3.9 Climate Change and Greenhouse Gases

This section discusses the considerations unique to greenhouse gas emissions (GHG) emissions and the potential effects on climate change to provide context for the discussion of potential effects associated with the proposed alternatives presented in Section 4.9, Climate Change and Greenhouse Gases. Climate change is a global phenomenon; however, the contributions to and impacts of climate change are considered here with respect to the Covered Lands. Therefore, the study area for this section is considered concurrent with the Covered Lands.

3.9.1 Sources of Greenhouse Gases

Some gases in the atmosphere affect the earth's heat balance by absorbing infrared radiation. This layer of gases in the atmosphere functions much the same as glass in a greenhouse. This is why this heating of the atmosphere is also known as the *greenhouse effect*, and the gases that cause this effect are referred to as GHGs. GHGs include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Important characteristics of GHGs, including global warming potential, lifetime in the atmosphere, and atmospheric concentration as of 2005, are shown in Table 3.9-1. The global warming potential is the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specified time period (U.S. Environmental Protection Agency 2010a).

GHG sources are both anthropogenic and natural. Human activities associated with industrial/manufacturing, utilities, transportation, residential, and agricultural sectors result in GHG emissions (California Energy Commission 2006). Transportation is responsible for 38% of California's GHG emissions, followed by electricity generation contributing 25% (California Air Resources Board 2007). Emissions of CO_2, CH_4, and N_2O are byproducts of fossil fuel combustion. Methane, a highly potent GHG, also results from off-gassing associated with agricultural practices, landfills, and wastewater treatment. Natural sources of GHGs include water vapor and naturally occurring CO_2, CH_4, N_2O, and O_3. GHGs remain in the atmosphere for a long period of time, adding to their capabilities to create greenhouse effects. Natural GHG sinks also exist, which deplete the atmosphere of GHGs. GHGs are utilized by plant life during photosynthesis to produce nutrient-rich sugars. Manmade GHGs, which have a much greater heat-absorption potential than CO_2, include HFCs, PFCs, SF_6, and NF_3, which are associated with certain industrial products and processes (California Environmental Protection Agency 2006).

Table 3.9-1. Characteristics of Significant Greenhouse Gases

Greenhouse Gas[1]	Global Warming Potential	Lifetime (years)	Concentration	Units
CO_2	1	50-200	379	parts per million
CH_4	21	9-15	1.7	parts per million
N_2O	310	120	0.32	parts per million
HFC-23	11,700	264	18	parts per trillion
HFC-134a	1,300	14.6	35	parts per trillion
HFC-152a	140	1.5	3.9	parts per trillion
CF_4	6,500	50,000	74	parts per trillion
C_2F_6	9,200	10,000	2.9	parts per trillion
SF_6	23,900	3,200	5.6	parts per trillion

Notes:

CO_2 = carbon dioxide; CH_4 = methane; N_2O; HFC = hydrofluorocarbons; CF_4 = tetrafluormethane C_2F_6 = hexafluoroethane; SF_6 = sulfur hexafluoride.

[1]CF_4 and C_2F_6 are perfluorocarbons. The global warming potential (GWP) values are for 100-year time horizon. The GWP values presented above are based on the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) and United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines (Intergovernmental Panel on Climate Change 1996). Although the IPCC Fourth Assessment Report (AR4) presents different GWP estimates, the current inventory standard relies on SAR GWPs to comply with reporting standards and consistency with regional and national inventories (U.S. Environmental Protection Agency 2010a).

Sources: Intergovernmental Panel on Climate Change 1996, 2001, 2007a

Worldwide, California is the 12th to 16th largest emitter of CO_2 and is responsible for approximately 2% of the world's CO_2 emissions (California Energy Commission 2006). In 2008, the most recent year for which statewide data are available, California produced 478 million gross metric tons of carbon dioxide equivalent (CO_2e) (California Air Resources Board 2010a). In comparison, the United States produced 6,957 million gross metric tons of CO_2e in 2008 (U.S. Environmental Protection Agency 2010b). As emissions of GHGs increase, temperatures in California are projected to rise significantly over the 21st century. The modeled magnitudes of this warming vary because of uncertainties in future emissions and in climate sensitivity. According to the California Climate Change Center, there are three projected warming scenarios referred to as the low, medium, and high range (California Energy Commission 2005). These rises (during the period of 2000 to 2100) vary from approximately 1.7°C to 3.0°C (3.0°F to 5.4°F) in the lower range of projected warming, 3.1°C to 4.3°C (5.5°F to 7.8°F) in the medium range, and 4.4°C to 5.8°C (8.0°F to 10.4°F) in the higher range.

Unlike criteria pollutants and toxic air contaminants (TACs), which are pollutants of regional and local concern, GHGs are global pollutants, and climate change is a global concern. Effects of GHG emissions are a function of their total atmospheric concentration and most GHGs are globally well-mixed atmospheric constituents. Therefore, the location of a particular GHG emission, in contrast to criteria pollutants or TACs, does not change its environmental effect.

3.9.2 Considerations from Global Climate Change

Several potential direct and indirect effects of climate change were identified in the 2009 California Climate Adaptation Strategy (CAS) (California Natural Resources Agency 2009). Climate changes identified in the CAS as currently occurring in California include the following:

- Increased average temperature
- More extreme hot days and fewer cold nights
- Seasonal shifts and lengthening of growing season
- Shifts in precipitation patterns, with less snowpack and snowmelt and rainwater running off sooner

As a result, the CAS found that there have been the following effects, including:

- More frequent and intense wildfires
- Increased sea level by up to 7 inches
- Reduction in water supply
- Stress on infrastructure

The CAS also identified several projected future effects of climate change based on information developed by the Intergovernmental Panel on Climate Change (IPCC) (2007b). These projected effects are uncertain because they depend on several assumptions of the various climate models, levels of future emissions, and uncertainty related to societal choices and policies (e.g., business as usual or cooperative efforts to reduce GHGs). The projected future effects identified by the CAS (California Natural Resources Agency 2009) that would occur under most climate change scenarios in California generally include:

- Temperature rise
  - 2°F to 5°F by 2050
  - 4°F to 9°F by 2100
  - More pronounced warming in summer than winter
  - More pronounced warming inland than in coastal areas
  - All models predict increased temperatures, with level of GHG emissions the biggest uncertainty
- Extreme weather events
  - More frequent and longer heat waves
  - More frequent and more intense wildfires
  - Prolonged drought
  - Increased winter and spring flooding due to more rain relative to snow, and earlier snowmelt

- Precipitation changes
  - 12% to 35% reduction by 2050
  - High uncertainty due to different models of where and how much snowfall and rain patterns will change
    - 11 of 12 precipitation models show overall decreases in rainfall in northern California (12% to 35%)
    - More water will fall as rain than as snow, affecting runoff patterns (earlier snowmelt)
- Seasonal shifts
- Sea level rise
  - 12 to 18 inches by 2050
  - 21 to 55 inches by 2100
- Generally hotter and drier conditions
- Potential abrupt climate change (although most models project gradual changes, tipping or threshold events [e.g., reduction in Arctic sea ice, accelerated Greenland/Antarctic ice sheet melting, warming of the Amazon, intensification of El Nino/Southern Oscillation Cycles] could cause rapid or abrupt changes).

Future climate change effects on Tejon Ranch, and specifically the Covered Lands, cannot be predicted with a high level of certainty, but it is expected that Tejon Ranch will experience warmer temperatures, altered precipitation, seasonal shifts, and lengthening of the growing season. The potential effects of such changes, both directly from climate change and indirectly from more frequent and intense wildfires, include alterations in runoff patterns, hydrology, vegetation communities, microclimates, and microhabitats. The potential effects of the alternatives on climate change and of climate change on the alternatives are discussed in Section 4.9, Climate Change and Greenhouse Gases. More detailed information regarding the potential effects of climate change is presented in Appendix C.