City of Carmel-by-the-Sea

CLIMATE CHANGE VULNERABILITY ASSESSMENT

PRE-FINAL REPORT

July 2021

Acknowledgments

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I. Introduction

The purpose of this Vulnerability Assessment is to characterize climate hazards that will impact the community and City assets in Carmel-by-the-Sea, determine our community's major climate vulnerabilities, and identify work that has already been done to improve community resilience. The Vulnerability Assessment will help provide focus to the City's adaptation planning efforts.

II. Historical Hazards

Historical hazards provide information about hazards that may be exacerbated by climate change, as well as potential vulnerabilities of City assets to those hazards. A table of historical hazards assembled from the Monterey County Multi-Jurisdictional Hazard Mitigation Plan (MJHMP), the National Oceanic and Atmospheric Administration (NOAA) Storm Events Database, and historic records at the Carmel Library, is included in **Appendix A**. Additionally, a map of historic wildland fires in Monterey County from the MJHMP is also included in **Appendix A**.

III. Changing Hazards with Climate Change

This Vulnerability Assessment uses information and modeling projections provided by the State of California to support climate adaptation efforts, including the Cal-Adapt modeling tool and the Fourth California Climate Assessment. The Cal-Adapt modeling tool provides climate change projections based on two different future greenhouse emissions gas scenarios: a high-emissions scenario, Representative Concentration Pathway (RCP) 8.5, in which greenhouse gas emissions continue to rise over the 21st century, and a low-emissions scenario, RCP 4.5, in which greenhouse gas emissions level off around the middle of the 21st century, and, by the end of the century, are lower than 1990 levels.

Increased Temperatures

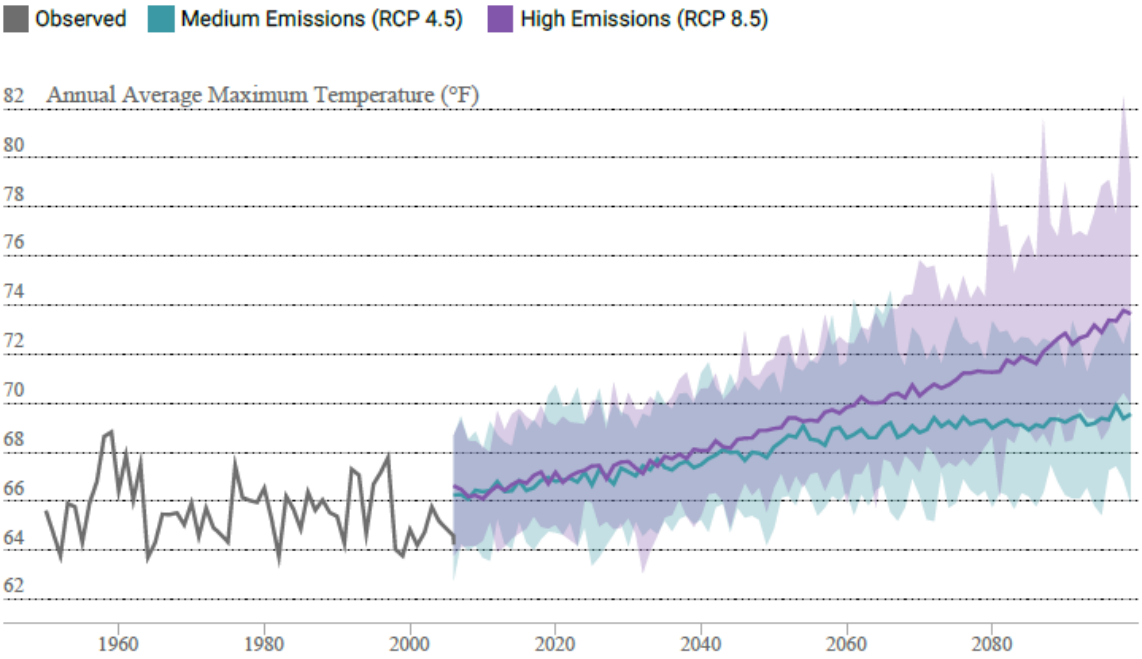
According to the State's Cal-Adapt modeling tool, overall temperatures are projected to rise in California during the 21st century. However, coastal areas will be less impacted due to the moderating effect of the Pacific Ocean. The current average annual maximum temperature (the average of all the hottest daily temperatures in a year) in Carmel-by-the-Sea is 65.6 degrees Fahrenheit (°F). According to the RCP 8.5 model, annual average maximum temperatures in Carmel-by-the-Sea could increase by 3.3°F by mid-century to 68.9°F, and by 6.3°F to 71.9°F by the end of the century.

The number of extreme heat days, defined as days with daily maximum temperature above 87.9 °F, is also projected to increase to an average of 6 days per year by mid-century, and to an average of 7 to 13 days per year by the end of the century, depending on the emissions scenario.

While the community and essential facilities of Carmel-by-the-Sea should be able to adapt to these gradual temperature changes, local ecosystems will be more adversely impacted by the increased heat.

Annual Average Maximum Temperature

Average of all the hottest daily temperatures in a year.



		30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	65.6 °F	65.3 - 65.8 °F
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+2.6 °F	68.2 °F	66.7 - 69.6 °F
HIGH EMISSIONS (RCP 8.5)	+3.3 °F	68.9 °F	67.3 - 70.6 °F
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+3.6 °F	69.2 °F	67.3 - 71.5 °F
HIGH EMISSIONS (RCP 8.5)	+6.3 °F	71.9 °F	69.2 - 76.0 °F

Drought

In 2014, the State of California, including Monterey County, faced one of the most severe droughts on record. Governor Brown declared a drought State of Emergency in January 2014, and directed State officials to take all necessary actions to prepare for water shortages during what was considered an "unprecedented" drought.

Prior to the 2014 drought, the National Climatic Data Center has recorded no instances of severe drought conditions in the Monterey County forecast zone for the period of 1/1/1996 through 12/31/2013.

According to the Fourth California Climate Assessment, even minor fluctuations in rainfall patterns will increase pressure on Monterey County's water resources, which are already over-stretched by the demands of a growing agriculture economy and population. Decreasing spring stream flows, coupled with increasing demand for water resulting from both a growing population and hotter climate, could lead to increasing water shortages.

According to the State's Cal-Adapt modeling tool, research suggests that for much of the state, wet years will become wetter and dry years will become drier. Dry years are also likely to be followed by dry years, increasing the risk of drought. While California does not see the average annual precipitation changing significantly in the next 50-75 years, precipitation will likely be delivered in more intense storms and within a shorter wet season. We are already seeing some of the impacts from a shift towards larger year to year fluctuations.

Fog Changes

According to California's Fourth Climate Assessment, the formation of coastal fog is very complex and involves highly dynamic ocean, air, and land processes. Ocean upwelling, once thought to drive the formation of coastal fog, is secondary to the global atmospheric circulation pattern that situates a North Pacific zone of atmospheric high-pressure. This air mass generates inversions under which coastal fog forms. The frequency and thickness of summertime fog depends on the location of the high-pressure zone, the strength of the inversion, and sea surface temperatures.

The future of coastal fog under climate change remains uncertain. Long term fog trends over the coastal ocean from ship observations since 1951 show an increase, while fog trends over land show a decrease. The effect of other land surface changes such as forest fires on fog is unknown.

Changes in coastal fog could have a significant impact on coastal ecosystems. Fog provides an important source of water for many coastal plant communities through fog drip, and it also acts to keep moisture in the ecosystem, preventing evaporation and maintaining cooler temperatures during the summer months. Ecosystems such as the coastal redwoods and maritime chaparral are dependent on fog for their survival. A decline in coastal fog could also lead to increased water use and an increased demand for water in the Central Coast Region due to warmer temperatures and increased evaporation during the summer months. This in turn could lead to increased agricultural and landscape water use.

Ocean Warming

According to information provided by the National Oceanic and Atmospheric Administration (NOAA), Office of National Marine Sanctuaries, water temperatures in the Monterey Bay Sanctuary have risen slightly over the past century and offshore waters could warm by 7 degrees Fahrenheit by 2100. In addition to rising average temperatures, marine heatwaves are expected to increase in frequency, duration, and intensity.

Monterey Bay is at an ecological transition zone that is the northern range edge of many warm-water species. Thus, warming of ocean waters may have a significant impact on marine communities by shifting warm-water species northward. Warming waters also hold less oxygen and may increase the mortality of a variety of local organisms, including mussels, oysters, sea stars, rockfish, kelp, and deep-water corals.

Many impacts of warming waters were observed during the 2014-2016 marine heatwave known as "The Blob", during which water temperatures in the Sanctuary reached 7.2 degrees Fahrenheit above normal. That marine heatwave caused significant impacts in the Bay, including a large Harmful Algal Bloom, reduced numbers of zooplankton, and migration of southern species. These changes in turn caused mass mortalities of seabirds and marine mammals, and early closure and delayed opening of the Dungeness crab fishery. Effects of the heatwave also led to significant declines in kelp forests in the region.

The varied impacts of The Blob on the marine ecosystems of the Monterey Bay and the fisheries that rely on them demonstrated the potential significant impacts of climate change on local marine communities; however, marine systems are complex, impacted by not only water temperature, but also upwelling, sea level rise, storm patterns, and ocean acidification. Thus, the long-term effects of climate change on local marine ecosystems are still under study and are difficult to predict.

Wildfires

Wildfires occur frequently in the Central Coast region. In recent years, much of California, including the Central Coast, has seen an increased risk of wildfire, with a wildfire season that starts earlier, runs longer, and features more extreme fire events.

According to California's Fourth Climate Assessment, annual climatic water deficit, which measures water availability relative to water demand, is generally a strong predictor of fire occurrence in semi-arid regions, largely due to the correlation between annual water deficit and fuel moisture. Warmer temperatures will increase water demand and climate water deficit, and thus fire risks.

A key factor affecting wildfires on the Central Coast will be precipitation patterns. Northern Central Coast areas typically have higher precipitation and may see fewer, more severe, wildfires; while areas to the south may see more frequent, less severe, wildfires as warming temperatures increase climatic water deficit there but also could reduce vegetation growth rates and fuel loads. Another important factor in wildfire severity will be wind; at this time, climate models have not determined yet how climate change will affect major wind patterns in the Central Coast.

Given the uncertainties in climate predictions of precipitation and wind for the Central Coast region and the sensitivity to precipitation and climatic water deficits of our local ecosystems, it is difficult to accurately predict the change in wildfire frequency and severity; however, there is little doubt that large, severe wildfires will continue to occur in this region. Thus, growing populations and expansion into the Wildland Urban Interface (WUI) will increase vulnerability to fires. Projected increases in precipitation intensity during storms may also increase post-fire impacts such as sediment flows, nutrient pulses in nearshore waters, and the spread of invasive grasses.

Stronger Storms

Projections of changes in precipitation in California are more nuanced than projected changes in temperature and have less separation between RCP4.5 and 8.5 scenarios. There is a projected increase of year-to-year variability with wetter days during periods of precipitation, but with fewer total days with precipitation. When combined with higher temperatures, these changes will create significant challenges for the state's water supplies, potentially creating more serious flooding events as well as more frequent drought conditions.

According to California's Fourth Climate Assessment, extreme atmospheric river events, which are associated with strong winds and severe flooding, are expected to increase under projected climate change in California. Atmospheric rivers are the dominant drivers of locally-extreme rainfall events along the Central Coast.

Across the Central Coast, projections suggest that the wet season will become shorter, and wetter, and dry years may become more severe, while, on the daily time scale, storm events will become more intense.

Maximum 1-day Precipitation

The maximum daily precipitation amount for each year. In other words, the greatest amount of daily rain or snow (over a 24 hour period) for each year.

		30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	1.341 inches	1.169 - 1.475 inches
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+0.060 inches	1.401 inches	1.157 - 1.627 inches
HIGH EMISSIONS (RCP 8.5)	+0.111 inches	1.452 inches	1.276 - 1.693 inches
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+0.093 inches	1.434 inches	1.258 - 1.723 inches
HIGH EMISSIONS (RCP 8.5)	+0.187 inches	1.528 inches	1.270 - 1.861 inches

Sea Level Rise

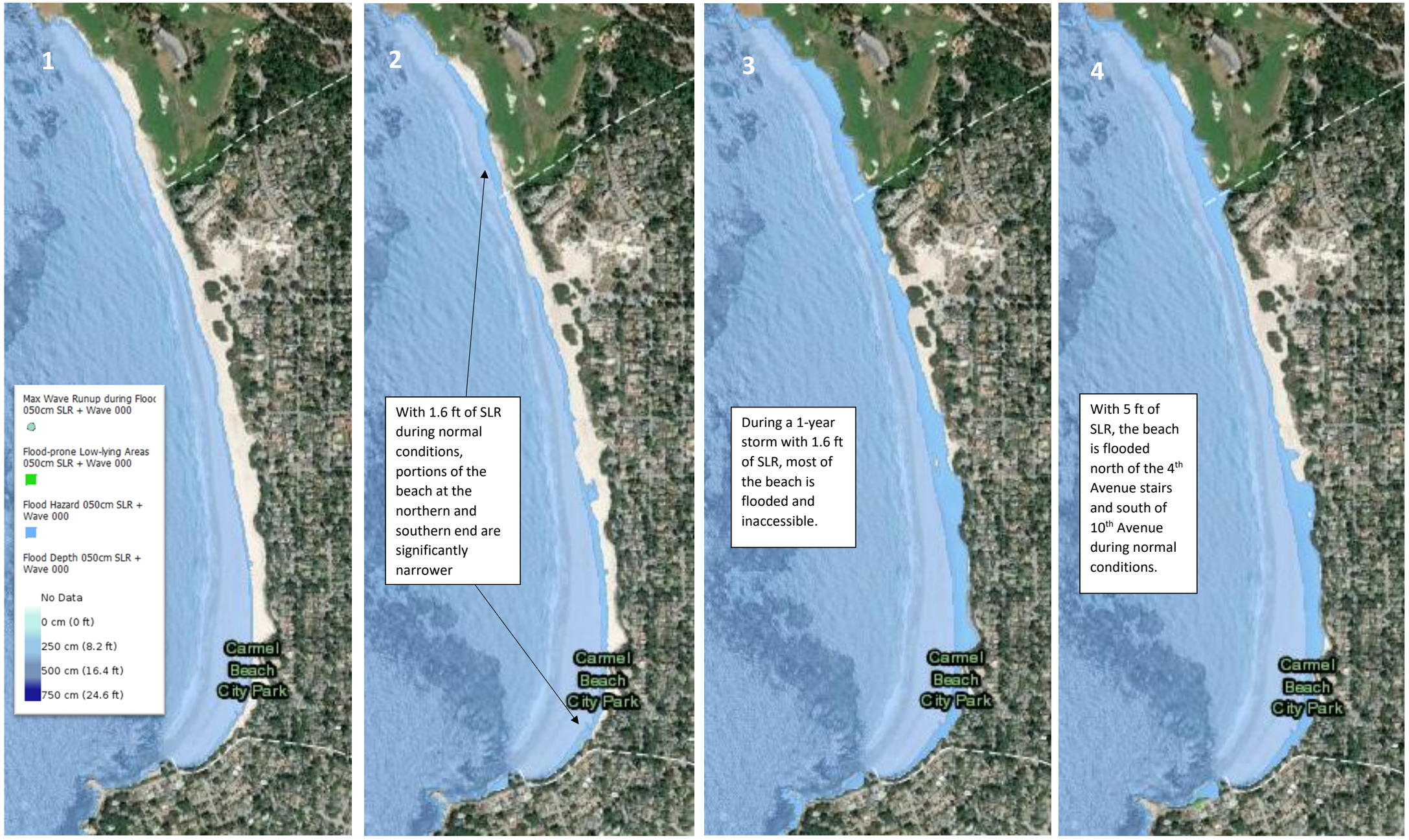
Global sea level rise is driven primarily by thermal expansion caused by the warming of the oceans and the loss of land-based ice such as glaciers and polar ice caps due to increased melting. The Monterey County MJHMP (September 2014) reports that Monterey County may experience an approximate 5-foot (150 cm) rise in sea level by the year 2100.

Figure 1 below is from the USGS Coastal Storm Modeling System and shows a range of inundation zones, starting with 1) current conditions, 2) 1.6 feet (50 cm) of Sea Level Rise (SLR) by mid-century under normal conditions, 3) 1.6 feet of SLR during a 1-year storm, and 4) 5 feet of sea level rise by 2100.

The figures indicate that the Carmel bluffs provide an important barrier against sea level rise impacts to property; however, Carmel Beach will continue to become narrower, particularly at the southern end of the bay, as well as the northern end near Pescadero Canyon, and will be inaccessible during and after storms. This phenomenon of beach loss is already happening after large winter storms in Carmel. With 5 feet of sea level rise (end of Century), much of the southern end of the beach will be gone, as well as the northernmost portions, even under normal conditions.

The loss of Carmel Beach will impact not only the recreational, environmental, and economic resources it provides but it also has the potential to amplify the impacts of hazard events such as storms, as well as coastal erosion. Coastal erosion analysis indicates that retreat rates for the Carmel bluffs average 2-4 inches a year. Sea level rise, combined with amplified coastal erosion could cause considerable damage and deterioration of the City's coastal facilities, including sea walls, revetments, access stairs, the Scenic pathway, bathrooms, Scenic Road, and utilities including the sanitary sewer, water supply, and stormwater systems.

Figure 1: Comparison of Carmel Beach maximum wave run-up during: 1) current conditions, 2) with 1.6 ft of sea level rise (SLR) and no storm, 3) 1.6 ft of SLR and 1-year storm, and 4) 5 ft of SLR and no storm.



IV. Hazard Ranking

Based on the information provided by historical hazards (Appendix A), as well as projected changes from climate change, several climate effects will significantly impact Carmel over the coming years. Climate hazards are ranked in the table below by the timeframe of their impacts, with hazards that are already causing observable impacts or representing a significant near-term risk in orange and those with potentially significant impacts into the future in yellow. Hazards in yellow have a longer planning time horizon. Hazards for which we do not have enough data yet are shown in grey.

- Orange: already causing observable impacts or a near-term significant risk
- Yellow: significant mid- to long-range impacts
- Grey: not enough data

Stronger Storms
Wildfires
Sea Level Rise
Drought
Increased Temperature
Fog Changes
Ocean Warming

V. Vulnerable City Assets and Populations

Climate change does not have the same effects in all parts of the community. Some people and physical assets will be affected more severely than others, and adaptation planning efforts should evaluate the full range of potential effects of climate change. Priority assets and populations at risk are organized in Table 1 below under the following main categories:

- Natural Assets
- Community
- Utilities
- Regional Infrastructure
- Local Infrastructure

Virtually all people and assets in our community will be affected by climate change in some way over the planning horizon; however, it is not feasible to assess the vulnerability of every group or every asset in our community. Thus, we have focused on those assets that face greater harm, require special consideration, or are critical to the community's well-being. They are listed below with potential hazards that may affect them.

Table 1: Vulnerable City Assets and Populations

Priority Assets at Risk	Priority Hazards						
	Stronger Storms	Wildfires	Sea Level Rise	More Droughts	Increased Temperature	Fog Changes	Ocean Warming
Natural Assets							
Mission Trail Nature Preserve	X	X	X	X	X	X	
North Dunes			X	X	X	X	
Urban forest	X	X		X	X	X	
Marine Sanctuary	X			X	X	X	X
Carmel Beach			X			X	X
Community							
Elderly population and people with disabilities	X	X		X	X		
Residents	X	X		X	X		
Visitors	X	X	X				X
Local businesses	X	X	X	X	X		X
Service industry workers	X	X	X		X		
Second homes	X	X	X		X		
Utilities							
Water supply		X	X	X	X		
Sanitary sewer system	X		X				
Power grid	X	X			X		
Overhead communication lines	X	X			X		
PG&E/communication underground lines (gas, cable)		X	X				
Regional Infrastructure							
Wastewater treatment facility	X		X		X		
Transportation infrastructure (Caltrans)	X	X	X				
Hospital and emergency medical care facilities	X	X			X		
Landfill & waste management	X						

Priority Assets at Risk	Priority Hazards						
	Stronger Storms	Wildfires	Sea Level Rise	More Droughts	Increased Temperature	Fog Changes	Ocean Warming
Local Infrastructure							
Shoreline access infrastructure: Scenic trail, public restrooms, beach stairs, coastal roadways, and parking	X	X	X		X (visitors)	X	
Seawalls and revetments	X		X				
Storm drainage system	X		X				
Other city streets	X						
Emergency response facilities (Fire station, EOC, PD, PW, City Hall, etc.)	X	X			X		

VI. Existing Strategies and Policies for Adaptation

The City has several existing documents that provide guiding policies and strategies that will help address elements of climate change adaptation. A summary of recommended projects in those documents that will help reduce the City's vulnerability to climate change is presented below, by asset category.

Natural Assets

a. Mission Trail Nature Preserve

Mission Trail Nature Preserve Master Plan

Adopted by the City Council: 1996

The Mission Trail Nature Preserve Master Plan has policies that will be beneficial to the short- and long-term health of the Preserve's ecosystems in the face of climate change. These policies can make the Preserve more resilient to increased heat, drought, and wildfires:

- O5-25: Preserve and enhance the vegetative diversity in Mission Trail Nature Preserve consisting of Monterey pine forest, central coast willow riparian forest, wet meadow, coast live oak woodland, redwood, box elder, cottonwood, coastal terrace prairie.
- O5-31: Maintain natural drainage patterns except where erosion or human safety problems may be created. Encourage/allow the channelized ditch to revert to a more natural channel in order to enhance the park's wetlands (riparian forest, wet meadow) and natural character.

- Prepare annual maintenance plans for habitats within the Preserve. Encourage native vegetation to reestablish on sites previously mowed, cut, or invaded by exotic species.

Implementation Status: *Initiated.* Many elements of the Mission Trail Nature Preserve Master Plan, including enhancing native habitats and site hydrology, have been initiated and are currently in progress. The City has been working with its private non-profit partners on invasive species and fire fuel removal throughout the Preserve for several years.

Mission Trail Nature Preserve Baseline Biological Assessment

Prepared by Nicole Nedeff: January 2016

The Mission Trail Nature Preserve Baseline Biological Assessment was completed in 2016 and includes an implementation plan for maintenance and enhancement of the various habitats of the Preserve. This is the primary guiding document for habitat restoration projects in the Preserve.

Implementation Status: *Initiated.* Many elements of the Mission Trail Nature Preserve Baseline Biological Assessment, including weed removal and improving the site's hydrology, have been initiated and are currently in progress. The City has been working with the Friends of Mission Trail Nature Preserve on invasive species and fire fuel removal throughout the Preserve.

Mission Trail Stream Stability Study

Prepared by Dudek and Waterways Consulting: February 2019

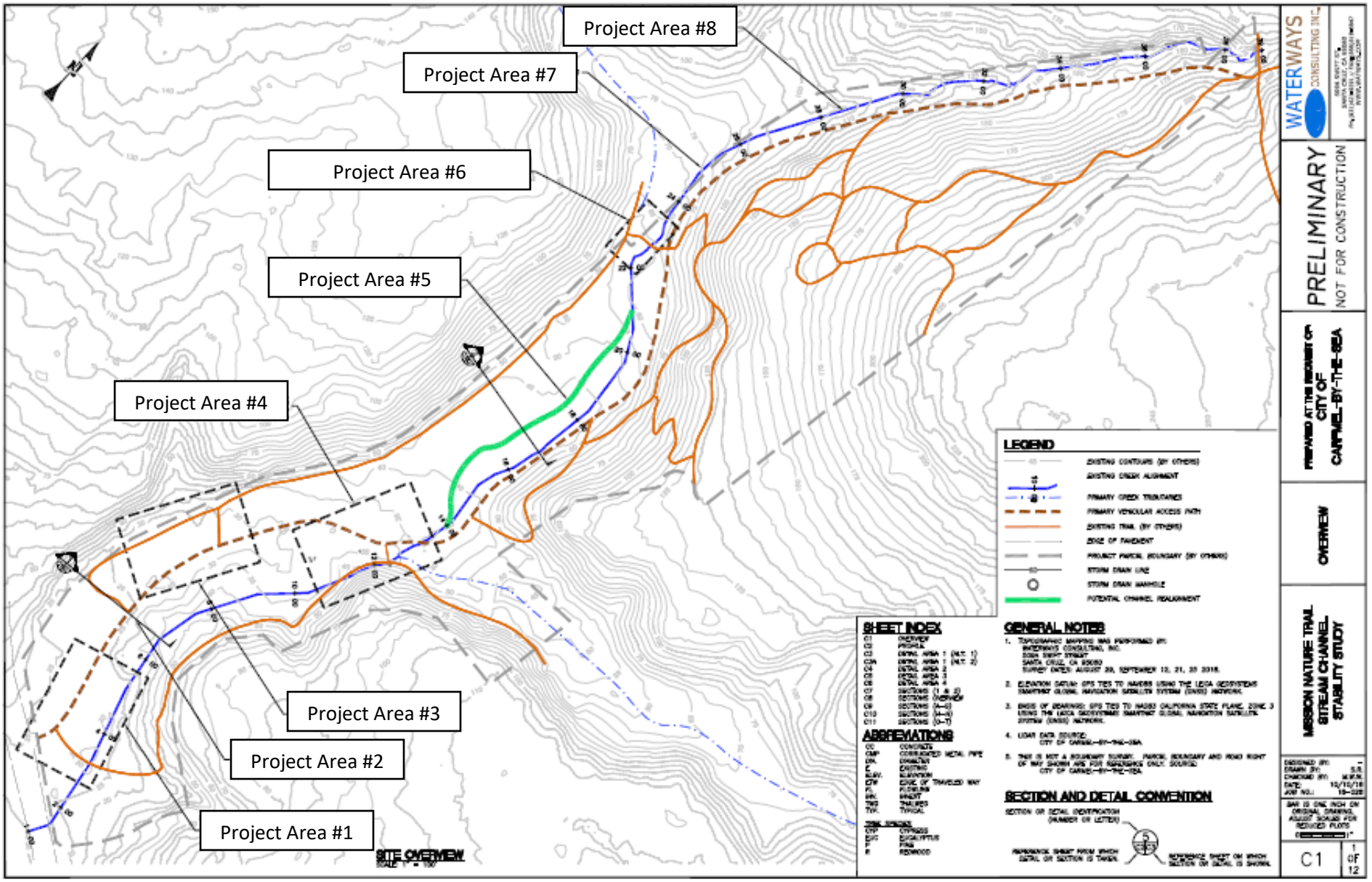
The Stream Stability Study was completed in 2019 to determine factors contributing to channel instability in Mission Trail Nature Preserve, to determine the stability of drainage improvements in the Preserve, and to recommend actions to restore the stream and habitat conditions in the riparian corridor. The study identified eight projects to restore natural hydrology and stream stability in the Preserve. The projects are shown on Figure 2 below and listed in Table 2.

Table 2: Mission Trail Stream Restoration Projects

PROJECT AREA	PROJECT COMPONENTS	APPROXIMATE COSTS	
		DESIGN	IMPLEMENTATION & ESTABLISHMENT
1 (Alt 1)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT OPEN SWALE TO CREEK	$17,000	$90,000
1 (Alt 2)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT PIPE TO CREEK	$17,000	$95,000
1 (Alt 3)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD	$15,000	$75,000
2	CONSTRUCT APPROX. 100 LF PEDESTRIAN BOARDWALK	$8,000	$40,000
3	INSTALL CULVERT OR ROCKED FORD AND REALIGN TRIBUTARY DRAINAGE, INSTALL SMALL DITCH CULVERT AND PERFORM DITCH MAINTENANCE	$7,500	$22,500
4	DEMOLISH PORTION OF EXISTING FORD, RESTORE DOWNSTREAM REACH OF CHANNEL, REALIGN TRAIL, CONSTRUCT PEDESTRIAN BRIDGE, RESTORE OLD TRAIL ALIGNMENT	$17,500	$100,000
5	REALIGN APPROX. 700 LF OF CHANNEL. RESTORE OLD CHANNEL BED, REVEGETATE DISTURBED AREAS	$27,500	$300,000
6	REPLACE EXISTING UNDERSIZED BRIDGE, RESTORE DOWNSTREAM CHANNEL AND ARMOR REACH TO PREVENT FURTHER INCISION UPSTREAM	$25,000	$230,000
7	REMOVE EXISITING WEIR, LOWER CHANNEL, STABILIZE NEW CHANNEL BED AND BANKS	$9,500	$30,000
8	PERFORM BOUNDARY SURVEY, DETAILED TOPOGRAPHY, GEOLOGIC & GEOTECHNICAL INVESTIGATION. PRIORITIZE A PHASED REPAIR PLAN, AND PREPARE PRELIMINARY AND FINAL DESIGNS FOR GRADE CONTROL.	$50,000	N/A

Implementation Status: *Initiated*. A successful grant application for $178,000 for the design and construction of Projects 1-3 has been submitted to the Per Capital Grant Program and is awaiting contract.

Figure 2: Mission Trail Stream Stability Projects



b. North Dunes

Del Mar Master Plan and North Dunes and Del Mar Dunes Habitat Restoration Plan (2009)

Adopted by the City Council: September 2009

The Del Mar Master Plan provides a framework for improving parking, circulation, pedestrian flow, handicap accessibility, aesthetics and environmental resources in the Del Mar and North Dunes areas. At the time of the Master Plan development, the North Dunes were a 4 to 5 acre tract of substantially disturbed dunes with small pockets of remaining native species. The Master Plan has several policies that support the restoration of the native habitats in the North Dunes, which will improve sensitive habitat resilience in the face of climate change:

P5-103: Identify and protect environmentally sensitive habitat areas against any significant disruption of habitat values. Only uses dependent upon those resources shall be allowed.

P4-48: Discourage any further incursion of recreational activities into the North Dunes habitat. Sensitive resources in the North Dunes habitat area shall be protected.

P5-28: Restore dune areas to improve habitat for Tidestrom's lupine and other native dune plants.

O5-7: Protect the fragile dunes and sensitive plants in the Del Mar Dunes and North Dunes against any significant disruption of habitat values.

P5-27: Maintain an attractive mix of plant material that favors native species and other, drought-tolerant, noninvasive species.

P5-29: Control the spread, and prohibit planting of, invasive non-native plants.

O5-40: Ensure that long-term management activities maintain the natural dune ecology of Carmel Beach in a manner consistent with public safety. Protect areas of the beach from the loss of habitat, where special status plant species are growing.

P5-173: Retain a qualified botanist to monitor the population of Tidestrom's lupine and other special status species on the North Dunes of Carmel Beach. The population should be assessed annually (or based upon a schedule agreed upon by the Department of Fish and Game, Coastal Commission and U.S. Fish and Wildlife Service) to determine if the population is stable and if measures to protect the population should be instituted. If the population appears heavily affected by public use, the City should consider fencing or placing barriers around the lupine habitat on the beach.

P5-176: Implement a Dune Restoration Plan.

P4-34 : Post educational/interpretive signs where appropriate along Scenic Road and in the North Dunes area.

P4-3: Improve and sign the vertical access at Fourth Avenue. Consider development of a pedestrian path from the foot of Jane Powers walkway to the Fourth Avenue beach access through Sand and Sea. Investigate and implement opportunities to establish or reestablish additional vertical access from North San Antonio to the beach to the extent feasible.

P4-18: Improve the pedestrian experience through the Del Mar Parking area for those arriving on foot and from parked vehicles to the beach. Consider construction of boardwalks or other improvements to aid beach circulation, protect tree roots and protect the sensitive vegetation in the North Dunes area.

A Habitat Restoration Plan for the North Dunes and Del Mar Dunes is included as an appendix to the Del Mar Master Plan, which guides the specific habitat restoration actions at the North Dunes. The Habitat Restoration Plan has the following success criteria:

- Aggressive non-native species shall have less than 1% of coverage in the project area.
- The dune scrub plant coverage should reach at least 70% coverage in the project area, with the other 30% occupied by bare sand or Monterey cypress within the cypress corridor.
- All planted species must be displaying evidence of reproduction.
- The dune scrub shall be comprised of all 22 native species listed in the report.
- Successful establishment of 10 locations of Tidestrom's lupine with at least 100 plants each.
- Successful establishment of the quantity and quality of available habitat for Black Legless Lizards, including the habitat corridor between Del Mar and North Dunes.
- Annual monitoring of the Tidestrom's lupine population is performed and results reported to the CA Department of Fish and Game's Data Base.
- The trail system has been established and is being used exclusively for visiting or traversing the dunes. No foot traffic impact is occurring within the Del Mar or North Dunes.
- Interpretive panels are increasing the visitors' experience and knowledge of the dune habitat.

Implementation Status: *substantial progress*. In 2010, the City installed a boardwalk connecting the 4th Avenue beach stairway to the dune access at the end of 4th Avenue, which reduces impacts on dune habitat and endangered Tidestrom's lupine. In 2016, the City obtained a CDP to conduct habitat restoration actions at the North Dunes. Significant strides have since been made in removing invasive weeds and restoring native dune vegetation throughout the North Dunes. The City retained a biologist who has been monitoring the progress of restoration activities. The latest preliminary results for the 2021 monitoring indicate that average percent cover of native species along 18 transects in the dunes is 65% and the average weed cover is 10%. The monitoring also indicated that 39 different native species were recorded in the North Dunes.

c. Urban Forest

Forest Management Plan (2000)

Prepared by: Michael Branson, City Forester, December 2000

Adopted by the City Council: March 2001

The Forest Management Plan establishes a broad set of goals and policies for management of the City's urbanized forest. Some policies of the Forest Management Plan are beneficial to drought and wildfire mitigation, and provide other adaptation benefits:

- Promote undergrounding of utilities where feasible and with minimum detriment to the root systems of trees.
- Monitor tree pest and disease problems and take appropriate measures to minimize their impact.
- Plant native Monterey pine seedlings of different genotypes to maximize resistance to diseases and make these seedlings available to the public.
- Establish and implement a procedure for removal of invasive vegetation.
- Maximize retention of surface water on each site through site design and use of best management practices.
- Where feasible, direct street runoff to open-space areas on public property for percolation into the soil.
- Implement development standards that minimize runoff and the amount of area paved with impervious surfaces.
- Require approval of landscape plans for drought tolerance and trees by the Forestry department on new construction.

Implementation Status: *Initiated.* Requirements for stormwater infiltration, drought tolerance, and trees on private property are in place in the municipal code and are enforced by City staff. The City Forester monitors tree pest and disease problems. Invasive vegetation removal is an on-going task.

d. Opportunities to build on Existing Adaptation Strategies for Natural Resources:

The following opportunities to build on existing adaptation strategies were identified based on technical expert presentations at Committee meetings (Appendix B) and from the review of previous reports:

- Update the Forest Management Plan to (1) address transitioning the urbanized forest to tree species that can withstand the projected temperatures of the second half of the century, and (2) include planting guidelines to improve tree health, (3) incorporate tree species that have greater drought and wildfire resistance, and (4) in addition to drought-tolerant landscaping, include landscaping guidelines that reduce wildfire hazard on private property.
- Encourage stormwater infiltration features as part of street CIP projects to reduce runoff volume and increase groundwater infiltration.
- When designing projects recommended in the Mission Trail Stream Stability Study, size improvements to handle larger storms.
- Earmark CIP funding for design, permitting, and implementation of stream stability study projects. Include strategies in 2021 MJHMP and Integrated Regional Watershed Management Program (IRWMP) for potential regional funding.
- Update the Mission Trail Nature Preserve Master Plan to consider the potential impacts of climate change and to reduce wildfire risk for neighboring private properties. Incorporate Best Practices into an annual maintenance plan, including cost estimates for implementation and revenue sources for implementation.
- Continue maintenance and monitoring at the North Dunes to determine how the changing climate will affect dune habitats.

Community

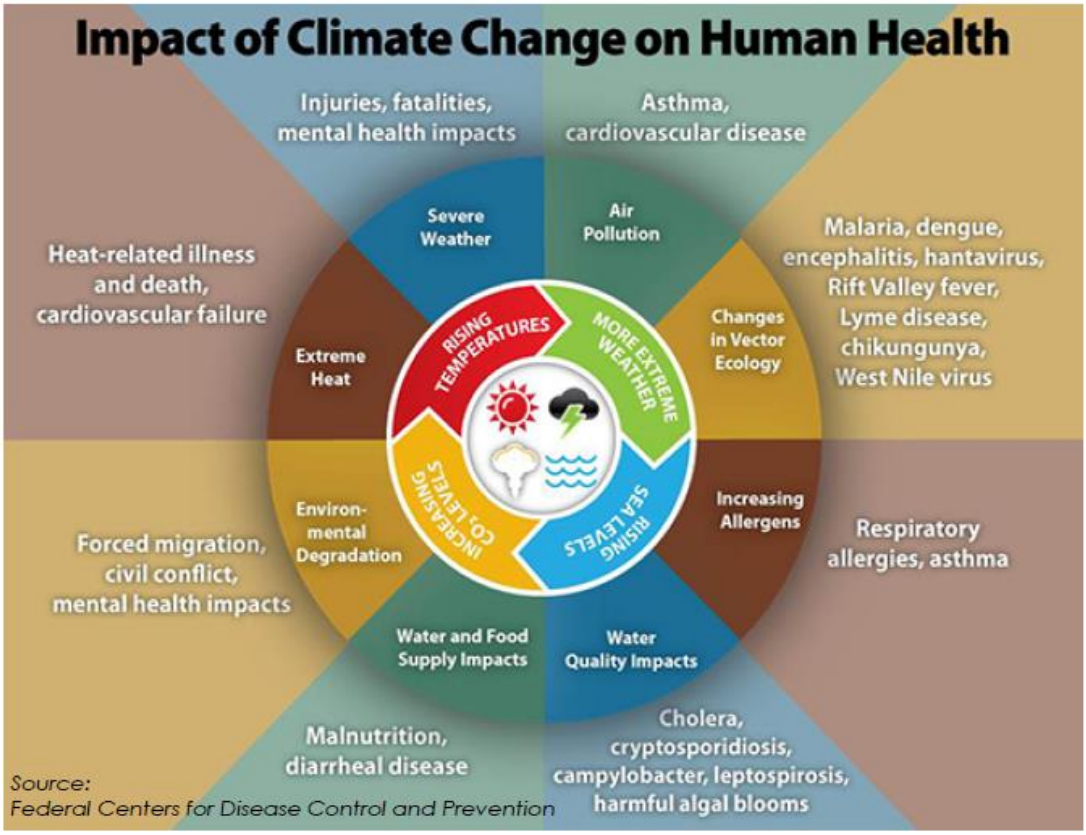
a. Elderly population and people with disabilities

Climate Change and Health Profile Report: Monterey County (2017)

Prepared by: California Department of Public Health, Office of Health Equity

Researchers have examined the pathways in which increased temperatures and hydrologic extremes can impact health and generally recognize three main pathways: direct exposures, indirect exposures, and socio-economic disruption. As shown in Figure 3 below, all Californians are vulnerable to the health impacts of climate change.

Figure 3: Impact of Climate Change on Human Health



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

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 outdoor or high risk work, a precarious socioeconomic status, or lack of social cohesion and collective

efficacy. Collective efficacy and local community cohesion may be associated with effective action to plan and coordinate responses to climate threats.

The Health Profile Report provides the following useful health statistics for the County of Monterey:

- In 2012, nearly 46% of adults (149,059) reported one or more chronic health conditions including heart disease, diabetes, asthma, severe mental stress or high blood pressure.
- In 2009, approximately 86% of households were estimated to lack air conditioning.
- In 2010, Monterey County had approximately 28,971 outdoor workers whose occupation increased their risk of heat illness.
- In 2005-2010, there was an annual average of 27 heat-related emergency room visits in the County.
- In 2010, approximately 14% (58,314 residents) of the county's population lived in fire hazard zones of moderate to very high severity.

b. Residents and Private Properties

California Green Building Standards (CALGreen) (2019)

CALGreen is California's first green building code and first in the nation state-mandated green building code. It is formally known as the California Green Building Standards Code, Title 24, Part 11, of the California Code of Regulations. The purpose of CALGreen is to improve public health, safety, and general welfare through enhanced design and construction of buildings using concepts which reduce negative impacts and promote those principles which have a positive environmental impact and encourage sustainable construction practices. CALGreen applies to the planning, design, construction, use, and occupancy of every newly-constructed building or structure on a statewide basis unless exempt. Additions and alterations to existing buildings which increase the building's conditioned area, interior volume, or size are also covered by CALGreen.

The latest iteration of CALGreen standards was issued in 2019. CALGreen includes minimum requirements for water and energy efficiency, waste reduction and recycling, use of materials that are less polluting, and better indoor air quality.

Defensible Space Inspection Program

Community wildfire preparedness is supported by Monterey Fire's Defensible Space Inspection Program and coordination with surrounding fire prevention organizations to limit fire and wildfire risk through planning, prevention, and mitigation. CalFire's Fire & Resource Assessment Program (FRAP) and Fire Hazard Severity Zone (FHSZ) maps are available online with information on forest assessment, fire severity zones, and defensible space. Monterey Fire personnel have inspected and graded all Carmel parcels as pass, pending, or fail. Grading criteria are evolving as knowledge on fire spread is developed. Current criteria are based on dry fuel accumulation, spark arrestors, and overhanging tree limbs.

Multi-Jurisdictional Hazard Mitigation Plan (2015)

Prepared by: The Monterey County Hazard Mitigation Planning Team with Professional Planning Assistance from AECOM, June 2015

The Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) provides a framework for regional collaboration on hazard mitigation and resilience. The goals of the plan are: (1) To protect life and property by reducing the potential for future damages and economic losses that result from known hazards; (2) To qualify for additional grant funding, in both the pre-disaster and post-disaster environment; (3) To speed recovery and redevelopment following future disaster events; (4) To sustain and enhance existing governmental coordination throughout Monterey County; and (4) To comply with federal and state requirements for local hazard mitigation plans. The MJHMP is currently in the process of being updated. The following City-specific community outreach projects that would improve community and private property resilience were included in the 2016 MJHMP:

Table 3: MJHMP City Community Resilience Actions

Action No.	Description	Priority	Admin. Dept	Potential Funding	Timeframe	Narrative Update/ Explanation
2	Develop a sustained public outreach program that encourages consistent hazard mitigation content. For example, consider publishing tsunami inundation maps in telephone books, wildland fire defensible space tips with summer water bills, and the safe handling and disposal of hazardous waste and chemicals with garbage bills.	High	City Clerk	General Funds, HMGP, and PDM Grants	0-1 years	The City has installed new tsunami warning signs along shoreline areas and beach access points. The City will be revamping its website in the next few years and can add information on hazard mitigation such as wildland fire prevention actions, evacuation routes, and hazardous waste disposal.
5	Develop and provide funding and/or incentives for defensible space measures (e.g., free chipping day, free collection day for tree limbs).	High	Fire	General Funds, HMGP, and PDM Grants	Ongoing	Due to staff and fund shortages, this item has not been implemented. The City has provided, and will continue to provide, inspection, information, and enforcement of fuel management on private property as appropriate.

General Plan Environmental Safety Element (2009)

Adopted by the City Council: 2009

The Environmental Safety Element focuses on reducing human injury, loss of life, property damage, and the economic and social dislocation caused by natural and human-caused hazards. The policies included in this element are intended to provide a framework to address natural and human induced hazards through prevention and emergency response. This element seeks to guide the continuous development of preventative measures that address existing and potential hazards, while also providing contingent emergency response procedures in the instance of a local or regional emergency.

The following issues were identified as relevant to the City of Carmel-by-the-Sea and are addressed in the Goals, Objectives, and Policies and Supporting Information sections.

- Earthquakes
- Landslides
- Drainage/Flooding
- Tsunami
- Fire
- Disaster Preparedness

The following policies from the safety element relate to storms, wildfire, sea level rise, drought, and increased temperatures:

P8-14 Educate the public regarding seismic, geologic, flood, fire, tsunami, and other potential disasters, by preparing periodic news articles for local media outlets, such as Carmel Pine Cone.

P8-16 Encourage property owners to retrofit older structures with fire detection and/or warning systems.

P8-19 Encourage new development located in or adjacent to fire hazard areas to incorporate fire preventative site design, access, landscaping and building materials, and other fire suppression techniques.

P8-20 Control excessive buildup of flammable vegetative material on vacant lots and within and adjacent to high severity fire hazard zones (such as Mission Trails and Pescadero Canyon), especially following wet springs.

c. Opportunities to build on Existing Community Adaptation Strategies:

The following opportunities to build on existing adaptation strategies were identified based on technical expert presentations at Committee meetings (Appendix B) and from the review of previous reports:

- Update City Planning guidelines to reflect and/or not conflict with current California codes (CBC Chapter 7 & CRC R337) in the Very High Fire Hazard Severity (VHFHS) Zone.
- Incorporate defensible space design in landscaping guidelines.

- Collaborate with Monterey Fire on its inspection and outreach efforts to reduce fire risks. Help spread information at critical times to increase resident awareness and knowledge of how to reduce wildfire risk and prepare for emergencies.
- Evaluate the feasibility of gaining Firewise Community Certification in Carmel-by-the-Sea.
- Consider updating the General Plan's Safety Element policy P8-17 to include "move or remedy existing" utilities in high severity fire hazard zones.
- Review and publicize the evacuation plan for the community in the event of a wildfire or other disaster.

Utilities

a. Water Supply

Integrated Regional Water Management Plan

The Monterey Peninsula, Carmel Bay, and South Monterey Bay Integrated Regional Water Management Plan (IRWMP) was updated in 2019. Integrated regional water management in California is established as a way to increase regional self-sufficiency by encouraging local water resource managers to take a proactive role in solving water management problems through collaboration with stakeholders to create innovative strategies and effective actions to achieve water management objectives. The Monterey Peninsula Regional Water Management Group (RWMG), the body responsible for the development and implementation of the IRWM Plan, includes 17 local agencies and organizations, including the City. The Monterey Peninsula IRWM Plan region is approximately 350 square miles and includes the coastal cities of Carmel-by-the-Sea, Del Rey Oaks, Monterey, Pacific Grove, Sand City, and Seaside. Also included are the unincorporated portions of Monterey County in Carmel Valley, Pebble Beach, the Carmel Highlands, the Laguna Seca area, and a portion of the Ord Community.

The IRWMP has the following prioritized regional objectives, which support climate change resilience:

- Improve regional water supply reliability through environmentally responsible solutions that promote water and energy conservation. Protect the community from drought and climate change effects with a focus on interagency cooperation and conjunctive use of regional water resources.
- Protect and improve water quality for beneficial uses consistent with regional community interests and the RWQCB Basin Plan through planning and implementation in cooperation with local and state agencies and regional stakeholders.
- Ensure that flood protection strategies are developed and implemented through a collaborative and watershed-wide approach and are designed to consider climate change effects and maximize opportunities for comprehensive management of water resources.
- Ensure that erosion management strategies are developed and implemented through a collaborative and watershed-wide approach and are designed to consider climate change effects.

- Develop watershed scale management strategies, considering climate change effects and maximizing opportunities for comprehensive management of water resources.
- Preserve the environmental health and well-being of the Region's streams, watersheds, and the ocean by taking advantage of opportunities to assess, restore and enhance these natural resources when developing water supply, water quality, and flood protection strategies. Seek opportunities to conserve water and energy, and adapt to the effects of climate change.
- Adapt the region's water management approach to deal with impacts of climate change using science-based approaches, and minimize the regional causal effects related to water resources.
- Identify an appropriate forum for regional communication, cooperation, and education. Develop protocols for encouraging integration and reducing inconsistencies in water management strategies between local, regional, State, and Federal entities.

The IRWMP identified the high priority adaptation strategies included in Table 3 below. Additionally, within the City of Carmel-by-the-Sea, the following three projects were submitted as concept proposals for inclusion in the IRWMP and potential future grant funding:

- **Carmel-by-the-Sea Pilot Wet-Dry Weather Diversion Program:** The goal of this project is to capture and treat runoff to substantially reduce the pollutants that enter the Carmel Bay Area of Special Biological Significance (ASBS). This project proposes to install a diversion facility at the City's 4th Avenue and Ocean Avenue storm drains, which capture most of the residential areas on the north side of the City and the downtown area. These diversion facilities would capture dry weather, first flush and small storm runoff from approximately 170 acres (approximately 50% of the City's watersheds that drain directly to the Pacific Ocean at Carmel Beach). Runoff captured would flow to the sanitary sewer collection system and ultimately to the Carmel Area Wastewater District's Wastewater Treatment Plant where the water would be treated and beneficially reused for irrigation of landscape at the Pebble Beach property.
- **Forest Hill Park Creek Restoration**: The goal of this project is to reduce erosion of the drainage channel that flows through Forest Hill Park on the north side of the City of Carmel-by-the-Sea and provide sediment capture to improve water quality flowing to the Carmel Bay ASBS from the City's largest watershed. The restoration would consist of rerouting and stabilizing the creek channel, which is eroding and impacting tree roots, slopes and nearby pedestrian walkways. Reducing sediment loads that flow into the storm drain system and to Carmel Bay from the City will also reduce heavy metals that bind to sediments such as lead and particulate copper.
- **Park Branch Library-Devendorf Rainwater Capture**: The goals of this project are to harvest and use dry weather flows and storm water from the Park Branch Library site for irrigation of neighboring Devendorf Park. This project also proposes to install permeable pavement at the Park Branch Library to allow storm water to infiltrate into the ground instead of running off in the street. This project could be integrated with the proposed Sixth Avenue / Devendorf Park Plaza.

Table 4: IRWMP High Priority Climate Adaptation Strategies

ADAPTATION RESPONSE STRATEGIES TO THE EFFECTS OF CLIMATE CHANGE		
Climate Change Effects	**Adaptation and Response Strategies**	**Initial Actions**
Rangelands are expected to be drier	Prepare fire reduction strategies to protect watershed lands using ecologically sustainable strategies. Implement adaptation strategies to conserve California's biodiversity.	N/A
Domestic landscaping water needs will be higher	Integrate land use and climate adaptation planning	Education Incentive programs Demonstration programs Grey water Xeriscaping Expand water supplies (purple pipe) and storage Aquifer management
Decrease in local rainfall	Promote community resilience to reduce vulnerabilities: Food sustainability Implement water conservation and supply management efforts Manage watersheds, habitat, and vulnerable species	Education Incentive programs Demonstration programs Grey water Xeriscaping
Sea level rise and higher groundwater extraction will lead to increased rates of seawater intrusion	Prepare a regional sea level rise adaptation strategy Promote working landscapes with ecosystem services Integrate land use and climate adaptation planning	Education Incentive programs Demonstration programs Grey water Xeriscaping Expand water supplies (purple pipe) and storage Aquifer management Expand agriculture water conservation programs

Adaptation Response Strategies To The Effects Of Climate Change		
Climate Change Effects	**Adaptation and Response Strategies**	**Initial Actions**
Droughts will be more frequent and severe	Implement adaptation strategies to conserve California's biodiversity. Educate, empower, and engage citizens regarding risks and adaptation Integrate land use and climate adaptation planning Promote community resilience to reduce vulnerabilities	Human safety response Education Incentive programs Demonstration programs Grey water Xeriscaping Expand water supplies (purple pipe) and storage Aquifer management Expand agriculture and urban water conservation programs
Lower seasonal surface flows can lead to higher pollutant concentrations	Manage watersheds, habitat, and vulnerable species	Minimize non-point source pollution Buffers
Changes in storm intensity will increase sediment loading in many systems	Prepare fire reduction strategies to protect watershed lands using ecologically sustainable strategies	Erosion control on farms and creeks Buffers
Channel stability will be impacted from higher storm flows causing additional turbidity	Provide guidance on protecting critical creek/river ecosystems and development	Erosion control on creeks Wastewater and stormwater infrastructure vulnerability analysis
Sea level rise will impact current estuary brackish water interface towards more marine systems	Implement adaptation strategies to conserve California's biodiversity	Retain freshwater in watershed Habitat migration Buffers Erosion control
Regional levees will provide less protection during higher storm flow events	Support essential data collection and information sharing Manage watersheds, habitat, and vulnerable species Prepare a regional sea level rise adaptation strategy	Refurbish or expand levees or tide gates (upgrade priority infrastructure) Map/inventory infrastructure

Adaptation Response Strategies To The Effects Of Climate Change		
Climate Change Effects	**Adaptation and Response Strategies**	**Initial Actions**
Natural creeks throughout the region and managed conveyance within the Carmel Valley will see higher flow rates leading to increased erosion and flooding	Manage watersheds, habitat, and vulnerable species	Refurbish or expand levees or tide gates(upgrade priority infrastructure) Map/inventory infrastructure
Coastal levees and control structures will be undersized to manage the combined influences of higher flow events and sea level rise	Support essential data collection and information sharing Prepare a regional sea level rise adaptation strategy	Refurbish or expand levees or tide gates(upgrade priority infrastructure) Map/inventory infrastructure/levee locations and WCS, ownership Phase II task 5 activity 3 - ecosystem services - be aware of services available Elevations of levees and sea walls - maybe with PWA-management strategies USGS elevation data
State recommendations suggest no new critical facilities be built within the 200-year flood plain(DWR 2008, DWR 2009b, CNRA2009)	Integrate land use and climate adaptation Planning	Work with Monterey County and cities, Coastal Commission (local jurisdiction)
Migration patterns and species distribution will change	Establish a system of sustainable habitat Reserves	Reduce migration impediments (dams, etc.) Compile data on species distribution Primary focus species - amphibians, waterfowl, salmonids, redwoods, tide water gobies Maintain habitat corridors - contiguous areas Fish and Game - wildlife adaptation plan - vulnerability for key species for each region
Invasive species populations will expand	Habitat/ecosystem monitoring and adaptive management	What are the invasive species and their ranges? Will they expand, be introduced? How are the habitats shifting (awareness)? Ecological adaptation investigation and strategy

Adaptation Response Strategies To The Effects Of Climate Change		
Climate Change Effects	**Adaptation and Response Strategies**	**Initial Actions**
Coastal wetland systems are especially vulnerable to the combined influences of climate change	Establish regional policies to protect critical habitats Provide guidance on protecting critical coastal ecosystems and development	Identify critical habitats and ecosystems Integrate ecosystem management Regulatory mechanisms dedicated to protecting future locations of these areas Inventory of wetlands currently
Some locally unique species such as coastal redwoods and giant kelp are susceptible to changes in certain locally favorable climate variables (fog duration, coastal upwelling)	Manage watersheds, habitat, and vulnerable species	Identify how they will be impacted - What are the changes? USGS study outcome - get a better handle on modeling fog changes in climate change

b. Wastewater

Carmel Area Wastewater District Sea Level Rise Study

CAWD conducted a Sea Level Rise study for their wastewater treatment facility in 2018. According to CAWD's study, the sea level rise projections do not identify new hazards to the WWTP of greater concern than the 100‐year flood risks that CAWD has previously planned for. However, increased storm intensities as well as higher sea levels may increase the base flood elevations. According to the study, increased storm intensity, as well as sea level rise, will not detrimentally effect the CAWD WWTP before the year 2062 under the "Extreme Risk Aversion" scenario. The study also identified facility retrofits needed to maintain operations of essential infrastructure. This will allow for 40 years of continued operation in the existing location while evaluating options of future improvements to increase flood resiliency vs. relocating the WWTP. Long term options for the facility seem to be:

- Retreat up Carmel Valley
- Pump to Monterey One Water

c. Opportunities to build on Existing Utilities Adaptation Strategies:

The following opportunities to build on existing adaptation strategies were identified based on technical expert presentations at Committee meetings (Appendix B) and from the review of previous reports:

- Provide information and incentives for residential water use reduction.
- Incorporate the Carmel projects included in the IRWMP into the City's 5-year CIP. Seek potential regional or State funding for projects.

Infrastructure

a. Local Infrastructure

General Plan Environmental Safety Element (2009)

Adopted by the City Council: 2009

The Environmental Safety Element focuses on reducing human injury, loss of life, property damage, and the economic and social dislocation caused by natural and human-made hazards. The following policies from the safety element relate to local utilities and infrastructure resilience to storms, wildfire, sea level rise, drought, and increased temperatures:

P8-7 Ensure that water, gas, and sewage utilities serving critical facilities are in good condition and are engineered to withstand damage from disasters.

P8-17 Avoid and discourage locating public structures and utilities in high severity fire hazard zone.

P8-18 Ensure adequate water supply for fire emergencies.

P8-30 Reduce flooding hazards in areas with flooding potential by improving drainage and minimizing the alteration of natural drainage and natural protective barriers that accommodate or channel floodwaters.

Multi-Jurisdictional Hazard Mitigation Plan (2015)

Prepared by: The Monterey County Hazard Mitigation Planning Team with Professional Planning Assistance from AECOM, June 2015

The following City-specific infrastructure and utility projects were included in the 2016 Multi-Jurisdictional Hazard Mitigation Plan:

Table 5: MJHMP Infrastructure and Utility Resilience Actions

Action No.	Description	Priority	Admin. Dept	Potential Funding	Timeframe	Narrative Update/ Explanation
1	Identify hazard-prone critical facilities and infrastructure and carry out acquisition, relocation, and structural and nonstructural retrofitting measures as necessary.	High	Planning and Building	HMGP and PDM Grants	Ongoing	The City has retained an engineering firm to assist in project management of Public Services Department hazard evaluation. The City will also be retaining an engineering consultant to evaluate the City's revetments and other shoreline protection structures in the next year or two.
4	Continue to conduct current fuel management programs and investigate and apply new and emerging fuel management techniques.	High	Fire	General Funds and PDM Grant	Ongoing	The City has provided for fuel management on City owned lands and will provide that service annually. Staff will explore the use of goats as a new method to do this work to improve the fuel management in steeper terrain areas.
6	Work with the Utility Companies (especially PG&E) to build and strengthen relationships to improve communication regarding emergency situations and develop an emergency response plan that includes all emergency responders and 911 communications.	Priority / Moderate	Public Safety/PD	General Funds	Ongoing	New action for 2014-2019.

b. Storm Drainage System

Storm Drain Master Plan (2020)

Prepared by: Schaaf & Wheeler for the City

The Storm Drain Master Plan was completed in 2020. The master plan identifies current system capacity, condition, and maintenance issues. The master plan also identifies 17 projects to restore the system's ability to handle a 10-year 24-hour storm without localized flooding in various locations in the City. The projects are shown on the map below (Figure 4) and listed, with cost estimates in Table 6. Modeling of a 16% increase in storm intensity that could be associated with Climate Change showed that, with the system upgrades outlined in the plan, most of the system could handle the increased storm intensity, with some localized flooding in Mission Trail Nature Preserve, the northeast part of the City, the 4th Avenue drainage, and the southwest near Santa Lucia Avenue. There is greater risk for flooding for larger storms as the city's drainage system was only designed for 10-year, 24-hour storms.

Figure 4: Map of Storm Drain Master Plan Projects

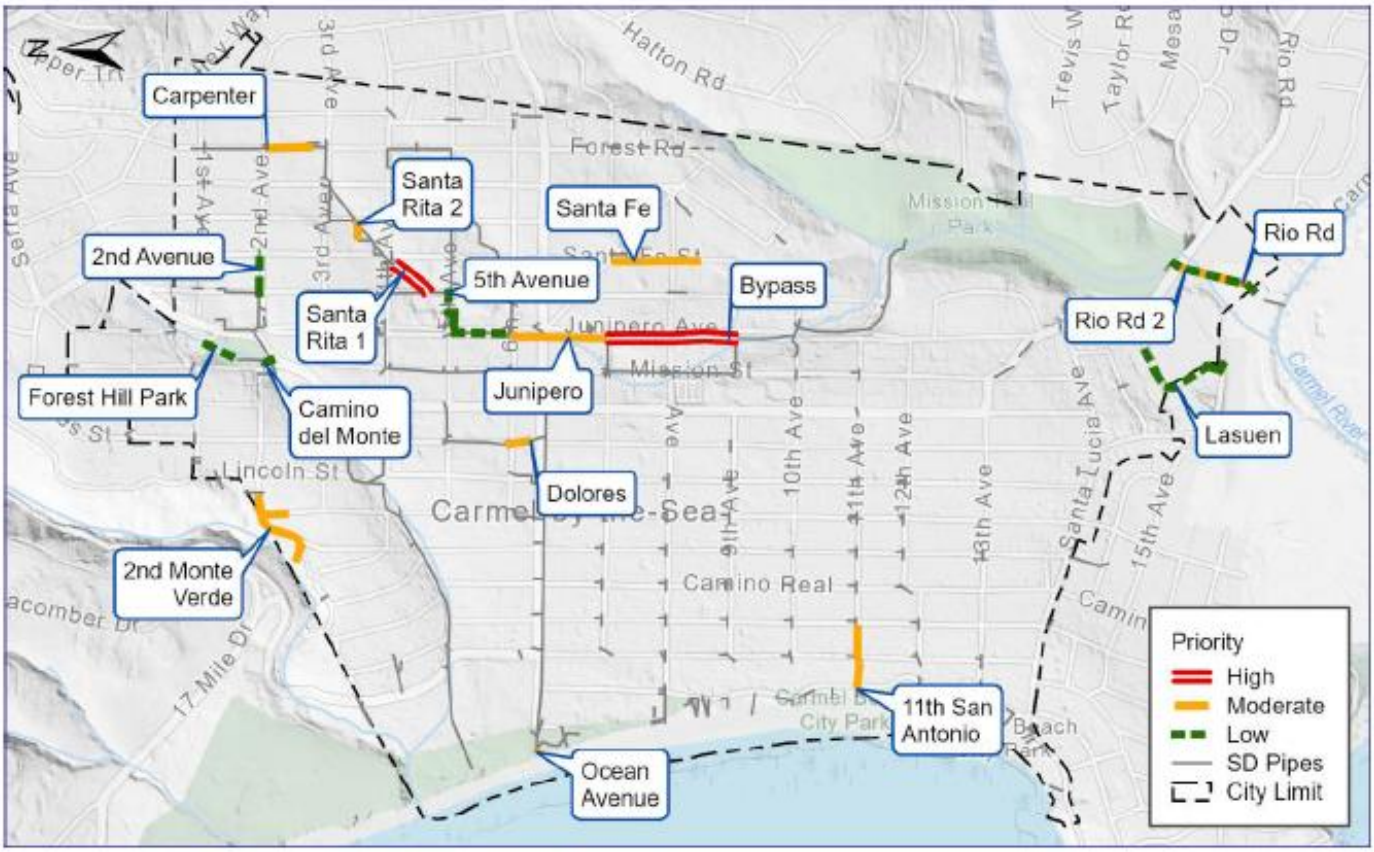


Table 6: Storm Drain Improvement Projects

Priority	Asset Name	Estimated Cost[1]
High Priority	Mission Street Bypass	$820,000
	Forest Hill Park – Emergency Repair	$130,000
	Santa Rita 1	$220,000
	High Priority Total	**$1,170,000**
Medium Priority	Junipero	$800,000
	Rio Road 1	$2,420,000
	Santa Rita 2	$170,000
	Ocean Ave	$250,000
	Santa Fe	$490,000
	Carpenter	$270,000
	11th and San Antonio	$400,000
	2nd and Monte Verde	$830,000
	Forest Hills Park - Realignment	$700,000
	Medium Priority Total	**$6,330,000**
Low Priority	2nd Avenue	$150,000
	5th and Junipero	$660,000
	Mission Trail Preserve Projects	$940,000
	Camino del Monte	$30,000
	Dolores	$20,000
	Rio Road 2	$140,000
	Lasuen	$460,000
	Low Priority Total	**$2,400,000**
Grand Total		**$9,900,000**

[1]Includes Contingencies (40%). 2020 Construction cost only. Construction cost includes mobilization, traffic control, trench, and surface restoration. Does not include costs associated with permitting, land acquisition, or other unforeseen special circumstances.

Implementation Status: *Initiated*. Staff is seeking funding to design and construct some priority repairs. Implementation included in the City's 5-year Capital Improvement Plan.

c. Shoreline Access and Protection Infrastructure

Shoreline Management Plan (2003)

Prepared by: David Shonman and Greg D'Ambrosio
Accepted by the City Council: September 2003

The Shoreline Management Plan provides an overview of the many resources of the Carmel coastline and management policies for long-term maintenance and enhancement of coastal resources. The Shoreline Management Plan includes information on erosion processes along the shoreline and the City's existing shoreline protection structures. A long-term coastal bluff erosion analysis was conducted by Johnson (1984), who analyzed aerial photographs from 1908 to 1983, and indicated that the coastal bluff was eroding at an average rate of 0.4 feet/year in the north and 0.3 to 0.7 feet/year in the southern portion. Aerial photograph analysis indicated some periods of extreme bluff erosion, including the loss of at least 20 feet of bluff near 13th Avenue and near Martin Way between 1968 and 1970.

Approximately 50% of the City's shoreline protection structures are seawalls. Most of Carmel's seawalls have held up well over the years. One seawall built in 1978 failed, apparently due to poor design. Since 1978, the City has used rock revetments to protect nearly one quarter of its shoreline.

Shoreline Management Plan Policies supporting sea level rise adaptation:

- Pursue scientific studies that document physical processes occurring at Carmel Beach (e.g. sediment transport, sand bar dynamics, influences from the Carmel Bay offshore canyon).
- Limit development along the Carmel shoreline to facilities that support passive and active recreational activities, beach access, bluff protection and protection of infrastructure. Bluff protection and protection of infrastructure shall be permitted only when required to protect existing structures that are in danger from erosion.
- Discourage any further incursion of recreational activities into the North Dunes habitat. Sensitive resources in the North Dunes habitat area shall be protected.
- Protect the fragile dunes and sensitive plants in the Del Mar Dunes and North Dunes against any significant disruption of habitat values.
- Maintain records of sand moved and the volumes needed to cover each revetment. When revetments fail or need to be substantially reconstructed, consider vertical seawalls as an alternative.
- Construct new shoreline armoring in areas previously unprotected only when required to protect existing structures in danger of erosion and when designed to eliminate or mitigate adverse impacts on local shoreline sand supply.
- Obtain and maintain an accurate digitized map of the Carmel shoreline to develop the City's beach management and maintenance policies. Analyze historic beach trends using aerial photo analysis and other available tools. Update topographic information at least every 5 years and analyze shoreline changes to facilitate early identification of erosion hot spots, sand losses/gains, migration of revetments, and other long-term impacts.
- Place a series of permanent surveyed benchmarks inland of the bluffs running the length of Carmel Beach for long-term monitoring.
- Protect public access, Scenic Road, and the aesthetic character of the coast be maintaining existing seawalls and engineered revetments. When any existing seawalls or revetments need to be replaced or substantially reconstructed, review other beach management strategies and

determine the best balance among objectives for access, aesthetics, and protection of coastal resources. Protect the natural character and features of the Del Mar and North Dunes by prohibiting the construction of any new shoreline protective structures unless required to protect existing structures in danger of erosion.

- Sand and bluff profiles shall be surveyed in 2003 and 2005 to establish a baseline. Thereafter, a set of sand profiles shall be taken at five-year intervals, beginning in 2010 to establish an on-going record of shoreline trends on Carmel's beaches and bluffs. For each set of profiles, measurements shall be taken at mid-winter (lowest sand level), at spring (prior to sand redistribution activities), at early summer (after sand redistribution), and in the early fall (before offshore retreat).
- After each 5-year period of monitoring beach sand elevations, review available data to make preliminary determinations on the effects of seawall structures and sand redistribution activities.
- If data indicate that the beach has been losing sand over time, investigate options for beach nourishment using offshore deposits or other sources matching Carmel Beach sand.

Geotechnical Inspection of Carmel Beach Shoreline Improvements (2016) and 2016 Shoreline Assessment Update

Inspections of the City's shoreline infrastructure were conducted in the winters of 2015 and 2016 by Easton Engineers. The inspection noted that the shoreline improvements were in acceptable condition with relatively minor repairs required. The Inspection results included the recommendations shown below in Table 7. Additional recommendations were included in the 2016 Shoreline Assessment Update and are included in Table 8.

Table 7: Recommendations from the Geotechnical Inspection of Carmel Beach Shoreline Improvements (2016)

Location	Recommendation
4th Avenue Outfall	Replacement of the outfall structure should be considered in the next few years, with a focus on how drainage can be appropriately released in a non-erosive manner. Additional recommendations: Prevent public access atop the structure and inspect the outfall structure when the beach is scoured and the structure's base is exposed.
10th Avenue Stairs Retaining Wall and Revetment	Settled portions of revetment should be restacked. Stairs, walls, and and revetments should be inspected when the beach is scoured.
10th Avenue Retaining Wall	Wall footing appears in good condition. Inspect when the beach is scoured.
Revetment south of 11th Avenue Stairs	Downcoast third of the revetment should be monitored. Additional large rip rap should be added to the downcoast third of the revetment and this portion keyed into bedrock and restacked to a more stable configuration.

Unprotected bedrock at 12th Avenue outfall	Inspect location when the beach is scoured so the base of the bluff is exposed. To protect the base of the bluff from undercutting, rip-rap revetment may be extended downcoast to a point just beyond the storm drain outfall.
Cove North of 13th Avenue Point	The wall's footing and repaired areas should be monitored and infilled with concrete as needed to help prevent further undermining. Remaining undercuts should be filled. Where constructed on potentially unstable material, the footing of the retaining wall should be underpinned. Restack fugitive rip-rap.
Retaining wall just north of 13th Avenue Point	Footing is significantly undermined and should be protected from further erosion by restacking the seaward revetment or constructing a deepened footing.
Rip-rap at Santa Lucia Stairs	The blufftop should be monitored for continued signs of erosion. The toe of the revetment should be monitored when the sand is scoured.
Seawalls between Santa Lucia & Martin Way	Wall segment A footing should be protected from further undermining by constructing a deepened footing or a rip-rap revetment across the areas of concern. The undercut, exposed portions of the footing should at a minimum be infilled with structural concrete to prevent further undermining. A deepened footing along the entire A through F wall segments will improve the stability and longevity of the walls. Alternatively, a rip-rap revetment along the base of the walls will help prevent continued undermining.
Martin Way Stairway	A concrete pedestal or piers should be constructed at the base of the stairs to support the stairs.

Table 8: Recommendations from the 2016 Carmel Shoreline Assessment Update

Location	Recommendation
Revetments: Unstable Rip Rap	Carmel's shoreline revetments should be regularly monitored (especially after the end of the storm season); perched riprap should be re-stacked and exposed revetments covered with redistributed sand whenever feasible.
Revetments: Migrated Riprap (12th & 13th Ave. Coves)	The re-stacking of migrated riprap should be conducted the next time conditions allow. This will best be accomplished if conducted during low sand conditions. Such work has been conducted in the past, but usually during periods of significant sand scour, a condition that is often accompanied by strong waves and a narrowing of Carmel Beach. This operation should be conducted with the advice of a qualified geotechnical specialist. It should be planned in advance so that all necessary preliminary steps (including funding, permits, and contracts) can be in-place of ahead of time, increasing the chances that it will be completed before the high sand level returns.
Stairways: general	The extensive list of stairway repairs recommended in the Graebe report (dated March 2, 2015) should be addressed as soon possible.
Shoreline Landscape Barriers (SLBs)	The Shoreline Landscape Barriers should be redesigned during FY 2016/2017, and rebuilt as soon as feasible. Their design should

Location	Recommendation
	conform with Carmel's design traditions, and the new barriers should be able to be maintained, repaired and replaced by staff. The installation and locations of the new SLBs should be coordinated with the re-surfacing of the Pathway and re-vitalization of the Carmel bluff-top landscape. Because people often trampled landscape vegetation to walk over to the SLBs, it has been suggested that new barriers be placed within 12-18" of the Pathway.
Monitoring Program	An effective monitoring program should be developed to be conducted by City staff as they work along the shoreline. This program would take advantage of the skills of staff as well as their familiarity with the Carmel shoreline. If done correctly, it will encourage staff to report conditions that are not necessarily in their direct area of responsibility. Asking staff to be alert for conditions of concern as they work along the shore would serve as a "force multiplier," greatly expanding the City's ability to address conditions at an early, more manageable, stage.
Stairway Closures	To protect the safety of those who use Carmel's shoreline stairways, the City should employ effective methods for closing these access ways when conditions warrant. Such methods should involve physical barriers, clearly worded signage and enforcement. City staff should also focus on re-opening the stairways to public use, once safer conditions return.

Implementation Status: *Partially initiated.* Public Works closes stairways to the public when hazardous conditions exist. Essential repairs to the stairs have been made. A landscape design was created and approved by the Planning Commission that incorporated restoration of the shoreline landscape barriers.

d. Regional Infrastructure

Climate Change Vulnerability Assessment Summary Report: Caltrans District 5 (2019)

Prepared by: Caltrans

Caltrans' District 5 incorporates the Counties of Monterey, Santa Cruz, San Benito, San Luis Obispo, and Santa Barbara. The Summary Report presents information on potential vulnerabilities to the Caltrans District 5 portion of the State Highway System (SHS), including climate stressors and their potential effects on how highways are planned, designed, built, operated, and maintained. Identified vulnerabilities are summarized below:

- Higher temperatures:
    - Higher temperatures could cause expansion that deteriorates bridge joint seals, which could accelerate replacement schedules, and even affect bridge superstructure.
    - Extreme heat could affect employee health and safety, especially for those working long hours outside.

    - High temperatures for extended periods could increase the need for protected transit facilities along roadways.
    - Right-of-way landscaping and vegetation must be able to survive longer periods of high temperatures.
    - Pavement quality will be affected by long-term temperature changes
- Wildfires:
    - Much of the SHS lies within high fire hazard zones.
    - Maintenance issues associated with wildfires for the SHS include: increased erosion and runoff, increased landslide potential, debris blocking culverts and bridges during rain events, destruction of signs and guardrails, damage to culverts and bridges
- Sea Level Rise:
    - SHS impacts from sea level rise are expected to be significant in Monterey County. Significant impacts of combined sea level rise and storm surges to Highway 1 are expected in the low-lying areas between Moss Landing and Castroville, and south of Carmel-by-the-Sea where the highway crosses the mouth of the Carmel River. Additionally, cliff erosion is expected to impact Highway 1 in Big Sur.

Additionally, Caltrans will need to consider the role of the SHS during a disaster when planning for climate change. The SHS is the backbone of most county-level evacuation plans and often provides the only high-capacity evacuation routes from rural communities. State highways also serve as the main access routes for emergency responders, and may serve as a physical line of defense such as a firebreak, an embankment against floodwaters, etc. As climate-related disasters become more frequent and more severe, this aspect of SHS usage will assume a greater importance that should be reflected in highway design.

e. Opportunities to build on Existing Infrastructure Adaptation Strategies:

The following opportunities to build on existing adaptation strategies were identified based on technical expert presentations at Committee meetings (Appendix B) and from the review of previous reports:

- Determine the feasibility of undergrounding power lines in Mission Trail Nature Preserve and in priority transportation corridors in the VHFHZ
- Upsize SDMP improvements, especially when making repairs in the lower reaches of watersheds, to handle larger storms.
- Consider incorporating green infrastructure in street and sidewalk projects to reduce runoff volumes into the City's storm drain system.
- Earmark CIP funding for design, permitting, and implementation of storm drain repairs. Include strategies in 2021 MJHMP for potential regional funding.
- Reinstate beach sand monitoring program described in the Shoreline Management Plan.
- Implement structural monitoring program and do follow-up monitoring post-storm to identify additional footing stability issues.

- Earmark CIP funding for design, permitting, and implementation of repairs. Include strategies in 2021 MJHMP for potential regional funding.
- Reach out to local researchers (e.g. CSUMB) or other sources to conduct Carmel Cove sand supply dynamics analysis.
- Hire a coastal engineer with experience in planning for climate change to conduct:
    - Further assessment of the risks to our coastal assets, including sea walls, revetments, bluffs, stairs and access, public bathrooms, parking areas, drainage infrastructure, and utilities.
    - Determine adaptation measures and LCP policy options.
        - Prioritize adaptations and projects that protect and maintain public resources and beach access, and the viability of the community and tourism.
        - Determine how the options and strategies along the coast are different for the:
            - Mostly natural, unarmored North Dunes area
            - Mostly armored bluffs along Scenic Road south of 8th Avenue
            - Unarmored dunes along private property between 8th Avenue and Del Mar Parking Lot
            - Armored private properties on the bluffs at the north end of the City (Pescadero Canyon area).
        - Evaluate feasibility and phasing, the use of thresholds for when different elements of these strategies are implemented. For example, maintaining armory or other defenses up to a point, but then if a threshold is reached, embracing a new bluff line and different adaptive measure.
- Update Shoreline Management Plan and LCP based on results of coastal engineering analysis.
- The City has an opportunity in 2021 to provide an updated list of projects to include in the MJHMP Update. The City should include a comprehensive list of projects based on its existing plans, as well as identified gaps in this Vulnerability Assessment.

VIII. Vulnerability Scoring Matrix

The vulnerability scoring matrix incorporates the potential threat of a climate hazard with the existence of current policies to mitigate hazards to vulnerable assets and populations. The matrix provides information to identify and prioritize vulnerable assets and populations that have not yet been addressed by City policies or projects.

Color coding:
- Already causing observable impacts or a near-term significant risk
- Mid- to long-range impacts
- Not enough data

YES Some policy/action initiated
NO No policy/action initiated

Priority Assets at Risk	Priority Hazards						
	Stronger Storms	**Wildfires**	**Sea Level Rise**	**More Droughts**	**Increased Temperature**	**Fog changes**	**Ocean Warming**
Natural Assets							
Mission Trail Nature Preserve	YES	YES	X	YES	YES	X	
North Dunes			**NO**	YES	YES	X	
Urban Forest	YES	**NO**		YES	**NO**	X	
Marine Sanctuary	X			X	X	X	X
Carmel Beach	YES		YES			X	X
Community							
Elderly population and people with disabilities	**NO**	**NO**		**NO**	**NO**		
Residents	YES	YES		YES	**NO**		
Visitors	**NO**	**NO**					X
Local Businesses	**NO**	**NO**	**NO**	YES	**NO**		X
Service industry workers	**NO**	**NO**	**NO**		**NO**		
Second homes	YES	YES	**NO**				
Utilities							
Water Supply		YES	YES	YES	YES		
Sanitary Sewer System	X		YES				
Power Grid	**NO**	**NO**			**NO**		
Overhead communication	**NO**	**NO**			X		

Priority Assets at Risk	Priority Hazards						
	Stronger Storms	Wildfires	Sea Level Rise	More Droughts	Increased Temperature	Fog changes	Ocean Warming
PG&E/communication underground lines (gas, cable)		NO	NO				
Regional Infrastructure							
Wastewater Treatment Facility	YES		YES		X		
Transportation Infrastructure (Caltrans)	YES	YES	YES				
Hospital and emergency medical care facilities	X	X			X		
Landfill & Waste Management	YES		X				
Local Infrastructure							
Shoreline Access Infrastructure: Scenic trail, public restrooms, beach stairs, coastal roadways, and parking	YES		YES		X (visitors)	X	
Seawalls and revetments	YES		YES				
Storm drainage system	YES		YES				
Emergency response facilities (Fire station, EOC, PD, PW, City Hall, etc.)	YES	YES			NO		

IX. Conclusion And Next Steps

The Climate Change Vulnerability Assessment provides the basis for the City to develop a Climate Adaptation Plan by identifying existing hazards, assets and communities at risk, as well as actions that have already been taken that enhance climate change resilience. The Climate Committee should utilize the Vulnerability Scoring Matrix and the list of opportunities to build on existing strategies as a starting point to identify and prioritize potential climate change adaptation strategies.

APPENDIX A

APPENDIX A - Historical Hazards

Data sources for historical hazards include: Monterey County Multi-Jurisdictional Hazard Mitigation Plan (MJHMP), the National Oceanic and Atmospheric Administration (NOAA) Storm Events Database, and historic records at the Carmel Library

Disaster Type (Storm, drought, wildfire, heat event)	**Date**	**Location**	**Local Impact**
Storm	Winter of 1982/83	Monterey Peninsula	El Niño winter. During this period, severe winter storms struck Carmel every 10 days. More sand was removed from the beach than at any previous time in the memory of long-term residents or documented history. Additionally, heavy rains overwhelmed the City's storm drain system. Uncontrolled stormwater flows washed away portions of the City's coastal bluffs and undermined beach access stairways. Between 1983 and 1988, the entire Scenic Road storm drain system was rebuilt with larger drain pipes and catch basins, and moving outfalls to less erosive locations. Johnson (1984) recorded several areas of significant erosion during the 1982/83 winter: - Loss of 20 feet of bluff north of 8th Avenue, - Loss of 25 feet of bluff between 10th and 11th Avenues, - Loss of 30 feet of bluff between 8th and 9th Avenues, - Loss of 30 feet of bluff near Santa Lucia Avenue, - Loss of 40 feet of bluff between 9th and 10th Avenues.
Wildfire	July 1987	Pebble Beach/Carmel	The fire that rushed up a canyon and destroyed 32 homes in Pebble Beach on May 31 was fueled by acres of dead underbrush and thick stands of trees, according to a forester who toured the area Thursday . Bill Ruskin, a vegetative management coordinator with the California Department of Forestry and Fire Protection in Felton, said after the tour: "It was a situation that was waiting to happen." Ruskin described the devastated residential area as one located in a "perilous" position, on top of a box canyon containing an "incredible number of stems per acre — about 200 to 300 per acre." Fanned by strong winds and funneled by steep terrain, the fire raced up the canyon as it burned dense underbrush and released gases that ignited above the tree crowns, creating a "crown fire" effect, Ruskin said. Ruskin collected fuel data in Del Monte Forest to simulate the path of the fire in a computer model. He said results would not be available until later this summer. "It may or may not verify whether the response should have been different," Ruskin said. In the computer model, Ruskin said, he will be able to use fuel data, topography and weather conditions to determine ways to manage the forest and devise ways to fight further fires in the area. As for the disastrous Sunday afternoon when heat from an illegal campfire ignited pine needles and set off the tragic chain of events,

			leaving 49 people homeless, Ruskin said the heat was so intense from the fire that houses began burning just from the radiated heat instead of flames. "The point is that you had so much heat going up that canyon," said Ruskin, 36, who has been a forester with CDF for five years and received a forestry management degree from the University of California at Berkeley. The point of origin of the fire has been determined as being on forested property owned by Pebble Beach Co. and adjacent to the Morse Botanical Reserve. Notified of Results The property was surveyed Tuesday by Pebble Beach Co., which notified the Del Monte Forest Foundation, owner of the botanical reserve, of the results in a letter this week. Ruskin said that dead materials, including fallen limbs and pine needles, burned the thickly packed Monterey pine trees and sent gases above the ground smoke to be fanned by oxygen and winds. The intense gaseous fire created "radiated and convected" heat that spared few of the homes." Only the houses made of stucco and not having wood on the outside and one with double-pane windows were able to withstand the heat," Ruskin said. "It was not a crown fire in those trees," Ruskin said. "... Flames shooting up and over the trees could very well have been gases going up to meet oxygen in the wind. That's where they were being ignited." In the wake of the fire, Ruskin said, the bad news is that many of the trees in the 160-acre swath cut by the four-day blaze did not survive. However, he said, seeds released by exploding pine cones will regenerate the forest. Alternative Vegetation Ruskin said that as equipment is used to clear trees and brush, now is a good time to consider alternative vegetation — coastal and coyote brush — that would stay succulent throughout a fire season and be less likely to add fuel to a fire. Ruskin added that selective hand-cutting of trees could also be done in forest management. Controlled burns, Ruskin said, can be effective but "it may not be aesthetically desirable from what we learned at Point Lobos." Foresters learned that a controlled burn last October at Point Lobos led to "an unexpectedly high amount of tree mortality." "The Monterey pine is a shallow-rooted tree," Ruskin said. "Even in a controlled burn, you are killing a lot of roots." In addition, Ruskin said, the controlled burn at Point Lobos created "burning pitch pockets," which also weaken trees. "I'm not sure that a prescribed burn is an acceptable management alternative," Ruskin said. Ruskin observed after the tour that the fire appeared to have fed on pine trees 60 to 80 years old and "petered out" in younger trees. Mission Trail Park Ruskin also toured Camel's Mission Trail Park to assess the amount of fuel there that could lead to fire. Ruskin recommended to Gary Kelly, Carmel city forester, that some clearing of brush and fallen trees should take place and that a "pre-suppression plan" should be devised for the park area. Ruskin said that "fire-retardant vegetation" should be planted at the park rather than pine trees. Ruskin said the Mission Trail Park area did not have as much stored fuels as the Pebble Beach area. "He didn't seem to find any major concerns other than cleanup and a pre-fire plan," Kelly said. Ruskin was invited to tour the area by Kelly and Roy Perkins, CDF district fire chief.

Heat Event	April 1988	Monterey Region	Hot temperatures Sunday in the mid-80s in Monterey and into the low-90s in Carmel Valley set weather records for April 10. Monterey's high temperature of 86 degrees at 2 p.m. topped the record of 80 degrees in 1968 for the date, according to Robert J. Renard, observer in Monterey for the National Weather Service. It also marked only the seventh time in 37 years of recordkeeping that the temperature reached 86 or higher during a day in April, he said. There has never been an 86-degree reading recorded in Monterey for January, February and March, he said, and Sunday's high temperature was the third earliest recording of an 86 or higher in a calendar year. Twice in previous years on April 2, the temperature climbed to 86 or above, with 88 and 87, respectively. Sunday's low temperature in Monterey also was a record. The 57 degrees was the highest minimum not only for April 10 but also for this early in the calendar year, Renard said. Meanwhile, in Carmel Valley, where temperatures on hot days are typically up to 10 degrees warmer than Monterey, the high temperature got up to 93 after an early morning low of 51, according to Graham Matthews, who keeps weather records for Carmel Valley. The 93 reading, which set a record for the date, topped the previous mark of 85 degrees set in 1968, Matthews said. Source: Monterey Herald, April 1988
Storm	January 1995	Monterey Region	In January 1995, sustained precipitation fell throughout the region and over 125 residential properties in the Carmel Valley sustained damage. Two months later, Monterey County experienced a second significant winter storm, which resulted in further sustained precipitation falling on already saturated watersheds. Devastating flooding occurred throughout Monterey County, particularly in the unincorporated communities of Castroville, Mission Fields, Carmel Valley, Cachagua, Carmel Highlands, Spreckels, and Big Sur. Over 1,500 residences and 100 businesses were damaged.
Storm	January 10, 1995	Carmel Area	A Monterey County Sheriffs deputy evacuates two elderly residents from their flooded Mission Fields neighborhood home in Carmel on January 10,1995. According to a new study, extreme weather swings — a historic drought followed by drenching winter storms that cause flooding — will become the norm over coming generations. Source: Monterey Herald, April 2, 2018
Wildfire	Oct – Nov 1996	Northern Big Sur	This fire known as the Big Sur fire began Oct 18 near Ventana Camp Park. Much of the fire occurred in the Ventana wilderness area. 2500 Fire fighter participated. 4400 acres were burned. Light rain helped control fire. The cost of fighting the fire is estimated 12.3 million. 180 fire engines were used. 13 helicopters and 3 air tankers were used.
Storm	December 21, 1996	Monterey Peninsula	2.96" of rain in 11 hours at Monterey, Seaside had 2.5"and Marina had 2.12". Streets and intersections were flooded in Monterey, Del Rey Oaks, Pacific Grove, Carmel Highlands, and Carmel. HWY 101 N of Salinas was flooded.

Wildfire	September 1999	Carmel Valley	A surface low off the CA Coast brought tropical moisture and mild instability over the coastal CA are and lightning continued through the night over the entire Central Coast and San Francisco Bay area. Kirk Complex (consisted of Tassajara, Five, Big Pine, Elephant, Lone Pine, Freed, 7, Torre, Devil, Kirk and Hare Fires) Complex was divided into the North and South Components). Cause: Lightning strikes Location: In the Ventana Wilderness approximately 20 miles Southeast of Carmel, CA. Monterey Co. Size: 85,634 acres (as of 10/19/99) Containment: October Fatalities: none Structures Lost: none Cost: $66.9 million (as of 10/19/99)
Storm	January 2008	Monterey Peninsula	Strong coastal storm brought flooding rains, high winds, record high surf and coastal flooding to Monterey County and resulted in nearly $1 million in property damages. Approximately 30 homes in the Carmel Lagoon area were affected by some degree of flooding.
Wildfire	December 2013	Northern Big Sur	The Pfeiffer Fire started on December 17th 2013 around midnight in the vicinity of Pfeiffer Ridge in the Monterey Ranger District of Los Padres National Forest. The fire burned 917 acres. Thirty four (34) residence and 4 outbuildings were damaged/destroyed. The fire was declared contained on December 20 2013 at 6:00 p.m.
Storm	January 8, 2017	Monterey Peninsula	Potent atmospheric river bringing heavy rain, strong southerly winds, and storm surge issues. This AR is following a normal to slightly above normal 3 month period, meaning the grounds were saturated. Three to four feet of standing water at Casa Verde Road and SR 1N.
Storm	February 9, 2017	Monterey Peninsula	A cold front passed over the area Thursday Feb 9. There were strong winds ahead of the front and heavy rains associated with the frontal passage that produced roadway flooding and debris flows.
Storm	February 20, 2017	Monterey Peninsula	Potent AR brought copious amounts of rain to the region causing widespread flooding, debris flow, accidents, and over topping of reservoir spillways. Roadway flooding on Quail Meadows Dr in Carmel Valley. Large section of roadway flooded, vehicles sliding.
Lightning / Wildfire	September 11, 2017	Central Coast/Monterey County	A disturbance rotating around an upper level low west of San Diego brought thunderstorm activity to the Bay Area on September 11. Widespread reports of lightning were received along with a few small hail reports and strong wind gusts. It has been reported that there were over 40,000 lightning strikes across the Central Coast of California during this event. Several brush fires were also ignited due to lightning strikes.

			Various lightning strikes sparked 15 fires in Monterey County that were contained on the same day http://www.mercurynews.com/2017/09/13/crews-contain-15-fires-started-by-lightning-in-monterey-county/. Timing has been estimated.
Storm	November 29, 2018	Monterey Peninsula	A mid/upper level low moved through the region at the end of November. A cool unstable air mass allowed for the development of scattered thunderstorms across the region that produced lightning and small hail. An associated surface low approached the coast during this time causing high surf and gusty winds. Some locations saw wave heights above 25 feet. This system caused roadway flooding, minor debris flows, and downed trees along with damage from gusty winds. Flooding at Hwy1 and Hwy 68.
Storm	January 2019	Carmel/Monterey Peninsula	After a strong cold front brought severe weather to the Central Coast on Wednesday night, the cleanup process began Thursday. Pacific Gas & Electric Co. crews worked to restore power after more than 10,000 Monterey Peninsula customers lost power due to the storm. Power was restored to about half of those without power by early afternoon Thursday and spokeswoman Mayra Tostado said PG&E was aiming to restore power by the evening to customers without any access issues caused by mudslides, flooding or blocked roads…. According to Carmel City Administrator Chip Rerig, a significant trunk line transformer just outside the city blew up, causing a citywide power outage. In Carmel, 12 streets were closed due to trees that fell on electrified wires. City crews began cleaning up the streets after PG&E removed trees touching or adjacent to live wires. "The storm last night hit us hard," Rerig wrote in a post to Carmel's website. "Fortunately there have been no reported injuries to residents, guests, staff, or contractors." The city opened the Carmel Youth Center as a warming center, welcoming residents to stop by and charge their mobile devices and get a cup of coffee or water. Speaking by phone Thursday afternoon, Rerig said city staff worked with PG&E to open up many of the streets that had been closed and explained the city came together overnight into Thursday to respond to the storm damage. "We really had a great concerted effort last night with our police department, our public works, who are fantastic, Monterey Fire (Department), which is our contracted fire services, responded to 1 think 32 calls, we had a series of volunteers, our Community Emergency Response Team and a litany of other staff members," he said. People from Senior Helping Seniors checked in on some of the city's elderly population to make sure they were OK during the outage. The Carmel Unified School District canceled classes and activities at all of its schools for Thursday due to the road closures and power outages but planned on opening its schools Friday. Source: Monterey Herald, Jan 18, 2019
Storm	February 4, 2019	Monterey Peninsula	A mid/upper low with a very cold air mass moved through in early February bringing snow to lower elevation peaks across the region prompting a rare Winter Weather Advisory. Junipero Serra Peak received around a foot of snow. Rainfall just ahead of this

			system also brought roadway flooding and minor debris flows. Carmel River flooding near Mid Valley. SR 1 at Rio Rod culvert is flooding, water going over the roadway.
Storm	November 30, 2019	Carmel	A low pressure system moving in from the Gulf of Alaska and drawing in moisture from the tropics combined to bring the first atmospheric river event of the winter season to the Greater Bay Area. This system brought widespread heavy rainfall, roadway flooding, and strong winds to the region. Rare Storm Warnings were issued over the coastal waters where buoys reported wind gusts in excess of 50 mph. Bay Area peaks recorded wind gusts between 60 to 70 mph with gusts along the Monterey Peninsula and Big Sur Coast at 50 to 60 mph. These winds caused downed trees and power outages across the area. Street at 3438 Martin Rd in Carmel, CA is flooding along with potential flooding at residence as water is being diverted down reporting party's driveway.
Storm	December 3, 2019	Carmel	A low pressure system moving in from the Gulf of Alaska and drawing in moisture from the tropics combined to bring the first atmospheric river event of the winter season to the Greater Bay Area. This system brought widespread heavy rainfall, roadway flooding, and strong winds to the region. Rare Storm Warnings were issued over the coastal waters where buoys reported wind gusts in excess of 50 mph. Bay Area peaks recorded wind gusts between 60 to 70 mph with gusts along the Monterey Peninsula and Big Sur Coast at 50 to 60 mph. These winds caused downed trees and power outages across the area. Carmel River Lagoon rose significantly overnight after 3 to 5 inches of rain fell over the Carmel River Basin. The Monterey OES phoned to say Public Works tried to breach the Lagoon and was unable to do so in time so the surrounding area had to be evacuated due to flooding. Minor Street flooding was observed along 15th, 16th, 17th Ave as well as Carmelo St and Scenic Rd. The unofficial flood stage of the Carmel River Lagoon is 10 ft. The gauge exceeded 10 ft during this time period before the Lagoon was breached and the water level fell dramatically just after 1 am.
Wildfire	August - September 2020	Central Coast, Carmel Valley	A prolonged and oppressive heat wave swept the Central Coast and Bay Area for almost a week from August 14th to August 19th with widespread record breaking temperatures observed across the region. This was caused by a strong high pressure system over the Desert Southwest that expanded westward into California. This dome of heat brought hot temperatures to the area for several days. Multiple days of triple digit afternoon highs were recorded inland with some coastal locations even reaching the mid-90s. Several days of hot and dry weather further dried fuels over the area increasing fire danger. During this event, a surge of monsoonal and tropical moisture from a former Tropical Storm advected northward with sufficient instability to generate multiple high based and dry thunderstorms that produced several thousand lightning strikes over the Greater Bay Area. Many locations saw wind gusts of 40-50 mph with isolated areas seeing gusts of 60-75 mph. This prompted the San Francisco Bay Area forecast office to issue a rare severe thunderstorm warning. These lightning strikes in combination with gusty and erratic outflow winds sparked hundreds of wildfires across the state of California. Several smaller

			fires combined to form complexes some of which are now among the largest wildfires in state history. Most of which were still actively burning at the end of August. Hundreds of thousands of acres have been burned with several hundred structures destroyed as well as a handful of deaths and injuries. Tens of thousands of residents were also forced to evacuate. Additionally, all of these wildfires burning simultaneously across the state gave the Bay Area the worst air quality in the world at one point. Lightning sparked the River Fire in Monterey County on the afternoon of the 16th. Several evacuation orders were issued throughout the month and four people including fire personnel and civilians were injured. Both the River and Carmel Fires caused smoke and ash to rain down on surrounding cities. The River Fire continued to burn through early September. A total of 48,088 acres burned with 30 structures destroyed, 13 damaged, and 4 injuries https://www.fire.ca.gov/incidents/2020/8/16/river-fire/.

Figure E-11. Historic Wildland Fires

Monterey County, California
Multi-Jurisdictional Hazard Mitigation Plan

County Map Scale

1 inch equals 4 miles

0 1 2 4 6 8 Miles

City Inset Map Scale

1 inch equals 1.5 miles

0 0.75 1.5 2.25 3 Miles

Legend

▪ Census Designated Place

Jurisdictional Boundaries
- County Boundary
- City Limits, Monterey County
- National Forest
- Military Reservation

Circulation
- US Highway
- State Highway
- County Highway
- Major Roads
- Local Roads *(City Insets Only)*
- Active Railroad (Union Pacific)

Hydrology (Perennial and Intermittent)
- Lake or Pond
- River, Creek or Tributary
- Artifical Path, Canal/Ditch or Connector

Basemap
Hillshades created from USGS 1" (county-wide) and 1/3" (city insets) National Elevation Dataset.

Fire Perimeters (1911 - 2005)

Fire Occurrence 1986 - 1996
Total Acres Burned
- ● 1 - 30
- ● 31 - 300
- ● 301 - 1000
- ● 1001 - 3000
- ● 3001 - 8850

Data Sources: County of Monterey - GIS Department, URS Corporation, US Geological Survey (USGS), US Census Bureau, University of California Santa Barbara (UCSB), HAZUS-MH MR2, Fire Sciences Laboratory - Rocky Mountain Research Station, Fire and Resource Assessment Program - California Department of Forestry and Fire Protection (CDF-FRAP)

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APPENDIX B

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet for Wastewater Treatment Facility and Associated Underground Infrastructure

September 17, 2020

TO:	Climate Committee Members
SUBMITTED BY:	Jeff Baron, Councilmember

SUMMARY

Asset: Wastewater treatment facility and associated underground infrastructure (CAWD)
Hazards: Sea level rise, Stronger Storms, More variable rainfall
Version: 2

General Comments and Outlook: The Carmel Area Wastewater District treatment facility (and underground infrastructure) will be under increasing environmental pressure as sea level rises and storms (and hence rainfall drainage down the Carmel River watershed) increase in intensity. CAWD's prediction is that the facility will need to be relocated by 2062, which is approximately 40 years in the future. The long term options for the facility seem to be

1. Retreat up the valley
2. Pump to Monterey One Water

Identified Issues:

- Both long term projects are said to be expensive, in the neighborhood of $100,000,000.
- It will take a significant amount of time to make the decision as to which path to take.
- The value (cost) of the current facility (which may have to be abandoned) is approximately $200,000,000
- The lagoon situation will become increasingly precarious as time passes.

Outstanding Issues:

- Do not understand (yet) an overrun scenario if the move is not completed in time. What are the consequences and/or costs if the plant is flooded during an extreme weather event?
- Of lesser visibility but still important are possible mitigation measures required for the CAWD underground and pumping infrastructures, particularly along the coastline.

Possible Committee Comments or Actions for Final Report

- The committee could/should recommend that the Carmel City Council pass a resolution on this topic, ensuring that the city monitors the transition towards a relocated plant, and perhaps has formal, written input into this process. The resolution might:
    - Document the asset and the various hazards
    - Assign staff/council personnel as liaisons to CAWD, with an eye towards resolution of this asset's vulnerability
    - Urge CAWD to take specific actions

REFERENCES

- The CAWD Sea Level Rise Study can found at https://www.cawd.org/2018-sea-level-rise-study
- The CAWD presentation to the Committee: https://ci.carmel.ca.us/sites/main/files/file-attachments/ccc_presentation_v3.pptx?1600365293
- Recording of the September 17, 2020 Meeting at which CAWD presented: https://drive.google.com/file/d/1PZK0tP8b2jB_XoTtBJLPcXmLVEl9kY1Z/view

HISTORY

- Version 1 presented at Committee meeting on 10/15/2020
- Version 2 presented at Committee meeting on 11/19/2020.

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet for the Urban Forest

October 15, 2020

TO:	Climate Committee Members
SUBMITTED BY:	Scott Lonergan, Committee Member

SUMMARY

Asset: Urban Forest
Hazards: Stronger Storms & Wind, More Variable Rainfall, Increased Temperature, Wildfires
Version: 1

General Comments and Outlook:

- Carmel-by-the-Sea's upper canopy trees impart a distinctive ambiance and identify to the City, and provide several climate adaptation benefits including reducing urban heat island effect, capturing stormwater runoff, improved air quality, and sequestering carbon
- Increased transpiration and water demand, coupled with less consistent water availability as a result of fewer, larger storms, and reduced fog, is increasing tree stress
- Tree species selection and density is a 50 to 100-year decision with implications for 1) tree resilience and ecology, 2) aesthetics, and 3) safety and maintenance cost

Identified Issues:

- Our urban forest lacks age and species diversity and is currently showing signs of stress.

Remaining Issues to be Understood:

- Urban forest consideration as part of Action Plan e.g. carbon capture, walkability and desirability of the environment

Possible actions to be recommended in the committee's Final Report

- Update the CBTS Forest Management Plan, including a public process to determine tree canopy species and density objectives, and a process for ongoing monitoring and plan review.

REFERENCES

- CBTS Forest Management Plan: https://ci.carmel.ca.us/sites/main/files/file-attachments/forest_management_plan_0.pdf?1510272614
- Sara Davis, City Forester 15-Oct-2020 Climate Change Committee presentation video: https://carmel.novusagenda.com/agendapublic/VODPreview.aspx?meetingVideoID=898ec714-3a25-42a8-ae8f-2441cf4c1440&index=329
- Canopy.org including the 16-Jul-2020 Resilient Trees for a New Climate webinar, including presentations from Igor Lacan, and Dave Muffly: https://canopy.org/more-trees-please/

History

- Version 1 presented at committee meeting on 11/19/2020
- Sent for comments to Sara Davis (City Forester) on 11/10/2020

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet – Community Wildfire Preparedness

October 15, 2020

TO:	Climate Committee Members
SUBMITTED BY:	John Hill, Committee Member

SUMMARY

Asset: Public and Private Property, Public Safety
Hazards: Local Fires and Wildfire damage due to accumulated dry fuel & increasing wind and weather events.
Version: 1

General Comments and Outlook: The severity of fires and wildfires in California continues to increase in intensity and occurrence. California had low intensity fires until the logging of old growth forests, the introduction of grazing and invasive grasses, indigenous burning was replaced by fire suppression, and urban sprawl invaded the wildland areas. Community wildfire preparedness is supported by Monterey Fire's Defensible Space Inspection Program and coordination with surrounding fire prevention organizations to limit fire and wildfire risk through planning, prevention, and mitigation. Monterey Fire and the Carmel Public Works Department have working relationships with the Pebble Beach Services District for fire mitigation in Pescadero Canyon, and partner with the Friends of Mission Trail Nature Preserve for fuel reduction in Mission Trail Nature Preserve. CalFire's Fire & Resource Assessment Program (FRAP) and Fire Hazard Severity Zone (FHSZ) maps are available on line with information on forest assessment, fire severity zones, and defensible space. Monterey Fire personnel have inspected and graded all Carmel parcels as pass, pending, or fail. Grading criteria is evolving as knowledge on fire spread is developed. Current criteria is based on dry fuel accumulation, spark arrestors, overhanging tree limbs, etc.

Identified Issues:

- Some northern and eastern areas within City limits are within the Very High Fire Hazard Severity and Wildland Urban Interface (WUI) Zones.
- Some areas within the City limits and adjacent communities have accumulated fuel levels as well as overhead infrastructure (i.e. Mission Trail Park) that present fire and wildfire risks.
- An integrated approach to fire resilience in the landscape along with hardening structures against fire are ways to mitigate fire impact on lives and property.
- Fire resiliency can be controlled by creating defensible space with Fire Defense Zones around structures, an ignition zone (5 feet), a defense zone (30 feet) and reduced fuel zone (100 feat)
- Fuel is affected by the height and placement of plants & their chemical content. Pine forests and Oak woodlands are resilient but dead material and limbed branches in the understory must be maintained.
- Fire retardant plants, trees, and ground covers can absorb heat and fire without burning, trap embers, reduce wind speed, and slow the travel of a fire.
- 9 out of 10 structures lost are due to low intensity ground fire and embers in the 5-foot zone around them. Combustible materials such as decks, wood chips, and plant material should not be located within 5 feet of nor attached to the structure.

- Vents and windows are the most vulnerable areas in a house, gaps in vent screening should be no more than 1/8” maximum and plants should not be located near or below windows.
- The City's Building Department has adopted the California Building Code requirements in the Very High Fire Hazard Zone but the City’s planning guidelines currently do not address them or may be in conflict with them.

Possible actions to be recommended in the committee’s Final Report

- Carmel City Council consider fire hazard severity and evacuation plans in the safety elements of the General Plan and monitor the level of fire hazards within and surrounding the community. Resolutions and/or Ordinances could include:
    - Documenting the various existing hazards.
    - Assigning staff/council personnel as liaisons to CalFire (Cypress Fire District), and adjacent communities which could threaten Carmel in a wildfire.
    - Assist Monterey Fire in its current efforts in inspecting and identifying fire risks.
    - City Forester consider fire retardant trees and plants in City controlled areas and for tree replacement requirements for private property.
    - Update City Planning guidelines to reflect or not conflict with current California codes (CBC Chapter 7 & CRC R337) in the Very High Fire Hazard Severity (VHFHS) Zone.

REFERENCES

- Fire and Resource Assessment Program (FRAP) ResilientCA.org
- Monterey Fire Defensible Space Inspection Program mry.maps.arcgis.com , monterey.org/fire
- CalFire Defensible Space/Home Hardening readyforwildfire.org
- CalFire Fire Severity Zone Viewer gis.data.ca.gov
- Wildland Urban Interface (WUI) frap.fire.ca.gov
- Every Building’s Wildfire Risk in Monterey County defensibleapp.com
- The A.I.A. Designing for Fire Presentation http://youtu.be/MWslhXidZnc

History

- Version 2 presented at committee meeting on 12/17/2020

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet for the Multi-Jurisdictional Hazard Mitigation Plan

November 19, 2020

TO:	Climate Committee Members
SUBMITTED BY:	Agnes Martelet, Environmental Compliance Manager

SUMMARY

Asset: multiple
Hazards: multiple
Version: 1

General Comments and Outlook:

- The Multi-jurisdictional Hazard Mitigation Plan (HMP) was presented by Kelsey Scanlon of the Monterey County Office of Emergency Services. The HMP establishes a broad local vision and guiding principles for reducing hazard risk, and proposes specific mitigation actions to reduce identified vulnerabilities. The plan is due for renewal in 2021.

- This plan helps local jurisdictions comply with the climate change planning requirements of SB 379, and also allows them to be eligible for pre- and post-disaster mitigation project grant funding from the Federal Emergency Management Agency (FEMA).

- Objectives of the HMP include:
  - Protect life and property
  - Minimize economic losses
  - Enhance community resilience
  - Reduce burden on local government and taxpayers
  - Break the cycle of repetitive disaster damages
  - Speed disaster recovery
  - Integrate hazard mitigation planning with other local planning and decision-making

- The HMP addresses the impacts of Climate Change and shares many objectives with Climate Adaptation Plans. Identified hazards that will be exacerbated by Climate Change in Monterey County include: wildfires, flooding, coastal erosion, landslides and debris flows, extreme heat and drought, human health hazards, and mass migration.

Identified Issues / To-do:

- Each of the 12 cities in the County will provide mitigation strategies and projects to include into the HMP. By including projects into the HMP, jurisdictions may be eligible for FEMA grant funding.

Possible Committee Actions

- The Committee could provide feedback and recommendations for hazard mitigation projects to include in the HMP. The Monterey County Office of Emergency Services anticipates soliciting comments and projects in the Spring of 2021.

REFERENCES

- Monterey County Hazard Mitigation webpage: http://www.co.monterey.ca.us/government/departments-a-h/administrative-office/office-of-emergency-services/hazard-mitigation

History

- Version 1 presented at committee meeting on 12/17/2020

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet – Storm Drain Master Plan

December 17, 2020

TO:	Climate Committee Members
SUBMITTED BY:	Agnes Martelet, Environmental Compliance Manager

SUMMARY

Asset: Public and Private Property, Public Safety
Hazards: Flooding due to stronger storms
Version: 1

General Comments and Outlook: The Director of Public Works presented the City's first Storm Drain Master Plan (SDMP), which was completed in 2020. The plan includes an evaluation of the physical condition of the existing storm drain system, a hydrologic and hydraulic analysis, and a prioritization of improvements to fix deficiencies and capacity issues. With the proposed improvements outlined in the SDMP at an estimated cost of $9.9 million, the drainage system could handle a 10-year storm (3 inches in 24 hours) without flooding.

Identified Issues:

- The City's storm drain system was built to handle only a 10-year storm; it was less costly to construct over the years but incurs the potential for more frequent flooding due to reduced capacity. Most agencies have storm drainage systems that accommodate 20-year storms.
- Repairs are needed for the system to currently be able to handle a 10-year storm.
- Climate change may cause storm intensities to increase by 12 to 20%. Models indicate that, with larger storms, some flooding may occur in the northeast part of the City, the southwest corner near Santa Lucia, and in Mission Trail Nature Preserve, even with improvements.

Possible actions to be recommended in the committee's Final Report

- Funding of the SDMP projects as part of the City's CIP and including them in the Multi-jurisdictional Hazard Mitigation Plan for potential FEMA funding.
- Upsizing pipes as repair projects are conducted so that critical components of the system can eventually handle larger storms

REFERENCES

- Carmel-by-the-Sea Storm Drain Master Plan: https://ci.carmel.ca.us/sites/main/files/file-attachments/complete_final_sdmp_report_september_2020_small.pdf?1602098761

History

- Version 1 presented at committee meeting on 2/18/2021

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet for the Beach, Bluff, Coastal Armoring, Public Infrastructure, and Private Property

February 18, 2021

TO:	Climate Committee Members
SUBMITTED BY:	Scott Lonergan, Committee Member

SUMMARY

Asset: Beach, Bluff, Coastal Armoring, Public Infrastructure, and Private Property
Hazards: Sea Level Rise, Stronger Storms and Waves, More Variable Rainfall
Version: 8-Feb-2021

General Comments and Outlook:

- It is not widely understood that the climate change threat to coastal infrastructure, private property, the beach, along with the associated impacts on tourism and Carmel's economy, is so substantial, and that the potential solutions so complex.
- Nearly the entire coastline south of 8th Avenue has been armored by a combination of seawalls, vertical or stepped retaining walls, or engineered rock revetments. Secondary impacts to armoring often include escalating maintenance costs, and the loss of beach, aesthetics, and ecology.
- Coastal erosion and storm events already pose a threat, and climate change driven sea level rise and storm intensity will dramatically increase that threat.
- Longer term, the degree to which the City should, or can, forestall the natural processes driven by climate change is not fully understood.

Identified Issues:

- The frequency and duration of beach inundation and wave attack on armoring and natural barriers is increasing. The impacts of armoring on beach sand loss, as well as the seasonal migration of sand on and off shore, has not been investigated.
- The natural erosion processes along the mostly unarmored North Dunes area will accelerate bluff retreat and potentially create space for the beach to migrate inland. North Dune habitat at the retreating bluff would be reduced in this case.
- Seawall integrity is being compromised by ongoing erosion of the relatively soft sandstone base of some seawalls. Equipment access to areas on the beach required for completing repairs and maintenance is increasingly limited.
- Public infrastructure at risk along the coast including Scenic Road and the bluff walkway, beach access stairways, bathrooms, armoring, Del Mar Avenue beach parking, and some utilities.
- Private property at risk along the coast including: 1) that along Scenic Road, 2) that between 8th Avenue and Del Mar Avenue, and 3) that at the north end of the City (Pescadero Canyon area).
- The need to educate the community about the climate change threat to coastal infrastructure, private property, the beach, and the associated impacts on tourism and Carmel's economy, along with the potential solutions.

Remaining Issues to be Understood (in Preparation for the Committee's Final Report):

- Engagement of a coastal engineer with experience in planning for climate change in an LCP context.
    - Further assessment of the risks to our coastal assets.

    - Determine adaptation measures and LCP policy options. Draft updated or new LCP for certification with the Coastal Commission.
        - Prioritize adaptations and projects that protect and maintain public resources and beach access, and the viability of the community and tourism.
        - Coordinate with regional partners (e.g. County, Pebble Beach) and align with the Coastal Commission on acceptable plans.
        - Determine how the options and strategies along the coast are different for the:
            - Mostly natural, unarmored North Dunes area
            - Mostly armored bluffs along Scenic Road south of 8th Avenue
            - Unarmored dunes along private property between 8th Avenue and Del Mar Avenue
            - Armored private properties on the bluffs at the north end of the City (Pescadero Canyon area).
        - Evaluate feasibility and phasing, the use of thresholds for when different elements of these strategies are implemented. For example, maintaining armory or other defenses up to a point, but then if a threshold is reached, embracing a new bluff line and different adaptive measure.
        - Consider legal liabilities, coastal armoring and building regulations, real estate disclosures, and fiscal impacts.
        - Community-wide outreach and education, including that focused on exposed property owners.
- Actions independent of engaging a coastal engineer including:
    - Characterize erosion hot spot areas of particular concern along the City's coastline based on maintenance records, historical knowledge, and further assessment.
    - Research Carmel Cove sand supply dynamics through the engagement of local experts (e.g. CSUMB, NPS) or other resources.
    - Assess risks with the USGS Coastal Storm Modeling System (CoSMoS).
    - Investigate and, if appropriate, apply for pre-disaster planning and mitigation funding from the State or other sources.
    - Amend City documents, if appropriate, to enable the request of FEMA disaster relief post-disaster.

Possible Actions to be Recommended in the Committee's Final Report

- Update the CBTS Shoreline Management Plan and the General Plan / LUP.
- Proactive sourcing or contracting for repair resources prior to episodic events.

REFERENCES

- Coastal Resource Management Element of the Carmel-by-the-Sea General Plan: https://ci.carmel.ca.us/post/general-plan
- Carmel-by-the-Sea / Shoreline Management Plan: https://ci.carmel.ca.us/post/additional-forestry-division-resources
- David Shonman and Greg D'Ambrosio 19-Nov-2020 Climate Change Committee presentation slides: https://ci.carmel.ca.us/sites/main/files/file-attachments/shonman_-_ccc_presentation_-_final_nov_19_2020.pdf?1605903015
- USGS representative, Andrea O'Neill, 17-Dec-2020 Climate Change Committee presentation video: https://carmel.novusagenda.com/agendapublic/MeetingView.aspx?MeetingID=922&MinutesMeetingID=510&doctype=Agenda
- California Coastal Commission and Local Government Public Workshop on 17-Dec-2020 to discuss sea level rise planning in an LCP context: https://documents.coastal.ca.gov/reports/2020/12/SM-Th3/th3-12-2020-report.pdf

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History

- Version 8-Feb-2021

CITY OF CARMEL-BY-THE-SEA

Water Supply Summary

January 21, 2021 Meeting

TO:	Climate Committee Members
SUBMITTED BY:	Michael LePage, Committee Member

SUMMARY

Asset:
Monterey Peninsula water supply

Hazards:
Seasonal drought, climate warming, sea level rise

General Comments and Outlook:
California is located in a drought-prone area of the United States. Even though there are yearly seasonal variations in rainfall, the average temperature in California is trending up. This is the result of climate change. A warming climate leads to the increase of drought frequency and duration.

Additionally, climate change is predicted to increase local sea level rise by 1.5 meters by the century's end. Storm surges along with high tides and extreme weather events will result in much higher levels of sea level rise. This will have an impact on the local water delivery infrastructure which is located in the areas of projected sea level rise.

The Monterey Peninsula's water supply has historically been provided by the Carmel River, local reservoirs and ground water. The State Water Resources Control Board has issued a Cease and Desist Order, 95-10, that requires California American Water Company (CalAm) to reduce its unlawful pumping of water from the Carmel River. The original pumping deadline has been extended to 2021. In response to the Cease and Desist Order, CalAm is pursuing a permit for a desalinization water treatment plant located in Marina that would utilize slant wells to source seawater for desalinization.

Simultaneously with this project, the Monterey Peninsula Water Management District (MPWMD) has worked in collaboration with 9 local agencies to create the Pure Water Monterey Project. The project sources water from four sources, domestic waste water, agriculture produce water, agriculture waste water and storm water. By the use of advanced water recycling technology, all these water sources are purified to provide potable water for domestic and agricultural use. Additionally, the project injects seasonal water flows into the Seaside aquifer to provide ground water replenishment. The project potentially will provide one third of the water demand for the area it serves.

Identified Issues:
- California is located in a drought-prone area of United States.
- Average temperatures are trending upward because of climate change
- Global warming is causing dryer weather patterns resulting in more frequent droughts.

- The State Water Resources Control Board has issued a Cease and Desist Order (95-10) to reduce unlawful pumping from the Carmel River.
- The proposed desalinization plant requires a cumbersome permitting process resulting in an expensive water source.
- Climate change is causing sea level rise that will impact water related infrastructure, both delivery and waste treatment

Possible actions to be recommended in the committee's Final Report

- Keep informed regarding the Carmel Lagoon Ecosystem Protective Barrier and the Scenic Road Protective Barrier System.
- Provide maps of predicted sea level rise for the required shore line assessment reports
- Review city infrastructure opportunities for implementing additional water conservation measures

REFERENCES

- Monterey Peninsula Water Management website, https://www.mpwmd.net/
- Pure Water Monterey Project, https://purewatermonterey.org/
- Monterey Peninsula Integrated Regional Water Plan, https://www.mpwmd.net/environmental-stewardship/irwm-program/final-draft-monterey-peninsula-integrated-regional-water-management-plan-update/
- Carmel Lagoon Ecosystem Protective Barrier and Scenic Road Protective Barrier System, https://www.co.monterey.ca.us/government/departments-i-z/resource-management-agency-rma-/planning/current-major-projects/carmel-lagoon-ecosystem-protective-barrier-and-scenic-road-

History

- Version 1 presented at committee meeting on 4/15/21

CITY OF CARMEL-BY-THE-SEA

2018 Draft Greenhouse Gas Inventory Summary

February 18, 2021 Meeting

TO:	Climate Committee Members
SUBMITTED BY:	Evan Kort, Associate Planner

SUMMARY

Asset:
2018 Draft Greenhouse Gas (GHG) Inventory

Hazards:
N/A

Key Terms:

- Baseline Year: A specific year against which emissions are tracked over time.
- Greenhouse gases (GHG): Carbon dioxide (CO2), methane (CH4), and nitrous oxide (N20). Emissions are expressed in equivalents of carbon dioxide (CO2e).
- Community Greenhouse Gas Inventory: A calculation of GHG emissions generated as a result of activities within a community.

General Comments and Outlook:
The Association of Monterey Bay Area Governments (AMBAG) has prepared GHG Inventories for member agencies for 2005, 2010, 2015. Starting 2018, in partnership with Central Coast Community Energy (3CE), AMBAG is preparing GHG Inventories for 3CE member jurisdictions for 2018, 2019, and 2020 –this 2018 GHG Inventory was prepared as part of the MOU between AMBAG and 3CE.

The state of California has adopted a baseline year of 1990 for statewide targets. The 2020 target (AB 32) was to return to 1990 emission levels, and the 2030 target (SB 32) is a 40% reduction from 1990 levels with the 2050 target (executive order: S-3-05) being an 80% reduction from 1990 levels. In 2018, an executive order (B-55-18) was passed with the goal of achieving carbon neutrality by 2045. Most cities do not have 1990 inventories and it is not possible to go back and establish a 1990 baseline. Therefore, in order to quantify targets, most cities use 2005 inventories and assume emissions increased by approximately 15% between 1990 and 2005.

The emission inventory is broken into 5 sectors: Residential, Commercial/Industrial, Transportation, Solid Waste, Wastewater. Residential and commercial/industrial sectors inventory electricity and natural gas emissions. The transportation sector is an inventory of emissions as a result of travel on local roads in the City of Carmel-by-the-Sea. Solid waste is an inventory of emissions as a result the waste that is generated by the community and sent to the landfill, and wastewater is an inventory of emissions as a result of the treatment of the wastewater.

Data is gathered directly from PG&E and 3CE in regard to electricity and natural gas consumption. Transportation data is gathered from an annual report prepared by the California Department of Transportation (CalTrans) that looks at the amount of Vehicle Miles Traveled on local roads as well as the CARB's EMFAC model which is used to estimate emissions based on on-road travel. Solid waste data is obtained from CalRecycle's annual

report as well as characteristic studies that study the composition of materials in the landfill. Lastly, wastewater data is gathered from a population-based method that uses the population to estimate the emission.

2018 Inventory Findings:

- Electricity between 2005 to 2018 has become cleaner. Electricity use has remained stable; however, the carbon intensity of the electricity has been drastically reduced (likely due to the local energy procurement being taken over by 3CE).
- Data sources have reported less and less travel on local roads over time resulting in a reduction in GHG for the transportation sector.
- Solid waste being sent to the landfill from the city has decreased significantly (46% emission reduction) and the composition of the solid waste being sent to the landfill is less impactful in 2018 than it was in 2005.
- Wastewater: not discussed.

Identified Issues:

- The California Air Resources Board (CARB) is required to update their Scoping Plan every 5 years. The scoping plan was last updated in 2017, prior to the executive order establishing a goal of carbon neutrality by 2045 so the carbon neutrality target has yet to be included in the Scoping Plan (80% reduction by 2050 is still the official target). When the scoping plan is updated in 2022, the 2045 carbon neutrality target will likely be included in the Scoping Plan and is expected to be the main target moving forward. There is still uncertainty regarding 2045 vs 2050 goal.
- The significant decrease in GHG emissions in the transportation sector may be the result of a change in methodology by CalTrans in preparing their annual report, which may account for some or most of the reduction in GHG emissions. The report provided to AMBAG from CalTrans is a finished product that does not provide the opportunity to evaluate the methodology used.
- CalRecycle reports the solid waste data and the reason for the significant decrease in emissions is unclear.

Possible actions to be recommended in the committee's Final Report

- Maintain the 2030 goal outlined in SB 32. There is still uncertainty regarding 2045 vs 2050 goal. The Committee could opt to use either long-term goal; however, the 2045 target is more rigorous and may become the new State goal in 2022.
- Re-evaluation of emissions may be required as a result of possible changes in methodology that may have impacted the outcomes of the inventory. Consultant assistance will be required in making a determination regarding the accuracy of the inventory and methodology.

REFERENCES

- City of Carmel Draft 2018 Greenhouse Gas Inventory
- EMFAC Model: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools

History

- Version 1 presented at committee meeting on 5/20/21

CITY OF CARMEL-BY-THE-SEA

Central Coast Community Energy

February 18,2021 Meeting

TO:	Climate Committee Members
SUBMITTED BY:	Agnes Martelet, Environmental Compliance Manager

SUMMARY

Asset:
Power Supply

Hazards:
Greenhouse gas emissions

General Comments and Outlook:
Central Coast Community Energy (3CE, formerly Monterey Bay Community Power) is a Joint Powers Authority with 33 municipal members to deliver energy throughout the Central Coast. 3CE delivers the energy to the power grid that is operated by PG&E locally. 3CE has a goal to reach 100% clean and renewable energy by 2030, although they have clarified that there will be times of the day when there will be natural gas on the grid for reliability when renewables are not available.

Regionally, 3CE is investing in technology to increase supply and storage capacity for reliable and clean power. Locally, 3CE is investing in programs to increase the pace of electrification, including in the transportation and construction sectors, and in the agricultural industry. 3CE also provides an incentive for local municipalities to adopt reach codes for energy conservation and electrification to reduce the use of natural gas in the built environment. Reach codes are more advanced or enhanced building codes that go above and beyond the State's building code requirements.

Identified Issues:

- Providing 100% clean energy power supply is challenging due to the times of energy use that do not always match the times of peak power supply from renewable sources. Thus, natural gas will remain a source of energy on the power grid.

Possible actions to be recommended in the committee's Final Report

- Consider taking advantage of 3CE's reach code incentive to amend the City's municipal code to increase the pace of energy conservation and electrification in local construction projects.

REFERENCES

- 3CE Presentation at the Climate Committee meeting: https://carmel.novusagenda.com/agendapublic/VODPreview.aspx?meetingVideoID=5ddd8ae3-bf7f-456c-8c9f-38f55eeb55a6&index=3004
- 3CE Energy Programs: https://3cenergy.org/energy-programs/

History

- Version 1 presented at committee meeting on 5/20/21

CITY OF CARMEL-BY-THE-SEA

Hazard and Asset Summary Sheet for Electrical Grid Resilience
May 20, 2021

TO:	Climate Committee Members
SUBMITTED BY:	Jeff Baron, Councilmember

SUMMARY

Asset: Electrical Grid
Hazards: Stronger Storms, Increasing temperatures
Version: 1

General Comments and Outlook: The electrical grid in Carmel has been historically somewhat unreliable during weather events, with outages affecting from half a block to the entire community. In the future, we could see causes of disruptions (related to climate change) include:

1. Larger weather events (storm damage to power line infrastructure.)
2. Public safety power shutoffs (related to the threat of wildfire during wind events along transmission lines.)
3. Supply shortages (related to grid shortages, as seen during the summer of 2020.)

Identified Issues:

Grid failure can lead to numerous effects, including:

- Residential – spoiled food, cold and dark homes
- Commercial – essential businesses shuttered
- Tourism – loss of income of reputation
- Government services impacts (police and fire, public works)

Outstanding Issues:

- Would be good to have access to PG&E Grid map to better understand power grid
- Ask PG&E for historical outage map (or list) with causes
- Work with PG&E to understand possible PSPS transmission lines. Which lines are subject to these? How does this effect Carmel?
- PG&E: Microgrids
  - Power sources within the power grid?
  - Could we get power from somewhere else, some dedicated “outside line” not subject to power outages?
- Community business survey to determine which businesses are grid resilient

Possible Committee Comments or Actions for Final Report

Explore and make recommendations on possible mitigation measures:

- Prevention
  - Tree planning and maintenance - Work with PG&E to prioritize tree trimming
  - Explore the possibility of undergrounding select or all utility lines (via with property assessments)
- Personal resiliency
  - Require new homes to be “ready” for home power storage
  - Require homes to be “EV ready” (also helps with GHG metrics.)

    - Explore new home requirements for home power generation (solar, fuel cells, generators)
- Carmel resiliency
    - Explore areas in which Carmel should or could provide resiliency services to local residents and business, beyond the simple continuation of essential government services. For example:
        - Warming or cooling areas
        - Electrical phone and other small appliance charging facilities
        - Food and other supplies (for visitors)
        - Communication infrastructure
- Regional resiliency
    - Explore possible peninsula microgrid

REFERENCES

- Click here to enter text.

HISTORY

- Version 1 presented at Committee meeting on 5/20/2021