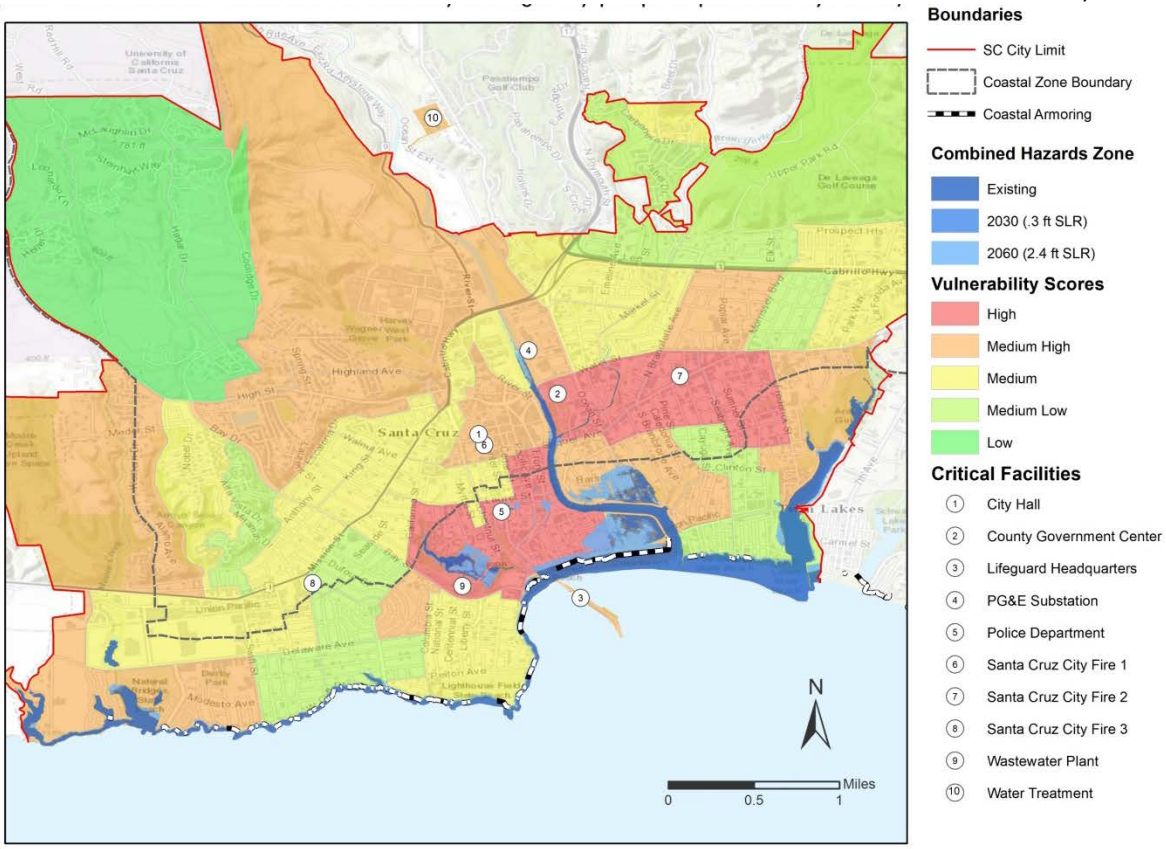
FIGURE 3.19: HIGH SOCIAL VULNERABILITY BLOCK SCORES AND INDICATORS



For example, the most socially vulnerable block group, group 6 at Laurel and Neary Lagoon, scores highest due to the highest possible scores for number or elderly persons, persons with a disability, low incomes and language limitation indicators yet has a relatively low crime incidence score in comparison to the other block groups.

Figure 3.20 is useful when the natural hazard zones are overlain onto the social vulnerability map as the community is better able to plan and implement adaptation strategies that address both infrastructure assets *and* the drivers of social vulnerability. For example, Figure 3.20 overlays the combined SLR impact hazard zones on the social vulnerability scoring. Figure 3.20, illustrates increased flooding and erosion in highly vulnerable Block groups 4, 5 and 6 primarily, and flooding in Block group 1 to a lesser degree. In Block groups 4, 5 and 6 language limitations are driving vulnerability. Based on the area demographics, any efforts to educate, inform, and alert residents about flooding in this area needs to be provided in languages other than English. The analysis further indicates that low incomes and high incidence of disability also drive social vulnerability in Blocks 4, 5 and 6.

FIGURE 3.20: SOCIAL VULNERABILITY SCORES AND COMBINED SEA LEVEL RISE HAZARDS (2030 AND 2060) (HAZARD ZONES INCLUDE AREAS CURRENTLY MANAGED BY PUMPS OR PROTECTED BY LEVEES)



Vulnerability scores were also overlain with fire hazard areas (Figure 3.21) and tsunami planning areas (Figure 3.22) and reveal similar results as the combined SLR hazard areas. Notably, high social vulnerability in Block group 6 coincides with the fire hazard zone where incidence of elderly persons, persons with a disability, low incomes and language limitation indicators are driving factors. Special attention by the Fire Department is warranted in these areas in terms of notifications and evacuations. Similarly to the combined SLR hazard zone, high social vulnerability also coincides with tsunami planning areas in Block groups 4, 5 and 6 and to a lesser degree in Block group 1.

FIGURE 3.21: SOCIAL VULNERABILITY SCORES AND FIRE HAZARDS (2030 ONLY)

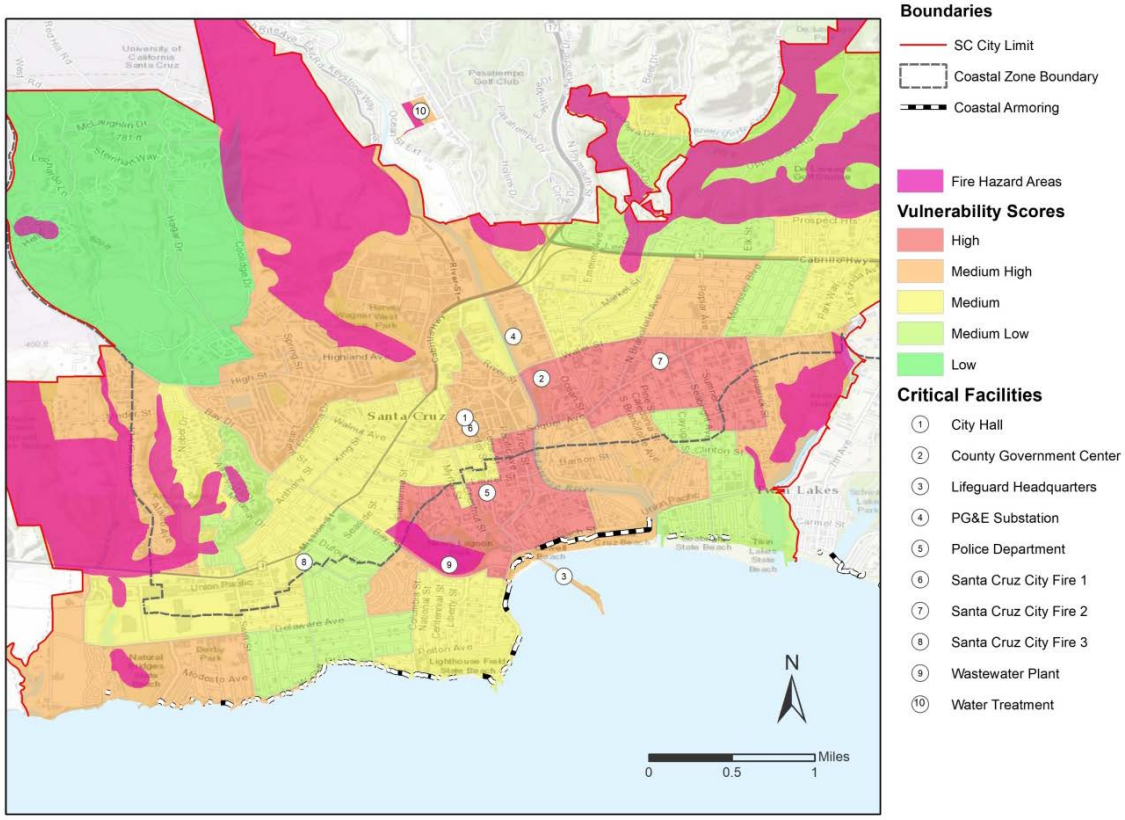
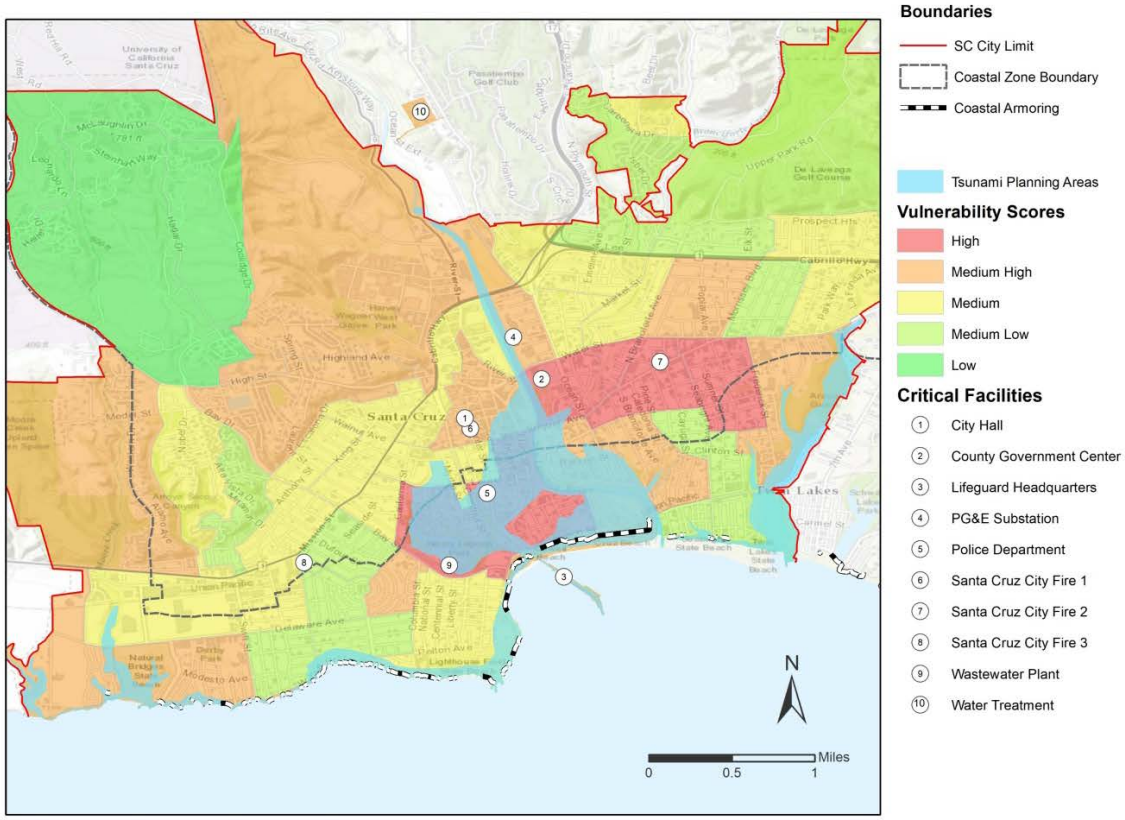


FIGURE 3.22: SOCIAL VULNERABILITY SCORES AND TSUNAMI PLANNING AREAS (2030 ONLY)



In Chapter 4, planning of the adaptation strategy has been modified to include consideration of social vulnerability. Individual strategies reference where and how social vulnerability can be addressed. Between the draft and final CAP Update, the Climate Action Program designed and implemented a robust award-winning[74] outreach campaign targeting socially vulnerable populations as indicated by this assessment. The details of that campaign are included in Chapter 4. Moreover, in future adaptation efforts, the City should ensure that outreach, engagement, and education efforts ensure that vulnerable communities have a seat at the table in coastal decision making processes and are prepared to effectively plan for the impacts of climate change. In future analyses, the City should evaluate impacts on socially vulnerable subpopulations, e.g., lesbian, gay, bisexual, transgender, homeless, immigrants, persons living with mental illness, other non-english speakers, climate refugees, and etc. and their particular needs and constraints (e.g., identification documents to obtain services).

PUBLIC HEALTH

Climate change deepens the need to take actions that reduce vulnerabilities and increase resilience in our communities. The impact of climate change in California varies across the state due to diversity in biophysical setting, climate, and jurisdictional characteristics. According to the *Climate Change and Health Profile Report: Santa Cruz County*[75]*,* temperatures in the Central Coast Region are expected to rise substantially throughout this century with an increase in average temperatures in January of "1°F to 2°F in 2050 and 4°F to 5°F by 2100. July increase in average temperatures of 2°F to 3°F by 2050 and 4°F to 7°F by 2100." In addition, "coastal areas should expect one more heat wave per year by 2050 and four to eight more per year by 2100." Santa Cruz is also projected to experience declines in annual precipitation (of about 2 inches by 2050 and 3 to 4 inches, by 2100 while more elevated areas are projected to experience loses of approximately 10 inches), as well as an increase in wildfire risk (the eastern edge of the region is projected to experience an increase in wildfire risk of 4 to 6 times current conditions). This combination of climate related effects can have significant impacts on public health through the following pathways: direct exposures, indirect exposures, and socioeconomic disruption (see Figure 3.23).

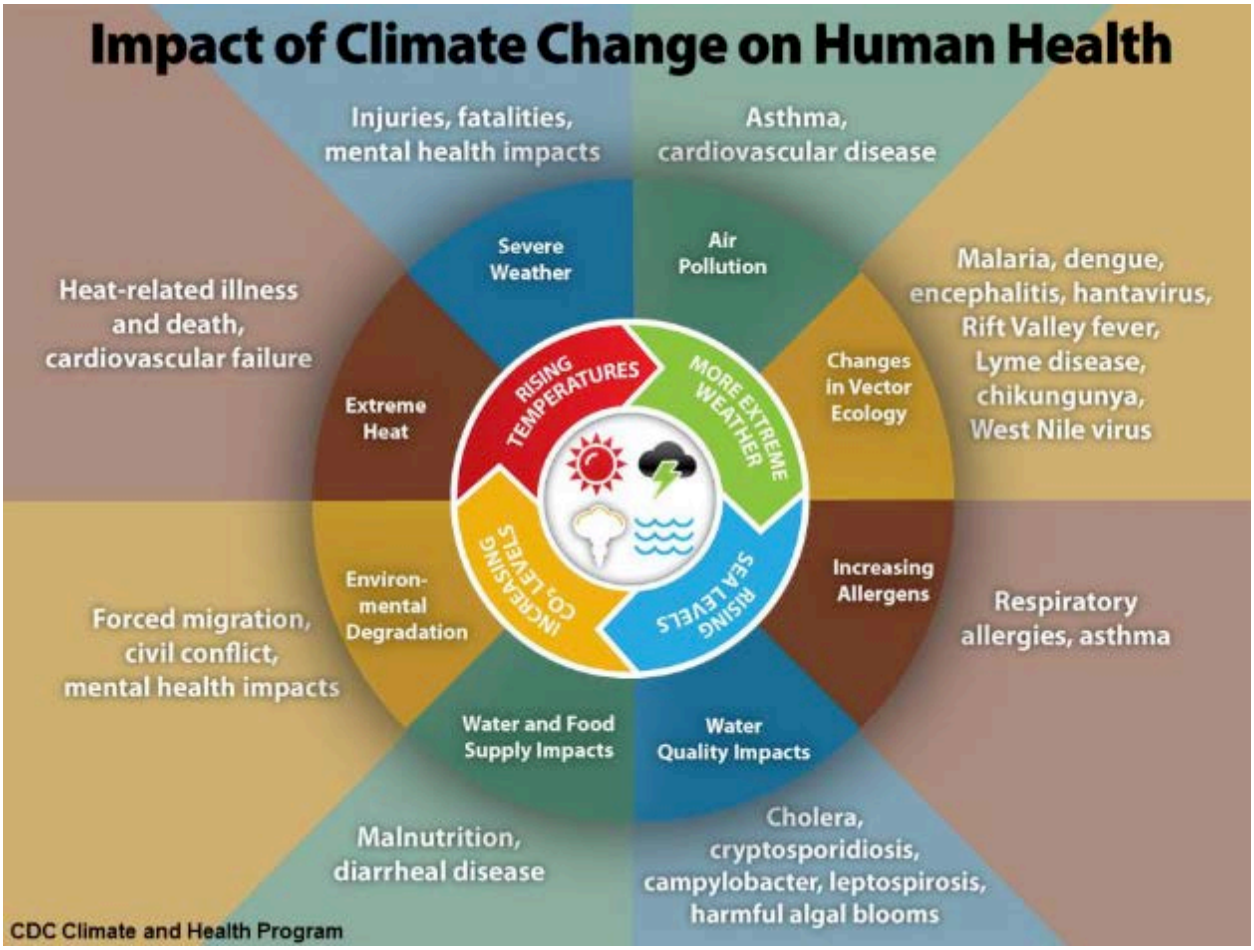
As noted previously, there is a broad range of environmental hazards attributed to climate change, including: heat waves, wildfires and wildfire smoke, air pollution, sea level rise and inland flooding. Climate change affects the social and environmental drivers of health outcomes, can exacerbate existing health conditions, and compounds the risks of adverse health outcomes.

All Californians are vulnerable to the health impacts of climate change; however, based on medical reviews of individuals who died during heat waves and other extreme weather events, those who are particularly vulnerable to the direct effects of climate change include the very old and very young, individuals who have chronic medical conditions and psychiatric illness, people

[74] Northern California American Planning Association Award of Merit for focus on social vulnerability in climate adaptation planning (2018).
[75] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*

taking multiple medications, people without means for evacuation (no access to public transit or private cars), people who are socially isolated, medically fragile people, and people living in institutions.[76]

FIGURE 3.23: IMPACT OF CLIMATE CHANGE ON HUMAN HEALTH[77]



As noted previously, there is a broad range of environmental hazards attributed to climate change, including: heat waves, wildfires and wildfire smoke, air pollution, sea level rise and inland flooding. Climate change affects the social and environmental drivers of health outcomes, can exacerbate existing health conditions, and compounds the risks of adverse health outcomes. All Californians are vulnerable to the health impacts of climate change; however, based on medical reviews of individuals who died during heat waves and other extreme weather events, those who are particularly vulnerable to the direct effects of climate change include the very old and very young, individuals who have chronic medical conditions and psychiatric illness, people

[76] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*

[77] American Public Health Association. 2018. <https://www.apha.org/topics-and-issues/climate-change/health-impacts>. Accessed July 27, 2018.

taking multiple medications, people without means for evacuation (no access to public transit or private cars), people who are socially isolated, medically fragile people, and people living in institutions.[78]

Although there are groups of people who may be particularly vulnerable to the direct effects of climate change, a much larger part of the population is vulnerable to intermediate or socioeconomic factors such as preexisting physical and mental health conditions, cultural or physical isolation, occupations involving outside or high risk work, a precarious socioeconomic status, or lack of social cohesion and collective efficacy. Furthermore, climate change magnifies existing health disparities; and disadvantaged populations, such as those with low education, experiencing racial segregation, low social support, poverty, and income inequality face disproportionate climate-related health burden.[79] To build resilience to climate change, the capacity of communities to prepare, respond, and recover from climate-related health risks should be improved. As such, according to the *Climate Change and Health Profile Report: Santa Cruz County*, some public health strategies and actions for adapting to climate change include the following. Many of these strategies are currently being implemented by the City on an ongoing basis or under consideration.

- Promote community resilience to climate change to reduce vulnerability
- Educate, empower and engage California residents, organizations and businesses to reduce vulnerability through mitigation and adaptation
- Identify and promote mitigation and adaptation strategies with public health co-benefits
- Establish, improve and maintain mechanisms for robust rapid surveillance of environmental conditions, climate-related illness, vulnerabilities, protective factors and adaptive capacities
- Improve and sustain public health preparedness and emergency response
- Work in multi-sectoral partnerships (local, regional, state and federal)
- Conduct applied research to enable enhanced promotion and protection of human health
- Implement policy changes at local, regional and national levels
- Identify, develop and maintain adequate funding for implementation of public health adaptation strategy

Overall, the goal of public health adaptation strategies is to minimize the negative health impacts of climate change.

[78] California Department of Public Health (CDPH). 2017. *Climate Change and Health Profile Report: Santa Cruz County.*
[79] Ibid.

SUMMARY OF POTENTIAL IMPACTS

The climate change vulnerability assessment reviews in more detail the potential hazards faced by the community as a result of climate change, including extreme storm events, drought, flooding, increased wildfire threat, ocean acidification, salt water intrusion and temperature change. The Social Vulnerability Assessment enables more tailored planning and response to the potential SLR and non-SLR hazards to those where risk is confounded by extrinsic factors. The updated Adaptation Strategy (see Chapter 4) enumerates the goals, objectives and strategies identified to respond to those threats.

This assessment identifies a number of potential risks and vulnerabilities that threaten our community as the result of climate change, but the timeframe of these impacts is uncertain. Regardless of this uncertainty, building resilience into policies, projects, programs and infrastructure is good government. This CAP Update is also an opportunity for City leaders to share this information with the community and to assist residents and businesses in preparing for potential climate change impacts. A comprehensive outreach campaign is a critical next step identified which the City is actively seeking resources to complete.

CHAPTER 4
ADAPTATION STRATEGIES

BUILDING RESILIENCY AND PREPARING FOR IMPACTS

The City of Santa Cruz endeavors to be a climate resilient community preparing for potential impacts of climate change, while preserving the diversity and quality of its natural and built environments. The community strives to offer excellent cultural and community services as well as to protect, preserve and improve infrastructure, community safety and emergency preparedness. The 2011 Climate Adaptation Plan sought to build short and long term resilience into policies, programs, projects and infrastructure. In addition, it focused on evaluation and resilience of City-owned structures, particularly those identified as critical facilities. It also encourages the establishment of standards to encourage private property owners to consider incorporating resilience planning as a part of the development process for their own properties in order to reduce the impacts of climate change. This 2018 CAP Update builds on the previous plan by updating climate change science into resiliency and preparedness.

ADAPTATION PLANNING DOES NOT STOP AT THE CITY LIMITS

The City is actively engaged with local, regional, state, and federal organizations to stay informed of the best available scientific data on potential climate change impacts, to collaboratively work towards meeting the City's objective of being a climate resilient community, and protect the quality of its natural and built environments. The City actively participates in the Monterey Bay Regional Climate Action Compact (Compact), an action network of government agencies, educational institutions, private businesses, non-profit, and non-governmental organizations who are committed to working collaboratively to address the causes and effects of global climate change through local initiatives that focus on economic vitality and reduce environmental impacts for the region. The City's Sustainability and Climate Action Manager facilitates the Compact's Intergovernmental Committee and is also a Steering Committee member of the newly formed Central Coast Climate Collaborative (4C). 4C is a membership organization fostering a network of local and regional community leaders throughout six central coast counties to address climate change mitigation and adaptation. 4C engages with other collaboratives throughout the state formed for the same purpose and recently hosted a well-attended Climate Resilience Workshop (April, 2018). The City's Sustainability and Climate Action Manager is also a member of the Local Stewardship Council for the Santa Cruz World Surfing Reserve where one of three foci is on sea level rise and its impact on surfing resources. City staff also regularly engage with the National Marine Sanctuary, Center for Ocean Solutions, California Coastal Conservancy, the International Council for Local Environmental Initiatives, along with representatives from local governments.

The City also relies on a vast network of residents, non-profit partners, technical consultants, advocacy groups, and academics who are interested in advancing mutually beneficially climate resilience goals. These groups meet though the City's Climate Action Task Force Adaptation

Subcommittee and the San Lorenzo River 2025 working group as well as other ad hoc collaborations.

This CAP Update focuses on potential strategies that might be implemented to reduce or avoid impacts of climate change. Despite uncertainty in range of climate change impacts, the community can achieve more climate resiliency and minimize damage by making informed policy, wise land use decisions, structural improvements on existing buildings, and maintaining ongoing programs such as vegetation management in wildland/urban interface areas. The city and collective community can also build resilience by engaging residents in dialog on and solutions to climate related impacts.

ADAPTATION STRATEGIES ALREADY UNDERTAKEN

The City has implemented or is in the process of implementing a number of actions that will build resilience to the impacts of climate change. The City continues to work with the US Army Corps of Engineers (USACE) to enhance the San Lorenzo River levee[80]. The City's former Water Supply Advisory Committee (WASC) and other regional water agencies evaluated water supply alternatives in 2014-2015 and the Water Department is currently implementing the strategy for supply augmentation as recommended by the WASC. The Water Department completed reconstruction of the Bay Street Reservoir Facility (Bay Reservoir Tanks Project), providing up to three days of water during an emergency, and recently outfitted one tank with solar photovoltaics, further enhancing the City's resilience to natural hazards. Moreover, the City continues to make investments in energy efficiency and renewable energy and joined a community choice energy program, all aimed at bolstering energy independence and reliability.

The City has undertaken a sea level rise and social vulnerability assessment as presented herein. Most of the bridges that have been damaged by or have exacerbated flooding in the past have also been replaced[81]. The Highway 1 Bridge is the last bridge in the City that requires full replacement due to the center span impacting the hydraulics of the river and obstructing debris during flood flows. The Fire Department continues its efforts to minimize risk to the City within the wildland/urban interface through both targeted and ongoing programs delineated in the 2017 LHMP Update.

Over FY18, the City will be completing a grant funded urban tree inventory and increasing tree canopy by planting 500 trees in addition to those planted in an normal year. In addition, City and nonprofit groups continue to complete coastal restoration projects. For example, there is an existing dune at Seabright that is in the process of being restored by Groundswell Coastal Ecology, known as the Seabright Beach Coastal Enhancement Project, which began in 2013. The

[80] Currently the Public Works department is working with USACE to reevaluate the hydraulics of the project after 50 years of operation, including sediment transport as the USACE prepares to turn the project over to the City. The City has designed a sediment deposition reduction project in the river to yield more flood carrying capacity without the need for frequent dredging.

[81] Initial evaluation by the Public Works department indicated that SLR did not have a significant impact on the river flow levels moving upstream. However, with new information on flooding and the projected contribution from sea level rise, bridges will need to be reevaluated for functional integrity.

project started at the entrance cove to Seabright and now extends from the San Lorenzo River Mouth to the West Harbor Jetty, making it the largest coastal restoration project in the City of Santa Cruz. As of now, over one-half mile of coastal dune, sand, and bluff habitat have been restored at Seabright Beach. A full list of the strategies identified in the 2011 Climate Adaptation Plan, progress on those strategies and other projects already completed or currently underway are available in Appendix H.

GOALS, OBJECTIVES AND STRATEGIES

Goals are general guidelines that explain what is to be achieved. They are broad-based, long-term, policy statements, and represent global visions. Goals help define the benefits that the plan is trying to achieve. The success of this Climate Adaptation Plan will be measured by the degree to which its goals are accomplished to yield actual climate impact risk reductions. To that end, the City must develop and implement a quantitative evaluation program to effectively measure efficacy.

OVERARCHING STRATEGIC GOALS FOR THE CITY OF SANTA CRUZ

In 2017, the City Council developed a strategic two-year work plan for the 2018–2019 fiscal years under a set of guiding principles that includes protecting our unique setting, our natural and established open space, and the sustainable use of our natural resources. In addition, the work plan identifies strategic goals for the community around housing, public safety and well-being, and infrastructure. City Council's strategic two-year work plan (FY 18 and FY 19) informs and supports the goals and objectives presented in this Climate Adaptation Plan Update. Moreover, this CAP Update is included in the City Council work plan as a featured Programs and Operations Spotlight focus area.

CLIMATE ADAPTATION PLAN GOALS

The City has retained the adaptation goals defined in the 2011 Climate Adaptation Plan as:

1. Protect the unique character, scenic beauty and culture in the natural and built environment from being compromised by climate change impacts
2. Support initiatives, legislation, and actions to respond to climate change
3. Build resilience into all programs, polices and infrastructure
4. Encourage climate change resilience planning and strategies in private companies, institutions, and systems essential to a functioning City of Santa Cruz
5. Support initiatives, legislation and strategies for reducing and responding to climate change
6. Encourage community involvement and public-private partnerships to respond to potential climate impacts.
7. Ensure that Santa Cruz remains a safe, healthy and attractive place with a high quality of life for its residents, businesses and visitors

OBJECTIVES

In the 2011 Climate Adaptation Plan development, the Climate Adaptation Team selected objectives to meet multiple goals. The objectives were also used to help establish priorities. The following list of objectives was developed for the CAP Update. Each is followed by direct general actions taken or recommended to support the achievement of the objectives:

1. Consider potential climate change impacts in planning and decision making processes.
    a. A proposal was made to the Finance Department for the capital improvement project (CIP) lists to identify projects that support or implement Climate Adaptation Plan Update goals.
    b. A proposal was made to City Manager's Office to modify the standard City Council Agenda report template to require inclusion of a statement on how the project or program supports or addresses CAP Update goals.[82] For example, for CIP projects that are located in climate hazard zones, staff will describe how they will be resilient to the projected risks for the life of the structure.
2. Coordinate adaptation planning with other land use plans, including the Local Hazard Mitigation Plan, General Plan, Local Coastal Program and zoning land use codes.
    a. The Local Coastal Plan Update is underway and the Planning Department staff is ensuring coordination between efforts. Coordinate with California Coastal Commission on the City's LCP update.
    b. Planning and Building staff have discussed augmenting energy efficiency and renewable energy strategies with the City's Green Building Program and should consider including climate adaptation as well.
    c. City staff should continue to participate in regional coastal sea level rise planning efforts.
3. Collaborate with others to raise awareness about climate change impacts
    a. The City's Community Climate Action Task Force has recently formed a Climate Adaptation subcommittee.
    b. The City's Sustainability and Climate Action Manager makes regular presentations to community groups, education institutions, and other local government agencies.
4. Seek opportunities to inform the community on potential climate change impacts.
    a. The City completed a broad public outreach campaign that started in the late Fall of 2017 that ended in June 2018.
    b. The City has and will support and participate in public events that incorporate hands on adaptation projects.
    c. The City has and will work with partners to integrate climate change adaption education in schools.
5. Incorporate ongoing monitoring processes to inform decisions.

[82] The City of San Francisco's *Guidance for Incorporating Sea Level Rise into Capital Planning* and *Sea Level Rise Checklist* serve as excellent reference resources in the development of the City of Santa Cruz' policies and practices.

   a. The City will develop a quantitative evaluation program to effectively measure efficacy. A proposal has been made to present an annual climate adaptation progress review to City Council (similar to the City's Sustainability and Climate Action Manager's annual climate action plan progress update).
   b. The City will develop a monitoring, triggers and threshold program to guide sequencing of adaptation strategies and policies
6. Seek opportunities to develop an environmentally sustainable economy.
   a. The City is in the process of developing its own socially and environmentally responsible business practices policy including an environmentally preferable purchasing policy.
7. Continue aggressive Greenhouse Gas (GHG) mitigation efforts.
   a. The City continues to work toward achieving its 2020 greenhouse gas emissions target and continues to evaluate and implement other opportunities to bring operations toward carbon neutrality.
8. Minimize impacts of future SLR.
   a. The City invested in its first SLR vulnerability assessment, using a best-science, metric driven process to consider climate adaptation options.
   b. The City should undertake additional evaluation of beach impacts particularly to understand the timing around beach narrowing, options to preserve beaches and protect development backing beaches, and provide recreational and tourism benefits.
   c. Consider adopting policy that provides for coastal ecological restoration following retreat actions.
9. Maintain and add to the city's urban tree canopy and increase tree diversity within urbanized areas.
   a. The City was awarded a 2017 Cal FIRE grant, which is enabling 500 additional trees to be planted in addition to the 300 annually planted in a normal year.
10. Support protection of the Monterey Bay Marine Sanctuary.
   a. The City has enacted policies such as the plastic bag ban, biofiltration of runoff, coastal restoration, and others along with sustained engagement in working groups actively seek to protect the Bay.

IDENTIFICATION & ANALYSIS OF ADAPTATION STRATEGIES

In support of the enumerated goals and objectives, the City of Santa Cruz has identified a number of potential climate adaptation Strategies. The strategies were developed through an inclusive departmental and community process. The process included input from, and collaboration, with:

- The Climate Adaptation Team
- Two Climate Adaptation Focus Groups
- Employee Sustainability Team
- Department Heads
- Scientific advisors
- Transportation and Public Works Commission

- Planning Commission
- Downtown Commission
- Interested community members via online survey responses on past LHMP and CAP
- Interested community members via a public outreach campaign

PRIORITIZATION OF STRATEGIES

Table 4.1 contains a list of strategies based on the Vulnerability Studies completed in 2011 and 2017. These are adaptation strategies that could be undertaken to reduce potential losses or damages to people or property as a result of climate change impacts. The City's Climate Adaptation Team and internal Sustainability Team met and discussed priorities based on risks identified and potential losses as a result of those risks, reviewed in relation to funding, ability to implement, and consistency with other plans. To aid in the prioritization process, Department Heads applied the FEMA-recommended STAPLEE method to evaluate costs in relation to benefits of implementing a particular strategy over another. A description of the STAPLEE indicator criteria, the results of the prioritization process comparing 2011 and 2017, and detailed descriptions for each strategy (including time horizon, status of proposed and ongoing activities for pre-2030 strategies, and other required resources and stakeholders) are contained in Appendix D.

The strategies compiled through this process are contained in Table 4.1. Strategies that address climate impacts with the highest risk to the community, primarily SLR and extreme storm events as well as wildfire potential received higher priority rankings. The City will pursue implementation of these strategies to meet Goals set out above. Strategies, along with initial suggestions for implementation, identification of lead departments in the City, preliminary estimates of resources required and timeline, are detailed in Appendix G. The priorities are three-tiered; however, the listing within each tier is not indicative of relative importance within that listing category. Symbols denote changes (Δ) from 2011 indicator assignments Yes, No or Maybe, (Y, N or M) and (+) when a new action was added for 2017.

The potential Strategies were selected as most beneficial for the City of Santa Cruz and represent the highest priority adaptation strategies identified. Each of these Strategies meets an objective or goal listed in the City of Santa Cruz Climate Adaptation Strategy (Chapter 3). These Strategies are not meant to be exhaustive but rather to provide a framework upon which to make current and future decisions to and provide each department with a role in climate adaptation and a baseline of strategies backed by a planning process that is consistent with the goals, objectives and capabilities of the City. Some identified strategies were combined to remove repetition.

TABLE 4.1: 2017 PRIORITIZED CLIMATE ADAPTATION STRATEGIES

Strategies		Social	Technical	Administrative	Political	Legal	Economical	Environmental	Priority	Lead Department
PLANNING – VERY HIGH PRIORITY										
A-1[+]	Increase public awareness, education, and public outreach in areas with social vulnerabilities that coincide with hazard zones	Y	Y	Y	Y	Y	Y	Y	Very high	City Manager
A-2	Evaluate all related decisions through a climate lens	Y	Y	Y	Y	Y	Y	Y	Very High	City Manager
A-3	Prepare for potential sea level rise throughout the City	M[Δ]	Y	N	M[Δ]	Y	N[Δ]	Y	Very High	City Manager
A-4[+]	Identify priority areas for managed retreat to retain public access and sufficient beach area for recreational use; plan to relocate roads and infrastructure	N	Y	N	N	N	Y	Y	Very High	Planning
INFRASTRUCTURE – VERY HIGH PRIORITY										
A-5[+]	Adopt policies to evaluate limiting municipal capital improvements that would be at risk	Y	Y	Y	Y	Y	Y	Y	Very High	Public Works
A-6[+]	Prioritize public coastal protection structures for upgrade and replacement	Y	Y	M	M	N	N	Y	Very High	Public Works
A-7	Upgrade or relocate City buildings, the Wharf and infrastructure to protect and prepare for sea level rise, flooding and storm events occurring as a result of climate change	Y	Y	Y	Y	Y	N	N	Very High	City Manager
A-8	Monitor and protect wastewater facility from ground water infiltration	Y	Y	Y	Y	N	Y	Y	Very High	Public Works
A-9	Seal wastewater pipes throughout system	Y	Y	Y	Y	Y	N[Δ]	Y	Very High	Public Works
A-10	Seal pump gallery at Wastewater Treatment Facility	Y	Y	Y	Y	Y	Y	Y	Very High	Public Works
A-11	Monitor all pumping station sites	Y	Y	Y	Y	Y	Y	Y	Very High	Public Works
A-12[+]	Storm drain pump station upgrades	Y	Y	Y	Y	Y	Y	Y	Very high	Public Works
A-13	Replace Highway 1 Bridge	Y	Y	N	N	Y	Y	Y	Very High	Public Works
A-14	Protect downtown and beach area from San Lorenzo River flooding	Y	Y	N	N	N	Y	N	Very High	Public Works

[+] These strategies were added in the CAP Update

[Δ] These criteria scores were changed from 2011 Climate Adaptation Plan strategy prioritization

Strategies		Social	Technical	Administrative	Political	Legal	Economical	Environmental	Priority	Lead Department
A-15	Protect adjacent neighborhoods and commercial areas from Branciforte Creek and other stream flooding	Y	Y	Y	Y	Y	Y	Y	Very High	Public Works
WATER – VERY HIGH PRIORITY										
A-16	Improve Water Supply Reliability	Y	Y	Y	Y	N$^{\Delta}$	N$^{\Delta}$	Y	Very High$^{\Delta}$	Water
A-17	Monitor open space/watershed	Y	Y	N	Y	N	N	Y	Very High	Water
A-18	Conserve and curtail water usage	Y	Y	Y	Y	N	M$^{\Delta}$	Y	Very High	Water
A-19	Protect, redesign or relocate coastline-related water infrastructure	Y	N	N	N	N	N	Y	Very High	Water
A-20^{+}	Improve resiliency to flooding along the Coast (project dependent)	M	Y	N	N	N	N	M	Very High	Planning
A-21	Reduce impacts of creek and/or river flooding to water system infrastructure	Y	Y	N	Y	N	N	Y	Very High	Water
A-22	Prepare for short-term water shortage and water emergency supply for climate related events	Y	Y	Y	Y	Y	Y	Y	Very High	Water
A-23	Rehabilitate water system infrastructure from landslides and erosion	Y	N	N	N	N	N	Y	Very High	Water
FIRE MANAGEMENT – VERY HIGH PRIORITY										
A-24	Establish and/or maintain cooperative fire agreements	Y	Y	Y	Y	Y	Y	Y	Very high	Fire Dept.
ECONOMIC DEVELOPMENT – VERY HIGH PRIORITY										
A-25	Protection of visitor serving venues and natural resources	Y	Y	Y	Y	N$^{\Delta}$	N	Y	Very High	P & R
INFRASTRUCTURE – HIGH PRIORITY										
B-1	Engineer a cut off wall to protect wastewater treatment facility	Y	Y	Y	Y	N	Y	N	High	Public Works
B-2^{+}	Investigate beach nourishment	Y	N	M	N	N	N	N	High	Public Works
WATER – HIGH PRIORITY										
B-3	Prevent risks from dam failure	Y	Y	Y	Y	Y	Y	Y	High	Water
B-4	Prepare for potential changes in water quality due to climate change	Y	Y	N	Y	N	Y	Y	High	Water
ECONOMIC DEVELOPMENT – HIGH PRIORITY										
B-5	Prepare for new opportunities and challenges to tourism and preserve the industry as an economic base	Y	Y	M	Y	M	Y	Y	High	Eco. Dev.
PLANNING – HIGH PRIORITY										
B-6	Develop and enforce appropriate setbacks for development adjacent to cliffs	Y	Y	Y	N$^{\Delta}$	N$^{\Delta}$	N$^{\Delta}$	Y	High	Planning

Strategies		Social	Technical	Administrative	Political	Legal	Economical	Environmental	Priority	Lead Department
B-7	Protect natural shoreline processes from alteration	M	Y	Y	N$^{\Delta}$	N$^{\Delta}$	N$^{\Delta}$	N	High	Planning
B-8	Mitigate development in flood plains	N	Y	N	N	N	N	Y	High	Planning
B-9	Disseminate flood hazard information and encourage participation in FFIP	Y	Y	Y	Y	Y	Y	Y	High	Planning
FIRE MANAGEMENT – HIGH PRIORITY										
B-10	Develop and enforce limitations for new development to prevent and mitigate impacts of wildfires	Y	Y	Y	Y	Y	Y	Y	High	Planning
INFRASTRUCTURE – IMPORTANT										
C-1	Protect, repair/replace Hwy 1 bridge crossing the San Lorenzo River	N	Y	Y	N$^{\Delta}$	N$^{\Delta}$	N	N	Impt.	Public Works
FIRE MANAGEMENT – IMPORTANT										
C-2	Increase vegetation management efforts and the transition to native fire resistant plant communities to reduce wild land fire potential	Y	Y	Y	Y	Y	Y	Y	Impt.	Fire Dept.
C-3	Increase public awareness, education and enforcement of wild land fire threat	Y	Y	Y	Y	Y	Y	Y	Impt.	Fire Dept.
C-4	Increase open space monitoring to reduce incidence of human caused wild land fire	Y	Y	Y	Y	Y	N	Y	Impt.	Fire Dept.
C-5	Prevent urban/wild land interface fire hazards in parks	Y	Y	Y	Y	Y	N	Y	Impt.	P & R
PARKS & RECREATION – IMPORTANT										
C-6	Protect and preserve tree canopy and other native coastal vegetation	Y	Y	Y	Y	Y	Y	Y	Impt.	P & R

Note: Appendix K contains a comparative table of strategies by climate hazard and impact for both the County of Santa Cruz and the City for reference.

STRATEGY FEEDBACK FROM PUBLIC OUTREACH

A description of the nine-month climate adaptation outreach campaign is summarized in Chapter 5 and more fully in the City's *Climate Adaptation Plan Update Outreach Plan*. However, strategy preferences indicated by residents and other stakeholder groups are included in this section. In addition to the pre-Plan Update public survey (Appendix I), during the summer of 2018, staff solicited feedback from local focus groups on both City specific (Table 4.1) and regionally identified climate hazard priorities.

The focus groups found it difficult to identify and prioritize strategies contained in Table 4.1 due to several strategies being broad and generalized. After some discussion, the highest strategy priorities identified by the focus groups included (in ranked order): (1) Identify priority areas for managed retreat; relocate roads and infrastructure; (2) evaluate all related decisions through a climate lens; and (3) prepare for potential sea level rise throughout the City.

The focus group also identified what they believed to be the most substantial barriers to implementing this work as well as the three catalyzers (or opportunities) that would help to implement this work. The focus group called out the following barriers (with the status on each): (1) consider how business-as-usual development must change in areas affected by SLR (occurring through the Local Coastal Program Update in progress); (2) clarify process for considering how managed retreat might work (this will be initiated by the West Cliff Shoreline Adaptation and Management Plan); (3) a rotating mayor-ship prevents sustained leadership, as well as political will; (4) conveying a sense of urgency; and (4) funding and incentivizing through regulation.

As for the catalyzers (or opportunities) to advance this work, the focus group identified the following: (1) joining many other vibrant cities that are embracing the need to change; (2) including discussions of future generations in outreach; (3) conducting scenario planning and identifying a post disaster vision; (4) including co-benefits into adaptation projects; (5) considering demonstration projects and (6) referencing other public outreach campaigns for best practices. Furthermore, those who participated in outreach events emphasized the needs for high level community leaders who can champion this work, actively engage, and be a face for climate resilience. They suggested these leaders should be diverse and include local youth, women, persons of color, artists, politicians and local surf heroes. Next step projects like the West Cliff Drive Shoreline Adaptation and Management Plan will strive to identify and work with diverse community leaders.

The central coast region (from Santa Cruz County to the North and Ventura County to the south) identified nearly twenty projects upon which it could collaborate in each of two priority climate hazard areas: wildfire and SLR[83]. For wildfire, the following strategies were prioritized: (1) multi-hazard assessment of wildfire, (2) regional no build easement downsizing in critical fire areas, and (3) electrical upgrades. [84] And for SLR, the following strategies were prioritized: (1) intentional environmental justice, (2) 50-year retreat plan, and (3) restore sand dunes. Two local focus groups of various stakeholders completed an exercise where they reviewed and discussed the full suite of projects proposed for the two climate hazard areas and identified the three top projects on which the City should collaborate with the rest of the central coast region. **The focus groups identified two priorities for wildfire that aligned with the regional priorities: (1) conducting a multi hazard assessment, and (2) creating no build easement /building downsizing in critical fire areas. The focus groups identified two priority projects for SLR that aligned with the regional priorities: (1) developing a 50-year retreat plan, and (2) an intentional focus on environmental justice.** Other highly ranked priorities for SLR include studying the dynamics of coastal armoring (impacts and feasibility) and relocation of critical infrastructure inland. These two SLR priorities are called out as adaptation strategies in Table 4.1. The focus group responses will guide collaboration and implementation of City specific strategy priorities.

[83] Due to time constraints, the regional project prioritization effort only considered wildfire and sea level rise as these were deemed the most severe and pervasive on the central coast.
[84] *Santa Cruz Draft Climate Adaptation Plan*. Regional Project or Coordination Priorities for Santa Cruz.

CHAPTER 5
PLAN MAINTENANCE PROCESS

KEEPING THE CLIMATE ADAPTATION PLAN ACTIVE & RELEVANT

The maintenance section of this document details the formal process that will ensure that the City of Santa Cruz Climate Adaptation Plan Update remains an active and relevant document informed by the best available scientific information. The Climate Adaptation Plan will be reviewed and evaluated annually and updated every five years. As a part of the monitoring process the Climate Action Program will incorporate climate science updates across departments, develop measures of resilience, review implementation of identified strategies, and track either quantitatively or qualitatively how well the implementation meets the established resilience goals. The City will continue to invite public participation throughout the plan maintenance and implementation process. Finally, this chapter explains how the City intends to incorporate the strategies outlined in this Climate Adaptation Plan Update into existing planning mechanisms and programs, such as the Climate Action Plan, the General Plan, the Capital Improvement Program, Local Coastal Program, and other ongoing City policies and programs. The City will continue to review and update specific strategies as more conclusive scientific data becomes available; incorporating procedures that allow revisions based on the best available scientific data to insure that the Plan will remain current and relevant and will contribute to the long term sustainability and resilience of the City of Santa Cruz.

EVALUATION OF THE PLAN

The City Climate Adaptation Team will be tasked with the evaluation of the Climate Adaptation Plan, staying current with the climate science including participation in regional and state planning climate adaptation groups, and using those resources incorporating the most recent available scientific data. This review will include the following:

- Summary of climate change impacts that occurred during the year.
- Development of measures of resilience to evaluate strategies.
- Review of successful strategies identified and implemented.
- Review of barriers to targeted strategies identified but not completed.
- Re-evaluation of Timelines as information on impacts and funding is updated.
- Recommendations for new action items.
- Identification of potential new funding options (grant opportunities).
- Participation in climate adaptation work groups
- Integration of new scientific data including GIS data and mapping used to inform the Plan.
- Review of other planning programs or initiatives within the City that may be impacted by climate change.

The Climate Action Program will prepare a formal annual report on the progress of the Climate Adaptation Plan Update. This report will be used as follows:

- Distributed to Department Heads for review.
- Posted on the City social media and website at the Climate Adaptation Plan page.
- Presented in the form of a council report to the Santa Cruz City Council.

METHOD AND SCHEDULE FOR UPDATING THE PLAN WITHIN 5 YEARS

The City of Santa Cruz intends to update the Climate Adaptation Plan in conjunction with the LHMP on a five-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than five years based on direction from City Council.

It is not the intent of this update process to start from scratch and develop a new complete hazard mitigation plan for the City of Santa Cruz. Based on needs identified by the Climate Adaptation Team, this update will, at a minimum, include the elements below:

- The update process will be convened through a Climate Adaptation Team appointed by the City Manager and will consist of at least one member of the General Plan Update committee or staff to ensure consistency between plans.
- The Vulnerability Study will be reviewed and updated using best available scientific information and technologies at a minimum of once every three years.
- The evaluation of critical structures and mapping will be updated and improved as funding becomes available.
- The proposed action items will be reviewed and revised to account for any strategies completed, dropped, or changed and to account for changes in risk assessment or new City policies identified under other planning mechanisms, as appropriate.
- The draft update will be sent to appropriate agencies for comment.
- The public will be given an opportunity to comment prior to adoption.
- The Santa Cruz City Council will adopt the updated plan.

IMPLEMENTATION THROUGH EXISTING PROGRAMS

The effectiveness of the City's LHMP including the CAP Update is dependent upon the incorporation of the outlined action items into existing City plans, policies, and programs. The CAP Update includes a range of action items that, if implemented, would reduce loss from potential climate change impacts in the City of Santa Cruz. Together, the action items in the CAP Update provide the framework for decision makers in building a more resilient community based on the best available climate science information. The Climate Adaptation Team has prioritized the plan's goals and identified strategies that may be implemented (resources permitting) through existing plans, policies, and programs.

In 2016, the City Manager's Office assumed responsibility for overseeing the CAP's update, implementation and maintenance through the City's existing Climate Action Program. The Deputy City Manager or appointee will assume lead responsibility for facilitating Climate Adaptation implementation and maintenance meetings. Although the City Manager's Office will have primary department responsibility for review, coordination, and promotion; plan

implementation and evaluation will be a shared responsibility among all departments identified as the lead departments in the Climate Adaptation Plan Update. The City Manager's Office with input from Public Works and the Planning Department will continue to work closely with the City's Office of Emergency Services Analyst to ensure consistency in Plans during updates.

PLANNING MECHANISMS FOR INCORPORATING THE REQUIREMENTS OF THE PLAN

The information on risks, vulnerabilities and potential adaptation strategies contained in this plan is based on the best information and technology available to the Climate Adaptation Team at the time the Climate Adaptation Plan was prepared. As previously stated, the City's General Plan is considered to be an integral part of this plan. The City views the General Plan, the LHMP, the adopted Climate Action Plan and the adopted Climate Adaptation Plan along with subsequent updates as complementary documents that work together to achieve the ultimate goal of the reduction of risk exposure and increased resilience to the citizens of Santa Cruz. Many of the recommended action items in this Plan are also recommended by the General Plan, the Urban Water Management Plan, The Fire Department Strategic Plan, The Capital Improvement Program and other adopted plans. Accordingly, the City will continue to coordinate the recommendations of the Climate Adaptation Plan with other planning processes and programs including the following:

- Emergency Operations Plan
- General Plan Update's Safety Element
- Local Coastal Plan Update (in progress)
- Capital Improvement Program
- City of Santa Cruz Municipal Code
- Community design guidelines
- Water-conservation guidelines
- Storm Water Management Program
- Fire Department Strategic Plan
- Fire Prevention Plan
- Parks Master Plan (currently in draft format)

Many strategies do not need to be implemented through regulation. Instead, these items can be implemented through upgrades to infrastructure, updates to policies and programs, creation of educational programs, continued interdepartmental and interagency coordination, incentives, and improved public participation.

PUBLIC INVOLVEMENT

Public involvement is a crucial aspect of the CAP Update, and as such, a nine-month, city-wide climate adaptation outreach campaign was conducted and aimed at increasing climate-readiness and resilience of residents, particularly vulnerable communities, to climate change impacts. The project did this by:

- improving community awareness of local climate change impacts,
- introducing community members to the city's Updated Adaptation Plan
- identifying community-based adaptation opportunities, and
- equitably providing the tools, materials, and encouragement necessary for residents and community groups to plan for and act on climate information on an ongoing basis.

The Climate Action Program developed fact sheets (See Appendix I), action sheets, frequently asked questions, slide decks, webpages and activities, all translated to Spanish and distributed in a variety of formats. Furthermore, the Climate Action Program actively engaged the community at over 50 events in activities that were aimed at increasing climate readiness and community resilience. Overall, approximately 57 percent of the events were targeted to the general public (approximately 20 percent of which were defined as socially vulnerable populations). Figure 5.1 depicts the overall audience distribution for these outreach events.

OUTREACH OUTCOMES

51 events with 20% targeted to socially vulnerable groups

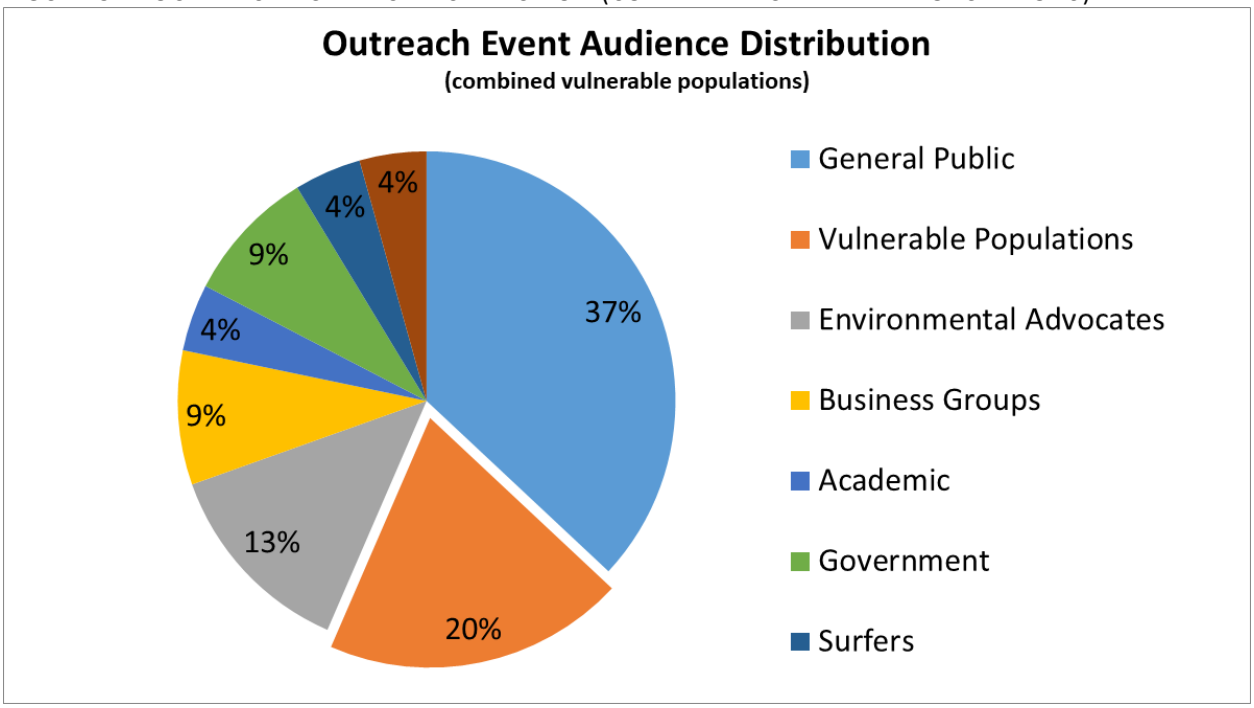
220 promotional fliers posted

10,846 Facebook impressions

603 Participants

275 Fact Sheets Distributed

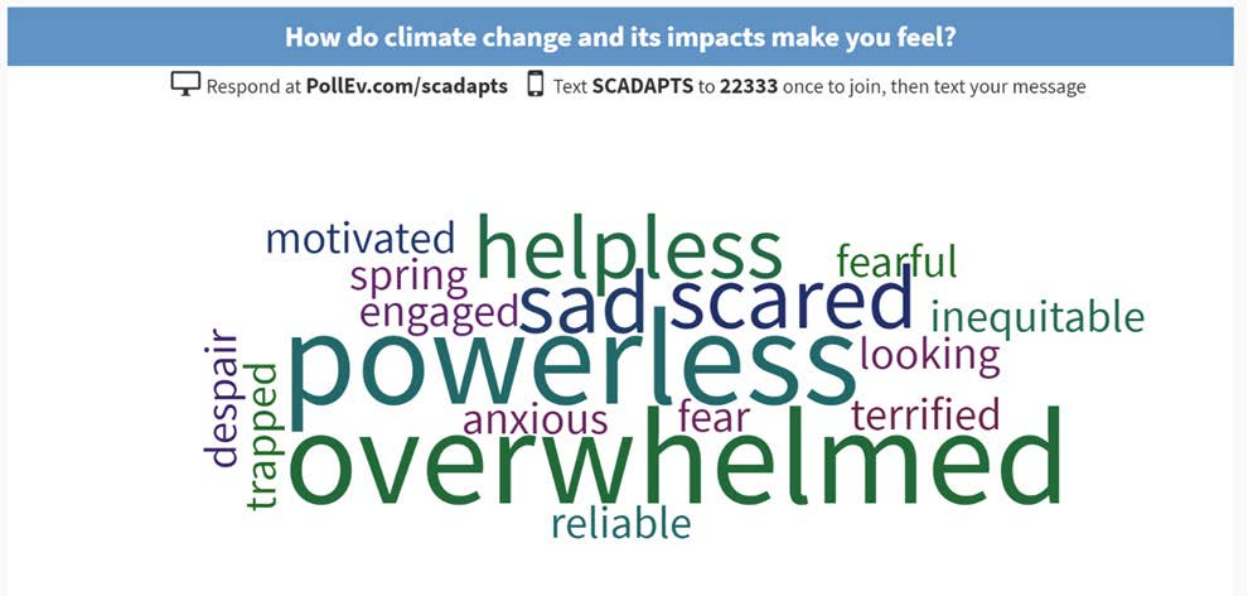
FIGURE 5.1: OUTREACH AUDIENCE DISTRIBUTION (COMBINED VULNERABLE POPULATIONS)



Interactive polling was used to inquire about stakeholder values and how climate change made them feel. Sample responses of the polling results are depicted in Figures 5.2 and 5.3.

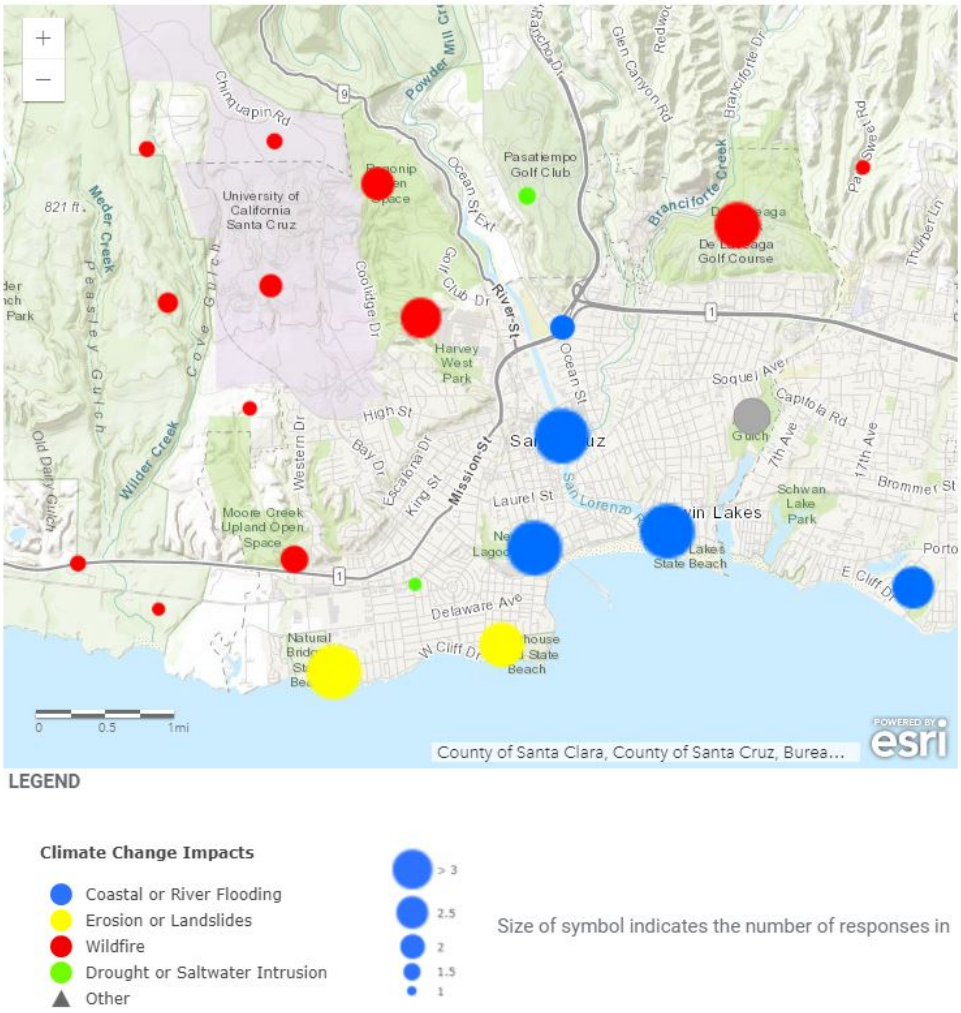
FIGURE 5.2: SHARED VALUES THAT ARE IMPACTED BY CLIMATE CHANGE ACTIVITY – "WHAT IS YOUR FAVORITE THING ABOUT SANTA CRUZ" [SAMPLE RESPONSES]

FIGURE 5.3: FEELINGS ACTIVITY – "HOW DOES CLIMATE CHANGE MAKE YOU FEEL?"[SAMPLE RESPONSES]



In addition to activities such as interactive polling, the Climate Action Program also collected geospatial data from residents on where they have experienced or are concerned about climate change impacts via a mapping activity[85]. Figure 5.4 depicts the cumulative results from the geospatial data collected at the public events.

FIGURE 5.4: WHAT CLIMATE CHANGE IMPACTS RESIDENTS ARE YOU CONCERNED ABOUT AND WHERE?



In addition to the outreach campaign in FY 18, the public will continue to be apprised of Climate Adaptation efforts through public outreach events, the City website and updates to responsible commissions. Copies of the CAP Update will be distributed to the Santa Cruz Library System. A partial listing of the activities associated with the public outreach campaign are contained in Appendix I. Upon initiation of the next CAP update process, a new public involvement strategy will be initiated.

[85] For this activity, participants placed sticky dots on locations where they were concerned about/have experienced climate change. Colored dots represent different climate change impacts: coastal or river flooding, drought or saltwater intrusion, wildfire, landslides and erosion, other. After the forum, maps were digitized and responses were placed on the Climate Adaptation website.

CITY OF SANTA CRUZ

APPENDICES

APPENDIX A
CRITICAL FACILITIES

A critical facility is vital to a community's ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact. Under the Santa Cruz Local Hazard Mitigation Plan (LHMP) definition, critical facilities include the following: Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers needed for disaster response before, during, and after hazard events.

Facility	Location
Police Station	155 Center Street
Fire Station No. 1	711 Center Street
Fire Station No. 2	1103 Soquel Avenue
Fire Station No. 3	335 Younglove Avenue
UCSC Fire Station	1156 High Street
City Hall and Annex	809 Center Street
Corp Yard	1125 River Street
Emergency Operations Center	495 Upper Park Road
Marine Safety and Lifeguard HQ	#1 Municipal Wharf
County Government Building	701 Ocean Street
Jail	259 Water Street
Blaine S. Facility (Women's Jail)	141 Blaine Street
County Mental Health	1400 Emeline Avenue
Harbor Master HQ	135 Fifth Avenue
Post Office -HQ	850 Front Street
Post Office	1146 Soquel Avenue
Wastewater Treatment Facility	110 California Street
Water Treatment	715 Graham Hill Road
Bay Street Reservoir	200 Cardiff Place
Lock Lomond Reservoir	100 Loch Lomond Way
Refuse Disposal	605 Dimeo Lane
PG&E Substation	Blaine Street

In addition to the above facilities there are public and private utilities and infrastructure vital to maintaining services to areas impacted by hazard events as well as facilities that serve populations requiring special services during hazard events including hospitals, nursing homes, senior and disabled housing and facilities likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event. There are no hospitals within the City limits. The following facilities may require special services: Family Shelter on Water Street; Senior Center; Hope Services; and Dorian Center for the Blind.

APPENDIX B
CITY OF SANTA CRUZ FACILITIES

City of Santa Cruz Facilities
Cultural Facilities
Civic Auditorium Dedicated in 1940 in downtown Santa Cruz, the Civic Auditorium is classic California. Arched granite pillars cover the brick entryway and warm pastel colors fill the hallways to create an inviting, slightly deco atmosphere. Hosting concerts, expos, meetings and private parties, the Civic has something for everyone.
Louden Nelson Center The Center's mission is to seek a balance between social, recreational and cultural services for the diverse communities of Santa Cruz. The Center strives to create a space that feels welcoming, comfortable, safe and accessible to all who use it.
Museums
Natural History Museum The City's Museum of Natural History is in Tyrrell Park above Seabright State Beach. Museum exhibits and programs are displayed in the modified 1915 Carnegie Library that sits on the park's southern edge, overlooking Monterey Bay. The Museum provides interesting exhibits and programs on the diverse cultural and natural history of the Santa Cruz region.
Surfing Museum The Santa Cruz Surfing Museum is housed in the Mark Abbott Memorial Lighthouse at Lighthouse Point on West Cliff Drive. Overlooking the internationally renowned surfing hot spot Steamer Lane, this little gem of a museum has photographs, surfboards, and other interesting items tracing over 100 years of surfing history in Santa Cruz.
Libraries
Santa Cruz Public Library The Santa Cruz Public Libraries is a city-county library system with libraries throughout the County of Santa Cruz, California. System Headquarters: 117 Union St., Santa Cruz, CA 95060, California 95060. 831-427-7706 ▪ Central Branch 224 Church Street ▪ Garfield Park 705 Woodrow Avenue ▪ Branciforte 230 Gault Avenue
Parks and Open Spaces
DeLaveaga Golf Course Carved in the hills overlooking Santa Cruz and the Monterey Bay, DeLaveaga Golf Course is a championship par 72 course known for its natural beauty, challenging layout and full range of services. DeLaveaga offers a lighted driving range, a comprehensive lesson program, men's and women's playing clubs and year-round tournaments.

City of Santa Cruz Facilities
Loch Lomond Recreational Area Loch Lomond Recreation Area offers fishing, boating, picnicking, and hiking. As a City of Santa Cruz drinking water reservoir, swimming and other body-contact water sports are not permitted.
Harvey West Park Harvey West Park is a 50 acre municipal park. Located just off the intersection of Hwys 1, 9, and 17 is truly Santa Cruz' most complete park complex. The park includes hiking trails, swimming pools, ball fields, play equipment, clubhouses, barbecue pits, and picnic areas.
Lighthouse Point, West Cliff Drive Point Santa Cruz, locally known as Lighthouse Point, forms the northern boundary of Monterey Bay. It is one of the last open headlands in any California urban area.
Neary Lagoon Neary Lagoon is an important part of the urban watershed for the west side of the City of Santa Cruz. A drainage area of approximately 850 acres empties into the lagoon, and from there, out to the Monterey Bay. However, during the dry season, Neary Lagoon flow is diverted to the Wastewater Treatment Facility in order to treat the water prior to discharge.
Pogonip A scenic 640 acre expanse of open meadows, woodlands and creeks, Pogonip features over nine miles of trails open to hikers.
Arana Gulch Arana Gulch is a 63 acre greenbelt land, featuring open meadows, oak woodland, Arana Creek, pedestrian and biking trails.
Neighborhood Parks Around Santa Cruz There are over 25 parks around Santa Cruz.
Wharf and Beaches
Santa Cruz Beaches
Santa Cruz Municipal Wharf Situated on the pristine Monterey Bay National Marine Sanctuary, the Santa Cruz Wharf combines the natural splendor of the sanctuary with the fun and recreation of the largest working wharf on the West Coast. Marine Safety and Lifeguard Headquarters are located on the Wharf.
Municipal Facilities
Landfill and Recycling Center The City of Santa Cruz Resource Recovery Facility and Recycling Center is owned and operated by the City of Santa Cruz. It is located at 605 Dimeo Lane which intersects Highway 1 about 3 miles north of the city limits.
Wastewater Treatment Facility The City of Santa Cruz has been treating sewage at the wastewater treatment facility near Neary Lagoon and disposing of the effluent in the ocean since 1928.
Water Treatment – Graham Hill Road

City of Santa Cruz Facilities
The Graham Hill Water Treatment Plant is a conventional surface water treatment plant that was commissioned in 1960 as a 12 mgd plant and can currently process up to 16 mgd with a year round average production of 10 mgd.

APPENDIX C
COASTAL PROTECTIONS STRUCTURE INVENTORY

COASTAL PROTECTION STRUCTURE INVENTORY[86]

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00037	36.964352	-122.015650	Seawall	Private, commercial	Developed	Protection of building	?	Good	concrete seawall on the beach side of the boardwalk
SC00038	36.964062	-122.011206	Retaining Wall	Public, local	Cliff/Bluff	Protection of parking	235	Good	stacked concrete precast as a stone wall
SC00039	36.964202	-122.010411	Retaining Wall	Public, local	Cliff/Bluff	Protection of road	60	Deteriorating	cemented sand bag retaining wall at the top of the bluff
SC00040	36.964196	-122.010168	Retaining Wall	Public, local	Cliff/Bluff	Protection of road	24	Deteriorating	cemented sand bag retaining wall at the top of the bluff
SC00041	36.963969	-122.007973	Surface Armor	Private, residential	Dune	Protection of residence	62	New	structure and fronting beach has been recently vegetated
SC00043	36.963846	-122.006710	Revetment	Public, state	Cliff/Bluff	Other	42	Good	small rocky revetment possibly covering culvert or storm drain outfall
SC00045	36.963512	-122.021533	Seawall	Public, local	Developed	Public access	765	Good	concrete vertical wall at the backshore of the beach in front of recreational path

[86] This table was prepared by CCWG using the Coastal Commission Coastal Protection Structure Inventory and updating it based on aerial imagery.

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00047	36.962378	-122.023471	Seawall	Public, local	Developed	Public access	50	Good	concrete seawall as part of wall protecting storm drain and culvert
SC00070	36.959144	-122.025745	Retaining Wall	Public, local	Cliff/Bluff	Public access	45	Unknown	sand bags stacked vertically possibly cemented together to form a retaining wall
SC00072	36.958647	-122.025702	Revetment	Public, local	Cliff/Bluff	Public access	845	Good	rocky revetment at the base of cliff
SC00093	36.954179	-122.024972	Revetment	Public, local	Cliff/Bluff	Public access	116	Good	rocky revetment
SC00094	36.952990	-122.025417	Revetment	Public, local	Cliff/Bluff	Public access	103	Good	rocky revetment
SC00095	36.953047	-122.039188	Revetment	Public, local	Developed	Public access	48	Good	rocky revetment on beach at base of concrete structure
SC00096	36.953047	-122.040204	Revetment	Public, local	Cliff/Bluff	Public access	107	Good	rocky revetment on beach at the base of the cliff
SC00097	36.953024	-122.040913	Revetment	Public, local	Cliff/Bluff	Public access	37	Good	rocky revetment placed in open space, possible sea save under vegetation
SC00098	36.953097	-122.039176	Retaining Wall	Public, local	Cliff/Bluff	Public access	150	Good	wall covers low bluff above shore platform
SC00099	36.953074	-122.039693	Revetment	Public, local	Cliff/Bluff	Public access	141	Good	rocky revetment on beach at the base of the cliff
SC00100	36.952918	-122.037952	Revetment	Public, local	Cliff/Bluff	Public access	34	Good	rocky revetment placed on the top of bluff
SC00101	36.952932	-122.037468	Revetment	Public, local	Developed	Public access	62	Good	rocky revetment placed on the top of bluff

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00102	36.953006	-122.038887	Revetment	Public, local	Developed	Public access	36	Good	rocky revetment placed at deteriorating pedestrian pathway
SC00103	36.952479	-122.025819	Revetment	Public, local	Cliff/Bluff	Public access	177	Good	rocky revetment
SC00104	36.952675	-122.036618	Revetment	Public, state	Cliff/Bluff	Protection of road	137	Good	structure absorbs wave energy through all tidal ranges
SC00105	36.952924	-122.038291	Revetment	Public, local	Cliff/Bluff	Public access	64	Good	rocky revetment on beach at the base of the cliff
SC00106	36.952817	-122.037116	Revetment	Public, local	Cliff/Bluff	Public access	26	Good	rocky revetment
SC00107	36.952078	-122.034629	Revetment	Public, local	Cliff/Bluff	Public access	312	Good	rocky revetment
SC00108	36.951920	-122.042130	Revetment	Public, local	Cliff/Bluff	Public access	64	Good	rocky revetment on beach and rocky platform
SC00109	36.952231	-122.035482	Revetment	Public, state	Cliff/Bluff	Protection of road	210	Good	structure length may extend to parking lot, check file
SC00110	36.952013	-122.033431	Revetment	Public, local	Cliff/Bluff	Public access	534	Good	rocky revetment covering cliff/bluff
SC00111	36.951762	-122.030128	Revetment	Public, local	Cliff/Bluff	Public access	67	Good	rocky revetment
SC00112	36.951818	-122.030189	Retaining Wall	Public, local	Cliff/Bluff	Public access	35	Unknown	revetment is made of sand bags possibly cemented together
SC00113	36.951695	-122.027162	Seawall	Public, local	Cliff/Bluff	Public access	407	Good	wall covers low bluff above shore platform
SC00114	36.951703	-122.030530	Revetment	Public, local	Cliff/Bluff	Public access	104	Good	rocky revetment on beach protecting cliff/bluff

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00115	36.951491	-122.042522	Revetment	Public, local	Cliff/Bluff	Public access	87	Good	rocky revetment on beach protecting cliff/bluff
SC00116	36.951123	-122.043178	Revetment	Public, local	Cliff/Bluff	Public access	98	Good	rocky revetment on beach protecting cliff/bluff
SC00117	36.950901	-122.043552	Revetment	Public, local	Cliff/Bluff	Public access	94	Good	rocky revetment on beach protecting cliff/bluff
SC00118	36.950406	-122.044592	Retaining Wall	Private, residential	Cliff/Bluff	Protection of residence	110	Unknown	gabions protects cliff, not sure of rocks contained in wire mesh
SC00119	36.950370	-122.044637	Revetment	Private, residential	Cliff/Bluff	Protection of residence	145	Good	same sized boulders 5' in length
SC00120	36.950271	-122.045178	Revetment	Public, local	Cliff/Bluff	Public access	82	Good	rocky revetment on beach protecting cliff/bluff
SC00121	36.949775	-122.046270	Revetment	Public, local	Cliff/Bluff	Public access	193	Good	rocky revetment on beach protecting cliff/bluff
SC00122	36.950412	-122.060445	Revetment	Private, residential	Inlet	Public access	122	Unknown	revetment protects a walkway surrounding a lagoon in mobile home community
SC00123	36.949746	-122.048051	Revetment	Public, local	Cliff/Bluff	Public access	56	Good	rocky revetment on beach protecting cliff/bluff
SC00124	36.949869	-122.047398	Revetment	Public, local	Cliff/Bluff	Public access	109	Good	rocky revetment on beach protecting cliff/bluff
SC00125	36.949561	-122.048527	Revetment	Public, local	Cliff/Bluff	Public access	140	Good	rocky revetment covers whole beach
SC00126	36.949595	-122.051496	Revetment	Public, local	Cliff/Bluff	Public access	91	Unknown	rocky revetment made of different sized material, material has been dispersed through wave action

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00127	36.949497	-122.050064	Revetment	Public, local	Cliff/Bluff	Public access	328	Good	large rocky revetment on beach protecting cliff/bluff
SC00128	36.949640	-122.056004	Revetment	Public, local	Cliff/Bluff	Public access	35	Good	rocky revetment protecting bluff
SC00129	36.949603	-122.055738	Retaining Wall	Public, local	Developed	Public access	144	Good	concrete vertical wall along pedestrian bike path
SC00130	36.949318	-122.054784	Revetment	Public, local	Cliff/Bluff	Public access	120	Good	very wide rocky revetment, covers the whole beach
SC00131	36.949150	-122.054076	Revetment	Public, local	Cliff/Bluff	Public access	62	Unknown	rocky revetment sits on platform of outcrop
SC00132	36.949165	-122.054079	Retaining Wall	Public, local	Cliff/Bluff	Public access	62	Unknown	sandbag stacked vertical on top of each other to create a wall structure
SC00152	36.960150	-122.025476	Retaining Wall	Private, commercial	Cliff/Bluff	Protection of building	?	Unknown	Installation of jacks, beam supports, or similar interim structural measures to support the cave ceiling, Construction of a tied back, reinforced concrete retaining wall at the mouth of the cave that will be keyed into the sandstone bedrock
SC00171	36.955069	-122.024607	Revetment	Public, local	Cliff/Bluff	Public access	207	Good	rocky revetment
SC00218	36.952067	-122.041977	Revetment	Public, local	Cliff/Bluff	Public access	54	Deteriorating	rocky revetment, rocks are dispersed, structure is placed on the toe of cliff below a storm drain

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00219	36.952376	-122.041817	Revetment	Public, local	Cliff/Bluff	Public access	55	Good	rocky revetment on beach at toe of bluff
SC00220	36.952426	-122.035775	Retaining Wall	Public, local	Cliff/Bluff	Public access	194	Good	vertical seawall on bluff in front of parking lot and pedestrian pathway
SC00221	36.952059	-122.026005	Revetment	Public, local	Cliff/Bluff	Public access	55	Good	rocky revetment
SC00222	36.958630	-122.025904	Retaining Wall	Public, local	Cliff/Bluff	Public access	318	Good	concrete wall with hand rails runs along pathway at the top of the bluff
SC00223	36.963811	-122.019329	Seawall	Private, commercial	Developed	Protection of building	323	Good	structure is a base of building pedestrian path
SC00224	36.964008	-122.007364	Retaining Wall	Public, local	Cliff/Bluff	Public access	44	Unknown	bin-wall structure at top of bluff underneath the railing
SC00225	36.963952	-122.006589	Retaining Wall	Public, state	Developed	Public access	176	Good	concrete seawall at the top of bluff with railings
SC00270	36.952619	-122.041558	Other	Public, state	Dune	Protection of utilities	158	Good	concrete structure possibly covers an outfall from pump station
SC00271	36.952261	-122.041697	Revetment	Public, state	Dune	Protection of utilities	?	Deteriorating	concrete structure possibly covers an outfall from pump station
SC00272	36.952900	-122.037147	Revetment	Public, local	Cliff/Bluff	Protection of road	13	Good	small rocky revetment
SC00273	36.952887	-122.037031	Revetment	Public, local	Developed	Protection of road	17	Good	small rocky revetment
SC00274	36.952971	-122.037633	Retaining Wall	Public, local	Developed	Public access	47	Unknown	concrete wall protects culvert for small creek outlet

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00275	36.952929	-122.037747	Revetment	Public, local	Cliff/Bluff	Protection of road	54	Good	small rocky revetment placed on top of rock platform
SC00276	36.951907	-122.032715	Revetment	Public, state	Cliff/Bluff	Protection of road	267	Good	large rocky revetment covering the exposed beach
SC00277	36.962335	-122.023832	Seawall	Public, state	Developed	Protection of parking	98	Good	concrete stairway for beach access from parking lot
SC00278	36.962310	-122.023604	Seawall	Public, state	Developed	Protection of utilities	53	Good	concrete wall with ridges for public viewing area
SC00279	36.964051	-122.011197	Retaining Wall	Public, local	Cliff/Bluff	Protection of parking	206	Good	stacked concrete precast as a stone wall
SC00280	36.963921	-122.007802	Retaining Wall	Private, residential	Cliff/Bluff	Protection of residence	52	Deteriorating	retaining wall made of slatted timber and steel may be leaning in some areas
SC00298	36.952370	-122.035960	Revetment	Public, state	Cliff/Bluff	Public access	80	Good	rocky revetment on beach and platform protecting recreational path
SC00299	36.959712	-122.025444	Infill	Public, local	Cliff/Bluff	Protection of road	68	Unknown	cave filled with 400 to 500 cubic yards of concrete
SC00300	36.951760	-122.032113	Revetment	Public, local	Cliff/Bluff	Public access	102	Good	rocky revetment at base of bluff
SC00301	36.952295	-122.035367	Retaining Wall	Public, local	Cliff/Bluff	Protection of road	37	Good	vertical concrete retaining wall at top of bluff
SC00302	36.962025	-122.024244	Revetment	Private, commercial	Developed	Protection of building	145	Good	riprap is partially covered by building and vegetation
SC00303	36.961162	-122.025245	Retaining Wall	Private, commercial	Developed	Protection of building	40	Good	6ft. high 40ft. long erosion control wall

Structure ID	Latitude	Longitude	Type	Public or Private?	Backshore	Armoring Purpose	Length (feet)	Condition	Physical Description
SC00333	36.965566	-122.013231	Revetment	Public, local	Cliff/Bluff	Public access	66	Good	rocky revetment
SC00334	36.963587	-122.019992	Retaining Wall	Private, commercial	Developed	Protection of building	285	Good	cantilevered deck
SC00347	36.949816	-122.053087	Revetment	Public, local	Cliff/Bluff	Public access	79	Good	rocky revetment protecting cove from erosion
SC00349	36.951716	-122.031577	Revetment	Public, local	Cliff/Bluff	Public access	75	Deteriorating	rocky revetment dispersed by wave action

APPENDIX D
COASTAL CLIMATE CHANGE VULNERABILITY ANALYSIS: METHODOLOGY, MAPS, TABLES & HAZARD INFORMATION

Prepared by Central Coast Wetlands Group / Adapted by City Staff

Disclaimer

The data utilized for purposes of this Vulnerability Assessment were collected from various sources and are not to be construed as "legal description." This information is intended to be used for planning purposes only. Site-specific evaluations may be needed to confirm/verify information presented in these data. Inaccuracies may exist, and Central Coast Wetlands Group (CCWG) implies no warranties or guarantees regarding any aspect or use of this information. Further, any user of these data assumes all responsibility for the use thereof, and further agrees to hold CCWG harmless from and against any damage, loss, or liability arising from any use of this information.

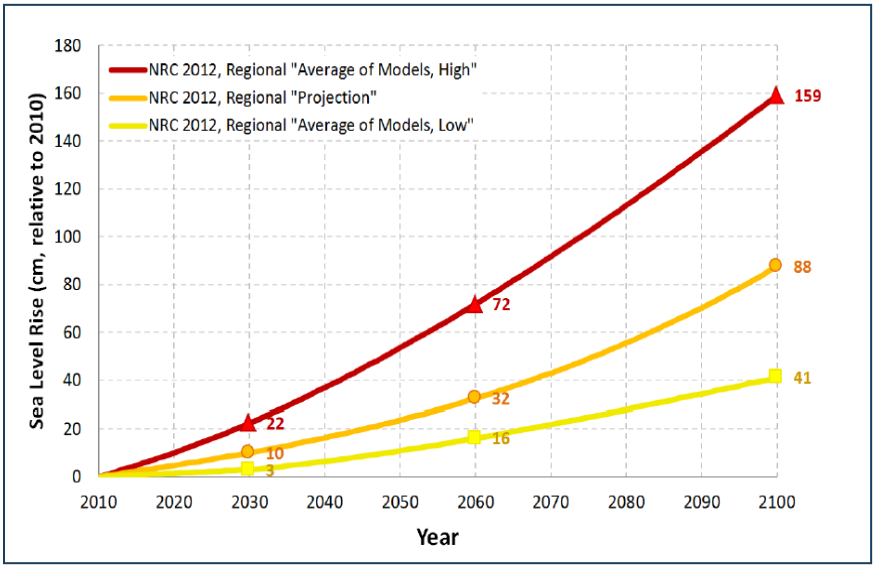
INTRODUCTION

This coastal climate change vulnerability analysis, conducted by the Central Coast Wetlands Group (CCWG) for the City of Santa Cruz, uses coastal hazard layers modeled by Environmental Science Associates (ESA) and funded by the State Coastal Conservancy. An important limitation of the original ESA hazard layers was addressed within this focus effort for the City of Santa Cruz. CCWG modified the hazard layers to account for reductions in potential hazards provided by current coastal protection infrastructure. This refinement of this coastal hazard analysis helped to better understand the future risks Santa Cruz may face from each individual coastal hazard process.

This vulnerability analysis evaluates the risks to infrastructure from both the combined impacts of coastal climate change and each individual coastal hazard process (rising tides, coastal storm flooding, and erosion) for time horizons 2010 (existing), 2030, 2060, and 2100. Although projected impacts to infrastructure were not summarized in the vulnerability tables for 2100 due to increased uncertainty in the models that far out, the coastal hazard maps do show the projected coastal hazard zones for 2100. This document provides an overview of the methodology used for this analysis, descriptions of each coastal hazard process, coastal hazard maps, and the associated vulnerability tables and charts.

For more information on the coastal processes and the methodology ESA used to model the original coastal hazards, please refer to the Monterey Bay SLR Vulnerability Assessment Technical Methods Report.[87]

SEA LEVEL RISE SCENARIOS FOR EACH TIME HORIZON (FIGURE SOURCE: ESA PWA 2014)



SCENARIO SELECTION

The California Coastal Commission guidance document[88] recommends all communities evaluate the impacts from sea level rise on various land uses. The guidance recommends using a method called "scenario-based analysis" (described in Chapter 3 of this Guidance). Since sea level rise projections are not exact, but rather presented in ranges, scenario-based planning includes examining the consequences of multiple rates of sea level rise, plus extreme water levels from storms and El Niño events. As recommended in the Coastal Commission guidance, this report uses sea level rise projections outlined in the 2012 NRC Report, *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*[89] (Figure 1).

The goal of scenario-based analysis for sea level rise is to understand where and at what point sea level rise and the combination of sea level rise and storms, pose risks to coastal resources or threaten the health and safety of a developed area. This approach allows planners to understand the full range of possible impacts that can be reasonably expected based on the best available science, and build an understanding of the overall risk posed by potential future sea level rise. The climate vulnerability maps used for this study identify hazard zones for each climate scenario for each of the three planning horizons.

[87] ESA PWA. 2014. *Monterey Bay SLR Vulnerability Assessment Technical Methods Report*. Prepared for The Monterey Bay Santuary Foundation. June 16, 2014.
[88] California Coastal Commission. 2015. California Coastal Commission Sea Level Rise Policy Guidance: Interpretative Guidelines for Ad dressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. Adopted August 12, 2015.
[89] National Research Council (NRC). 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Report by the Committee on Sea Level Rise in California, Oregon, and Washington. National Academies Press, Washington, DC. 250 pp.

For clarity, this report focuses the hazard analysis on a subset of those scenarios, recommended by local and state experts (Table 1).
The Coastal Commission recommends all communities evaluate the impacts of the highest water level conditions that are projected to occur in the planning area. Local governments may also consider including higher scenarios (such as a 6.6 ft (2m) Scenario) where severe impacts to Coastal Act resources and development could occur from sea level rise. In addition to evaluating the worst-case scenario, planners need to understand the minimum amount of sea level rise that may cause impacts for their community, and how these impacts may change over time.

ASSETS USED IN ANALYSIS

GIS layer metadata will be provided with Coastal Climate Change Vulnerability Study GIS layer transmittal

Time Horizon	EMISSIONS Scenario	SLR	Notes
2030	med	0.3 ft (10 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm)
2060	high	2.4 ft (72 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)
2100	high	5.2 ft (159 cm)	Erosion projection: Includes long-term erosion and the potential erosion of a large storm event (e.g. 100-year storm) Future erosion scenario: Increased storminess (doubling of El Niño storm impacts in a decade)

ASSET CATEGORY	ASSET	DATA LAYER SOURCE	STATUS IN ANALYSIS
Land Use	Building Footprints: Commercial, Residential, Mixed Use Public, Industrial, Other	AMBAG (used City of Santa Cruz assessor parcel shapefile "use code" to determine building type)	Analyzed
	Parcels	City of Santa Cruz	Analyzed
	Facilities (Fire, Police, Hospitals, Schools, Libraries, Churches, Community Centers, Water treatment, etc.)	City of Santa Cruz	Analyzed
	Affordable Housing	City of Santa Cruz	Analyzed
	Historic District Buildings	City of Santa Cruz	Analyzed
	Farmland	Farmland Mapping and Monitoring Program	Analyzed, but not reported[90]
Water and Utilities [91]	Sewer Structures & Pipes	City of Santa Cruz	Analyzed
	Storm Drain Structures & Pipes	City of Santa Cruz	Analyzed
	Water Main Lines	City of Santa Cruz	Analyzed
	Culverts	Fish Passage Database	Analyzed
Recreation and Public Access	Coastal Access Points	CCWG	Analyzed
	Parks	City of Santa Cruz	Analyzed[92]
	Beaches	CCWG	Analyzed
	Coastal Path	CCWG	Analyzed[4]
Transportation	Roads	Cal Trans	Analyzed[93]

[90] Farmland was analyzed, but it was determined that the FFMP areas within the city limits are actually former grazing land and not farmland, and so it was not reported

[91] No gas or electric utilities layers were available for this study

[92] The parks layer includes acres of State Beaches.

[93] Excludes length of bridges, as projected impacts were determined to be unreliable in this area due to the height of the bridges.

ASSET CATEGORY	ASSET	DATA LAYER SOURCE	STATUS IN ANALYSIS
	Hwy 1	Cal Trans	Analyzed
	Rail	AMBAG	Analyzed[4]
	Bridges	CCWG	Analyzed, but not reported[94]
	Downtown Parking Lots	City of Santa Cruz	Analyzed
	Bike routes	City of Santa Cruz	Analyzed[4]
Natural Resources	Wetlands	US Fish & Wildlife Service (National Wetlands Inventory)	Analyzed
	Sensitive Habitat	City of Santa Cruz	Analyzed
	Monarch Habitat	City of Santa Cruz	Analyzed
Other	Hazmat Cleanup Sites	City of Santa Cruz	Analyzed
	Geotracker Sites	Regional Water Quality Control Board	Analyzed

MODIFICATIONS TO ESA HAZARD ZONES

COASTAL ARMORING

The ESA coastal hazard projections do not account for the protections that existing coastal armoring provide. The areas identified as vulnerable by the original coastal erosion ESA GIS layers overestimate future hazard zones (as recognized within the ESA supporting documentation). A GIS layer of existing coastal armoring was referenced within this analysis to recognize areas where some level of protection currently exists.[95]

To account for the protections provided by coastal armor, properties and structures located behind those structures were removed from the existing and 2030 erosion vulnerability analysis. In many cases, properties were reclassified as "protected" from coastal hazards by recognizing the protections those structures provided. Coastal flooding layers, however, did account for the height of coastal structures (hip walls etc.) and estimate wave overtopping and flooding that may

[94] All projected impacts to Bridges were determined to be unreliable in this area due to the height of the bridges.

[95] California Coastal Commission. 2014. GIS layer of existing coastal armor structures in Santa Cruz County.

occur with those structures in place. Some structures were therefore identified as protected from coastal erosion and vulnerable to coastal flooding.

Because the life span of coastal protective infrastructure (seawalls, rip rap, etc.) is limited, this vulnerability analysis assumes that all existing coastal armoring will need to be removed, replaced or significantly redesigned at some point between 2030 and 2060. If these structures fail, erosion will accelerate and quickly meet projected inland migration rates (as documented at Stilwell Hall, Fort Ord), unless protective measures are implemented. Therefore, the erosion analysis for the 2060 planning horizon evaluates vulnerability of infrastructure under two separate assumptions: 1) coastal armoring remains in place and functioning, and 2) current coastal armoring fails and is not replaced, and therefore modeled hazard zone layers provided by the ESA technical team represent the hazards for these time horizons. For the 2100 hazard zones represented within the maps, it is assumed that coastal armoring is no longer in place.

EROSION

Cliff erosion and dune erosion were originally two sets of separate coastal hazard layers provided by ESA-PWA. Cliff erosion was characterized as erosion of mudstone cliff sides generally along the Santa Cruz County coastline. Whereas dune erosion was characterized as erosion of sandy slopes predominantly found along the Monterey Bay coastline. Since these two hazards were functionally different and spatially separate, it was decided to merge them into one set of 'Erosion' coastal hazard process layers using the 'Merge' tool within ArcGIS. Therefore, for each time horizon both cliff erosion and dune erosion impact zones were combined into a single erosion impact zone. The 'erosion' coastal hazard series was used throughout the analysis and included in the tables. Erosion hazard layers were modified as described above to account for the protections provided by existing seawalls through 2060.

COASTAL STORM FLOODING

The ESA coastal storm flooding hazard layers included cliff areas predicted to have eroded during previous time horizons that then become vulnerable to coastal flooding hazards because the land elevation within those areas was assumed to have been reduced due to that cliff erosion. For example, sections of cliff in Santa Cruz that are projected to erode by 2060 (if coastal armoring no longer functions) are also projected to experience coastal flooding and wave over-topping within those newly eroded coastal areas. This is an accurate interpretation of the projected combined erosion and coastal flooding processes but introduces a confounding effect when attempting to evaluate risks of one hazard verses another. To address this overlap, erosion processes were removed from the coastal hazard processes by trimming the coastal flooding layer along cliff areas to the 20ft topographic contour for all time horizons (existing, 2030, 2060, 2100). This allows coastal flooding and erosion hazards to be evaluated individually.

VULNERABLE, MANAGED, AND PROTECTED (COASTAL STORM FLOODING AND RISING TIDES)

Per the City's request, specific inundation areas in Santa Cruz were reclassified from 'Vulnerable'[96] to either 'Managed' or 'Protected' for both rising tides and coastal storm flooding hazards. These areas included low-lying neighborhoods of lower Ocean Street, the beach flats, and some streets in downtown, as well as Neary Lagoon. These areas are already at risk of inundation during high-flow events of the San Lorenzo River (lower Ocean, beach flats, downtown) or from tidal forces (Neary Lagoon); which are currently mitigated by water control structures such as levees, flap gates, slide gates, and pumps. Classifications were assigned based on input provided by City Public Work's staff and vary depending on location and hazard type. The classifications are summarized as follows:

COASTAL FLOODING

Beach Flats = Managed (due to storm pumps along the river levee)
Lower Ocean = Protected (by the river levees)
Downtown = Protected (due to storm pumps along the river levee)
Lagoon = Managed (due to storm pumps at the mouth of the lagoon)

RISING TIDES

Beach Flats = Managed (due to storm pumps along the river levee)
Lower Ocean = Managed (due to storm pumps along the river levee)
Downtown = Not Applicable
Lagoon = Managed (due to storm pumps at the mouth of the lagoon)

It is assumed that during coastal storm flooding Lower Ocean and Downtown will be protected by the levee, while the Lagoon and the beach flats are managed by water control structures. It should also be noted that in the 2060 and 2100 time horizons the beach flats area may become fully connected to the ocean over land flow, therefore in those scenarios those areas are classified as 'Vulnerable.' It is assumed that water control structures will mitigate tidal inundation to all low-lying areas within the city. When compiling hazard data layers for the combined threatened area within each time horizon, classifications of those areas listed above were chained to the coastal flooding attributes.

The analysis was developed and results were generated taking those classifications into consideration, therefore enabling querying of these management structures separately from normally 'Vulnerable' areas.

COMBINED COASTAL CLIMATE CHANGE HAZARD ZONES

CCWG merged the individual coastal hazard layers to create a new combined hazard layer for each planning horizon (Existing, 2030, 2060 and 2100). These merged layers represent the combined vulnerability zone for "Coastal Climate Change" for each time horizon. Projections of

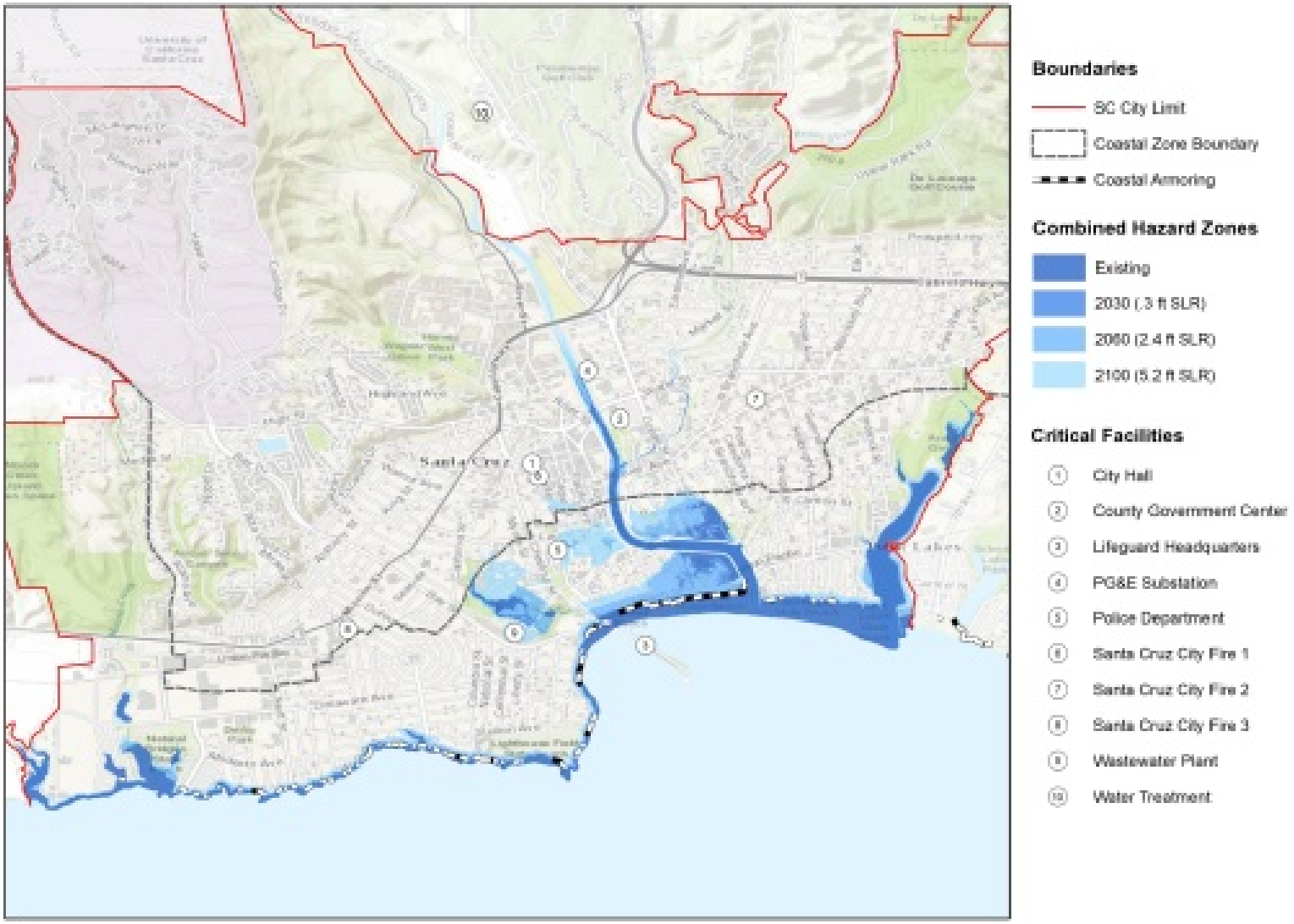
[96] The term 'Impacted' is used instead of 'Vulnerable' within the GIS file. Per the City's request, 'Impacted" was changed to "Vulnerable' for reporting purposes.

the combined hazards of Coastal Climate Change are intended to help estimate the cumulative effects on the community and help identify areas where revised building guidelines or other adaptation strategies may be appropriate. Combined hazards however, do not provide municipal staff with the necessary information to select specific structural adaptation responses. Therefore, this study also evaluates the risks associated with each individual coastal hazard.

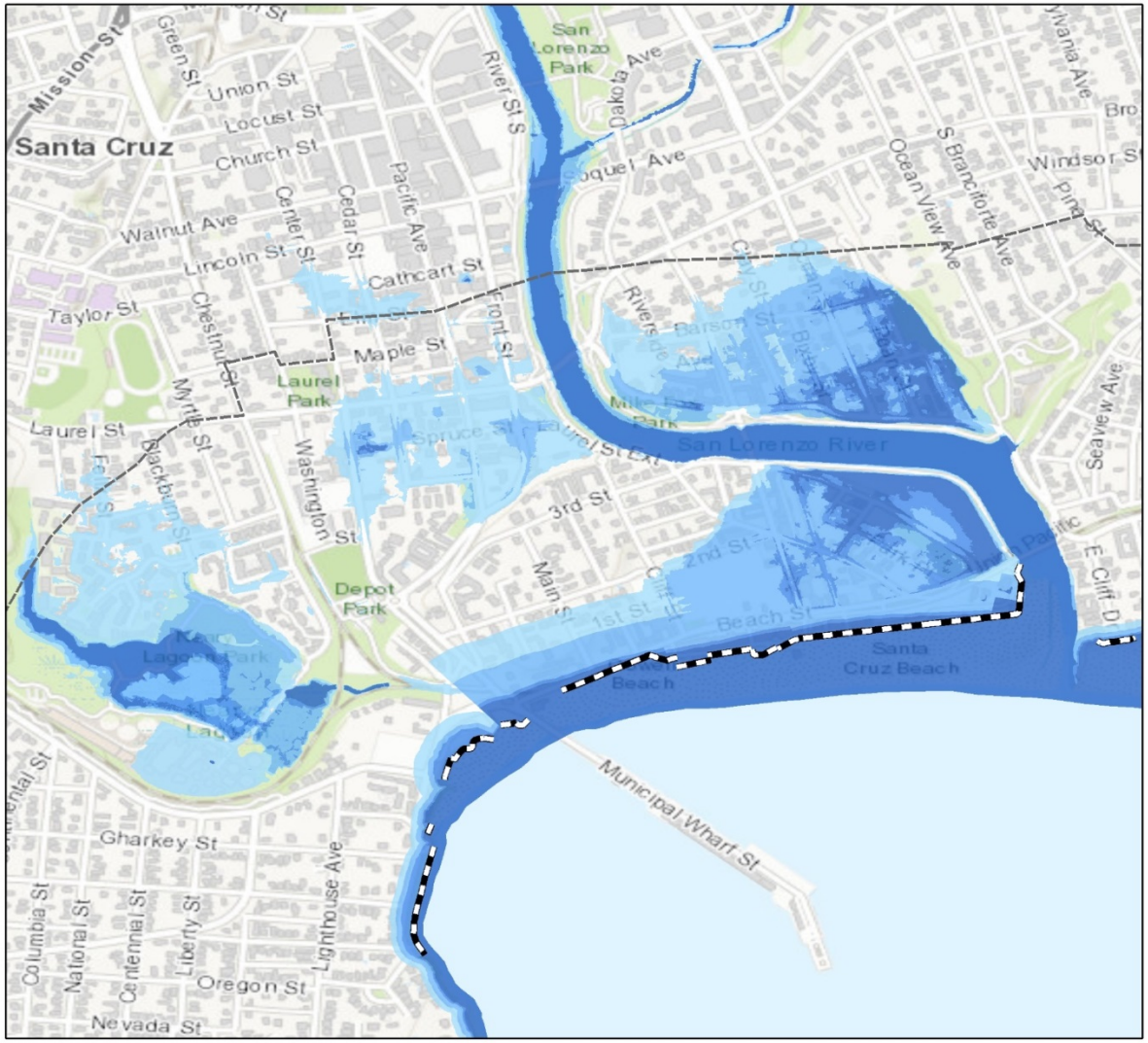
Infrastructure vulnerable to the Combined Hazards within each time horizon were calculated and 'vulnerable,' 'managed,' and 'protected' classifications were linked to the coastal storm flooding GIS layer attributes. The combined hazard zone maps, however, do not distinguish between areas that are managed or protected because the effects of protective structures are not equally effective in addressing each individual hazard (coastal storm flooding and rising tides). To view areas managed by pumps or protected by levees for coastal storm flooding or rising tides, please view those specific sections within this document.

Within the combined hazard maps, coastal storm flooding is the primary hazard risking property. Although armoring may prevent impacts associated with coastal erosion, in many areas the models suggest this infrastructure will not protect property from wave overtopping during coastal storm events.

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COMBINED COASTAL CLIMATE CHANGE HAZARD ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COMBINED COASTAL CLIMATE CHANGE HAZARD ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



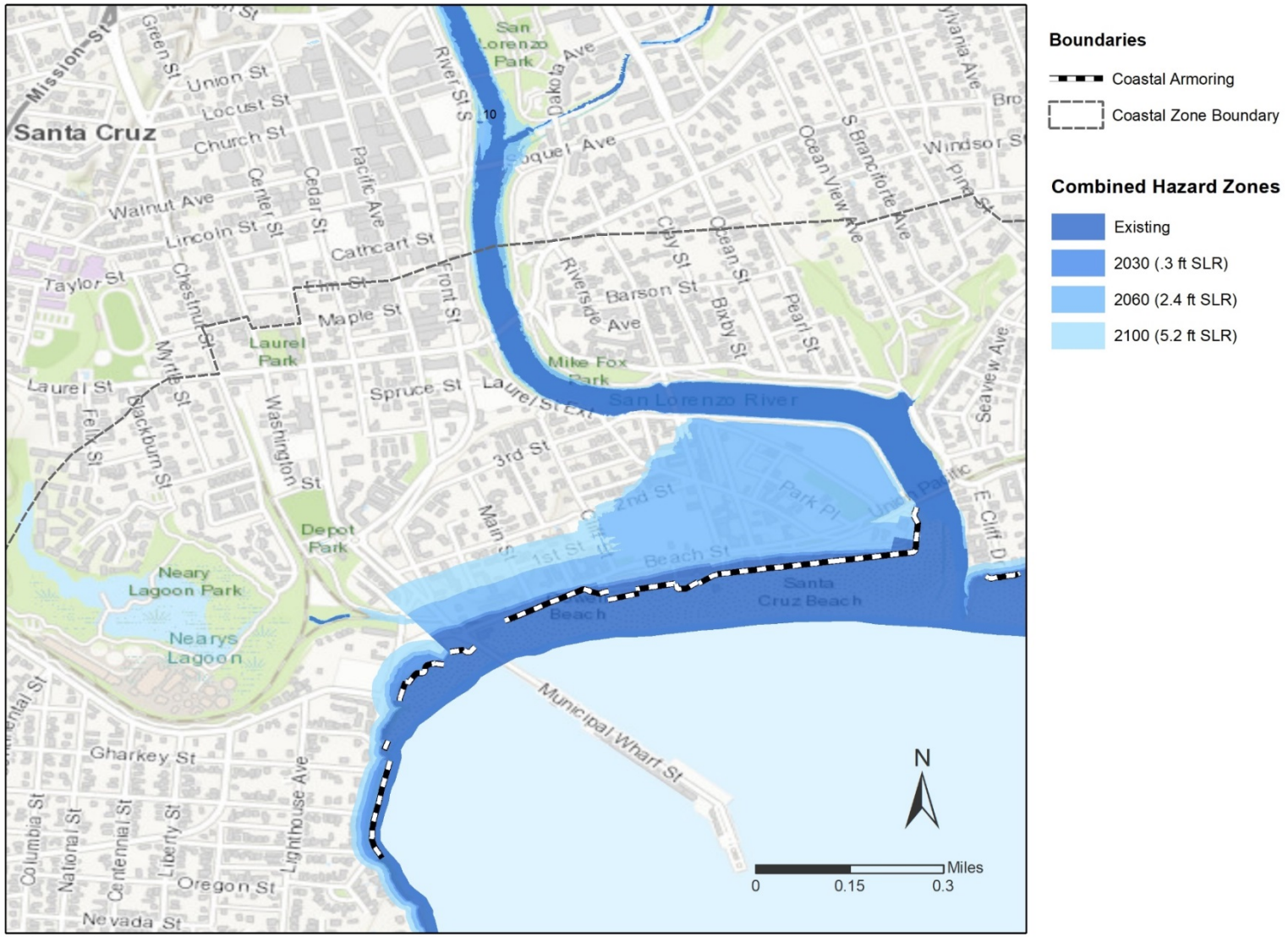
Boundaries

- Coastal Zone Boundary
- Coastal Armoring

Combined Hazard Zones

- Existing
- 2030 (.3 ft SLR)
- 2060 (2.4 ft SLR)
- 2100 (5.2 ft SLR)

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COMBINED COASTAL CLIMATE CHANGE HAZARD ZONES
(areas determined to be protected or managed are removed)



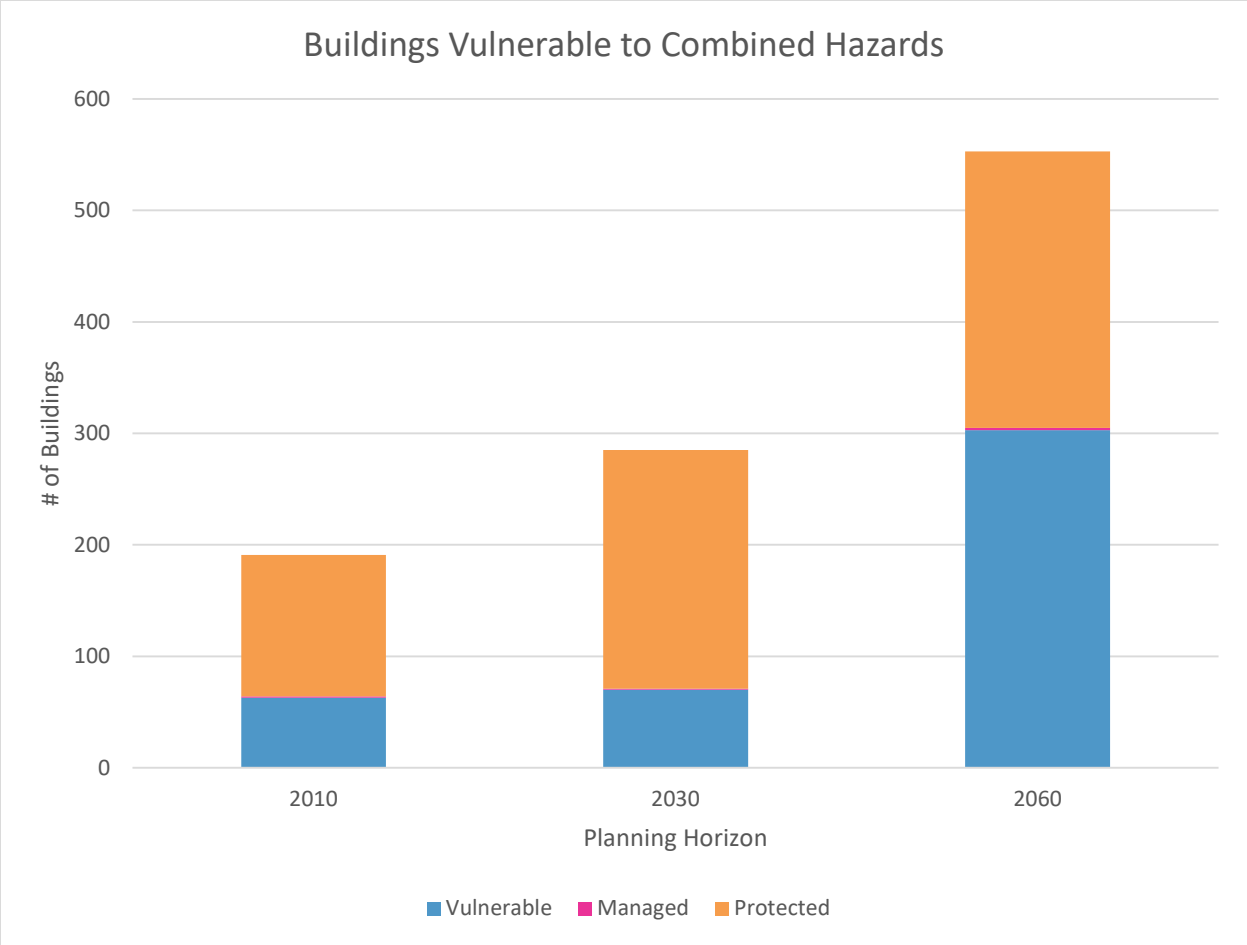
COMBINED HAZARDS: ASSET VULNERABILITY TABLE

V= Vulnerable, M= Managed, P= Protected

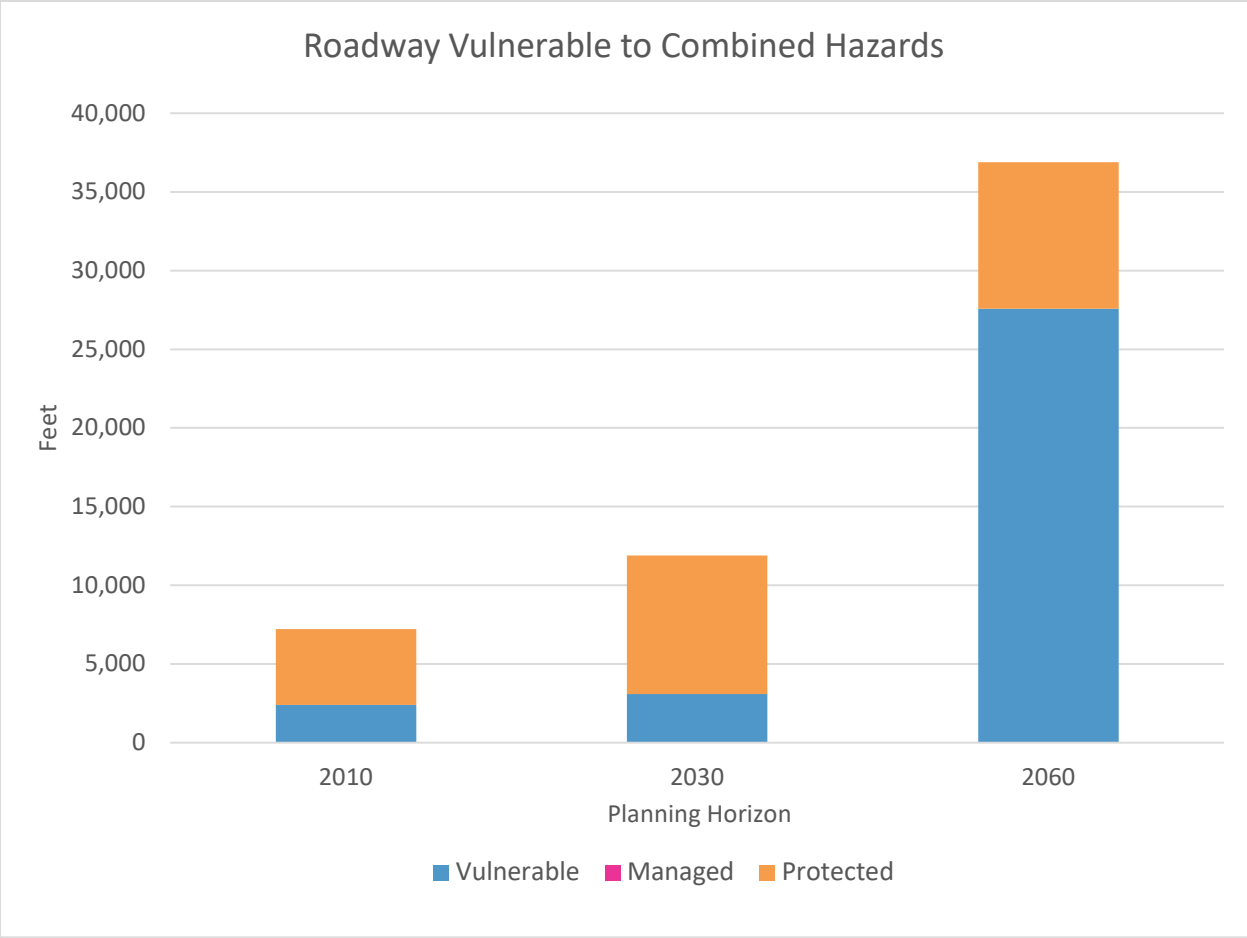
ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Land Use											
Total Buildings	Count	22,961	63	1	127	70	1	214	303	2	248
Residential	Count	20,686	23	0	119	28	0	194	213	1	218
Commercial	Count	888	17	0	8	18	0	18	50	0	24
Public	Count	915	23	1	0	23	1	1	36	1	3
Industrial	Count	217	0	0	0	0	0	0	0	0	0
Mixed Use	Count	112	0	0	0	1	0	1	4	0	3
Other	Count	143	0	0	0	0	0	0	0	0	0
Facilities	Count	115	1	0	0	1	0	0	2	0	0
Affordable Housing	Count	149	0	0	0	0	0	0	4	0	1
Parcels	Acres	6,809	117	7	10	130	3	17	195	18	24
National Historic District	Count	718	8	0	0	8	0	2	16	0	7
Recreation and Public Access											
Coastal Access Points	Count	36	19	0	0	21	1	0	28	1	0
Coastal Path	Feet	32,167	6,398	0	127	8,689	0	185	26,672	0	0
Beaches	Acres	78	77	0	0	77	0	0	78	0	0
Parks	Acres	1,853	83	7	2	84	10	2	95	24	3
Transportation											

ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Roads	Feet	866,944	2,387	0	4,830	3,096	0	8,789	27,580	0	9,311
Highway 1	Feet	28,781	0	0	0	0	0	0	0	0	0
Rail	Feet	35,576	1,077	0	0	1,240	0	0	3,620	0	0
Bike Routes	Feet	373,101	1,790	0	1,719	2,731	0	3,356	22,020	0	4,559
Downtown Parking Lots	Feet	253,830	33	0	575	45	0	639	2,386	0	470
Water and Utility											
Sewer Pipe	Feet	812,897	3,127	58	5,454	3750	277	10,369	18,705	635	14,397
Sewer Structures	Count	3,367	16	0	25	23	0	40	104	0	50
Storm Pipes	Feet	289,431	2,699	0	4,459	3,156	0	6,795	14,116	3	7,043
Storm Structure	Count	3,442	79	0	66	87	0	90	260	1	86
Water Mains	Feet	855,270	2,827	0	5,313	3,895	0	9,569	28,684	0	9,657
Culverts	Count	22	0	0	0	0	0	0	1	0	0
Natural Resources											
Wetlands	Acres	272	165	7	0	167	9	0	181	18	0
Sensitive Habitat	Acres	1,298	50	6	0	51	10	0	58	21	0
Monarch Butterfly Habitat	Acres	162	1	0	0	2	0	0	3	0	0
Hazard Sites											
Hazmat Cleanup Sites	Count	1,408	66	2	0	67	2	2	96	2	6
GeoTracker Sites	Count	22	0	0	0	0	0	0	0	0	1

COMBINED HAZARDS: VULNERABLE BUILDINGS



COMBINED HAZARDS: VULNERABLE ROADWAY



RISING TIDES HAZARD ZONES

These zones show the area and depth of inundation caused simply by rising tide and ground water levels (not considering storms, erosion, or river discharge). The water level mapped in these inundation areas is the Extreme Monthly High Water (EMHW) level, which is the high-water level reached approximately once a month.

There are two types of inundation areas: (1) areas that are clearly connected over the existing digital elevation through low topography, (2) and other low-lying areas that don't have an apparent connection, as indicated by the digital elevation model, but are low-lying and flood prone from groundwater levels and any connections (culverts, storm drains and underpasses) that are not captured by the digital elevation model. This difference is captured in the "Connection" attribute (either "connected to ocean over topography" or "connectivity uncertain") in each Rising Tides dataset. These zones do not, however, consider coastal erosion or wave overtopping, which may change the extent and depth of regular tidal flooding in the future. Projected risks from rising tides lead to reoccurring flooding hazards during monthly high tide events.

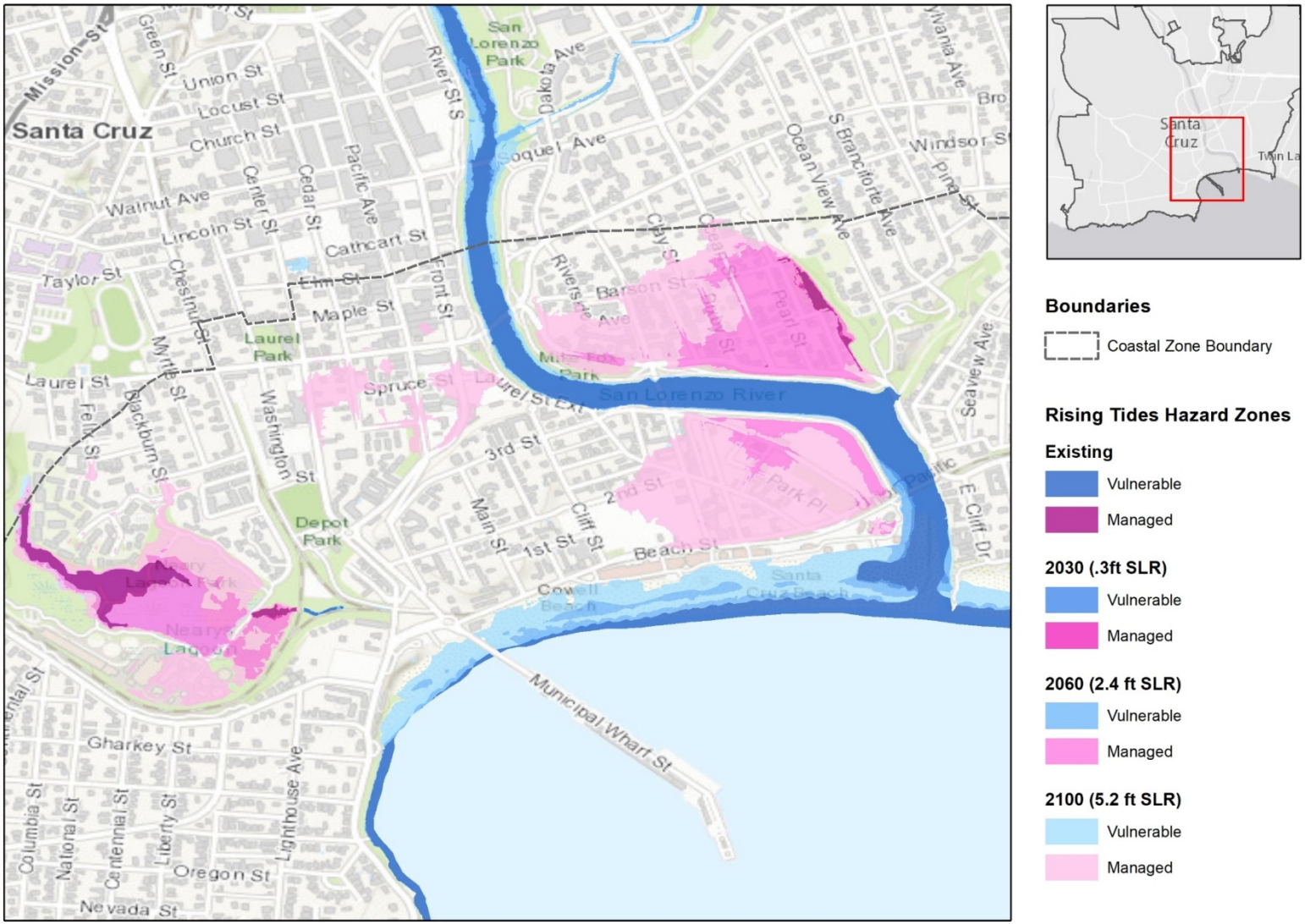
It is assumed that water control structures will mitigate tidal inundation to all low-lying areas within the city. Classifications were assigned based on input provided by City Public Work's staff and vary depending on location. The classifications are summarized as follows:

RISING TIDES

Beach Flats = Managed
Lower Ocean = Managed
Downtown = Not Applicable
Lagoon = Managed

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
RISING TIDES HAZARD ZONES
(hazard zones include areas that are currently managed by pumps)

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
RISING TIDES HAZARD ZONES
(hazard zones include areas that are currently managed by pumps)



Boundaries

Coastal Zone Boundary

Rising Tides Hazard Zones

Existing

Vulnerable

Managed

2030 (.3ft SLR)

Vulnerable

Managed

2060 (2.4 ft SLR)

Vulnerable

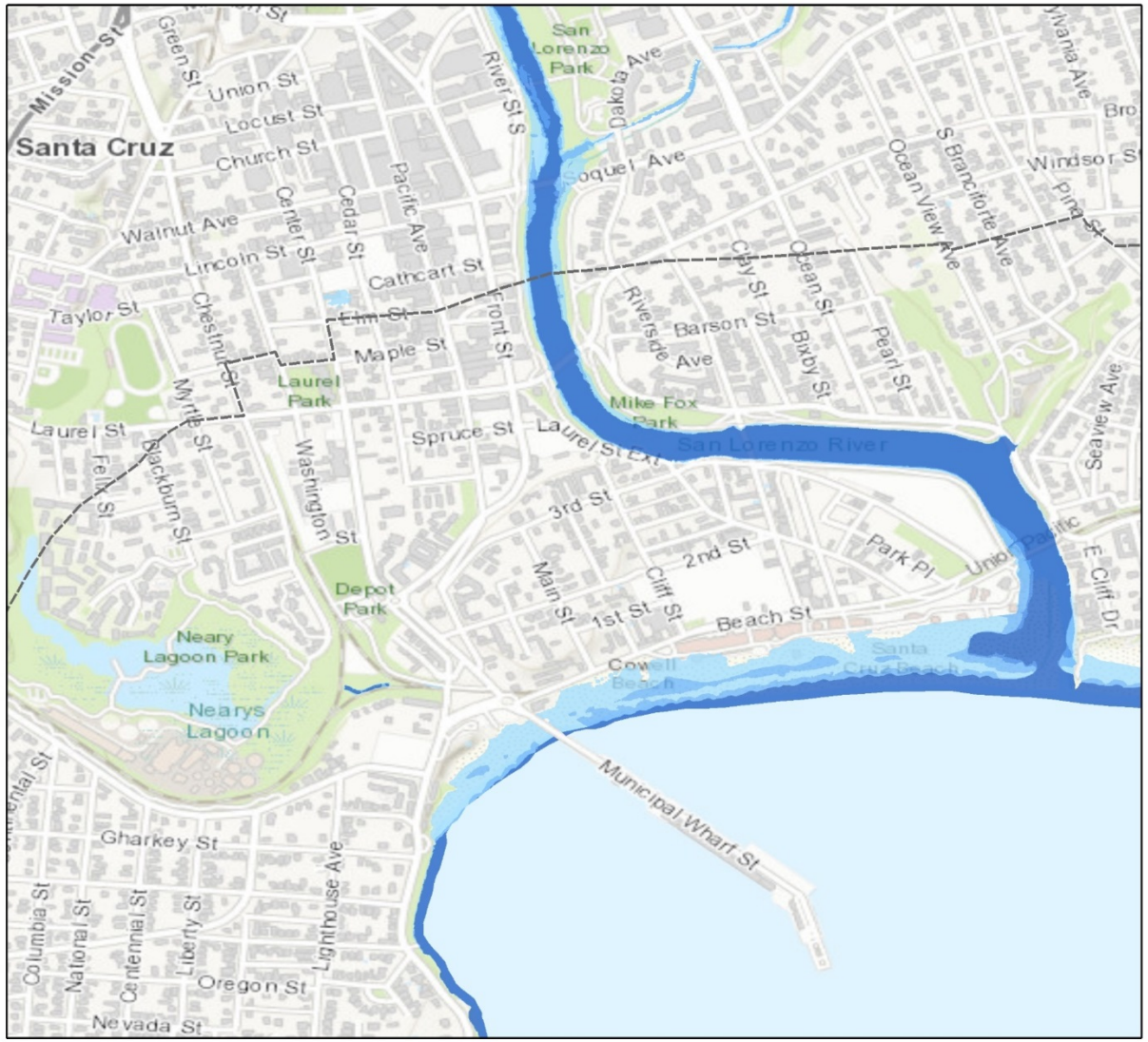
Managed

2100 (5.2 ft SLR)

Vulnerable

Managed

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
RISING TIDES HAZARD ZONES
(hazard zones exclude areas that are currently managed by pumps)



Boundaries

Coastal Zone Boundary

Rising Tides Hazard Zones

- Existing
- 2030 (.3ft SLR)
- 2060 (2.4 ft SLR)
- 2100 high (5.2 ft)

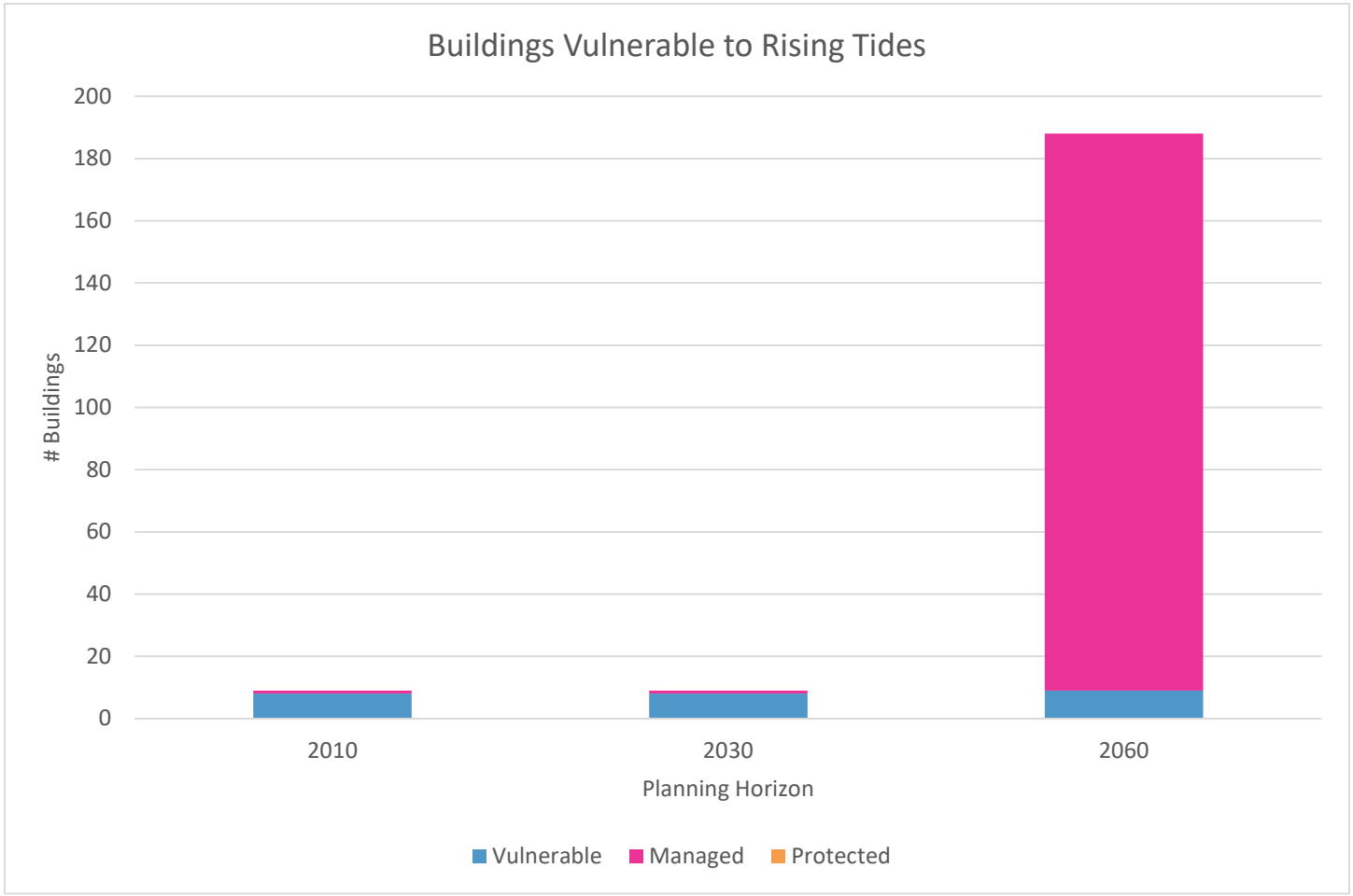
RISING TIDES: ASSET VULNERABILITY TABLE

V= Vulnerable, M= Managed, P= Protected

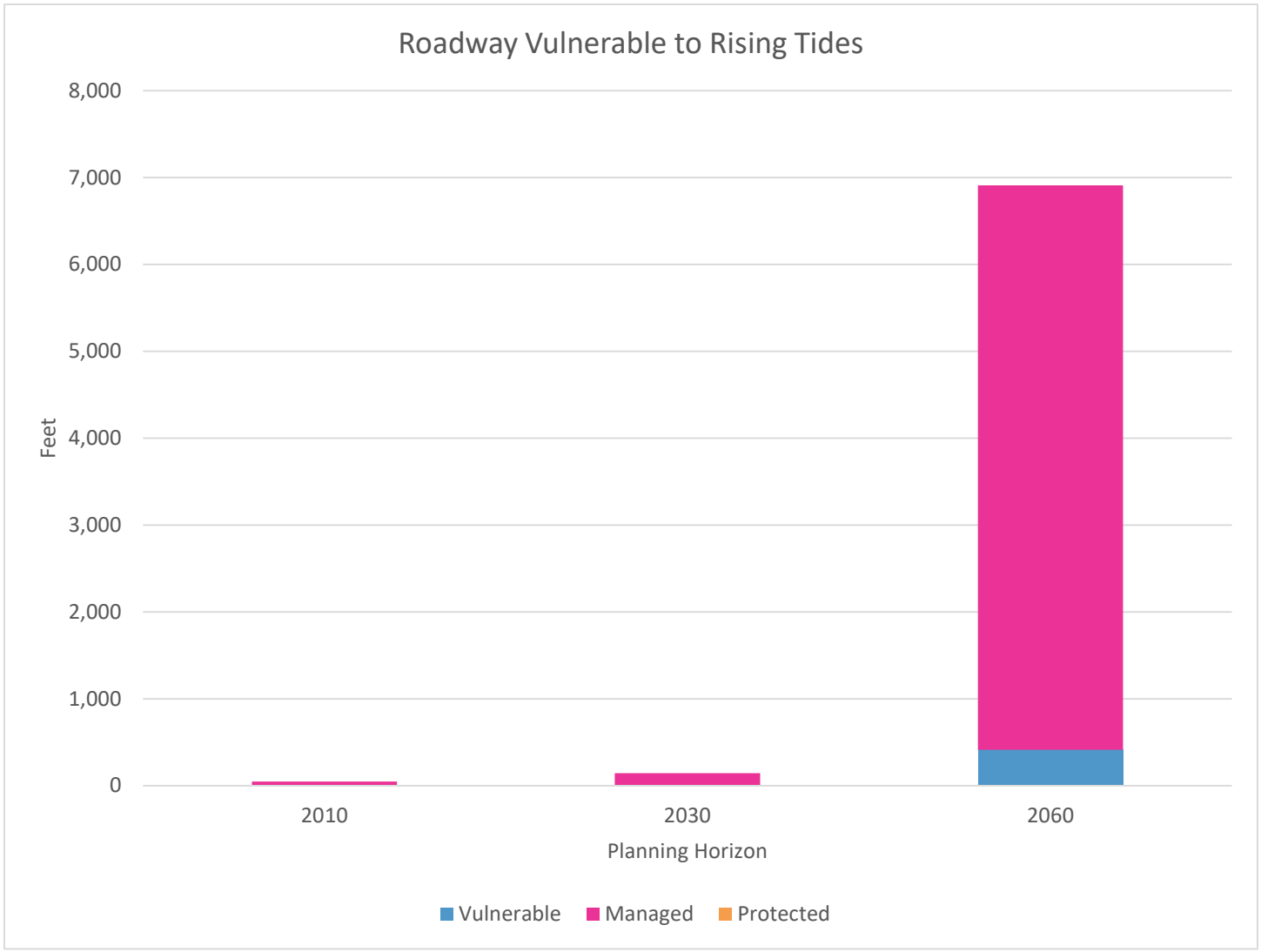
ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Land Use											
Total Buildings	Count	22,961	8	1	0	8	1	0	9	179	0
Residential	Count	20,686	0	1	0	0	1	0	0	165	0
Commercial	Count	888	1	0	0	1	0	0	1	12	0
Public	Count	915	7	0	0	7	0	0	8	1	0
Industrial	Count	217	0	0	0	0	0	0	0	0	0
Mixed Use	Count	112	0	0	0	0	0	0	0	1	0
Other	Count	143	0	0	0	0	0	0	0	0	0
Facilities	Count	115	1	0	0	1	0	0	1	0	0
Affordable Housing	Count	149	0	0	0	0	0	0	0	0	0
Parcels	Acres	6,809	51	6	0	52	6	0	64	33	0
National Historic District	Count	718	3	0	0	3	0	0	3	2	0
Recreation and Public Access											
Coastal Access Points	Count	36	1	0	0	1	0	0	2	1	0
Coastal Path	Feet	32,167	0	0	0	0	0	0	770	4	0
Beaches	Acres	78	8	0	0	10	0	0	22	0	0
Parks	Acres	1,853	13	6	0	14	6	0	29	19	0
Transportation											

ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Roads	Feet	866,944	0	49	0	0	145	0	414	6,495	0
Highway 1	Feet	28,781	0	0	0	0	0	0	0	0	0
Rail	Feet	35,576	0	0	0	0	0	0	0	0	0
Bike Routes	Feet	373,101	0	0	0	0	0	0	464	2,554	0
Downtown Parking Lots	Feet	253,830	0	0	0	0	0	0	0	535	0
Water and Utility											
Sewer Pipe	Feet	812,897	805	0	0	808	0	0	1,144	8,836	0
Sewer Structures	Count	3,367	2	0	0	2	0	0	4	32	0
Storm Pipes	Feet	289,431	134	0	0	157	23	0	394	5,499	0
Storm Structure	Count	3,442	14	0	0	16	1	0	28	73	0
Water Mains	Feet	855,270	341	0	0	344	0	0	993	7,021	0
Culverts	Count	22	0	0	0	0	0	0	0	0	0
Natural Resources											
Wetlands	Acres	272	78	5	0	79	6	0	95	17	0
Sensitive Habitat	Acres	1,298	30	5	0	31	5	0	38	17	0
Monarch Butterfly Habitat	Acres	162	0	0	0	0	0	0	0	0	0
Hazard Sites											
Hazmat Cleanup Sites	Count	1,408	12	0	0	12	0	0	12	5	0
GeoTracker Sites	Count	22	0	0	0	0	0	0	0	0	0

RISING TIDES: VULNERABLE BUILDINGS



RISING TIDES: VULNERABLE ROADWAY



VOLUME OF WATER

VOLUME OF WATER (FT^3) FROM RISING TIDES WITHIN NEIGHBORHOODS

Extreme Monthly High Water (EMHW) level, which is the high water level reached approximately once a month. These volumes do not include any additional runoff from rain storm events.

Neighborhood	2010	2030 mid	2060 mid	2060 high
Lower Ocean	0	0	83,620	703,750
Beach flats	0	0	180	84,050
Downtown	0	0	670	1,340

COASTAL STORM FLOODING HAZARD ZONES

These hazard zones depict the predicted flooding caused by future coastal storms. The processes that drive these hazards include (1) storm surge (a rise in the ocean water level caused by waves and pressure changes during a storm), (2) wave overtopping (waves running up over the beach and flowing into low-lying areas, calculated using the maximum historical wave conditions), and (3) additional flooding caused when rising sea level exacerbate storm surge and wave overtopping. These hazard zones do NOT consider upland fluvial (river) flooding and local rain/run-off drainage, which likely play a large part in coastal flooding, especially around coastal confluences where creeks meet the ocean. Storm flood risks represent periodic wave impact and flooding.

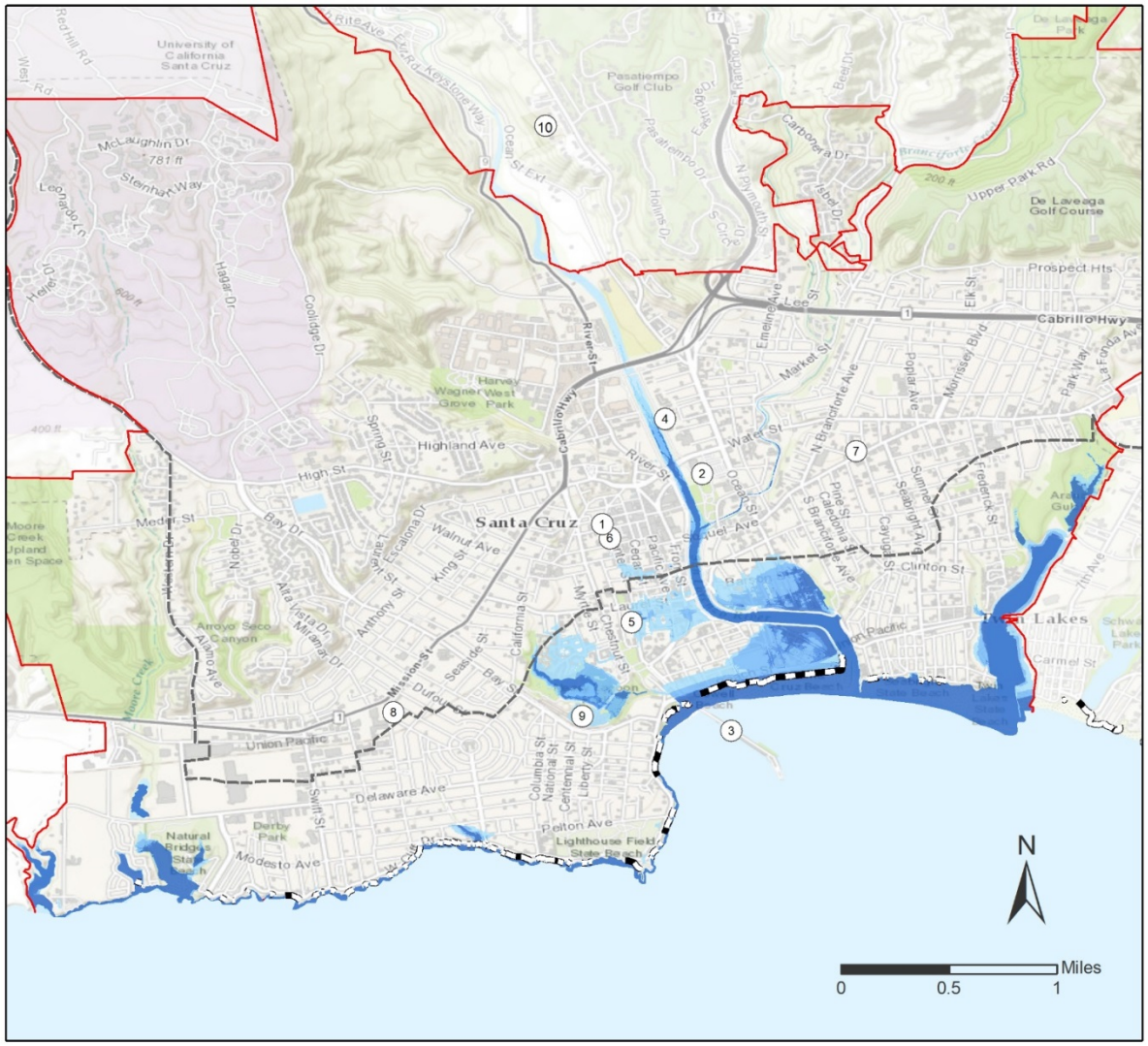
It is assumed that during coastal storm flooding Lower Ocean and Downtown will be protected by the levee, while the Lagoon and the beach flats are managed by water control structures. It should also be noted that in the 2060 and 2100 time horizons the beach flats area may become fully connected to the ocean over land flow, therefore in those scenarios those areas are classified as 'Vulnerable.'

Classifications were assigned based on input provided by City Public Work's staff and vary depending on location. The classifications are summarized as follows:

COASTAL FLOODING

Beach Flats = Managed
Lower Ocean = Protected
Downtown = Protected
Lagoon = Managed

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COASTAL STORM FLOOD HAZARD ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



Boundaries

- SC City Limit
- Coastal Zone Boundary
- Coastal Armoring

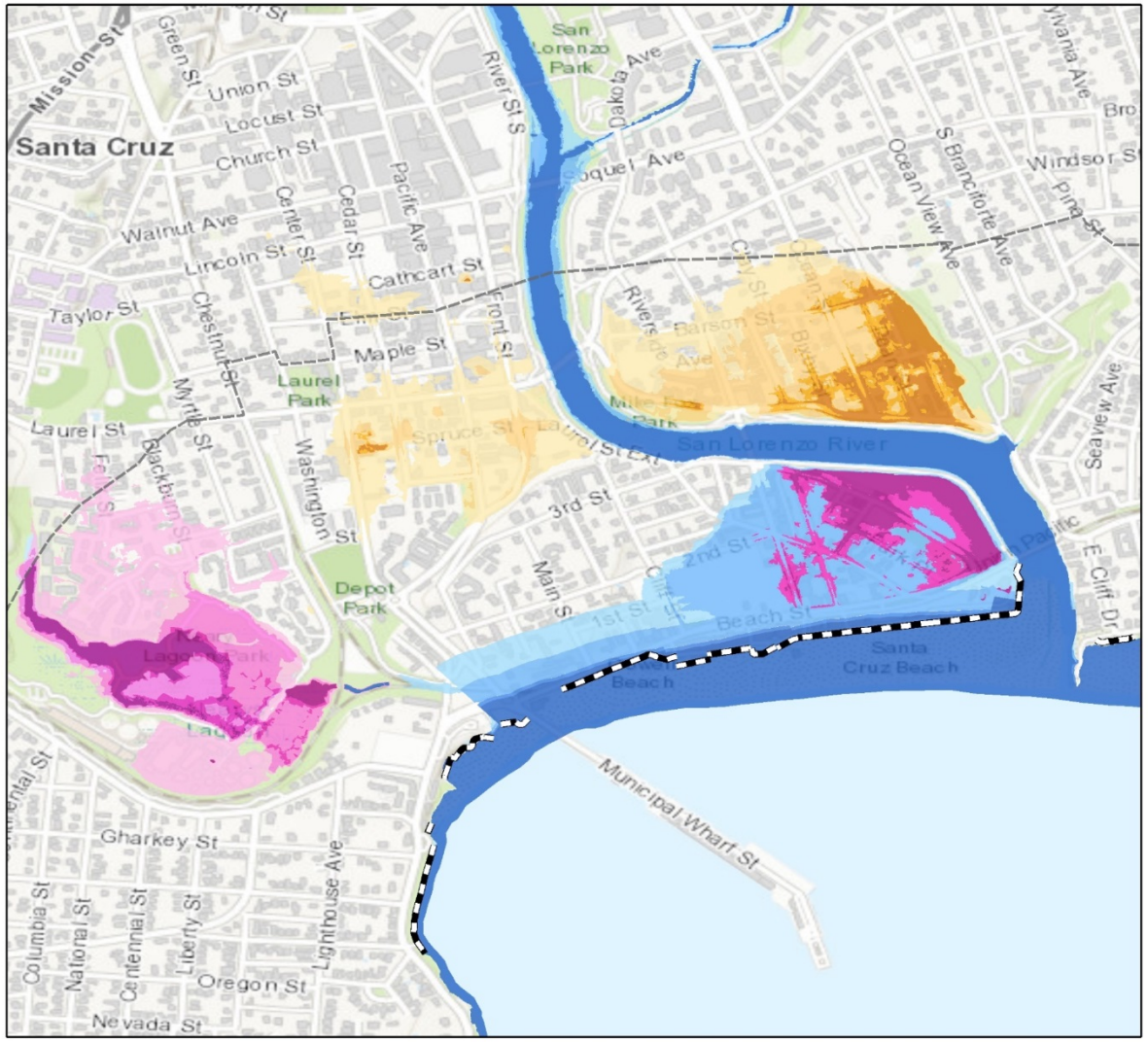
Coastal Storm Flood Hazard Zones

- Existing
- 2030 (.3 ft SLR)
- 2060 (2.4 ft SLR)
- 2100 (5.4 ft SLR)

Critical Facilities

1. City Hall
2. County Government Center
3. Lifeguard Headquarters
4. PG&E Substation
5. Police Department
6. Santa Cruz City Fire 1
7. Santa Cruz City Fire 2
8. Santa Cruz City Fire 3
9. Wastewater Plant
10. Water Treatment

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COASTAL STORM FLOOD HAZARD ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



Boundaries

- Coastal Zone Boundary
- Coastal Armoring

Coastal Storm Flood Hazard Zones

Existing

- Vulnerable
- Managed
- Protected

2030 (.3ft SLR)

- Vulnerable
- Managed
- Protected

2060 (2.4 ft SLR)

- Vulnerable
- Managed
- Protected

2100 (5.2 ft SLR)

- Vulnerable
- Managed
- Protected

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
COASTAL STORM FLOOD HAZARD ZONES
(hazard zones exclude areas that are currently managed by pumps or protected by levees)

Boundaries

- Coastal Zone Boundary
- Coastal Armoring

Coastal Storm Flood Hazard Zones

- Existing
- 2030 (.3ft SLR)
- 2060 (2.4 ft SLR)
- 2100 (5.2 ft SLR)

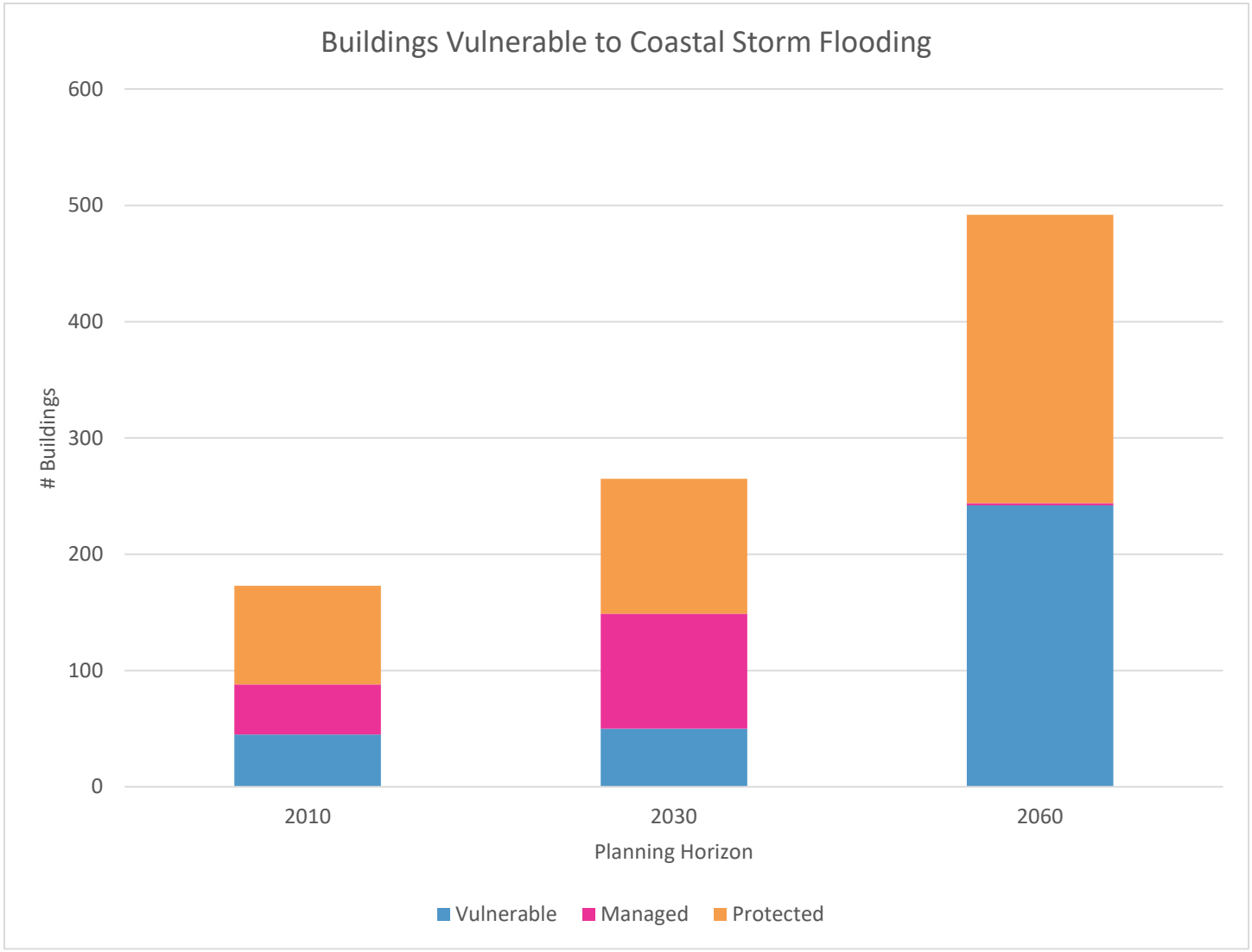
COASTAL STORM FLOODING: ASSET VULNERABILITY TABLE

V= Vulnerable, M= Managed, P= Protected

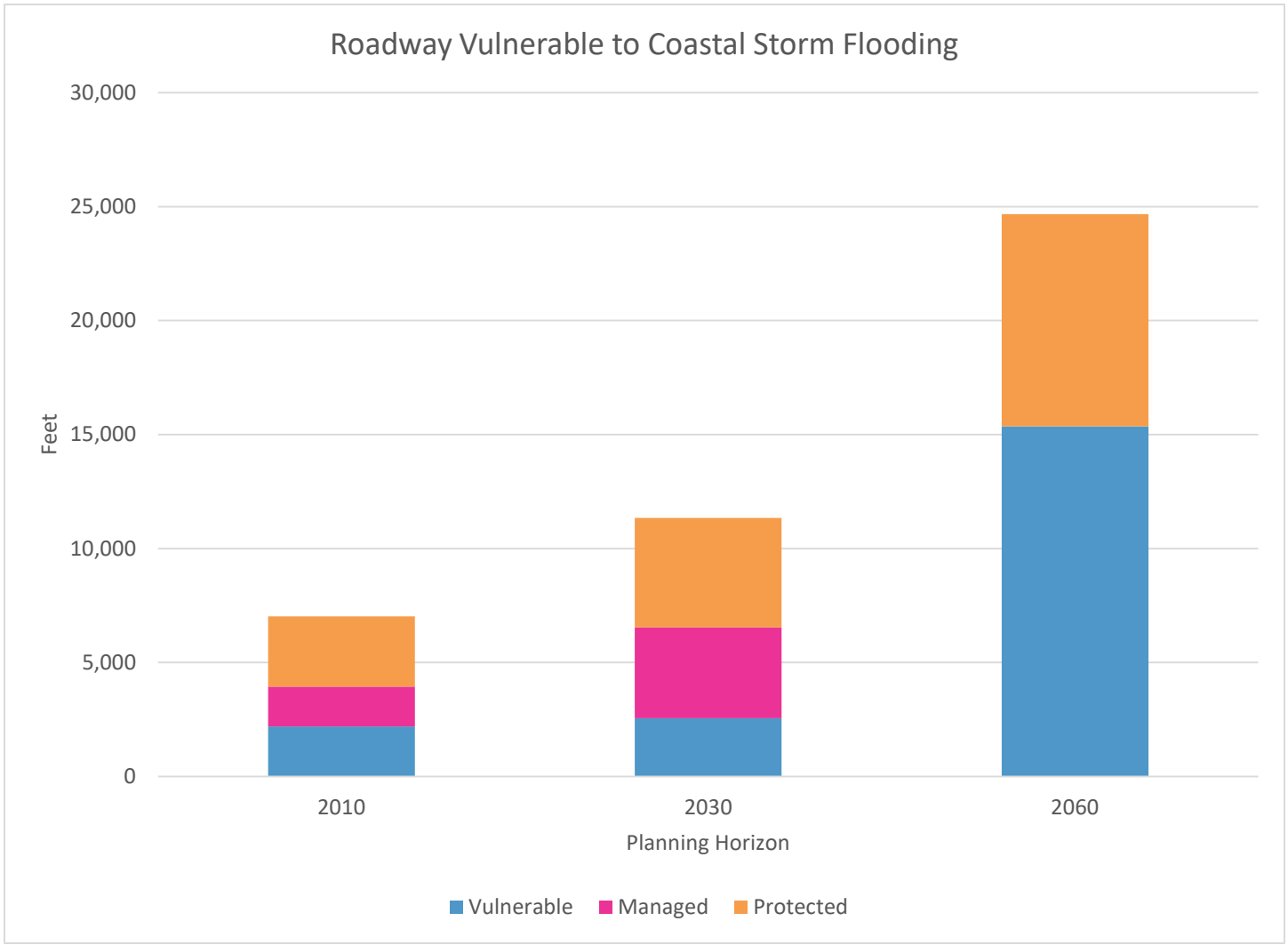
ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Land Use											
Total Buildings	Count	22,961	45	43	85	50	99	116	242	2	248
Residential	Count	20,686	7	38	81	10	85	109	158	1	218
Commercial	Count	888	15	4	4	16	11	7	46	0	24
Public	Count	915	23	1	0	23	2	0	34	1	3
Industrial	Count	217	0	0	0	0	0	0	0	0	0
Mixed Use	Count	112	0	0	0	1	1	0	4	0	3
Other	Count	143	0	0	0	0	0	0	0	0	0
Facilities	Count	115	1	0	0	1	0	0	2	0	0
Affordable Housing	Count	149	0	0	0	0	0	0	4	0	1
Parcels	Acres	6,809	109	13	4	120	13	7	168	18	24
National Historic District	Count	718	8	0	0	8	0	2	12	0	7
Recreation and Public Access											
Coastal Access Points	Count	36	20	0	0	17	1	0	19	1	0
Coastal Path	Feet	32,167	3,144	127	0	3,476	185	0	10,339	0	0
Beaches	Acres	78	77	0	0	77	0	0	78	0	0
Parks	Acres	1,853	80	7	2	80	10	2	85	24	3
Transportation											

ASSETS	UNITS	TOTAL	2010			2030			2060		
			V	M	P	V	M	P	V	M	P
Roads	Feet	866,944	2,191	1,756	3,074	2,551	3,989	4,800	15,362	0	9,311
Highway 1	Feet	28,781	0	0	0	0	0	0	0	0	0
Rail	Feet	35,576	1,077	0	0	1,240	0	0	3,467	0	0
Bike Routes	Feet	373,101	1,753	904	816	2,102	1,758	1,598	10,840	0	4,559
Downtown Parking Lots	Feet	253,830	0	193	382	0	240	398	358	0	470
Water and Utility											
Sewer Pipe	Feet	812,897	2,830	1,768	3,744	3,110	4,227	6,418	14,351	635	14,397
Sewer Structures	Count	3,367	11	7	18	14	17	23	70	0	50
Storm Pipes	Feet	289,431	2,106	1,964	2,495	2,386	3,317	3,478	9,903	7	7,043
Storm Structure	Count	3,442	57	36	30	59	53	37	169	2	86
Water Mains	Feet	855,270	2,576	2,103	3,210	3,135	4,722	4,847	17,367	0	9,657
Culverts	Count	22	0	0	0	0	0	0	1	0	0
Natural Resources											
Wetlands	Acres	272	163	7	0	165	9	0	178	18	0
Sensitive Habitat	Acres	1,298	49	7	0	51	10	0	56	21	0
Monarch Butterfly Habitat	Acres	162	1	0	0	1	0	0	2	0	0
Hazard Sites											
Hazmat Cleanup Sites	Count	1,408	66	2	0	67	2	2	90	2	6
GeoTracker Sites	Count	22	0	0	0	0	0	0	0	0	1

COASTAL STORM FLOODING: VULNERABLE BUILDINGS



COASTAL STORM FLOODING: VULNERABLE ROADWAY



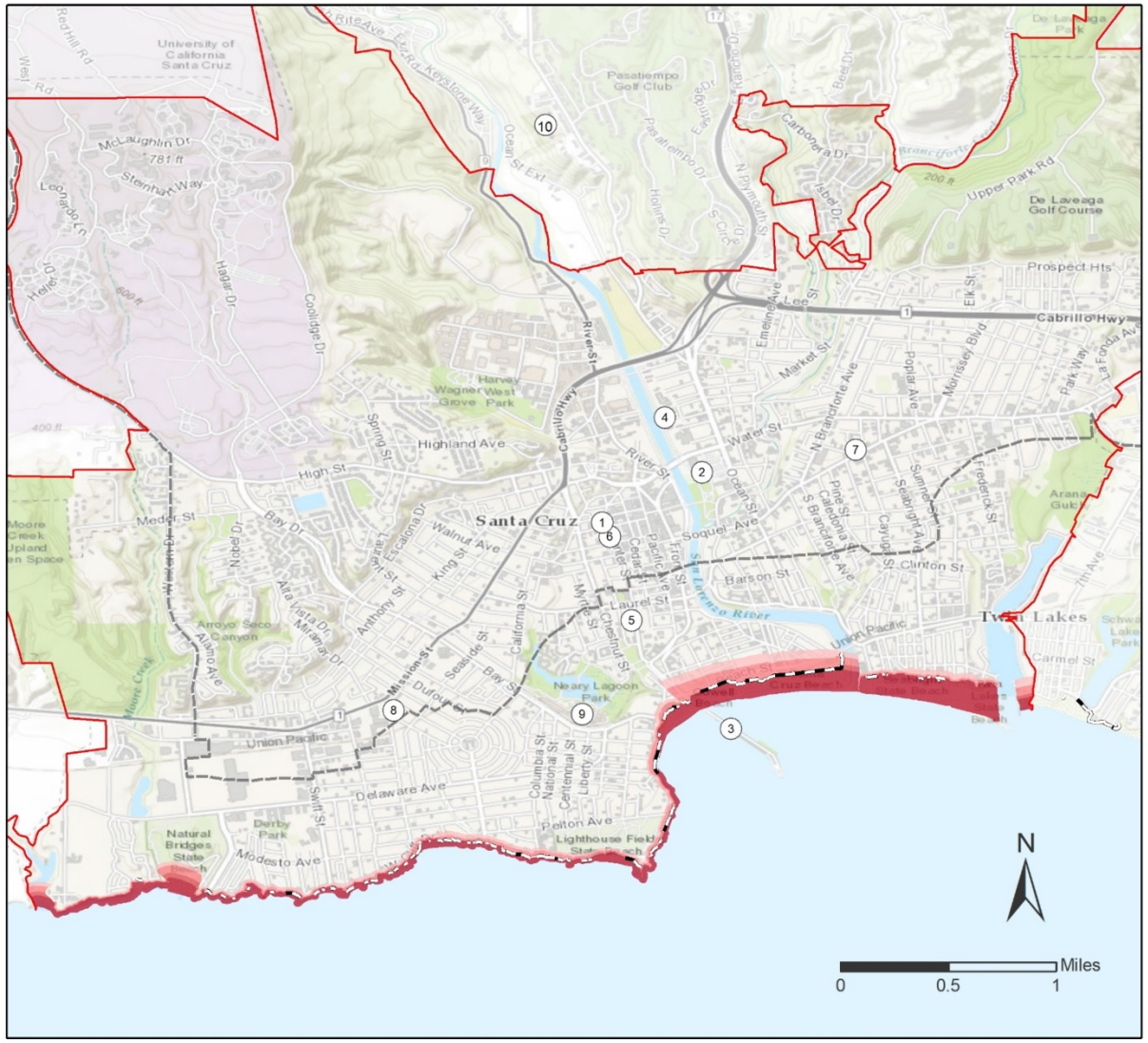
EROSION HAZARD ZONES

These layers represent future cliff and dune (sandy beach) erosion hazard zones, incorporating site-specific historic trends in erosion, additional erosion caused by accelerating sea level rise and (in the case of the storm erosion hazard zones) the potential erosion impact of a large storm wave event. The inland extent of the hazard zones represents projections of the future crest of the dunes, or future potential cliff edge, for a given sea level rise scenario and planning horizon. Erosion can lead to a complete loss of habitat, infrastructure and/or use of properties.

The 2030 rate assumes the medium SLR scenario (.3ft SLR) with no change in storminess, while the uncertainty represents two standard deviations of the alongshore historic erosion rate and the near-term potential for bluff failures. The 2060 and 2100 rates assume the high SLR scenario (2.4ft and 5.2ft SLR respectively) and doubling of El Nino effects per decade, while the uncertainty represents two standard deviations of the alongshore variability of historic erosion rates.

Because the life span of coastal protective infrastructure (seawalls, rip rap, etc.) is limited, this vulnerability analysis assumes that all existing coastal armoring will need to be removed, replaced or significantly redesigned at some point between 2030 and 2060. If these structures fail, erosion will accelerate and quickly meet projected inland migration rates (as documented at Stilwell Hall, Fort Ord), unless protective measures are implemented. Therefore, the erosion analysis for the 2060 planning horizon evaluates vulnerability of infrastructure under two separate assumptions: 1) coastal armoring remains in place and functioning, and 2) current coastal armoring fails and is not replaced and therefore modeled hazard zone layers provided by the ESA technical team represent the hazards for these time horizons. For the 2100 hazard zones represented within the maps, it is assumed that coastal armoring is no longer in place.

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
EROSION HAZARD ZONES



Boundaries

- SC City Limit
- Coastal Zone Boundary
- Coastal Armoring

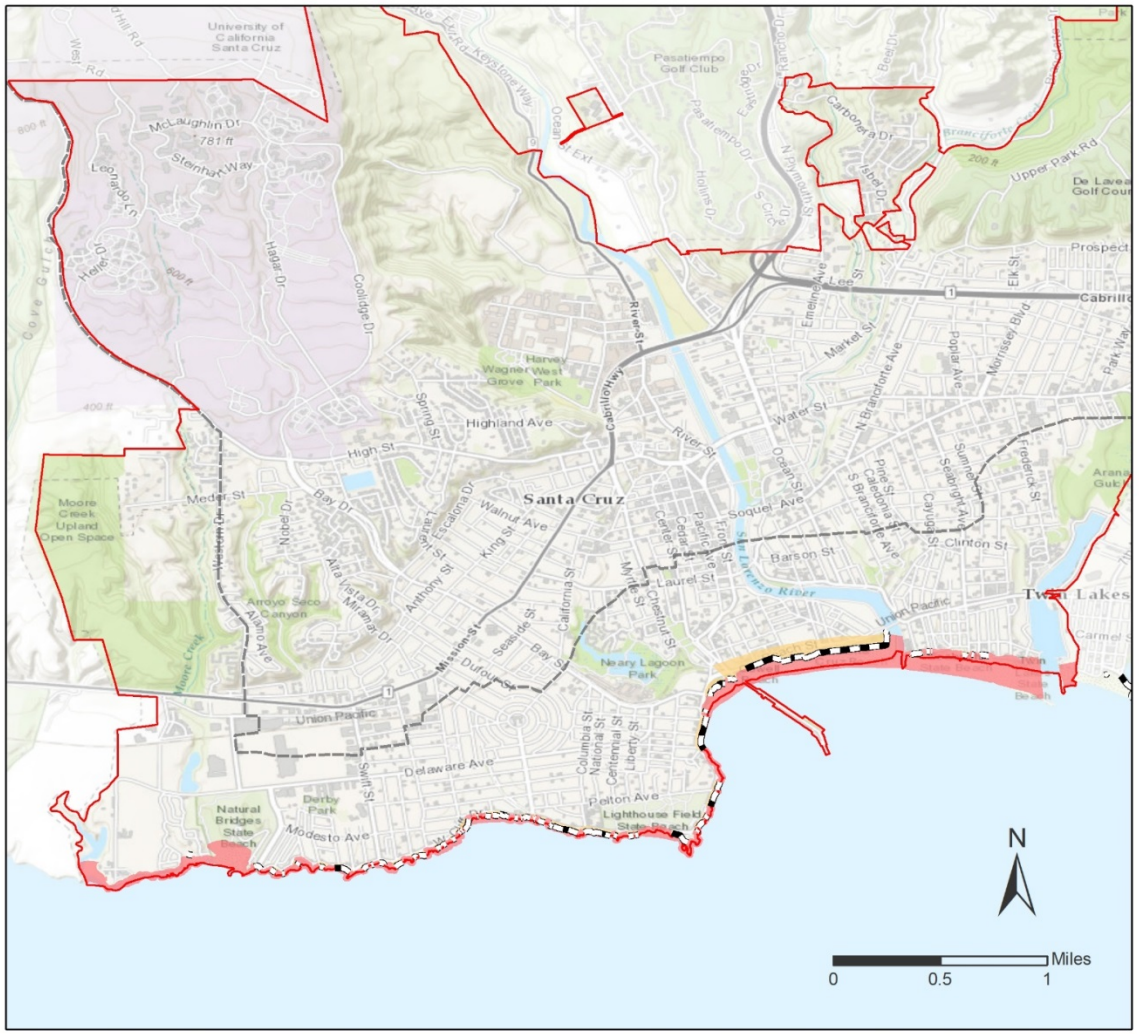
Erosion Hazard Zones

- Existing
- 2030 (.3 ft SLR) with armoring
- 2060 (2.4 ft SLR) no armoring
- 2100 (5.2 ft SLR) no armoring

Critical Facilities

1. City Hall
2. County Government Center
3. Lifeguard Headquarters
4. PG&E Substation
5. Police Department
6. Santa Cruz City Fire 1
7. Santa Cruz City Fire 2
8. Santa Cruz City Fire 3
9. Wastewater Plant
10. Water Treatment

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
EROSION HAZARD ZONES
2060 with armoring compared to 2060 without armoring



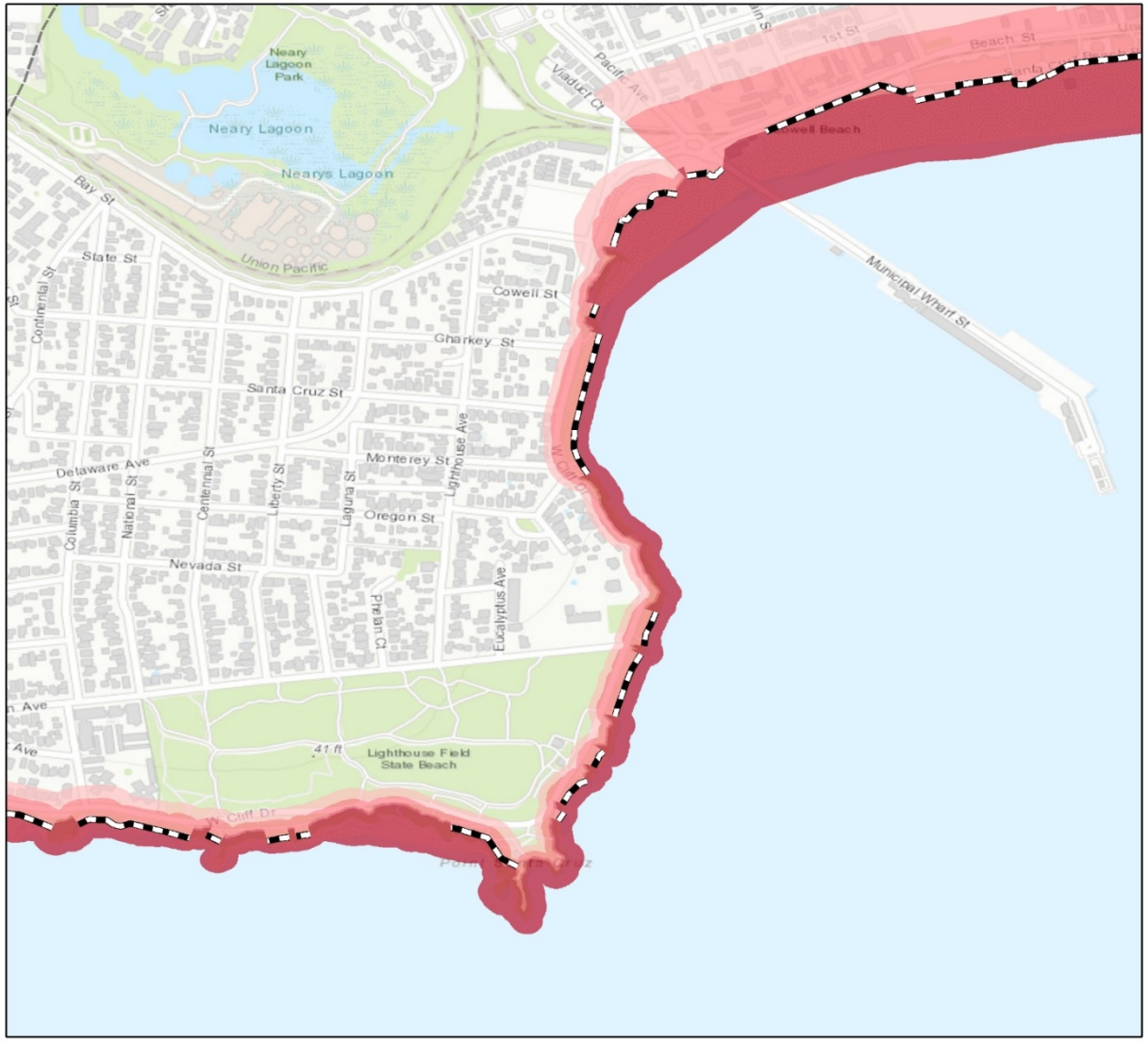
Boundaries

- SC City Limit
- Coastal Zone Boundary
- Coastal Armoring

Erosion Hazard Zones

- 2060 (2.4 ft SLR) with armoring
- 2060 (2.4 ft SLR) no armoring

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
EROSION HAZARD ZONES



Boundaries

- Coastal Zone Boundary
- Coastal Armoring

Erosion Hazard Zones

- Existing
- 2030 (.3 ft SLR) with armoring
- 2060 (2.4 ft SLR) no armoring
- 2100 (5.2 ft SLR) no armoring

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
EROSION HAZARD ZONES
2060 with armoring compared to 2060 without armoring

Boundaries

Coastal Zone Boundary

Coastal Armoring

Erosion Hazard Zones

2060 (2.4 ft SLR) with armoring

2060 (2.4 ft SLR) no armoring

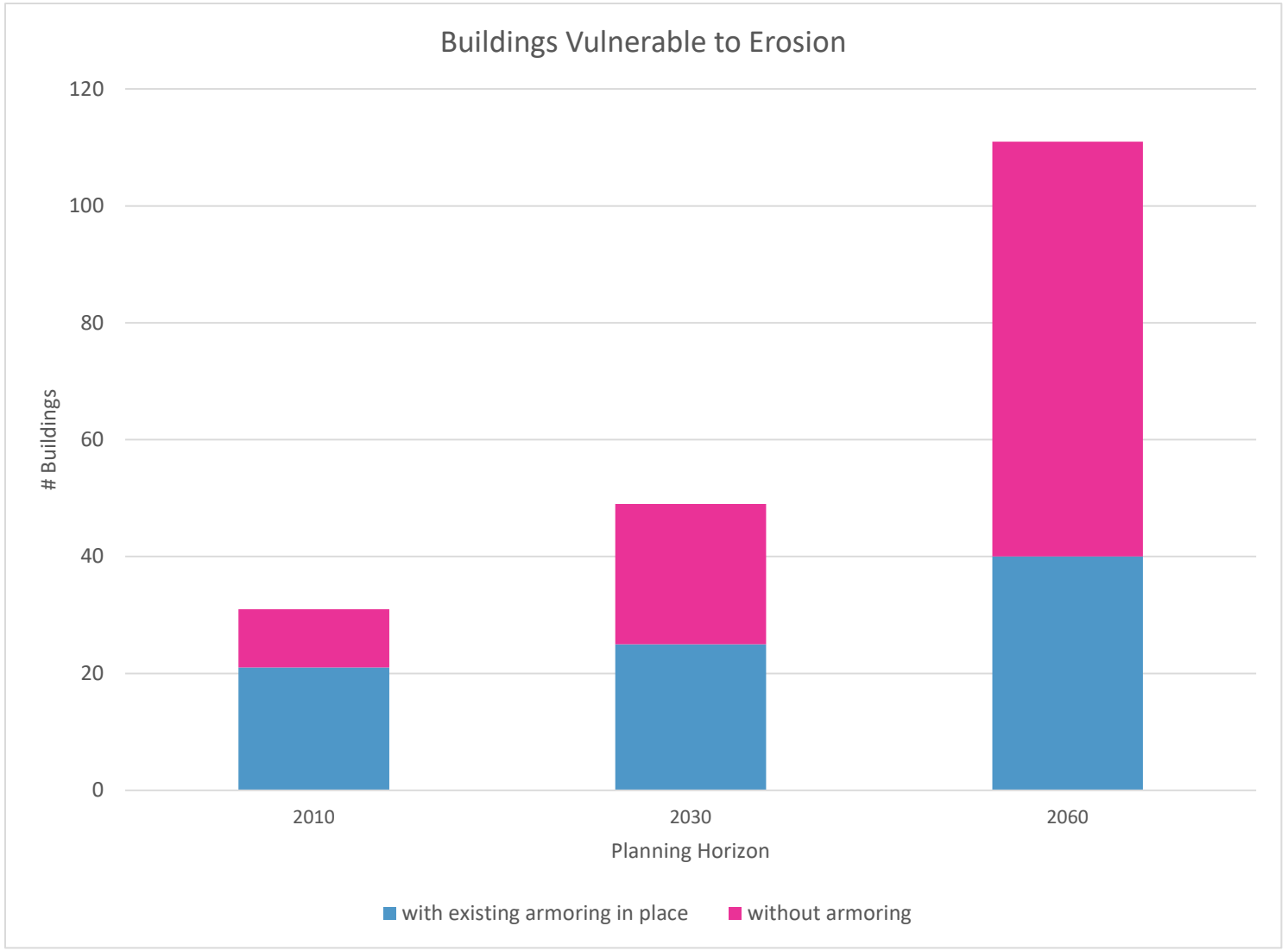
COASTAL EROSION: ASSET VULNERABILITY TABLE

With Armor: Assumes that exiting coastal armoring structures (seawalls, revetments, etc.) help protect against erosion.
Without Armor: Assumes that existing coastal armoring is no longer in place or does not function enough to protect from erosion.

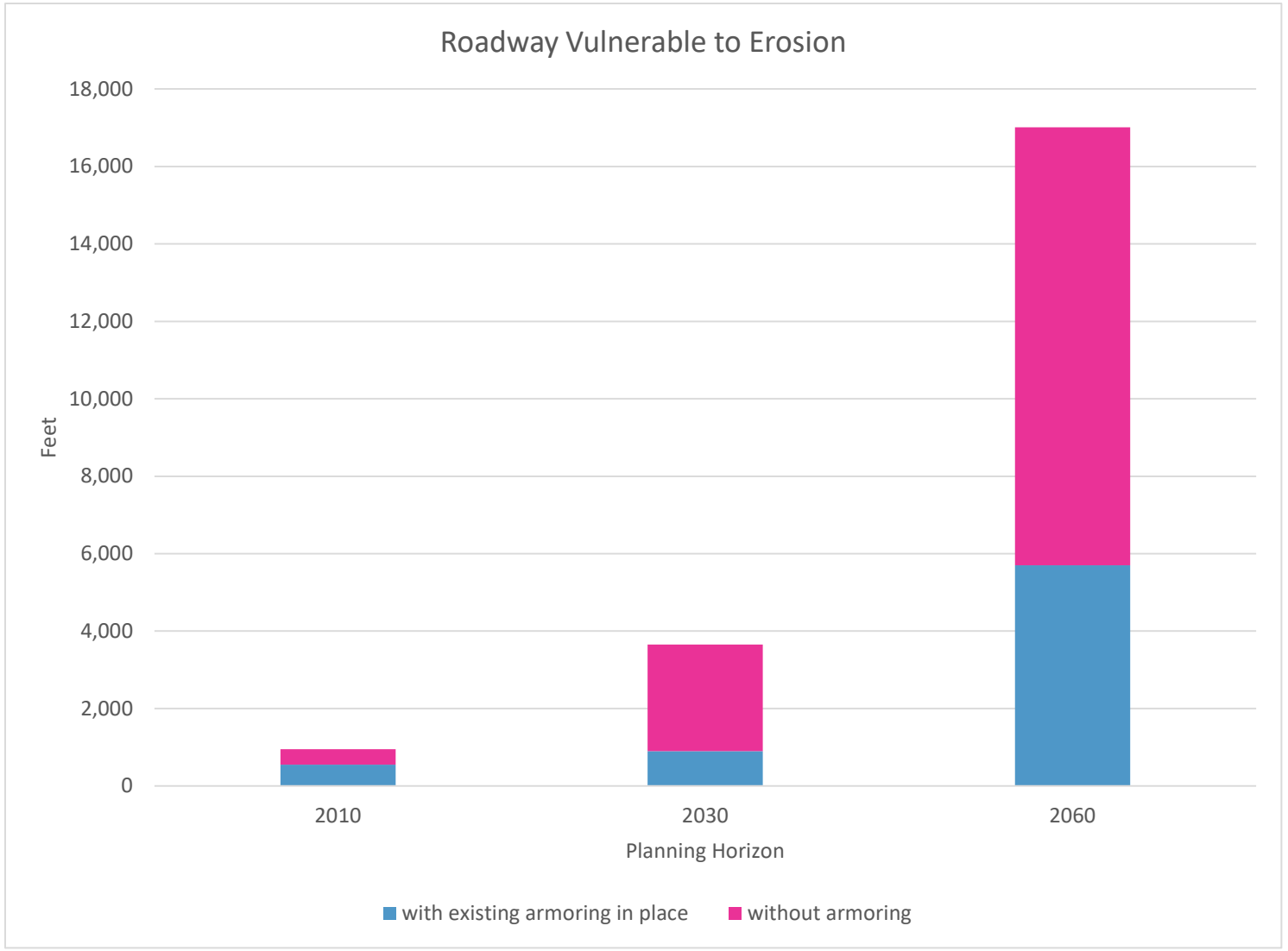
ASSETS	UNITS	TOTAL	2010		2030		2060	
			With armor	Without Armor	With armor	Without Armor	With armor	Without Armor
Land Use								
Total Buildings	Count	22,961	21	31	21	49	40	111
Residential	Count	20,686	15	19	15	24	31	63
Commercial	Count	888	2	7	2	17	2	36
Public	Count	915	4	5	4	7	7	10
Industrial	Count	217	0	0	0	0	0	0
Mixed Use	Count	112	0	0	0	1	0	2
Other	Count	143	0	0	0	0	0	0
Facilities	Count	115	0	0	0	0	0	0
Affordable Housing	Count	149	0	0	0	0	0	1
Parcels	Acres	6,809	35	40	35	55	54	81
National Historic District	Count	718	5	5	5	5	5	9
Recreation								
Coastal Access Points	Count	36	14	20	14	23	17	24
Coastal Path	Feet	32,167	4,114	8,139	6,161	13,876	9,003	20,906
Beaches	Acres	78	72	72	72	75	77	77
Parks	Acres	1,853	64	65	64	72	76	80
Transportation								

ASSETS	UNITS	TOTAL	2010		2030		2060	
			With armor	Without Armor	With armor	Without Armor	With armor	Without Armor
Roads	Feet	866,944	551	948	900	3,652	5,698	17,014
Highway 1	Feet	28,781	0	0	0	0	0	0
Rail	Feet	35,576	0	0	0	965	0	3,321
Bike Routes	Feet	373,101	37	250	629	3,527	4,365	14,790
Downtown Parking Lots	Feet	253,830	33	59	45	79	854	2,145
Water and Utility								
Sewer Pipe	Feet	812,897	808	1,183	1,151	2,521	2,518	8,901
Sewer Structures	Count	3,367	6	8	6	17	21	54
Storm Pipes	Feet	289,431	779	2,355	990	4,144	1,541	7,254
Storm Structure	Count	3,442	33	65	33	92	50	144
Water Mains	Feet	855,270	587	965	1,095	3,695	4,981	16,239
Culverts	Count	22	0	0	0	0	0	0
Natural Resources								
Wetlands	Acres	272	65	66	65	69	71	72
Sensitive Habitat	Acres	1,298	5	5	5	8	11	12
Monarch Butterfly Habitat	Acres	162	0	0	0	0	1	1
Hazard Sites								
Hazmat Cleanup Sites	Count	1,408	1	50	1	50	2	66
GeoTracker Sites	Count	22	0	0	0	0	0	0

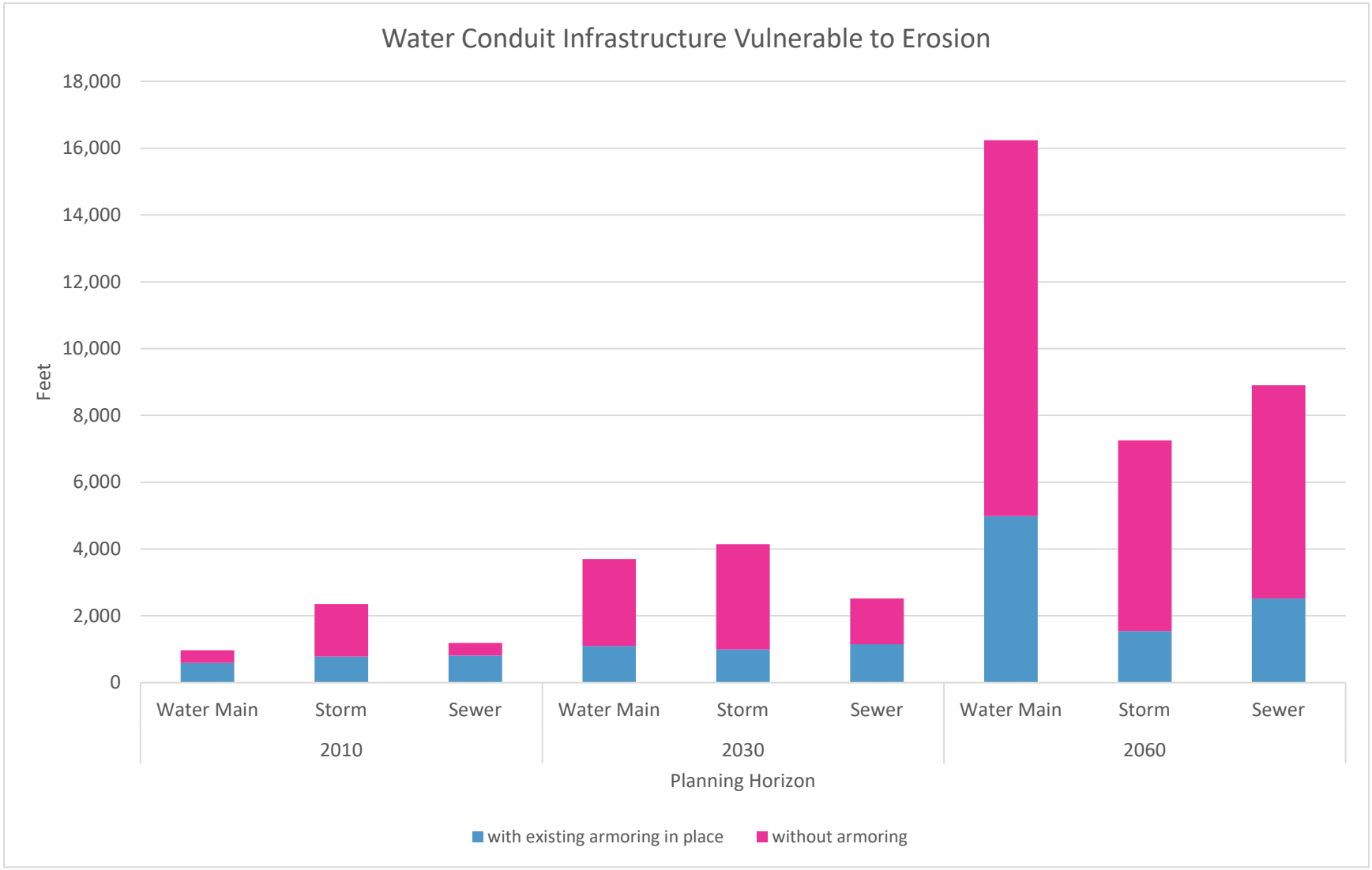
COASTAL EROSION: VULNERABLE BUILDINGS



COASTAL EROSION: VULNERABLE ROADWAY

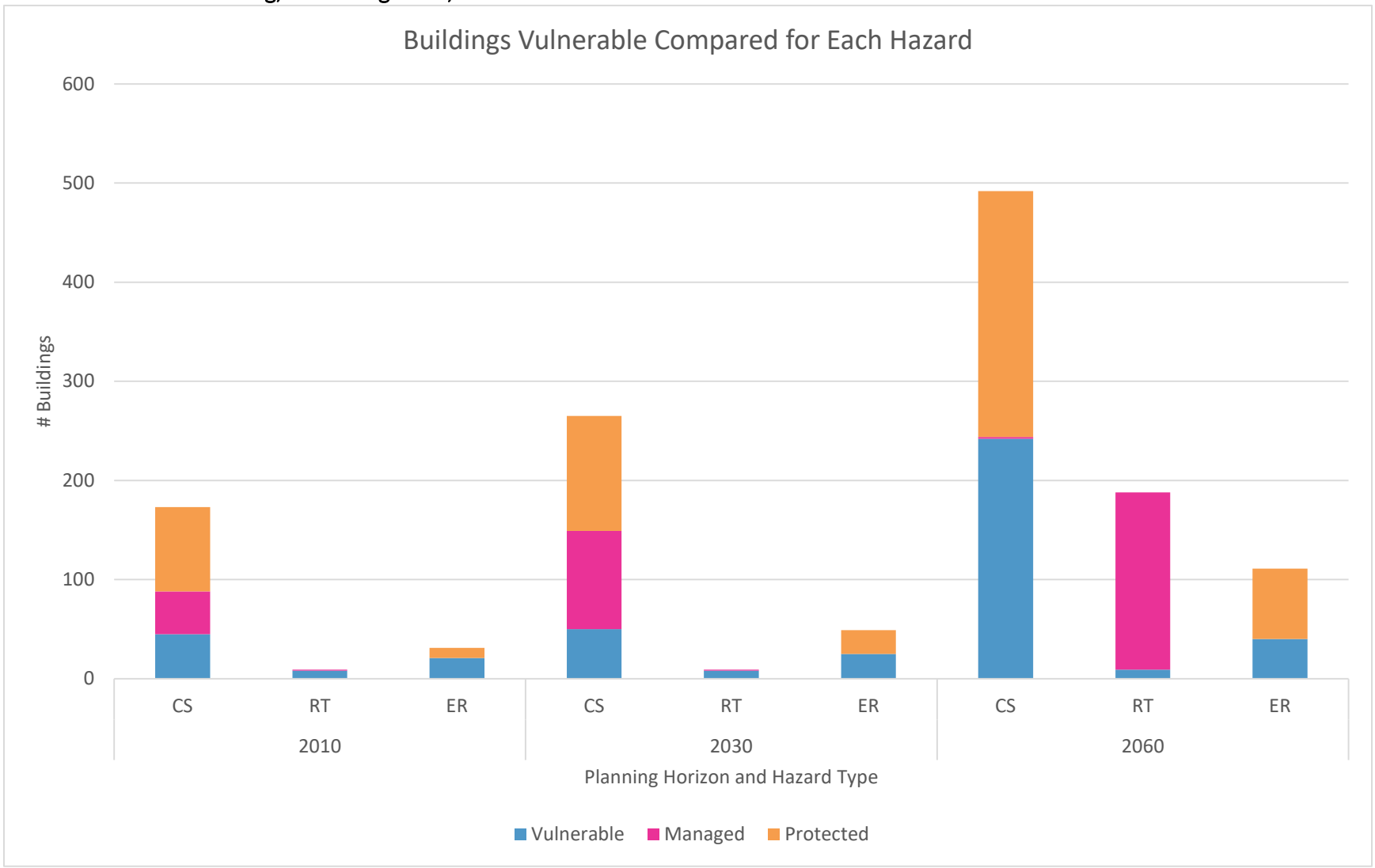


COASTAL EROSION: VULNERABLE WATER INFRASTRUCTURE



COASTAL CLIMATE CHANGE HAZARDS SUMMARY TABLE: BUILDINGS

CS= Coastal Storm Flooding, RT= Rising Tides, ER=Erosion



SUMMARY OF CITY BUILDINGS PROJECTED TO BE VULNERABLE

	Vulnerable	Managed	Protected
FACILITY	**2030 mid**	**2060 high**	**2100 high**
Beach Flats Clinic		Coastal Storm	Rising Tides
Police Department			Coastal Storm
Wastewater Plant			Rising Tides Coastal Storm

FEMA FLOOD ZONES

FEMA flood hazard maps are used for the National Flood Insurance Program and present coastal and fluvial flood hazards. These flood maps were used to identify current hazards as defined by FEMA. These maps, however, are believed to underestimate coastal flood hazards for future time horizons.

FEMA FLOOD ZONE DESCRIPTIONS:

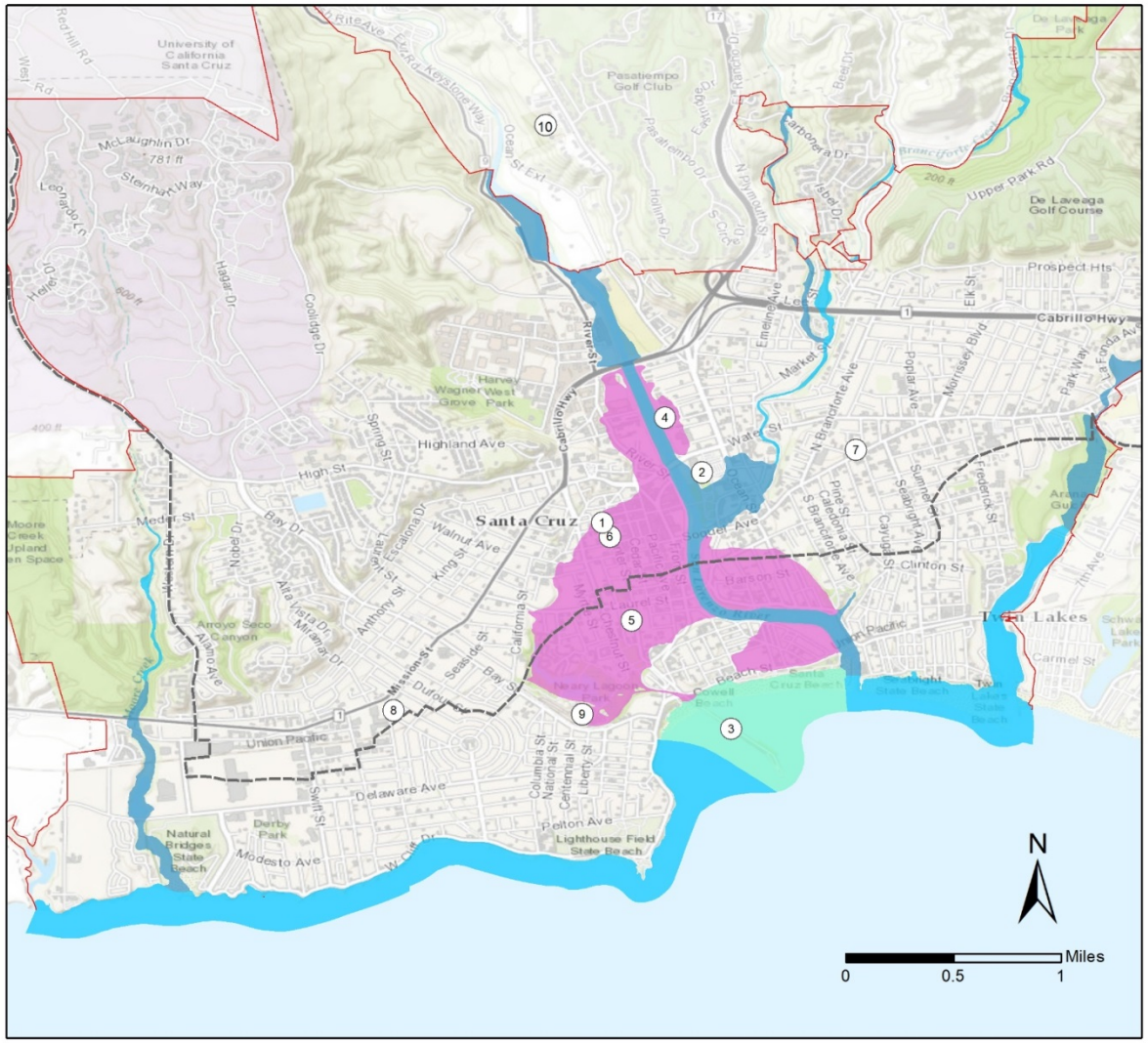
A: Areas subject to a one percent or greater annual chance of flooding in any given year. Because detailed hydraulic analyses have not been performed on these areas, no base flood elevations are shown.

AE: Areas subject to a one percent or greater annual chance of flooding in any given year. Base flood elevations are shown as derived from detailed hydraulic analyses.

VE: Areas along coasts subject to a one percent or greater annual chance of flooding in any given year that include additional hazards associated with velocity wave action. Base flood elevations are shown as derived from detailed hydraulic analyses.

A99: Areas subject to a one percent or greater annual chance of flooding in any given year, but will ultimately be protected by a flood protection system under construction. No base flood elevations or flood depths are shown.

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
FEMA FLOOD HAZARD ZONES



FEMA: ASSET VULNERABILITY TABLE

ASSETS	UNITS	TOTAL	FEMA FLOOD ZONE				
			A	AE	VE	A99	.2%
Land Use							
Total Buildings	Count	22,961	30	204	24	1,852	190
Residential	Count	20,686	18	152	0	1,450	129
Commercial	Count	888	4	24	6	251	46
Public	Count	915	8	22	18	97	10
Industrial	Count	217	0	1	0	10	1
Mixed Use	Count	112	0	2	0	29	4
Other	Count	143	0	3	0	15	0
Facilities	Count	115	1	2	1	25	4
Affordable Housing	Count	149	0	2	0	34	3
Parcels	Acres	6,809	0	0	0	0	51
National Historic District	Count	718	0	4	5	171	18
Recreation and Public Access							
Coastal Access Points	Count	36	15	1	2	1	2
Coastal Path	Feet	32,167	6,692	0	167	1,820	1,509
Beaches	Acres	78	0	0	0	0	1
Parks	Acres	1,853	0	0	0	0	5
Transportation							
Roads	Feet	866,944	3,646	10,996	2,411	76,969	8,131

Highway 1	Feet	28,781	119	578	0	0	90
Rail	Feet	35,576	271	547	0	6,134	3,245
Bike Routes	Feet	373,101	4,170	17,380	0	51,629	4,765
Downtown Parking Lots	Acres	5.8	.01	.02	0	.10	.01
Water and Utility							
Sewer Pipe	Feet	812,897	1,668	12,310	3,714	104,069	9,527
Sewer Structures	Count	3,367	6	52	9	411	41
Storm Pipes	Feet	289,431	1,263	5,352	154	66,021	6,045
Storm Structure	Count	3,442	46	101	5	723	72
Water Mains	Feet	855,270	3,345	12,279	2,777	76,800	7,950
Culverts	Count	22	3	9	0	0	1
Natural Resources							
Wetlands	Acres	272	0	0	0	0	2
Sensitive Habitat	Acres	1,298	0	0	0	0	4
Monarch Butterfly Habitat	Acres	162	0	0	0	0	1
Hazard Sites							
Hazmat Cleanup Sites	Count	1,408	12	47	9	306	83
GeoTracker Sites	Count	22	0	1	0	7	1

APPENDIX E
SOCIAL VULNERABILITY ANALYSIS – METHODS AND DATA

Prepared by Dr. Juliano Calil and adapted by City Staff

The objective of this study is to assess Social Vulnerability of the City of Santa Cruz to natural hazards (coastal storms, flooding, coastal erosion, tsunami and wild fire) at the city block level. In this study, we used an equal-weights overlay spatial model developed in a desktop geographic information system (ESRI ArcGIS version 10.5).

FIRST STEP: SOVI EVALUATION STEPS AND LIMITATIONS:

The first step in the analysis was an investigation of the preexisting Social Vulnerability Index (SoVI©), developed at the Hazards and Vulnerability Research Institute at the University of South Carolina. Due to spatial scale and other limitations from SoVI© that will be discussed below, we decided to develop a customized social vulnerability approach better suited to the project objectives.

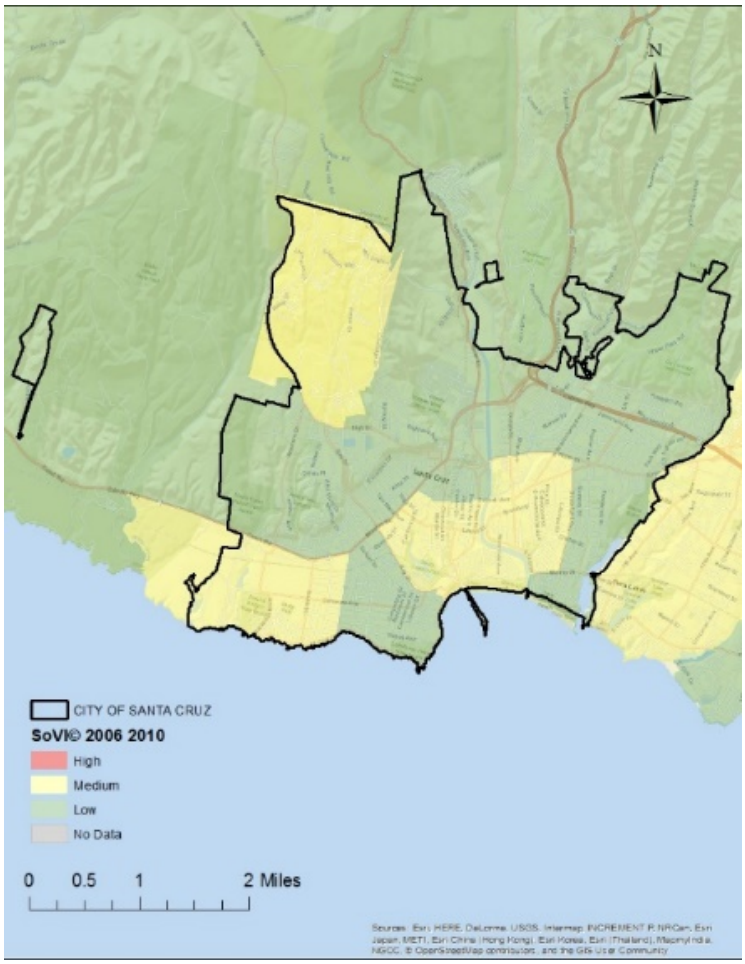
SoVI© Background (extracted from Calil and Newkirk (2016) – forthcoming):

"The Social Vulnerability Index (SoVI©) measures community vulnerability, defined as a reduction in the community's ability to prepare for, respond to, and recover from hazards ("Social Vulnerability Index 2006–2010" 2017). In the 2006 to 2010, nearly 30 variables we reduced to seven independent components, which describe social vulnerability: (i) race (Black) and class (poverty); (ii) wealth; (iii) elderly residents; (iv) Hispanic ethnicity; (v) special needs individuals (nursing home residents); (vi) Native American ethnicity; and (vii), service industry employment ("2006–2010 Social Vulnerability Component Summary" 2017)

SoVI© is a dynamic index and future iterations are expected to include additional variables including: homeless population, physical mobility constraints, and social capital ("Changes and Improvements in the SoVI© Formulation for 2006–10" 2017)."

Figure E1 shows the most detailed (publicly available) SoVI© data for the city of Santa Cruz. Note that the data is available only at the census tract level for the State of California. Only 4 of the 16 tracts that are inside or overlap with the city boundaries have SoVI values equal "medium", and no tracts are classified with High SoVI©. Most likely, the more socially vulnerable areas are diluted by less vulnerable block groups in the same tract.

SOVI© (2006 – 2010) SCORES FOR SANTA CRUZ, CA



List of SoVI© limitations identified during this study:

1) Data is available at the tract level (City only has 15/16 tracts)
2) Despite the existence of pockets of known social vulnerability in the city, no tracts are classified as Medium High, or High SoVI©.
3) Some of the principal components calculated by SoVI do not or provide a clear adaptation path/action (e.g. Hispanic and Native American Ethnicity).

SECOND STEP: ADOPTED METHODS AND MATERIALS:

For the reasons outlined above, a customized social vulnerability approach to the study was developed. The present study focuses on five social vulnerability indicators, which are tied to specific adaptation alternatives (Table 1).

SELECTED SOCIAL VULNERABILITY INDICATORS

Indicator	Source	Vulnerability Reason	Level	Unit	Metadata	Year
Income below Median Income (based on HUD home income limits)	Social Explorer; U.S. Census Bureau - Census Field: SE_T056A011 (Households: Less than $60,000)	Poverty limits ability to prepare for, and recover from natural disasters	Census Block Group	Number of Households	Social Explorer	ACS 2015 (1-Year Estimates)
Elderly (more than 65 years old)	Social Explorer; U.S. Census Bureau. Table T7B (Age – Cumulative)	Elderly population is more likely to need special assistance related to health and mobility challenges.	Census Block Group	Total Population	Social Explorer	ACS 2013 (1-Year Estimates)
Language Limitations (Speaks English "Not Well" and "Not at All")	U.S. Census Bureau. B16005. Nativity by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over	Inability to Speak English can severely limit the understanding of official communications related to preparation for, and recovery from natural disasters	Census Tract	Population 5 years and Over	Social Explorer	ACS 2015 (5-Years Estimates)
Disability	U.S. Census Bureau. Field B22010 (Receipt of Food Stamps/Snap in the Past 12 Months by Disability Status for Households).	Disabled population is more likely to need special assistance related to health and mobility challenges.	Census Block Group	Number of Households with 1 or More Persons with A Disability	Social Explorer	ACS 2012 (5-Year Estimates)

Indicator	Source	Vulnerability Reason	Level	Unit	Metadata	Year
Crimes (FBI Part I)*	Santa Cruz Police Department	Population in areas of high number of serious crimes is less likely to evacuate and preparing for low frequency but severe natural hazards (or long-term ones) is likely a low priority	City Block (aggregated at the block group for analysis)	Number of Part I crimes at each city block (2015/2016 -year end numbers).	Communications with Santa Cruz City Staff	2015

*FBI Part I crimes include violent and property crimes. Aggravated assault, forcible rape, murder, and robbery are classified as violent while arson, burglary, larceny-theft, and motor vehicle theft are classified as property crimes.

First, values for the five indicators above (Table 1) were assigned to each one of the 53 census block groups in the city of Santa Cruz. Next, individual scores were calculated for each variable (using 5 classes, based on Jenks Natural Breaks) and scaled between 0 and 100. As an example, the number of crimes in each block group (which in this case ranged between 0 and 651) were grouped into 5 categories with values of 20, 40, 60, 80, and 100 as follows:

CRIME SCORING WITHIN CENSUS BLOCKS

Number of Crimes (2015/2016)	Crime Score	Description
0 to 25	20	Low
26 to 70	40	Medium-Low
71 to 129	60	Medium
130 to 238	80	Medium-High
239 to 651	100	High

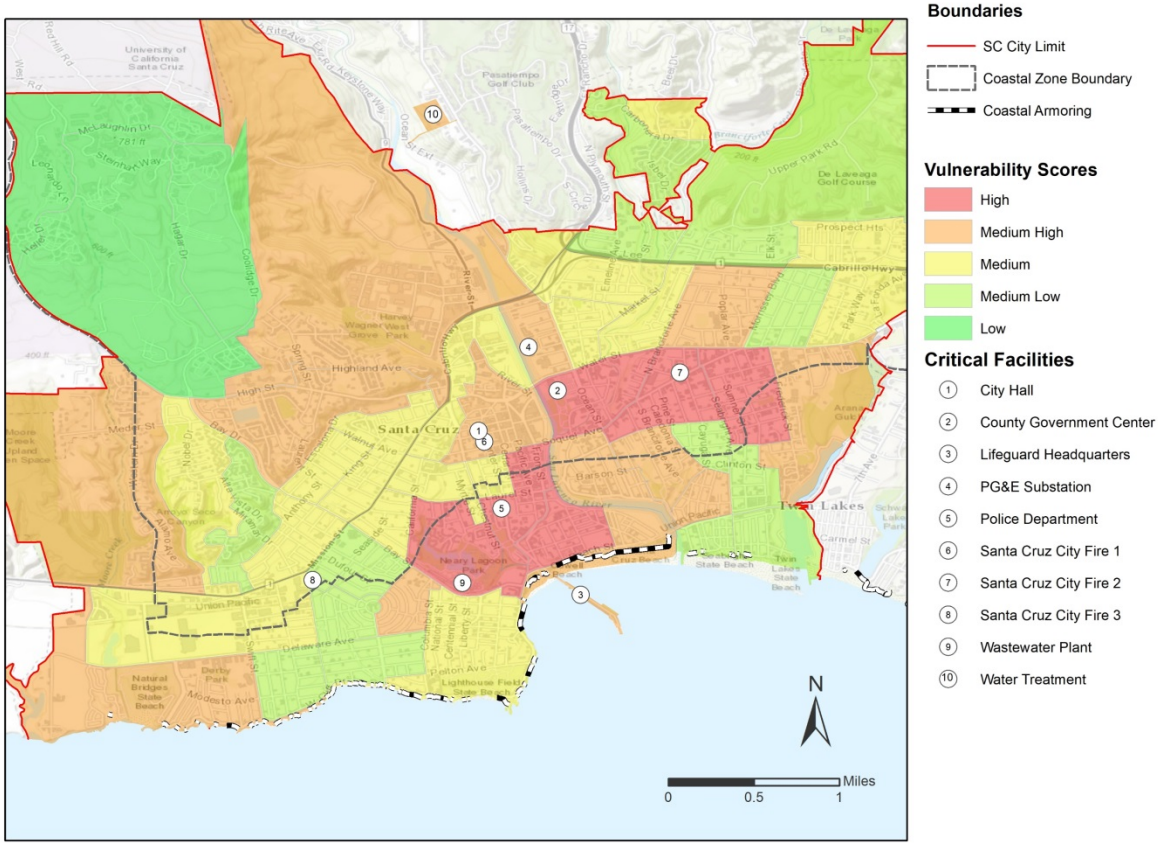
Finally, an overall Vulnerability Score was calculated for each census block group as follows:

$$VS = \frac{(IS+AS+LS+DS+CS)}{5} \qquad (1)$$

Where:
VS is the Vulnerability Score (Fig. 2);
IS is the Income Score (Fig. 3);
AS is the Age Score (Fig. 4);
LS is the Language Score (Fig. 5);
DS is the Disability Score (Fig. 6); and
CS is the Crime Score (Fig. 7).

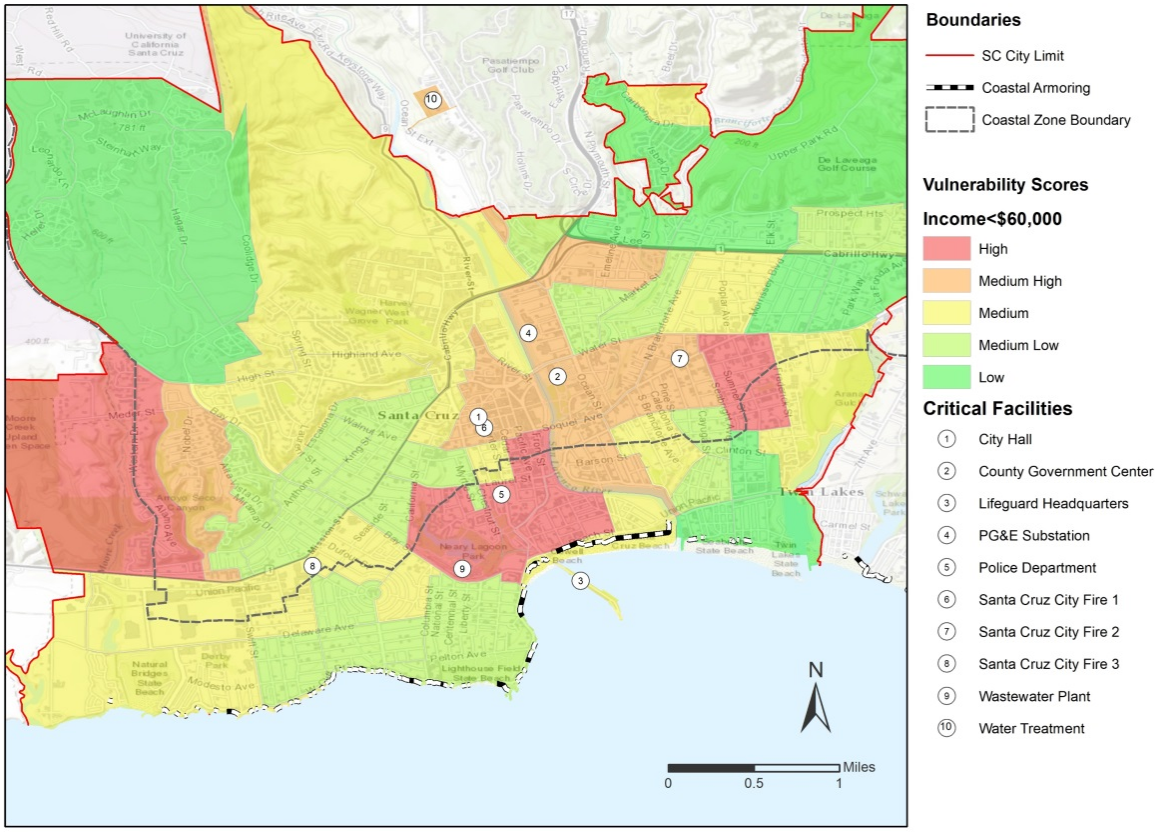
VULNERABILITY SCORES

CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY SCORES



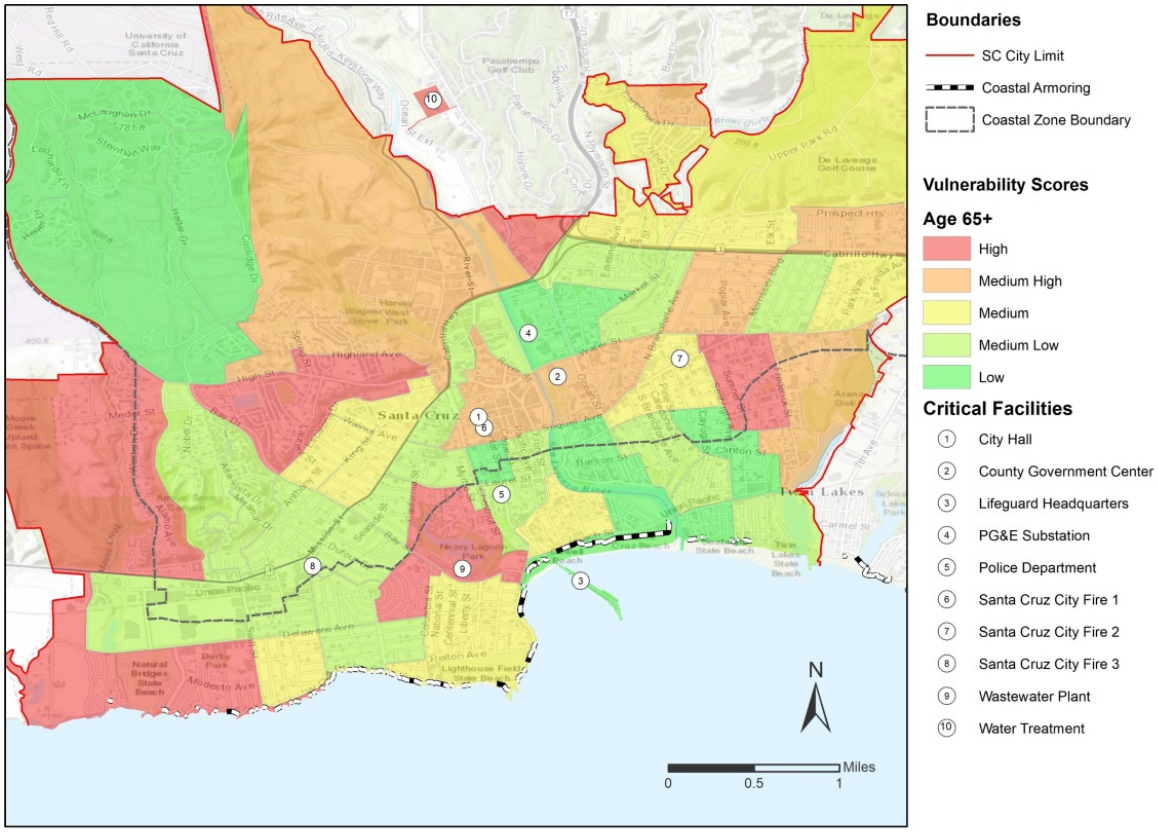
INCOME SCORES

CITY OF SANTA CRUZ - COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY - INCOME < $60,000



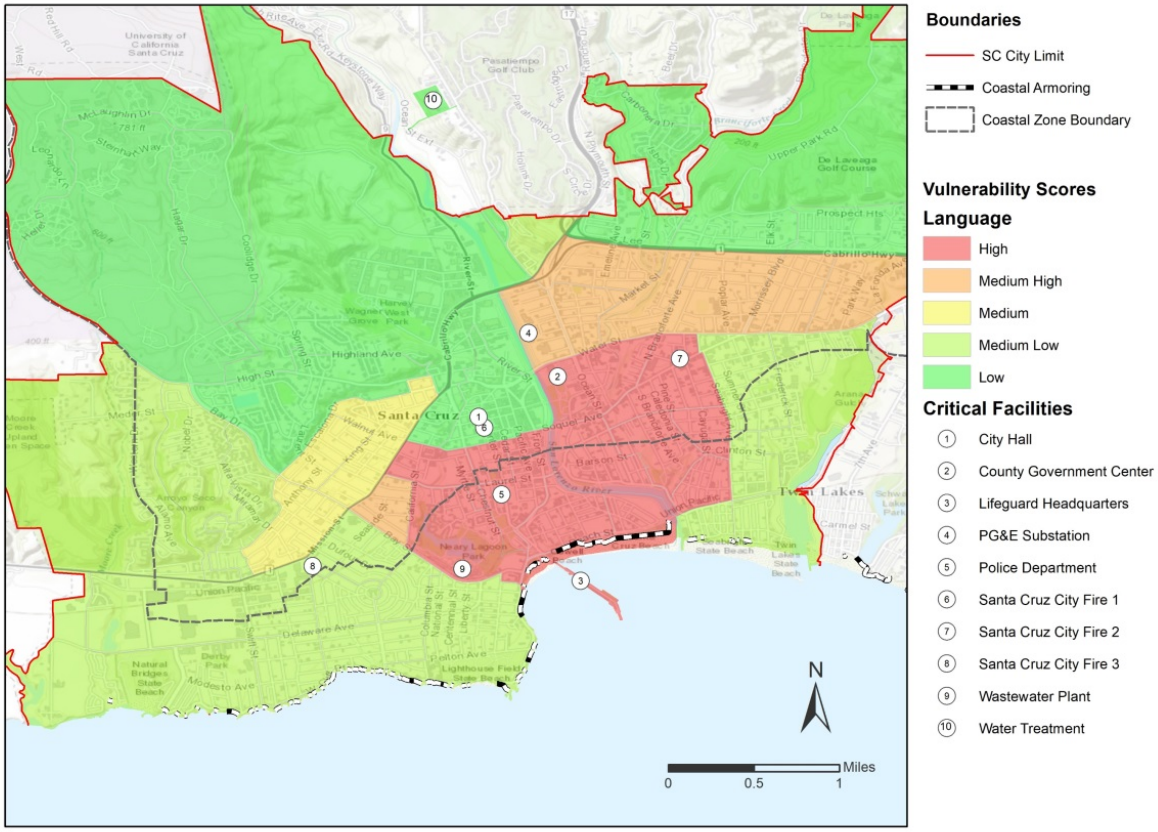
AGE SCORES

CITY OF SANTA CRUZ - COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY - AGE 65+



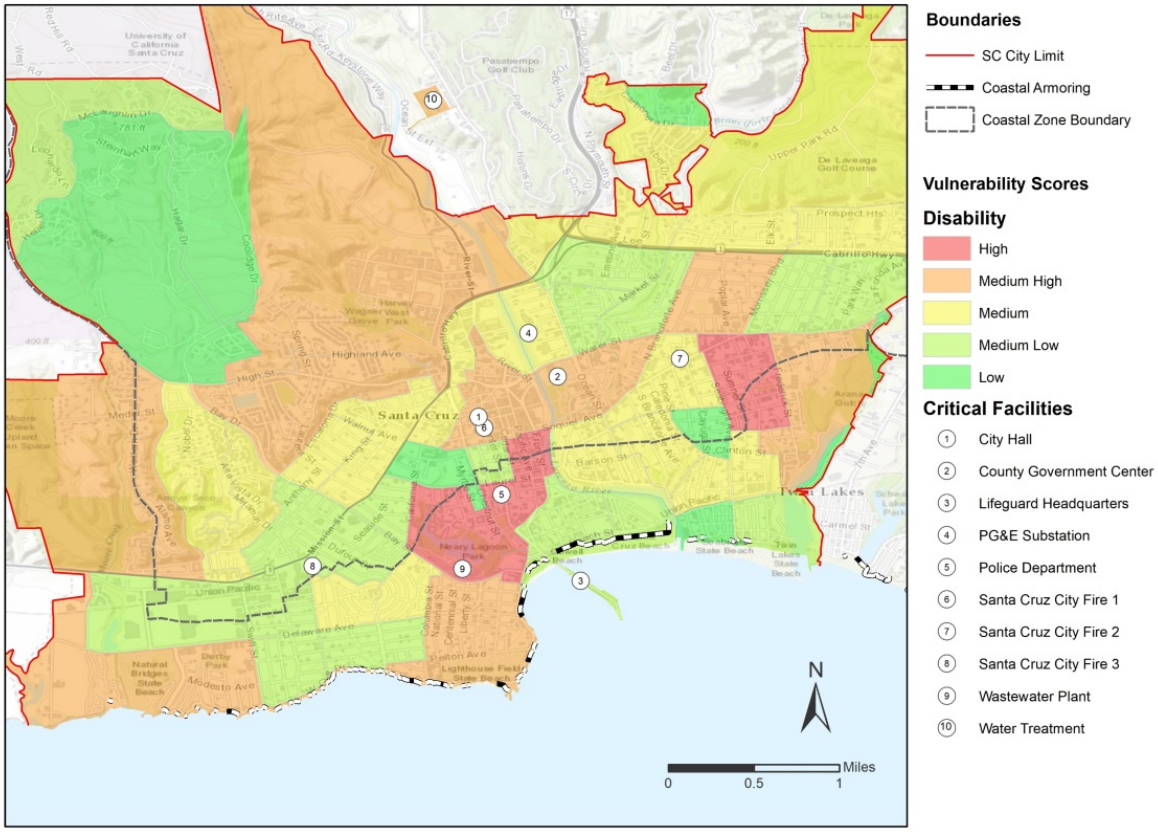
LANGUAGE SCORES

CITY OF SANTA CRUZ - COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY - LANGUAGE



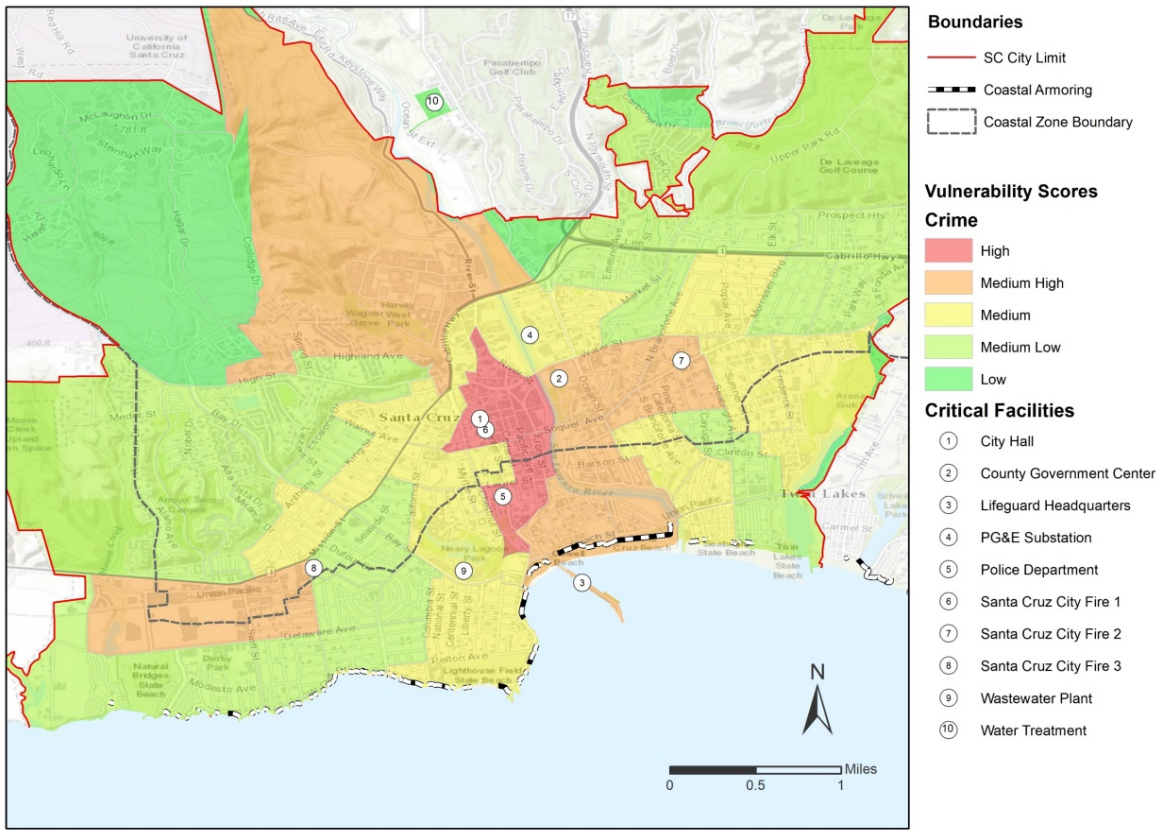
DISABILITY SCORES

CITY OF SANTA CRUZ - COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY - DISABILITY



CRIME SCORES

CITY OF SANTA CRUZ - COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY - CRIME



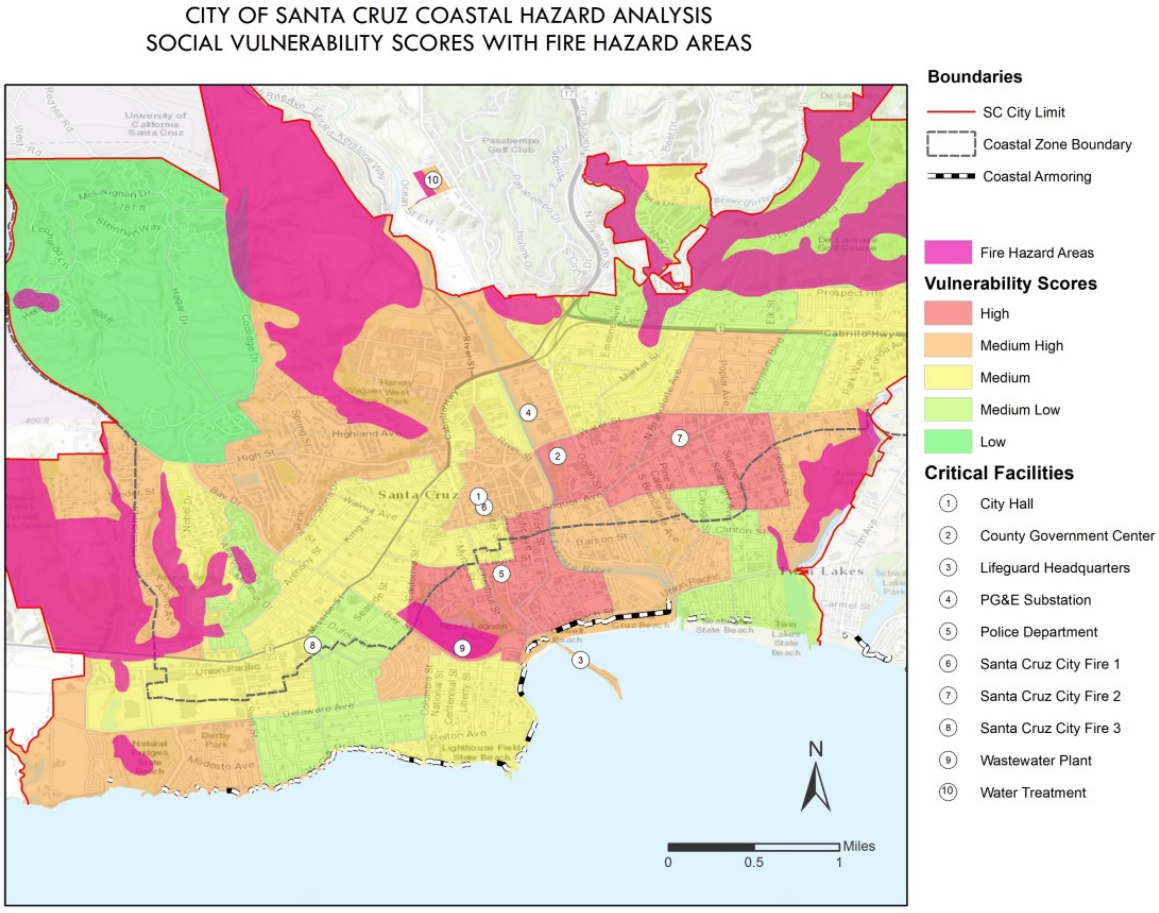
RESULTS AND HAZARDS OVERLAYS:

CITY WIDE

Various maps showing the overlap between the vulnerability scores (Figures 8 to 10), and various natural hazards were produced, for the full extent of the city. Additionally, detailed maps were also produced for the areas with high social vulnerability scores (Figures 11 to 13).

SOCIAL VULNERABILITY SCORES AND FIRE HAZARDS (2030 FIRE HAZARDS)

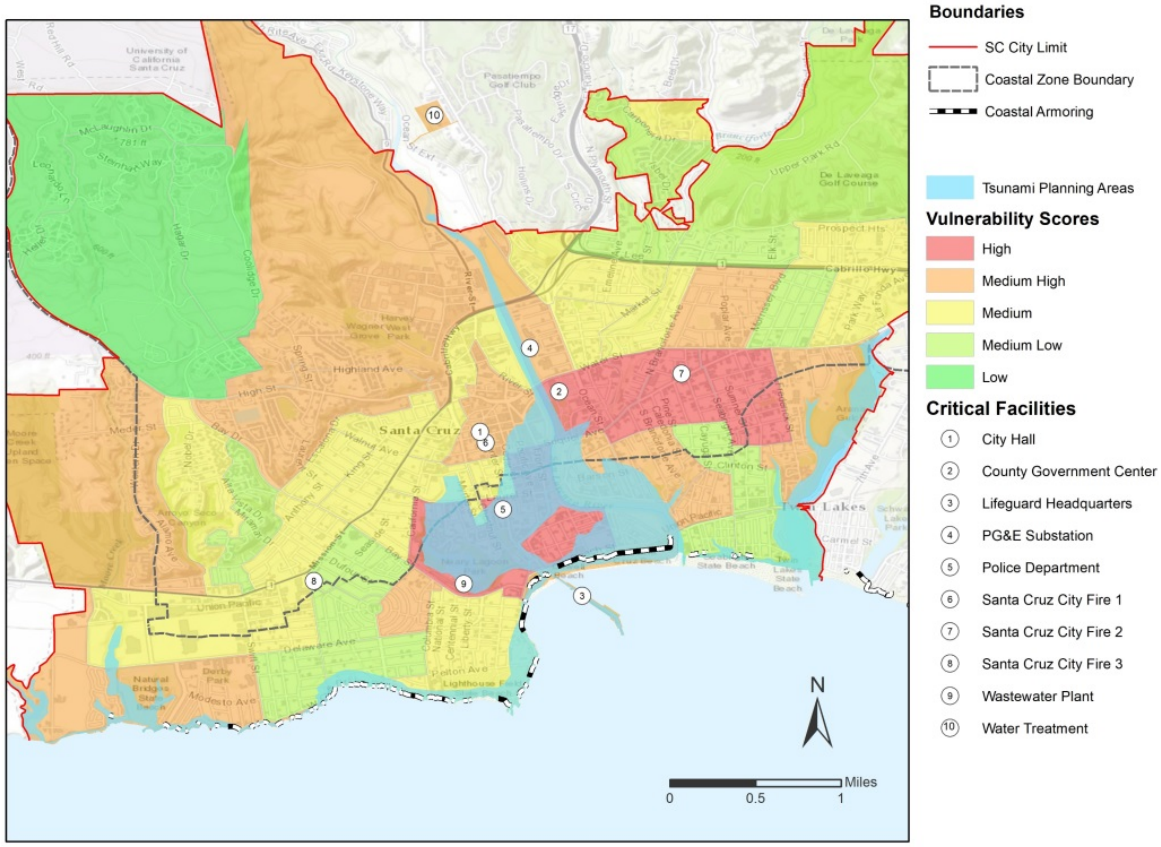
(Data Source: Santa Cruz GIS 2030 Fire hazards):



SOCIAL VULNERABILITY SCORES AND TSUNAMI PLANNING AREAS

(Data Source: Tsunami Planning Areas):

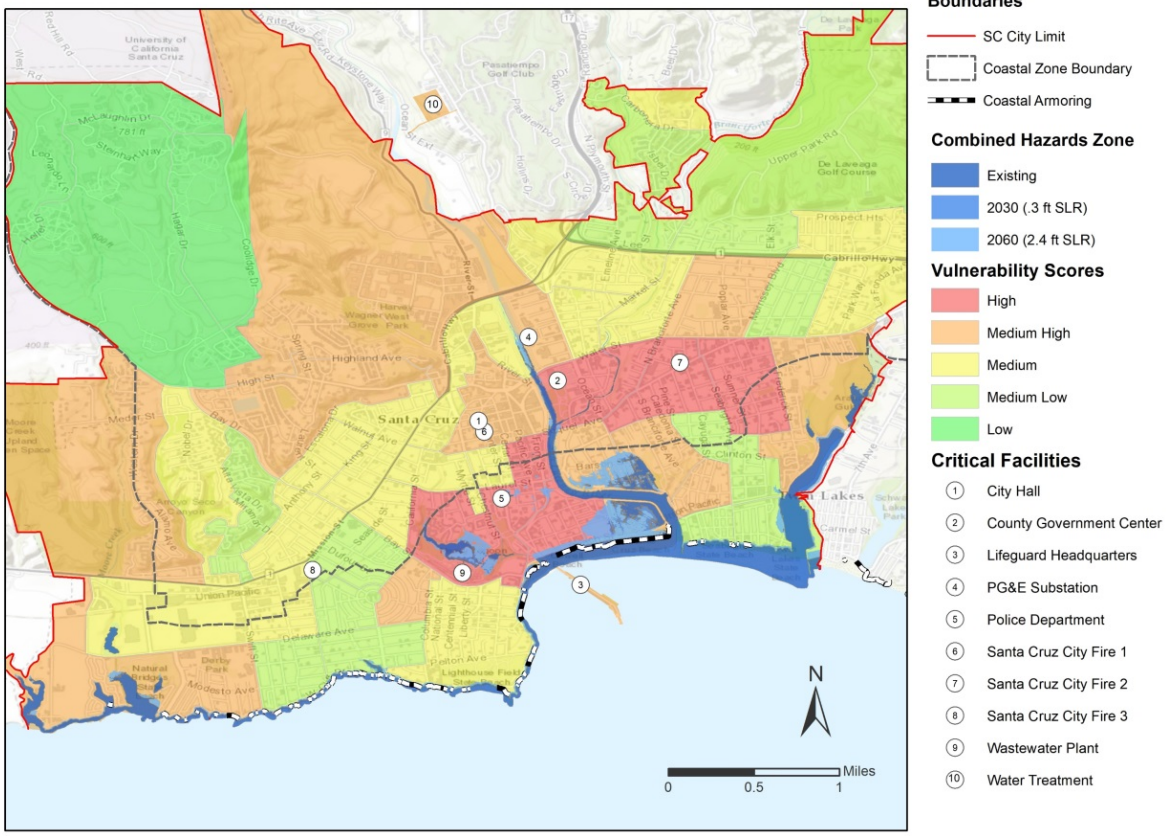
CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY SCORES WITH TSUNAMI PLANNING AREAS



SOCIAL VULNERABILITY SCORES AND COMBINED COASTAL HAZARDS (2030 AND 2060)

(Combined Coastal Hazard Layers Data Source: Central Coast Wetlands Group:

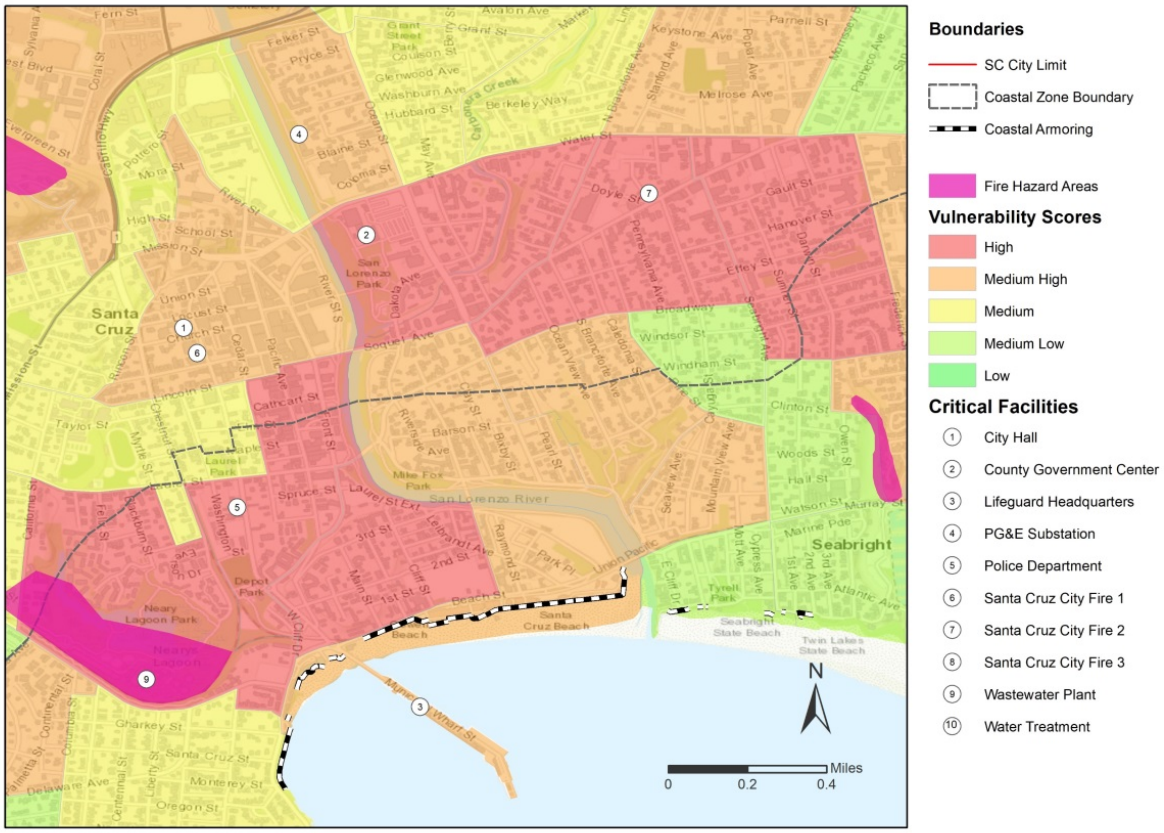
CITY OF SANTA CRUZ COASTAL HAZARD ANALYSIS
SOCIAL VULNERABILITY SCORES WITH COMBINED HAZARDS ZONES
(hazard zones include areas that are currently managed by pumps or protected by levees)



BEACH FLATS AND LOWER OCEAN – SOCIAL VULNERABILITY SCORES AND FIRE HAZARDS (2030)

Detailed maps were also produced for the two neighborhoods containing block groups with high social vulnerability scores (Beach Flats and Lower Ocean):

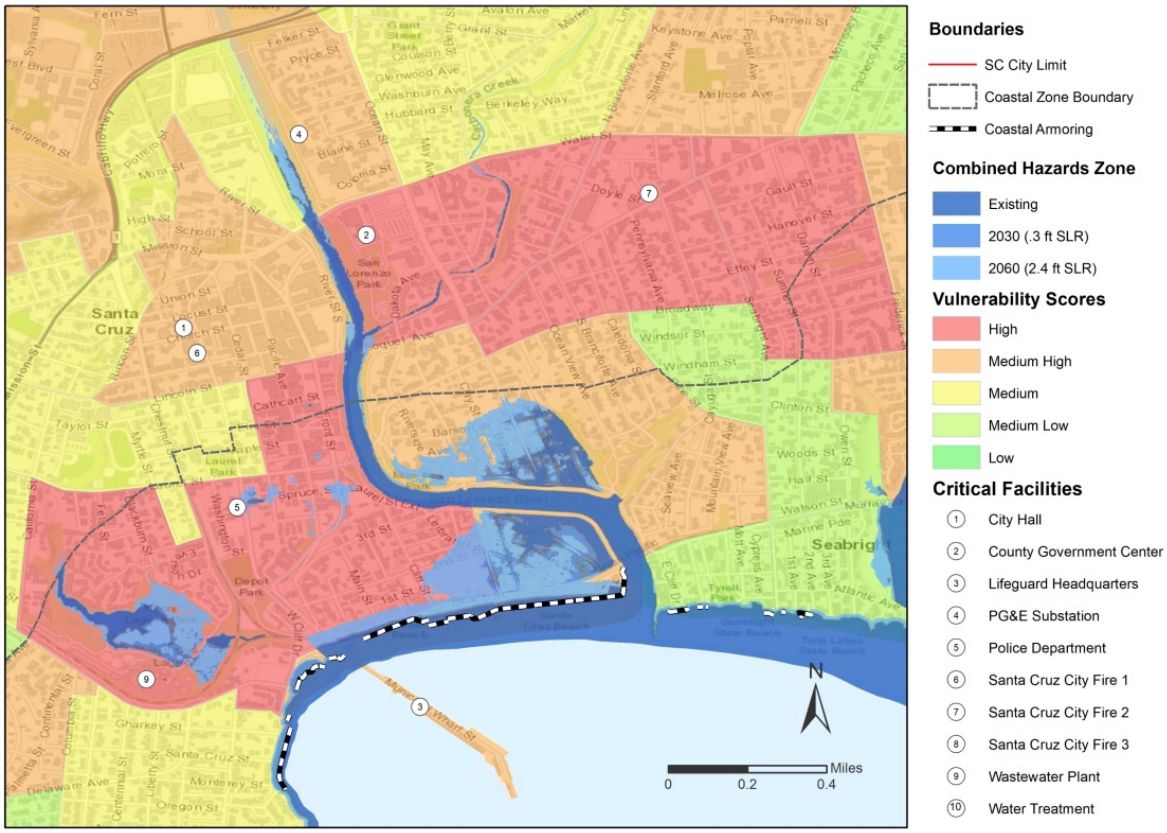
CITY OF SANTA CRUZ - BEACH FLATS AND LOWER OCEAN - COASTAL HAZARDS ANALYSIS
SOCIAL VULNERABILITY SCORES WITH FIRE HAZARD AREAS



BEACH FLATS AND LOWER OCEAN – SOCIAL VULNERABILITY SCORES AND COMBINED COASTAL HAZARDS (2030 AND 2060)

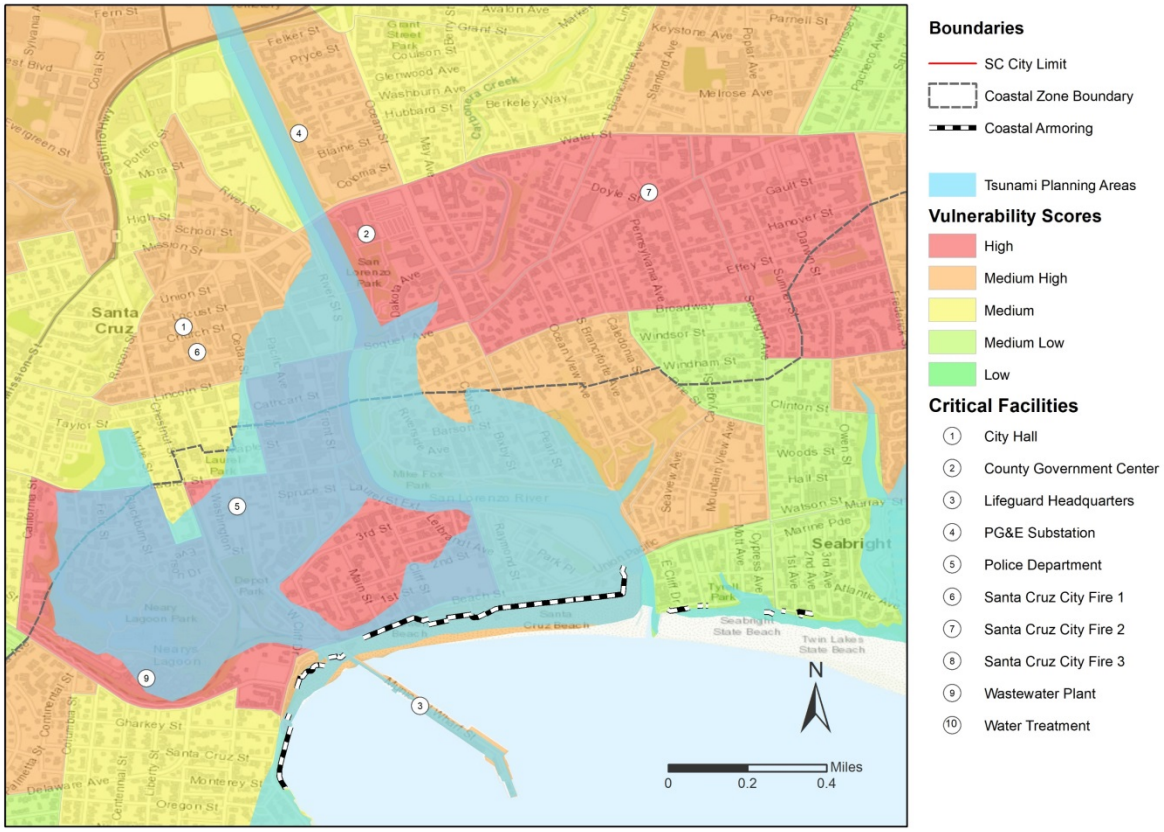
Beach Flats and Lower Ocean — Social Vulnerability Scores and Tsunami Planning areas:

CITY OF SANTA CRUZ - BEACH FLATS AND LOWER OCEAN
SOCIAL VULNERABILITY SCORES WITH COMBINED HAZARDS
(hazard zones include areas that are currently managed by pumps or protected by levees)



BEACH FLATS AND LOWER OCEAN — VULNERABILITY SCORES AND TSUNAMI PLANNING AREAS

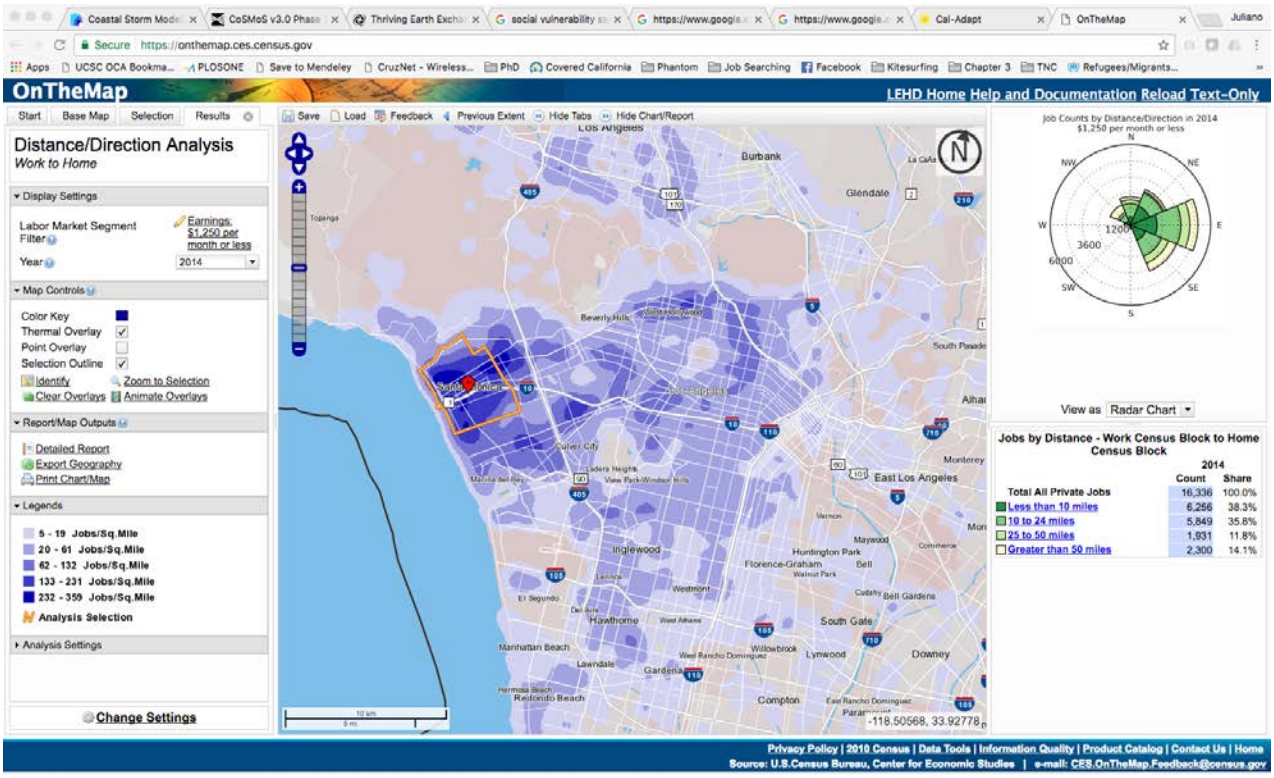
CITY OF SANTA CRUZ - BEACH FLATS AND LOWER OCEAN - COASTAL HAZARDS ANALYSIS
SOCIAL VULNERABILITY SCORES WITH TSUNAMI PLANNING AREAS



OTHER DATA SOURCES:

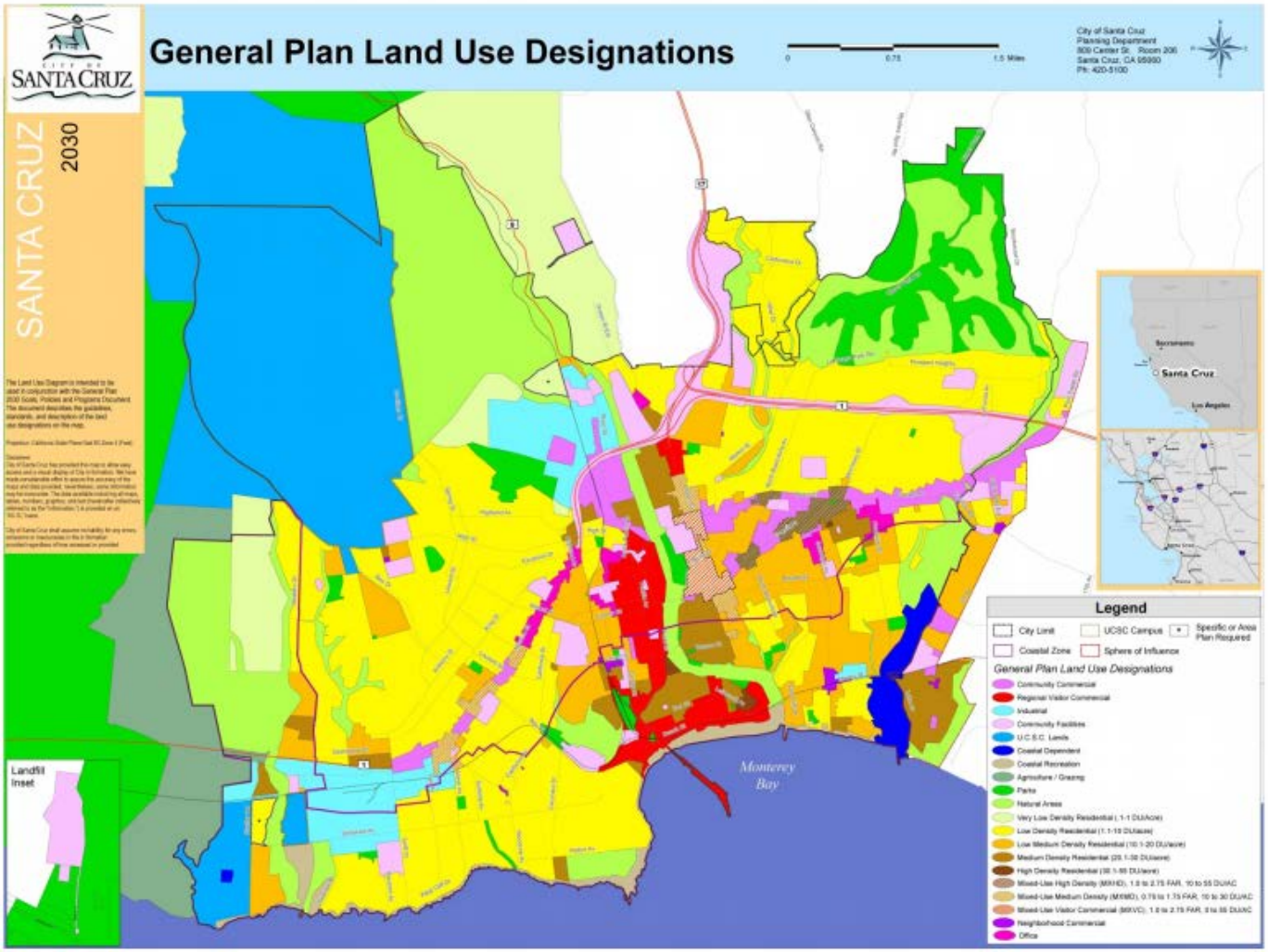
SoVI©:

Longitudinal Employer-Household Dynamics



Social Explorer

APPENDIX F
GENERAL PLAN LAND USE MAP



APPENDIX G
EVALUATION AND RANKING OF PROPOSED STRATEGIES WITH FEMA'S STAPLEE FRAMEWORK

To assist in prioritizing potential adaptation strategies, the team applied FEMA's STAPLEE criteria in reviewing each identified strategy. Unlike earthquakes or other more immediate threats, impacts of climate change are gradual. Evaluation of future potential impacts that may occur, the City is able to better integrate resilience planning into regular municipal policies, programs and investment in infrastructure investment over time.

The Climate Adaptation Team assigned a basic Yes =Y or No=N value (with some M= Maybes) within the STAPLEE framework. This did not yield a ranked score but was the foundation for identification of priorities (A=very high priority; B=high priority, C=important) as determined through the use of the following rubric:

STAPLEE

S – Social: Is the strategy socially acceptable?
Strategies are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the communities social and cultural values.

T – Technical: Is the proposed strategy technically feasible, and cost effective, and does it provide the appropriate level of protection?
Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.

A – Administrative: Does the community have the capability to implement the strategy and is the lead agency capable of carrying out oversight of the project?
Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.

P – Political: Is the strategy politically acceptable?
Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support of the action.

L – Legal: Does the community have the authority to implement the proposed strategy?
It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.

E – Economical: Do the economic base, projected growth, and opportunity costs justify the strategy?
Budget constraints can significantly deter the implementation of mitigations actions. Hence, it is

important to evaluate whether an action is cost-effective, as determined by a cost-benefit review, and possible to fund.

E – Environmental: Does the proposed action meet statutory considerations and public desire for sustainability and environmentally healthy communities?
Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with Federal, State, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

STRATEGY DESCRIPTIONS

A-1	Increase public awareness, education, and public outreach in areas with social vulnerabilities that coincide with hazard zones.
Proposed activities	Bilingual (Spanish/English) public outreach through social media, radio/TV spots, websites, presentations to local schools and stakeholder meetings. Neighborhood and city staff trainings to teach emergency response techniques. Develop Sea Level Rise hazard disclosures to renters. Create partnerships with the USCS and others to educate and bring public awareness
Hazard	Sea level rise; erosion, storm induced flooding and rising tides
Environmental concerns	Community concerns
Lead department	City Manager
Additional departments	Planning, Public Works and collaboration with local, county, regional and state agencies preferred
Timeline	2017–2030
Status	Ongoing but targeted outreach campaign planned for FY18; State technical assistance requested in FY18
Resources required	Staff time, Community Climate Action Task Force Adaptation Subcommittee, state and local funds
Funding source	General Fund; grants
Priority	Very high

A-2	Evaluate related decisions through a climate change impact lens
Proposed activities	Evaluate capital project, capital improvements program and infrastructure, and land use decisions in light of best available climate science. Ask, "What are the potential climate impacts and adaptation actions that might be considered," just as every proposed program or project defines potential fiscal impacts to the City. Address the effects of climate change through changes in land use and building codes for low-lying areas that may be flooded by increases in sea levels and storm intensity.
Hazard	Sea level rise; flood; severe storm/weather events; ocean acidification salt water intrusion; coastal erosion; increased wildfires
Environmental concerns	Protection of natural environment. Coastal and riparian habitat
Lead department	City Manager, Planning Department
Additional departments	All departments
Timeline	Ongoing

Status	CIP adaptation list, staff report adaptation statement template, annual progress review proposed for approval in FY17
Resources required	Staff time, technical and engineering consultants, materials
Funding source	Federal, state and local funds, operating budget, General Plan Maintenance Fund
Priority	Very high

A-3	Prepare for potential sea level rise throughout the City
Proposed activities	Install permanent tide gauges to monitor sea level or work conjunctively with agencies that intend to install gauges; install ground water monitoring wells to track water table rise; upgrade infrastructure to adapt to higher sea level and water table. Protect freshwater resources from saltwater intrusion. Prepare for redistribution of groundwater pumping away from coastal areas susceptible to salt intrusion. Pursue river mouth drain system to prevent groundwater flooding in the Beach Flats and Lower Ocean Area.
Hazard	Sea level rise, higher water table, flooding
Lead department	City Manager, Public Works and Water
Additional departments	All departments; Port District
Timeline	Ongoing
Status	*unknown*
Resources required	Technical and engineering consultants, materials
Funding source	Federal, state and local funds, operating budget
Priority	Very high

A-4	Identify priority areas for managed retreat to retain public access and sufficient beach area for recreational use; plan to relocate roadways
Proposed activities	Identify which areas should be protected from the combined forces of sea level rise and increased storm intensity. Between 2060 and 2100, some properties will be difficult and expensive to protect in place and therefore a change in use may be necessary. Develop policies early enough for property owners to consider these changes. Coordination with State and federal agencies is required to implement such policies and ensure that proper compensation programs are established to compensate private property owners for the transitions from private to public use (i.e., beaches, public access and river and bluff setbacks). Policies may indicate the need to identify and implement realignment of roads and utility infrastructure.

Hazard	Sea level rise: erosion, storm induced flooding and rising tides
Environmental Concerns	Community concerns, loss of public access and private property
Lead Department	Planning, Public Works, Parks and Recreation, Economic Development
Addition Departments	City Manager
Timeline	2030–2060, 2060–2100
Status	Local Coastal Plan update in progress; Cost benefit analysis of business as usual vs. adaptation strategies pending funding
Resources required	Staff time and capital for studies
Funding source	General Fund, grants
Priority	Very high

A-5	Adopt policies to evaluate limiting municipal capital improvements that would be at risk
Proposed activities	Develop City policies that establish review processes for proposed Capital Improvement Projects located within existing and future hazard zones to minimize risk and maximize capital investment. These guidelines will help staff and the public be aware of projects that may become vulnerable to projected climate risks within the expected lifespan of the project.
Hazard	Sea level rise: erosion, storm induced flooding and rising tides
Environmental concerns	Community concerns, state and local agency review
Lead Dept.	Public Works and Water
Addition Departments	City Manager, Planning, Parks and Recreation, Economic Development
Timeline	2017–2030; Ongoing
Status	CIP adaptation list, staff report adaptation statement template proposed for approval in FY17
Resources required	Staff time, local funds
Funding source	General Fund
Priority	Very high

A-6	Prioritize coastal protection structures for upgrade and replacement
Proposed activities	Develop coastal bluff and beach management policies and plans (e.g., West Cliff Management Plan) that outline short and long term coastal bluff management strategies that can help establish protection and adaptation priorities. Future allocation of public funds to protect current infrastructure is to be prioritized and weighed against the longevity and feasibility of the proposed structures. Consider coastal armoring, beach nourishment, groin

	construction and retreat. Prioritize protecting public beaches, public coastal access/use, and integration of ecological functionality.
Hazard	Sea level rise: erosion, storm induced flooding and rising tides
Environmental concerns	Community concerns, state and local agency review, habitat
Lead Dept.	Public Works, Parks and Recreation, Planning
Addition Departments	Economic Development
Timeline	2017–2060; Ongoing
Status	West Cliff Management Plan pending funding; Cost benefit analysis of business as usual vs. adaptation strategies pending funding
Resources required	Staff time and capital for replacement
Funding source	General Fund, Grants
Priority	Very high

A-7	Upgrade or relocate city buildings and infrastructure including Emergency Operations Center access road to protect and prepare for landslides, sea level rise, flooding and storm events occurring as a result of climate change
Proposed Activities	Protect, preserve and reinforce City buildings, Municipal Wharf and infrastructure from impacts of climate change. Evaluate and upgrade infrastructure, including, but not limited to City Hall, Civic Auditorium, Police Department, Fire Department, Library, Corporation Yard, Wharf, Lighthouse, Wastewater Treatment Facility, water facilities and supply lines, storm water pipes, dams, roads, bridges, intakes, or pumps. Relocate or upgrade any facilities or infrastructure that may be impacted by ongoing or increased storm events, such as sea level rise, permanent coastline or cliff erosion, repetitive flooding or salt water intrusion.
Hazard	Flood, sea level rise, storm surge damage, erosion
Environmental concerns	State and local agency review, information needs, community concerns
Lead department	City Manager, Public Works, Water, Emergency Operations Center
Additional departments	Planning, Economic Development, Police, Fire, Parks and Recreation
Timeline	Ongoing with annual status reviews
Status	Murray Street Bridge design to resist seismic events in progress. Unknown status for other proposed activities.
Resources required	Staff time and technical consultants (geologist, hydrologist, geotechnical and civil engineering) and engineering contractor, County Public Works, National Flood Insurance Program (NFIP)

Funding Source	Federal, state, local funds; General Fund.
Progress to Date	Public Works is constructing a seismic retrofit of the main building at the City's Corporation Yard. Public Works is designing Murray Street Bridge to resist seismic events. Emergency Operations Center was relocated to the 911 Center at DeLaveaga Park; EOC access road repair from 2017 storms is being developed along with an alternate entrance.
Priority	Very high

A-8	Monitor and protect wastewater facility from ground water infiltration
Proposed activities	Provide ground water monitoring wells to monitor level of ground water rise. Monitor the City's wastewater facility isolation and dewatering ability as water table rises beneath facility from the rest of Neary Lagoon area.
Hazard	Flood, storm surge, sea level rise infrastructure damage to process units and associated equipment.
Environmental concerns	Ability to treat raw sewage to required discharge standards for safe ocean disposal
Lead Dept.	Public Works
Timeline	Ongoing
Status	*unknown*
Resources required	$5M+ in unidentified grant funds, sewer fund, storm water fund; regulatory review
Funding source	Unidentified grant funds, sewer fund, storm water fund
Priority	Very high

A-9	Seal wastewater pipes throughout system
Proposed activities	Seal wastewater pipes throughout system that are at or below existing groundwater levels to protect system against rising groundwater.
Hazard	Sea level rise, flooding, storm surge
Lead department	Public Works
Timeline	ongoing
Status	continue pipe sealing
Resources required	Approximately $2 million/year
Funding source	Operating budget and unidentified outside funding
Priority	Very high

A-10	Seal pump gallery at wastewater treatment facility
Proposed activities	Seal pump gallery under the wastewater treatment facility to protect against a rise in groundwater, plus possible improvement to secondary clarifiers to protect against groundwater rise.
Hazard	Sea level rise, flooding, storm surge
Lead department	Public Works
Timeline	continue as needed
Status	continue as needed
Resources required	Up to $5M before 2021
Funding source	Operating budget and unidentified outside funding
Priority	Very high

A-11	Monitor all pumping station sites
Proposed activities	Monitor, repair enhance and replace (when necessary) all system pump stations including the one at Neary Lagoon as well as five storm water pump stations along the San Lorenzo River
Hazard	Sea level rise, flood, storm surge
Environmental concerns	Habitat preservation
Lead department	Public Works
Additional departments	Parks and Recreation
Timeline	ongoing as needed
Status	ongoing as needed
Resources required	Up to $50k/year
Funding source	Operating budget, Measure E funds (Clean Rivers, Beaches and Ocean Tax), unidentified outside funds
Priority	Very high

A-12	Storm Drain Pump Station upgrades
Proposed activities	Storm drains are currently vulnerable to high water during winter storms and these systems will become further compromised as water levels rise at discharge points along the coast and river leading to a reduction in discharge rate. Evaluate and improve pump stations along the San Lorenzo River and Neary Lagoon that are located within the FEMA flood zone that may need to be upgraded to increase pumping capacity and ensure continued operations with predicted salt water flooding risks. Evaluate flooding when combined with rain events.
Hazard	Sea level rise: erosion, storm induced flooding and rising tides
Environmental concerns	Community concerns, storm drain function

Lead department	Public Works
Additional departments	Planning
Timeline	2020–2060; ongoing
Status	Pump capacity evaluated with respect to projected flooding volumes; evaluation of flood combined with rain events pending staff capacity. All storm drain pump stations on San Lorenzo River may need to be upgraded.
Status of upgrades	Downtown Hydrologic study in progress; no schedule or funding for upgrades, however.
Resources required	Staff time and capital for upgrades
Funding source	General Fund, Storm Water Fund
Priority	Very high

A-13	Replace Highway 1 Bridge
Proposed activities	Work with Caltrans to replace and raise bridge to reduce flooding hazard potential due to its low flood clearance, and number and angle of piers in the river.
Hazard	Flood
Environmental concerns	Habitat maintenance, community concerns
Lead department	Public Works, Caltrans
Additional departments	Redevelopment, federal, state and local agencies,
Timeline	By 2032
Status	Partial funding obtained; Project report approved by CalTrans; consultant to be hired in FY19
Resources required	Funding, staffing, technical consultants and engineering contractor, NFIP
Funding source	State, Federal and Redevelopment funds
Priority	Very high

A-14	Protect downtown, beach area, and surrounding neighborhoods from San Lorenzo River flooding
Proposed activities	Evaluate and raise levees and/or sediment removal to improve water flow and protect the downtown and beach area from flooding.
Hazard	Flood, sea level rise, extreme storm/surge events, erosion
Environmental concerns	Habitat maintenance, community concerns
Lead department	Public Works, Army Corps of Engineers; other agencies
Additional departments	Water, Economic Development, Parks and Recreation, federal, state and local agencies

Timeline	Ongoing project
Status	*ongoing*
Resources required	Funding, staffing, technical consultants and engineering contractor, NFIP
Funding source	Federal, state, local funds
Priority	Very high

A-15	Protect adjacent neighborhoods and commercial areas from Branciforte Creek and other stream flooding
Proposed activities	Evaluate Branciforte Creek flooding potential, and monitor and improve natural creek conditions to improve flood flow, reduce erosion, improve habitat and protect the adjacent neighborhoods and commercial areas.
Hazard	Flood, sea level rise, erosion
Environmental concerns	Habitat maintenance, community concerns, restrictive permit requirements
Lead department	Public Works
Additional departments	Water, Economic Development, Parks and Recreation, federal, state and local agencies
Timeline	Ongoing
Status	Habitat restoration plan in progress with PW, consultant and agencies.
Resources required	Funding, staffing, technical consultants and engineering contractor, NFIP
Funding source	Federal, state, local funds
Progress	Working with a consultant and agencies on habitat restoration plan
Priority	Very high

A-16	Improve Water Supply Reliability
Proposed activities	Provide significant improvements to the sufficiency and reliability of the Santa Cruz water supply by 2025 as recommended by Water Supply Advisory Committee and directed by City Council under a work plan that includes the elements of passive or active recharge of regional aquifers, expanded conservation programs, and supplemental supply through either recycled water or desalination.
Hazard	Drought, climate change-related altered precipitation, seawater intrusion into groundwater, changing air temperature
Environmental concerns	Wildlife habitat, energy consumption, water quality growth inducement
Lead department	Water

Additional departments	Public Works, Scotts Valley Water District, Soquel Creek Water District, Santa Cruz Mid-County Groundwater Agency and Santa Margarita Groundwater Basin Advisory Committee
Timeline	Estimated timeline to be operational 2025 (tentative 2020 decision point)
Status	2015 Urban Water Master Plan complete; ongoing WSAC work
Resources required	Estimated as more than $100 million, City staff plus a team of outside technical consultants (engineering and environmental)
Funding source	Water fund, water system development fees fund, external funding is required, grants and bond financing
Priority	Very high

A-17	Monitor and protect open space/watershed lands
Proposed activities	Review and revise usage of open space to reduce incidence of human-caused wildfire; maintain access, remove garbage and debris, increase surveillance or security measures to ensure prompt response to emergencies, such as fire or flood; add weather monitoring stations to track temperature rise; increase ability to monitor fuel load, moisture content, capacity in all watershed and open space areas. Increase efforts to reduce fire risk in watershed and within open spaces, near water supply lines where applicable, and around water department assets to mitigate potential increase in wildfire risk due to climate change; replant post-wildfire to decrease risk of erosion or landslide. Purchase a wildland firefighting apparatus and equipment to allow for rapid response to areas with limited access. Provide adequate staffing levels to partrol and enforce rules and regulations.
Hazard	Fire, flooding
Environmental concerns	Vegetation Management Plan approval
Lead department	Water, Fire and Parks and Recreation
Additional departments	Police, CAL FIRE, County Sheriff
Timeline	Ongoing
Status	Some coastal revegetation completed by non-profit coastal ecology organization. Statue of other items is *unknown.*
Resources required	Citywide effort, consultant, personnel, equipment, non-profit coastal restoration organizations
Funding source	Various, operating budget, general fund, FEMA Hazard Mitigation Funding; unidentified outside funds
Priority	Very high

A-18	Conserve and curtail water usage

Proposed activities	Reduce impacts of drought-related water shortages through increased water conservation activities and, if necessary, implementation of water shortage contingency plan. Reduce system demand through implementing water conservation programs developed in the Water Conservation Master Plan and following recommendations from the Water Supply Advisory Committee, focusing on reducing peak season demand. If necessary, implementation of the water shortage contingency plan.
Hazard	Limited water resources, drought, climate change impacts on resources, and long-term water shortages
Lead department	Water
Timeline	Conservation: ongoing, curtailment: during water shortages/drought
Status	City met all state water conservation goals and reporting during 2012–2015 drought. Mandatory curtailment lifted summer 2017.
Resources required	Conservation: outside consultants, $1,000,000; Curtailment temporary additional staff depending on level of curtailment
Funding source	Water fund, Water system development fees fund, and external funding
Priority	**Very High**

A-19	Protect coastline related water infrastructure
Proposed activities	Protect current infrastructure or assets through coastal restoration efforts as related to reinforcing, replacing, relocating, or otherwise safeguarding current and future pipelines, assets, or other water department holdings.
Hazard	Flood, sea level rise, storm damage, coastal erosion
Environmental concerns	Coastal Commission review, community concerns
Lead department	Water and Public Works
Additional departments	Parks and Recreation, Planning
Timeline	Ongoing
Status	*unknown*
Resources required	Technical consultants (geologist, hydrologist, geotechnical and civil engineering) and engineering contractor, County Public Works
Funding source	Federal, state, local funds
Priority	**Very high**

A-20	Improve resiliency to flooding along the Coast
Proposed activities	This risk assessment suggests that flooding of the Beach Flats area will become a more significant hazard after 2030. Continued focus

	on emergency response and improved building guidelines (increase free board and first floor parking) can help reduce temporary impacts of flooding. A temporary or permanent barrier along Beach Street may help to reduce wave overtopping and flooding of Beach Flats within this high risk area. Evaluation of wave reflection structures under the Santa Cruz Beach Boardwalk to eliminate pathways that would lead to inland flooding is appropriate.
Hazard	Sea level rise: erosion, storm induced flooding and rising tides
Environmental concerns	Community concerns, state and local agency review
Lead department	Planning and Building
Additional departments	Public Works, City Manager, Economic Development
Timeline / Status	2030–2060; ongoing
Resources required	Staff time and capital for studies and protective infrastructure
Funding source	General Fund
Priority	Very high

A-21	Reduce impacts of creek and/or river flooding to water system infrastructure
Proposed activities	Provide flood protection for key water facilities and assets. Reduce flooding hazard potential along creeks, river, or other flowing water sources; stabilize, augment, raise levees or floodwalls, improve structures or features at water department sites; minimize debris that could increase flood potential where permitted and applicable. Protect vulnerable assets in flood risk or low-lying areas, such as the Coast Pump Station and Tait Wells. Next step funding for fluvial analysis of San Lorenzo River flooding is required.
Hazard	Flood
Environmental concerns	Land use issues
Lead department	Water
Additional departments	California Department of Fish and Game, other regulatory agencies; County of Santa Cruz
Timeline	Ongoing
Status	*unknown;* fluvial analysis of San Lorenzo river flooding pending funding
Resources required	Technical consultants (geologist, hydrologist, geotechnical and civil engineering) and engineering contractor, NFIP
Funding source	Federal, state, local funds, grants and loans
Priority	Very high

A-22	Prepare for short-term water shortage and water supply emergency for climate related events
Proposed activities	Ensure completeness and availability of identified emergency supplies and resources; including, but not limited to items such as water main repair parts, generators, pumps, sandbags, road clearing, medical, and communication. Identify/catalogue current supply; procure additional items/services to ensure preparedness in the event of a climate event. Develop multi-agency response protocol for emergency drinking water procurement and distribution; coordinate with county, regional, state, and/or federal entities to create response plan for emergency — such as a flood or storm event — or short-term water shortage — potentially caused by hazards such as blackouts due to heat waves or supply disruption due to weather change. Implement water shortage contingency plan
Hazard	Landslide, earthquake, liquefaction, flooding, erosion, storms, drought
Lead department	Water
Timeline	Ongoing
Status	Implement water shortage contingency plan in place
Resources required	Staff time, funds for emergency supplies; Local, county, regional, state, federal agencies
Funding source	Operating budget; Unidentified outside funding
Priority	Very High

A-23	Rehabilitate or replace water system infrastructure
Proposed activities	Protect water system infrastructure and reservoir from landslides and other failure — landslide monitoring and slope stabilization
Hazard	Landslide, earthquake, liquefaction, flooding, erosion, storms
Environmental concerns	Geologic, hydrologic
Lead department	Water
Timeline	Ongoing
Status	FY17 winter storms caused damage requiring infrastructure replacement and rehabilitation
Resources required	City staff plus outside technical consultants (geologist, hydrologist, geotechnical and civil engineering) and engineering contractor
Funding source	Grants, water fund, and Water System Development Fees Fund
Priority	Very High

A-24	Establish and/or maintain cooperative fire agreements and procure equipment required to protect against wildfire damage
Proposed activities	Continue to maintain and/or establish agreements with local fire agencies for emergency response to increased Wildland incidents which may occur as the result of climate change. Purchase a Type 3 wildland fire engine to assure that the most effective and reliable equipment is available to protect life, property and the environment. Continue to train firefighters in wildland firefighting techniques.
Hazard (potential threat)	Wildland fire
Environmental concerns	None
Lead department	Fire Department
Additional departments	County Fire Agencies
Timeline	Ongoing
Status	*unknown*
Resources required	Administrative staff time
Funding source	General Fund
Priority	Very High

A-25	Protect visitor serving venues and natural resources
Proposed activities	Protect, maintain and preserve visitor serving venues, museums, facilities, parks, Wharf, beaches and other natural resources including the lighthouse and West Cliff Drive, pathways, infrastructure, open space and parks
Hazard	Coastal erosion, flooding, sea level rise, increased storm events, flood, ocean acidification, salt water intrusion and heat
Environmental concerns	Coastal impacts
Lead department	Parks and Recreation and Public Works
Additional departments	Economic Development, Planning
Timeline	Ongoing with annual status reviews
Status	*unknown*
Resources required	Staff time, outside experts and consultants, funding
Funding source	General Fund and unidentified outside funding
Priority	Very high

ACTION ITEMS RATED "HIGH PRIORITY"

B-1	Engineer a cut off wall to protect Wastewater Treatment Facility
Proposed activities	Engineer a cut-off wall such as a steel sheet pile barrier or grout curtain and pump system to isolate ground water beneath the Wastewater Treatment Facility from Neary Lagoon.

Hazard	Sea level rise, flooding, storm surge
Lead department	Public Works
Timeline	By 2022
Status	*unknown*
Resources required	$5,000,000 onetime expenditure if needed.
Funding source	Operating budget and unidentified outside funding
Priority	High

B-2	Investigate beach nourishment
Proposed activities	Small to medium scale beach nourishment has been found to be a cost effective, although temporary, adaptation measure when material is available. Strategic placement of river sediment at a site north of Santa Cruz could artificially increase local littoral sand abundance, which would be passively distributed down coast, benefitting multiple pocket beaches and subtidal areas along West Cliff as well as Cowell and Main beaches.
Hazard	Sea level rise, erosion, storm induced flooding and rising tides
Environmental Concerns	Community concerns, state and local agency review, habitat
Lead department	Public Works
Additional Departments	Planning
Timeline	2017–2060; ongoing
Status	Beach nourishment from San Lorenzo River designed and pending suitable funding.
Resources required	Staff time and capital for nourishment
Funding source	General Fund
Priority	High

B-3	Prevent dam failure
Proposed activities	Monitor Newell Creek dam and infrastructure to preserve water resources and minimize risks to people and property resulting from dam failure; Replace or rehabilitate inlet/outlet works to meet Division of Safety of Dams operational requirements.
Hazard	Landslide, earthquake, liquefaction, multi-hazard
Environmental concerns	Flooding,
Lead department	Water
Additional departments	California Department of Water Resources and Division of Safety of Dams
Timeline	Ongoing

Status	Monitoring indicates no risk of dam failure currently. Unknown on inlet/outlet work.
Resources required	Capital Improvement Investment of $40 million, City staff plus outside consultants (geologists, geotechnical and civil engineers)
Funding source	Outside funding.
Priority	High

B-4	Prepare for potential changes in water quality due to climate change
Proposed activities	Evaluate options for mitigating future water quality problems, such as increased turbidity in flowing sources due to intensifying storm activity or salt intrusion into groundwater due to advancing sea levels. Evaluate potential changes or increases needed in treatment levels, new technology to handle poorer quality raw water. Prepare for increase in nuisance algae blooms in Loch Lomond.
Hazard	Drought, seawater intrusion, extreme weather events
Environmental concerns	Water use rights, habitat or sensitive species protections
Lead department	Water
Timeline	Ongoing
Status	*unknown*
Resources required	Consulting engineers for water treatment improvements, chemical supplies and services
Funding source	Operating budget
Priority	High

B-5	Promote and preserve economic base and tourism industry in the face of a changing climate
Proposed activities	Promote and preserve economic base and tourism in the face of a changing climate through collaboration with Visitor Center, Downtown Association and other community groups to promote tourism. Monitoring and proactive steps should be taken as information becomes available. Prepare for new opportunities and challenges in the tourism industry. Review of properties available for lodging and other new development. Insure that a variety and adequate quantity of lodging options are provided.
Hazard	Sea level rise, extreme heat events, extreme storm
Environmental concerns	Unknown until prospective properties are identified
Lead department	Economic Development
Timeline	Ongoing
Status	Outreach to Downtown Association via the Downtown Commission
Resources required	Staff time; possibly consultants; unidentified funding partners

Funding source	Unknown
Priority	High

B-6	Develop and enforce appropriate setbacks adjacent to cliffs
Proposed activities	For development adjacent to cliffs, require setbacks for buildings that anticipates future cliff retreat.
Hazard	Coastal erosion
Environmental concerns	Coastal habitat
Lead department	Planning
Additional departments	Coastal Commission
Timeline	2017–2030
Status	Planning Department is working with the Coastal Commission on the Local Coastal Plan Update, which will provide guidance on how to implement this strategy.
Resources required	Staff time
Funding source	Permit fee revenue, general fund
Priority	High

B-7	Protect natural shoreline
Proposed activities	Allow construction that alters natural shoreline processes only when required to serve coastal-dependent uses or to protect existing infrastructure, structures or public beaches from erosion, create wildlife habitat, or when designated to eliminate or mitigate adverse impacts on local shoreline sand supply.
Hazard	Coastal erosion
Environmental concerns	Coastal habitat
Lead department	Planning
Additional departments	Public Works, Parks and Recreation, Coastal Commission
Timeline	2017–2030
Status	Will be a consideration of West Cliff Management Plan pending identification of suitable funding
Resources required	Staff time; consultant fees
Funding source	General Fund
Priority	High

B-8	Mitigate development in flood plains
Proposed activities	Maintain flood plain and floodway regulations in developed flood areas.
Hazard	Flood

Environmental concerns	Riparian habitat
Lead department	Planning
Status	City maintains flood plain and floodway regulations in developed flood areas. There are few undeveloped flood areas to develop.
Additional departments	Federal Emergency Management Agency
Timeline	2017–2030
Resources required	Staff time, National Flood Insurance Program (NFIP)
Funding source	General Fund
Priority	High

B-9	Disseminate flood hazard information and encourage participation in Federal Flood Insurance Program
Proposed activities	Ensure that flood information is made available to property owners, potential buyers, and residents living in flood plains and coastal inundation areas, and encourage them to participate in the Federal Flood Insurance Program.
Hazard	Flood
Environmental concerns	None
Lead department	Planning
Additional departments	Federal Emergency Management Agency, Coastal Commission, Economic Development
Timeline	2017–2030
Status	*unknown*
Resources required	Staff time
Funding source	General Fund
Priority	High

B-10	Develop and enforce development limitations for new development to prevent and mitigate impacts of wildfires
Proposed activities	Develop policies to regulate development in and adjacent to areas with steep canyons, arroyos and fire prone vegetation. Require new development in areas susceptible to wildfires to be responsible for fire prevention activities (visible house numbering and use of fire-resistant and fire retardant building and landscape materials) and to also provide a defensible zone to inhibit the spread of wildfires. Conduct public outreach on maintain defensible space.
Hazard	Urban wildland interface fires
Environmental concerns	Woodland and riparian habitat
Lead department	Planning

Additional departments	City Fire, CAL FIRE
Timeline	2017–2030
Status	*unknown*
Resources required	Staff time
Funding source	Permit fee revenue, general fund
Priority	High

ACTION ITEMS RATED "IMPORTANT"

C-1	Monitor, protect, repair or replace bridges crossing the San Lorenzo River
Proposed activities	Evaluate and raise bridges to reduce flooding hazard potential along the San Lorenzo River, Water Street, Soquel Avenue, Laurel Street, Riverside Avenue, and two pedestrian bridges.
Hazard	Flood
Environmental concerns	Federal, state and local agencies, habitat maintenance, community concerns
Lead department	Public Works, Army Corps of Engineers ongoing project
Timeline	Long Term
Status	All San Lorenzo River bridges except Highway 1 and the train trestle have been raised and the flows improved. When next step fluvial climate projection analysis has been completed, reassess to determine if bridges need to be raised further.
Resources required	Funding, staffing, technical consultants and engineering contractor
Funding source	Grants, Gas Tax and Storm Water funds
Priority	Important (bridges have been raised in the past)

C-2	Increase vegetation management efforts
Proposed activities	Increase efforts to reduce the increased fire risks a result of climate change in wildland/urban interface areas through vegetation management and code enforcement including mowing fuel breaks, eucalyptus grove management and create shaded fuel breaks for access and fighting fires.
Hazard (potential threat)	Wildfire
Environmental concerns	Vegetation Management
Lead department	Fire Department
Additional departments	Public Works, Parks and Recreation
Timeline	Ongoing
Status	*unknown*
Resources required	Staff time, outside resources, funding

Funding source	General Fund, outside grants
Priority	**High**

C-3	**Conduct public outreach to increase public awareness, education and enforcement of wildland fire threat**
Proposed activities	Educate the public in the maintenance of defensible space, i.e., adequate clearance of residential property as outlined in the LHMP; enforce adequate clearance through codes and ordinances.
Hazard (potential threat)	Fire
Environmental concerns	Vegetation Management Plan approval, continued approval and enforcement of the California Fire Code
Lead department	Fire Department
Additional departments	Parks and Recreation
Timeline	Ongoing
Status	*unknown*
Resources required	Staff time
Funding source	General Fund
Priority	**Important**

C-4	**Increase open space monitoring**
Proposed activities	Review and revise usage of open space to reduce incidence of human caused wildland fire
Hazard (potential threat)	Fire risk increases as the result of climate change
Environmental concerns	Vegetation Management Plan approval
Lead department	Fire
Status	*unknown*
Additional departments	Parks and Recreation, Police
Timeline	Ongoing
Resources required	Staff time
Funding source	General Fund, outside grants
Priority	**Important**

C-5	**Prevent urban/wildland interface fire hazards in Parks, greenbelts and open spaces.**
Proposed activities	Protect parks and facilities from the increased risk of urban/Wildland fire through increased underbrush clearing, perimeter protection, adequate patrol and staffing. Fire Department to update Urban Interface Policy to reduce fire hazards in parks, greenbelts and open spaces.

Hazard	Urban/wildland fire
Environmental concerns	Threats to forest and animal habitat
Lead department	Parks and Recreation, Fire Department
Additional departments	Water, Public Works, Police
Timeline	Ongoing with annual status reviews
Status	*unknown*
Resources required	Staff time, outside consultants, funds
Funding source	General Fund and unidentified outside funding
Priority	High

C-6	Protect and preserve tree canopy and other native coastal vegetation
Proposed activities	Evaluate, preserve and protect tree canopy including species evaluation and replacement with resilient trees that can withstand extreme weather events, salt water intrusion, and drought. Use ecological restoration on lands severely impacted by climate change. Integrate ecological restoration in coastal retreat policy.
Hazard	Drought, salt water intrusion, extreme weather events, sea level rise, and heat
Environmental concerns	Animal habitats
Lead department	Parks and Recreation
Additional departments	Economic Development, Planning
Timeline	Ongoing with status reviews
Status	FY17 CAL FIRE grant provides for development of a GIS-based urban tree inventory and planting of 500 trees in addition to the 300 trees planted annually in the City.
Resources required	Staff time, outside experts and consultants, funding
Funding source	General Fund and unidentified outside funding
Priority	Important

2060–2100 STRATEGY CONSIDERATIONS

Between 2060 and 2100, increased coastal wave damage, greater flooding depths and frequency and higher tides will threaten significant portions of current beach front properties and low lying areas, and will degrade the local beach community charm that currently exists. Protection and/or relocation of buildings and infrastructure from these risks will be costly, technically challenging. Decisions regarding what the urban/beach front area will look like in 2100 will need to be made (i.e., coastal bluff and beach management plan), if adaptation is to be strategic and cost effective.

APPENDIX H
ADAPTATION RELATED PROGRAMS AND PROJECTS

Successful programs and projects should be aligned with the 2011 adaptation strategy list. These should include ongoing projects and programs OR those implemented since the 2011 Plan development (i.e., new and ongoing projects only).Newly added projects and programs are **bolded** and denoted with a + symbol.

Program/Project	Description	Hazard	Department
Updated Emergency Operations Plan	Emergency Operations Plan is reviewed and updated annually	Multi-hazard	Fire: Emergency operations management
Relocation of Emergency Operations Center+	Relocated EOC to DeLaveaga Park, outside of hazard zones in 2016	Multi-hazard	Fire: Emergency operations management
Emergency staff training	City staff is assigned, trained and regularly participates in Emergency Operations drills	Multi-hazard	Fire: Emergency operations management
Ongoing coordination with other agencies	City of Santa Cruz Fire/OES Analyst meets with SC County office of Emergency Services, UCSC and other cities and agencies in the region to share information and coordinate preparedness efforts.	Multi-hazard	Fire: Emergency operations management
Ongoing Warning System	The City of Santa Cruz Fire/OES Analyst works with the SC Office of Emergency Services to manage the early warning system for evacuation of areas susceptible to flooding, tsunami inundation, seiches or dam failure.	Flood Tsunami Dam failure	Fire: Emergency operations management
Ongoing promotion of fire protection systems	The Santa Cruz Fire Department promotes installation, inspection, and testing of built-in fire extinguishing and early warning fire alarm systems	Fire	Fire
Ongoing Cooperative agreements	The Santa Cruz Fire Department maintains cooperative fire protection agreements with UCSC, the County fire districts and the California Department of Forestry	Wildfire	Fire

Program/Project	Description	Hazard	Department
Ongoing design review	Working together, the Fire and Planning and Building Departments review new development design, circulation and access to ensure that development provides for minimum emergency response times and that emergency vehicles have safe and expedient passage at all times	Multi-hazard	Fire Planning and Building
Ongoing UBC requirement	The Planning and Building Department requires that all new construction conform with the latest edition of Uniform Building Code	Earthquake /Flood	Planning and Building
Ongoing Geologic requirement	The Planning and Building Department requires geologic investigations by qualified professionals	Earthquake	Planning and Building
Ongoing coastal protection permit review	The Planning and Building Department continues to protect and preserve the coastline and City infrastructure through the permit review process	Sea level rise hazards	Planning and Building
Revision to the Local Coastal Plan+	The Planning Department is in the process of updating its LCP	Multi-hazard	Planning
Ongoing historic preservation	The Planning and Building Department encourage and support the protection of cultural, historic and architecturally significant structures to preserve neighborhood and community character as defined in the General Plan.		Planning and Building
Storm drain improvement	Public Works completed the Center Street Storm Drain and Paving Project	Flood	Public Works
Seismic safety+	Public Works (with review by the Building Department) is in the process of completing a seismic retrofit at the Corporation Yard	Earthquake	Public Works
Ongoing floodplain management—Limit alteration	Public Works continues with a program to minimize the alteration of floodplains, stream channels and natural protective barriers that accommodate overflow	Flood	Public Works
Ongoing creek flooding reduction	Public Works with the assistance of Planning and Building endeavors to reduce flooding hazards in potential	Flood	Public Works

Program/Project	Description	Hazard	Department
	flood areas along Branciforte and Carbonera Creeks.		
NFIP compliance monitoring	The State of California Department of Water Resources monitors compliance for FEMA for cities to confirm compliance with National Flood Insurance Program	Flood	Public Works Economic Development
CRS compliance	The City of Santa Cruz annually certifies compliance with the CRS program as a part of that certification NFIP compliance components are included	Flood	Public Works Economic Development
Public awareness	Public Works (in conjunction with Planning and Building) continues to regulate development in floodplains and strives to increase public awareness of flood hazards	Flood	Public Works Planning and Building Economic Development
Bay Reservoir Tanks Project	Conversion of Bay Street Reservoir to two elevated tanks with solar photovoltaic installation	Multi-hazard drought	Water
Increasing Tree Canopy	Planting additional trees and seeking funding to further forest the community, addressing rainwater infiltration rates, permeable soil volumes and tree canopy coverage percentages. Urban tree inventory project starting fall 2017	Flooding, Storm, temperature rise	Parks & Recreation
Increasing Biodiversity	Increasing native biodiversity and maintaining terrestrial littoral transport processes along coastal bluffs of West Cliff and Natural Bridges	Biodiversity	Groundswell Coastal Ecology, CADPR, CA Native Plant Society
Increasing Coastal Resiliency using Green Coastal Infrastructure	Dune stabilization projects at Twin Lakes State Beach.	Flooding, Storm, SLR	Groundswell Coastal Ecology, CADPR, CA Native Plant Society and P&R

APPENDIX I
PROJECT TIMELINE, PUBLIC OUTREACH AND SURVEY RESULTS

PROJECT TIMELINE

November 8, 2016	Adaptation Planning and Adaptation Collaborative Discussion w/AMBAG
November 16, 2016	Internal Organizing Meeting on Climate Adaptation Planning and SLR
January 17, 2017	Quotes from Vulnerability Assessment Consultants received
January 18, 2017	City LHMP / CAP Kickoff Meeting
February 20, 2017	Review scope with CCWG
February 28, 2017	Confirm scope with TEX scientists assessing non-coastal impacts
February 28, 2017	MK/TW meeting with R Westfall and Joe Hall to identify GIS layers and infrastructure/categories to use and discuss socioeconomic impact piece
March 1, 2018	Data request for coastal revetment records made to PW
March 2, 2017	Received Public Works Climate Change Adaptation Action Items update
March 7, 2017	Contract with CCWG executed
March 7, 2017	USGS CosMOS SLR impacts mapping meeting
March 8, 2017	CAP+LHMP Update Team Lead meeting
March 9, 2017	Discuss coastal armoring with Josh Spangrud/obtain files
March 9, 2017	Discuss water infrastructure with Matt Zeman / NDA required with layer request
March 9, 2017	Vulnerability Assessment Meeting to review/agree upon model assumptions (MK, TW, TEX, and CCWG)
March 21, 2017	CCWG/Team meeting with PW team to review coastal armoring inventory /discuss water control structures; progress to date on adaptation strategies from CA and Local Hazard Mitigation Plans
March 23, 2017	Public Comment period begins on existing LHMP (approx. start date/2 month period)
March 30, 2017	Social vulnerability meeting between TW and Dr. Juliano Calil to define the process
March 21-31, 2017	City research social impact indicators/indices

April 6, 2017	TW/MK/CCWG review model assumptions and discuss progress on adaptation strategies (completed and priorities for new ones) with larger LHMP team
April 5, 2015	Social vulnerability analysis meeting (Katie, Michelle, Rich, Juliano, Joe, Tiffany)
April 7 – 25, 2017	City Updates LHMP Adaptation sections as much as possible (text/tables/map)
May 3, 2017	CCWG, TW and MK meeting on map presentation and sequencing options; identify socioeconomics/scenarios that City may run itself in GIS
May 3 - 11, 2017	CCWG revises preliminary maps and findings
May 4, 2017	Meeting on LHMP/Climate Adaptation Plan Maintenance.
May 5, 2017	Preliminary social vulnerability assessment complete/CCWG submits to City adaptation strategy progress and make recommendations on other strategies (reference FEMA Mitigation Ideas documents)
May 31 2017	Public comment on 2012 plans ends (survey closes)
May 11, 2017	Full LHMP team progress meeting on Vulnerability Assessment update; CCWG present preliminary maps, findings to core LHMP team (CCWG compile); City staff collect adaptation strategy progress by department (in progress)
May 12 – June 12	TW revise CAP update (text/tables/map); work with J. Calil and R. Westfall on presenting social vulnerability and loss valuation piece and other scenarios, if necessary
May 17, 2017	Provide technical advisor/project team comments to CCWG on Revised Preliminary SLR Vulnerability Analysis | Develop stakeholder review list; contact stakeholders to notify of timeline
May 24, 2017	Sustainability Team complete adaptation strategy evaluation rubric (TW)
June 6, 2017	Department heads complete adaptation strategy evaluation rubric (TW)
June 7, 2017	TW compile adaptation strategy evaluation rubrics and summarize in CAP update
June 23, 2017	TW Present draft plan to Climate Action Task Force; request comment
July 7, 2017	Internal/external stakeholder comments due
July 7–20, 2017	TW to integrate review comments into Final CAP Update report
July 15, 2017	Final Vulnerability Report Updates and CAP Updates (content /maps only) due from CCWG; GIS layers turned over to City; Final social vulnerability maps due from Juliano
July 17, 2017	Transportation and Public Works Commission meeting
July 20, 2017	Tentative date for Presentation to Planning Commission

July 20–31, 2017 Dovetail Adaptation Plan and LHMP Updates to ensure consistency (reference FEMA Plan Integration Guide and Handbook

August 1, 2017 Review comments due from City staff

August 8, 2017 Presentation to City Council (CC is dark in July)

September 7, 2017 Presentation to Planning Commission

September 8, 2017 Presentation to Climate Action Task Force Adaptation Subcommittee

September 28, 2017 Presentation to Downtown Commission

September 22, 2017 Final Updates to LHMP, Vulnerability Assessment and Draft Climate Adaptation Plan complete.

PUBLIC OUTREACH

November 15, 2017	City Hall to You tabling with other departments
December 7, 2017	Citizen Science Presentation: Main Library
Month of January	Main Library Civic Engagement End Cap Display
January 13, 2018	Citizen's Climate Lobby Presentation
January 16, 2018	Interactive Community Forum
January 17, 2018	Awareness Walk for Ecology Action
January 25, 2018	Levee Tour with Congressman Panetta & Staff
Month of February	Main Library Civic Engagement End Cap Display
February 1, 2018	Tabling with Bookmobile: Arbor Cove Senior Commons
February 5, 2018	Tabling with Meals on Wheels at Louden Nelson
February 15, 2018	Tabling with Bookmobile: Garfield Park Village
February 20, 2018	Present to Downtown Association
February 21, 2018	Tabling at Downtown Library Branch
February 22, 2018	Freshwater Policy Presentation at UC Santa Cruz
March 5, 2018	Tabling at Global Waves Conference
March 7, 2018	Global Waves Conference Talk
March 7, 2018	Surfer Stakeholder Talk
March 12, 2018	Tabling at Live Oak Branch during Spanish Storytime
March 14, 2018	Presentation to Ocean Protection Council
March 15, 2018	Tabling with Bookmobile: Arbor Cove Senior Commons
March 20, 2018	Green Schools Committee presentation
March 21, 2018	Tabling at Downtown Farmers Market
March 31, 2018	Tabling at Westside Farmers Market

April 4, 2018	Tabling at Downtown Library Branch
April 11, 2018	Tabling at Downtown Farmers Market
April 11, 2018	Presentation to Santa Cruz County Business Council
April 12, 2018	Tabling with Bookmobile: Garfield Park Village
April 21, 2018	Tabling at Santa Cruz Earth Day
April 24, 2018	Central Coast Climate Collaborative Workshop
April 26, 2019	Crepe Place / Women in Science and Engineering Speaker Series
April 26, 2018	Tabling with Bookmobile: Arbor Cove Senior Commons
May 2, 2018	Tabling at Downtown Farmers Market
May 4, 2018	Follow the Flush Festival Tabling
May 10, 2018	Presentation to Santa Cruz Chamber of Commerce
May 12, 2018	Tabling at Westside Farmers Market
May 20, 2018	Tabling at Vive Oaxaca Guelaguetza, San Lorenzo Park
June 9, 2018	Shrinking Shores Event – Cowell Beach
June 27, 2018	City Sustainability Team
July 11, 2018	Save our Shores Sanctuary Speaker Series Talk
July 14, 2018	Monterey Bay Community Power Community Festival
July 18, 29, 2018	University of California Irvine Coastal Resilience workshop (speaker/panelist)
July 20, 2018	Local nonprofit/consultant stakeholder focus group
July 21, 2018	Tidewater Film screening/Adaptation Talk at Garfield Library
Jul 24, 2018	Davenport Resource Center youth
August 9, 2018	Presentation to Boardwalk
August 9, 2018	Climate Action Task Force meeting
August 15, 2018	Museum of Natural History – Naturalist speaker series
August 22, 2018	Other academic/nonprofit stakeholder focus group
August 28, 2018	Panelist at California Adaptation Forum session: Adaptive Pathways

2018 CLIMATE ADAPTATION PLAN UPDATE
FACT SHEET

Climate Action Program

Why should Santa Cruz Residents be Concerned about Climate Change?

- Climate change is both a global and local problem.
- Greenhouse gas emissions increase global temperatures, accelerating polar ice melt and causing sea levels to rise and disrupting the water cycle.
- The impacts of climate change are happening now.

How is Santa Cruz negatively impacted by Climate Change?

- Increases in temperature and sea level rise will intensify drought, wildfires, flooding, erosion and ocean acidification.
- These impacts jeopardize homes, buildings, utilities, beaches and entire ecosystems.
- Damage to these systems may result in unsafe conditions, loss of properties, infrastructure and recreation, and costly repairs.

What is the City doing and what can I do to become climate resilient?

Implementing the City's climate adaptation plan reduces the City's vulnerability to Climate Change. The City is using best available science, education, infrastructure and policy to bolster resiliency.

Residents have an important role in addressing climate change. The City encourages residents to continue reducing their emissions, learn about and plan for climate change impacts to which they are vulnerable, and become engaged in the City's climate adaptation planning efforts.

Progress on 2011 Climate Adaptation Plan

- Relocation of Emergency Operations Center to DeLaveaga Park
- Initiation of Local Coastal Program Update
- Conversion of Bay Street Reservoir to 2 elevated tanks w/solar PV
- Increasing urban tree canopy through grant funded tree plantings and developing urban tree inventory as management tool
- Conducting sea level rise and social vulnerability assessments
- Raised all San Lorenzo River bridges except Hwy 1 bridge & train trestle
- Branciforte Creek Habitat Restoration Plan in progress
- 2015 Urban Water Master Plan completed
- Some coastal revegetation completed
- Beach nourishment from San Lorenzo River designed

What's Next

- Regulatory review of draft Climate Adaptation Plan Update
- San Lorenzo River Flow Analysis
- Cost/benefit analysis of Business as Usual vs. implementation of Plan
- Public Input via Climate Adaptation outreach – Nov '17 to July '18
- Complete Local Coastal Program Update
- LHMP/CAP Updates Adoption by City Council in Aug 2018
- West Cliff Drive Shoreline Management Plan (funded through CalTrans grant)
- Implementation of Plan Update & adaptation strategies
- Annual reporting to City Council on progress

For more information contact Dr. Tiffany Wise-West
Twise-west@cityofsantacruz.com | 831.420.5433 | tinyurl.com/SC-Adapts

CITY OF SANTA CRUZ
Climate Action Program

Hoja de hecho de adaptación climática 2018

¿Por qué los residentes de Santa Cruz deberían preocuparse por el cambio climático?

- El cambio climático es a la vez un problema global y local.
- Las emisiones de gases de efecto invernadero aumentan las temperaturas globales, aceleran la fusión del hielo polar y provocan un aumento del nivel del mar y la interrupción del ciclo del agua.
- Los impactos del cambio climático están sucediendo ahora.

¿Cómo se ve afectado Santa Cruz negativamente por el cambio climático?

- El aumento de la temperatura y el aumento del nivel del mar intensificarán la sequía, los incendios forestales, las inundaciones, la erosión y la acidificación de los océanos.
- Estos impactos ponen en peligro hogares, edificios, servicios públicos, playas y ecosistemas enteros.
- Daños a estos sistemas pueden resultar en condiciones inseguras, pérdida de propiedades, infraestructura y recreación, y costosas reparaciones.

¿Qué está haciendo la Ciudad y qué puedo hacer para convertirme en resistente al cambio climático?

La implementación del plan de adaptación climática de la Ciudad reduce la vulnerabilidad de la Ciudad al Cambio Climático. La Ciudad está utilizando la mejor ciencia, educación, infraestructura y política disponibles para reforzar la resiliencia.

Los residentes tienen un papel importante en el tratamiento del cambio climático. La Ciudad alienta a los residentes a continuar reduciendo sus emisiones, conocer y planear los impactos del cambio climático a los cuales son vulnerables y participar en los esfuerzos de planificación de adaptación climática de la Ciudad.

Avances en el Plan de adaptación climática 2011

- Reubicación del Centro de Operaciones de Emergencia al Parque DeLaveaga
- Inicio de la actualización del plan costero local
- Conversión del embalse Bay Street a 2 tanques elevados con solar PV
- El aumento del dosel de árboles urbanos a través de la concesión de plantaciones de árboles financiados y el desarrollo de inventario de árboles urbanos como herramienta de gestión
- Llevar a cabo evaluaciones de aumento de nivel del mar y vulnerabilidad social
- Levantaron todos los puentes del río San Lorenzo, excepto el puente de la autopista 1 y el puente del tren
- Plan de Restauración del Hábitat de Branciforte Creek en progreso
- Plan maestro de agua urbana 2015 completado
- Alguna revegetación costera completa
- Nutrición en la playa del río San Lorenzo diseñada

Que sigue

- Revisión reglamentaria del proyecto de actualización del Plan de Adaptación Climática
- Análisis Fluvial del Río San Lorenzo
- Análisis de costo / beneficio de los negocios como de costumbre frente a la implementación del plan
- Difusión pública a través del alcance de adaptación climática - lanzado en Noviembre de 2017
- Completar la actualización del programa costero local
- Actualizaciones de LHMP / CAP Adopción por el Ayuntamiento a principios de 2018
- Solicitar fondos para estudios adicionales e implementación
- Implementación de Actualización del Plan y estrategias de adaptación
- Informe anual al Concejo Municipal sobre el progreso

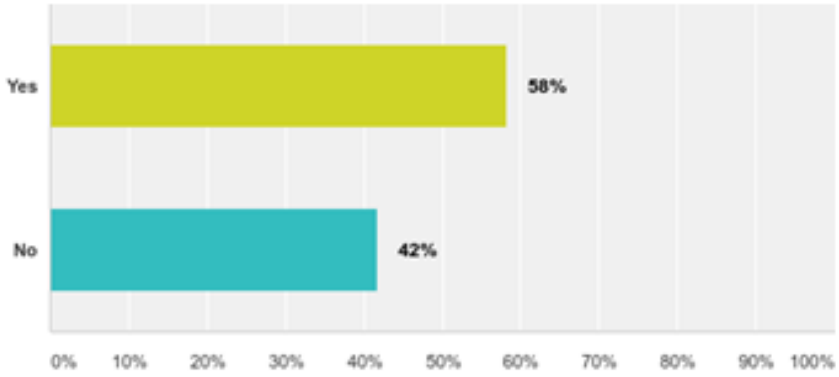
Para mas informacion contacte Dr. Tiffany Wise-West
Twise-west@cityofsantacruz.com | 831.420.5433 | tinyurl.com/SC-Adapts

PUBLIC SURVEY (RESULTS FROM 386 RESPONDENTS FOLLOW)

A joint Climate Adaptation Plan and LHMP Updates public survey was conducted during the month of May, 2017

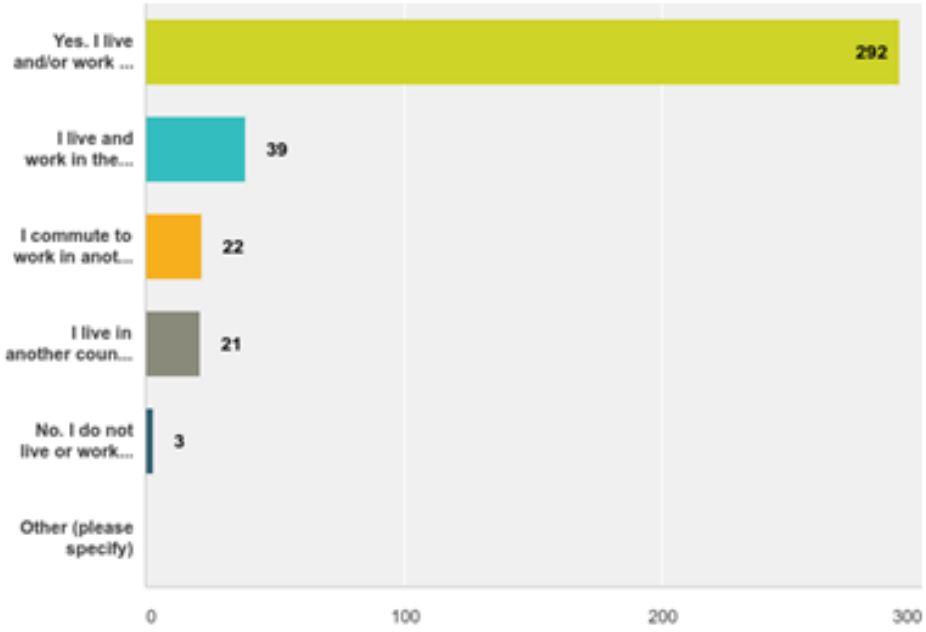
Q1: Do you own property in the City of Santa Cruz?

Answered: 384 Skipped: 2



Q2: Do you work and live in the City of Santa Cruz ?

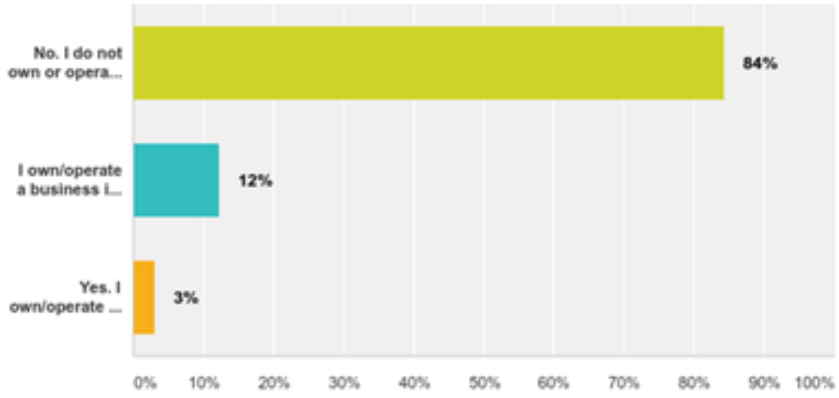
Answered: 360 Skipped: 26



Answer Choices	Responses	
Yes. I live and/or work in the City of Santa Cruz	81%	292
I live and work in the unincorporated area of the County of Santa Cruz (Live Oak, Aptos, etc.)	11%	39
I commute to work in another county from the City of Santa Cruz.	6%	22
I live in another county and commute to the City of Santa Cruz for work.	6%	21
No. I do not live or work in the City or County of Santa Cruz	1%	3
Other (please specify)	0%	0
Total Respondents: 360		

Q3: Do you own/operate a business in the City of Santa Cruz

Answered: 347 Skipped: 39



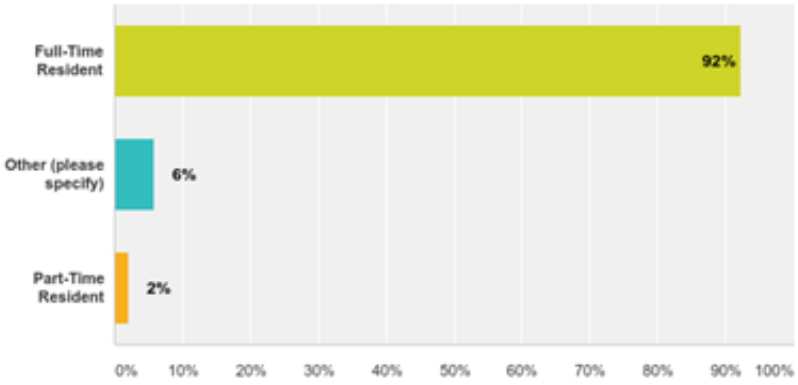
Q4: Where do you live in the City of Santa Cruz?

Answered: 339 Skipped: 47

Answer Choices	Responses	
Westside	25%	84
Other (please specify)	23%	77
Eastside	11%	36
Upper Westside	11%	36
Seabright	9%	29
Downtown	8%	26
Banana Belt	4%	12
Prospect Heights	3%	11
Lower Seabright	3%	10
Beach Hill	1%	4
Pasatiempo	1%	4
Lower Ocean	1%	3
Lighthouse	1%	3
Circles	1%	2
Beach Flats	0%	1
Arana Gulch	0%	1
Total		**339**

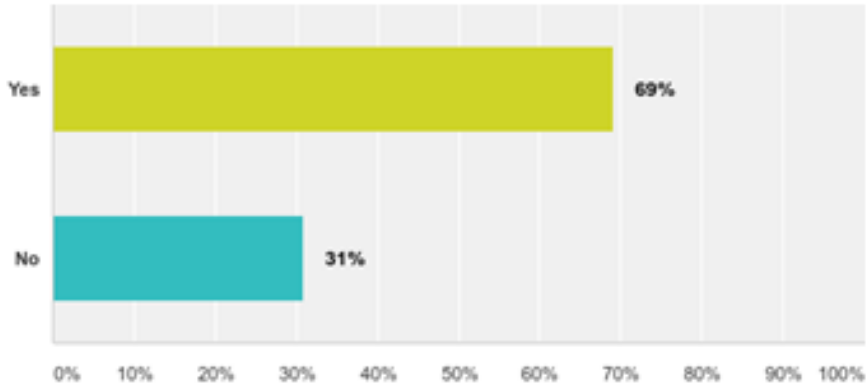
Q5: Are you a full-time or part-time resident? If part-time please explain below.

Answered: 348 Skipped: 38



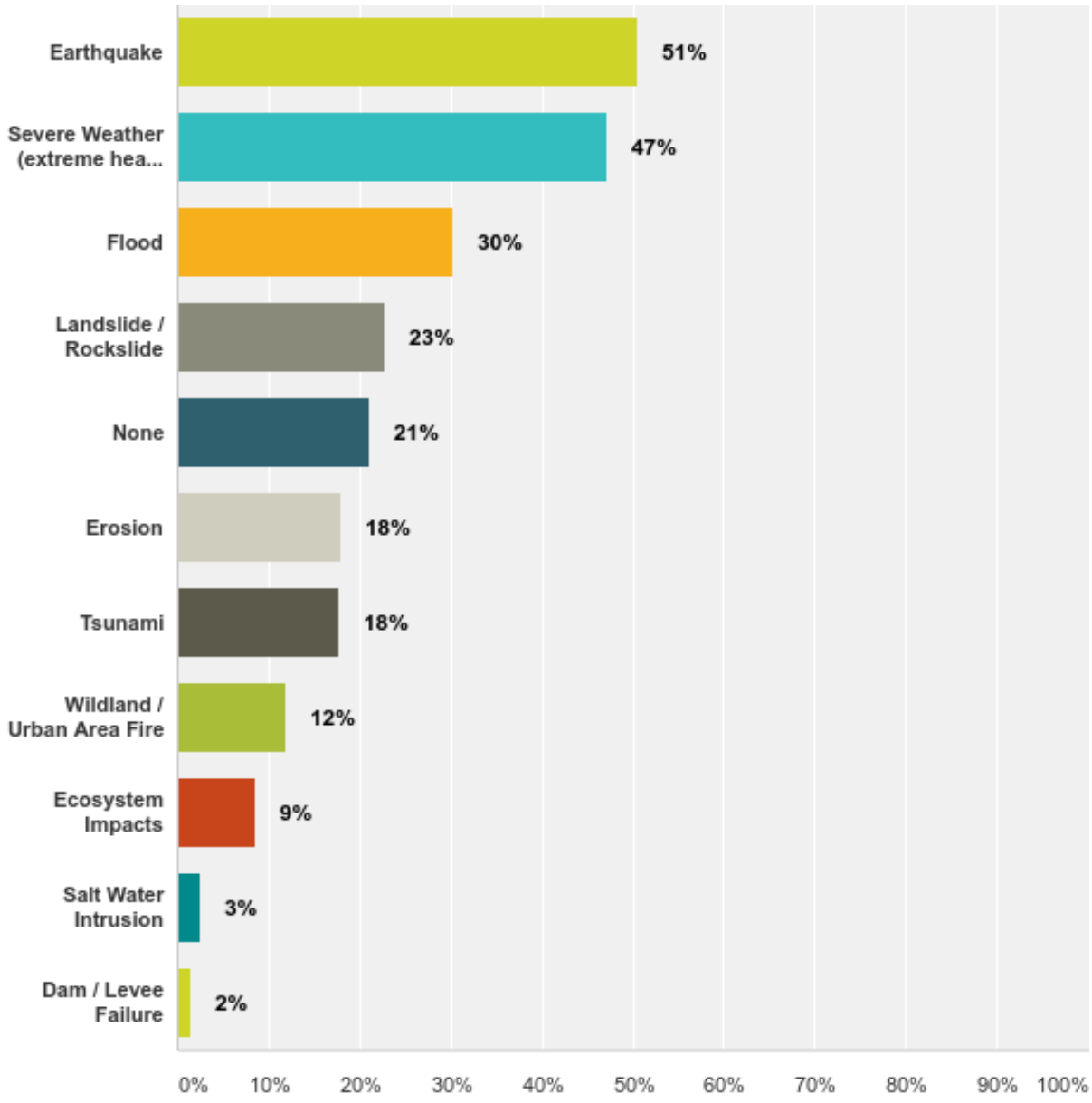
Q6: Do you work in the City of Santa Cruz?

Answered: 379 Skipped: 7



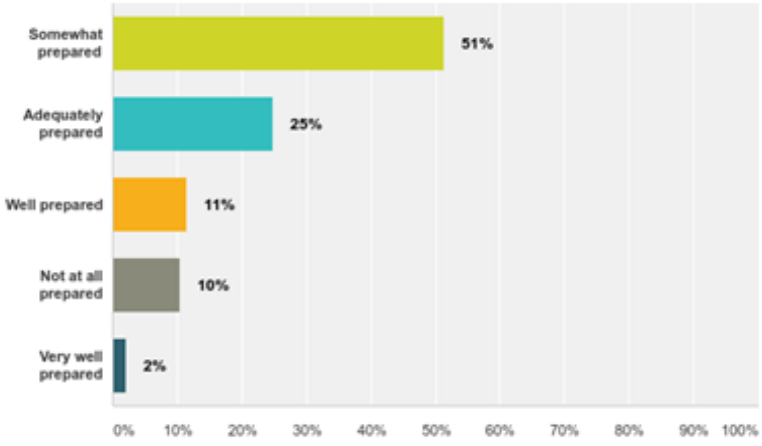
Q7: Which of the following hazards have you or your family experienced in the City of Santa Cruz in the last 20 years? (Check all that apply)

Answered: 384 Skipped: 2



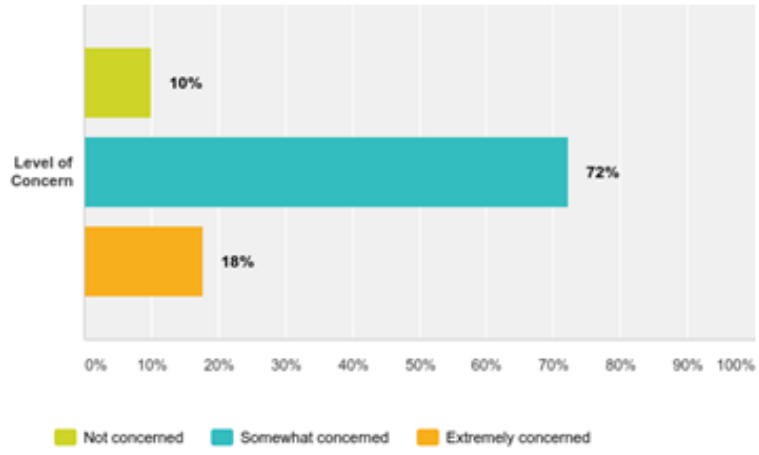
Q8: How prepared is your household for a natural hazard/disaster event?

Answered: 384 Skipped: 2



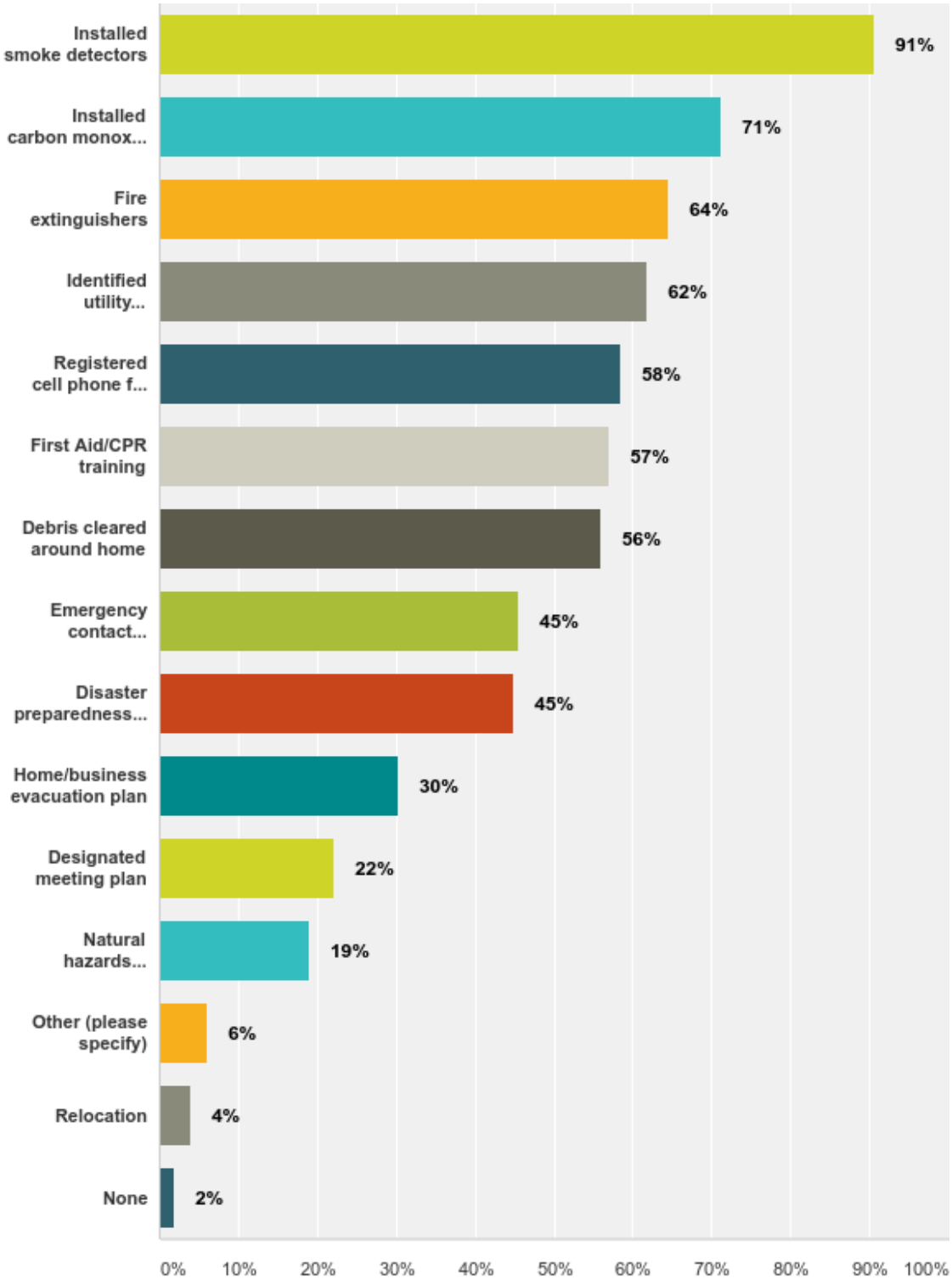
Q9: How concerned are you about the possibility of your neighborhood and the community being impacted by a natural hazard/disaster event?

Answered: 381 Skipped: 5



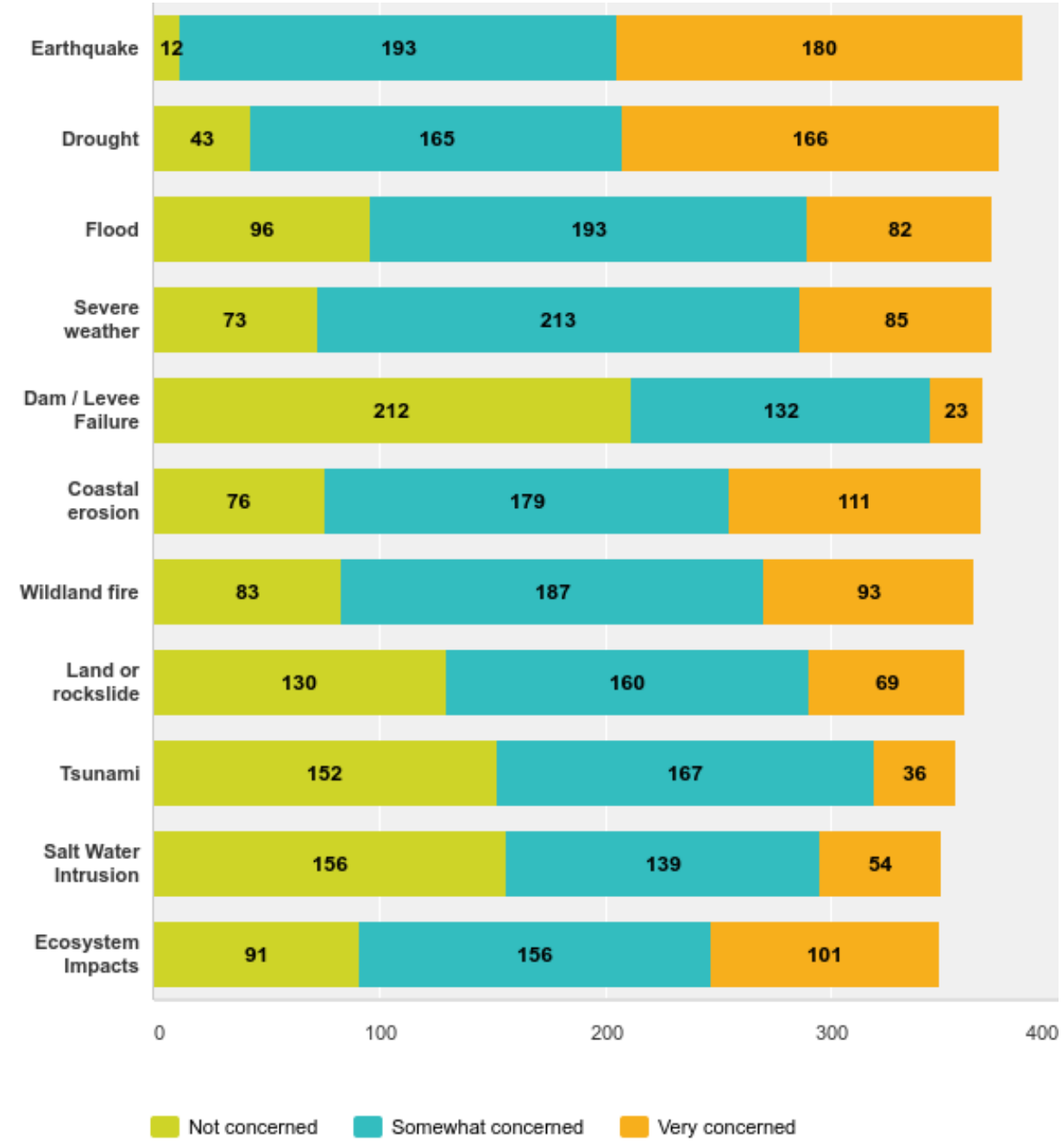
Q10: What steps has your household taken to prepare for a natural hazard/disaster event? (Check all that apply)

Answered: 383 Skipped: 3



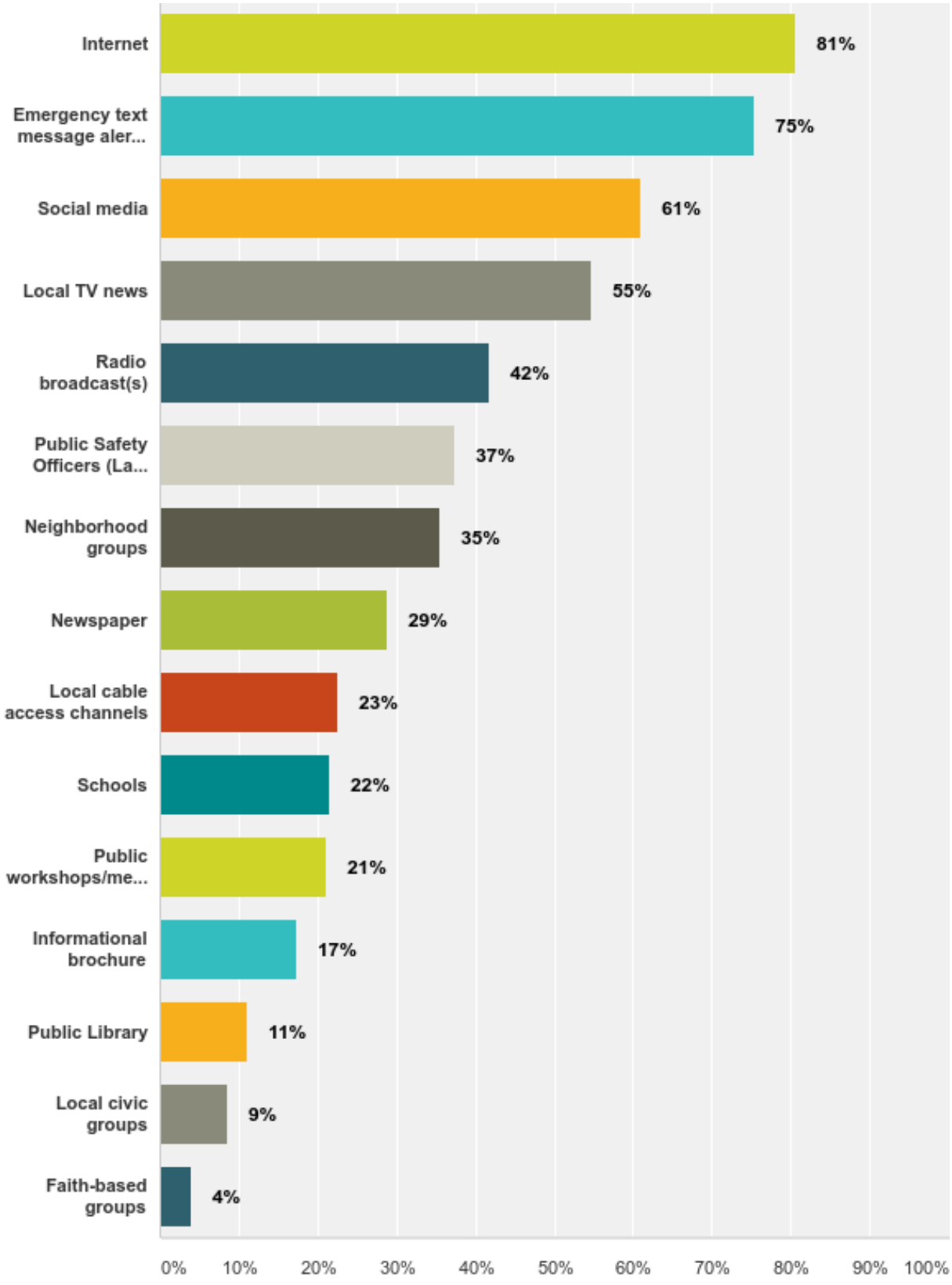
Q11: How concerned are you about the following natural hazards affecting the City of Santa Cruz? (Check a response for each hazard)

Answered: 385 Skipped: 1



Q12: Which of the following methods do you feel are the most effective ways for you to get emergency, hazard and disaster information? (Check all that apply)

Answered: 386 Skipped: 0



Q13 In your opinion, what are some steps the City of Santa Cruz could take to reduce or eliminate the risk of future hazard damages in your neighborhood?

Answered: 174
Skipped: 212

#	Responses	Date
1	Information campaign to reach especially vulnerable populations	5/29/2017 9:20 AM
2	Checking buildings for earthquake retrofits and giving incentives for owners to do what they need to do. Not allow anymore building near the river. Holding CERT training regularly for city residents.	5/16/2017 9:08 PM
3	Have goats eat the high vegetation growing in the arroyos around Nobel Dr. cul de sacs (steep terrain not easily accessible to other equipment). Also, patrol areas where homeless are likely to set up "campsites" and possibly start fires. Sweep those campsites of "campers."	5/16/2017 3:20 PM
4	Work with other agencies and organizations to: trim trees around power lines; clean overgrown vegetation around the creeks and rivers.	5/14/2017 8:48 PM
5	Ease restrictions on tree removal, especially eucalyptus and older pines with roots which are undermining sidewalks and city streets. Lower existing high speed bumps which slow down emergency vehicles.	5/14/2017 9:12 AM
6	Practice drills.	5/13/2017 9:18 AM
7	Regular infrastructure analysis, threat analysis, drills	5/13/2017 6:15 AM
8	In any emergency, good drinking water is an essential need. We are on N. Branciforte Ave, which is an old section of town, it is important to make sure we have access to good water.	5/12/2017 8:39 PM
9	Acquire additional water storage capability eg dam	5/12/2017 4:23 PM
10	More storm drains on High St. Large volume flows down street. Street repair on High St. heavy traffic Trim trees over High St. traffic	5/12/2017 4:05 PM
11	Run electricity underground	5/12/2017 12:46 PM
12	Budget for emergency funds	5/12/2017 12:01 PM
13	Provide adequate housing for all residents so some are not sleeping/living in flood or fire zones.	5/12/2017 9:15 AM
14	Be sure sewer drains are cleared regularly.	5/12/2017 8:27 AM
15	Inspect trees, roadways and sidewalks and take measures to prevent downed trees and mudslides in case of high winds and heavy rains. Participate in regional and national efforts to stop global warming which increases likelihood of tsunami and other extreme weather events. Build cisterns to capture rainwater for future use. Perhaps partner with local, state and national government to secure funding.	5/12/2017 8:15 AM
16	Provide CERT trainings, Free CPR/First Aid Trainings, and/or help with Disaster Prep trainings in Spanish and English	5/12/2017 8:07 AM
17	Best communication and real time updates	5/12/2017 7:39 AM
18	Public works has to replace all the old clay sewer pipes so we don't have flooding of our streets when we have rain storms.	5/12/2017 6:29 AM
19	Redouble efforts to keep storm drains clear. Convince the voters to fund long-deferred work, like building new seawalls and fortifying old ones.	5/12/2017 2:22 AM

20	Branciforte Creek runs through our backyard. We would welcome more information regarding steps to take to mitigate flooding and erosion	5/11/2017 10:55 PM
21	Info spots online and in the Sentinel. Earned media through interviews or events.	5/11/2017 10:46 PM
22	Education, provide resources, communication across community through various platforms	5/11/2017 10:37 PM
23	Don't know	5/11/2017 10:18 PM
24	seriously consider how high density housing effects water and traffic jams during emergecies	5/11/2017 10:15 PM

25	Check for natural gas leaks regularly. We found a serious previously undetected gas leak in our home when we bought it 2 years ago. Gas lines are antiquated and prone to leaks, earth movement and water intrusion create leaks.	5/11/2017 8:41 PM
26	Work with the County to go solar to be less dependent on power outages, speed up on fixing transportation issues and work on passing a desalination plant so we are prepared for the next droughts	5/11/2017 7:47 PM
27	Drainage improvements	5/11/2017 7:44 PM
28	the neary lagoon,downtown, lower ocean and beach flats areas seem to be at risk for long term flooding problems due to climate change, but I have not yet seen any plans (tentative or otherwise) that seem to address this issue in any effective fashion. And short of building dikes from the train trestle to the bluff at Dream Inn I wonder how we as a community would do anything other than retreat to higher ground.	5/11/2017 7:26 PM
29	I live very close to the San Lorenzo River and when it rains I get nervous. I hope that the attention paid to the river and the levee continue to be a priority in our city.	5/11/2017 7:11 PM
30	Insure alternate ingress and egress.	5/11/2017 7:09 PM
31	Allow wetlands, river area to inhabit natural paths.	5/11/2017 6:31 PM
32	Keep Neary Lagoon free of tules. Make sure to clear up whatever is causing the end of Blackburn St to flood. Maintain levees. Not build on flood-prone land. Keep access roads in and out of the county maintained.	5/11/2017 6:14 PM
33	Do not build high density housing.	5/11/2017 6:02 PM
34	Eliminate large stands of eucalyptus trees that if caught fire ...embers can travel 5 mile radius...which could take out our entire City> This fact is completely ignored and we defer to "heritage" tree. It is a large weed, spreading, uncontrolled.	5/11/2017 5:46 PM
35	Require property owners to remove debris and hazards fro their property; require them to install smoke and carbon monoxide detectors	5/11/2017 5:42 PM
36	1. Allow this survey to be seen, I can only see the left 2/3 of it on my iPad and wasn't able to check certain boxes 2. Have a designated system for different area of the city so people can respond quickly to problems in their area. 3. I had an alert on my phone and had to take it off due to being warned of things that didn't concern us	5/11/2017 5:38 PM
37	fix the drainage to prevent street flooding	5/11/2017 5:34 PM
38	Underground electrical service	5/11/2017 5:03 PM
39	Listen	5/11/2017 4:57 PM
40	No clue-	5/11/2017 4:48 PM
41	to inspect my house and the neighborhood for prevent for a future hazard damage	5/11/2017 4:03 PM
42	Have the State mow Lighthouse field. Trim up all the trees there too.	5/11/2017 3:53 PM

43	I used to live in Cupertino which has a very active CERT community. I think that Santa Cruz could do more in engaging people in CERT activities.	5/11/2017 3:51 PM
44	Remove dangerous non native trees like the Eucalyptus. Secure steep hillsides with retaining walls.	5/11/2017 3:36 PM
45	address flooding after large rain storms	5/11/2017 3:20 PM
46	Cut all overgrown branches in the city that would impact a road or power lines if they were to come down in a storm or high winds. Remove any trees that are not stable enough to resist falling into a roadway or power line in a storm or high winds.Keep firebreaks mowed or plowed in natural open grassy areas and weed-prone roadsides. Maintain maximum levels of reserve water in any water storage facility or reservoir. Pass and/or enforce City Ordinances requiring rural and/or forested property owners to maintain an effective clearance/firebreak around any structures by removing debris and mowing overgrown areas that would be prone to burning in a wildfire. Keep all potholes repaired to prevent hazardous deterioration in heavy rains and floods.	5/11/2017 3:14 PM
47	Offer 90 minute emergency preparedness sessions to be hosted in someone's home once each year for each Nextdoor neighborhood.	5/11/2017 2:54 PM
48	Have an excellent notification system	5/11/2017 2:49 PM
49	You're doing it!	5/11/2017 2:46 PM
50	Until there's a way to control earthquakes, I am not sure there's much to be done. The PGE gas pipeline is probably the biggest culprit.	5/11/2017 2:41 PM
51	Prepare for future drought	5/11/2017 2:26 PM
52	I don't really know - I don't live in the floodplain, near the cliffs, or in the hills, so I think not much could be done to eliminate the risk of future hazard damages.	5/11/2017 2:04 PM
53	Better supervision of city employed outdoor maintenance workers. More police and city workers patrolling the neighborhood to look for potential and actual hazards.	5/11/2017 2:04 PM
54	Education Kits or a list of items and easy ways to purchase.	5/11/2017 2:04 PM
55	The constant problem that effects my quality of life is the drug addicts and outlaw homeless people (not all homeless are outlaws) that roam our town stealing whatever they can find. IT IS WAY out of control.	5/11/2017 1:59 PM
56	Be Ready	5/11/2017 1:48 PM
57	Put electrical and phone underground. PGE to provide neighbor maps of gas lines. Wireless internet	5/11/2017 1:46 PM
58	Keep El Rancho fixed. One slide newly fixed after what over 10-12 yrs (I Know -Co. road)... We could be cut off. Keep homeless from building fires in woods behind Emeline Co. building, not to mention fire arms	5/11/2017 1:41 PM
59	Help homeowners with coast of retrofitting; subsidize emergency preparedness kits;	5/11/2017 1:39 PM
60	utilize groups like NextDoor online platform and santa cruz neighbors to create geographic zones for encouraging and educating about emergency preparedness, like monthly reminders about what to do to prepare or local workshops about how to make a family disaster plan or create a preparedness kit	5/11/2017 1:28 PM
61	Take care of the homeless situation so illegal camps can be cleared out.	5/11/2017 1:15 PM
62	Highly dangerous eucalyptus trees are not directly addressed by this survey.	5/11/2017 1:14 PM
63	Put power lines underground. Invest in desalination. Come up with a comprehensive coastal protection plan.	5/11/2017 1:10 PM
64	Earthquake preparedness meetings?	5/11/2017 1:10 PM
65	Maintain levee constantly	5/11/2017 1:08 PM

66	Replace age-old pipes and lines.	5/11/2017 1:03 PM
67	Messages on preparedness and where to get info in the case of an emergency.	5/11/2017 1:02 PM
68	Improve drainage; allow more trees to be removed; enforce/enact property owners keeping lots cleared of weeds etc; issue a "who to call/contact" list for downed trees/blocked drainage/sinkholes etc	5/11/2017 1:00 PM
69	Make emergency management more of a day to day instead of a once in a while thing. Simulations, Workshops. drills at schools and hospitals, farmers market outreach, training for parents and teachers, elder caregivers, and what to do when..... (at teh beach, traveling, cell phone outage, etc.	5/11/2017 12:56 PM
70	Improve erosion controls. Upgrade water system--I'm very concerned that downtown is vulnerable to saltwater inundation.	5/11/2017 12:54 PM
71	Watch for illegal camping sites	5/11/2017 12:45 PM
72	Develop brochures which could be in print and web-based. Covering all topics. New neighbor (a example) has allowed the entire backyard to become full of Scotch Broom so fire is a concern to us. Need polite neutral ways to have an agency the city contact the owners for these and similar situations. Neighborhood groups online are ok but cover too many topics and the definitions of the neighborhoods are up to the individual. Maybe have the City develop a separate online presence for disasters. I would also like dearly to hear from our country supervisor, we never hear from him and disaster planning should be a joint issue.	5/4/2017 2:35 PM
73	N/A	5/2/2017 1:18 PM
74	Community awareness	5/1/2017 6:46 PM
75	tree removal and stronger enforcement of no camping.	4/27/2017 12:30 PM
76	Clean up the homeless encampments which have been known to cause fires.	4/20/2017 11:22 AM
77	Require property owners to regularly maintain any trees on their property; require erosion control on property; require water permeability on property (i.e., not too much concrete or non-permeable material covering property).	4/19/2017 10:06 AM
78	Improve surface drainage and install storm lines/drains.	4/18/2017 8:26 AM
79	Address the homeless issue.	4/10/2017 9:50 AM
80	None, we good	4/10/2017 8:43 AM
81	If the climate change and rising sea levels are a true concern the city should stop issuing building permits in the projected flood area without raising occupied spaces above the projected flood level.	4/9/2017 4:42 PM
82	Stop cutting down trees. Trees root systems are connected with other trees. They loose their integrity if you cut down all trees close by. Also, the erosion in Delaveaga park and Pognip caused by mountain biking is real and may have led to some toppled trees in the recent storms. Paving over streams does not work.	4/8/2017 4:03 PM
83	After the stress the levee has undertaken this winter, check it thoroughly for damage.	4/8/2017 1:22 PM
84	Financial incentives to secure neighborhoods (home by home), relaxing both tiny home and RV laws so more people are able to get out of the way of an emergency, funding CERT and other like trainings, partnering with the public library and local businesses to teach about and even distribute supplies...	4/8/2017 11:31 AM
85	continuous assessment of areas of concern, educational meetings for the general public (and available in other languages)	4/7/2017 1:54 PM
86	Create incentives (tax credits maybe) for people who make positive changes to their property.	4/7/2017 12:50 PM
87	have people take care of their own stuff and not relying on government to solve all the problems	4/7/2017 8:23 AM
88	evacuation destination signs in flood areas.	4/6/2017 5:14 PM

89	The City should conduct full emergency service practice Drill Scenario. Can't say that I have ever seen the City have one.	4/6/2017 3:52 PM
90	Utilize the help from Fire/EMS/Police personnel for a real world point of view and plan	4/6/2017 3:12 PM
91	Maintain the storm drains consistently and capture rain water runoff.	4/6/2017 2:51 PM
92	Food and water storage. Organized Emergency Action Plans.	4/6/2017 2:03 PM
93	improve/fix drainage on public streets; building structural inspections for earthquake damage prevention; good plan for evacuations of residents and employees	4/6/2017 1:00 PM
94	reduce population	4/6/2017 12:00 PM
95	In Lompico, where I work, the community has formed a group to address emergency evacuation routes and process -- a very good idea, considering our winter.	4/6/2017 11:56 AM
96	Keep public informed of how to be prepared. Try to insist that public do not sight see events	4/6/2017 11:53 AM
97	increased maintenance	4/6/2017 11:37 AM
98	Increased education/instruction especially as city employees there is an added level of responsibility aside form normal personal responsibilities.	4/6/2017 10:03 AM
99	Community trainings, encourage neighborhoods to have a plan.	4/6/2017 9:55 AM
100	Fire prevention, forest management and ecosystem augmentation. Harmful Algal Blooms and habitat destruction are another local hazard that are immediate and arguably preventable.	4/6/2017 9:46 AM
101	Keep residents and business informed about potential hazards, especially drought problems. Maybe have a workshop or class about what to do when something happens, to help lessen injuries and fear about what to do in an emergency so we can help each other.	4/6/2017 9:08 AM
102	Clearing old/dead trees and excess brush. Keeping the roads in great condition.	4/6/2017 8:23 AM
103	Community outreach programs, informative education	4/6/2017 8:03 AM
104	Ensure water supply infrastructure is well prepared for emergency situations.	4/6/2017 7:57 AM
105	Preparation/training's on response Catching up on deferred maintenance	4/6/2017 7:47 AM
106	Control all the crack heads and or people that are going to raise havoc when they get more of an opportunity. Than they do right now, cause it's bad enough !!	4/6/2017 7:45 AM
107	N/A	4/6/2017 7:39 AM
108	communication	4/6/2017 7:21 AM
109	The main risk is flooding. Make more room for the river to roam?	4/5/2017 11:28 PM
110	Invest in infrastructure improvements to reduce risks of flooding. Protect water supply. I live in an area with lots of rentals, so outreach to property owners, as opposed to residents, would be important.	4/5/2017 10:33 PM
111	Elaborating on previous question - Record public meetings and post online. Have online courses or videos for preparedness	4/5/2017 7:51 PM
112	Proactive preventive maintenance	4/5/2017 7:33 PM
113	Offer free green waste removal.	4/5/2017 6:35 PM
114	Make neighbors collaborate	4/5/2017 5:47 PM
115	disaster kits and advanced warnings and assistance in disaster targeted areas	4/5/2017 5:41 PM
116	My neighborhood is safe from hazards	4/5/2017 5:21 PM
117	Improve existing infrastructure to comply with updated safety codes.	4/5/2017 5:00 PM

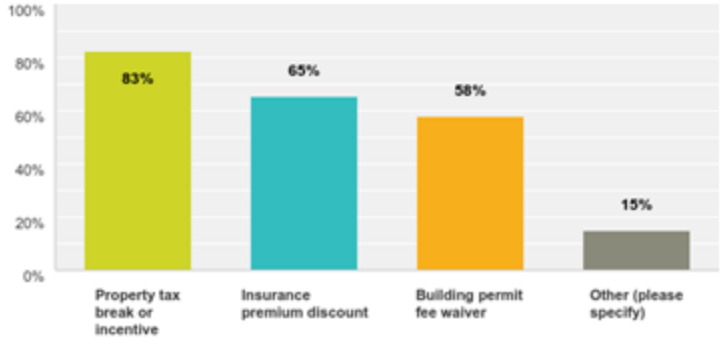
118	Publish emergency plans for various types of problem events.	4/5/2017 4:56 PM
119	Build another reservoir to catch the rain we receive to reduce the need for ground pumping or to replenish ground pumping.	4/5/2017 4:52 PM
120	Give every resident a banjo. Everyone loves the banjo.	4/5/2017 4:50 PM
121	Set up more local/ neighborhood based groups to identify their concerns and then compile the info. Some people can't get out, don't use media, etc. and as neighbors living in the same area can communicate and identify the risks. Let's look at the City community by sections just like the National EOC.	4/5/2017 4:47 PM
122	Inspect Dam more often to ensure no cracks that could cause a break. Have better maintenance by roadways to eliminate dead/dry brush during fire season. Have a City evacuation plan readily available to the public in cause of emergency that is efficient.	4/5/2017 4:47 PM
123	Maintain the existing facilities.	4/5/2017 4:47 PM
124	My neighborhood is not likely to flood, burn, or be affected by tsunami. First Aid classes would be good, and lessons in what to put into a "go" bag and what to have in the house.	4/5/2017 4:43 PM
125	Invests in more reliable infrastructures	4/5/2017 4:39 PM
126	Have emergency supply & communication stations in each neighborhood - with radio equipment, food etc.	4/5/2017 4:37 PM
127	Clean Drains to ocean. Trims Trees.	4/5/2017 4:32 PM
128	Start funding and supporting programs that have an impact on these issues.	4/5/2017 4:22 PM
129	Not sure, it's hard to control Mother Nature. Last year we were all worried about El Nino, but this year's rain has been worse.	4/5/2017 4:22 PM
130	Stop being concerned about non citizens and focus on protecting legal residents. Stop wasting money on unneeded social programs, and making city offices pretty, until you have fixed all of the infrastructure	4/5/2017 4:17 PM
131	Provide alternative transportation forms, like a passenger rail system, so that first responders and evacuees don't get all caught up in traffic.	3/29/2017 5:43 PM
132	There's no other place for general comments. In item 12, include radio. In item 2, there's no place for people like me who live here but do not work. Maybe live or work instead of live and work in the first option. In my neighborhood, the storm sewer backs up and puddles turn to pond and then to lakes when the rains are fast. Also downtown on Locust St in back of the library. The very best the City can do is education leading to individual preparedness, prevention and maintenance of systems, and arguably most effective, education in primary school, maybe 5th or 6th grade, create junior monitors or some similar program.	3/29/2017 6:13 AM
133	CERT and emergency preparedness trainings. Give out emergency preparedness supplies to local households.	3/28/2017 5:53 AM
134	Improve roads. Don't overbuild the city because we will be trapped by traffic to flee wildfires or other weather events	3/27/2017 10:41 PM
135	reduce GHG emissions. send winter water to mid county. keep enough water in the streams for fish. don't let people rebuild where there are consistent floods and landslides. address sea level rise in downtown area. implement mass transit in rail corridor, accommodating for sea level rise.	3/27/2017 12:48 PM
136	Surprised RADIO was not included in question 12. Regular, repeated PSA's (newspaper, radio, etc.) that delivers a single DISASTER PREPARATION message that runs, for example, on a quarterly basis (e.g., In earthquake, Know where utility shut-off is & if/when to turn off.) Education campaign over radio/flyers, etc to educate simple tips over time. One thing all people can do.	3/27/2017 12:40 PM
137	realistic scenarios of things that have happened - not seriously dramatized - and how best to prepare for them	3/27/2017 10:12 AM

138	Let me know what kind of damages my home/neighborhood is most susceptible to so we can prepare.	3/27/2017 7:47 AM
139	Keeping drains cleared.	3/26/2017 11:07 PM
140	Infrastructure updates	3/26/2017 5:08 PM
141	I have been trying to deal with excess water on my property in the City of Santa Cruz by myself. I would appreciate help from the City in the form of rebates for bioswales, clear guidelines, advice, etc. A program that deals with runoff at neighborhood levels instead of lot by lot.	3/26/2017 8:31 AM
142	Taking better care of our roads would greatly decrease the number of pot holes and potential cracking and even breaking of our roads. The drainage systems should be looked at and possibly redesigned to insure less flooding during future rainfall. Trees should be kept clear of the electrical cords and better maintained. A lot of power polls look weak and should probably be looked at to see if they can withstand another huge rainfall. Hillsides with the potential of rockslides and mudslides could be secured with netting, plants or walls. More community meetings for people interested in learning more about disaster	3/26/2017 7:03 AM
143	Don't pack our neighborhoods with over 3 story buildings. Don't take away the corridor parking thereby pushing the on street parking to our neighborhoods. Require adequate parking for apartment units and other large housing developments. At least one space per unit and preferably two. Require UCSC to house their students or limit number of students. Don't let UCSC continue to use the city resources without developing their own resources.	3/26/2017 4:46 AM
144	Another streetlight along 7th Ave by Dolores or Carmel to make evacuation route safer, raise the road between twin lakes and beach so water flows under a bridge instead of being flooded out, and another bridge across the harbor to increase evacuation routes.	3/25/2017 6:25 PM
145	Need better wildfire hazard information for people who live near parks and open spaces, or who have big lots. My neighbors don't seem to be aware of the risk or what to do to reduce their risk. Their properties are a hazard to mine!!! Need enforcement of weed laws, and require defensible space clearance. My friends in Santa Clara County have a chipper program and they clear their brush and prune their trees and can get rid of the brush piles for free every year. I have to haul and it's a pain. I think many people don't do the brush clearing because getting rid of it is a problem. Also, French broom should be illegal to sell in nurseries! Eucalyptus trees should be banned and permit fees waived to remove them, they are EXTREMELY hazardous in a wildfire. The city should have a program to help people remove eucalyptus as well as any dead trees. There are a lot of dead oaks and pines in this area, and it can cost over $1000 a tree just to have it cut and hauled.	3/25/2017 11:58 AM
146	Emergency/disaster training	3/25/2017 11:04 AM
147	Neighborhood action groups like CERT. CITY SPONSORED 'education' sessions, town hall seminars to discuss MENTAL HEALTH AND DRUG ISSUES AFFECTING OUR COMMUNITY. PRESSURE ON COUNTY TO BETTER MANAGE OUR HOMELESS CRISIS SPILLING INTO OUR NEIGHBORHOODS- theft, assault, open drug use, mental health episodes, human waste, needles, etc. PUSH COUNTY TO DEAL WITH THIS STUFF- SUPERVISORS NEED TO BE HELD ACCOUNTABLE FOR THIS DROP IN HEALTH STANDARDS. HOW LONG ARE THEY GOING TO LET THIS GO ON?	3/25/2017 10:27 AM
148	Perhaps start a campaign that tells us what the city can and can't do so that we know what we need to prepare for ourselves. For instance, we have big trees on our property in front of our house. They are heritage trees which have to remain...yet, they are enormous and very scary during storms. What do we do if one falls during a storm? Do we call 911? If it falls on our house, what company do we call to help us fix the damage? I have very little idea (some now that one of my best friends had her house flood in San Jose recently and worked with a remediation company).	3/25/2017 7:48 AM
149	Deal with the homeless! They set up camps in my neighborhood were my rental is. They start fires in the field frequently. Stop giving them handouts that keep them around begging for more.	3/25/2017 7:25 AM
150	Use a system like AtHoc to communicate to us.	3/25/2017 6:33 AM
151	planning 4 emergencies meetings or email / text TBSC online infoo	3/25/2017 2:01 AM

152	Preventive measures- clearing trees that pose future risk immediately upon discovery, conduct geological surveys to assess which areas are suspectible to erosion in order to fix them before people/environment is grossly impacted, maybe some sort of public service announcement to encourage folks to report areas requiring attention by sending in pictures or calling a number	3/24/2017 10:45 PM
153	They could provide home inspections to look for hazards such as a lack of J bolts holding the house to the foundation, at Cetera	3/24/2017 8:58 PM
154	Not too concerned for my neighborhood no	3/24/2017 7:39 PM
155	I live 3 blocks from West Cliff Drive. The City could address (not in order of importance, just numbering these as I think of them): 1) What happens with West Cliff Drive? on a spectrum from constant spending to repair coastal damages (not recommended!) to managed retreat? What happens when these high-value properties become low- value properties because you cannot drive to them anymore and they're about to fall into the ocean? 2) As a method/tool, scenario planning to envision where we want to go as a community -- what type of future do we want to build? -- and how to get there 3) Inclusion of the functions of natural ecosystems, and their services, as buffers for storm surge, water-filtration systems, and water-flow regulation systems. As one subset of this topic: dealing with stormwater, capturing rainwater in tanks, and making sure that big rain events don't lead to problems with the sewers. Mapping areas of aquifer recharge in the county (as Dr. Andy Fisher is doing) is an important step to knowing where to keep natural vegetation/natural areas to recharge groundwater.	3/24/2017 5:02 PM
156	Cell phone alerts system. Repair roads.	3/24/2017 11:05 AM
157	N/A	3/24/2017 9:23 AM
158	Maintain the roads better. Especially the main roads/commute roads. San Jose Soquel road closure has made me not want to drive into town/spend my money there. Also there is a high level of concern if HWY17 closes bc it's my only way in and out??	3/23/2017 2:23 PM
159	Update info structure, power and water supply systems.	3/23/2017 9:36 AM
160	illegal campsites equal fire danger. Keep creeks clear of trees for flooding.	3/22/2017 11:16 PM
161	I think the City is doing a great job of keeping us informed/	3/22/2017 11:02 PM
162	Overground power lines	3/22/2017 9:43 PM
163	The city lacks adequate reserves of food and water for residents and visitors should a large scale disaster such as an earthquake occur.	3/22/2017 9:16 PM
164	Every neighborhood needs a designated building to meet at if there is an emergency.	3/22/2017 5:15 PM
165	O	3/22/2017 2:19 PM
166	Keep Laurel Creek clear of debris just downstream of the Babbling Brook. Perhaps build small levees to contain Laurel Creek as it enters Neary Lagoon.	3/22/2017 1:10 PM
167	Keep the storm drains clean.	3/22/2017 1:10 PM
168	Maintenance of roads, vegetation and ocean cliffs.	3/22/2017 12:41 PM
169	Clean up tree debris in Delaveaga park. It is literally feet deep near the old zoo. Seems like a huge fire hazard.	3/22/2017 12:10 PM
170	Help with hazardous tree and weed removal	3/22/2017 11:18 AM
171	Have jail inmates participate in roadway clean ups. City workers can cut/ prune trees and inmates can clean up the mess. Pruning big trees, reinforcing landscapes could help reduce fire hazards.	3/22/2017 10:59 AM
172	Sweep streets after morning commuters have gone to work; not when so many more cars are parked on the street in the early morning hours.	3/22/2017 10:14 AM
173	investment in maintaining and shoring up roadways from potholes to landslide prevention	3/22/2017 9:57 AM
174	Provided more information	3/22/2017 9:37 AM

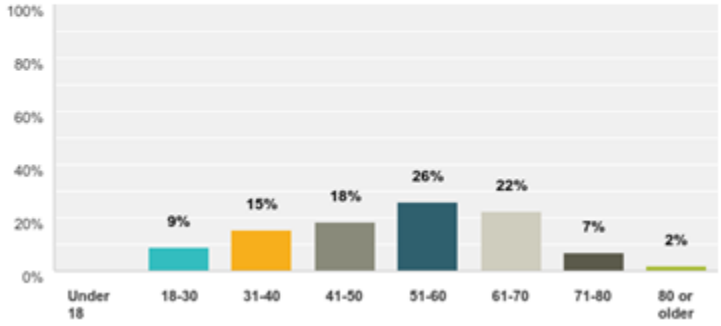
Q14: Which of the following incentives would encourage you to spend money to retrofit your home and/or business to protect against natural disasters? (Check all that apply)

Answered: 327 Skipped: 59



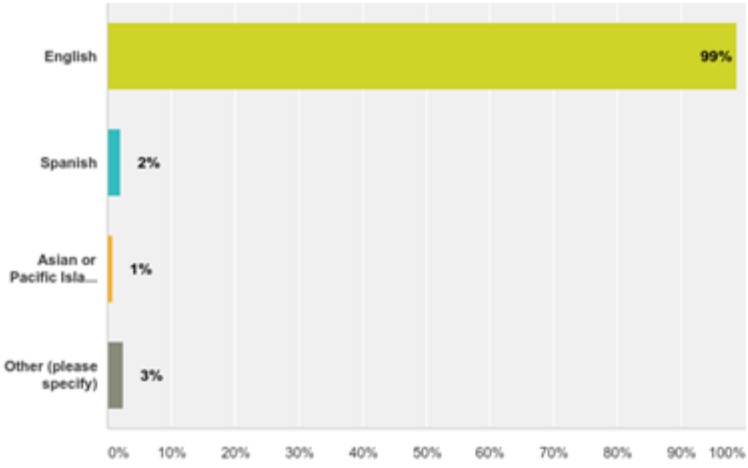
Q15: Please indicate your age range

Answered: 384 Skipped: 2



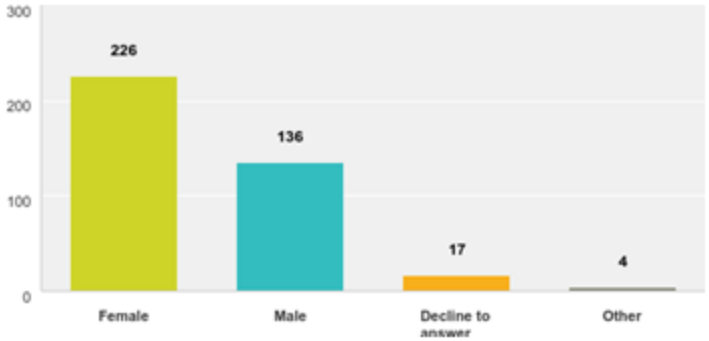
Q16: Please indicate the primary language spoken in your household (Check all that apply)

Answered: 385 Skipped: 1



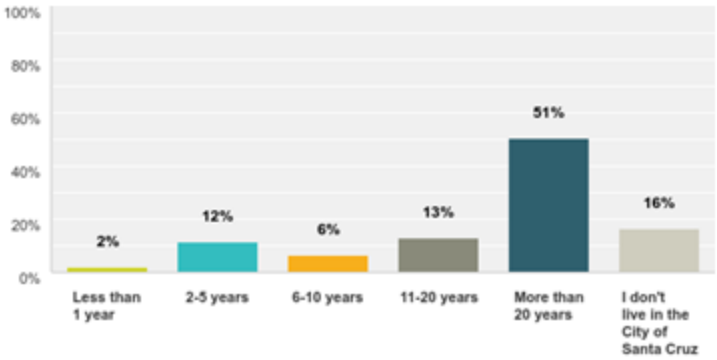
Q17: Please indicate your gender

Answered: 383 Skipped: 3



Q18: How long have you lived in the City of Santa Cruz?

Answered: 385 Skipped: 1



Q19: Do you have regular access to the Internet?

Answered: 385 Skipped: 1

Answer Choices	Responses	
Yes	99%	383
No	1%	2
Total		385

APPENDIX J
CROSSWALK OF LOCAL HAZARD MITIGATION PLAN AND CLIMATE ADAPTATION PLAN UPDATE

Hazards	LHMP		CAP	
	Impact	Mitigation Strategy	Impact	Adaptation Strategy
Earthquakes and Liquefaction	Ch. 4	Ch. 13	Not Addressed	NA
Wildfires	Ch. 5	Ch. 13	Ch. 3	Ch. 4
Floods and Associated Coastal Storms	Ch. 6	Ch. 13	Ch. 3	Ch. 4
Drought	Ch. 7	Ch. 13	Ch. 3	Ch. 4
Tsunami	Ch. 8	Ch. 13	Not Addressed	
Coastal Erosion	Ch. 9	Ch. 13	Ch. 3, Appendix D	Ch. 4, Appendix G
Dam Failure	Ch. 10	Ch. 13	Not Addressed	Ch. 4,
Landslide	Ch. 11	Ch. 13	Not Addressed	Ch. 4, Appendix A, G
Sea Level Rise	Ch. 6, 9	Not Addressed	Ch. 3	Ch. 4
Severe Storm/Weather Events	Ch. 6,11	Not Addressed	Ch. 3	Ch. 4
Ocean Acidification	Not Addressed		Ch. 3	Ch. 4
Salt Water Intrusion	Not Addressed		Ch. 3	Ch. 4
Increasing Temperature	Not Addressed		Ch. 3	Ch. 4
Food and Fuel Availability	Not Addressed		Ch. 3	Ch. 4
Impacts to Ecosystems	Not Addressed		Ch. 3	Ch. 4

APPENDIX K

COMPARISON OF COUNTY OF SANTA CRUZ & CITY OF SANTA CRUZ ADAPTATION STRATEGIES BY CLIMATE HAZARD/IMPACT

COLOR KEY: RED = NO PROGRESS YELLOW = SOME PROGRESS/ACTIVELY WORKING ON GREEN = ONGOING/DONE

Climate Change Process	Impact	County Strategy	City Strategy
Continuing and accelerated sea level rise	Gradual Permanent inundation of low lying shoreline areas	Consider designing and siting all future county projects and infrastructure to account for sea level rise projections, considering projected life span of project.	Develop City policies that establish review processes for proposed Capital Improvement Projects located within existing and future hazard zones to minimize risk and maximize capital investment. These guidelines will help staff and the public be aware of projects that may become vulnerable to projected climate risks within the expected lifespan of the project.
		Develop a detailed priority list for addressing public infrastructure that has been identified as vulnerable, and consider developing retreat or retrofit plans for high priority infrastructure subject to future inundation.	Protect current infrastructure or assets through coastal restoration efforts as related to reinforcing, replacing, relocating, or otherwise safeguarding current and future pipelines, assets, or other water department holdings.
			Install permanent gauges to monitor sea level or work conjunctively with agencies that intend to install gauges.
		Consider developing a plan to elevate E. Cliff Drive at Twin Lakes State Beach, Corcoran Lagoon and Moran Lake to alleviate frequent coastal flooding and potential inundation.	Allow construction that alters natural shoreline processes only when required to serve coastal-dependent uses or to protect existing infrastructure, structures or public beaches from erosion, and when designated to eliminate or mitigate adverse impacts on local shoreline sand supply.

		Develop a forum for ongoing engagement with coastal private property owners and the California Coastal Commission to discuss frameworks for land use policies that respond to expected future losses. Topics would include post-disaster reconstruction, policies regarding engineered protective structures and legal instruments that would allow property owners to acknowledge and accept responsibility for future losses.	
		Consider a program to identify areas where high priority wetlands will be inundated, and evaluate options to allow wetland areas to migrate with the shoreline.	
		Consider relocating coastal development away from areas that will be inundated to eliminate the risk of damage and the need for coastal protection. This concept is known as "managed retreat" and may only be technically, financially and legally feasible in limited situations.	Relocate or upgrade any facilities or infrastructure that may be impacted by ongoing or increased storm events, such as sea level rise, permanent coastline or cliff erosion, repetitive flooding or salt water intrusion.
			Prepare for redistribution of groundwater pumping away from coastal areas susceptible to salt intrusion.
			This risk assessment suggests that flooding of the Beach Flats area will become a more significant hazard after 2030. Continued focus on emergency response and improved building guidelines (increase free board and first floor parking) can help reduce temporary impacts of flooding. A temporary or permanent barrier along Beach Street may help to reduce wave overtopping and flooding of Beach Flats within this high risk area. Evaluation of wave reflection structures under the Santa Cruz Beach Boardwalk to eliminate pathways that would lead to inland flooding is appropriate.

	Gradual inundation of beaches where back edge of beach is fixed with a structure	Consider limiting new engineered protection structures to infill in locations where the back beach is currently fixed.	Evaluate and raise bridges as needed to reduce flooding hazard potential along the San Lorenzo River, Water Street, Soquel Avenue, Laurel Street, Riverside Avenue, and two pedestrian bridges.
		Consider a program to identify those areas where managed retreat should replace engineered protection structures, based on public benefit.	For development adjacent to cliffs, develop and enforce setbacks for buildings that anticipate future cliff retreat.
	Rise in groundwater table		Install permanent tide gauges to monitor sea level or work conjunctively with agencies that intend to install gauges; install ground water monitoring wells to track water table rise; upgrade infrastructure to adapt to higher sea level and water table. Protect freshwater resources from saltwater intrusion. Prepare for redistribution of groundwater pumping away from coastal areas susceptible to salt intrusion. Pursue rivermouth drain system to prevent groundwater flooding in the Beach Flats and Lower Ocean Area.
		Consider securing federal grant funding for the following drainage improvements within the Rio Del Mar Esplanade necessary to protect against a 10-year storm:	Storm drains are currently vulnerable to high water during winter storms and these systems will become further compromised as water levels rise at discharge points along the coast and river leading to a reduction in discharge rate. Evaluate and improve pump stations along the San Lorenzo River and Neary Lagoon that are located within the FEMA flood zone that may need to be upgraded to increase pumping capacity and ensure continued operations with predicted salt water flooding risks. Evaluate flooding when combined with rain events.
		Construct pump station to include a new concrete vault at the southeast end of the parking lot centerline equipped with multiple pumps and associated control	Provide ground water monitoring wells to monitor level of ground water rise. Seal wastewater pipes throughout

		panels; establish new discharge outfall, provide new piping to connect to the existing storm drain systems and install a water quality treatment unit	system that are at or below existing groundwater levels to protect system against rising groundwater.
		Install a closed gravity pipe system along Winfield Way that intercepts runoff along the ramped section of Aptos Beach Drive. Install a closed gravity pipe system near the Esplanade frontage that intercepts runoff flowing down the ramped section of Rio Del Mar Boulevard	
		Replace the undersized 12-inch pipes along Aptos Beach Drive with 24-inch diameter PVC, HDPE or RCP piles (PIPES?!) Relocate and replace the Esplanade parking lot storm drain system with 18-inch pipes	
		Rebuild the 12-inch storm drain lateral from the downstream end of the main storm drain up Venetian Road to Lake Court. Provide several inlet locations and a point of connection at Sand Street.	
		Construct a new seawall within the Esplanade parking lot on County property rather than State Parks property. Alignment would likely divide the parking lot into two halves, with the interior side offering year-round use, and the beach side closed in the storm season only.	Protect current infrastructure or assets through coastal restoration efforts as related to reinforcing, replacing, relocating, or otherwise safeguarding current and future pipelines, assets, or other water department holdings.
		Consider coordinating with the City of Santa Cruz on programs to minimize vulnerabilities at the Neary Lagoon Plant.	Monitor, repair enhance and replace (when necessary) all system pump stations including the one at Neary Lagoon as well as five storm water pump stations along the San Lorenzo River.
		Continue to improve wastewater collection system to reduce infiltration by groundwater or surface water. Monitor groundwater and increase efforts as necessary.	Provide ground water monitoring wells to monitor level of ground water rise. Monitor the City's wastewater facility isolation and dewatering ability as water table rises beneath facility from the rest of Neary Lagoon area.

			Engineer a cut-off wall such as a steel sheet pile barrier or grout curtain and pump system to isolate ground water beneath the wastewater treatment facility from Neary Lagoon.
			Develop policies early enough for property owners to consider these changes.
			Seal pump gallery under the wastewater treatment facility to protect against a rise in groundwater, plus possible improvement to secondary clarifiers to protect against groundwater rise.
Sea level rise in combination with winter storms	Increased impacts to residential development from wave run-up, storm surge and flooding	Develop a forum for ongoing engagement with coastal private property owners and the California Coastal Commission to discuss frameworks for land use policies that respond to expected future losses. Topics would include post-disaster reconstruction, policies regarding engineered protective structures and legal instruments that would allow property owners to acknowledge and accept responsibility for future losses.	Coordination with State and federal agencies is required to implement such policies and ensure that proper compensation programs are established to compensate private property owners for the transitions from private to public use (i.e., beaches, public access and river and bluff setbacks).
		Work with the engineering community to define a standard increment of additional height that should be added to the FEMA 100 year wave run up, storm surge, and flood levels when analyzing hazards in specific locations.	
		In consultation with the California Coastal Commission, consider revising regulations that address rebuilding structures that are repeatedly damaged by sea level rise and coastal storms.	Identify which areas should be protected from the combined forces of sea level rise and increased storm intensity. Between 2060 and 2100, some properties will be difficult and expensive to protect in place and therefore a change in use may be necessary.
		Consider relocating coastal development away from hazardous areas to eliminate the risk of damage and the need for coastal protection. This concept is known as	Maintain flood plain and floodway regulations in developed flood areas

		"managed retreat" and may only be technically, financially and legally feasible in many situations.	
		Continue implementing and improve the FEMA flood hazard program.	Ensure that flood information is made available to property owners, potential buyers, and residents living in flood plains and coastal inundation areas, and encourage them to participate in the Federal Flood Insurance Program.
			Monitor Newell Creek dam and infrastructure to preserve water resources and minimize risks to people and property resulting from dam failure; Replace or rehabilitate inlet/outlet works to meet Division of Safety of Dams operational requirements.
	Damage to Public infrastructure from storm surge	Develop a priority list for addressing public infrastructure that has been identified as vulnerable to storm surge and wave run up associated with 16.5-65.7 inches of sea level rise in 2100, and consider developing retreat or retrofit plans for high priority public infrastructure.	Relocate or upgrade any facilities or infrastructure that may be impacted by ongoing or increased storm events, such as sea level rise, permanent coastline or cliff erosion, repetitive flooding or salt water intrusion.
		Work with the County Office of Emergency Management to refine FEMA flood hazard mapping to account for climate change, as maps are the basis for evacuation notification in the event of anticipated flooding and/or a tsunami.	Policies may indicate the need to identify and implement realignment of roads and utility infrastructure.
			Protect, preserve and reinforce City buildings, Municipal Wharf and infrastructure from impacts of climate change. Evaluate and upgrade infrastructure, including, but not limited to City Hall, Civic Auditorium, Police Department, Fire Department, Library, Corporation Yard, Wharf, Lighthouse, Wastewater Treatment Facility, water facilities and supply lines, storm water pipes, dams, roads, bridges, intakes, or pumps.

	Increase in coastal bluff erosion rates	Consider evaluating unprotected developed coastal bluff areas subject to future erosion, and develop plans and timeline for either armor placement, or retreat and relocation of existing public structures and/or infrastructure.	Develop coastal bluff and beach management policies and plans (e.g., West Cliff Management Plan) that outline short and long term coastal bluff management strategies that can help establish protection and adaptation priorities.
		Consider evaluating areas that are presently armored to determine whether additional armor or managed retreat is the most practical long-term approach.	Consider coastal armoring, beach nourishment, groin construction and retreat. Prioritize protecting public beaches and public coastal access. Future allocation of public funds to protect current infrastructure is to be prioritized and weighed against the longevity and feasibility of the proposed structures.
	Increase in landslides due to magnitude of storm event	Continue to require that the County Geologist review development in areas of suspected landsliding and require engineering geology reports when landsliding is identified or suspected.	Protect water system infrastructure and reservoir from landslides and other failure — landslide monitoring and slope stabilization
		Continue to require that an engineering geologist and/or geotechnical engineer investigate the site of any proposed construction near landsliding and require mitigation of landslide hazards before issuing any building or grading permits.	
		Continue to require that an engineering geologist and/or a geotechnical engineer investigate any landslide damage to homes or roadways before repair of the landslide and reuse of the homes or roadways.	
Changing patterns of seasonality of precipitation	Increased frequency and magnitude of winter flooding in response to more concentrated winter rainfall	Continue to work with the US Army Corps of Engineers, County of Monterey, and City of Watsonville to develop a feasible flood control alternative to reduce the potential overtopping of the Pajaro River levees within both Santa Cruz and Monterey counties, including construction of setback levees to reclaim a portion of the floodplain while increasing the flood capacity.	

		Amend the Safety Element of the General Plan and revise implementing regulations to increase the efficacy of the damage prevention and flood protection aspects of the National Flood Insurance Program. This would include revising the method of calculating "Substantial Improvement" in the floodplain, maintaining participation in the Community Rating System to improve floodplain management and reduce insurance costs for residents, and creating an online database of elevation certificates (LHMP).	Ensure that flood information is made available to property owners, potential buyers, and residents living in flood plains and coastal inundation areas, and encourage them to participate in the Federal Flood Insurance Program.
		Consider increasing the freeboard above the projected 100 year flood level that is required for new development, in order to account for sea level rise and increased winter storms.	Provide flood protection for key water facilities and assets. Reduce flooding hazard potential along creeks, river, or other flowing water sources; stabilize, augment, raise levees or floodwalls, improve structures or features at water department sites; minimize debris that could increase flood potential where permitted and applicable. Protect vulnerable assets in flood risk or low-lying areas, such as the Coast Pump Station and Tait Wells. Next step funding for fluvial analysis of San Lorenzo River flooding is required.
		Evaluate the effectiveness of current policies and ordinances designed to limit storm water runoff and flooding and, if needed, recommend revisions to improve the effectiveness of these policies and codes. Specifically, evaluate the effectiveness of current drainage plan requirements for new development to ensure that runoff from impervious surface does not contribute to flooding, and revise development permit conditions of approval if needed *(LHMP).*	Evaluate and raise levees and/or sediment removal to improve water flow and protect the downtown and beach area from flooding.

		Prepare a "Storm Water Facilities Master Plan" for Flood Control Districts 5 & 6, which includes portions of Live Oak, Soquel, Aptos, Seacliff and Rio Del Mar. This will include an inventory of existing facilities, development of hydraulic and hydrologic modeling of these facilities, development of a prioritized Capital Improvement Program list, hydromodification analysis and development of generic best management practices and design standards *(LHMP).*	Evaluate Branciforte Creek flooding potential, and monitor and improve natural creek conditions to improve flood flow, reduce erosion, improve habitat and protect the adjacent neighborhoods and commercial areas.
	Reduced water availability due to more frequent drought	Incorporate findings and recommendations of the integrated Regional Water Management Plan into County water policy.	
		Consider implementing additional water conservation programs, regulations and policies to conserve water supplies in the unincorporated area.	Reduce system demand through implementing water conservation programs developed in the Water Conservation Master Plan and following recommendations from the Water Supply Advisory Committee, focusing on reducing peak season demand.
		Support the Pajaro Valley Water Management Agency in continuing efforts to conserve groundwater supplies and mitigate salt water intrusion in the Pajaro Valley.	
		Support the development of additional water supplies that meet environmental standards (*LHMP*).	Protect freshwater resources from saltwater intrusion.
		Promote more effective use of groundwater storage through increased groundwater recharge and conjunctive use among agencies (*LHMP*).	Reduce impacts of drought-related water shortages through increased water conservation activities and, if necessary, implementation of water shortage contingency plan.
		Water supply plans should incorporate potential increases in water demand and reduced availability of supply that is projected as a result of climate change	If necessary, implementation of the water shortage contingency plan.

		Promote drought planning by 130 small water systems under County jurisdiction (*LHMP*)	Provide significant improvements to the sufficiency and reliability of the Santa Cruz water supply by 2025 as directed by Water Supply Advisory Committee under a work plan that includes the elements of passive or active recharge of regional aquifers, expanded conservation programs, and supplemental supply through either recycled water or desalination.
			Evaluate options for mitigating future water quality problems, such as increased turbidity in flowing sources due to intensifying storm activity or salt intrusion into groundwater due to advancing sea levels. Evaluate potential changes or increases needed in treatment levels, new technology to handle poorer quality raw water. Prepare for increase in nuisance algae blooms in Loch Lomond.
Higher temperatures and lower rainfall	More intense heat waves (hotter, longer)	Consider developing or updating existing public health plans that address the health needs of chronically ill people and other vulnerable groups during extreme heat events, including designating emergency cooling centers	Ensure completeness and availability of identified emergency supplies and resources; including, but not limited to items such as water main repair parts, generators, pumps, sandbags, road clearing, medical, and communication. Identify/catalogue current supply; procure additional items/services to ensure preparedness in the event of a climate event. Develop multi-agency response protocol for emergency drinking water procurement and distribution; coordinate with county, regional, state, and/or federal entities to create response plan for emergency — such as a flood or storm event — or short-term water shortage — potentially caused by hazards such as blackouts due to heat waves or supply disruption due to weather change. Implement water shortage contingency plan

		Consider a system for contacting home-bound or disabled residents and moving them to air conditioned shelters as needed.	
		Consider updating emergency response plans for limited term and extended power outages.	
		Consider planning for greater influx of visitors to the County from hotter inland regions during extended and more frequent heatwaves.	
		Review site design standards for new development, the Urban Forestry Master Plan, and Parks Department plans for public spaces for opportunities to increase tree canopy in the urban area and for continued emphasis on increasing the number of trees in the built environment.	Evaluate, preserve and protect tree canopy including species evaluation and replacement with resilient trees that can withstand extreme weather events, salt water intrusion, and drought.
		Encourage efforts by agricultural organizations such as the Santa Cruz County Farm Bureau and the U.C. Agricultural Extension to assist the agricultural sector to identify and adjust to changes in pest management, cropping patterns, water management and other on farm practices that may be required as precipitation and temperature patterns change.	
	Increased frequency and magnitude of wildfire	Establish and maintain cooperative fire protection and fire prevention agreements with other agencies (*LHMP*).	Continue to maintain and/or establish agreements with local fire agencies for emergency response to increased Wildland incidents which may occur as the result of climate change. Purchase a type 3 wildland fire engine to assure that the most effective and reliable equipment is available to protect life, property and the environment. Continue to train firefighters in wildland firefighting techniques.
		Work with State and Federal natural resources agencies to standardize environmentally appropriate fuel reduction practices in sensitive habitats.	

		Maintain early notification/warning of residents by technology based applications (*LHMP*).	Review and revise usage of open space to reduce incidence of human-caused wildfire; maintain access, increase surveillance or security measures to ensure prompt response to emergencies, such as fire or flood; add weather monitoring stations to track temperature rise; increase ability to monitor fuel, load moisture content, capacity in all watershed and water department asset areas.
		Increase visibility and reduce response times with proper road and address markings *(LHMP).*	Increase efforts to reduce fire risk in watershed, near water supply lines where applicable, and around water department assets to mitigate potential increase in wildfire risk due to climate change; replant post-wildfire to decrease risk of erosion or landslide.
		Enhanced support for interoperability communications systems with local, state and federal emergency services both inside and around the County (LHMP).	
		Reduce fire risks in the urban/wildland interface through improved building materials and appropriate code enforcement including defensible space programs (*LHMP and Calgreen building code*).	Protect parks and facilities from the increased risk of urban/Wildland fire through increased underbrush clearing, perimeter protection, adequate patrol and staffing. Fire Department to update Urban Interface Policy to reduce fire hazards in parks, greenbelts and open spaces.
		Develop fuel reduction approaches in all areas, with special approaches for sensitive habitat areas.	
		Implement additional fire prevention education programs, to include school and commercial business (LHMP).	Conduct public outreach on maintain defensible space. Educate the public in the maintenance of defensible space, i.e., adequate clearance of residential property as outlined in the LHMP; enforce adequate clearance through codes and ordinances.

			Regulate development in and adjacent to areas with steep canyons, arroyos and fire prone vegetation. Require new development in areas susceptible to wildfires to be responsible for fire prevention activities (visible house numbering and use of fire-resistant and fire retardant building and landscape materials) and to also provide a defensible zone to inhibit the spread of wildfires.
	Increased threat to the County's biotic resources, biodiversity and ecological systems	Consider protecting, and/or assisting non-profit organizations to protect habitat that is essential to facilitating species adaptation to changing climate. This would include protecting potential refuge areas and large, interconnected habitat patches that achieve multiple conservation benefits. Areas to consider include butter areas around existing protected habitat, areas that facilitate connectivity between populations, representative areas of the County's diverse local climates, and areas that are more likely to be climatically stable or support species in the predicted hotter and drier climate, including streams, ponds, lakes, wetlands, springs, and north-facing slopes	Review and revise usage of open space to reduce incidence of human caused wildland fire
		Consider revising the Conservation and Open Space element of the General Plan to address the challenges of climate change and to update conservation policies, working with local scientists, conservation and environmental organizations	Purchase a wildland firefighting apparatus and equipment to allow for rapid response to areas with limited access.
		Support private and non-profit organizations efforts to promote community awareness of Santa Cruz County's rich biological systems and their vulnerability to climate change, as well as their role in mitigating climate change,	Increase efforts to reduce the increased fire risks a result of climate change in wildland/urban interface areas through vegetation management and code enforcement including mowing fuel breaks, eucalyptus

		and to track indicators of the effects of climate change on important biological systems.	grove management and create shaded fuel breaks for access and fighting fires.
Countywide strategies that address multiple impacts from climate change	Many existing policies and programs do not address climate change	Consider how climate-related goals and strategies can be incorporated into an amendment of the General Plan. This may be coordinated with policies that flow from the Transit Corridors Plan for Sustainable Communities and the Disaster Recovery Initiative funded update of the Safety Element.	
		Consider incorporating the topic of developing resiliency in important sectors of the economy (such as agriculture and tourism) into the County economic vitality strategy that is currently being developed.	Evaluate capital project, capital improvements program and infrastructure, and land use decisions in light of best available climate science. Ask, "What are the potential climate impacts and adaptation actions that might be considered," just as every proposed program or project defines potential fiscal impacts to the City. Address the effects of climate change through changes in land use and building codes for low-lying areas that may be flooded by increases in sea levels and storm intensity.
		Consider a program to identify the key transportation infrastructure, communication infrastructure, utilities, beaches and other amenities that support tourism, agriculture and commercial activity in general, and prioritize them for protection or retrofit.	Promote and preserve economic base and tourism in the face of a changing climate through collaboration with Visitor Center, Downtown Association and other community groups to promote tourism. Monitoring and proactive steps should be taken as information becomes available. Prepare for new opportunities and challenges in the tourism industry such as an increase in climate refugees including review of properties available for lodging and other new development. Continue to work with Parks and Recreation Department and the lodging industry to insure that a

			variety and adequate quantity of lodging and camping options are provided.
		Consider adding adaptation to climate change as a specific component of the next update of the LHMP.	
			Protect, maintain and preserve visitor serving venues, museums, facilities, parks, Wharf, beaches and other natural resources including the lighthouse and West Cliff Drive, pathways, infrastructure, open space and parks.
			Small to medium scale beach nourishment has been found to be a cost effective, although temporary, adaptation measure when material is available. Strategic placement of river sediment at a site north of Santa Cruz could artificially increase local littoral sand abundance, which would be passively distributed down coast, benefitting multiple pocket beaches and subtidal areas along West Cliff as well as Cowell and Main beaches.
			Bilingual (Spanish/English) public outreach through social media, radio/TV spots, websites, presentations to local schools and stakeholder meetings. Neighborhood and city staff trainings to teach emergency response techniques. Develop Sea Level Rise hazard disclosures to renters. Create partnerships with the USCS and others to educate and bring public awareness
			Replace Highway 1 Bridge. Work with Caltrans to replace and raise bridge to reduce flooding hazard potential due to its low flood clearance, and number and angle of piers in the river.