2.5 Climate Change and Greenhouse Gases

Global climate change (GCC) poses an immediate threat to the Bay Area's economy, environment, and public health. The anticipated impacts of climate change in California range from water shortages to inundation from sea level rise. Transportation systems contribute to climate change primarily through the emissions of certain greenhouse gases (CO_2, CH_4, and N_2O) from nonrenewable energy (primarily gasoline and diesel fuels) used to operate passenger, commercial and transit vehicles. Land use changes contribute to climate change through construction and operational use of electricity and natural gas, and waste production.

This section of the EIR analyzes quantitatively how implementation of the proposed Plan Bay Area may contribute to global climate change through greenhouse gas emissions related to transportation and land uses. In addition, the analysis qualitatively describes the potential impacts of sea level rise on the proposed regional land use patterns included in the Plan, as well as on the proposed transportation investment projects.

Environmental Setting

PHYSICAL SETTING

Global Climate Change

Climate is defined as the average statistics of weather, which include temperature, precipitation, and seasonal patterns such as storms and wind, in a particular region. Global climate change refers to the long term and irrevocable shift in these weather related patterns. Using ice cores and geological records, baseline temperature and CO_2 data extends back to previous ice ages thousands of years ago. Over the last 10,000 years, the rate of temperature change has typically been incremental, with warming and cooling occurring over the course of thousands of years. However, scientists have observed an unprecedented increase in the rate of warming over the past 150 years, roughly coinciding with the global industrial revolution, which has introduced tremendous amounts of greenhouse gases (defined below) into the atmosphere.

Climate modeling capabilities have been greatly enhanced in recent years allowing for the future range of climate change effects to be better understood. However, there are limitations to representing the antici-

pated changes at a downscaled or regional level. What is certain is that, even if specifics are unknown, the global forecasted future trends will still apply at a local level.

The world's leading climate scientists—the IPCC[1]—have reached consensus that global climate change is "very likely" caused by humans, and that hotter temperatures and rising sea levels will continue for centuries. The rate at which these changes occur will be affected by current and future anthropogenic emissions. In particular, human influences have:

- *Very likely* contributed to sea level rise and increased storm surge during the latter half of the 20th century;
- *Likely* contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns;
- *Likely* increased temperatures of extreme hot nights, cold nights and cold days; and
- *More likely than not* increased risk of heat waves, area affected by drought since the 1970s, and frequency of heavy precipitation events.[2]

The IPCC predicts that the global mean temperature increase between 1990 and 2100 could range from 2.0 to 11.5 degrees Fahrenheit. They project a sea level rise of seven to 23 inches (0.2 to 0.6 meters) by the end of the century, with a greater rise possible depending on the rate of polar ice sheet melting.

According to the California Energy Commission (CEC), accelerating GCC has the potential to cause adverse impacts in the Bay Area[3], including but not limited to:

- *Water Supply:* Changes in local rainfall, salt water intrusion, sea water flooding the delta, and a reduced Sierra snowpack can all threaten the Bay Area's water supply.
- *Infrastructure:* Increased risks of flooding due to sea level rise, coastal erosion, more frequent and extreme storms, and stronger precipitation events may lead to damage, inoperability, or impairment of critical infrastructure such as wastewater treatment plants, sewage, power plants, and transportation. This would affect not only daily commutes and activities, but also emergency response.

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[1] The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP). Its role is to assess, on a comprehensive, objective, open and transparent basis, the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts, and options for adaptation and mitigation.

[2] Intergovernmental Panel on Climate Change, 2007a.

[3] Climate Change Impacts, Vulnerabilities, and Adaptation in the San Francisco Bay Area: A synthesis of PIER Program Reports and Other Relevant Research. A white paper from the CEC's California Climate Change Center. CEC-500-2012-071. July 2012.

- *Agriculture:* Changes in temperatures, more extreme heat days, and the earlier onset of spring may lead to suboptimal growing conditions for grapes and other agricultural products that significantly contribute to the Bay Area economy and tourism.

- *Ecosystems and Biodiversity:* With sea level rise, the Bay Area's coastal wetlands are threatened and cannot naturally move inland due to existing developments, thus destroying this important ecosystem. This threatens the region's freshwater fish species and may allow non-native species to thrive. Increased temperatures also result in increased fire risk.
- *Energy Demand, Supply, and Transmission:* Energy demand will increase as temperature extremes become more common. This could lead to rolling blackouts or other issues with the Bay Area's aging energy infrastructure.
- *Public Health:* Most Bay Area residences and businesses were not built with air conditioning to control temperatures on extreme heat days, which may lead to heat stroke. Higher temperatures also lead to worsened air quality and potentially the spread of diseases and pests. Increased incidence and severity of wildfires may also contribute to worsening air quality. These changes will disproportionately burden children, the elderly, and those with pre-existing health conditions.

Greenhouse Gases

Gases that trap heat in the Earth's atmosphere are called greenhouse gases (GHGs). These gases play a critical role in determining the Earth's surface temperature. Part of the solar radiation that would have been reflected back into space is absorbed by these gases, resulting in a warming of the atmosphere. Without natural GHGs, the Earth's surface would be about 61 degrees cooler.[4] This phenomenon is known as the greenhouse effect. However, scientists have proven that emissions from human activities—such as electricity generation, vehicle emissions, and even farming and forestry practices—have elevated the concentration of GHGs in the atmosphere beyond naturally-occurring concentrations, enhancing the greenhouse effect and contributing to the larger process of global climate change. The six primary GHGs are:

- **Carbon Dioxide (CO_2),** emitted when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned;
- **Methane (CH_4),** produced through the anaerobic decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, incomplete fossil fuel combustion, and water and wastewater treatment;
- **Nitrous oxide (N_2O),** typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning;
- **Hydrofluorocarbons (HFCs),** primarily used as refrigerants;
- **Perfluorocarbons (PFCs),** originally introduced as alternatives to ozone depleting substances and typically emitted as by-products of industrial and manufacturing processes; and

[4] California Climate Action Team, 2006.

- **Sulfur hexafluoride (SF_6),** primarily used in electrical transmission and distribution.

Though there are other contributors to global warming[5], these six GHGs are identified explicitly by the US Environmental Protection Agency (EPA) as threatening the public health and welfare of current and future generations[6]. GHGs have varying potential to trap heat in the atmosphere, known as global warming potential (GWP), and atmospheric lifetimes. GWPs reflect how long GHGs remains in the atmosphere, on average, and how strongly they absorb energy. Gases with a higher GWP absorb more energy per pound than gases with a lower GWP, and thus contribute more to warming Earth. For example, one ton of CH_4 has the same contribution to the greenhouse effect as approximately 23 tons of CO_2; hence, CH_4 has a 100-year GWP of 23 while CO_2 has a GWP of 1.[7] GWP ranges from 1 (carbon dioxide) to 22,000 (sulfur hexafluoride). GWP is alternatively described as "carbon dioxide equivalents", or CO_2e. The parameter "atmospheric lifetime" describes how long the molecules will remain in the atmosphere. Atmospheric lifetimes of GHGs range from tens to thousands of years. All of these gases remain in the atmosphere long enough to become well mixed. The amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.

California and Bay Area GHG Emissions

GHG emissions contributing to global climate change are attributable in large part to human activities associated with the electricity, transportation, industrial, commercial, residential, and agricultural/forestry sectors. The State of California alone produces about 2 percent of the entire world's GHG emissions, with major emitting sources here including fossil fuel consumption from transportation (38 percent), electricity production (23 percent), industry (20 percent), agricultural and forestry (7 percent), residential (6 percent), and commercial (4 percent)[8]. Much like nations around the world, California government is putting in place programs and legislation to drastically reduce GHG emissions with the hope of thereby delaying, mitigating, or preventing at least some of the anticipated impacts of GCC on California communities.

Furthermore, local and regional agencies in the Bay Area have taken steps to measure, quantify, evaluate, and mitigate their contributions to GHG emissions and GCC. For example, 45 cities and counties in the Bay Area have already developed their own climate action plans and 101 have completed GHG emissions

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[5] Diesel particulate matter, which is also referred to as black carbon, is a strong absorber of solar radiation; scientists have known for many years that when black carbon particles combine with dust and chemicals in air they become more efficient in absorbing solar radiation. Black carbon constitutes the largest uncertainty in current predictions of climate change in global climate models. See California Air Resources Board, Climate Change – Characterization of Black Carbon and Organic Carbon Air Pollution Emissions and Evaluation of Measurement Methods, page 1, available at http://www.arb.ca.gov/research/apr/past/04-307_v2.pdf [as of August 22, 2012]. See also Chapter 2.2: Air Quality of this EIR for an analysis of diesel particulate matter emissions.

[6] Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, Final Rule, Federal Register, Docket ID No. EPA-HQ-OAR-2009-0171, December 14, 2009.

[7] California Climate Action Registry, General Reporting Protocol Version 3.1, 2009.

[8] California Air Resources Board Greenhouse Gas Inventory Data 2000-2009.

inventories.[9] Additionally, many cities, business, and municipal agencies are voluntary members of the Climate Action Registry, a private non-profit organization originally formed by the State of California that serves as a voluntary GHG registry to protect and promote early actions to reduce GHG emissions by organizations.

In 2010, the Bay Area Air Quality Management District (BAAQMD) updated a baseline inventory of GHG emissions for the year 2007. According to that inventory, 95.8 million tons of CO_2e were emitted in the Bay Area in 2007.[10] **Table 2.5-1** shows the emissions breakdown by pollutant.

TABLE 2.5-1: 2007 BAY AREA CO_2E EMISSIONS BY POLLUTANT

Pollutant	*Percentage*	*CO_2e (Million Metric Tons/Year)*
Carbon Dioxide	92	88
Methane	3	3
Nitrous Oxide	2	2
HFC, PFC, SF_6	4	4
Total	**100**	**96**

Source: Bay Area Air Quality Management District, Source Inventory of Bay Area Greenhouse Gas Emissions, Updated 2010.

The Bay Area's transportation sector alone contributes 36 percent of the CO_2e GHG emissions, tied with industrial and commercial sources (36 percent), and followed by energy production activities (electricity generation and co-generation) (16 percent), residential fuel use (7 percent), off road equipment (3 percent), and agriculture/farming (1 percent). Bay Area emissions by sector are illustrated in **Figure 2.5-1**.

Before accounting for regulations that have been adopted since 2007, Bay Area GHG emissions were expected to grow at a rate of 1.4 percent a year due to population growth and economic expansion.[11] Economic activity variations and the fraction of electric power generation in the region[12] will cause year-to-year fluctuations in the emissions trends. **Figure 2.5-2** shows the emission trends by major sources for the period of 1990 to 2029.

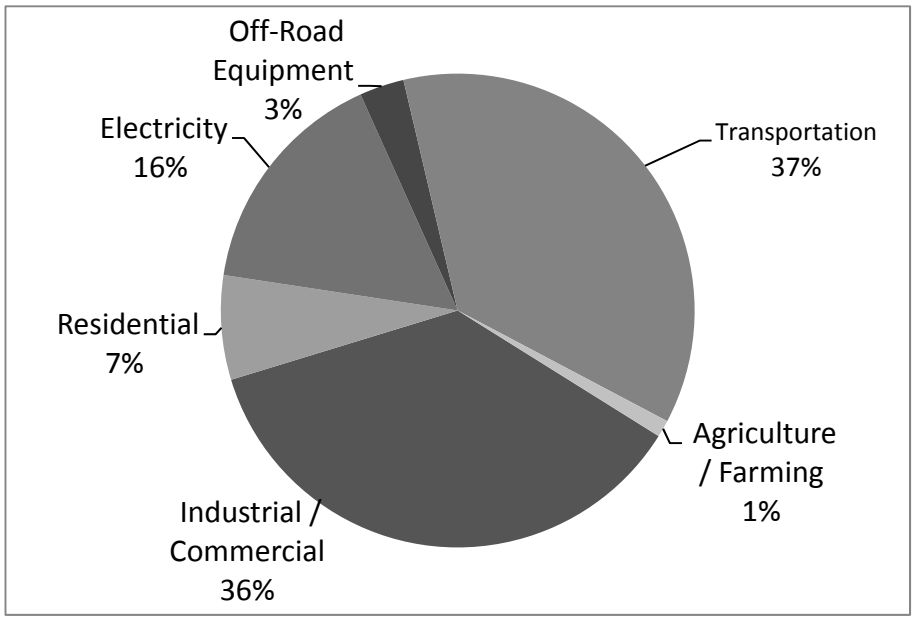
[9] Bay Area Air Quality Management Office, SF Bay Area Climate Portal, 2012.

[10] Bay Area Air Quality Management District, Source Inventory of Bay Area Greenhouse Gas Emissions, Updated February 2010.

[11] Ibid.

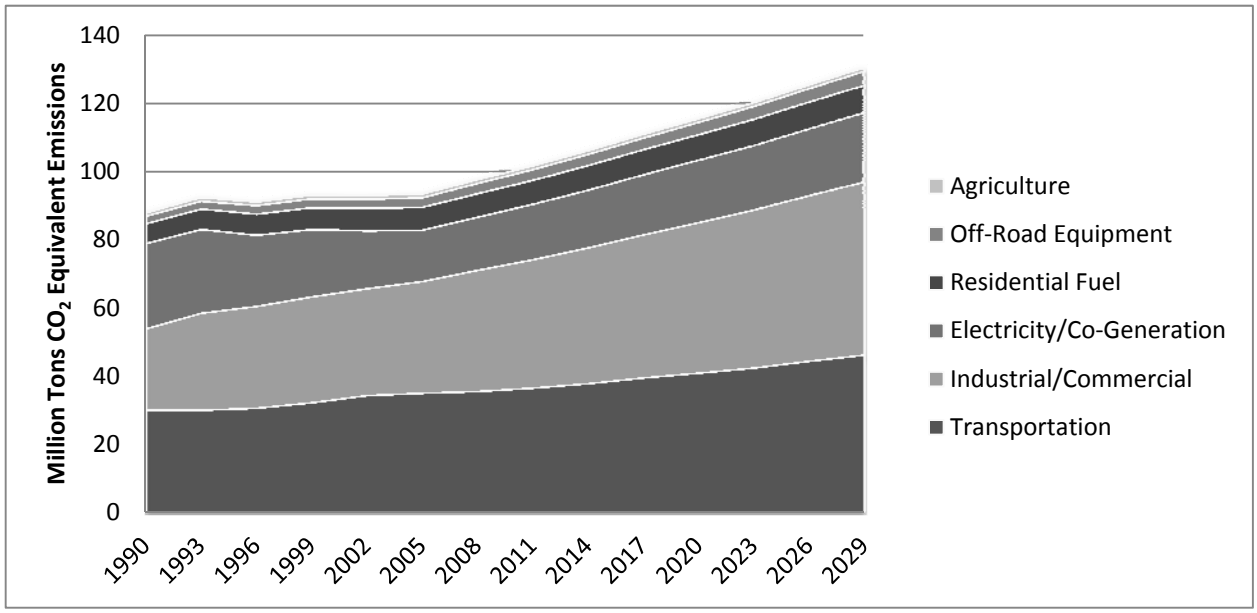
[12] Ibid. Electric power generation includes fossil fuels, imports, and co-generation, as well as more generalized electricity generation. Year-to-year variation in the Bay Area depends on several factors including the availability of hydroelectric and other imported power.

Figure 2.5-1: 2007 Bay Area Greenhouse Gas Emissions by Sector, as a Percent of Total Emissions



Source: Bay Area Air Quality Management District, Source Inventory of Bay Area Greenhouse Gas Emissions, Updated 2010.

Figure 2.5-2: Bay Area Greenhouse Gas Emissions Trends by Major Source



Source: Bay Area Air Quality Management District, Source Inventory of Bay Area Greenhouse Gas Emissions, Updated 2010.

Sea Level Rise

Historical Data

Sea levels began rising globally at the end of the last ice age more than 10,000 years ago.[13] Data on ocean water levels is collected continuously from a worldwide network of more than 1,750 tidal gages, and new satellite-based sensors are extending these measurements. The data indicates that the global mean sea level is rising at an increasing rate, and sea level rise is already affecting much of California's coastal region, including the San Francisco Bay and its upper estuary (the Sacramento-San Joaquin Delta). Water level measurements from the San Francisco Presidio gage (CA Station ID: 9414290), indicate that mean sea level rose by an average of 0.08 ± 0.008 inches per year (reported as 2.01 ± 0.21 millimeters per year) from 1897 to 2006, equivalent to a change of about eight inches in the last century.[14]

According to California's Ocean Protection Council Science Advisory Team, future sea level rise projections should not be based on linear extrapolation of historic sea level observations. For estimates beyond one or two decades, linear extrapolation of sea level rise based on historic observations is considered inadequate and would likely underestimate the actual sea level rise because of expected non-linear increases in global temperature and the unpredictability of complex natural systems.[15]

Projected Climate Conditions

Global and regional climate models can be used to project the range of estimated sea level rise rates based on emission scenarios and climate simulations. Global climate models are based on well-established physical principles and have been demonstrated to reproduce observed features of recent climate and past climate changes.[16] Global models provide information about climate response to various scenarios, but usually at a low resolution that does not provide the level of detail needed to make planning decisions at a local level. A regional-based model can provide an evaluation of climate processes that are unresolved at the global model scale. There is a broad range of regional-based climate models from the sub-continental-scale with a resolution of approximately 50 kilometers, to a local-scale with resolution of approximately

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[13] United States Geological Survey. Sea Level and Climate. USGS Fact Sheet 002-00. January 2000.

[14] Heberger, Matthew, Heather Cooley, Pablo Herrera, Peter H. Gleick, and Eli Moore. The Impacts of Sea Level Rise on the California Coast. A Paper From: California Climate Change Center. CEC-500-2009-024-F. May 2009.

[15] Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team. State of California Sea-Level Rise Interim Guidance Document. Developed with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust, October 2010.

[16] Intergovernmental Panel on Climate Change. Climate Models and Their Evaluation. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Randall, D.A., R.A. Wood, S. Bony, R. Colman, T. Fichefet, J. Fyfe, V. Kattsov, A. Pitman, J. Shukla, J. Srinivasan, R.J. Stouffer, A. Sumi and K.E. Taylor]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.

one to five kilometers.[17] The resolution is typically determined based on the size of the study area and by climate-relevant features such as topography and land cover, and the specific processes to be evaluated. Regional-based climate models that provide locally-relevant climate information are based on model output from global models, and the scale and resolution of the regional-based climate models vary widely depending on the original application and intent of the developed model.

Global Climate Projections

In order to evaluate climate change effects such as sea level rise, the IPCC developed future emission scenarios that differ based on varying assumptions about economic development, population, regulation, and technology. Three of IPCC's emission scenarios were chosen to develop a range of sea level rise projections: the A2 high-emissions scenario, B1 low-emissions scenario, and the A1F1 fast-paced high-emission scenarios.

The A2 high-emission scenario most closely represents the business-as-usual condition. Under this scenario, the world's population exceeds 10 billion by 2050, and atmospheric CO_2 concentrations at the middle and end of the 21st century in this scenario would be about 575 and 870 parts per million (ppm), respectively, which exceeds concentrations associated with dangerous climate change (at ~350 to 400 ppm).

Under the B1 low-emission scenario, global population would peak by midcentury, then decline. The low-emission scenario also includes a shift to less fossil fuel-intensive industries and increased use of clean and resource-efficient technologies. Atmospheric CO_2 concentrations would reach 550 ppm by 2100, below catastrophic levels, but about double pre-industrial levels (~280 ppm).

The A1Fl future scenario describes a world characterized by rapid economic growth. Global population would peak at midcentury and decline thereafter. New and more efficient technologies would be rapidly introduced. However, fossil fuels would remain the primary energy supply, and atmospheric carbon dioxide concentrations would reach 940 ppm by 2100—more than triple pre-industrial levels, and more than double the level associated with dangerous climate change.

[17] Intergovernmental Panel on Climate Change. Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.

Sea Level Rise Projections

The 2007 IPCC reports estimated that global mean sea levels were projected to rise by 0.2 meters (m) to 0.6 m by 2100, relative to a 1980 to 2000 baseline, depending on future GHG emissions.[18] However, these projections were found to under-predict sea level rise primarily because of the limited ability of global climate models to simulate the dynamics of ice sheets and glaciers.[19] The sea level rise projections associated with the IPCC emission scenarios were subsequently updated to include the dynamics of ice sheets and glaciers, as shown in **Table 2.5-2**.[20]

Sea Level Rise in San Francisco Bay

Table 2.5-2 presents the sea level projections adopted in the California Sea Level Rise Interim Guidance Document.[21] Additional research regarding global and regional sea level rise has occurred since this guidance document was adopted. A 2012 report by the National Research Council (NRC) assessed historic and projected sea level rise for specific locations along the open Pacific coasts of California, Oregon, and Washington. **Table 2.5-3** presents the study findings for local sea level rise near San Francisco.[22] In general, the sea level rise projections presented for San Francisco in **Table 2.5-3** are similar to the projections adopted by the State of California presented in **Table 2.5-2**.

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[18] Using three emission scenarios: A2 (High Emissions Scenario), B1 (Low Emissions Scenario) and A1Fl (Fast-Paced High-Emissions Scenario). See Intergovernmental Panel on Climate Change Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao, 2007]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.

[19] Ibid.

[20] Rahmstorf, Stefan, and Martin Vermeer.Proceedings of the National Academy of Sciences, Published online before print December 7, 2009, doi: 10.1073/pnas.0907765106, PNAS December 22, 2009 vol. 106 no. 51 21527-21532.

[21] Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team, October 2010.

[22] National Research Council. Sea-level rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Prepared by the Committee on Sea Level Rise in California, Oregon, and Washington and the National Research Council Board on Earth Sciences and Resources and Ocean Studies Board Division on Earth and Life Studies. Pre-publication copy, 2012

TABLE 2.5-2: CO-CAT (2010) SEA LEVEL RISE PROJECTIONS USING 2000 AS THE BASELINE

Year	*Emissions Scenario*	*Range of Models, inches above 2000**	*Average of Models, inches above 2000**
2030		5 - 8 in	7 in
2050		10 - 17 in	14 in
	Low (B1)	17 - 27 in	23 in
2070	Medium (A2)	18 - 29 in	24 in
	High (A1FI)	20 - 32 in	27 in
	Low (B1)	31 - 50 in	40 in
2100	Medium (A2)	37 - 60 in	47 in
	High (A1FI)	43 - 69 in	55 in

***Note:** Rahmstorf and Vermeer's paper presents values using 1990 as a baseline. Here the values are adjusted by subtracting 3.4 cm, which represents 10 years of sea-level rise that has already occurred, at an average rate of 3.4 mm/year.

Source: California Ocean Protection Council (CO-CAT) 2010.

TABLE 2.5-3: NRC (2012) REGIONAL SEA LEVEL RISE PROJECTIONS NEAR SAN FRANCISCO, CA

Year	*Projection **	*Range *****
2030	6 in ± 2.0 in	1.8 - 11.7 in
2050	11 in ± 3.6 in	4.8 - 23.9 in
2100	36 in ± 10.0 in	16.7 - 65.5 in

* Projection indicated the mean and ± standard deviation computed for the Pacific coast as defined in NRC (2012).

** Ranges are the means for the IPCC B1 and A1F1 scenarios, as presented in NRC (2012).

Source: National Research Council, 2012.

The National Oceanic and Atmospheric Administration (NOAA) Coastal Service Center released sea level rise inundation maps for the San Francisco Bay Area within NOAA's Sea Level Rise and Coastal Flooding Impacts Viewer in September 2012.[23] The NOAA inundation maps depict sea level rise relative to a mean higher high water (MHHW) condition in the Bay. NOAA's inundation maps benefit from using the latest 2010 high-resolution LiDAR (Light Detection and Ranging) topography data funded by the United States Geological Survey (USGS) and NOAA, as well as improved inundation mapping method-

[23] http://www.csc.noaa.gov/digitalcoast/tools/slrviewer

ologies that account for hydraulic connections to the flooding source.[24] This methodology identifies areas that are low-lying, but protected from inundation by levees, other structures, or topographic features, from the projected inundated area. Because these areas are still at risk of inundation, for example, if a levee, topographic feature or structure were to fail, breach, or be overtopped, these areas are typically presented on the inundation maps as potentially vulnerable, but distinguished from unprotected vulnerable areas. **Figure 2.5-3** presents NOAA's sea level rise inundation map with 24 inches of sea level rise. This map focuses on the San Francisco Bay Area as this is where the primary sea level rise inundation occurs. Limited inundation occurs along the California open coast as the inundation mapping does not include the additional impact of waves.

[24] Marcy D., and B. William, and K. Draganoz, B. Hadley, C. Haynes, N. Herold, J. McCombs, M. Pendleton, S. Ryan, K. Schmid, M. Sutherland, and K. Waters. New mapping tool and techniques for visualizing sea level rise and coastal flooding impacts. Proceedings of the 2011 Solutions to Coastal Disasters Conference, Anchorage, AK, June 2011.

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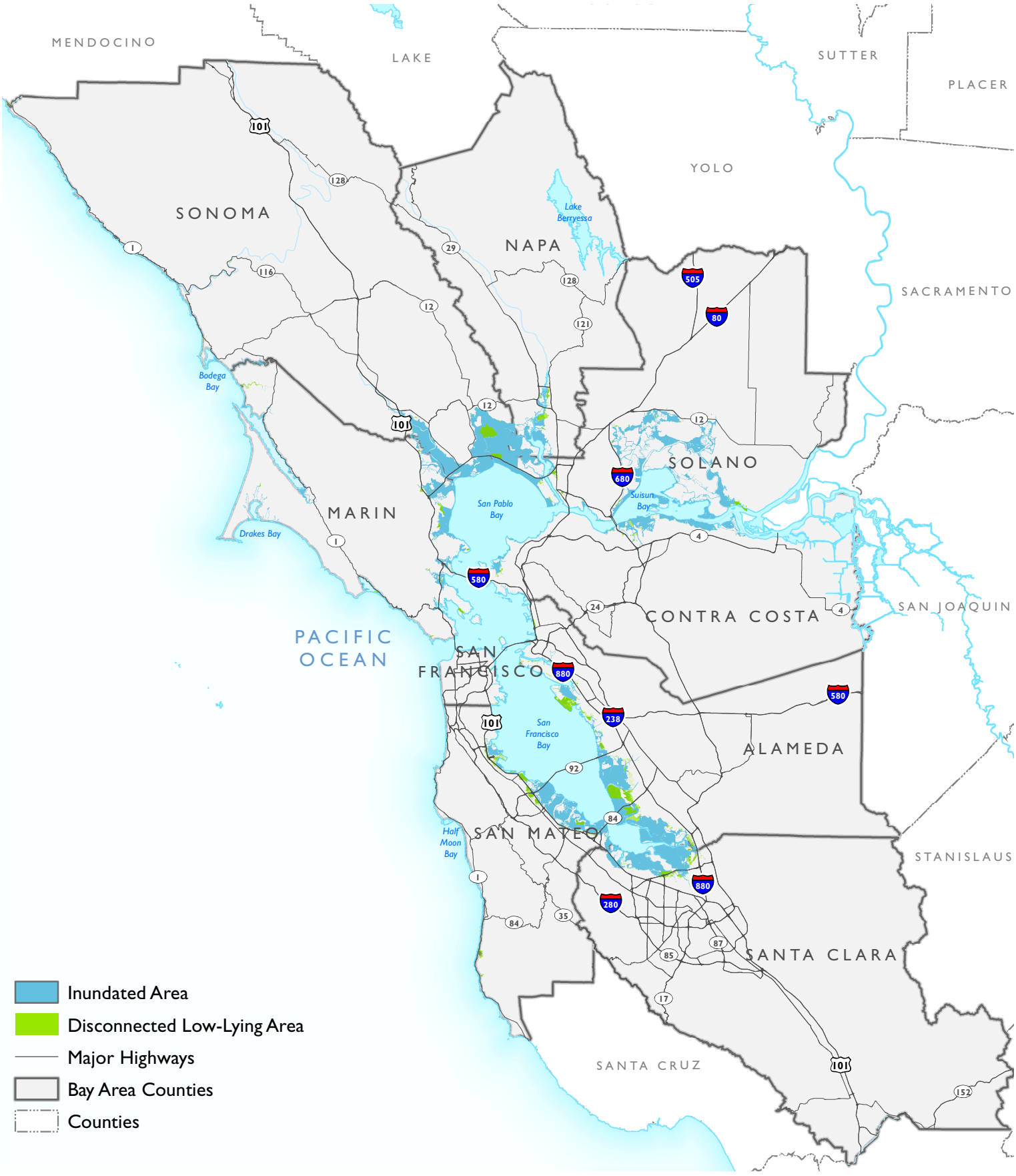
Figure 2.5-3

24-inch Sea Level Rise at Mean Higher High Water



Data Source: NOAA Coastal Services Center Sea Level Rise Inundation Map 2012; AECOM, 2012; Cal-Atlas Geospatial Clearinghouse, 2012; Tom Tom North America, 2011; Dyett & Bhatia, 2012.

0 5 10 20 Miles

1 in = 16 miles

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San Francisco Bay Shoreline

The San Francisco Bay and adjacent Pacific coast shoreline is highly diverse, ranging from natural wetlands with limited inboard (or landward) development, to hardened shorelines with developments built up to, and beyond, the shoreline. The level of coastal flood protection and armoring along the shoreline varies based on the inboard land use, topographic conditions and a site's exposure to extreme water levels and waves – both of which can lead to inland flooding and shoreline erosion. As sea level rises, the exposure to higher water levels and increasing wave hazards will increase along the shoreline, thereby increasing the likelihood for inland inundation and flooding. This section describes the existing shoreline characteristics of the nine Bay Area counties at a high level, using a shoreline categorization approach developed for the Adapting to Rising Tides: Transportation Vulnerability and Risk Assessment Pilot Project.[25]

Shoreline Categories

The Adapting to Rising Tides pilot study reduced the highly varied and diverse shoreline in Alameda County into five categories based on their primary physical characteristics, functions and abilities to inhibit inland inundation. The categories include: engineered flood protection structures (i.e., levees, sea walls), engineered shoreline protection structures (i.e., bulkheads, revetments), non-engineered berms (i.e., salt pond and agricultural berms), wetlands, and natural non-wetland shorelines (i.e., beaches, cliffs). The categories developed for Alameda County reasonably encompass the range of shoreline types found throughout the nine-county San Francisco Bay Area.

The flood and erosion protection value of each shoreline category will vary as sea level rises. Engineered flood protection structures may be most effective for preventing near-term inundation by sea level rise, as they are designed to protect inland areas from flooding and inundation. The level of protection will depend on the height of the structure relative to existing conditions and the rate of sea level rise, as well as the condition of the structure and the potential for levee weakening and thus, levee failure. Any structural failure, regardless of its magnitude or spatial extent, could result in significant inland inundation.

Non-engineered berms are common around the San Francisco Bay shoreline. Non-engineered berms protect marshes, ponds, and agricultural areas from wave erosion and provide flood protection to inland developments. These berms are often comprised of Bay mud that has been excavated from the Bay floor and piled and/or stacked in a mound. Many non-engineered berms have been in place around the Bay for several decades, with some dating back over 100 years. Most berms are periodically maintained to compensate for settlement, erosion, failure and rising sea levels. Several areas around the Bay contain extensive networks of non-engineered berms that provide multiple lines of flood defense between the Bay and developed areas. However, the non-engineered nature of their construction typically classifies them as highly vulnerable to sea level rise and seismic events.

Figure 2.5-4 depicts the locations of the engineered levees and non-engineered berms within the low-lying areas adjacent to the Bay, based on the Federal Emergency Management Agency's (FEMA) Mid-

[25] Adapting to Rising Tides: Transportation Vulnerability and Risk Assessment Pilot Project. MTC, BCDC, and Caltrans with technical assistance from AECOM. November 2011. Funded in part by FHWA.

term Levee Inventory (MLI).[26] This data set does not distinguish between engineered levees and non-engineered berms.

Engineered shoreline protection structures harden the shoreline to reduce erosion and prevent land loss. These structures, by themselves, are not designed to provide flood protection. As sea levels rise, the functionality and stability of revetments can be compromised, particularly if erosive wave forces also increase. As wave conditions exceed the design conditions, the structure could fail, resulting in severe erosion and land loss.

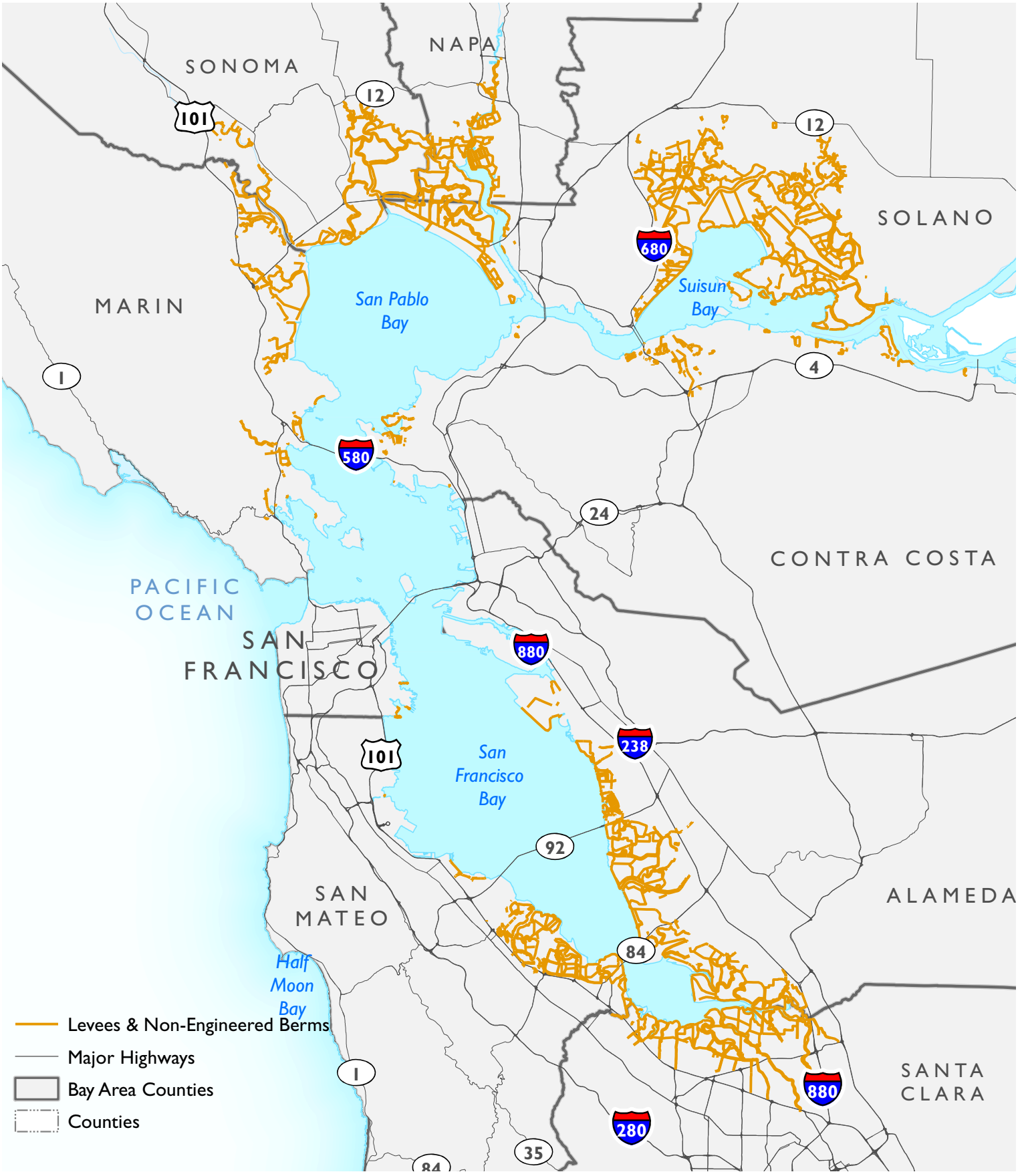
Wetlands dissipate wave energy and provide ecological habitat value. Although many wetlands around the Bay have historically kept pace with sea level rise, it is not known if wetlands will continue to keep pace with the projected accelerated rates of sea level rise.

Other natural or managed non-wetland shorelines, such as natural or artificially maintained beaches, can also provide some wave energy dissipation. San Francisco Bay has a variety of non-wetland natural shorelines, such as beaches, steep slopes, and cliffs. Beaches, whether natural or artificially nourished, are the most vulnerable to rising sea levels. Steep natural slopes and cliffs can also be vulnerable to sea level rise and shoreline erosion, particularly in areas with a dynamic wave climate.

[26] Federal Emergency Management Agency. Midterm Levee Inventory Project Summary Report: Standard Operations Task Order 4. August 1, 2012.

Figure 2.5-4

Levees and Non-Engineered Berms



Data Source: FEMA, Mid-Term Levee Inventory, 2012; AECOM, 2012; Cal-Atlas Geospatial Clearinghouse, 2012; Tom Tom North America, 2011; Dyett & Bhatia, 2012.

0 2.25 4.5 9 Miles

1 in = 8 miles

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Air Quality and Public Health

The negative effects of climate change on air quality in the Bay Area will significantly impact public health, largely through increasing levels of ozone and fine particulate matter (PM). These pollutants will increase through emissions from wildfires and more frequent and longer-lasting heat waves. The health effects of exposure to both ozone and particulate matter have historically been primarily associated with respiratory ailments, such as asthma and bronchitis. However, in recent years, many epidemiological studies have also been published linking exposure to these pollutants, especially PM, with serious cardiovascular illness, including arterosclerosis, strokes, and heart attacks all of which can cause premature death. A recent study at Rice University indicates that a small but significant percentage of cardiac arrests that occur outside hospitals (which are almost always fatal) appear to be triggered by exposure to increased levels of fine particulate matter and ozone.[27]

Exposure to higher levels of ozone and fine particulate matter tend to disproportionately impact the people in our society that are most vulnerable—children, the elderly and the health-impaired. In addition, many people impacted by poor air quality are also subject to socioeconomic conditions that make them less able to prepare for and cope with these effects of climate change.

Wildfires

Climate change is expected to increase the frequency and severity of wildfires in California by altering precipitation and wind patterns, changing the timing of snowmelt, and inducing longer periods of drought. In addition to the direct threat to human life and property, wildfires emit huge quantities of fine particles such as black carbon, and can cause dramatic short-term spikes in pollution levels, greatly increasing population exposure to PM and other harmful pollutants.

According to the BAAQMD report, *Understanding Particulate Matter: Protecting Public Health in the San Francisco Bay Area*, the rash of wildfires that swept across California in late June 2008 caused ambient concentrations of ozone and PM to soar to unprecedented levels.[28] A recent study found that the PM concentrations from these fires not only reached high levels, but that the PM they released was much more toxic than the PM more typically present in the California atmosphere.[29] Smoke from wildfires can cause a variety of acute health effects, including irritation of the eyes and the respiratory tract, reduced lung function, bronchitis, exacerbation of asthma, and premature death. In addition to these health effects, wildfires also release immense quantities of carbon dioxide stored in trees and vegetation into the atmosphere. Therefore, to the extent that climate change increases wildfires, this will increase atmospheric concentrations of GHGs that contribute to climate change, establishing a feedback loop.

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[27] Raun L, and Ensor K. Association of Out-of-Hospital Cardiac Arrest with Exposure to Fine Particulate and Ozone Ambient Air Pollution from Case-Crossover Analysis Results: Are the Standards Protective? Rice University, October 2012.

[28] During the final week of June 2008, PM2.5 levels increased five or ten-fold compared to normal readings at several Bay Area monitoring stations. *Understanding Particulate Matter: Protecting Public Health in the San Francisco Bay Area*, Bay Area Air Quality Management District, November, 2012.

[29] Wegesser et al. "California Wildfires of 2008: Coarse and Fine Particulate Matter Toxicity." *Environmental Health Perspectives* Volume 117, June 2009

Heat

Rising temperatures due to climate change are likely to have negative effects on air quality and public health in the Bay Area. Ground level ozone—the primary component of smog—is formed through photo-chemical reactions among precursor pollutants. The most important of these precursor pollutants are oxides of nitrogen (NO_2) and volatile organic compounds (VOCs). Higher temperatures lead to greater evaporative emissions of VOCs from sources such as fuel storage tanks and motor vehicle fuel tanks, as well as greater emissions of VOCs from biogenic sources such as trees and vegetation. Increased demand for electricity to power air conditioners can also lead to higher emissions of ozone precursors from power plants. In addition to greater emissions of ozone precursors, ozone levels are also expected to increase because ozone formation is highly temperature-sensitive, increasing rapidly as temperatures rise above 90 degrees Fahrenheit. As the Bay Area experiences more extreme heat days, with higher temperatures during both the days and evenings, higher ozone levels will make it more difficult for the region to attain and maintain air quality standards.

Increasing amounts of ground level ozone pose a significant threat to human health. Breathing ozone can trigger a variety of health problems, such as asthma, bronchitis, impacts to lung function, and chest pains. Recent studies have linked premature death to even short-term exposure to ozone.[30] Certain segments of the population are less able to adapt to extreme weather events than others. The 2009 California Adaptation Strategy highlights "elderly, infants, individuals suffering from chronic heart or lung disease, persons with mental disabilities, the socially and/or economically disadvantaged, and those who work outdoors" as particularly vulnerable.[31] According to a 2011 report by the Union of Concerned Scientists, increases in ozone levels induced by climate change in California could result in nearly 443,000 additional cases of serious respiratory illnesses. These and other health-related impacts could cost more than $729 million (in 2008 dollars) in 2020 alone.[32]

As shown in **Figure 2.5-5** the years in which the Bay Area has greater numbers of days exceeding the 8-hour ozone standard correlate very closely with years in which the region experiences higher temperatures.

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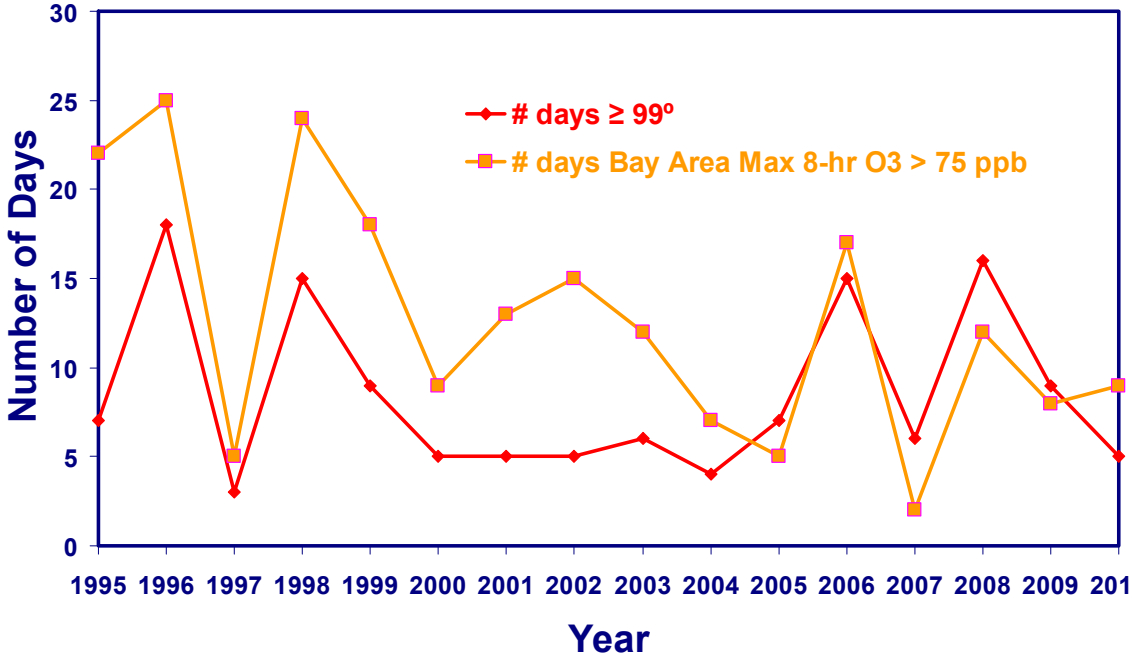
[30] Bell ML, Dominici F, and Samet JM. A Meta-Analysis of Time-Series Studies of Ozone and Mortality with Comparison to the National Morbidity, Mortality, and Air Pollution Study. Epidemiology 2005; 16:436-445. Levy JI, Chermerynski SM, Sarnat JA. Ozone Exposure and Mortality: an empiric Bayes metaregression analysis. Epidemiology 2005; 16:458-468. Ito K, De Leon SF, Lippmann M. Associations Between Ozone and Daily Mortality: analysis and meta-analysis. Epidemiology 2005; 16:446-429.

[31] California Natural Resources Agency, "2009 California Climate Adaptation Strategy: A Report to the Governor of the State of California in Response to Executive Order S-13-2008" 2009, P. 30.

[32] Union of Concerned Scientists, "Climate Change and Your Health: Rising Temperatures, Worsening Ozone Pollution" June, 2011, P. 3.

Figure 2.5-5: Number of Days Exceeding the 8-Hour Ozone Standard and 99 Degree Weather



Source: BAAQMD, 2013.

If higher temperatures lead to increased ozone formation for the reasons described above, this may erode the progress that the region has made over the past 50 years of regulatory action. The BAAQMD's research indicates that, at the current rate of emissions control, the projected increase in ozone due to climate change from 2000 to 2050 would offset about 15 years of progress in reducing ambient ozone levels.[33]

Urban Heat Islands

The high concentration of buildings, parking lots and roadways in urban areas create dry, hot microclimates, or "heat islands," which absorb more of the sun's heat than surrounding rural areas. As urban areas develop, paved and dark surfaces and impermeable structures replace natural vegetation and open spaces. According to the US EPA, on hot, sunny summer days, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures of 50 to 90 degrees Fahrenheit (27 to 50 degrees Celsius) hotter than the surrounding air, while more shaded and open surfaces—often in more rural surroundings—remain close to air temperatures.[34] These impermeable, dark manmade surfaces also tend to retain heat longer after the sun goes down, thus limiting the ability of urban areas to cool off during periods of heat waves.

[33] http://www.baaqmd.gov/Divisions/Planning-and-Research/Research-and-Modeling/Ozone-Modeling.aspx

[34] http://www.epa.gov/heatisland/about/index.htm

Urban heat islands have a direct impact on human health. In addition to contributing to direct health impacts from heat, such as heat stroke, heat islands also contribute to elevated ozone levels, which contribute to a range of cardio-respiratory ailments as described above. The Chicago heat wave of 1995 resulted in the deaths of over 700 people, many of whom were low income and/or elderly. According to the National Weather Service, "Heat is the number one weather-related killer in the United States."[35]

Increased High Global Warming Potential Gases

Certain gases hold the potential to warm the climate at far greater levels than equivalent amounts of carbon dioxide. As discussed earlier, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) have "global warming potential," ranges from 140 to 23,900 times that of CO_2. The greatest source of HFCs, and the greatest source of any high GWP gas, is leakage from refrigeration, heat pumps and air conditioning equipment.

One major coping strategy to rising temperatures in the Bay Area will likely be increased use of air conditioning in buildings and vehicles. Refrigerators and air conditioners leak these powerful high GWP gases into the atmosphere. As rising temperatures increase the demand for refrigeration and air conditioning, this will result in greater emissions of these high GWP gases, which will in turn contribute to additional global warming.

REGULATORY SETTING

Federal Regulations

U.S. Environmental Protection Agency (EPA)

On April 2, 2007, in *Massachusetts v. EPA*, 549 U.S. 497 (2007), the Supreme Court found that greenhouse gases are air pollutants covered by the Clean Air Act. The Court held that the Administrator must determine whether or not emissions of greenhouse gases from new motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision.

On December 7, 2009, Administrator Lisa Jackson signed a final action, under Section 202(a) of the Clean Air Act, finding that six key well-mixed greenhouse gases constitute a threat to public health and welfare, and that the combined emissions from motor vehicles cause and contribute to the climate change problem.

This action was a prerequisite for implementing greenhouse gas emissions standards. Current efforts include issuing greenhouse gas emission standards for new motor vehicles, developing and implementing renewable fuel standard program regulations, proposing carbon pollution standards for new power plants, and setting greenhouse gas emissions thresholds to define when permits are required for new and existing industrial facilities under the Clean Air Act, and establishing a greenhouse gas reporting program.

[35] http://www.nws.noaa.gov/om/heat/index.shtml

Global Change Research Act (1990)

In 1990, Congress passed and the President signed Public Law 101-606, the Global Change Research Act. The purpose of the legislation was: "…to require the establishment of a United States Global Change Research Program aimed at understanding and responding to global change, including the cumulative effects of human activities and natural processes on the environment, to promote discussions towards international protocols in global change research, and for other purposes." To that end, the Global Change Research Information Office (GCRIO) was established in 1991 (it began formal operation in 1993) to serve as a clearinghouse of information. The Act requires a report to Congress every four years on the environmental, economic, health and safety consequences of climate change; however, the first and only one of these reports to date, the *National Assessment on Climate Change*, was not published until 2000. In February 2004, operational responsibility for GCRIO shifted to the U.S. Climate Change Science Program.

Energy Independence and Security Act of 2007

The Energy Independence and Security Act of 2007 was intended to move the U.S. toward greater energy independence and security. This energy bill increases the supply of alternative fuel sources by setting a mandatory Renewable Fuel Standard (RFS) requiring fuel producers to use at least 36 billion gallons of biofuel in 2022. It also tightens the Corporate Average Fuel Economy (CAFE) standards that regulate the average fuel economy in the vehicles produced by each major automaker.

National Fuel Efficiency Policy

On May 7, 2010, the U.S. Department of Transportation and EPA jointly issued national fuel efficiency and GHG emissions standards for model year 2012-2016 passenger vehicles and light duty trucks. The National Highway Traffic Safety Administration (NHTSA) issued CAFE standards for model year (MY) 2012-2016 passenger cars and light trucks under the Energy Policy and Conservation Act (EPCA) and Energy Independence and Security Act (EISA) and EPA issued national GHG emissions standards under the federal Clean Air Act. These joint GHG and fuel economy standards represent the first phase of the National Program to improve fuel economy and reduce GHG emissions from U.S. light-duty vehicles. Starting with 2012 model year vehicles, the rules require automakers to improve fleet-wide fuel economy and reduce fleet-wide GHG emissions by approximately five percent every year. It is expected that the regulations will result in a 2016 fleet average of 35.5 mpg. These standards are expected to conserve about 1.8 billion barrels of oil and reduce nearly a billion tons of GHG emissions over the lives of the vehicles covered.

In 2012, NHTSA and EPA proposed draft language to extend the National Program (coordinated GHG and fuel economy standards) for model year 2017 through model year 2025. The proposed CAFE standards are projected to require, on an average industry fleet-wide basis for cars and trucks combined, 40.3 to 41.0 miles per gallon (mpg) in model year 2021, and 48.7-49.7 mpg in model year 2025. EPA's proposed GHG standards, which are consistent with NHTSA's CAFE standards, are projected to require 163 grams/mile of CO_2 in model year 2025. This second phase of the National Program is projected to save approximately four billion barrels of oil and two billion metric tons of GHG emissions over the lifetimes of those light duty vehicles sold in MY 2017-2025.

Federal Highway Administration

The Federal Highway Administration encourages the development of Transportation Asset Management Plans (TAMPs) as a means to outline an agency's vision for its transportation future, collect information about specific assets, including their condition and performance, and plan for future risk, among other objectives. The preparation of TAMPs would require inventorying specific components of the region's transportation network and their specific needs, information essential to planning for sea level rise and identifying the most appropriate adaptation strategies.

State Regulations

Assembly Bill 1493 (Chapter 200, Statutes of 2002)

Assembly Bill (AB) 1493 (Pavley) amended Health and Safety Code sections 42823 and 43018.5 requiring the California Air Resources Board (ARB) to develop and adopt regulations that achieve maximum feasible and cost-effective reduction of GHG emissions from passenger vehicles, light-duty trucks, and other vehicles used for noncommercial personal transportation in California. The regulations prescribed by AB 1493 took effect on January 1, 2006, and apply only to 2009 and later model year motor vehicles.

In September 2004, pursuant to AB 1493, the ARB approved regulations to reduce GHG emissions from new motor vehicles. Under the new regulations, one manufacturer fleet average emission standard is established for passenger cars and the lightest trucks, and a separate manufacturer fleet average emission standard is established for heavier trucks. The regulations took effect on January 1, 2006 and set near-term emission standards, phased in from 2009 through 2012, and mid-term emission standards, to be phased in from 2013 through 2016 (referred to as the Pavley Phase 1 rules). For model year 2017 through 2025 the ARB has adopted the National Fuel Efficiency Policy standards as previously described.

Executive Order S-3-05 (Gov. Schwarzenegger, June 2005)

Executive Order S-3-05 was signed on June 1, 2005. The Order recognizes California's vulnerability to climate change, noting that increasing temperatures could potentially reduce snow pack in the Sierra Nevada, which is a primary source of the State's water supply. Additionally, according to this Order, climate change could influence human health, coastal habitats, microclimates, and agricultural yield. The Order set the GHG reduction targets for California: by 2010, reduce GHG emissions to 2000 levels; by 2020 reduce GHG emissions to 1990 levels; by 2050 reduce GHG emissions to 80 percent below 1990 levels.

The Order directs the Secretary of the California Environmental Protection Agency to coordinate oversight of efforts made to achieve these targets with other state agencies and, like all executive orders, the Order has no binding legal effect on regional agencies, such as MTC and ABAG, which are outside of the California Executive Branch. MTC and ABAG may voluntarily consider the emissions reduction targets and other provisions of the Order, but MTC and ABAG play no formal role in the Order's implementation.

California Global Warming Solutions Act of 2006 (AB 32)

Assembly Bill (AB) 32, the California Global Warming Solutions Act (Health and Safety Code Section 38500 et seq.), was signed in September 2006. The Act requires the reduction of statewide GHG emissions to 1990 levels by the year 2020. This change, which is estimated to be a 25 to 35 percent reduction from current emission levels, will be accomplished through an enforceable statewide cap on GHG emissions that will be phased in starting in 2012. The Act also directs the ARB to develop and implement reg-

ulations to reduce statewide GHG emissions from stationary sources and address GHG emissions from vehicles. The ARB has stated that the regulatory requirements for stationary sources will be first applied to electricity power generation and utilities, petrochemical refining, cement manufacturing, and industrial/commercial combustion. The second group of target industries will include oil and gas production/distribution, transportation, landfills and other GHG-intensive industrial processes.

On December 11, 2008, ARB adopted its *Climate Change Scoping Plan* (Scoping Plan), which functions as a roadmap of the ARB's plans to achieve GHG reductions in California required by AB 32 through subsequently enacted regulations. The Scoping Plan contains the main strategies California will implement to reduce CO_2e emissions by 174 MMT, or approximately 30 percent, from the State's projected 2020 emissions level of 596 MMT CO_2e under a "business-as-usual" scenario. The Scoping Plan also breaks down the amount of GHG emissions reductions the ARB recommends for each emissions sector of the State's GHG inventory. The Scoping Plan's recommended measures were developed to reduce GHG emissions from key sources and activities while improving public health, promoting a cleaner environment, preserving natural resources, and ensuring that the impacts of the reductions are equitable and do not disproportionately impact low-income and minority communities. These measures also put the State on a path to meet the long-term goal of reducing California's GHG emissions by 2050 to 80 percent below 1990 levels.

Senate Bill 1368 (Chapter 598, Statutes of 2006)

Senate Bill (SB) 1368, signed in September 2006, required the California Public Utilities Commission (PUC) to establish a GHG emissions performance standard for "baseload" generation from investor-owned utilities by February 1, 2007. The CEC was required to establish a similar standard for local publicly-owned utilities by June 30, 2007. The legislation further required that all electricity provided to California, including imported electricity, must be generated from plants that meet or exceed the standards set by the PUC and the CEC. In January 2007, the PUC adopted an interim performance standard for new long-term commitments (1,100 pounds of CO_2 per megawatt-hour), and in May 2007, the CEC approved regulations that match the PUC standard.

Executive Order S-01-07 (Gov. Schwarzenegger, January 2007)

In January 2007, Executive Order S-01-07 established a Low-Carbon Fuel Standard. The Order calls for a statewide goal to be established to reduce the carbon intensity of California's transportation fuels by at least 10 percent by 2020 ("2020 Target"), and that a Low Carbon Fuel Standard (LCFS) for transportation fuels be established for California. Further, it directs the ARB to determine if an LCFS can be adopted as a discrete early action measure pursuant to AB 32, and if so, to consider the adoption of an LCFS on the list of early action measures required to be identified by June 30, 2007, pursuant to Health and Safety Code Section 38560.5. The LCFS applies to all refiners, blenders, producers or importers ("Providers") of transportation fuels in California, will be measured on a full fuels cycle basis, and may be met through market-based methods by which Providers exceeding the performance required by an LCFS shall receive credits that may be applied to future obligations or traded to Providers not meeting the LCFS.

In June 2007, the ARB approved the LCFS as a Discrete Early Action item under AB 32 and in April 2009 the ARB approved the new rules and carbon intensity reference values with the new regulatory requirements taking effect in January 2011. The standards require providers of transportation fuels to report on the mix of fuels that they provide and demonstrate that they meet the LCFS intensity standards annually. This is accomplished by ensuring that the number of "credits" earned by providing fuels with a

lower carbon intensity than the established baseline (or obtained from another party) is equal to or greater than the "deficits" earned from selling higher intensity fuels.

In December 2011, the U.S. District Court for the Eastern District of California issued three rulings against the LCFS including a requirement for ARB to abstain from enforcing the LCFS. In April 2012, the Ninth Circuit granted ARB's motion for a stay of the injunction while it continues to consider ARB's appeal of the lower court's decision.

Executive Order B-16-2012

Executive Order B-16-2012 directs State entities to support and facilitate the rapid commercialization of zero-emission vehicles. The order outlines benchmarks for 2015, 2020, and 2025 related to establishing infrastructure to support and accommodate zero-emission vehicles, helping get zero-emission vehicles to market and on the road, and increasing their use for public transportation and public use, among others. It also establishes a goal of an 80 percent reduction of greenhouse gas emissions from the transportation sector in California as compared to 1990 levels by 2050. This Executive Order also explicitly states that it "is not intended to, and does not create any rights or benefits, substantive or procedural, enforceable at law or in equity, against the State of California, its agencies, departments, entities, officers, employees, or any other person."

Senate Bill 97 (Chapter 185, Statutes of 2007)

Senate Bill (SB) 97, adopted August 2007, directed the Governor's Office of Planning and Research (OPR) to adopt amendments to the California Environmental Quality Act (CEQA) Guidelines to address GHG emissions. These amendments became effective in March 2010.

Senate Bill 375 (Chapter 728, Statutes of 2008)

Senate Bill (SB) 375, adopted September 30, 2008 helps meet the AB 32 goals of reducing emissions from cars and light duty trucks. SB 375 requires regional planning agencies to include a Sustainable Communities Strategy (SCS) in their regional transportation plan (RTP) that demonstrates how the region could achieve GHG emissions reductions set by ARB through integrated land use and transportation planning. Local governments retain control of land use planning authority; however, SB 375 amended the California Environmental Quality Act (Pub. Resources Code § 21000 et seq.) to ease environmental review of specific types of developments that are anticipated to reduce emissions. Plan Bay Area is the integrated SCS and RTP for the San Francisco Bay Area, consistent with SB 375.

California's Energy Efficiency Standards for Residential and Nonresidential Buildings

Known by the shorthand name of "Title 24," this policy was established in 1978 in response to a legislative mandate to reduce California's energy consumption. Title 24 is updated periodically to allow for incorporation of new energy efficiency technologies and methods. The most recent update, in 2008, incorporated AB 32 mandates and advanced the energy efficiency requirements in order to meet California's energy needs. The 2013 update to the standards will build upon the previous standards and will take effect in January 2014. Several State energy policy goals drive the design of the current standards: the "Loading Order," which directs California's growing demand must first be met with cost-effective energy efficiency; "Zero Net Energy" (ZNE) goals for new homes by 2020 and commercial buildings by 2030; Governor Brown's Executive Order on Green Buildings; the Green Building Standards Code, and AB 32. The 2013 Standards will use 25 percent less energy for lighting, heating, cooling, ventilation, and wa-

ter heating than the 2008 Standards. Additionally, the 2013 Standards will result in a reduction of 170,500 tons of GHG emissions per year.

California Green Building Standards Code (2010), California Code of Regulations Title 24, Part 11

California's green building code, referred to as "CalGreen," was developed to provide a consistent approach to green building within the State. Taking effect in January 2011, the Code lays out the minimum requirements for newly constructed residential and nonresidential buildings to reduce GHG emissions through improved efficiency and process improvements. It also includes voluntary tiers to further encourage building practices that improve public health, safety and general welfare by promoting the use of building concepts which minimize the building's impact on the environment and promote a more sustainable design. Local jurisdictions are required to adopt the CalGreen provisions. CalGreen is complimentary with California Energy Code, Title 24, Part 6, which continues to regulate energy efficiency in buildings. CalGreen references Title 24, Part 6 where relevant and several voluntary measures in the CalGreen building code require energy efficient that exceeds Title 24, Part 6 requirements by 15 or 30 percent.

Senate Bill 1 (Chapter 132, Statutes of 2006)

The "Million Solar Roofs" legislation sets a goal of installing 3,000 megawatts of new solar capacity by 2017 in order to move the State toward a cleaner energy future and help lower the cost of solar systems for consumers. The Million Solar Roofs program is a ratepayer-financed incentive program aimed at transforming the market for rooftop solar systems by driving the cost down over time. It provides up to $3.3 billion in financial incentives that decline over time.

Executive Order S-13-08

Governor Schwarzenegger signed California Executive Order (EO) S-13-08 on November 14, 2008, to address the potential impacts of global climate change, including sea level rise. The order emphasizes the need for timely planning to mitigate and adapt to the potential effects of sea level rise on the State's resources. As a result, any State agency planning construction projects in areas vulnerable to future sea level rise must evaluate and reduce the potential risks and increase resiliency, to the extent feasible. Planning must consider a range of sea level rise scenarios for 2050 and 2100.

California Sea Level Rise Interim Guidance Document

EO S-13-08 directs the California Natural Resources Agency, in coordination with other state agencies and the National Academy of Sciences, to assess sea level rise for the Pacific Coast and create official sea level rise estimates for state agencies in California, Oregon and Washington. The assessment and official estimates are expected in 2012—in the interim, the California Ocean Protection Council convened the Sea Level Rise Task Force, comprised of representatives from 16 state agencies, to provide guidance to state agencies on incorporating sea level rise into planning decisions. The California Sea Level Rise Interim Guidance Document, released in October 2010, seeks to enhance consistency across agencies as each develops its respective approach to planning for sea level rise.

The California Sea Level Rise Interim Guidance Document contains seven recommendations for incorporating sea level rise into project planning:

- Use sea level rise projections from the December 2009 Proceedings of National Academy of Sciences, along with agency- and context-specific considerations of risk tolerance and adaptive capacity;
- Consider timeframes, adaptive capacity, and risk tolerance when selecting estimates of sea level rise;
- Coordinate with other state agencies when selecting sea level rise projections, and use the same projections, where feasible;
- Do not base future sea level rise projections on linear extrapolation of historic sea level observations;
- Consider trends in relative local mean sea level;
- Consider storms and extreme events; and
- Consider changing shorelines.

The interim guidance document is expected to be updated regularly, to keep pace with scientific advances associated with sea level rise.

California Climate Adaptation Strategy

In response to EO S-13-08, the California Natural Resources Agency released the California Climate Adaptation Strategy (CAS) in 2009. The strategy proposes a comprehensive set of recommendations designed to inform and guide State agencies in their decision making processes as they begin to develop policies to protect the State, its residents, and its resources from a range of climate change impacts, including sea level rise. The CAS presents recommendations for seven sectors, including Ocean and Coastal Resources and Transportation and Energy Infrastructure.

CAS recommendations specific to Ocean and Coastal Resources emphasize hazard avoidance, adaptation planning, and collaboration with local governments to address sea level rise. The CAS directs State agencies, in general, not to plan, develop, or build any new significant structure in a location requiring significant protection from sea level rise, storm surges, or coastal erosion during the expected life of the structure. The strategy notes that the most risk-averse approach for minimizing the adverse effects of sea level rise and storm activities is to carefully consider new development within areas vulnerable to inundation and erosion. The CAS also recommends that all State agencies prepare sea level rise adaptation plans, guidance, and criteria, as appropriate. The strategy directs State agencies to coordinate with any other agencies with jurisdiction over the coastal zone, (e.g., BCDC, the California Coastal Commission), local governments, and regional organizations on regional adaptation planning. The CAS also recommends that State agencies encourage local governments to adopt policies on setbacks, buffer areas, clustered coastal development, and engineering solutions, among others.

Within the Transportation Energy Infrastructure sector, the CAS specifically directs Caltrans to incorporate climate change vulnerability assessment planning tools, policies, and strategies into existing transportation and investment decisions. The strategy also instructs Caltrans to develop guidelines to establish buffer areas and setbacks to avoid risks to structures within projected "high" future sea level rise or flooding inundation zones.

Caltrans Guidance on Incorporating Sea Level Rise

Pursuant to EO S-13-08 and the California Sea Level Rise Interim Guidance Document, in May 2011 Caltrans released guidance on incorporating sea level rise into planning and decision making with respect to transportation projects. Caltrans' guidance recommends first determining if sea level should be incorporated into project planning, based on the project location and level of risk. A screening process with ten criteria guides the assessment of whether to incorporate sea level rise: design life, redundancy/alternative route(s), anticipated travel delays, evacuations/emergencies, traveler safety, expenditure of public funds, scope of project, effect on non-state highways, and environmental constraints. If the screening determines that sea level rise should be incorporated into project planning, the next step is to estimate the degree of potential impact and assess alternatives for preventing, mitigating and/or absorbing the impact. Caltrans uses the statewide sea level rise estimates presented in the California Sea Level Rise Interim Guidance Document for different years (2030 through 2100) to determine target sea level rise values; Caltrans directs projects with a life that extends to 2030 or earlier not to assume impacts from sea level rise. Having identified target sea level rise values for a project, Caltrans then lays out steps for implementation, including conducting more technical studies of inundation and subsidence and determining any adverse effects on facility functions and operations (e.g., from erosion, exposure to salt water), necessary adaptation measures, and the costs of mitigation.

California Department of Public Health Guidance on Integrating Public Health into Climate Action Planning

In February of 2012, the California Department of Public Health released a guidance document, *Climate Action for Health: Integrating Public Health into Climate Action Planning*. This document introduces key health connections to climate change mitigation strategies, and suggestions for where these fit into a local climate action plan or general plan. The guidance document also provides a number of examples of strategies taken from actual climate action plans that integrate public health objectives, with policy efforts to improve community health and reduce GHG emissions. The information provided is advisory, voluntary, and educational. The document includes specific policy recommendations for transportation and land use planning, including incorporation of green space and tree canopy to mitigate urban heat islands, and healthy siting of housing, schools and health care facilities to avoid major air quality impacts.

Coastal Act

The California Coastal Act of 1976 directs the California Coastal Commission (Coastal Commission) to protect and enhance the State's coastal resources. The Coastal Commission has planning, regulatory, and permitting authority over all development within the coastal zone, whose landward boundary varies with location. The Act governs coastal hazards for new development, mandating that it minimize risks to life and property in areas of high flood. New development must be located such that it will not be subject to erosion or stability hazard over the course of its design life, and construction of protective devices (e.g., seawalls, revetment) that substantially alter natural land forms along bluffs and cliffs are not permitted (Section 30253).

The Coastal Commission's mandate extends to climate change, including sea level rise; however, the agency is currently assessing how best to address sea level rise and other challenges resulting from climate change. The Coastal Commission partners with local governments to form Local Coastal Programs (LCPs), transferring the power to regulate development within the coastal zone to cities and counties.

Within the Bay Area, all of San Mateo, San Francisco, Marin, and Sonoma counties, along with the cities of Daly City, Pacifica and Half Moon Bay have certified LCPs. Any changes in the Coastal Commission's policies and/or regulations with respect to sea level rise may ultimately require revisions to LCPs.

Regional Coordination

In the Bay Area, the Joint Policy Committee (JPC) coordinates the regional planning efforts of ABAG, the BAAQMD, the San Francisco BCDC and MTC. In 2011, the JPC was given direction to produce a Bay Area Climate and Energy Resilience Strategy to provide guidance on how to include protecting the Bay Area's economy, public health, infrastructure and ecosystems from sea-level rise, water shortages, high energy prices and other impacts in long-term regional and local planning, including Plan Bay Area. This work focuses on the institutional structures and resources that will be needed to create a multi-stakeholder adaptive management process on regional resilience. This project will make the Bay Area economically stronger and healthier in the near-term and more prepared for the major challenges confronting us between now and the middle of the 21st Century.

In September 2012, the JPC adopted a work plan to develop a Regional Sea Level Rise Adaptation Strategy. The objective of the project is to ensure the ongoing health and ecological viability of regional natural resources, such as San Francisco Bay; coordinate adaptation mechanisms that transcend local jurisdictional boundaries; and share the costs of adaptation responses at a regional level, especially when regional resources are involved. The sea level rise adaption strategy work plan focuses on providing enough background information and support to develop a "bottom-up" regional strategy where the regional agencies work with local entities to assess vulnerabilities and risks, identify critical assets, explore adaptation options, and use a balanced approach to identify costs, benefits and adaptation strategies for the natural resources/ecosystem services provided by the Bay and its watersheds. The lessons learned from these collaborative efforts will be used to inform the second iteration of Plan Bay Area and be fully integrated into the third iteration.

Regional and Local Regulations

BAAQMD Guidance on GHG Policies

The BAAQMD published updated CEQA Air Quality Guidelines in May 2012. This document includes a section listing policies and mitigation measures recommended for plans prepared within the San Francisco Bay Area Air Basin, and in particular for local general plans. Recommended policies and mitigation measures are incorporated in the identification of mitigation measures in the impact analysis as needed.

San Francisco Bay Plan

The BCDC is charged with the protection, enhancement, and responsible use of the San Francisco Bay. The agency's jurisdiction includes the Bay itself, all land within 100 feet of the Bay shoreline, salt ponds, managed wetlands and certain waterways named in the Commission' law. BCDC guides uses of the Bay and its shoreline through policies set forth in the McAteer-Petris Act, the Suisun Marsh Preservation Act, the San Francisco Bay Plan, originally adopted in 1968, and the Suisun Marsh Protection Plan, originally adopted in 1977. In October 2011, BCDC amended its Bay Plan sea level rise policies and added new climate change findings and policies to the Bay Plan with the adoption of Amendment No. 1-08.

The policies included in the Bay Plan amendment aim to protect existing and planned development from sea level rise while preserving public access to the Bay and ecosystems. New large shoreline projects must

assess the risks of sea level rise and storms, based on the best available estimates of sea level rise. Large projects that could experience risks to public safety, e.g., flooding, must be designed to cope with flood levels expected at the midcentury and have an adaptive strategy for the end of century, depending on the life of the project. The new policies encourage projects whose benefits outweigh the risks of flooding—specifically, those that reduce carbon emissions by locating jobs and housing near public transportation. Projects may place fill in the Bay to protect existing and planned development from flooding and erosion, provided that a number of provisions are met to minimize flood risks (e.g., shoreline setbacks, elevation above flood levels) and avoid, minimize and mitigate impacts to Bay resources. Shoreline protection projects (e.g., levees, sea walls) and public access must be designed to withstand the effects of sea level rise and storms. The new policies also encourage habitat preservation and enhancement in undeveloped areas subject to flooding. Finally, the Bay Plan directs BCDC to collaborate with other agencies and the public to create a regional strategy that addresses and adapts to sea level rise.

County Climate Action Plans

Alameda County Climate Action Plans

The County of Alameda has adopted two climate action plans addressing specific county-wide concerns. Both plans seek to achieve a goal of 15 percent GHG reductions by 2020.

Alameda County (Unincorporated Areas) Climate Action Plan

The Alameda County (Unincorporated Areas) Community Climate Action Plan addresses reduction of greenhouse gas emissions in the unincorporated areas of Alameda County. These communities include Ashland, Castro Valley, Cherryland, Fairview, Hayward Acres, San Lorenzo, Sunol, and Rural East County. The Plan identifies a series of 37 local programs and policy measures related to transportation, land use, building energy, water, waste, and green infrastructure. The Plan identifies a total potential reduction in community-wide emissions by more than 15 percent by the year 2020. This Plan was approved in June 2011, and an EIR will be completed prior to the Plan becoming effective.

Alameda County Climate Action Plan for Government Services and Operations

The Alameda County Climate Action Plan for Government Services and Operations was adopted in 2010. The Board of Supervisors adopted 16 Commitments to Climate Protection that provide overarching vision, a goal of 15 percent GHG reductions by 2020, and the Climate Action Plan, which includes 80 recommended actions to achieve the identified goal.

Contra Costa Climate Action Plan

On December 26, 2012, a Draft Climate Action Plan was completed for Contra Costa County and released by the Department of Conservation and Development for public review and comment. The Draft Climate Action Plan identifies specific measures on how the County can achieve a GHG reduction target of 15% below baseline levels by the year 2020. In addition to reducing GHG, the Draft Climate Action Plan includes proposed policies and actions to improve public health and provide additional community benefits, and it lays the groundwork for achieving long-term greenhouse reduction goals for 2020 and 2035. Adoption of this plan is pending.

Marin County Greenhouse Gas Reduction Plan

Adopted in October 2006, the Marin County Greenhouse Gas Reduction Plan identifies an emissions inventory and reduction target. It includes a range of CO_2 reduction measures to reduce GHG emissions to 15 to 20 percent below 1990 levels by the year 2020 for internal government and 15 percent county-wide. Measures are organized in the categories of building energy use, transportation, waste management, and land use.

Climate Action Plan for San Francisco

Adopted in 2004, the Climate Action Plan for San Francisco: Local Actions to Reduce Greenhouse Gas Emissions includes an emissions inventory of community-wide and municipal operations and a reduction target of 20 percent below 1990 levels by 2012. With "business as usual," greenhouse gas emissions are predicted to rise to 10.8 million tons per year in 2012. The 20 percent reduction target would reduce San Francisco's overall GHG emissions to 7.2 million tons per year by 2012. As of 2010 San Francisco had achieved citywide emission reductions of 14.5 percent from 1990 levels. The CAP includes several actions and next steps related to transportation, energy, renewable energy and solid waste. San Francisco further adopted GHG emissions reduction goals including 20 percent reduction below 1990 levels for 2012, 25 percent by 2017, 40 percent by 2025 and 80 percent by 2050.

Sonoma County Community Climate Action Plan

Adopted in October 2008, the Sonoma County Community Climate Action Plan includes an emissions inventory and several solutions designed to reach its goal of reducing greenhouse gas (GHG) emissions to 25 percent below 1990 levels by 2015. Strategies are related to electricity and natural gas, transportation and land use, agriculture and forests, and solid waste.

The CAP finds that implementation of all major quantified solutions will reach about 22 percent below 1990 levels, which is about 37 percent below business as usual (multiple solutions are not yet quantified).

County of Solano Climate Action Plan

Adopted in 2011, the County of Solano Climate Action Plan communitywide GHG emissions reduction goal of 20 percent below 2005 levels by 2020. The CAP addresses both municipal and communitywide emissions for the unincorporated County. The CAP recommends 31 measures and 94 implementing actions that the community can take to reduce both emissions and communitywide contributions to global climate change. Measures and actions are related to statewide reductions, agriculture, energy and efficiency, transportation and land use, waste reduction and recycling, and water conservation.

County Sea Level Rise Programs

Solano County Sea Level Rise Strategic Program

In June 2011, Solano County released its Sea Level Rise Strategic Program (SLRSP) to address climate change and associated sea level rise at the local level. As directed by the County's General Plan, the SLRSP investigates the potential effects of sea level rise on Solano County, including specific properties and resources, and presents protection and adaptation strategies. The SLRSP considers two inundation scenarios: 16 inches by midcentury and 55 inches by the end of the century. According to their analysis, sea level rise is expected to inundate 130 square miles in Solano County by midcentury, including approximately 27 miles of total roadway (Interstate highways, State highways and local roadways) and eight miles

of railway. By the end of the century, sea level rise will inundate 163 square miles of land, 80 miles of total roadway, and 15 miles of railway.

Major roads and highways, along with railways, in the County are considered to be highly sensitive and vulnerable to the effects of sea level rise, with low adaptive capacity. Residential, industrial, and commercial developments are also all highly sensitive and vulnerable to sea level rise, although the adaptive capacity of these uses is low-to-medium, given the ability for residents and businesses with resources to pursue alternative locations. For all new transportation infrastructure and development, the SLRSP recommends designing projects to tolerate periodic flooding and providing for new development that can be adapted or relocated. New development in areas prone to flooding from sea level rise should be minimal. The SLRSP notes the difficulty in determining adaptive strategies for transportation infrastructure, as they will be developed based on future vulnerability and risk analyses specific to each asset. However, it specifically recommends collaborating with MTC and Caltrans on adaptation planning for affected roadways.

County General Plans

Marin Countywide Plan

The Marin Countywide Plan (November 2007), effectively the County's general plan, includes goals, policies, and implementing programs that address climate change and the risks of sea level rise in Marin County.

The Natural Systems and Agriculture Element includes a section on Atmosphere and Climate, including the following goal and policies, which are supported by implementing programs:

- **GOAL AIR-4: Minimization of Contributions to Greenhouse Gases.** Prepare policies that promote efficient management and use of resources in order to minimize greenhouse gas emissions. Incorporate sea level rise and more extreme weather information into the planning process.
  - **AIR-4.1 Reduce Greenhouse Gas Emissions.** Adopt practices that promote improved efficiency and energy management technologies; shift to low-carbon and renewable fuels and zero emission technologies.
  - **AIR-4.2 Foster the Absorption of Greenhouse Gases.** Foster and restore forests and other terrestrial ecosystems that offer significant carbon mitigation potential.

- **GOAL AIR-5: Adaptation to Climate Change.** Adopt policies and programs that promote resilient human and natural systems in order to ease the impacts of climate change.
  - **AIR-5.1 Determine Marin-Specific Climate Change.** Participate in research that examines the effects of climate change on human and natural systems in Marin.
  - **AIR-5.2 Prepare Response Strategies for Impacts.** Prepare appropriate response strategies that aid systems in adapting to climate change based on sound scientific understanding of the potential impacts.

In terms of sea level rise, the Plan's Environmental Hazards Element includes policies to minimize flooding, including evaluating the potential for sea level rise when processing development applications (Policy EH-3.3). Additional policies specifically address the risk of sea level rise by directing the County to amend its Development Code to incorporate construction standards consistent with Bay Plan policies for

areas subject to increased flooding from sea level rise (Implementing Program EH-3.k) and limit new construction or require elevated buildings and infrastructure in areas subject to sea level rise (Implementing Program EH-3.n). The Environmental Hazards Element also seeks to limit the repair, replacement, and construction of coastal seawalls and erosion barriers to protect against sea level rise (Implementing Program EH-3.l) and pursue funding for levee reconstruction in areas threatened by sea level rise (Implementing Program EH-3.o).

The Marin Countywide Plan's Natural Systems and Agriculture Element specifically states the goal of incorporating sea level rise into the planning process (GOAL AIR-4) and adopting policies and programs to adapt to climate change (GOAL AIR-5). More specific policies seek to assess the effects of sea level rise on property and infrastructure (Implementing Program AIR-5.b) and prepare response strategies in coordination with BCDC, the Coastal Commission, and other relevant agencies, including limiting development on coastal wetlands (Implementing Program AIR-5.c). The Natural Systems and Agriculture Element also calls for the establishment of criteria for setbacks to buffer existing and historic baylands from development, including the possible implications of future sea level rise (Implementing Program BIO-5.a) and the identification of baylands that could provide protection from sea level rise (GOAL BIO-5, Implementing Program BIO-5.i).

Contra Costa County General Plan

The Contra Costa County General Plan (January 2005) includes several policies that address sea level rise. The general plan specifically notes the flood hazards for islands in the Sacramento-San Joaquin Delta. The Safety Element requires that buildings in urban development near the shoreline and in flood-prone areas be protected from flood dangers, including from sea level rise (Policy 10-41). New housing must be sited above the highest water level expected during the life of the project or protected by levees (Policy 10-42). The County must review flooding policies annually to incorporate new scientific data on sea level rise and amend the policies as necessary (Policy 10-44).

Napa County General Plan

The Napa County General Plan (June 2008) addresses climate change – including the risk of sea level rise—and sustainable practices for environmental health related to water, energy conservation, air pollutant, greenhouse gas emissions, clean energy generation, and similar issues in its Conservation Element. Goals, policies, and action items specific to climate change and greenhouse gases include:

- **Goal CON-15:** Reduce emissions of local greenhouse gases that contribute to climate change.
- **Policy CON-65:** The County shall support efforts to reduce and offset greenhouse gas (GHG) emissions and strive to maintain and enhance the County's current level of carbon sequestration functions through the following measures:
  - Study the County's natural, agricultural, and urban ecosystems to determine their value as carbon sequesters and how they may potentially increase.
  - Preserve and enhance the values of Napa County's plant life as carbon sequestration systems to recycle greenhouse gases.
  - Perpetuate policies in support of urban-centered growth and agricultural preservation preventing sprawl.

  - Perpetuate policies in support of alternative modes of transportation, including transit, paratransit, walking, and biking.
  - Consider GHG emissions in the review of discretionary projects. Consideration may include an inventory of GHG emissions produced by the traffic expected to be generated by the project, any changes in carbon sequestration capacities caused by the project, and anticipated fuel needs generated by building heating, cooling, lighting systems, manufacturing, or commercial activities on the premises. Projects shall consider methods to reduce GHG emissions and incorporate permanent and verifiable emission offsets.
  - Establish partnerships with experts, trade associations, non-governmental associations, and community and business leaders to support and participate in programs related to global climate change. [Implemented by Action Items CON CPSP-1 and 2]

- **Policy CON-74:** The County shall evaluate new technologies for energy generation and conservation and solid waste disposal as they become available, and shall pursue their implementation as appropriate in a manner consistent with the principle of adaptive management. This evaluation shall include review of promising technological advances which may be useful in decreasing County greenhouse gas (GHG) emissions, increase in renewable energy that is generated locally, and review of the County's success in meeting targets for GHG emission reductions. [Implemented by Action Item CON CPSP-4]
- **Policy CON-75:** The County shall work to implement all applicable local, state, and federal air pollution standards, including those related to reductions in GHG emissions. [Implemented by Action Item CON CPSP-6]
- **Action Item CON CPSP-1:** The County shall develop a greenhouse gas (GHG) emissions inventory measuring baseline levels of GHGs emitted by County operations through the use of electricity, natural gas, fossil fuels in fleet vehicles and County staff commute trips, and shall establish reduction targets. [Implements Policy CON-65]
- **Action Item CON CPSP-2:** The County shall conduct a GHG emission inventory analysis of all major emission sources in the County by the end of 2008 in a manner consistent with Assembly Bill 32, and then seek reductions such that emissions are equivalent to year 1990 levels by the year 2020. Development of a reduction plan shall include consideration of a "green building" ordinance and other mechanisms that are shown to be effective at reducing emissions. [Implements Policy CON-65]
- **Action Item CON CPSP-3:** The County shall conduct an audit within the next five years of County facilities to evaluate energy use, the effectiveness of water conservation measures, production of GHGs, use of recycled and renewable products and indoor air quality to develop recommendations for performance improvement or mitigation. The County shall update the audit periodically and review progress towards implementation of its recommendations. [Implements Policy CON-67]
- **Action Item CON CPSP-5:** The County shall quantify increases in locally generated energy between 2000 and 2010, and establish annual numeric targets for local production of "clean" (i.e., minimal GHG production) energy by renewable sources, including solar, wind, biofuels, waste, and geothermal. [Implements Policy CON-70]

In terms of sea level rise, the plan establishes the goal of maintaining and improving marshland habitat in the County's southern portion. Specific policies direct the County to monitor the effects of sea level rise on marshlands, wetlands, agriculture, and the economy and to modify practices through adaptive management, when necessary (Policy CON-31-e, Policy CON-73).

Solano County General Plan

The Solano County General Plan includes several goals, policies, and implementation programs to address climate change. In addition, the plan includes a table that identifies a range of policies from related to other issues addressed throughout the plan (such as community form, Energy Efficiency Transportation Water Management, etc.) that are related to addressing climate change. Specific climate change policies include:

- **HS.G-5:** Recognize the multiple functions of the natural environment for safety, recreation, protection from climate changes, and economic uses.
- **HS.G-6:** Increase awareness of the effect humans have on the environment and encourage individuals and organizations to modify habits and operations that cause degradation to the environment and contribute to climate change.
- **HS.G-7:** Prepare for and adapt to the effects of climate change.
- **HS.P-53:** Evaluate the potential effects of climate change on Solano County's human and natural systems and prepare strategies that allow the County to appropriately respond and adapt.
- **HS.I-57:** Comply with all federal and/or state GHG emission reduction targets to reduce the County's contribution to global climate change. The plan should include strategies to reduce vehicle miles traveled, energy consumption, and other sources of GHGs within the county. This should be done in conjunction with the County's Climate Action Plan found in HS.I-73.
- **HS.I-73:** Develop and adopt a climate action plan for Solano County. It is the intent of Solano County to coordinate and seek participation from all cities in preparation of a countywide baseline study and in preparation and implementation of the Climate Action Plan (CAP).

Sonoma County General Plan 2020

In 2005, Sonoma County and all of its Cities pledged to measure and reduce their greenhouse gas emissions by 25 percent below 1990 levels by 2015. The Sonoma County General Plan, adopted in 2008, includes the following policies and objectives related to GHG emissions (in addition to polices related to energy efficiency and green development):

- **Objective OSRC-14.4:** Reduce greenhouse gas emissions by 25 percent below 1990 levels by 2015.
- **Policy OSRC-14g:** Develop a Greenhouse Gas Emissions Reduction Program, as a high priority, to include the following:
  - A methodology to measure baseline and future VMT and greenhouse gas emissions;
  - Targets for various sectors including existing development and potential future development of commercial, industrial, residential, transportation, and utility sources;

  - Collaboration with local, regional, and State agencies and other community groups to identify effective greenhouse gas reduction policies and programs in compliance with new State and Federal standards;
  - Adoption of development policies or standards that substantially reduce emissions for new development;
  - Creation of a task force of key department and agency staff to develop action plans, including identified capital improvements and other programs to reduce greenhouse gases and a funding mechanism for implementation; and
  - Monitoring and annual reporting of progress in meeting emission reduction targets.

- **Policy OSRC-14i:** Manage timberlands for their value both in timber production and offsetting greenhouse gas emissions.
- **Objective OSRC-16.1:** Minimize air pollution and greenhouse gas emissions.

Local Climate Action Plans

Several Bay Area jurisdictions have completed community emissions inventories (101), and 45 jurisdictions have finalized and adopted community climate action plans, as shown in **Table 2.5-4**. It is noted that there are also jurisdictions that have drafted or are in the process of drafting climate actions plans, which are not included in **Table 2.5-4**.

TABLE 2.5-4: BAY AREA CITIES WITH COMPLETED GHG EMISSIONS INVENTORIES OR CLIMATE ACTION PLANS

Jurisdiction	*Completed Community Emissions Inventory*	*Finalized and Adopted Community Climate Action Plan*
Alameda County	**x**	**x**
Alameda	**x**	**x**
Albany	**x**	**x**
Berkeley	**x**	**x**
Dublin	**x**	**x**
Emeryville	**x**	**x**
Fremont	**x**	**x**
Hayward	**x**	**x**
Livermore	**x**	**x**
Newark	**x**	**x**
Oakland	**x**	**x**
Piedmont	**x**	**x**
Pleasanton	**x**	**x**
San Leandro	**x**	**x**
Union City	**x**	**x**
Contra Costa County	**x**	**-**
Antioch	**x**	**x**
Brentwood	-	-
Clayton	-	-
Concord	**x**	-
Danville	**x**	-
El Cerrito	**x**	-
Hercules	**x**	-
Lafayette	**x**	-
Martinez	**x**	**x**
Moraga	**x**	-
Oakley	**x**	-
Orinda	**x**	-
Pinole	**x**	-
Pittsburg	**x**	-
Pleasant Hill	-	-
Richmond	**x**	-
San Pablo	**x**	**x**

TABLE 2.5-4: BAY AREA CITIES WITH COMPLETED GHG EMISSIONS INVENTORIES OR CLIMATE ACTION PLANS

Jurisdiction	*Completed Community Emissions Inventory*	*Finalized and Adopted Community Climate Action Plan*
San Ramon	**x**	**x**
Walnut Creek	**x**	**x**
Marin County	**x**	**x**
Belvedere	**x**	**x**
Corte Madera	**x**	-
Fairfax	**x**	-
Larkspur	**x**	**x**
Mill Valley	**x**	-
Novato	**x**	**x**
Ross	**x**	**x**
San Anselmo	**x**	**x**
San Rafael	**x**	**x**
Sausalito	**x**	-
Tiburon	**x**	**x**
Napa County	**x**	**-**
American Canyon	**x**	-
Calistoga	**x**	-
Napa	**x**	-
St. Helena	**x**	-
Yountville	**x**	-
San Francisco	**x**	**x**
San Mateo County	**x**	**-**
Atherton	**x**	-
Belmont	**x**	-
Brisbane	**x**	-
Burlingame	**x**	**x**
Colma	**x**	-
Daly City	**x**	**-**
East Palo Alto	**x**	**x**
Foster City	**x**	-
Half Moon Bay	-	-
Hillsborough	**x**	**x**
Menlo Park	**x**	**x**

TABLE 2.5-4: BAY AREA CITIES WITH COMPLETED GHG EMISSIONS INVENTORIES OR CLIMATE ACTION PLANS

Jurisdiction	*Completed Community Emissions Inventory*	*Finalized and Adopted Community Climate Action Plan*
Millbrae	**x**	-
Pacifica	**x**	-
Portola Valley	**x**	-
Redwood City	**x**	**x**
San Bruno	**x**	-
San Carlos	**x**	**x**
San Mateo	**x**	**x**
S. San Francisco	**x**	-
Woodside	-	-
Santa Clara County	**x**	**-**
Campbell	-	-
Cupertino	-	-
Gilroy	**x**	**x**
Los Altos	**x**	-
Los Altos Hills	**x**	-
Los Gatos	**x**	-
Milpitas	**x**	-
Monte Sereno	-	-
Morgan Hill	**x**	-
Mountain View	**x**	**x**
Palo Alto	**x**	**x**
San José	**x**	**x**
Santa Clara	**x**	-
Saratoga	**x**	-
Sunnyvale	**x**	**x**
Solano County	**x**	**x**
Benicia	**x**	**x**
Dixon	**x**	-
Fairfield	**x**	-
Rio Vista	**x**	-
Suisun City	**x**	-
Vacaville	**x**	-
Vallejo	**x**	-

TABLE 2.5-4: BAY AREA CITIES WITH COMPLETED GHG EMISSIONS INVENTORIES OR CLIMATE ACTION PLANS

Jurisdiction	*Completed Community Emissions Inventory*	*Finalized and Adopted Community Climate Action Plan*
Sonoma County	**x**	**x**
Cloverdale	**x**	-
Cotati	**x**	-
Healdsburg	**x**	-
Petaluma	**x**	-
Rohnert Park	**x**	-
Sebastopol	**x**	-
Santa Rosa	**x**	**x**
Sonoma (city)	**x**	-
Windsor	**x**	-
TOTALS	**101**	**44**

Source: Bay Area Air Quality Management District, 2012; Dyett & Bhatia, 2012.

Impact Analysis

The climate change impact analysis assesses the potential for significant adverse impacts related to GHG emissions, plan consistency, and impacts of sea level rise. Impacts of the environment (such as sea level rise) on a project or plan (as opposed to impacts of a project or plan on the environment) are beyond the scope of required CEQA review. "[T]he purpose of an EIR is to identify the significant effects of a project on the environment, not the significant effects of the environment on the project." (*Ballona Wetlands Land Trust v. City of Los Angeles* (2011) 201 Cal.App.4th 455, 473.) The impacts discussed in this section related to sea level rise are effects on users of the project and structures in the project of preexisting environmental hazards, as explicitly found by the court in the *Ballona* decision, and therefore "do not relate to environmental impacts under CEQA and cannot support an argument that the effects of the environment on the project must be analyzed in an EIR." (*Id.* at p. 475.) Nonetheless, an analysis of these impacts is provided for informational purposes.

SIGNIFICANCE CRITERIA

Implementation of Plan Bay Area would have a potentially significant adverse impact if the Plan would:

Criterion 1: Fail to reduce per capita passenger vehicle and light duty truck CO_2 emissions by seven percent by 2020 and by 15 percent by 2035 as compared to 2005 baseline, per SB 375.

Criterion 2: Result in a net increase in direct and indirect GHG emissions in 2040 when compared to existing conditions.

Criterion 3: Substantially impede attainment of goals set forth in Executive Order S-3-05 and Executive Order B-16-2012.

Criterion 4: Substantially conflict with any other applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs.

Criterion 5: Result in a net increase in transportation investments within areas regularly inundated by sea level rise by midcentury.

Criterion 6: Result in a net increase in the number of people residing within areas regularly inundated by sea level rise by midcentury.

Criterion 7: Result in an increase in land use development within areas regularly inundated by sea level rise by midcentury.

METHOD OF ANALYSIS

Greenhouse Gas Emissions

MTC generates vehicle activity data from its travel demand forecasting models, and uses EMFAC 2011 to calculate the CO_2 emissions from motor vehicle sources. Because the emissions model is based on the travel demand forecast model outputs, it accounts for the land use pattern as well as transportation improvements outlined in the proposed Plan. The emissions model also accounts for the effects of congestion (changes in average vehicle speeds) on CO_2 emissions. A detailed description of EMFAC 2011 is included in *Chapter 2.2: Air Quality* and a detailed description of the MTC travel demand forecasting model is included in *Chapter 2.1: Transportation*. EMFAC 2011 CO_2 output was subsequently adjusted to account for MTC's Climate Policy Initiatives, which are part of the proposed Plan and are expected to reduce overall emissions in 2020 by 3,950 tons of CO_2 per day, and by 5,900 tons of CO_2 per day in 2035 and 2040. **Table 2.5-5** shows these reduction assumptions by policy and corresponding reductions in annual Metric Tons of CO_2 equivalent ($MTCO_2e$). Detailed information on how the policy reductions were calculated and details on the assumed implementation year for each policy are included in MTC's supplemental technical report, *Summary of Predicted Traveler Responses*, available on the project website www.onebayarea.org.

TABLE 2.5-5: PLAN BAY AREA CLIMATE POLICY INITIATIVES AND REDUCTIONS

Policy	*2020*			*2035 /2040*		
	% Per Capita Reduction from 2005	*Daily Tons of CO_2*	*Annual $MTCO_2e$[1]*	*% Per Capita Reduction from 2005*	*Daily Tons of CO_2*	*Annual $MTCO_2e$*
Regional Electric Vehicle Public Charger Network	-0.1%	-90	-25,800	-0.3%	-270	-75,000
Vehicle Buy-Back and Plug-In/ Electric Vehicles Purchase Incentives	0.0%	-	-	-0.5%	-480	-133,500
Car Sharing	-2.6%	-2,060	-572,400	-2.8%	-2,540	-703,700
Vanpool Incentives	-0.3%	-230	-63,800	-0.4%	-360	-98,500
Clean Vehicles Feebate Program	0.00%	-	-	-0.7%	-640	-176,300
Smart Driving Strategy	-1.9%	-1,450	-403,100	-1.6%	-1,390	-384,800
Commuter Benefits Ordinance	-0.2%	-120	-32,500	-0.3%	-230	-64,700
Total	**-5.1%**	**-3,950**	**-1,097,600**	**-6.6%**	**-5,900**	**-1,636,500**

Note: Figures may not sum due to independent rounding.

1. A ratio of 1.00:1.02 was applied to all EMFAC 2011 generated CO_2 estimates to convert them to CO_2e. Emissions are annualized by multiplying by 300 to take account for the fact that there is less traffic on weekends. Conversion factors are taken from the California Air Resource Board Local Government Operations Protocol, Version 1.1, May 2010.

Source: MTC, 2013, Dyett & Bhatia, 2013.

The analysis conducted for Criterion 1 focuses on carbon dioxide (CO_2) emissions related to the operation of passenger vehicles and light duty trucks. Emissions for Criterion 1 are considered to be conservative estimates because they are presented without accounting for reductions in mobile source emissions that would be expected to result from ongoing implementation of Pavley 1 and the LCFS; per SB 375 the impact assessment does not include the emissions reductions from these legislative requirements. However, application of Pavley fuel efficiency standards and LCFS are anticipated to reduce levels even further in 2020 and 2035.

For Criterion 2, the analysis incorporates operational land use emissions, mobile sources, and waste. Land use and transportation impacts are identified separately in order to distinguish impacts and develop appropriate mitigation measures as needed, but the final analysis considers the combined impact of all emission sources. Unlike Criterion 1, transportation emissions include all vehicle classes and the emissions reduction benefits from Pavley and the LCFS. Operational land use emissions are calculated based on existing and projected electricity and natural gas use. Usage and conversion factors are taken from the Bay Area Greenhouse Gas Model,[36] and emissions factors are taken from the Local Government Opera-

[36] Bay Area Air Quality Management District, April 2010.

tions Protocol.[37] Waste emissions are calculated using US EPA's WARM model. All emissions are shown in $MTCO_2e$.

Land use emissions also account for ARB Scoping Plan[38] (described in the Regulatory Setting) reductions related to the electricity and natural gas sectors, and recycling and waste sector. The Scoping Plan identifies 49.7 million $MTCO_2e$ worth of reductions in the electricity and natural gas sector. Waste emission reductions identified in the Scoping Plan from landfill methane control (a discrete early action) are also included (one million MTCO2e). Other recycling and waste-related measures are not included since the Scoping Plan notes that the remaining two measures are not counted toward the AB 32 goal. The Scoping Plan also identifies a 26 million $MTCO_2e$ reduction as a result of green buildings; however this is not included in the analysis since the Scoping Plan notes that measures would overlap with reductions already identified for the electricity and natural gas Sectors (most Green Building emissions reductions are accounted for in energy, waste, water, and transportation sectors for purposes of AB32).

To account for the ARB Scoping Plan measures, this analysis derives the Bay Area's share of statewide reductions by calculating the region's share of forecasted statewide growth in dwelling units for 2020. The statewide forecast of dwelling units identifies 19 percent of California's future population and households in the Bay Area in 2020.[39] Therefore, 19 percent of the 50.7 million $MTCO_2e$ are applied to the GHG emissions forecast total, resulting in a total reduction of 9.6 million $MTCO_2e$.

It is likely that additional measures will be taken beyond 2020, thereby increasing this reduction in GHG emissions beyond what is currently identified in the ARB Scoping Plan. However, since these measures are not yet identified, this analysis only considers measures currently included in the ARB Scoping Plan for 2020 as the total reduction in 2040. ARB Scoping Plan reductions incorporated in the GHG emissions analysis are shown in **Table 2.5-6**.

[37] California Air Resource Board Local Government Operations Protocol, Version 1.1, May 2010, Appendices E and G.

[38] California Air Resources Board, Climate Change Scoping Plan: A Framework for Change, December 2008.

[39] Population Growth: State of California, Department of Finance, Interim Population Projections for California and Its Counties 2010-2050, Sacramento, California, May 2012; Household Growth: California Department of Housing and Community Development, Exhibit 7: Projected Household Growth by Metro Region, MSA, and County: 1997-2020, accessed January 8, 2013.

TABLE 2.5-6: ARB SCOPING PLAN REDUCTIONS FOR ELECTRICITY AND NATURAL GAS SECTORS

Measure No.	*Measure Description*	*Scoping Plan GHG Reductions (Annual MMT CO_2e)*	*19% of Scoping Plan Total $MTCO_2e$*
E-1	Energy Efficiency (32,000 GWh of Reduced Demand) - Increased Utility Energy Efficiency Programs - More Stringent Building and Appliance Standards - Additional Efficiency and Conservation Programs	15.2	2,888,000
E-2	Increase Combined Heat and Power Use by 30,000 GWh (Net reductions include avoided transmission line loss)	6.7	1,273,000
E-3	Renewables Portfolio Standard (33% by 2020)	21.3	4,047,000
E-4	Million Solar Roofs (including California Solar Initiative, New Solar Homes Partnership and solar programs of publicly owned utilities); Target of 3000 MW Total Installation by 2020	2.1	399,000
CR-1	Energy Efficiency (800 Million Therms Reduced Consumptions) Utility Energy Efficiency Programs Building and Appliance Standards Additional Efficiency and Conservation Programs	4.3	817,000
CR-2	Solar Water Heating (AB 1470 goal)	0.1	19,000
RW-1	Landfill Methane Control (Discrete Early Action)	1	190,000
Total		**50.7**	**9,633,000**

Sources: California Air Resource Board, Climate Change Scoping Plan: A Framework for Change, December 2008; Dyett & Bhatia, 2013.

This assessment also includes a qualitative analysis of airport emissions. Construction-related GHG emissions are addressed qualitatively as a contributor to overall emissions levels, with a focus on best management practices (BMPs).

It is noted that analyses for Criteria 1 and 2 are considered conservative because they do not account for additional local measures and policies to reduce GHG emissions, such as those included in local climate action plans.

Long-Range Consistency with EO S-3-05 and EO B-16-2012

The assessment for Criterion 3 evaluates the proposed Plan's likelihood to impede implementation of executive orders S-3-05 and B-16-2012, which both identify GHG reduction targets for 2050 (80 percent reduction as compared to 1990 levels for overall GHG emissions and transportation sector GHG emissions, respectively). Because these orders target a year beyond the life of the proposed Plan, and because executive orders do not apply directly to regional agencies like MTC and ABAG, but rather apply to agencies within the executive branch of government, this assessment evaluates whether or not implemen-

tation of the proposed Plan would impede attainment of the identified orders and whether the Plan moves the region towards a downward trajectory of GHG emissions in 2050.

This evaluation builds on the analyses completed for Criteria 1 and 2, and looks at the trajectory of emissions into the future based on these assessments. The analysis assumes a continued rate of benefits over time as a result of ongoing identification and implementation of effective regulations.

Plan Consistency

For Criterion 4, the EIR assesses the Plan's consistency with State and regional GHG plans, policies, and regulations. In addition, local climate action plans (CAPs) are discussed in the context of local efforts to achieve the same state and regional goals and targets as Plan Bay Area.

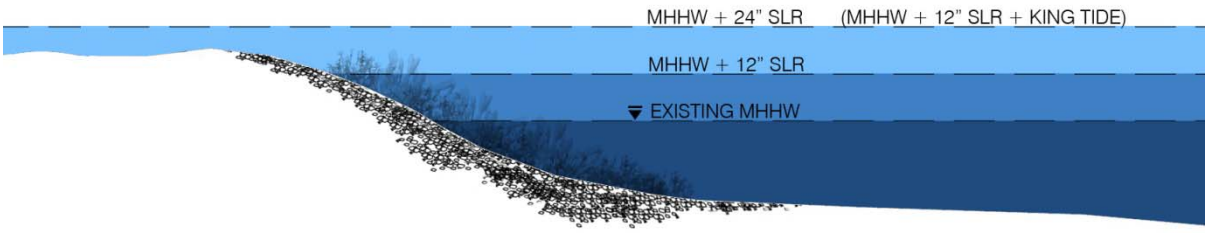
Sea Level Rise

The sea level rise analysis provides a program-level assessment of generalized potential impacts associated with future sea level rise in the San Francisco Bay Area utilizing the inundation mapping produced by NOAA for their Sea Level Rise and Coastal Flooding Impacts Viewer. Potential midcentury (e.g., 2050) sea level rise conditions were selected for this analysis, rather than 2040 conditions, as most sea level rise projections are associated with midcentury and end-of-century conditions. NOAA's inundation maps depict sea level rise on top of MHHW conditions, which are a good approximation of the highest "average" daily tidal inundation an area could be subjected to under future conditions. However, extreme high tides occur that are higher than MHHW. The most well-known extreme high tide condition in San Francisco Bay is often referred to as a "King Tide." King Tide is a colloquial term that refers to the especially high tide conditions that happen only a few times a year. In San Francisco Bay and along the California coast, King Tides generally occur during the winter months.

King Tides can be 12 (or more) inches higher than MHHW; therefore, the inundation of low-lying areas around the Bay observed during a King Tide event is often used as a real-world illustration of the areas around the Bay that would be subjected to regular, daily inundation by midcentury with sea level rise. In other words, the extent of inundation that occurs during an existing King Tide event could be used as a surrogate for the future, regular inundation extent that would be observed with 12 inches of sea level rise relative to MHHW.

The sea level rise impact analysis considers the inundation extent associated with 24 inches of sea level rise at MHHW, as presented within NOAA's Sea Level Rise and Coastal Flooding Impacts Viewer and in **Figure 2.5-3.** This extent of inundation is used as a surrogate for 12 inches of sea level rise at midcentury, coupled with a King Tide event. This scenario was selected as it represents a level of future inundation by Bay waters that could be expected to occur multiple times each year, particularly during the winter months when King Tides typically occur, even in the absence of extreme coastal storm surge events. For the purposes of this assessment, this level of inundation is considered "regular inundation" by sea level rise. **Figure 2.5-6** presents the relationship of these different scenarios for illustrative purposes.

Figure 2.5-6: Comparative Inundation by Scenario



Source: AECOM, 2012.

The proposed transportation projects and land use development projects—in particular in PDAs and transit priority project eligible areas (TPPs)—are analyzed based upon their location relative to inundation areas presented in **Figure 2.5-3**. For Criterion 5, transportation investments located entirely or partially within the inundated areas are identified. For linear transportation projects, such as highway improvements, the length of the projects within the inundated area is calculated relative to the total length of the projects (presented as the percent within the inundation zone). For non-linear projects (such as facility improvements), it is assumed that the project is 100 percent within the inundation zone. The primary shoreline type(s) (e.g., flood protection structure, shoreline protection structure, non-engineered berm, wetland, and natural shoreline) between each project and the Bay or Pacific coast are also identified in order to facilitate the selection of appropriate mitigation measures (adaptation strategies) that may include shoreline modifications or improvements. The primary shoreline types were identified using high-resolution oblique and aerial imagery along with professional judgment. The San Francisco Bay shoreline is complex and highly diverse; therefore, multiple shoreline types may be present in any given area. A more detailed identification of shoreline types and shoreline vulnerabilities may be required as part of future project-level planning.

Along with the areas subject to potential future inundation, **Figure 2.5-3** displays low-lying hydraulically disconnected areas—these are areas with ground elevations below the projected future sea level rise water surface elevations, but they are not inundated, as they do not have a direct hydraulic connection to the Bay. In other words, these areas are protected from inundation by levees, embankments, or other topographic features. Although the transportation investments within these low-lying areas are not projected to be within the sea level rise inundation zone, based on existing levels of protection, these investments are still at risk of inundation in the event that an existing structure fails or is not properly maintained into the future.

Similarly, for Criteria 6 and 7, the PDAs and TPPs that intersect the inundated areas and the low-lying, hydraulically-disconnected areas are identified in order to estimate the potentially-impacted population as well as land-use development changes within both the PDAs and TPPs and the inundated areas. The locations of forecast population growth and new land use development are identified using GIS raster data developed by MTC using the UrbanSim model land use outputs for the proposed Plan. More information on the raster processes can be found in an appendix to the supplementary report *Summary of Predicted Land Use Responses*, available on the project website www.onebayarea.org. For Criterion 6, the total

impacted population within each of the nine Bay Area counties was also evaluated. While development will be focused within PDAs, development will ultimately occur both within and outside of PDA areas. The same approach was also used for Criterion 7 to estimate the number of employees and the number of households within the inundated areas (including within PDAs, TPPs, and for each county overall). Employment and households were used as a surrogate for increases in commercial and industrial land use development and residential land use development, respectively.

It is noted that multiple uncertainties are inherent in the sea level rise impact analysis, beyond the uncertainties associated with the projected rate of sea level rise anticipated to occur by midcentury. The inundation mapping used for the analysis is intended as a planning-level tool to illustrate the potential for inundation and coastal flooding under future conditions. The maps are based on model outputs and do not account for all of the complex and dynamic bay processes or future conditions such as erosion, subsidence, future construction or shoreline protection upgrades, or other changes to San Francisco Bay or the region that may occur in response to sea level rise. The maps also rely on USGS and NOAA 2010 Light Detection and Ranging (LIDAR) topographic data at a two-meter horizontal grid resolution. Although this data set represents the best available topographic data, and the data has undergone a rigorous review by a third party, the data has not been extensively ground-truthed. Levee crests and other topographic features that may impact coastal floodwater conveyance may be over or under-represented by the LIDAR data. For more context about the maps and the associated caveats and uncertainties, please refer to the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer.[40]

SUMMARY OF IMPACTS

Consistency with SB 375

The proposed Plan is consistent with SB 375, as modeled CO_2 emissions meet the SB 375 targeted reductions for per capita car and light duty truck emissions. In fact, the proposed Plan would result in greater emission reductions than the SB 375 targets.

Net Change in Total GHG Emissions

Forecast GHG emissions are expected to decline with the implementation of the proposed Plan when considering scoping plan reductions for electricity and natural gas, recycling and waste, and implementation of Pavley and the LCFS regulations. Overall emissions in 2040 are expected to be less than under existing conditions.

Long-Range Consistency with EO S-3-05 and EO B-16-2012

Because the goals of executive orders S-3-05 and B-16-2012 are more than 35 years into the future, the assessment considers the following factors:

[40] NOAA Coastal Services Center Digital Coast, Sea Level Rise and Coastal Flooding Impacts Viewer: http://www.csc.noaa.gov/digitalcoast/tools/slrviewer

- Per capita car and light duty truck emissions decline from 2005 through 2040, and are expected to continue to decline into the future;
- Total GHG emissions from land use and transportation are expected to decline from 2010 through 2040, and are expected to continue to decline into the future;
- New innovations in technology and science are expected, along with continued market shift towards green building and zero emission vehicles; and
- The RTP and SCS must be updated every four years, providing frequent opportunities to reevaluate progress towards executive order achievement.

Therefore, the Bay Area is heading in the direction of achieving the executive order goals, and does not impede achievement of these identified goals.

Plan Consistency

The proposed Plan is found to be consistent with State goals and mandates. Further, it is not expected that the proposed Plan would conflict with local CAPs or GHG reduction plans as they are complimentary efforts towards the reduction of GHG emissions in line with State goals and mandates. Therefore, the proposed Plan is expected to be consistent with other GHG reduction plans.

Sea Level Rise

All nine San Francisco Bay Area counties have areas that are vulnerable to rising Bay sea levels. The low-lying areas adjacent to the Bay shoreline contain some of the Bay Area's most significant transportation corridors and infrastructure, many of which have planned enhancements, expansions and improvements under the proposed Plan. These low-lying areas are also home to Bay Area residents and businesses, and many counties will see increases in population density and land-use development within future flood prone areas under the proposed Plan.

Under the proposed Plan, the transportation investments would increase within areas subjected to potential future inundation by sea level rise. These investments include a mix of project types, including enhancements to existing transportation infrastructure, expansions of existing infrastructure and facilities, as well as new infrastructure.

IMPACTS AND MITIGATION MEASURES

Because greenhouse gas emissions are global in nature and regulatory targets are defined at the state and regional level, this analysis considers only the cumulative effects of implementation of the proposed Plan. Further, modeling of passenger vehicle and light duty truck emissions accounts for both the land use strategy (increase in households and jobs) and transportation projects and therefore land use development and transportation projects are addressed together for each impact.

The impacts associated with sea level rise vary throughout the region depending on the inland topography and the existing shoreline protection structures; therefore, this analysis evaluated the impacts at the local scale. Regional impacts are essentially the culmination of localized impacts throughout the region. Each of the impacted transportation projects is evaluated individually. The impacts associated with population and land-use development are also evaluated spatially at the local scale, with impacts presented at the county level.

Impact

2.5-1 Implementation of the proposed Plan could fail to reduce per capita passenger vehicle and light duty truck CO_2 emissions by 7 percent by 2020 and by 15 percent by 2035 as compared to 2005 baseline, per SB 375.

Table 2.5-7 shows total daily and per capita car and light duty truck CO_2 emissions, which are expected to decline over time. The proposed Plan is expected to result in a 10.3 percent decline in per capita emssions from 2005 to 2020, and a 16.4 percent decline in per capita CO_2 emissions from 2005 to 2035, exceeding the SB 375 targets (of seven and 15 percent, respectively). This decline is attributable to numerous factors, most importantly the integrated land use and transporation plan in which the land use pattern focuses growth in higher-density locations near transit services. This compact approach to growth allows more efficient use of the existing transportation infrasturcture. The land use development pattern is described in greater detail in *Chapter 1.2: Overview of the Proposed Plan Bay Area.*

While total vehicle miles traveled are expected to increase by 20 percent from existing conditions to 2040 as a result of the Plan, this is less than the overall population growth of 30 percent over the same period. This is attributable in part to the proposed Plan investments in transit operations and expansion. These investments will result in a 27 percent increase in daily transit seat-miles from existing conditions due to the transit expansion and frequency improvement projects included in the proposed Plan. The proposed Plan also results in an increase in the share of trips that are made by transit and by walking, while drive along trips are expected to decline. More detail on the performance of the transportation network under the proposed Plan can be found in *Chapter 2.1: Transportation.*

TABLE 2.5-7: TOTAL AND PER CAPITA PASSENGER VEHICLE AND LIGHT DUTY TRUCK CO_2 EMISSIONS

Year	*Population*	*Modeled GHG Emissions (daily tons of CO_2)*	*Policy Initiatives Reduction (daily tons of CO_2)*	*CO_2 Emissions Per Capita (lb)*	*Per Capita CO_2 Emissions Relative to 2005*	*SB 375 Target*
2005	7,008,000	72,000	0	20.5	0.0%	n/a
2020	7,694,000	75,000	-4,000	18.3	-10.3%	-7.0%
2035	8,749,000	81,000	-5,900	17.1	-16.4%	-15.0%
2040	9,137,000	83,000	-5,900	16.8	-18.0%	n/a

Source: MTC, 2013.

This analysis does not include implementation of Pavley or LCFS standards, which are expected to further reduce CO_2 emissions and result in a decrease in total CO_2 emissions over time. These standards are incorporated in Impact 2.5-2. Because the proposed Plan woud result in a decrease in per capita car and light duty truck CO_2 emissions that exceed the SB 375 target, there is no adverse impact (NI). No mitigation measures are required.

Mitigation Measures

None required.

Impact

2.5-2 Implementation of the proposed Plan could result in a net increase in direct and indirect GHG emissions in 2040 when compared to existing conditions.

Land Use GHG Emissions

An overview of GHG emissions related to land use projects is shown in **Table 2.5-8**. As described in the methodology section, ARB's Scoping Plan reductions for the electricity and natural gas and recycling and waste sectors are incorporated in this analysis. Operational GHG emissions as a result of implementation of the land use component of Plan Bay Area were forecast based on existing and forecast single family and multifamily occupied housing units and existing and forecast jobs by sector. As shown in **Table 2.5-8**, GHG emissions from electricity and natural gas would increase by 28 percent over existing conditions without implementation of scoping measures. Note that residential GHG emissions would increase by 22 percent and nonresidential GHG emissions would increase by 35 percent. The relatively lower increase in residential GHG emissions is tied to an increase in the share of multifamily units, which require less electricity and natural gas to operate. Waste GHG emissions would increase by 30 percent, consistent with overall anticipated population growth. After application of scoping measures related to electricity and natural gas and recycling and waste, however, overall land use GHG emissions (electricity, natural gas, and waste GHG emissions) would decrease by 12 percent overall, relative to existing conditions.

Since overall land use-related GHG emissions are expected to decline from existing conditions to 2040 with implementation of the proposed Plan, there is no adverse impact (NI) and no mitigation measures are required.

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TABLE 2.5-8: EXISTNG AND FORECASTED ANNUAL LAND USE GHG EMISSIONS ($MTCO_2E$)

			Baseline (2010)		*Project (2040)*			
Land Use/GHG Source	*Usage Factor*	*Unit*	*Total Usage*	*$MTCO_2e$*	*Total Usage*	*$MTCO_2e$*	*Change in $MTCO_2e$ 2010-2040*	*% Change 2010-2040*
Single-Family Residential								
Electricity	7.42	MWh/du/yr	12,225,000	2,997,000	13,807,000	3,385,000	388,000	
Natural Gas	49.60	MMBtu/du/yr	81,775,000	5,476,000	92,358,000	6,185,000	709,000	
Multi-Family Residential								
Electricity	4.43	MWh/du/yr	4,254,000	1,043,000	6,412,000	1,572,000	529,000	
Natural Gas	22.50	MMBtu/du/yr	21,585,000	1,445,000	32,537,000	2,179,000	734,000	
Residential Subtotal				***10,961,000***		***13,321,000***	***2,360,000***	***22%***
Commercial								
Electricity	0.0136	MWh sf/yr	1,943,000	476,000	2,223,000	545,000	69,000	
Natural Gas	0.0295	MMBtu/sf/yr	4,200,000	281,000	4,807,000	322,000	41,000	
Office								
Electricity	0.0214	MWh sf/yr	21,216,000	5,202,000	30,240,000	7,414,000	2,212,000	
Natural Gas	0.0205	MMBtu/sf/yr	20,392,000	1,366,000	29,064,000	1,946,000	580,000	
Industrial								
Electricity	0.0077	MWhsf/yr	3,667,000	899,000	3,809,000	934,000	35,000	
Natural Gas	0.0043	MMBtu/sf/yr	2,059,000	138,000	2,139,000	143,000	5,000	
Non-Residential Subtotal				***8,362,000***		***11,304,000***	***2,943,000***	***35%***
Electricity and Natural Gas GHG Emissions (No Reductions)				**19,323,000**		**24,625,000**	**5,302,000**	**27%**
Waste GHG Emissions (No Reductions)			**5,025,000**	**4,943,000**		**6,410,000**	**1,467,000**	**30%**
Total Land Use GHG Emissions (No Reductions)				**24,266,000**		**31,035,000**	**6,769,000**	**28%**
Electricity and Natural Gas and Recycling and Waste Scoping Plan Reductions				0		-9,633,000		

TABLE 2.5-8: EXISTNG AND FORECASTED ANNUAL LAND USE GHG EMISSIONS ($MTCO_2E$)

			Baseline (2010)		*Project (2040)*			
Land Use/GHG Source	*Usage Factor*	*Unit*	*Total Usage*	*$MTCO_2e$*	*Total Usage*	*$MTCO_2e$*	*Change in $MTCO_2e$ 2010-2040*	*% Change 2010-2040*
Total Land Use GHG Emissions (With Scoping Plan Reductions)				**24,266,000**		**21,402,000**	**-2,864,000**	**-12%**

Note: Figures may not sum due to independent rounding.

1. Usage factors reflect average use for climate zone four per the BAAQMD BGM User's Manual.
2. Dwelling unit = du; square feet = sf; MWh = megawatt hour; MMBtu = one million British thermal units.
3. Conversion factors from number of jobs to sf: commercial: 1:403sf (retail); office: 1:424 sf (finance, health, other); industrial: 1:815 sf (agriculture and manufacturing). Factors based on average square feet per job used in the UrbanSim model

Source: MTC 2013; Dyett & Bhatia, 2013; BAAQMD, 2010; ARB, 2010.

Transportation GHG Emissions

Overall, as a result of the growing number of residents and jobs in the region, total on-road transportation GHG emissions would be expected to increase over time if no standards were put in place. However, consistent with State legislation, the analysis incorporates implementation of Pavley and LCFS regulations over the life of the proposed Plan. As shown in **Table 2.5-9**, when these standards are taken into account overall GHG emissions decline by 25 percent for passenger vehicles and by 7 percent for buses. While trucks and other vehicles GHG emissions continue to increase over time, these modes make a relatively small contribution to overall on-road GHG emissions. In sum, annual GHG emissions are expected to decrease by over 4.6 million $MTCO_2e$ from 2010 to 2040 under the proposed Plan, a 19 percent decline.

TABLE 2.5-9: EXISITNG AND FORECASTED ANNUAL TRANSPORTATION GHG EMISSIONS ($MTCO_2e$)

	2010 Baseline $MTCO_2e$	*2040 Proposed Plan $MTCO_2e$*	*Change from Existing*	*Percent Change from Existing*
Vehicle GHG Emissions (No Reductions)				
Passenger Vehicles	19,457,000	22,919,000	3,462,000	18%
Trucks	4,447,000	6,908,000	2,461,000	55%
Buses	615,000	634,000	19,000	3%
Other Vehicles	136,000	177,000	41,000	30%
MTC Climate Policy Initiative	--	-1,636,000	--	--
Total (No Reductions)	**24,655,000**	**29,002,000**	**4,347,000**	**18%**
Vehicle GHG Emissions (Pavley + LCFS)				
Passenger Vehicles	19,383,000	14,631,000	-4,752,000	-25%
Trucks	4,447,000	6,217,000	1,770,000	40%
Buses	615,000	571,000	-44,000	-7%
Other Vehicles	136,000	159,000	23,000	17%
MTC Climate Policy Initiative	--	-1,636,000	--	--
Total (Pavley + LCFS)	**24,581,000**	**19,942,000**	**-4,639,000**	**-19%**

Note: Figures may not sum due to independent rounding.

Source: MTC, 2013; Dyett & Bhatia, 2013.

Other regional GHG emissions are expected to occur from airport use. While airports can be expected to increase the number of flights to serve the increase in population and jobs, airports will also continue to have access to new technology and be required to comply with BAAQMD General Conformity rules for criteria air pollutants,[41] which would likely also have benefits for GHG emissions. For instance, as a result

[41] A requirement in federal law and administrative practice that requires that projects will not be approved if they do not conform with the State Implementation Plan by: causing or contributing to an increase in air pollutant emissions, violating an air pollutant standard, or increasing the frequency of violations of an air pollutant standard.

of development of newer engine technology and the continuing trend in the use of larger aircraft by the airlines, in the long term, the reduction in organic compound (ORG) and carbon monoxide (CO) emissions will offset some of the effects of the overall increase in the number of aircraft operations.[42] While criteria pollutants are not primary GHG pollutants, trends in criteria pollutants, ORG, and CO may have implications for CO_2 emissions and other GHG pollutants over time. These effects are not currently quantified, and therefore are not incorporated into a quantitative analysis.

Since overall transportation-related GHG emissions are expected to decline from existing conditions to 2040 with implementation of the proposed Plan, there is no adverse impact (NI). No mitigation measures are required.

Combined Effects

With land use GHG emissions (electricity, natural gas, and waste GHG emissions) expected to decline by 12 percent and transportation GHG emissions expected to decline by 19 percent, the combined effect of land use and transportation GHG emissions would result in a 15 percent reduction in total GHG emissions from 2010 to 2040, as shown in **Table 2.5-10**.

TABLE 2.5-10: TOTAL REGIONAL ANNUAL GHG EMISSIONS

	2010 $MTCO_2e$	*2040 $MTCO_2e$*	*Change from 2010 to 2040*	*Percent Change from 2010 to 2040*
Land Use Emissions Subtotal[1]	24,266,000	21,402,000	-2,864,000	-12%
Transportation Emissions Subtotal[2]	24,581,000	19,942,000	-4,639,000	-19%
Regional Emissions Total	**48,847,000**	**41,344,000**	**-7,503,000**	**-15%**

Note: Figures may not sum due to independent rounding.

1. Land Use emissions account for ARB Scoping Reductions, as outlined in Table 2.5-7.
2. Transportation emissions account for Pavley regulations, and the LCFS, as outlined in Table 2.5-8.

Source: MTC, 2013; Dyett & Bhatia, 2013.

Additional construction-related GHG emissions from implementation of both land use and transportation projects would contribute to emissions levels in the Bay Area. Project level details would be required to assess the specific construction-related impact. Best practice measures may include using alternative fueled (e.g., biodiesel, electric) construction vehicles/equipment for at least 15 percent of the fleet; using local building materials for at least 10 percent; and recycling or reusing at least 50 percent of construction waste or demolition materials.[43] Additional best practice measures for reduction of GHG emissions during construction are outlined in **Appendix E**. Due to the project-specific nature of construction emissions, quantitative estimates are not included in the assessment.

[42] This trend is not true for NOx emissions, which is expected to be at a higher rate than the rate of increase in the number of aircraft operations. BAAQMD, Emission Inventory Methodology for Commercial Aircraft, Jet (Excerpt), updated by Sukarn Claire, 2011.

[43] BAAQMD, California Environmental Quality Act Air Quality Guidelines, Updated May 2012.

Since overall GHG emissions are expected to decline from existing condition to 2040 with implementation of the proposed Plan, there is no adverse impact (NI) and no mitigation measures are required.

Mitigation Measures

None required.

Impact

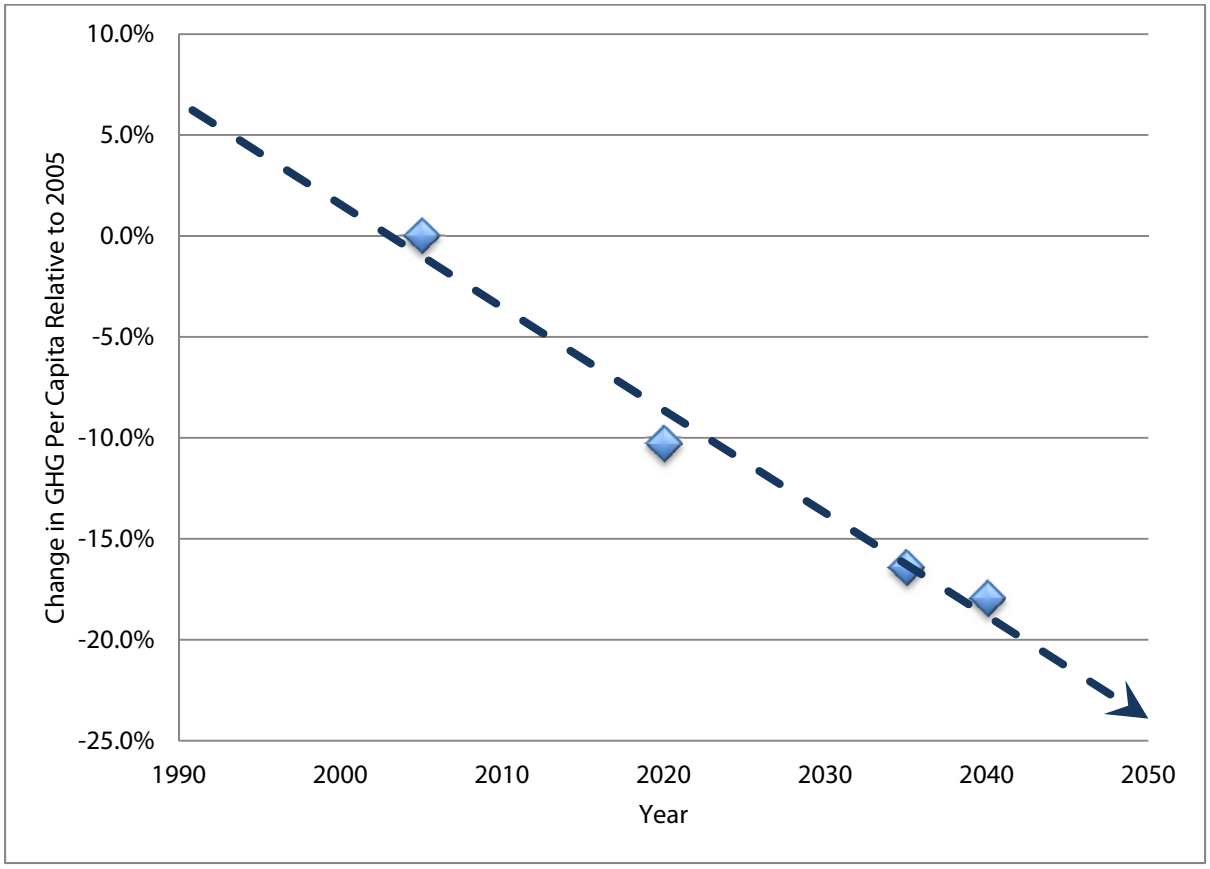
2.5-3 Implementation of the proposed Plan could substantially impede attainment of goals set forth in Executive Order S-3-05 and Executive Order B-16-2012.

This assessment evaluates the proposed Plan's likelihood to impede implementation of executive orders S-3-05 and B-16-2012, which both identify GHG reduction targets for 2050 (80 percent reduction as compared to 1990 levels for overall GHG emissions and transportation sector emissions, respectively), thereby extending beyond the life of the proposed Plan. Because these orders target a year beyond the life of the proposed Plan, this assessment evaluates consistency by identifying whether or not implementation of the proposed Plan is likely to impede attainment of the identified orders.

This analysis is based on a continued rate of benefits over time as a result of similarly effective regulations and regional plans that will be identified for the next time period through State and local processes. Building on analyses completed for Impacts 2.5-1 and 2.5-2, this analysis looks at the trajectory of emissions into the future.

Figure 2.5-7 shows per capita car and light duty truck CO_2 emissions, with modeled years identified as blue diamonds and a trend line identifying the trajectory through 2050. As shown in **Figure 2.5-7,** emissions are expected to continue on a downward trajectory beyond the horizon year of the proposed Plan. This assessment does not include Pavley or LCFS reductions, which are expected to further contribute to greater vehicle emission reductions by 2050.

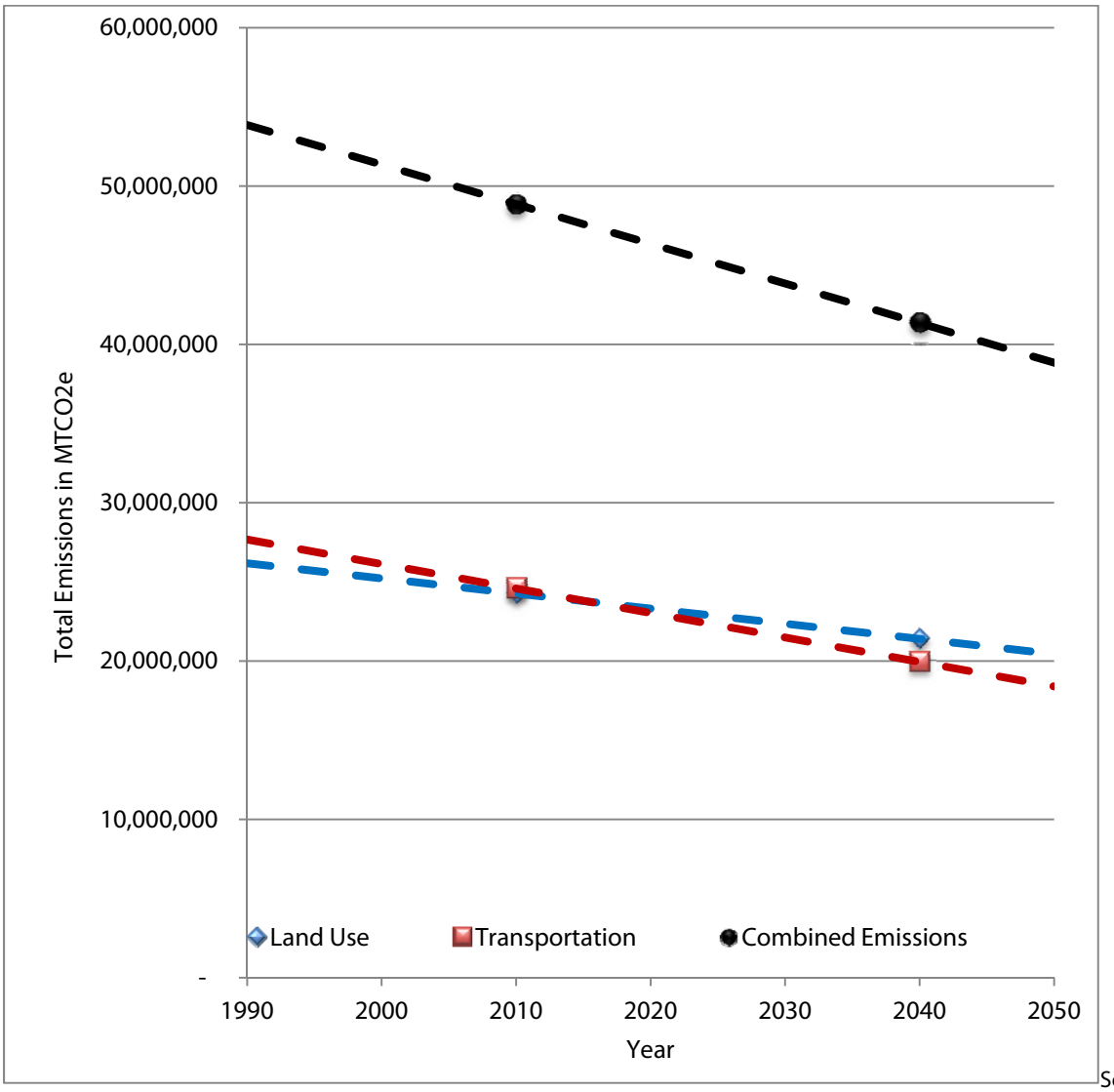
Figure 2.5-7: Per Capita Emissions Car and Light Duty Truck Emissions



Source: MTC, 2013.

Similarly, **Figure 2.5-8** shows total $MTCO_2e$ emissions both separately and combined for operation of land uses and on-road transportation in 2010 and 2040, as evaluated for Impact 2.5-2. The chart also identifies trend lines showing the emissions trajectory through 2050. Estimates include emissions reductions identified in ARB's Scoping Plan for electricity and natural gas, recycling and waste, and assumes implementation of Pavley and LCFS regulations. As shown in **Figure 2.5-8,** emissions are expected to continue to decline beyond the horizon of the proposed Plan.

Figure 2.5-8: Total Emissions by Sector and Linear Trajectory, Annual $MTCO_2e$



Source: MTC, 2013; Dyett & Bhatia, 2013.

Because the goals of executive orders S-3-05 and B-16-2012 are more than 35 years into the future, and new innovations in technology and science are expected, along with continued market shift towards green building and zero emission vehicles, it is reasonable to determine that, given the downward trajectories identified, the Bay Area is heading in the direction of achieving the executive order goals, and therefore

does not impede achievement of these identified goals. And, according to the ARB Scoping Plan, new technologies and strategies will be necessary to achieve the long-term goal: "Reducing our greenhouse gas emissions by 80 percent will require California to develop new technologies that dramatically reduce dependence on fossil fuels, and shift into a landscape of new ideas, clean energy, and green technology."[44] In addition, several documents outline measures and policies that individual projects and/or local jurisdictions may implement to further reduce greenhouse emissions, including:

- The Bay Area Air Quality Management District's 2012 CEQA Guidelines, Recommended Plan Level GHG Mitigation Measures or General/Area Plan Policies Sections 9.6.1-9.6.6;
- The California Air Pollution Control Officers Association's Model Policies for Greenhouse Gases in General Plans, June 2009; and
- Tier 2 measures outlined in CalGreen, the 2010 California Green Building Standards Code.

Further, the proposed Plan must be updated every four years, thereby providing frequent opportunities to reevaluate progress towards executive order achievement. While modeling may not be able to show achievement of an 80 percent reduction today, given the overall downward trajectory beyond 2040, which indicates that implementation of the proposed Plan would not impede achievement of executive order goals, the impact is considered less than significant (LS). No mitigation measures are required.

Mitigation Measures

None required.

Impact

2.5-4 Implementation of the proposed Plan could substantially conflict with any other applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs.

Development facilitated by the proposed Plan is not expected to conflict with any applicable plan, policy or regulation adopted with the intent to reduce GHG emissions. The *Regulatory Setting*, above, describes the plans, policies, and regulations relevant to the proposed Plan that are related to the reduction of GHG emissions. The proposed Plan would not conflict with these plans, policies, and regulations. Specifically, the proposed Plan would not be in conflict with the GHG reduction goals of SB 375, AB 32, EO S-3-05 and EO B-16-2012, as outlined in Impacts 2.5-1 through 2.5-3.

Local CAPs or GHG reduction plans are adopted in an effort to comply with the goals set for local governments in the AB 32 Scoping Plan and are therefore designed to support the same State-mandated goals and targets for GHG reduction outlined above. While the proposed Plan is consistent with AB 32 and SB 375 goals, it is ultimately local jurisdictions that have authority to determine if projects are consistent with local plans. MTC and ABAG have no jurisdiction in approval of development within the region.

[44] California Air Resources Board, Climate Change Scoping Plan, a Framework for Change, December 2008.

The proposed Plan does not address all of the potential reduction measures, goals, and GHG targets that are identified in local CAPs, general plans, and other plans that address climate change; each locality will set targets based on state, regional, or local conditions. Further, not all plans will have the same reduction goals and implementation measures as a result of various local factors and considerations (see **Table 2.5-4** in the Regulatory Setting for a list of local jurisdictions with GHG inventories and adopted CAPs). The proposed Plan identifies a compact land use pattern that is paired with targeted transportation investments in order to identify an efficient system that results in reductions to per capita and overall GHG emissions. However, some variations may exist on the local level. For instance, the proposed Plan's focused growth pattern may not support an individual jurisdiction's efforts to meet its GHG target by constraining growth. While some variations may exist between the proposed Plan and specific local Climate Action Plans, these variations would need to be assessed at the local level. On a whole, it is expected that local climate action plans and the proposed Plan would be complimentary efforts towards the reduction of GHG emissions in line with State goals and mandates.

Therefore, the proposed Plan is not expected to substantially conflict with local climate action or GHG reduction plans, and the impact is considered to have no adverse impact (NI) and no mitigation measures are required.

Mitigation Measures

None required.

Impact

2.5-5 Implementation of the proposed Plan may result in a net increase in transportation investments within areas regularly inundated by sea level rise by midcentury.

Thirty-two of the approximately 700 Plan Bay Area transportation projects under the proposed Plan are located, partially or wholly, within areas projected to be regularly inundated (i.e., inundated multiple times each year) by sea level rise by midcentury, as shown in **Table 2.5-11**. Any increase in transportation investments within the sea level rise inundation zone is considered a significant impact; however, these impacts can be mitigated through careful project-level planning and design that considers long-term sea level rise and includes adaptive strategies that are appropriate to the project type, surrounding land use, and the adjacent Bay shoreline type. This impact is considered potentially significant (PS). Mitigation measures 2.5(a), 2.5(b), 2.5(c) and 2.5(d) are outlined below.

Twenty one transportation projects are located within low-lying areas that are currently protected from existing and/or future inundation from Bay waters by levees and/or other topographic features or structures that act to inhibit the conveyance of floodwaters inland (see **Table 2.5-12**). Some of these projects run through both inundated and low-lying areas and therefore are included in both **Table 2.5-11** and **Table 2.5-12.** Although the portions of projects within the low-lying areas are not projected to be within the sea level rise inundation zone, based on the existing level of protection, they are still at risk of inundation in the event that an existing structure (e.g., levee, roadway embankment) fails or is not properly maintained into the future, or the topographic feature that is providing protection erodes or is modified in a way that reduces is protective value. This impact is considered potentially significant (PS). Mitigation measures 2.5(a), 2.5(b), 2.5(c) and 2.5(d) are outlined below.

TABLE 2.5-11: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*
Alameda County[2]			
22009	Expand Capitol Corridor intercity rail service from Oakland to San José - project development	5%	Berms, wetlands
22780	Implement AC Transit Grand-MacArthur Bus Rapid Transit (BRT)	< 5%	Engineered shore protection structures
230054	Construct auxiliary lanes on I-880 between Whipple Road and Industrial Parkway West	< 5%	Berms, wetlands
240018	Implement commuter service between Peninsula and East Bay (includes implementation of Phase 1 service as determined by on-going environmental work, railroad right-of-way acquisition, and environmental only for rail improvements)	< 5%	Berms, wetlands
98207	Construct Bus Rapid Transit facility from Alameda Naval Station to 12th Street BART station, improve freeway weaving at I-880/I-980 interchange, construct new on-ramp at Market Street/6th Street and off-ramp at Martin Luther King Way/5th Street, improve operations at Posey and Webster Tubes, construct park and ride on Mariner Square Drive near Posey Tube entrance, add Intelligent Transportation Systems (ITS) elements on Webster Street, Ralph Appezatto Memorial Parkway, 6th Street, 5th Street, Broadway, Harrison Street, and 7th Street (Phase 1)	45%	Engineered shore protection structures
Marin County			
98154	Implement Marin Sonoma Narrows Stage 1 (Marin County)	< 5%	Berms, wetlands
21325	Improve U.S. 101 Greenbrae/Twin Cities Corridor (includes modifying access ramps, new bus stops, improving transit stops and facilities, and adding pedestrian/bicycle facilities)	30%	Wetlands
240552	Construct multi-use pathway connecting Calpark tunnel and the Ferry Terminal in Larkspur	5%	Wetlands
240691	Marin Sonoma Narrows HOV Lane and corridor improvements	< 5%	Berms, wetlands
San Mateo County			
21613	Widen Route 92 between San Mateo-Hayward Bridge to I-280, includes uphill passing lane from U.S. 101 to I-280	20%	Engineered flood protection structures
230428	Extend Blomquist Street over Redwood Creek to East Bayshore and Bair Island Road	10%	Berms, wetlands
230704	Make Route 92 operational improvements to Chess Drive on- and off-ramps	100%[3]	Engineered flood protection structures
240060	Modify existing lanes on U.S. 101 from Whipple to County line to accommodate HOV/T lane	< 5%	Engineered flood protection structures

TABLE 2.5-11: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*
240143	Construct new multi-purpose pedestrian/bicycle overcrossing across U.S. 101, north of and adjacent to existing Millbrae Avenue Bridge across U.S. 101	45%	Engineered shore protection structures
240176	Widen Triton Drive between Foster City Boulevard and Pilgrim Drive	100%	Engineered flood protection structures
Santa Clara County			
230267	Widen Montague Expressway to 8-lanes for HOV lanes between Lick Mill and Trade Zone boulevards and on Guadalupe River Bridge and Penitencia Creek Road	< 5%	Engineered flood protection structures
230267	Widen Montague Expressway to 8-lanes for HOV lanes between Lick Mill and Trade Zone boulevards and on Guadalupe River Bridge and Penitencia Creek Road	< 5%	Engineered flood protection structures
230531	Construct auxiliary lanes on U.S. 101 in Mountain View and Palo Alto, from Route 85 to Embarcadero Road	50%	Berms, wetlands
230532	Improve interchange at Route 237/North 1st Street	100%[3]	Engineered flood protection structures
240436	Improve southbound U.S. 101 between San Antonio Road to Carleston Road/Rengstorff Avenue	75%	Berms, wetlands
240441	Improve interchange at U.S. 101/Oregon Expressway/Embarcadero Road	100%[3]	Engineered flood protection structures
240463	Convert Route 237 HOV lanes to express lanes between North First Street and I-880 (included under VTA Express Lane Network RTPID #240742)	25%	Engineered flood protection structures
240466	U.S. 101 express lanes between Whipple Avenue and Cochrane Road: Convert HOV lane to express lane between Whipple Avenue (in San Mateo County) and Santa Clara County line; Convert HOV lane into express lane and construct additional express lane between Santa Clara County line and Cochrane Road (included under VTA Express Lane Network RTPID #240742)	< 5%	Berms, wetlands
240481	Convert Route 237 HOV lanes to express lanes between North First Street to Mathilda Avenue (included under VTA Express Lane Network RTPID #240742)	< 5%	Engineered flood protection structures
Multi-County			
21013	State-Owned Toll Bridge Rehabilitation/Replacement/Retrofit	< 5%	Berms, wetlands
22001	Implement Sonoma-Marin Area Rail Transit District (SMART) Commuter Rail and Multi-Use Pathway Project (Initial Operating Segment)	5%	Berms, wetlands
230221	Implement I-80 Integrated Corridor Mobility (ICM) project operations and management	< 5%	Engineered shore protection structures

TABLE 2.5-11: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*
230581	San Francisco Ferry Berthing Improvements Program (Phase 1): improvements to existing ferry terminals and construction of new terminals to accommodate increases in ferry ridership	100%[3]	Engineered shore protection structures
230668	Convert I-880 HOV lanes to express lanes between Hengenberger Road and Route 237 southbound, and Hacienda Drive to 237 northbound (included under MTC Regional Express Lane Network RTPID #240741)	< 5%	Berms, wetlands
230685	Express Lanes on I-680: Widen I-680 northbound for express lane from Rudgear to North Main; Convert HOV lanes to express lanes between Benicia Bridge and Alcosta Boulevard in each direction (included under MTC Regional Express Lane Network RTPID #240741)	< 5%	Engineered shore protection structures
230686	Widen I-680 in each direction for express lanes between Martinez Bridge to I-80 (included under MTC Regional Express Lane Network RTPID #240741)	< 5%	Berms, natural shoreline
240587	Widen I-680 northbound for express lanes from Marina Vista Avenue to North Main Street (included under MTC Regional Express Lane Network RTPID #240741)	< 5%	Berms, engineered shore protection structures
240736	Expand and enhance the SMART commuter rail system (Phase II) by constructing a one-station extension from San Rafael to Larkspur, constructing a one-station extension from North Santa Rosa to Windsor, implementing capacity improvements along the Initial Operating Segment (Sonoma County only), and completing the multi-use pathway from Larkspur to Cloverdale.	20%	Engineered shore protection structures

Notes:

1. % Inundated represents the sum of all areas within the sea level rise inundation zone for a given project. Inundation calculations are based on based on MTC GIS files identifying transportation project locations. The projects were mapped to the best of MTC's ability based on the information submitted by the project sponsor. The exact project locations may change as the projects are further developed.
2. Counties without inundated transportation projects are not shown.
3. These projects were represented as point projects in MTC's GIS-based maps of each transportation project, therefore they are considered 100% inundated as the point is located within the sea level rise inundation zone.

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-12: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY LOW-LYING HYDRAULICALLY DISCONNECTED ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*
Alameda County[2]			
21131	Build a BART Oakland Airport Connector between Coliseum BART station and Oakland International Airport	15%	Engineered flood protection structures
22009	Expand Capitol Corridor intercity rail service from Oakland to San José - project development	< 5%	Berms, wetlands
240018	Implement commuter service between Peninsula and East Bay (includes implementation of Phase 1 service as determined by on-going environmental work, railroad right-of-way acquisition, and environmental only for rail improvements)	< 5%	Berms, wetlands
98207	Construct Bus Rapid Transit facility from Alameda Naval Station to 12th Street BART station, improve freeway weaving at I-880/I-980 interchange, construct new on-ramp at Market Street/6th Street and off-ramp at Martin Luther King Way/5th Street, improve operations at Posey and Webster Tubes, construct park and ride on Mariner Square Drive near Posey Tube entrance, add Intelligent Transportation Systems (ITS) elements on Webster Street, Ralph Appezatto Memorial Parkway, 6th Street, 5th Street, Broadway, Harrison Street, and 7th Street (Phase 1)	25%	Engineered shore protection structures
San Francisco County			
240147	Implement Southeast Waterfront Transportation Improvements - Phase 1	< 5%	Engineered shore protection structures
240163	Implement Hunters Point Shipyard and Candlestick Point Local Roads Phase 1	100%	Engineered shore protection structures
240358	Implement Mission Bay New Roadway Network	5%	Engineered shore protection structures
240400	Implement Treasure Island/Yerba Buena Island Street Network (includes a new street network, traffic calming, pedestrian improvements, biking improvements, streetscape improvements, and transit/shuttle stops)	100%	Engineered flood protection structures; engineered shore protection structures
San Mateo County			
21608	Construct auxiliary lanes (one in each direction) on U.S. 101 from Marsh Road to Embarcadero Road	5%	Engineered flood protection structures
21612	Improve access to and from the west side of Dumbarton Bridge on Route 84 connecting to U.S. 101, includes flyovers, interchange improvements, and conversion of Willow Road between Route 84 and U.S. 101 to expressway	15%	Engineered flood protection structures

TABLE 2.5-12: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY LOW-LYING HYDRAULICALLY DISCONNECTED ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*
21613	Widen Route 92 between San Mateo-Hayward Bridge to I-280, includes uphill passing lane from U.S. 101 to I-280	< 5%	Engineered flood protection structures
230592	Improve streetscape and traffic calming along Bay Road, and construct new northern access connection between Demeter Street and University Avenue	20%	Berms, wetlands
240060	Modify existing lanes on U.S. 101 from Whipple to County line to accommodate HOV/T lane	< 5%	Engineered flood protection structures
240133	Widen Millbrae Avenue between Rollins Road and U.S. 101 southbound on-ramp and resurface intersection of Millbrae Avenue and Rollins Road	90%	Engineered shore protection structures
240143	Construct new multi-purpose pedestrian/bicycle overcrossing across U.S. 101, north of and adjacent to existing Millbrae Avenue Bridge across U.S. 101	40%	Engineered shore protection structures
Santa Clara County			
240374	Extend BART to Berryessa (includes environmental, preliminary engineering, property acquisition and construction phases)	< 5%	Berms, wetlands
240466	U.S. 101 express lanes between Whipple Avenue and Cochrane Road: Convert HOV lane to express lane between Whipple Avenue (in San Mateo County) and Santa Clara County line; Convert HOV lane into express lane and construct additional express lane between Santa Clara County line and Cochrane Road (included under VTA Express Lane Network RTPID #240742)	< 5%	Berms, wetlands
240481	Convert Route 237 HOV lanes to express lanes between North First Street to Mathilda Avenue (included under VTA Express Lane Network RTPID #240742)	15%	Engineered flood protection structures
Multi-County			
21627	Caltrain Service Frequency Improvements (6-Train Service during Peak Hours), Electrification (San Francisco to Tamien), and Communications-Based Overlay Signal System (CBOSS) and Positive Train Control System (PTC)	< 5%	Engineered shore protection structures
22001	Implement Sonoma-Marin Area Rail Transit District (SMART) Commuter Rail and Multi-Use Pathway Project (Initial Operating Segment)	< 5%	Berms, wetlands
240588	Widen I-680 southbound for express lanes from Marina Vista Avenue to Livorna Road (included under MTC Regional Express Lane Network RTPID #240741)	< 5%	Berms, engineered shore protection structures

TABLE 2.5-12: PROPOSED TRANSPORTATION PROJECTS WITHIN MIDCENTURY LOW-LYING HYDRAULICALLY DISCONNECTED ZONE

RTP ID	*Project Name*	*% Inundated*[1]	*Shoreline Type*

Notes:

1. % Inundated represents the sum of all areas within the low-lying hydraulically disconnected zone for a given project. Inundation calculations are based on MTC GIS files identifying transportation project locations. The projects were mapped to the best of MTC's ability based on the information submitted by the project sponsor. The exact project locations may change as the projects are further developed.
2. Counties without inundated transportation projects are not shown.

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

Mitigation Measures

2.5(a) MTC and ABAG shall continue coordinating with BCDC, in partnership with the Joint Policy Committee and regional agencies and other partners who would like to participate, to conduct vulnerability and risk assessments for the region's transportation infrastructure. These assessments will build upon MTC and BCDC's Adapting to Rising Tides Transportation Vulnerability and Risk Assessment Pilot Project focused in Alameda County. Evaluation of regional and project-level vulnerability and risk assessments will assist in the identification of the appropriate adaptation strategies to protect transportation infrastructure and resources, as well as land use development projects, that are likely to be impacted and that are a priority for the region to protect. The *Adaptation Strategy* sub-section found at the end of this section includes a list of potential adaptation strategies that can mitigate the impacts of sea level rise. In most cases, more than one adaptation strategy will be required to protect a given transportation project or land use development project, and the implementation of the adaptation strategy will require coordination with other agencies and stakeholders. As MTC and ABAG conduct vulnerability and risk assessments for the region's transportation infrastructure, the Adaptation Strategy sub-section should serve as a guide for selecting adaptation strategies, but the list should not be considered all inclusive of all potential adaptation strategies as additional strategies not included in this list may also have the potential to reduce significant impacts.

2.5(b) MTC and ABAG shall work with the Joint Policy Committee to create a regional sea level rise adaptation strategy for the Bay Area.

Implementing agencies and/or project sponsors shall consider implementation of mitigations measures including but not limited to those identified below.

2.5(c) Mitigation measures that shall be considered by implementing agencies and/or project sponsors where feasible based on project-and site-specific considerations include, but are not limited to the following. The project sponsors and implementing agencies shall coordinate with BCDC, Caltrans, local jurisdictions (cities and counties), and other transportation agencies to develop Transportation Asset Management Plans (TAMPs) that consider the potential impacts of sea level rise over the asset's life cycle.

2.5(d) Mitigation measures that shall be considered by implementing agencies and/or project sponsors where feasible based on project-and site-specific considerations include, but are not limited to the following. Executive Order S-13-08 requires all state agencies, including Caltrans, to incorporate sea level rise into planning for all new construction and routine maintenance projects; however, no such requirement exists for local transportation assets and development projects. Implementing agencies shall require pro-

ject sponsors to incorporate the appropriate adaptation strategy or strategies to reduce the impacts of sea level rise on specific transportation and land use development projects where feasible based on project- and site-specific considerations. Potential adaptation strategies are included in the *Adaptation Strategy* subsection found at the end of this section.

Significance After Mitigation

Any increase in transportation investments within the area projected to be inundated by sea level rise is considered significant. Selection and implementation of appropriate mitigation measures and adaptation strategies may reduce the impact associated with sea level rise to less than significant on a project-by-project basis. The appropriate adaptation strategies will be selected as part of the future project-level analysis and planning. At this time, sufficient detail is not available to identify which adaptation strategy or strategies would be the most effective for each individual transportation project. In addition, successful implementation of the mitigation measures and adaptation strategies requires participation by other agencies and stakeholders.

This EIR includes a range of adaptation strategies to guide local jurisdictions, regional agencies, and transportation agencies in identifying strategies that are appropriate for transportation and development projects that may be subjected to regular future inundation by sea level rise. However, this EIR does not include guidance on how to select an adaptation strategy from the range of options presented, as local jurisdictions and transportation agencies will consider feasibility during subsequent project-level planning.

Projects taking advantage of CEQA Streamlining provisions of SB 375 (Public Resources sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as feasible, to address site-specific conditions. To the extent that an individual project adopts and implements all feasible mitigation measures described above, the impact would be less than significant with mitigation (LS-M).

MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore it cannot be ensured that this mitigation measure would be implemented in all cases, and this impact remains significant and unavoidable (SU).

Impact

2.5-6 Implementation of the proposed Plan could result in a net increase in the number of people residing within areas regularly inundated by sea level rise by midcentury.

The projected land use changes under the proposed Plan results in an increase in the number of residents within the area of the PDAs projected to be regularly inundated by sea level rise (**Table 2.5-13**), TPPs (**Table 2.5-14**), and within each county as a whole (**Table 2.5-15**). The most significant increases within the inundation zone (numerically) are located within Santa Clara County, which is a low-lying and densely populated county. The least significant increases (numerically) are located in Napa and Sonoma Counties, which are both more sparsely populated within the potentially inundated areas.

The population within the potentially-inundated portion of the PDAs would increase by 245 percent between 2010 and 2040 (**Table 2.5-13**). Within the TPPs, the number of residents within the inundated areas would increase by 60 percent (**Table 2.5-14**), and throughout the San Francisco Bay Area as a

whole, the number of people within the potentially inundated areas would increase by 30 percent between 2010 and 2040 (**Table 2.5-15**).

Within the midcentury low-lying, hydraulically disconnected areas, the increase in the number of residents within the PDAs is 360 percent (**Table 2.5-13**), compared to an increase of 100 percent within the TPPs (**Table 2.5-14**) and 80 percent within the San Francisco Bay Area as a whole (**Table 2.5-15**).

This impact is considered potentially significant (PS). Mitigation measures 2.5(b) and 2.5(d) are outlined for Impact 2.5-5.

TABLE 2.5-13: TOTAL POPULATION WITHIN PDA AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	< 10	20	100	3,450	1,470%	17,150%	90	3,430
Contra Costa	300	0	490	30	65%	350%	190	30
Marin	120	0	430	< 10	245%	0%	300	< 10
Napa	< 10	0	10	0	630%	0%	10	0
San Francisco	30	10	970	4,200	2,730%	41,900%	940	4,190
San Mateo	210	2,250	710	10,330	250%	360%	510	8,080
Santa Clara	2,240	2,140	9,880	2,210	340%	< 10%	7,630	70
Solano	1,680	0	3,240	40	90%	420%	1,570	40
Sonoma	< 10	0	20	0	320%	0%	10	0
Total	**4,600**	**4,420**	**15,850**	**20,270**	**245%**	**360%**	**11,250**	**15,850**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-14: TOTAL POPULATION WITHIN TPP AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	1,350	1,130	1,540	2,210	10%	100%	190	1,080
Contra Costa	10	< 10	90	20	500%	1,320%	70	10
Marin	7,920	1,470	9,000	1,480	10%	< 10%	1,080	10
Napa	< 10	0	< 10	0	350%	0%	< 10	0
San Francisco	330	10	2,030	2,240	510%	19,280%	1,700	2,230
San Mateo	12,900	1,1750	15,590	25,050	20%	110%	2,690	13,300
Santa Clara	3,920	2,610	12,960	2,890	230%	10%	9,040	280
Solano	0	220	0	270	0%	30%	0	60
Sonoma	< 10	0	11	0	90%	0%	< 10	0
Total	**26,450**	**17,180**	**41,220**	**34,150**	**60%**	**100%**	**14,770**	**16,970**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-15: TOTAL POPULATION WITHIN COUNTY[1] AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	1,450	2,050	1,630	6,110	10%	200%	180	4,050
Contra Costa	750	10	1,360	50	80%	450%	610	40
Marin	11,170	3,060	12,380	3,180	10%	< 10%	1,210	120
Napa	100	20	120	30	20%	60%	20	10
San Francisco	340	10	1,930	3,910	480%	33,720%	1,600	3,900
San Mateo	50,680	23,790	56,320	41,950	10%	80%	5,640	18,170
Santa Clara	11,930	2,690	26,820	3,030	130%	10%	14,890	340
Solano	1,790	280	3,370	340	90%	20%	1580	60
Sonoma	130	30	170	30	20%	0%	30	0
Total	**78,340**	**31,940**	**104,090**	**58,630**	**30%**	**80%**	**25,750**	**26,690**

1. Includes all population within each county that is within the sea level rise inundation zone, including population within and outside of the PDAs and TPPs.

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

Mitigation Measures

Implement Mitigation Measures 2.5(b) and 2.5(d) under Impact 2.5-5.

Significance after Mitigation

Any increase in the number of residents within the areas projected to be inundated by sea level rise is considered significant. Selection and implementation of the appropriate mitigation measures and adaptation strategies may reduce the impact associated with sea level rise to less than significant. However, the appropriate adaptation strategies will be selected as part of future project-level analysis and planning. At this time, sufficient detail is not available to identify which adaptation strategy or strategies would be the most effective at protecting the population within the sea level rise inundation zone. In most cases, regional strategies that aim to protect large developed areas will be the most effective at protecting the impacted population, but successful implementation of regional adaptation strategies requires participation by other agencies and stakeholders.

This EIR includes a range of adaptation strategies to guide local jurisdictions, regional agencies, and transportation agencies in identifying strategies that are appropriate for transportation and development projects that may be subjected to regular future inundation by sea level rise. However, this EIR does not include guidance on how to select an adaptation strategy from the range of options presented, as local jurisdictions and transportation agencies will consider feasibility during subsequent project-level planning.

Projects taking advantage of CEQA Streamlining provisions of SB 375 (Public Resources Code sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as feasible, to address site-specific conditions. To the extent that an individual project adopts and implements all feasible mitigation measures described above, the impact would normally be less than significant with mitigation (LS-M). However, there may be instances in which site-specific or project-specific conditions preclude the reduction of all project impacts to less than significant levels. For purposes of a conservative analysis, therefore, this impact remains significant and unavoidable (SU).

MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore it cannot be ensured that this mitigation measure would be implemented in all cases. Further, there may be instances in which site-specific or project-specific conditions preclude the reduction of all project impacts to less-than-significant levels. For purposes of a conservative analysis, therefore, this impact remains significant and unavoidable (SU).

Impact

2.5-7 Implementation of the proposed Plan could result in an increase in land use development within areas regularly inundated by sea level rise by midcentury.

The increase in land use development was evaluated using employment as a surrogate for an increase in commercial and industrial land use (or land use density), and households as a surrogate for an increase in residential land use (or an increase in residential housing density). The increase in employment and households was evaluated within the PDAs (**Tables 2.5-16** and **2.5-19**), TPPs (**Tables 2.5-17** and **2.5-20**), and within the counties as a whole (**Tables 2.5-18** and **2.5-21**).

Employment within the PDAs and potentially inundated areas is projected to increase by 55 percent between 2010 and 2040 under the proposed Plan (**Table 2.5-16**). Within the potentially inundated TPPs, employment would increase by 30 percent (**Table 2.5-17**), and throughout the San Francisco Bay Area as a whole, the number of people employed within the potentially inundated areas would increase by 30 percent between 2010 and 2040 (**Table 2.5-18**). Since employment is a surrogate for commercial and industrial land use, under the proposed Plan, there is projected to be an increase in commercial and industrial land use development within the PDAs, TPPs, and throughout the nine Bay Area counties within the sea level rise inundation zone. Santa Clara County is projected to have the largest increase in commercial and industrial land use development (numerically) within the potentially inundated portions of PDAs (**Table 2.5-16**), and San Mateo County is projected to have the largest increase (numerically) within the potentially inundated portions of TPPs and the county as whole, when compared to the other Bay Area counties (**Table 2.5-17**).

Within the low-lying, hydraulically disconnected areas, the increase in employment within the PDAs is 110 percent (**Table 2.5-16**), compared to an increase of 50 percent within the TPPs (**Table 2.5-17**) and 50 percent within the San Francisco Bay Area as a whole (**Table 2.5-18**). San Mateo County is projected to have the largest increase in industrial and commercial land use development within the low-lying, hydraulically disconnected areas within the PDAs, TPPs, and within the county as a whole.

The number of households (and thus, residential land-use development) within the PDAs and potentially inundated areas is projected to increase by 260 percent between 2010 and 2040 under the proposed Plan (**Table 2.5-19**). Within the TPPs, the number of households is projected to increase by 50 percent (**Table 2.5-20**), and throughout the San Francisco Bay Area as a whole, the number of households within the potentially inundated areas is projected to increase by 30 percent between 2010 and 2040 (**Table 2.5-21**). Santa Clara County is projected to have the largest increase in residential development within the sea level rise inundation zone within the PDAs, TPPs, and within the county as a whole when compared to the other eight Bay Area counties.

Within the low-lying, hydraulically disconnected areas, the increase in households within the PDAs is 310 percent (**Table 2.5-19**), compared to an increase of 100 percent within the TPPs (**Table 2.5-20**) and 80 percent within the San Francisco Bay Area as a whole (**Table 2.5-21**). San Mateo County is projected to have the largest increase in residential land use development within the low-lying, hydraulically disconnected areas within the PDAs and the county as a whole, while Santa Clara County is projected to have the largest increase within TPPs.

This impact is considered potentially significant (PS). Mitigation measures 2.5(b) and 2.5(d) are outlined for Impact 2.5-5.

TABLE 2.5-16: TOTAL EMPLOYMENT WITHIN PDA AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	120	260	370	800	210%	205%	250	530
Contra Costa	20	0	30	0	60%	0%	10	0
Marin	900	40	1,050	40	15%	0%	150	0
Napa	0	0	0	0	0%	0%	0	0
San Francisco	160	780	690	2,670	335%	245%	530	1,900
San Mateo	1,250	6,130	1,940	11,500	55%	90%	680	5,370
Santa Clara	5,690	70	8,460	100	50%	45%	2,770	30
Solano	230	60	410	90	80%	45%	180	30
Sonoma	10	0	30	0	185%	0%	20	0
Total	**8,380**	**7,340**	**12,980**	**15,200**	**55%**	**110%**	**4,600**	**7,860**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-17: TOTAL EMPLOYMENT WITHIN TPP AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	1,090	1,470	1,430	2,030	30%	40%	340	560
Contra Costa	340	50	520	70	60%	50%	190	20
Marin	9,510	210	11,330	220	20%	< 10%	1,810	20
Napa	0	0	0	0	0%	0%	0	0
San Francisco	170	910	670	2,660	300%	190%	500	1,750
San Mateo	24,100	6,280	29,880	9,490	20%	50%	5,790	3,210
Santa Clara	5,100	2,660	6770	3,550	30%	30%	1,670	880
Solano	< 10	870	10	1,020	80%	20%	< 10	160
Sonoma	10	0	30	0	170%	0%	20	0
Total	**40,310**	**12,440**	**50,640**	**19,040**	**30%**	**50%**	**10,330**	**6,600**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-18: TOTAL EMPLOYMENT WITHIN COUNTY[1] AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	1,500	5,370	1,890	7,580	30%	40%	390	2,210
Contra Costa	1,390	410	2,020	420	50%	< 10%	630	10
Marin	11,510	1,000	13,720	1,100	20%	10%	2,210	100
Napa	30	520	40	570	30%	10%	< 10	50
San Francisco	130	900	520	2,790	300%	210%	390	1,880
San Mateo	48,750	20,090	65,070	30,960	30%	50%	16,320	10,870
Santa Clara	16,890	2,830	24,500	3,850	50%	40%	7,610	1,020
Solano	450	940	680	1,110	50%	20%	230	170
Sonoma	280	10	350	10	30%	< 10%	80	0
Bay Area	**80,920**	**32,060**	**108,790**	**48,400**	**30%**	**50%**	**27,870**	**16,340**

1. Includes all population within each county that is within the sea level rise inundation zone, including population within and outside of the PDAs and TPPs.

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-19: TOTAL HOUSEHOLDS WITHIN PDA AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	< 10	< 10	30	910	1,250%	11,790%	30	900
Contra Costa	90	0	140	10	50%	110%	40	10
Marin	50	0	180	0	250%	100%	130	0
Napa	< 10	0	< 10	0	0%	0%	< 10	0
San Francisco	20	< 10	350	1,400	2,070%	17,260%	330	1,390
San Mateo	40	850	210	3,990	410%	370%	170	3,140
Santa Clara	900	890	4,060	910	350%	< 10%	3,170	20
Solano	580	0	1,100	10	90%	140%	520	10
Sonoma	< 10	0	< 10	0	255%	0%	< 10	0
Total	**1,690**	**1,750**	**6,080**	**7,240**	**260%**	**310%**	**4,400**	**5,490**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-20: TOTAL HOUSEHOLDS WITHIN TPP AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	510	390	570	740	10%	90%	60	350
Contra Costa	< 10	< 10	30	< 10	240%	790%	20	0
Marin	2,430	600	2,750	580	10%	< 0%	320	-20
Napa	0	0	< 10	0	370%	0%	< 10	0
San Francisco	160	< 10	800	790	410%	9670%	640	780
San Mateo	5,570	4,380	6,400	9,760	20%	120%	830	5380
Santa Clara	1,460	1,100	4,760	1,270	230%	20%	3,300	180
Solano	0	90	0	120	0%	0%	0	20
Sonoma	< 10	0	< 10	0	70%	0%	< 10	0
Total	**10,130**	**6,570**	**15,310**	**13,260**	**50%**	**100%**	**5,180**	**6,690**

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

TABLE 2.5-21: TOTAL HOUSEHOLDS WITHIN COUNTY[1] AND MIDCENTURY SEA LEVEL RISE INUNDATION ZONE

County	*Year 2010*		*Year 2040 Proposed Plan*		*% Increase*		*Numerical Increase*	
	Within SLR Zone	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*	*Within SLR Zone*	*Within LOW Zone*
Alameda	540	710	580	1,820	< 10%	160%	40	1,110
Contra Costa	230	< 10	440	10	100%	700%	210	10
Marin	3,760	1,240	4,110	1,260	< 10%	< 10%	350	20
Napa	40	< 10	40	10	10%	50%	< 10	< 10
San Francisco	160	< 10	760	1,270	380%	15,610%	600	1,260
San Mateo	19,620	8,580	21,290	15,640	< 10%	80%	1,670	7,060
Santa Clara	4,300	1,120	9,890	1,330	130%	20%	5,590	210
Solano	630	120	1,150	140	80%	20%	520	20
Sonoma	40	10	60	10	30%	0%	10	0
Total	**29,320**	**11,800**	**38,320**	**21,490**	**30%**	**80%**	**9,000**	**9,690**

1. Includes all population within each county that is within the sea level rise inundation zone, including population within and outside of the PDAs and TPPs

Source: MTC, 2012; NOAA, 2012; AECOM 2013.

Mitigation Measures

Implement Mitigation Measures 2.5(b) and 2.5(d) under Impact 2.5-5.

Significance after Mitigation

Any increase in land use development within areas projected to be regularly inundated by sea level rise is considered a significant impact. Selection and implementation of the appropriate mitigation measures and adaptation strategies may reduce the impact associated with sea level rise to less than significant. However, the appropriate adaptation strategies will be selected as part of future project-level analysis and planning. At this time, sufficient detail is not available to identify which adaptation strategy or strategies would be the most effective at protecting the projected land use development within the sea level rise inundation zone. In most cases, regional strategies that aim to protect large developed areas will be the most effective at protecting the impacted development, but successful implementation of regional adaptation strategies requires participation by other agencies and stakeholders.

This EIR includes a range of adaptation strategies to guide local jurisdictions, regional agencies, and transportation agencies in identifying strategies that are appropriate for transportation and development projects that may be subjected to regular future inundation by sea level rise. However, this EIR does not include guidance on how to select an adaptation strategy from the range of options presented, as local jurisdictions and transportation agencies will consider feasibility during subsequent project-level planning.

Projects taking advantage of CEQA Streamlining provisions of SB 375 (Public Resources Code sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as feasible, to address site-specific conditions. To the extent that an individual project adopts and implements all feasible mitigation measures described above, the impact would normally be less than significant with mitigation (LS-M). However, there may be instances in which site-specific or project-specific conditions preclude the reduction of all project impacts to less than significant levels. For purposes of a conservative analysis, therefore, this impact remains significant and unavoidable (SU).

MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore it cannot be ensured that this mitigation measure would be implemented in all cases. Further, there may be instances in which site-specific or project-specific conditions preclude the reduction of all project impacts to less-than-significant levels. For purposes of a conservative analysis, therefore, this impact remains significant and unavoidable (SU).

Adaptation Strategies

Each of the adaptation strategies presented below has the potential to reduce significant impacts to less than significant levels, although the ultimate outcome will depend on the vulnerability and risk of inundation associated with the specific project or development. Additional adaptation strategies not included within this list may also have the potential to reduce significant impacts. Many transportation and development projects will require a combination of several adaptation strategies. The selection of the appropriate adaptation strategy, or strategies, would be made during subsequent project-level analysis and planning. In many cases, particularly with respect to land use development projects, implementation of the

selected adaptation strategies may require coordination and collaboration with multiple agencies and stakeholders.

Some adaptation strategies, particularly those involving the construction of new structures such as floodwalls, may have secondary environmental impacts and require their own CEQA evaluations. Therefore, adaptation strategies specific to transportation projects and land use development projects will be developed as part of subsequent project-level EIRs, and the adaptation measures themselves will be subject to separate CEQA/NEPA compliance.

Many of the adaptation strategies presented below can be applied to multiple asset types—for example, providing an alternative transportation mode would be an option for impacted local streets and roads, state highways and commuter rail. Therefore, the strategies are organized according to their outcome, specifically: protection, functional inundation, or inundation. For example, strategies such as relocating an asset or building a levee would protect an asset against inundation, while conducting partial/temporary closure or providing an alternative transportation mode would allow for the asset to function if inundated. Some strategies may result in a variety of outcomes, from protection to inundation, depending on the goals at hand, and so are included as a fourth category ("Strategies with a Range of Outcomes"). The suite of options discussed below includes adaptation that is both asset-specific (e.g., elevation of a single road segment) and that which applies to multiple assets (e.g., construction of a floodwall), along with structural and non-structural/policy strategies. While some strategies are specific to transportation or development assets (e.g., structures, infrastructure), others may apply to both. The applicability of each adaptation strategy is noted in parentheses at the end of each adaptation strategy definition.

Protection Strategies

This subset of adaptation strategies focuses on protecting transportation projects and land use development projects from the impacts of sea level rise through both structural and non-structural (policy) approaches. If implemented, the following strategies would help minimize or avoid the damage to transportation assets and new development expected to be regularly inundated by rising sea levels:

- **Update building/design codes:** Counties and communities should adopt updated building codes within their respective Building Ordinances that require transportation and development projects to consider sea level rise and include adaptation strategies. For example, the building codes can require the implementation of structural measures, such as improving drainage, or raising road surfaces or the first floor elevation of new structures (e.g., transit stations, residential buildings), or making any structures (e.g., rail and transit stations, residential buildings) more resilient to flooding through specific construction techniques and materials. (*Transportation projects, land use development projects.*)
- **Apply zoning restrictions in high-risk-areas:** Local jurisdictions should amend their zoning codes or create specific shoreline zoning ordinances to limit development (i.e., designate open space or low-density residential) or specify design requirements in areas subject to sea level rise. Overlay zoning districts that delineate areas with special characteristics (e.g., sea level rise or coastal storm surge inundation hazard) and apply additional regulations are another tool to guide development towards areas that are at low risk for sea level rise. (*Land use development projects.*)
- **Establish setbacks/buffers:** Minimum setbacks from the shoreline can limit development in areas at risk for sea level rise. Setbacks can be applied uniformly or vary with the scale of devel-

opment, increasing for larger developments to minimize the property and residents/employees placed at risk. In the case of sea level rise, setbacks and buffers guide development to lower-risk areas. Buffers also restrict development adjacent to sensitive natural areas, such as tidal wetlands. In areas with tidal wetlands, buffers can preserve the storm surge and wave dissipation properties of tidal wetlands while allowing wetlands and beaches room to migrate landward as sea levels rise. (*Transportation projects, land use development projects.*)

- **Implement conditional development in high-risk-areas:** Local jurisdictions can require that developers meet specific conditions to obtain a permit to develop in areas at risk for sea level rise. Such conditions include building design that is flood proof/resilient, raised foundations or first floor elevations, impact fees to fund emergency preparedness/response, buffers and other coastal protection measures, protection measures that have limited redirection of flood impact onto other adjacent areas, and the removal of structures as sea levels rise, among others. (*Land use development projects.)*
- **Encourage cluster development in low-risk areas:** This strategy involves the use of incentives (e.g., density bonuses, reduced development impact fees, tax incentives, streamlined permitting) to focus development in areas not expected to be regularly inundated by sea level rise. This will increase the density of development in areas not at risk for regular inundation, thereby decreasing the density of new development in high-risk areas. (*Land use development projects.*)
- **Transfer of development rights:** For this strategy, a local jurisdiction would create a voluntary program that allows property owners to transfer development rights from sensitive areas, such as those subject to sea level rise, to areas more appropriate for development. A property owner with development rights in an area likely to be inundated would sell the development rights to an owner or developer of a property in a low-risk area, increasing the density of development in lower-risk areas. As a result, less new development would be likely to occur in higher-risk areas. *(Land use development projects.)*
- **Create rolling easements:** Rolling easements establish a boundary from the shoreline that moves inland as sea levels rise, allowing wetlands and beaches to migrate inland. This strategy allows development along the coast but transfers the risk to property owners, requiring the removal of certain structures as the shoreline moves landward over time. Communication of risk is important for this strategy to be effective. Rolling easements may be appropriate where the restriction of development and the purchase of land by local governments are infeasible. (*Land use development projects.*)
- **Prioritize infrastructure investments in low-risk areas:** Local jurisdictions can guide new development away from areas at risk of inundation from sea level rise by prioritizing investments in supporting infrastructure (e.g., municipal sewer) in lower-risk areas. Transportation agencies can adopt a similar approach, focusing first on the planning and construction of new projects that are not subject to sea level rise. (*Transportation projects, land use development projects.)*
- **Incorporate open space into the urban fabric:** Designating low-lying areas as open space (e.g., parks, natural areas) can reduce the risk of sea level rise by restricting development in high-risk areas. Open space can be designed or allowed to be periodically inundated, such as during extreme tides (e.g., King Tides). *(Land use development projects.)*
- **Raise elevation:** This strategy involves elevating the surface or grade of new transportation or development projects (e.g., local road, railroad tracks, buildings, structures) above the expected

sea level rise inundation level. Consideration of changes to overland flow and increased flooding to adjacent areas would be applied to manage any potential negative impacts of this strategy. (*Transportation projects, land use development projects.*)

- **Elevate mechanical/electrical equipment:** Transportation assets, buildings and other infrastructure with mechanical and/or electrical equipment at grade may malfunction if inundated. This strategy involves elevating any critical components, such as switchgears or substations—for existing or planned assets—to ensure that they are above flood levels and not at risk of inundation from sea level rise. (*Transportation projects, land use development projects.*)
- **Relocate:** The movement of transportation assets, structures, and functions from areas subject to sea level rise to lower-risk areas may be a possible strategy. Relocation may occur before an asset experiences inundation, or it may be planned as a response to sea level rise. (*Transportation projects, land use development projects.*)
- **Build/raise levee (engineered flood protection):** Building a new levee or raising the elevation of existing levees is a form of engineered flood protection designed to protect inland areas from inundation and erosion resulting from sea level rise. Levees are earthen structures constructed with sloped sidewalls, where the base is wider than the top. The level of protection will depend on the height of the levee relative to existing conditions and the rate of sea level rise, as well as the condition of the levee. This strategy could be implemented at the local or regional level, the latter involving the collaboration of multiple local jurisdictions and/or transportation agencies. (*Transportation projects, land use development projects.*)
- **Construct floodwall (engineered flood protection):** Floodwalls are also a form of engineered flood protection; however, in contrast to levees, floodwalls are concrete or steel structures. Floodwalls are often built in lieu of or on top of levees, typically where space does not allow for a levee's broad base. As with levees, the construction of floodwalls could be implemented at the local or regional level. (*Transportation projects, land use development projects.*)
- **Create berm:** Berms are non-engineered earthen structures that provide protection from wave erosion and provide flood protection to inland development and infrastructure. Expansive networks of berms currently exist along the San Francisco Bay shoreline that protect marshes, ponds, and agricultural areas, and may provide multiple lines of flood defense for developed areas. However, because berms are not engineered and experience settlement, erosion, and failure, they are highly vulnerable to sea level rise and storm surge. The effectiveness of berms in providing protection from sea level rise and storm surge events may depend on regular and routine maintenance. (*Transportation projects, land use development projects.*)

Functional Inundation Strategies

The following strategies focus on physical and operational measures designed to allow transportation and land use development projects to continue functioning with sea level rise:

- **Increase maintenance at flooding hotspots:** Transportation and development assets that are allowed to flood frequently are likely to experience greater wear and tear and therefore, have greater maintenance needs. This strategy entails planning for an increased level and/or frequency of maintenance in targeted areas of transportation and development projects that are anticipated to flood regularly with sea level rise. (*Transportation projects, land use development projects.*)

- **Use corrosion-resistant materials:** Some materials are more resistant to the corrosive effects of saltwater, and incorporating them into certain parts of infrastructure that are likely to be permanently inundated, such as bridge touchdowns or building foundations, may prolong asset life. (*Transportation projects, land use development projects.*)
- **Retrofit/make waterproof:** Bridge tollbooths, ferry terminals, and other structures can be upgraded to withstand periodic inundation and continue to function, either in conjunction with sea level rise or following storm events. (*Transportation projects, land use development projects.*)

Inundation Strategies

The strategies below plan and allow for inundation, focusing on alternatives where assets experience flooding from sea level rise. These strategies are primarily aimed at transportation assets, although the implementation of partial or temporary closures may be adapted to address commercial development as well:

- **Provide alternative transportation mode:** Commuters and other passengers can be offered a different mode of transportation when assets experience flooding from sea level rise depending on the road, rail, BART, and ferry options available and appropriate. Providing alternatives for goods movement is considered less viable. This strategy may include the identification of emergency measures to maintain mobility and safety in the event that longer-term closures are needed to repair damage. *(Transportation projects.)*
- **Conduct partial or temporary closure:** The closure of part or all of a transportation asset is a management option, particularly during extreme events. The level of service required would determine the adequacy of this adaptation strategy, as it is unlikely that recurring closure would be acceptable for some assets. In the case of such closures, commuters and other passengers could use nearby assets (e.g., adjacent transit stations) or alternative transportation modes or routes; alternate routes for goods traffic are less likely to be readily available. *(Transportation projects.)*
- **Construct low-water crossings:** For roads likely to flood frequently from sea level rise or extreme tide levels such as King Tides, this strategy offers an alternative to raising road elevations. Low-water crossings allow vehicles to travel safely over a waterway during low tide or normal flow conditions, either via a bridge or causeway under dry conditions; however, under extreme high tide or high flow conditions, vehicles may either travel safely over the crossing with "wet wheels," or the crossing may be closed to traffic if inundation exceeds a certain depth. The creation of low-water crossings acknowledges access limitations due to frequent inundation, and the crossings can be designed to avoid blocking drainage pathways. This strategy is most appropriate for local streets and roads with low traffic volumes and likely requires the availability of alternative routes or transportation modes, as low-water crossings can effectively close affected roadways. *(Transportation projects.)*
- **Develop emergency management plan:** An emergency management plan can designate alternative transportation modes or routes for use during periodic inundation associated with extreme coastal flood events. This plan may be coupled with a community's Hazard Mitigation Plan. *(Transportation projects.)*

Strategies with a Range of Outcomes

The specific outcome of the following strategies, in terms of their respective abilities to mitigate the impacts of sea level rise, depends on the specific goals of the local jurisdiction, transportation agencies, or other implementing entity, as well as asset- and site-specific conditions. The outcome could range from protection to inundation:

- **Revise planning guidance/policy:** The review and revision of existing guidance and policies on sea level rise and flood management for specific assets can facilitate proactive planning and adaptation. The incorporation of sea level rise into general and specific plans is a tool for local jurisdictions to address the impacts of sea level rise comprehensively and devise the most appropriate strategies for adaptation over the long-term. Caltrans currently applies their internal guidance on incorporating sea level rise when planning new transportation projects, pursuant to requirements for state agencies. Other agencies charged with implementing transportation projects can adopt a similar approach. *(Transportation projects, land use development projects.)*
- **Form multi-jurisdictional partnerships:** Partnerships between cities, regional entities, federal and state agencies, transportation providers, ports, and others may lead to the development of regional strategies that address sea level rise impacts for multiple transportation and/or development projects. Such partnerships may also facilitate cost-sharing or implementation of structural and/or policy solutions needed to address vulnerabilities and risks to sea level rise. In some cases, existing partnerships could expand their focus to address adaptation solutions in conjunction with other planning activities. MTC and ABAG have been partnering with BCDC, and other local, state, and federal agencies and stakeholders on the Adapting to Rising Tides Project focused in Alameda County. This effort can serve as an example for continued and expanded partnerships in other counties, or as the foundation for the development of regional partnerships in coordination with the Joint Policy Committee. *(Transportation projects, land use development projects.)*
- **Create a comprehensive sea level rise plan:** For local jurisdictions and/or transportation agencies likely to experience sea level rise impacts for multiple assets, the creation of a plan that assesses risk and vulnerability and develops appropriate adaptation strategies represents a comprehensive, proactive approach. Comprehensive sea level rise plans can also be created at the regional level for multiple jurisdictions or partnerships, which may facilitate creative solutions and cost-sharing for any new investments. MTC, ABAG and BCDC, through the Joint Policy Committee, along with other agencies and stakeholders, collaborated on the Adapting to Rising Tides Project focused in Alameda County, which can be used as an example plan for other counties, or as the foundation for the development of a wider-scale regional plan, potentially. *(Transportation projects, land use development projects.)*
- **Create or update hazard mitigation plans:** Mitigation plans identify policies and actions that can be implemented over the long term to minimize risk and the loss of life and property. The Federal Emergency Management Agency (FEMA) requires a hazard mitigation plan as a condition for granting non-emergency funds to a local jurisdiction. In 2010, ABAG adopted the Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area, an update of its 2005 plan. ABAG's plan includes references to sea level rise hazards. Hazard mitigation plans incorporate a range of hazards and can be created or updated to include sea level rise; such plans may be prepared by individual or multiple local jurisdictions (cities and counties). For hazard mitigation plans to be effective, they must be regularly updated and approved. *(Land use development projects.)*

- **Create/restore/enhance wetlands:** Tidal wetlands can mitigate the impacts of sea level rise by serving as open space buffers that restrict development in high-risk areas and by helping to dissipate storm surge and wave energy associated with storm events. The creation of a sediment management program that considers wetland processes such as vertical accretion, as well as planning for wetland transgression or migration, is one example of a way in which local jurisdictions and/or transportation agencies can support the creation, restoration, or enhancement of wetlands. This strategy is most appropriate where shoreline and/or flood protection structures (e.g., bulkheads, floodwalls) do not impede the migration of wetlands to higher ground as sea levels rise. *(Transportation projects, land use development projects.)*
- **Beach nourishment:** The ongoing replenishment of sand from off-site locations can preserve beaches—both natural and artificial—that are subject to erosion and land loss from rising sea levels. This form of soft shoreline protection can maintain a barrier between rising sea levels and transportation and development. In addition to inundation, beach nourishment can protect against storm surge by dissipating wave energy *(Transportation projects, land use development projects.)*
- **Construct shoreline armoring (engineered shore protection):** Revetment and bulkheads are forms of engineered shoreline protection structures that harden the shoreline to reduce erosion and prevent land loss. However, these structures alone do not provide flood protection, and sea level rise, coupled with storm surge, can compromise their functionality and stability. *(Transportation projects, land use development projects.)*
- **Improve drainage:** A number of structural strategies can be employed to facilitate drainage and mitigate the impacts of temporary inundation associated with extreme tide events and storm surge on transportation assets, structures, and infrastructure. The inclusion of more under-drains and/or cross-drains in new roadways could improve the drainage of transportation projects. For development, the installation of backflow/flex valves and/or construction of perimeter wall or piling/column foundations could reduce the impacts of inundation on structures and infrastructure. *(Transportation projects, land use development projects.)*
- **Build causeway:** Causeways represent an alternative for roads or rail tracks likely to be regularly inundated, as they typically traverse open water or wetlands on elevated embankment. While some causeways are designed to avoid all inundation, others may function only at low tide. *(Transportation projects.)*

Shoreline Types

Both the asset type (e.g., rail, transit, residential development, commercial development) and shoreline type (e.g., berms, wetlands) play a role in project-level adaptation planning. For example, enhancing wetlands would not likely be appropriate where flood and shoreline protection structures are present. The following tables illustrate asset and shoreline types by county for transportation projects that fall within the sea level rise inundation zones (**Table 2.5-22**) and low-lying hydraulically disconnected zones by asset type and primary shoreline type (**Table 2.5-23**). Although still important considerations, it is more difficult to assign specific shoreline types to PDAs and TPPs, which are not linear features. Other components that will be important to consider in determining the feasibility of adaptation strategies for specific assets include exposure, sensitivity, adaptive capacity, consequence, overtopping potential, and shoreline system—these elements would be covered under subsequent project-level planning and are not addressed in this EIR.

TABLE 2.5-22: ASSET TYPES AND SHORELINE TYPES OF PROPOSED TRANSPORTATION PROJECTS WITHIN SEA LEVEL RISE INUNDATION ZONE

County	*Engineered shore protection structures*[1]	*Engineered flood protection structures*[2]	*Berms*	*Wetlands*	*Natural Shoreline*
Marin					
Interstate and State Highways[3]			X	X	
Bicycle and Pedestrian				X	
Alameda					
Interstate and State Highways			X	X	
Rail			X	X	
Transit	X				
San Mateo					
Interstate and State Highways		X			
Local Streets and Roads[4]		X			
Transit			X	X	
Bicycle and Pedestrian	X				
Santa Clara					
Interstate and State Highways		X	X	X	
Multi County					
Interstate and State Highways	X		X	X	X
Rail					X

Notes:

1. "Engineered shore protection structures" refers to bulkheads and revetments.
2. "Engineered flood protection structures" refers to levees and flood walls.
3. Interstate and State Highways includes toll bridges.
4. Local Streets and Roads includes arterials and collectors.

TABLE 2.5-23: ASSET TYPES AND SHORELINE TYPES OF PROPOSED TRANSPORTATION PROJECTS WITHIN LOW-LYING HYDRAULICALLY DISCONNECTED ZONE

County	*Engineered shore protection structures*[1]	*Engineered flood protection structures*[2]	*Berms*	*Wetlands*	*Natural Shoreline*
San Francisco					
Local Streets and Roads[3]	X				
Transit	X				
Alameda					
Rail			X	X	
Transit	X	X			
San Mateo					
Interstate and State Highways[4]		X			
Local Streets and Roads	X				
Bicycle and Pedestrian	X		X	X	
Santa Clara					
Interstate and State Highways		X	X	X	
Rail			X	X	
Multi County					
Interstate and State Highways	X		X		
Rail	X		X	X	

Notes:

1. "Engineered shore protection structures" refers to bulkheads and revetments.
2. "Engineered flood protection structures" refers to levees and flood walls.
3. Local Streets and Roads includes arterials and collectors.
4. Interstate and State Highways includes toll bridges.