3.0 Adaptation to Climate Change

Over time, climate changes are projected to result in some serious effects to public health and safety, the physical environment, and local economies. Even with efforts to reduce the man-made generation of carbon emissions causing accelerated climate changes, high atmospheric carbon levels are already in place causing warming and other climate changes, and are projected to cause substantial changes in weather patterns over the next century.

This section describes the types of climate change effects the city of Santa Barbara community is likely to be vulnerable to in coming decades, and strategies for future adaptation.

3.1 *Climate change effects and Santa Barbara vulnerability*: Addresses the potential for temperature, rainfall, and extreme weather changes, sea level rise, and associated effects on flooding, wildfires, air and water pollution, coastal erosion and inundation, water supply, agriculture and food, energy demand, wildlife habitats, and local economies.

3.2 *Adaptation strategies*: Identifies programs in place and strategies for future climate adaptation pre-planning.

3.1 Climate change effects & Santa Barbara vulnerability

The following discussion describes the types of climate change effects anticipated to occur in the Santa Barbara area over the coming decades. These are expected to include:

- Increased frequency and severity of heat waves, droughts, and wildfires;
- Larger storms and associated flooding and erosion;
- Increased air and water pollution, and changes in pest and vector transmission;
- Sea level rise effects on storm damage, inundation, beach loss, and coastal cliff erosion;
- Changes to water supply, agriculture/food supply, and energy demand;
- Effects on wildlife and habitats; and
- Changes to local economies such as tourism and fisheries.

Climate processes are complex, not completely understood, and not easily forecasted into the future. Modeling efforts to date have been done primarily on global and regional levels. The timing, pace, and extent of climate changes ahead for California and Santa Barbara are uncertain. The timing will likely vary for different types of effects.

However, the 2009 California Climate Adaptation Strategy cites accelerated climate changes already affecting California, including sea level rise, water supply pressures, faster coastal erosion, and increased average temperatures with more extreme hot days. Because greenhouse gases remain in the atmosphere for decades and are already at high levels, climate changes are projected to occur over the coming decades regardless of efforts made to reduce the rate of emissions generation.

Whether substantial effects occur in Santa Barbara and adaptation actions are needed by the year 2030 or within a longer time frame, the City needs to look ahead to monitor climate changes and do additional analysis and planning to identify the best strategies for adaptation and to inform current development decisions. More detailed data for the Santa Barbara area will become available in coming years to assist these efforts.

Sources of data for this discussion include the City of Santa Barbara *Program Environmental Impact Report for the Plan Santa Barbara General Plan Update* (2010); the 2009 California Climate Adaptation Strategy; California's www.Cal-Adapt.org web site; and documents of the Intergovernmental Panel on Climate Change (IPCC), California Air Resources Board (CARB), and Governor's Office of Planning and Research (OPR).

The discussion of sea level rise and effects associated with storm damage, flooding and inundation, and coastal erosion of bluffs and beaches is largely based on a recent study of future vulnerability of the Santa Barbara area (Griggs & Russell, University of California, Santa Cruz, *City of Santa Barbara Sea-Level Rise Vulnerability Study,* California Energy Commission, 2012*)*.

3.1.1 Temperature, rainfall, and extreme weather

Natural global temperature and weather pattern variations have occurred over millions of years with key factors being changes in the earth's orbit, axis tilt and wobble (affecting distance from the sun) and atmospheric heat-trapping CO_2 levels (increased with volcanic eruptions). Physics and chemistry data from arctic ice cores provide atmospheric components going back to ancient times that indicate past weather patterns of cooling and warming involved CO_2 levels gradually ranging between 180 and 280 parts per million (ppm) respectively in cycles of thousands of years. The CO_2 level has now been increased to more than 380 ppm within just a few hundred years and continues to increase rapidly. A pattern of increasing temperatures and more extreme weather events is projected in coming decades.

California's 2009 Climate Change Impacts Assessment (2009 Scenarios Project) identified average projections of climate changes based on six models and two carbon emissions scenarios. The A2 scenario assumes a business-as-usual scenario of continued acceleration of carbon emissions, and the B1 scenario assumes global cooperation to reduce carbon emissions (both scenarios used in Intergovernmental Panel on Climate Change (IPCC) 2009 assessment).

Temperature changes and heat waves

Based on the State assessment, average temperatures within California are projected to increase by $1.82^0 – 5.4^0$ Fahrenheit by 2050. Summer temperature increases are expected to be greater, with more heat waves of longer duration. Coastal regions such as Santa Barbara are expected to experience less warming than inland areas. The State 2009 Scenarios Project forecasts that extreme high and low temperatures will occur much more frequently in many areas of the State.

These changes have the potential to result in public health effects such as more incidences of heat exhaustion and heat stroke, particularly among more vulnerable populations such as the elderly, children, disadvantaged, and those with medical conditions.

Adaptation approaches: Public health programs; additional emergency preparedness planning; development and landscape design incorporating passive cooling and heating.

Precipitation changes

Weather in the State is projected to become generally drier and subject to erratic weather patterns. Models projecting changes in rainfall and snowpack vary as to the amount and location of changes, in part depending on future global carbon emissions levels.

Scripps Institute of Oceanography models project a decrease in precipitation levels in California by 2050 in the range of 12-35%. The State 2009 Scenarios Project expects that more precipitation will fall as rain than snow, affecting the State's water supply (further discussion in section below). More frequent and longer droughts are likely to alternate with infrequent but intense rainstorms.

Wildfires

The Santa Barbara urban interface with the foothills of the Santa Ynez Mountains and Los Padres National Forest is likely to experience gradually increasing wildfire risks in coming decades due to projected climate changes.

Warmer temperatures, drier conditions with lower rainfall averages and more drought periods, periodic high rainfall events causing vegetation growth, and more frequent sun downer wind conditions (down-slope winds typically associated with high temperature and low humidity) all factor into increased wildfire risk.

Adaptation approaches: Emergency preparedness; vegetation management; development policies.

Storm events and flooding

Climate changes such as increased temperature of the ocean can affect extreme storm patterns. The State 2009 Scenarios Project forecasts more erratic patterns including increased frequency and size of extreme rainstorm events in California, and changes in wind patterns.

Flood hazards related to major storm events in the City are largely at the floodplains (along Mission Creek in portions of Downtown, Laguna Channel and Sycamore Creek on the Eastside, and Arroyo Burro Creek in the Upper State Street and Hitchcock Avenue areas and along Modoc Road). The Santa Barbara Airport property is at a low elevation with five creeks and the adjacent Goleta Slough, and most of the area between Los Carneros Road, Hollister Road, and Fairview Avenue has historically flooded during large storm events. At the coast, creeks and smaller storm drains can also develop backwater conditions preventing floodwaters from draining quickly, causing streams to slow or back up with upstream areas flooding.

The frequency and severity of flooding from creeks would be affected by more high-magnitude rainfall events. The depth and velocity of floodwaters could increase, resulting in larger areas subject to flooding. Rising sea levels could combine with these effects to increase storm-related flooding (discussed further below). This poses increased future risk to private property and public infrastructure such as the Harbor, Airport, wastewater, roads, and underground utilities (sewer, electric, and gas lines).

More frequent and severe wildfires could also subject areas downstream from burned watersheds to more rapid runoff from denuded slopes and obstruction of creek channels with debris flows, particularly with a large storm event.

Adaptation approaches: Emergency preparedness; more detailed mapping of vulnerable areas; public facilities programs; and land use policies.

Pests and vectors

Temperature and weather changes could alter transmission and distribution patterns for air- and water-borne pests and vectors and the transmission of diseases, potentially increasing public health risks and effects on agriculture.

Adaptation approaches: Scientific monitoring; vector control and public health programs.

Air pollution

Temperature increases are expected to facilitate smog production, with the potential for adverse effects on public health. Deposition of reactive nitrogen affects agriculture and natural habitats. Changes in weather patterns and associated plant migrations could also alter the timing and duration of pollen production and allergen effects, affecting public respiratory conditions. Increased risk of drought and wildfires could also lead to higher particulate matter levels.

Adaptation approaches: Additional air pollution regulations; public health programs; protective measures to strengthen resiliency of agriculture and habitats.

Water pollution

Climate changes will likely affect pollution levels in streams, groundwater, and the ocean. Water quality in City creeks such as Mission and Arroyo Burro creeks could be affected by lower oxygen content from higher temperatures and nutrient loads, and from greater urban runoff in more intense rainstorms. The risk of seawater intrusion into City coastal aquifers and groundwater basins could increase with large magnitude storms and sea level rise. Storms can also result in pollution from backflow conditions when drainage capacity is increased and wastewater spills. Contaminated groundwater in areas of shallow groundwater, particularly in the waterfront and Estero areas, could be mixed with floodwaters spreading pollution.

The ocean absorbs 30-50 percent of atmospheric CO_2 emissions. Ocean acidification is projected to increase from greater CO_2 concentrations. Carbonic acid is formed from dissolved CO_2, resulting in difficulties for marine creatures to form calcium carbonate shells and skeletons. Species such as crabs, sea urchins, abalones, oysters, mussels, and many plankton species are affected, and their decreased survival also affects birds and fish that feed on them. Acidification also affects fertilization, development, and function of marine species, including kelp, an essential component of West Coast ecosystems and commercially harvested species.

Adaptation approaches: Reduce carbon emissions; monitor and address sources of pollution; prioritize clean-up of groundwater contamination.

3.1.2 Sea level rise

Sea level changes affect temporary storm-related and long-term coastal erosion and retreat, flooding and inundation, and tsunami potential. Sea levels change over time based on changing volumes of seawater and sea basins. Higher temperatures correlate with greater water volumes due to expansion of warmer seawaters and more melting of ice caps and glaciers.

Past and present sea levels

Globally, average sea levels have gradually risen by 350 feet since the last Ice Age ended about 20,000 years ago. Around 1900, the rate of change began to increase, with an average global sea level rise of seven inches over the century. Satellite altimetry indicates an overall increase in average global rates of sea level rise in the last 16 years; however the eastern Pacific rates off the U.S west coast have leveled off and dropped during this period. The reasons for this are not well understood, but it is considered to be a short-term trend.

Along the California coast, 14 National Oceanic and Atmospheric Administration (NOAA) tide gauge stations have measured sea levels over variable periods of 15 to 153 years. Sea levels rose by an average of about eight inches along the California coast in the past century, ranging about 3-8 inches in Southern California. Rates of sea level rise differ by region depending on whether the adjacent land area is gradually subsiding or uplifting. Sea levels are also elevated for months during El Nino storm event periods when the ocean is warmer than usual and there are stronger westerly wind patterns.

The NOAA tide gauge on the Santa Barbara pier within the harbor was initially established in 1973, but has been moved twice due to construction projects, resulting in multiple-year gaps in the record. The gauge has identified an average sea level rise of 1.25 mm/year since 1973 (a rate of about 5 inches per century), but there is a large margin of error (+/- 1.82 mm/yr). However, a study by technical analyst Zervas (2001) identified a faster rate, estimating sea level rise at 3.4 inches for the Santa Barbara City coastline for the period from 1973 to 1999.

Projected future sea level rise

The California Ocean Protection Council (OPC), consisting of representatives of 15 State agencies, has adopted future sea level rise projections for use in State planning and regulatory actions (e.g., Coastal Commission, State Lands Commission, Department of Fish & Game, etc.). State agencies are directed to incorporate sea level rise into planning and decision-making for new construction projects and other coastal activities (e.g., design, assumed life expectancy of structures, permit conditions, etc.). The current sea level rise guidelines adopted for use by State agencies (Figure 3-1) identify averages of 14 inches by 2050 and 47 inches by 2100.

The projections by the OPC Coast and Ocean Climate Action Team (CO-CAT) are based on the Vermeer & Rahmstorf scenarios that relate global sea level rise to global mean surface air temperature increases.

For the year 2030, State projections identify an average increase of seven (7) inches over year 2000 levels, with a range of five to eight (5-8) inches. For 2050, projections are for average sea level rise of 14 inches over year 2000 levels, with a range of 10-17 inches. The year 2100 projections diverge substantially depending on low, medium, or high carbon emission levels, with averages of 40-, 47-, and 55-inch rise respectively.

Figure 3-1. Sea Level Rise Projections Adopted by California Ocean Protection Council

YEAR	AVERAGE OF MODELS (Rise above year 2000 level)	RANGE OF MODELS (Rise above year 2000 level)
2030	7 inches	5 – 8 inches
2050	14 inches	10 – 17 inches
2070		
Low	23 inches	17 – 27 inches
Medium	24 inches	18 – 39 inches
High	27 inches	20 – 32 inches
2100		
Low	40 inches	31 – 50 inches
Medium	47 inches	37 – 60 inches
High	55 inches	43 – 69 inches

Storm damage

Future sea level rise can be expected to exacerbate the severity of high-magnitude storm events that occur when high tides and winter storms coincide, resulting in potentially greater wind, wave, and beach run-up, and greater storm damage to public and private structures as well as accelerated cliff erosion during these events. Storm occurrences during El Nino conditions would be the most severe.

A recent wave height study of the California coast using offshore buoy data (Seymour 2011) indicates an increasing frequency of large wave heights is occurring. Between 1984 and 1995, there were five instances of mean wave heights in southern California (south of Point Conception) exceeding 16 feet for at least 24 hours, while there were 25 such events during 1996-2007.

Past storm events have periodically damaged structures and public facilities along the City waterfront (e.g., Harbor and Leadbetter Beach). The Griggs-Russell vulnerability study assesses that, with projected climate change and sea level rise to the year 2050 (estimated 14 inches), the severity and frequency of such storms will likely increase, and the probability of future storm-related wave damage, flooding, and erosion is high. Historically the magnitude of such damage has been moderate, but can be expected to increase to high by 2050. In the longer-term to 2100 the probability of increased storms and extent of damage could be very high.

Adaptation approaches: Monitoring and further scientific study of likely future local climate patterns; emergency preparedness; planning for future strengthening in place or moving of vulnerable resources, including elevation of infrastructure and structures; and land use policies and standards for future development.

Flooding and inundation

As discussed in the earlier section, increased temporary storm-related flooding potential along City creeks could result due to changes in weather patterns. Elevated sea levels, whether temporary from high tides or storm surges, or from longer-term sea level rise, is expected to increase future storm flooding risks. Sea level rise also increases coastal areas subject to permanent inundation.

Much of the City Waterfront, Downtown, and lower Eastside communities as well as the Santa Barbara Airport are less than ten feet above historic mean sea level. If 100-year floodplains identified on current federal Flood Insurance Rate Maps (FIRM) are projected ahead with seven or 14 inches of sea level rise, a future 100-year flood could flood much of the Waterfront and low-lying City areas and Airport, including private property, public facilities, and subsurface infrastructure.

However, the FIRMs were developed based on topographic maps without precise elevation controls. More accurate base information would provide for better projections. NOAA is collecting new satellite LiDAR imagery and precise elevation data along the California coast which produces a higher resolution topographic map on which to update such projections of areas vulnerable to flood risks.

The Griggs-Russell report, using LiDAR data and average projected 2050 sea level rise (14 inches), identifies that sea level could extend inland by about 35 to 70 feet north of the current high water line, crossing into Shoreline Drive in a few locations along West Beach but not reaching the parking lot or structures west of the Harbor. In the period to 2050, the report rates probability and impact from flooding and inundation as moderate for the City, high for Airport.

Much greater projected sea level rise in the period to the year 2100 (40-55 inches) could cover much of the waterfront area and into low-lying inland areas and the report deems the future impact to be of high probability and magnitude. Public facilities such as the El Estero Waste Water Treatment Plant and coastal roads would become vulnerable. The probability of increased flooding and permanent inundation on the Airport property by 2100 is rated very high.

Adaptation approaches: Additional detailed assessment of future area effects; programs addressing vulnerable resources currently located at water level, e.g., strengthening in place or elevation of infrastructure such as transportation, breakwater, pier, wharf, and buildings; or phased relocation; land use policies and standards for new development.

Beach retreat

Coastal bluffs and beaches are subject to gradual wave-driven erosion, and naturally move landward over time. Projected climate changes, including sea level rise and larger storm events, would accelerate the rate and extent of erosion and retreat. Higher water levels create greater wave energy reaching the shoreline and waves hit higher on cliff faces.

Beach erosion is affected by the width and elevation of a beach, the existence of back barriers that do not allow the beach to retreat, sea level rise, high tides, and large storms. Santa Barbara's three miles of beaches vary in width from about 50 to 175 feet, and experience seasonal changes in sand deposition and erosion. Leadbetter, East, and West Beaches have all temporarily eroded or flooded during large storms (e.g., 1914, 1983). Federal and City dredging and sand management processes are ongoing, as well as efforts by BEACON (Beach Erosion Authority for Clean Oceans and Nourishment), a joint powers authority of the counties and coastal cities of Santa Barbara and Ventura.

Beach erosion at Leadbetter Beach, West Beach, and East Beach is complicated by the Santa Barbara Harbor and coastline to the west. These beaches exist because of the sand trapping nature of the harbor. The rate of sand supply from beaches up the coast should persist with sea level rise since long shore sand transport will continue and the sand is supplied by local streams and bluff erosion. As such, Leadbetter Beach and West Beach can be expected to largely maintain their widths and heights with sea level rise to the year 2050.

The western half of East Beach would likely keep pace with sea level rise, but potentially to a lesser extent because it is within the wave shadow of Santa Barbara harbor. Beach widths in this area could also be controlled by changing the point of discharge for the harbor dredge pipeline. The eastern half of East Beach is more likely to experience substantial beach erosion because it is outside the harbor wave shadow and has a full sandy profile. As sea level rises, the low timber groin in front of the Clark Estate that controls present beach width will become less effective and allow more sand to slip by.

Other beaches along the Santa Barbara and Ventura County coastlines are largely thin veneers of sand over rocky shale terraces, and backed by coastal bluffs, and can be expected to experience substantial beach erosion with sea level rise.

The Griggs-Russell vulnerability study finds a low probability of the permanent loss of City beaches by passive erosion or inundation in the period to 2050 with a projected 14-inch sea level elevation. The probability increases to moderate or high by the year 2100 that all City beaches could be substantially narrowed or lost, affecting beach use, recreation, and tourism.

Adaptation approaches: Monitoring and study of climate changes and specific beach profiles; further study of resource vulnerability; plans for future changes addressing vulnerable resources, such as elevating infrastructure.

Coastal cliff erosion

Miles of actively eroding and retreating sea cliffs 50-150 feet in height front the coast along the Mesa area of the City to Hope Ranch. For the most part, the cliffs are Monterey Shale with unconsolidated marine terrace deposits, tilted toward the beach. The cliffs experience terrestrial erosion, and where close to the ocean, wave erosion at the base of the cliffs. The long-term erosion rates have averaged 6-12 inches/year.

These formations are also prone to landslides and sudden bluff failures. Seawalls and revetments can temporarily slow erosion, but may lead to more erosion at adjacent bluff areas and sand areas below. Bluff top activities such as irrigation can accelerate cliff erosion and susceptibility to bluff failures. Following a large El Nino storm event in 1978, two Mesa home were lost in a landslide. In 2008, a landslide along a portion of Shoreline Park moved the cliff edge back by 38 feet.

Within City limits there are 98 single-family homes along the Mesa cliffs. The homes were constructed at different times and have current setbacks from the cliffs ranging from 35 to 300 feet, and averaging 100 feet. Homes along Cliff Drive, Shoreline Drive, and Camino de la Luz are vulnerable to cliff erosion, as are Shoreline Park, the Douglas Family Preserve, the Clarke Estate, and the Santa Barbara Cemetery.

A bluff retreat model (PWA 2009) that includes the projected increase in wave impacts from sea level rise estimates that long-term retreat rates to the year 2100 in the Mesa and Shoreline Park areas would be much greater than average historic rates.

The Griggs-Russell vulnerability study identifies a moderate probability of significantly increased cliff erosion rates (doubled to 12-24 inches/year) in the period to 2050, with a likely 40-50 foot cliff retreat, which would threaten 30 or more homes and secondary structures. By the year 2100, the report deems the probability and vulnerability high, as this increased retreat rate would threaten 67 bluff-top homes. At potentially even higher retreat rates, nearly all of the oceanfront homes would be affected.

Coastal Act and Local Coastal Plan policies limit new bluff top development and armoring of the coast. City policy requires new habitable development to plan for a 75-year structure life. Development proposals within an area based on a general 12-inch/year retreat rate (per URS Master Environmental Assessment Geology and Geohazards Report, 2009) are required to submit site-specific technical reports used in determining a bluff setback providing for a 75-year structure life.

Adaptation approaches: Additional monitoring and study of vulnerabilities; land use and public safety policies (e.g., periodic update of analytic and setback guidelines for new development on cliff tops).

Tsunami

Tsunamis are ocean waves triggered by earthquakes, landslides, or volcanoes that dramatically increase in size as they reach the shore, which can cause flooding and destruction onshore. Local offshore earthquakes have the greatest potential for generating large tsunamis without warning time. Tsunamis from distant seismic events within the Pacific Ocean can also reach Santa Barbara. Massive tsunamis in the Indian Ocean in 2004 and Japan in 2011 demonstrated the great potential for devastation.

There is no clear direct correlation between climate change and tsunami occurrence or frequency. However, there is potential that tsunami size and damage could increase in the future with sea level rise, because tsunami waves could reach higher elevations and move further inland.

There have been many large earthquakes around the Pacific Rim within the past century, but no record of substantial tsunami damage in Santa Barbara. California Geological Survey records indicate three tsunamis affected Santa Barbara in the nineteenth century: a six-foot 1812 tsunami due to offshore earthquakes; a six-foot 1877 tsunami following a large earthquake in Chile; and an 1896 tsunami with eight-foot waves following a southern California earthquake. Following the 2011 Japan earthquake, a five-foot tidal fluctuation occurred within the Santa Barbara Harbor.

Based on few moderate-size tsunami events in the last 200 years, the Griggs-Russell report considers tsunamis to be of very-low probability of occurrence with a low risk of damage.

Adaptation approaches: Further scientific study, modeling, and mapping of potential risks; additional response planning; and consideration of additional structural provisions.

3.1.3 Public services

Water supply

Statewide weather systems and water systems are complex, and there are many uncertainties in estimating future effects of climate changes on water supply. State studies (Department of Water Resources, 2009 and California Climate Action Team, 2009) identify that future weather changes may likely result in less water storage and water availability in California due to decreased average rainfall, more droughts, less of the precipitation as snow, and earlier melting of snow pack. Warmer weather would also increase demand for irrigation of agriculture and landscaping.

Santa Barbara's water supply has diversified sources, including the Santa Ynez River watershed, State Water Project, groundwater, and recycled water, along with a strong water conservation program. The City also has a decommissioned desalination plant as a back-up supply. Future temperature and weather pattern changes could result in more variable or reduced supplies from the Santa Ynez River watershed and State Water Project, and potentially more saltwater intrusion issues for groundwater.

Studies and planning to address water supply issues, including climate change effects, are ongoing by the State (Department of Water Resources), regional agencies (e.g., Cachuma Operation and Maintenance Board, Santa Barbara County's Integrated Regional Water Management Program), and the City.

Adaptation approaches: Measures to increase water storage capacity and diversify supplies (e.g. water sharing and banking agreements among jurisdictions and sectors; desalination, etc.). The City adopted an updated Long Term Water Supply Plan in 2011 that analyzed future water supply and demand issues to the year 2030, including potential effects of climate change on State Water Project deliveries. The Plan establishes water supply and water conservation management strategies and policies, and concludes that adequate supplies will exist for the City through the planning period of 2030.

Agriculture & food supply

Climate changes in California affecting average temperatures, temperature ranges, rainfall patterns, extreme weather, and water supply can be expected to alter crop yields, growing seasons, and pest ranges. The same is true worldwide, and depending on the rate of climate changes and locations of effects on agriculture, more food shortages could result.

Adaptation approaches: Supporting the protection and adaptation of regional agriculture and local food production and markets.

Energy demand

Temperature increases and more extreme weather events may likely increase future energy demand and use in California, such as for cooling, peak electricity demand (e.g., summer air conditioning), utilities and water transport, and key industries. Although per capita energy use in the State has stabilized in past decades, even with future per capita energy reductions, total statewide energy consumption is expected to increase with population growth.

Future temperature, rainfall, and snowpack changes may also reduce the reliability of hydroelectric power supplies, which currently provide for approximately 16% of Santa Barbara County electricity supplies.

Adaptation approaches: Measures identified in Chapter 2 for energy efficiency, conservation, use of renewable energy sources; statewide utility management of energy provision.

3.1.4 Biological resources

Projected climate changes would have substantial effects on plants and animals. Factors affecting habitats and individual species include rising temperatures, reduced rainfall, variable weather patterns and extreme weather events, wildfire frequency, rising sea levels, coastal erosion, air pollution, creek pollution, ocean acidification, and saltwater intrusion. Climate change is added to existing pressures on natural ecosystems due to urbanization, invasive species, and pollution.

It is expected that various species and habitats would respond in different ways; some species would adapt to changing conditions, some would survive in reduced ranges, some would migrate to areas with suitable conditions, and others would not survive the changes. Species responses are determined by factors such as existing population sizes, tolerance to a range of conditions, genetic diversity and potential to adapt, ability to migrate, response to invasive species, and specialized needs (such as soil types, pollinators).

Specific outcomes cannot be accurately predicted, but researchers expect a general trend of plants and wildlife shifting northward and toward the coast or to higher mountain elevations in response to temperature and rainfall changes. Similar northward movement could occur by marine species. Many habitats would be expected to experience reduced ranges and loss of the biodiversity that strengthens sustainability.

In Santa Barbara, potential future effects on coastal resources include reduction or loss of intertidal habitats, loss or inland movement of wetlands and marshes, and biodiversity loss from gradual coastal bluff, dune, and beach erosion. Upland and foothill species and habitats may experience upslope movement and/or northward migrations. Ocean species and habitats are at risk from temperature and weather changes, and ocean acidification.

Adaptation approaches: Similar to current approaches for conservation of natural areas. These include maintaining contiguous habitats and links between urban area habitats and larger open space areas to aid in migration of species, and restoring degraded habitats to provide flexibility and added range.

3.1.5 Local economies

Fisheries

Increases in ocean temperatures, extreme weather patterns, and pollution have the potential to change the habitable range, distribution, and abundance of marine species, and may include species migration. Marine habitats are complex and many uncertainties exist about how local City fisheries would be affected. Factors affecting the future will include the adaptive capacity of species and changes to the marine food web.

Adaptation approaches: Further scientific study and monitoring, and measures to support sustainable habitats and populations.

Tourism and Recreation

Future heat events may draw more visitors to the coast from inland areas. Climate change effects such as weather events, wildfire frequency, and coastal erosion could also negatively affect tourism and recreation. Future effects are uncertain, but it seems unlikely that they would substantially reduce tourism or recreation in Santa Barbara.

3.2 Adaptation strategies

Existing City of Santa Barbara goals and programs and future strategies are identified for future Santa Barbara planning for adaptation to climate changes anticipated in coming decades.

Community activities

In addition to City programs, there are other programs in place in the Santa Barbara community by organizations, businesses, and agencies that benefit climate adaptation planning, such as the following examples:

- *Emergency response.* The Santa Barbara community has a number of organizations such as the local chapter of the American Red Cross and Direct Relief International with plans and resources to respond in community emergencies. Many businesses, institutions, and neighborhoods also have emergency preparedness plans.
- *Public health services.* Existing programs and services are in place which provide public health protection and public education though hospitals and other private, non-profit, and community medical organizations and facilities, Santa Barbara County programs such as the Health Department and vector control programs, and the Santa Barbara County Air Pollution Control District.
- *Habitat restoration.* Nonprofit community organizations such as the Santa Barbara Foundation, Surfriders Foundation, and Heal the Ocean have funded numerous projects to restore and protect natural habitat areas.
- *Groundwater contamination:* Heal the Ocean is proposing a project with the Regional Water Quality Control Board and Santa Barbara County Fire hazardous materials unit to prioritize contaminated groundwater sites for clean-up.
- *California agency data and guidelines:* The State of California has prepared climate adaptation reports and guidelines, and identified sea level rise assumptions (16 inches) that State agencies are directed to use for State agency planning and development permitting processes.

Santa Barbara General Plan Excerpts

CLIMATE ADAPTATION GOALS

Goal: Climate Change Adaptation. If applicable, incorporate adaptation to climate change in proposals for new development, redevelopment, and public infrastructure.

Goal: Present and Future Service Needs. Ensure that public infrastructure and services are planned, sited, upgraded, and maintained to meet present and future service needs efficiently, economically, and in a manner consistent with a sustainable community and climate change.

Figure 3-2

3.2.1 Existing City programs

The following identifies examples of City of Santa Barbara programs in place that would benefit future planning for climate adaptation.

Emergency preparation programs in place

- ***Emergency plans.*** The City has emergency operations plans that are activated in the event of a natural disaster or other emergency. The City emergency operations center was recently upgraded, and updates to the emergency plan and associated Municipal Code provisions are underway. Inter-jurisdictional assistance agreements are also in place with other local and State agencies.
- ***Hazard mitigation plans.*** In 2011, the City of Santa Barbara together with Santa Barbara County and the other cities adopted updated inter-jurisdictional hazard mitigation plans that identify public safety vulnerabilities in the City and region and measures to address them.
- ***City Wildland Fire Plan and Fire Code.*** The adopted City Wildland Fire Plan and recently updated Fire Code identify wildfire hazard zones and measures to address public safety, including vegetation management, evacuations, and building requirements.
- ***Tsunami plan.*** The City is finalizing a tsunami plan to improve community response readiness, consistent with National Weather Service Tsunami Ready provisions, including methods for public communications and education, installation of signs along the coast, and evacuation routes.

Local plans and programs in place

- ***Long-Term Water Supply Plan.*** In 2011, the City adopted an updated Long-Term Water Supply Plan (LTWSP) that addresses management of diversified sources of City water supply for the coming decades, including consideration of climate change issues. The City also coordinates within the Santa Barbara County region as part of the Integrated Regional Water Management Program (IRWMP).
- ***Creek water quality programs.*** With voter-approved funding, the City has an ongoing program undertaking a wide range of measures to improve creek and ocean water quality and riparian habitats.
- ***Storm Water Management Plan***. The City has an adopted plan identifying measures undertaken during construction and post-construction to reduce storm water and water pollution.
- ***Airport Facilities Plan.*** The current Santa Barbara Airport Facilities Plan is undergoing an updating process, which includes the study of climate issues such as sea level rise.

- ***Harbor Master Plan.*** The City has an adopted Harbor Plan that identifies the City's harbor land use resources, and operates an ongoing waterfront management program.
- ***Safety Element.*** The existing General Plan Safety Element is undergoing an update process that will include discussion of climate change adaptation issues involving wildfires, flooding, and coastal erosion.
- ***Floodplain Management Plans/Ordinance.*** A City floodplain ordinance is in place, periodic local floodplain mapping studies are conducted, and numerous City and County infrastructure improvements have occurred and are planned. Federal (FEMA) floodplain mapping is undergoing an update process.
- ***General Plan Land Use Map.*** Low-density land use designations for High Fire Hazard Areas limit additional residential development in these areas.
- ***BEACON (Beach Erosion Authority for Clean Oceans & Nourishment).*** A joint powers authority of coastal jurisdictions (Counties of Santa Barbara and Ventura, and cities of Santa Barbara, Goleta, Carpinteria, Ventura, Oxnard, and Port Hueneme), BEACON addresses issues of coastal erosion, beach sand nourishment, and clean oceans in the area between Point Conception and Point Mugu.
- ***Coastal development guidelines.*** As part of the Coastal Act and City Safety Element and Local Coastal Program, policies have been in place for coastal development with respect to sea cliff development, including for cliff retreat, slope stability, and development setbacks. Updates have incorporated sea level rise assumptions.

3.2.2 Future planning for adaptation

The following strategies for the period to 2030 identify measures to plan for adaptation of the Santa Barbara community to future climate changes.

Climate change adaptation planning

69. Planning for adaptation (City program; target 2020, 2030, ongoing)

a. *Timeline of climate changes* (General Plan (GP) Policy PS3). The City shall include in the Climate Action Plan an estimated timeline of anticipated potential climate changes over the next 100 years to the extent information is available. This timeline will be periodically updated as part of the Adaptive Management Program and will be considered in all City capital projects. *[See Section 3.1 discussion and Executive Summary time line]*

b. *Monitoring, analysis, and adaptation planning.* Establish ongoing climate change adaptation planning:

- Monitor local climate changes and obtain analysis of local climate effects to support future adaptation planning
- Conduct local vulnerability analysis for future climate change effects
- Identify options and priorities for feasible adaptation planning projects, programs, and updates to land use and safety policies, ordinances, and development standards for hazard areas.

70. Coordination of climate planning efforts (City program; ongoing to 2030)

Continue to coordinate climate-planning efforts as part of existing City operations and resource management programs, and continue to coordinate efforts with other agencies and groups for efficiency:

a. Coordinate among City departments and with other local, regional, State, & Federal jurisdictions, institutions, and community organizations in monitoring, analysis, and adaptation planning and programs.

b. Continue to team with local universities & colleges to evaluate scientific climate information and develop more detailed local Santa Barbara analysis of climate changes and effects

c. Continue to pursue grant funding opportunities to help fund local climate change studies and adaptation programs

d. Establish ongoing mechanisms for providing climate change and adaptation planning information to the public.

Emergency preparedness

71. Emergency response strategies and climate change (GP policy ER2; target 2015)
The City shall incorporate into its response strategies for emergency preparations the potential effects of climate change, including extreme weather, sea level rise, epidemics, and other effects on humans and the built and natural environments.

72. Emergency workforce (GP policy PS11; target 2015, ongoing)
Work cooperatively with other jurisdictions in the South Coast Region to ensure in the event of a disaster, essential workers are available and ready to respond adequately and with timeliness.

73. Public education for emergencies (GP policy PS11.2; target 2015, ongoing).
Promote public education on emergency and disaster preparedness to enhance community resilience.

74. Consider people with disabilities in emergency planning (GP PS12; 2015, ongoing).
Update evacuation plans and other emergency or contingency plans with provisions addressing the special needs and measures required to ensure the safety of people with disabilities.

75. Community resilience planning for emergencies *(Public-private program, target 2020)*
Participate in a community resiliency planning process to help improve both initial local response/relief efforts and later recovery phases of emergencies, as well as for ongoing community self-sufficiency and sustainability.

a. *Plan products.* Develop the following as part of resiliency planning:

- Data base of maps and inventories of relief facilities, resources, businesses, and people that can help provide community relief during emergencies; the means for informing the public of resources data base; and a process for maintaining and updating data base information
- An outline and example for development of neighborhood plans
- An outline of additional community actions or projects for improvement to facilities, equipment, supplies, etc. that would benefit community resiliency (e.g., communications systems improvements)

b. *Plan process.* Conduct the resilience planning process as a broad, cross-sector effort in coordination with the South Coast to engage public and institutional involvement, including:

- Public safety agencies
- Neighborhood groups
- Businesses, non-profit groups, and other non-governmental entities
- Health care facilities and practitioners (e.g., hospital, clinics)

- Relief supplies and volunteers (e.g., Red Cross, DRI)
- Hotels and Institutional facilities (e.g., schools; churches, Fairgrounds)
- Water, wastewater, waste management agencies/companies (including debris removal)
- Local agriculture, groceries, and restaurants
- Energy utilities and companies
- Transportation companies and agencies
- Communications companies
- Animal care facilities; funeral facilities; and other special needs facilities
- Local government departments and special districts (information systems; building & safety; animal control, vector control; etc.)

Wildfire, flooding, and water quality measures

76. Limit residential development in high fire hazard areas (GP policy LG6.5; 2015)
Land use map designations limit residential density in High Fire Hazard Areas. Further limit new residential development in the High Fire Hazard Areas by offering incentives and/or an option for property owners to transfer development rights from the High Fire Hazard Area to the High Density residential land use designations.

77. Fire prevention and creek restoration (GP policy PS13; target 2015)
Coordinate fire prevention and creek protection planning through the development of a set of best practices within and adjacent to creek corridors or other habitat.

78. Water system improvements for firefighting (GP policy PS14; ongoing)
Evaluate the potential for additional water system improvements to assist in emergency preparedness and incorporate feasible measures into the City Capital Improvement Plan.

79. Private water supplies for firefighting (GP policy PS15; target 2015; ongoing)
Encourage and assist homeowners in High Fire Hazard Areas to install their own emergency water supplies for firefighting operations. Assistance could include expedited permit review.

80. Floodplain mapping update (GP policy ER16.3; target 2020)
Update the Flood Insurance Maps (FIRM) floodplain boundaries for Special Flood Hazard Areas such as the Mission and Sycamore creek drainages and Area A near the Estero. Update maps to incorporate sea level rise forecasts.

81. Creek resources and water quality (GP ER15 - 15.4; plans 2025; ongoing to 2030)
Encourage development and infrastructure that is consistent with City policies and programs for comprehensive watershed planning, creeks restoration, water quality

protection, open space enhancement, storm water management, and public creek and water awareness programs.

a. *Comprehensive creek action plan.* Prepare a comprehensive long term action plan for protecting and enhancing creek water quality, riparian area, and steelhead use, and maintaining or enhancing flood management.

b. *Master drainage plan.* In coordination with watershed planning, develop a comprehensive drainage plan that identifies the existing system, policies and development standards to better address drainage and water quality issues, areas appropriate for drainage retention/detention, future capital improvements, and funding plan to finance the projects.

c. *Beach water quality improvement.* Consider actions for further improving water quality at East Beach, which could include: (1) a restoration plan for Lower Mission Creek/Laguna Channel, including the potential for a constructed wetland at the creek/ocean interface and/or (2) an ultraviolet treatment system to disinfect the flow within Laguna Creek during low flow periods (e.g., May-September) prior to entering the channel and discharging to the beach.

d. *Watershed action plans.* Continue work toward completion of Watershed Action Plans for Mission Creek, Sycamore Creek, Arroyo Burro Creek, and Laguna Watersheds.

Coastal vulnerability and adaptation planning

82. Monitoring, data collection, and analysis of sea level rise (City program; target 2020)
Develop the following data and analysis to support future sea level rise risk assessment, vulnerability analysis, and adaptation planning.

a. *Tide gauge.* Protect ongoing functioning of the NOAA tide gauge at the Santa Barbara breakwater to establish a long-term monitoring record of sea level changes.

b. *Sea cliff monitoring.* Establish a sea cliff monitoring program with surveyed transects that can be regularly monitored to document and track rates of cliff retreat.

c. *Beach profiles.* Establish a set of beach profiles (spaced at about 500 feet) from Leadbetter Beach to the Clarke Estate, and a set of winter and summer profiles from Cabrillo Boulevard to the shoreline, for annual surveys to track seasonal and long-term changes.

d. *Flooding and inundation.* Obtain detailed topographic mapping of low-lying areas of the City and the Airport (accurate to at least 12 inches, such as from State LiDAR satellite survey), and develop projected future flooding and inundation area maps to assist future adaptation planning.

83. Sea level rise risk assessment and vulnerability analysis (City program; target 2020)
Conduct periodic sea level rise studies that provide risk analysis indicating probability and magnitude of future impacts to Santa Barbara due to sea level rise to support future adaptation planning. Consider effects associated with storm flooding, beach and cliff erosion, permanent inundation, and groundwater contaminations. Consider short-term effects (storms), intermediate-term effects (to 2050), and long-term effects (to 2100).

84. Incorporate adaptation in development (GP ER1, ER4-4.1; target 2015, ongoing).
As applicable, private development and public facilities and services may be required to incorporate measures to minimize contributions to climate change and to adapt to climate changes anticipated to occur within the life of each project.

a. New public and private development or substantial redevelopment or reuse projects shall estimate the useful life of proposed structures, and, in conjunction with available information about established hazard potential attributable to climate change, incorporate adaptation measures in the design, siting, and location of the structures.
b. The City shall prepare adaptation guidelines for development projects, and to the extent of information available to the City, provide information about potential climate change hazards to developers.

85. Sea level rise adaptation (GP ER4.2; target 2020)
Identify policy options, costs, and consequences for addressing sea level rise issues, including:

a. Techniques to minimize wave energy and damage from storm surges, while minimizing disruption of coastal activities and habitats.
b. Review of City public improvements and utilities (aboveground and underground) for potential consequences of sea level rise, and consideration of means of adaptation such as measures to protect in place, raising facilities above projected flood heights, managed retreat or relocation of facilities, and pollution prevention.
c. Coordination with private property owners along the waterfront on techniques for structural adaptation and new design.

86. Future inundation (City program; target 2020)
Consider the following options in the development of adaptation plans for future permanent inundation effects:

a. Establishing mandatory rolling setbacks that move landward over time for future development or significant redevelopment in areas likely to be affected by sea level rise inundation within the expected lives of the structure.
b. Restricting rebuilding when structures are substantially damaged by sea level rise inundation and coastal storms.
c. Developing policies and identify funding or tax incentives to relocate away from areas subject to future sea level rise inundation.
d. Evaluating the costs, impacts, and estimated lifespan of a seawall along Cabrillo Boulevard and Shoreline Drive.

87. Bluff retreat guidelines (GP Policies PS10, PS10.1, PS10.2; target 2015)
All development and redevelopment, renovations and additions on bluff-top parcels shall consider the potential effects of climate change on bluff retreat for the life of the project.

a. *Sea cliff retreat formula.* Update the existing Safety Element and Local Coastal Plan bluff retreat formula to reflect updated information for the 75-year bluff setback line for use of siting development on sea cliffs. Once updated, monitor bluff retreat rates and update the formula as needed.

b. *Sea cliff development guidelines.* The following guidelines shall be used for development on sea cliffs, and incorporated into the Local Coastal Plan policy "Sea Cliff Retreat" #1:

1) Bluff setbacks shall be adequate to address long-term erosion and slope stability issues.

2) New development on top of a cliff shall be placed at a distance away from the edge of the cliff, such that potential accelerated rates of erosion and cliff material loss associated with climate change-induced sea level rise as projected by the State of California, or an area or site-specific geologic investigation that accounts for climate change, will minimize sea cliff-related impacts, and not seriously affect the structure during the expected lifetime.

3) The design life of new structures is presumed to be a minimum of 75 years. Exact future rates of accelerated sea cliff retreat are unknown, but are currently projected to be 12 inches per year, potentially accelerating to 1 to 3 feet per year if sea level rise progresses.

4) The City recognizes the need for owners of threatened coastal properties to perform maintenance and modest improvements to threatened coastal homes and other facilities. The City's goal is to minimize exposure of substantial new improvements to hazards of bluff retreat and avoid the need for installation of environmentally harmful coastal protection structures that could be requested to protect such improvements. To meet these goals, the following guidelines apply:

- Protection for existing structures shall first focus on techniques that avoid use of coastal protection structures including use of non-intrusive techniques such as drainage control, installation of drought tolerant landscaping, construction of cantilevered grade beam foundations, removal of threatened outbuildings, etc. Protection structures should use soft materials rather than hard.
- Relocation of threatened structures further inland on parcels shall be favored over installation of coastal protection structures.
- The siting of new major improvements shall consider accelerated rates of sea cliff retreat associated with climate change-induced sea level rise as projected by the State of California, or an area- or site-specific geologic investigation that accounts for climate change.

88. Cliff erosion policies (City program; target 2020)
Consider additional policies as part of future adaptation planning for sea cliff retreat.

a. Identify policy for relocation of structures as setback distance from cliff edge decreases and risk of failure increases.
b. Identify further policies or programs for control of drainage and runoff to reduce potential for sea cliff failures from terrestrial processes.

89. Shoreline management plan (GP policy PS10.3; target 2020; ongoing)
Develop a comprehensive Shoreline Management Plan to identify, manage and to the extent feasible mitigate or reduce climate change-induced sea level rise impacts on public facilities and private property along the City shoreline. Continue coordination with the Beach Erosion Authority for Clean Oceans and Nourishment (BEACON), the County, other South Coast cities, and UCSB to manage coastal issues including:

a. Protection/restoration of natural sand transport and sand supply replenishment projects;
b. Natural bluff restoration, stabilization and erosion control measures;
c. Non-intrusive methods to slow sand transport and retain sand along the beaches that front the City's bluffs; and
d. Funding mechanisms to implement beach replenishment and methods to reduce bluff retreat.

90. Beach erosion policies (City program; target 2020)
Consider the following policies as part of future adaptation planning for beach erosion.

a. Allow beaches to gradually retreat.
b. Utilize beach nourishment along with sand retention structures for maintaining beach width over near to intermediate term period.
c. Consider selective removal of back beach barriers to allow beaches to migrate landward.

91. ***Coastal ecosystems study*** (City/joint agency program; target 2020)
Seek grant funding for a joint research study in cooperation with other South Coast agencies to evaluate vulnerability and adaptation of coastal ecosystems to climate change effects, including consideration of wetlands, beach & sand dune habitats, riparian areas, intertidal zone, and offshore kelp forests.

Public services

92. Water supply planning (GP policy PS4; target 2015, ongoing).
The Long Term Water Supply Plan update process should assess and plan for potential water supply effects of climate change and identify feasible means of tracking the development of such impacts. *[Note: 2011 LTWSP update considered climate effects.]*

93. Regional cooperation on water supply reliability (GP policy PS7; ongoing).
Continue to work with the County and other jurisdictions to develop regional programs and projects to improve water supply reliability.

94. Local food cultivation (GP policies ER18, 19, 20, 21, 22; target 2030)
Support cultivation and marketing of local food.

a. *Farmers Markets.* Continue to support local farmers markets, and expand locations to include neighborhood locations consistent with Sustainable Neighborhood Plans, expand infrastructure to support them, and expand hours of operations.

b. *Gardener Education.* Continue to support the City/County/SBCC Green Gardener training program, and expand community and school educational programs for producing gardens year-round using sustainable gardening practices. Encourage the use of fruit trees in landscaping where appropriate.

c. *Food Scrap Recovery and Composting Program.* Continue and expand the City program for diversion of food scraps from landfill disposal, to be composted for use as soil amendments so long as economically viable.

95. Community gardens (GP policies OP1.5; ER21, ER22; target 2030)
Support establishment of community gardens.

a. *Community gardens on vacant land.* Establish a program for use of vacant or underutilized properties (not within creek setbacks) for temporary community gardens throughout the City, to enable residents who do not have access to land to grow food, orchards, or other crops.

b. *Public and Private Food Gardens.* Provide for infrastructure to support local community gardens. With neighborhood support, develop publicly-available edible landscaping in existing and new parks. Reserve space for public gardening within the urban core area to be maintained by the community. Design for green roofs and urban rooftop gardens in residential development Downtown.

c. *Food Gardens for Schools.* Work with the Santa Barbara School Districts to develop organic gardens at schools and a healthy and waste-free lunch program.

96. Regional agriculture (GP Policy ER23; ongoing to 2030).
Support regional coordination toward expanding local sustainable food sources. Support incentives for maintaining and establishing additional agricultural farms and farm stands within the City, the South Coast, and tri-county areas. Support directing local food to our schools, cafeterias, groceries, convenience stores, and restaurants.

Biological resources

97. Wildlife, coastal, & native plant habitat protection (ER12-12.5; target 2020, ongoing)
Protect, maintain, and to the extent reasonably possible, expand the City's remaining diverse native plant and wildlife habitats, including ocean, wetland, coastal, creek, foothill, and urban-adapted habitats.

a. *Designate habitats.* Map and designate important City upland habitats and wildlife corridors that merit long-term protection, enhancement, and preservation for habitat and wildlife values. Include criteria and monitoring objectives such as largest areas of contiguous coastal sage scrub (generally five acres or greater), oak woodlands (generally one-half acre or greater), perennial grasslands (generally 0.25 acres or greater), annual grasslands (generally five acres or greater), and important wildlife movement corridors.

b. *Multi-use plan for coast and native habitat restoration.* Develop updated multi-use plans and monitoring guidelines for publicly owned beaches and other coastal areas to provide for both recreational uses and protection of coastal habitats and wildlife/native plant species. Incorporate as part of the Multi-Use Plan, a Waterfront habitat and wildlife management program that provides measures to improve the extent and quality of native coastal habitats within the City Waterfront, with the following goals:

   1) Restoration and protection of remnant coastal sand dune habitat along the City Waterfront, including the removal of non-native and/or invasive plants.

   2) Restoration and enhancement of the estuaries of Mission and Sycamore creeks and the Laguna Channel, including appropriate revegetation and removal and control of invasive species. Measures should be considered to improve these estuaries where feasible to maximize biological productivity and ecological function taking into consideration the dynamics of ocean waves and currents and ongoing movement of sand along the City coast.

   3) A public access management plan that maintains public access to and along the shoreline, but channels the public to appropriate access locations as needed through sensitive habitat areas of the beach.

c. Coastal bluff habitat restoration program and protection

   1) Coastal Bluff Scrub Protection. Site and design new development or major remodels/expansions along the City coastal bluffs (including access, drainage, and landscape improvements) to:
      - minimize impacts to coastal bluff scrub habitat;
      - include provisions for habitat restoration of coastal bluff scrub habitats where development creates direct or indirect impacts to affected habitat;
      - provide compatible landscaping within 10 feet of the edge of the bluff or on the bluff face, consisting of appropriate native coastal bluff scrub species.

   2) Coastal Bluff Restoration. Establish a goal to restore 5.0 acres of coastal bluff habitat over the 20-year life of Plan Santa Barbara.

   3) Restoration on Publicly Owned Lands. Work to increase the acreage of coastal bluff scrub through restoration projects on publicly owned lands along Shoreline Park and the Douglas Family Preserve, and through providing education and assistance to private landowners to encourage the restoration of such habitats.

d. *Native species habitat planning.* Protect and restore habitat areas for native flora and fauna, and wildlife corridors within the City, including for chaparral, oak woodland, and riparian areas. In particular, provide land use/design guidelines to:

1) Require buildings and other elements of the built environment, and landscaping to be designed to enhance the wildlife corridor network as habitat.

2) Ensure that the City and new development preserve existing trees within identified wildlife corridors, and promote planting new trees, and installing and maintaining appropriate native landscaping in new developments within or adjacent to important upland wildlife corridors and all streams. Ensure that efforts are made to minimize disturbance to understory vegetation, soils, and any aquatic habitats that are present below the trees in order to provide movement of species that utilize the habitat.

3) Ensure that new development and redevelopment projects will not result in a net reduction or loss in size and value of native riparian habitats.

4) Increase riparian habitat within the City and / or its sphere of influence by 20 acres or more, and 1 linear mile or more, over the 20-year life of Plan Santa Barbara. Priorities for restoration include perennial reaches of the major streams, reaches of creek on publicly owned land, and degraded areas of the City's three major creeks.

e. *Riparian woodland protection*. Site new development outside of riparian woodlands to the extent feasible. Within and adjacent to riparian woodlands:

1) Avoid removal of mature native trees;

2) Preserve and protect native tree saplings and understory vegetation;

3) Provide landscaping within creek setback compatible with the continuation and enhancement of the habitat area, consisting primarily of appropriate native species and excluding use of invasive non-native species;

4) Include conditions of approval for habitat restoration of degraded oak woodlands where such development creates direct or indirect impacts to affected habitat;

5) Include water quality protection and enhancement measures consistent with the adopted City Storm Water Management Plan.

98. Open space connectivity and trails (OP1.2, ER13, OP1.3, OP2; OP2.3; target 2020, ongoing) Protect and enhance contiguous open space and connectivity.

a. *Open space preservation*. Identify key open space areas that merit long-term protection and take actions to preserve as passive open space, focusing on larger areas of contiguous open space.

b. *Trails management*. Existing and future trails along creeks or in other natural settings shall be managed for both passive recreational use and as native species habitat and corridors.

c. *Open space policies for development*. All new development within identified key open space areas shall be sited and designed to preserve contiguous tracts of open space and connectivity with open space on adjacent parcels, including connectivity of habitats and wildlife corridors.

d. *Open space funding*. Develop funding options to support acquisition and maintenance of public open space including access and connectivity between open spaces. Establish requirements that new development and redevelopment contribute commensurate with the incremental need generated.

e. *Regional open space*. Coordinate with the County of Santa Barbara, School District, and recreational service providers in the cities of Goleta and Carpinteria on regional open space protection.

99. Creek setbacks, protection, restoration (ER17, ER17.1-ER17.4; target 2020, ongoing)
Protection and restoration of creeks and their riparian corridors is a priority for improving biological values, water quality, open space and flood control in conjunction with adaptation planning for climate change.

a. *Creek setback standards*. Establish updated creek setback and restoration standards for new development and redevelopment along all creeks, and prepare or update guidelines for restoration, increase of pervious surfaces and appropriate land uses within designated creek side buffers.

1) Develop setback standards of greater than 25 feet from the top of bank for new structures and hard surfaces adjacent to creeks and wetlands.
2) At a given site, creek buffers should be adequate for protection from flood, erosion, and geologic hazards, and to provide habitat support.
3) In developing creek setback and restoration standards, consider applicable creek standards in surrounding jurisdictions and the Santa Barbara County Flood Control District general recommendation for new development setbacks of 50 feet from the top of bank of major creeks with natural creek banks, with a reduction up to 25 feet where “hard bank” protection is present.
4) For new development that is closer than 50 feet to the top of the bank of any major stream, creek bank stabilization shall be provided through planting of native trees and shrubs on creek banks and along the top of banks to minimize erosion and the potential for bank failure.
5) When the City determines that a structure must be constructed within proposed creek setbacks or where a project would be exposed to unusually high risk of bank erosion or collapse, non-intrusive bank stabilization methods such as bio-engineering techniques (e.g. revegetation, tree revetment, native material revetment, etc.) shall be used where feasible rather than hard bank solutions such as rip-rap or concrete.

b. *Creekside development guidelines.* Establish design guidelines for development and redevelopment near creeks, such as measures to orient development toward creeks, and better incorporate creeks as part of landscape and open space design. Utilize native riparian palettes for landscaping along creeks, and prohibit the use of non-native invasive plants. Encourage public creek side pedestrian paths where appropriate to increase connectivity and provide pocket parks and signage to improve public awareness and enjoyment of the City's creeks.

c. *Creek naturalization.* Prohibit the placement of concrete or other impervious material into or piping of major creeks and primary tributaries except for water supply projects or flood control projects that are necessary for public safety, or to maintain or repair a structure that protects existing development. These protection measures shall only be used for water supply or flood control purposes where no other less environmentally damaging method is available and the project has been designed to minimize damage to creeks, wetlands, water quality, and riparian habitats.

   Whenever feasible, existing concrete lining shall be removed from creek channels, and reaches of drainages that have been previously under-grounded shall be "day lighted".

d. *Surface water drainage restoration.* Set a goal to restore or daylight a total of at least .5 miles of surface water drainages over the life of Plan Santa Barbara. Priority areas for restoration include segments of Mission Creek consistent with sound flood control practices, the reach of Arroyo Hondo Creek through City College, the tributary to Arroyo Burro Creek west of Las Positas Road, and the segment of Arroyo Burro Creek adjacent to La Cumbre Plaza.

Also see tree and vegetation protection measures in carbon reduction strategies (Section 2.3 vegetation).

Local economies

100. Coordinate with local business sectors (City program; 2015,ongoing)
Include local industries that may be affected by climate changes, including fisheries and tourism, in adaptation planning processes.