

CHAPTER 7

Climate Change

7.1 Introduction

Climate change is a shift in the average weather patterns observed on earth, which can be measured by such variables as temperature, wind patterns, storms, and precipitation (SCWA, 2008). This chapter presents a discussion of climate change and its potential consequences and how it would affect or be affected by the proposed project.

The earth's atmosphere includes gases such as carbon dioxide and methane that trap solar radiation entering the earth's atmosphere. As a result, the heat and the radiation that otherwise would have escaped back into space is retained, resulting in warming of the earth's atmosphere. This phenomenon is known as the greenhouse effect (refer to **Section 3.8, Air Quality**, for details). The gases that trap the heat and radiation are called greenhouse gases (GHGs).

Scientific research to date indicates that observed climate change is most likely a result of increased emission of GHGs associated with human activity (Intergovernmental Panel in Climate Change, 2007a; 2007b). Among the prominent GHGs contributing to the greenhouse effect are water vapor, methane, ozone, nitrous oxide, carbon dioxide (CO₂), and chlorofluorocarbons. GHG emissions in excess of natural ambient concentrations are responsible for enhancing the greenhouse effect. Emissions of the GHGs contributing to global climate change are attributable in large part to human activities associated with the industrial/manufacturing, utility, transportation, residential and agricultural sectors (California Energy Commission, 2006). In California, the transportation sector is the largest emitter of GHGs (accounting for 40.7 percent of the total GHG emissions in the state in 2004), followed by electricity generation (California Energy Commission, 2006). If California were a country, it would rank between the 12th and 16th largest emitters of CO₂ in the world. California produced 492 million gross metric tons of CO₂ equivalents¹ in 2004 (California Energy Commission, 2006).

One of the actions taken to address climate change and GHG emissions in California is the 2005 Executive Order S-3-05. This order mandates GHG emission reduction targets as follows:

- by 2010, GHG emissions reductions to 2000 levels;

¹ Carbon dioxide equivalent (CO₂E) is a measurement used to account for the fact that different GHGs have different potential to retain infrared radiation in the atmosphere and contribute to the greenhouse effect. This potential, known as the global warming potential of a GHG, is also dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. For example, methane is a much more potent GHG than CO₂.

- by 2020, GHG emissions reductions to 1990 levels; and
- by 2050, GHG emissions reductions to 80 percent below 1990 levels.

In 2006, the California Global Warming Solutions Act of 2006 was passed (AB 32; California Health and Safety Code Division 25.5, Sections 38500, et seq.), which requires the California Air Resources Board to design and implement emission limits, regulations, and other feasible and cost-effective measures, such that statewide GHG emissions are reduced to 1990 levels by 2020 (representing an approximate 25 percent reduction in emissions).

Two general areas relevant to the discussion of potential environmental effects related to climate change are:

- Would the proposed project contribute to the adverse effects of climate change (e.g., GHG emissions)?
- Would the proposed project be adversely affected by the environmental changes projected to result from climate change (e.g., sea level rise)? What would the role of the project be as it relates to the effect of climate change on water resources?

The first question, regarding the project's contribution to climate change, relates to GHG emissions and is analyzed in **Section 3.8, Air Quality**, of this Environmental Impact Report / Environmental Impact Statement (EIR/EIS). As discussed in the section, the proposed project would result in less-than-significant long term GHG emissions. Refer to Section 3.8, Air Quality, for details.

The second question, whether the proposed project would be affected adversely by the projected environmental changes associated with climate change, centers on issues such as water resources and sea level rise, which is discussed in this chapter. Sea level rise is also discussed in Section 3.2, Surface Hydrology.

7.2 Potential Changes and Effects from Climate Change

The many effects of GHG emissions are still being researched and are not fully known, but are expected to include increased temperatures, which could reduce snowpack, which in most areas is a primary source of fresh water². Climate change is expected to exacerbate air quality problems and adversely affect human health by increasing heat stress and related deaths; increase the incidence of infectious diseases, asthma and respiratory health problems; cause sea level rise threatening urban and natural coastal areas; cause variations in natural plant communities affecting wildlife; and cause variations in crop quality and yields (SCWA, 2008). Climate change is also expected to result in more extreme weather events and heavier precipitation events that can lead to flooding as well as more extended drought periods.

² Snowpack provides limited water to NBWRP services areas, and no water to MST or Carneros areas in Napa. While the City of Napa does receive water from the State Water Project, the City does not serve unincorporated areas of Napa County.

7.2.1 Water Resources

Water supply can be described in terms of indices such as precipitation, snow pack, and runoff. Analysis of data and weather records are studied to determine the trend and the variability in the indices (e.g., precipitation and runoff), which affect water availability.

Most precipitation events in California occur between October and April more specifically, in terms of amount of precipitation occurring from November through March. An analysis by the United States National Weather Service (USNWS) using data from 1931 through 2005 indicates a long-term trend of increasing annual precipitation (i.e., increase of up to 1.5 inches per decade) in California, especially in northern California (USNWS, 2008). A second investigation completed by the California Department of Water Resources (DWR) indicated a statistically significant increasing trend in total precipitation in northern and central California since the late 1960s (DWR, 2006). An investigation by Bardini and others (2001) showed a trend of potentially decreasing annual precipitation in California; however, this result is probably related to the specific subset of data that the Bardini study relied upon, wherein extremes at the beginning or end of time series data can substantially impact the identified trend (DWR, 2006). Rainfall data from November through March of 1930 through 1997 indicated significant increases in California rainfall (Mote, 2005).

There is also evidence that the amount of precipitation that occurs on an annual basis is becoming more variable (i.e., periods of both high and low rainfall are becoming more common). Specifically, a study performed by DWR (2006) indicates that present day variability in annual precipitation is about 75 percent greater than that of the early 20th century.

As stated above, precipitation across California appears to have increased over the past century, and individual water years have become more variable in terms of the amount of precipitation that occurs. It follows, therefore, that similar trends would be observed for runoff. Annual runoff (i.e., runoff measured from October 1st through September 30th) and peak runoff (i.e., typically measured for individual storm events) include flows derived from precipitation events, snowmelt, and river base flow. However, most of the water mass present during a peak runoff event is typically derived from concurrent precipitation and/or snowmelt.

A DWR study by DWR (2006) compares pre- and post-1955 annual average water year unimpaired runoff³ for 24 watersheds across northern, central, and southern California. The study indicates an annual increase in runoff of up to 27 percent for 21 of the 24 watersheds, with an overall average increase of 9 percent. However for summer months the runoff from April to July is decreasing. In May 2008, seasonal runoff of Napa River in the San Francisco Bay Region totaled 45,000 acre-feet which is 60 percent of average runoff for this period. In 2007, the runoff for the same period was 30 percent of average (DWR, 2006).

³ Unimpaired runoff refers to the runoff that occurs within a river above major regulating impoundments such as major dams.

7.2.2 Flooding and Sea Level Rise

As discussed above, it is anticipated that climate change will have a substantial effect on the timing and magnitude of snowfall, rainfall, and snowmelt events in California. Large annual variations in winter rainfall and runoff, which are normal in California, create uncertainty surrounding potential increase in flooding as a result of climate change.

According to a report by DWR (2006), the mean sea level at the Golden Gate Bridge has risen by at least 8 inches since 1900. This is in line with a report by the IPCC (2007a), which indicates average increases of 3.9 to 7.9 inches globally during the last century. The observed sea level rise likely results from a combination of factors, including melting of polar and terrestrial ice and snow, and thermal expansion of ocean water as the earth's temperature increased (IPCC, 2007b).

Efforts have been made to predict the amount of sea level rise that would likely occur in the future under various worldwide GHG emissions scenarios. Results from a recent IPCC report indicated that global sea level could increase by an estimated 7 to 23 inches by 2099, or about 0.6 to 3.8 inches per 10 years (IPCC, 2007b). There is some disagreement and uncertainty in regards to sea level rise projections (Munk, 2002); however, the IPCC (2007b) study represents what is probably the most highly regarded and accepted study.

7.2.3 Climate Change and the Proposed Project

Water Resources

Current climate change research generally indicates that the most probable water resources impacts associated with climate change would be related to increases in peak winter flows and decreases in spring and early summer runoff. These factors would result in a reduction of water available for capture within the state and federal water projects, as well as other local water projects and diversions. Without substantial changes in water management, it is therefore likely that climate change could result in reduced deliveries to water contractors in the project area.

As discussed in **Section 3.3, Groundwater Resources**, saline intrusion continues to be an issue in areas bordering San Pablo Bay. Increased groundwater pumping, low rainfall, saline intrusion from San Pablo Bay, low soil permeability, and geothermal upwelling are believed to contribute to declining groundwater levels and poor groundwater quality in portions of the project area. Although the clay content holds water in the soil, it can restrict water percolation to the water table and can, therefore, reduce the volume of groundwater available for irrigation in certain areas. Groundwater pumping in Sonoma and Napa Counties has increased in the past 20 years because of population growth and an increase in agriculture. Several pumping depressions are now evident within Sonoma and Napa Counties, and groundwater levels have generally declined in these areas (Farrar et al 2006; Farrar and Metzger, 2003). The MST groundwater basin has been designated as a groundwater deficient basin by Napa County because of declining groundwater levels.

Predictive climate models have been improved in recent years to provide reasonable stimulations of future climate conditions for snowpack watersheds as those of the Sierra Nevada mountain range. However, the models would not be likely able to provide reasonably accurate results for the project area (e.g., the Russian River watershed) due to highly erratic and variable nature of storm formation in the Pacific region. Preliminary climate modeling results for the Pacific coastal regions have predicted that it could be wetter, drier, or the same. Consequently, the numeric climate models are not a useful water supply planning tool for this region, and the best information SCWA has to predict climate in the region continues to be 95 years of hydrologic information (1909 – 2004 hydrologic period) used as a foundation for SCWA’s Russian River System Model. Although SCWA will continue to monitor and evaluate developing modeling capabilities, it is currently not possible to predict with a reasonable degree of accuracy the water resource impacts of climate change on the Russian River watershed (SCWA, 2008), which likely is applicable to the project area.

As described in Chapter 1, Introduction, the NBWRA Member Agencies have initiated programs to promote sustainability and implement energy efficiency and water conservation programs including local recycled water projects as means of adaptive strategies to the effects of climate change. As part of the proposed project, the NBWRA would expand the recycled water use in the North San Pablo Bay region. As discussed in **Section 3.11, Public Services and Utilities**, the proposed project would treat and reuse the wastewater that is otherwise discharged to the San Pablo Bay. The project would therefore offset the potable water supply, making an equivalent amount of potable water available for other uses. Given the increased variability in the precipitation and thus, the water supplies, the proposed project would have a beneficial effect on the water supplies in the region. The proposed project would provide several opportunities for management flexibility and implementation of adaptive management strategies to improve water supply reliability.

Flooding

As discussed in **Section 3.2, Surface Hydrology**, the watersheds within the project area have experienced multiple severe flood events in the last 100 years. The Novato Creek Watershed has experienced five serious floods since 1955, the Petaluma River has had four major floods since 1982, and the Napa River has experienced serious floods 21 times since 1862. Historical trends for annual runoff and peak flows over the last hundred years indicated a decrease in runoff from April to July and an increase in and more variable three-day peak flows (DWR, 2006). Independent climate modeling efforts (Dettinger et. al., 2004 and Miller et. al., 2003), predict that more variable river flows and more frequent flooding events will continue into the future, as a result of climate change.

As discussed further in **Section 3.2, Surface Hydrology**, sea-level rise could cause impacts in certain areas of the proposed project. The Department of Geosciences Environmental Studies Laboratory Climate Change and Sea Level Rise data identifies areas in Marin, Sonoma, and Napa Counties that would likely be susceptible to impacts based on elevation and proximity to San Pablo Bay. Susceptible areas that have been identified include the following portions of the project area:

- the eastern portion of Marin County, north of the community of Santa Venetia, south of State Route 37, east of U.S. 101 and the railroad;
- areas along the Petaluma River, north of the city of Novato;
- areas along the southern portion of Sonoma Creek in Sonoma County; and
- the majority of Napa County, predominantly south of the Northwestern Pacific Railroad, west of the airport, and along the Napa River corridor.

As discussed in **Section 3.2, Surface Hydrology** of the EIR/EIS, some of the project facilities in the above areas would be potentially impacted from sea level rise. To alleviate the significant impact, the project design would take into account the sea level rise potential and address potential impacts related to sea level rise, similar to those applied to facility installation within 100-year flood plains. Design measures may include, but are not limited to: facility siting, access placement, access vault extension above projected water elevation, water tight vaults, and site protection (see **Section 3.2, Surface Hydrology**).

References – Climate Change

- Bardini, G., Guillen, S., Pierotti, B, Rooks, H., and Sou, S., 2001. *Climate Change in California: Potential Consequences and Strategies to Cope and Adapt*. California Department of Water Resources Report. 91 pp.
- California Department of Water Resources (DWR), 2006. Progress on Incorporating Climate Change into Management of California’s Water Resources. July, 2006 Technical Memorandum Report.
- California Department of Water Resources (DWR). *The State Water Project Delivery Reliability Report, 2007*, August 2008.
- California Energy Commission, 2006. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. Available: <http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-13-SF.PDF>.
- Dettinger, M., Cayan, D., Meyer, M., and Jeton, J. 2004. Simulated hydrologic responses to climate variations and change in the Merced, Carson, and American Rivers, Sierra Nevada, 1900-2099. *Climatic Change* 62: 283-317.
- Farrar C.D., Metzger, L.F., Nishikawa, T., Koczot, K.M., and Reichard, E.G. 2006. *Geohydrologic Characterization, Water Chemistry, and Ground Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California*. U.S. Geological Survey (USGS) Scientific Investigations Report 2006-5092.
- Farrar C.D., and Metzger L. F. 2003. *Ground-Water Resources in the Lower Milliken–Sarco–Tulucay Creeks Area, Southeastern Napa County California, 2000–2002*. USGS Water-Milliken, Sarco, Tulucay Creeks Area, Southeastern Napa County, California, 2000-2002, USGS

Intergovernmental Panel on Climate Change (IPCC), 2007a. Fourth Assessment Report, Climate Change 2007: Synthesis Report.

Intergovernmental Panel on Climate Change (IPCC), 2007b. Climate Change 2007 – The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC.

Mote, 2005. Declining Snowpack in Western North America. Bulletin of the American Meteorological Society 86(1): 39-49.

Miller, N.L., Bashford, K. E., and E. Strem. 2003. Potential impacts of climate change on California hydrology. Journal of the American Water Resources Association 39:771-784.

Munk, W. 2002. Twentieth Century Sea Level: An Enigma. Proceedings of the National Academy of Sciences, 20(10): 6550-6555.

Sonoma County Water Agency (SCWA), Water Project Environmental Impact Report, 2008.

United States National Weather Service (USNWS), 2008.

