3A.4 CLIMATE CHANGE – LAND

Emissions of greenhouse gases (GHGs) have the potential to adversely affect the environment because such emissions contribute, on a cumulative basis, to global climate change. The proper context for addressing this issue in an EIR/EIS is as a discussion of cumulative impacts, because although the emissions of one single project will not cause global climate change, GHG emissions from multiple projects throughout the world could result in a cumulative impact with respect to global climate change. In turn, global climate change has the potential to result in rising sea levels, which can inundate low-lying areas; to affect rainfall and snowfall, leading to changes in water supply; to affect habitat, leading to adverse effects on biological resources; and to result in other effects.

Therefore, the cumulative global climate change analysis presented in this section of the EIR/EIS includes two subsections: 3A.4.1 and 3A.4.2. In Subsection 3A.4.1, the projected GHG emissions generated by the No Project, No USACE Permit, Proposed Project, Resource Impact Minimization, Centralized Development, and Reduced Hillside Development Alternatives are analyzed with respect to their potential to contribute to global climate change. In Subsection 3A.4.2, the potential effects of global climate change are identified based on available scientific data, and their potential effects on the project are evaluated to the extent possible based on the quality of the data. Consequently, the format of this subsection is altered in comparison to other sections in Chapter 3.

3A.4.1 GREENHOUSE GAS EMISSIONS AND CONTRIBUTION TO GLOBAL CLIMATE CHANGE

INTRODUCTION

Cumulative impacts are the collective impacts of one or more past, present, and future projects that, when combined, result in adverse changes to the environment. In determining the significance of a proposed project's contribution to anticipated adverse future conditions, a lead agency should generally undertake a two-step analysis. The first question is whether the *combined* effects from *both* the proposed project *and* other projects would be cumulatively significant. If the agency answers this inquiry in the affirmative, the second question is whether "the proposed project's *incremental* effects are cumulatively considerable" and thus significant in and of themselves. The cumulative project list for this issue (climate change) comprises anthropogenic (i.e., human-made) GHG emissions sources across the globe, and no project alone would reasonably be expected to contribute to a noticeable incremental change to the global climate. However, legislation and executive orders on the subject of climate change in California have established a statewide context for and a process for developing an enforceable statewide cap on GHG emissions. Given the nature of environmental consequences from GHGs and global climate change, CEQA requires that lead agencies consider evaluating the cumulative impacts of GHGs, even relatively small (on a global basis) additions. Small contributions to this cumulative impact (from which significant effects are occurring and are expected to worsen over time) may be potentially considerable and therefore significant.

This section presents a discussion of existing climate conditions, the current state of climate change science, and GHG emissions sources in California; a summary of applicable regulations; and a description of project-generated GHG emissions and their contribution to global climate change.

AFFECTED ENVIRONMENT

Existing Climate

Climate is the accumulation of daily and seasonal weather events over a long period of time, whereas weather is defined as the condition of the atmosphere at any particular time and place (Ahrens 2003). The SPA is located in a climatic zone characterized as dry-summer subtropical or Mediterranean (abbreviated Cs) on the Köppen climate classification system. The Köppen system's classifications are primarily based on annual and monthly averages of temperature and precipitation.

The Sacramento Valley Air Basin (SVAB) is relatively flat, bordered by mountains to the east, west, and north. The climate is characterized by hot, dry summers and cool, rainy winters. Periods of dense and persistent low-level fog that are most prevalent between storms are characteristic of SVAB winter weather. The extreme summer aridity of the Mediterranean climate is caused by sinking air of subtropical high pressure regions. In the case of the SVAB, the ocean has less influence than in the coastal areas, giving the interior Mediterranean climate (abbreviated CSA on the Köppen climate system) more seasonal temperature variation (Ahrens 2003).

Most precipitation in the area results from air masses that move in from the Pacific Ocean during the winter months. These storms usually move from the west or northwest. More than half the total annual precipitation falls during the winter rainy season (November–February); the average winter temperature is a moderate 49 degrees °F. During the summer, daily temperatures range from 50°F to more than 100°F. The inland location and surrounding mountains shelter the area from much of the ocean breezes that keep the coastal regions moderate in temperature.

The local meteorology of the SPA and vicinity is represented by measurements recorded at the Folsom Dam station. The normal annual precipitation, which occurs primarily from November through March, is approximately 24 inches (Western Regional Climate Center 2009). January temperatures range from an average minimum of 37.9°F to an average maximum of 53.7°F. July temperatures range from an average minimum of 60.3°F to an average maximum of 94.5°F (Western Regional Climate Center 2009). The predominant wind direction and speed is from the south-southwest at approximately 10 miles per hour (mph) (California Air Resources Board [ARB] 1994).

Attributing Climate Change—The Physical Scientific Basis

Certain gases in the earth's atmosphere, classified as GHGs, play a critical role in determining the earth's surface temperature. Solar radiation enters the earth's atmosphere from space. A portion of the radiation is absorbed by the earth's surface, and a smaller portion of this radiation is reflected back toward space. This absorbed radiation is then emitted from the earth as low-frequency infrared radiation. The frequencies at which bodies emit radiation are proportional to temperature. The earth has a much lower temperature than the sun; therefore, the earth emits lower frequency radiation. Most solar radiation passes through GHGs; however, infrared radiation is absorbed by these gases. As a result, radiation that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the greenhouse effect, is responsible for maintaining a habitable climate on Earth. Without the greenhouse effect, Earth would not be able to support life as we know it.

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. It is *extremely unlikely* that global climate change of the past 50 years can be explained without the contribution from human activities (Intergovernmental Panel on Climate Change [IPCC] 2007).

Climate change is a global problem. GHGs are global pollutants, unlike criteria air pollutants and toxic air contaminants , which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about 1 day), GHGs have long atmospheric lifetimes (1 year to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule is dependent on multiple variables and cannot be pinpointed, it is understood that more CO_2 is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. Of the total annual human-caused CO_2 emissions, approximately 54% is sequestered through ocean uptake, uptake by northern hemisphere forest regrowth, and other terrestrial sinks within a year, whereas the remaining 46% of human-caused CO_2 emissions remains stored in the atmosphere (Seinfeld and Pandis 1998).

Similarly, impacts of GHGs are borne globally, as opposed to localized air quality effects of criteria air pollutants and toxic air contaminants. The quantity of GHGs that it takes to ultimately result in climate change is not precisely known; suffice it to say, the quantity is enormous, and no single project alone would measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro climate. From the standpoint of CEQA, GHG impacts to global climate change are inherently cumulative.

Attributing Climate Change—Greenhouse Gas Emission Sources

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the transportation, industrial/manufacturing, utility, residential, commercial and agricultural emissions sectors (ARB 2009a). In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation (ARB 2009a). Emissions of CO_2 are byproducts of fossil fuel combustion. CH_4, a highly potent GHG, results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) is largely associated with agricultural practices and landfills. N_2O is also largely attributable to agricultural practices and soil management. CO_2 sinks, or reservoirs, include vegetation and the ocean, which absorb CO_2 through sequestration and dissolution, respectively, two of the most common processes of CO_2 sequestration.

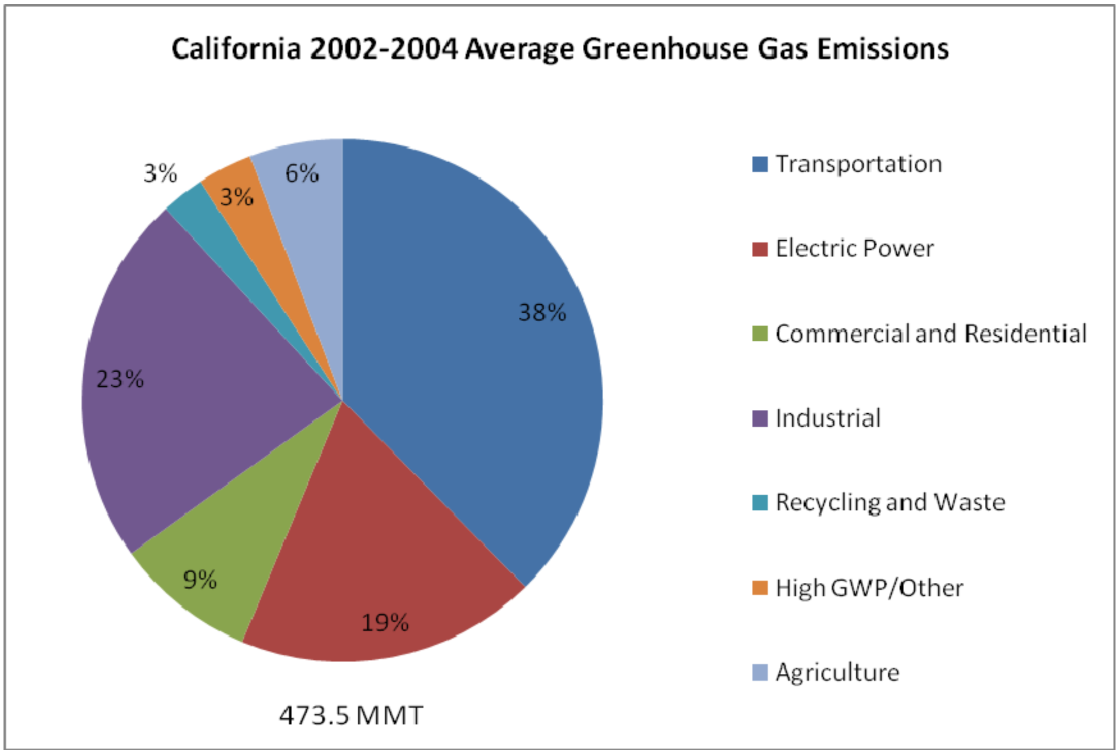
State Greenhouse Gas Emissions Inventory

According to different ranking systems, California is the 12th to 16th largest emitter of CO_2 in the world (California Energy Commission [CEC] 2006). California produced 484 million gross metric tons of CO_2 equivalent (CO_2e) in 2004 (ARB 2009a). CO_2e 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 (GWP) of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. For example, as described in Appendix C, "Calculation References," of the General Reporting Protocol of the California Climate Action Registry (CCAR) (CCAR 2009), 1 ton of CH_4 has the same contribution to the greenhouse effect as approximately 21 tons of CO_2. Therefore, CH_4 is a much more potent GHG than CO_2. Expressing emissions in CO_2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO_2 were being emitted.

Combustion of fossil fuel in the transportation sector was the single largest source of California's GHG emissions in 2004, accounting for 38% of total GHG emissions in the state (ARB 2009a). This sector was followed by the electric power sector (including both in-state and out-of-state sources) (19%) and the industrial sector (23%) (ARB 2008). See Exhibit 3A.4-1 below.

Local Inventory

A GHG emissions inventory was conducted for each incorporated city in Sacramento County, including the City of Folsom (City), and the unincorporated area of Sacramento County (County) for the year 2005. The City of Folsom estimated that communitywide GHG Emissions totaled approximately 609,009 metric tons of CO_2e in 2005. The City of Folsom contributed approximately 4.4% of the GHG emissions generated in Sacramento County. On-road transportation emissions composed 41.1% of Folsom's GHG emissions, followed by 24.0% from commercial/industrial land uses, and 21.6% from residential uses (Sacramento County 2009).



Source: ARB 2008

California's Greenhouse Gas Emissions by Economic Sector (2002-2004 Average) Exhibit 3A.4-1

REGULATORY FRAMEWORK

Numerous Federal, state, regional, and local laws, rules, regulations, plans, and policies define the framework that regulates and will potentially regulate climate change. The following discussion focuses on climate change requirements applicable to the project.

Federal Plans, Policies, Regulations, and Laws

Supreme Court Ruling

The U.S. Environmental Protection Agency (EPA) is the Federal agency responsible for implementing the Federal Clean Air Act (CAA). The Supreme Court of the United States ruled on April 2, 2007 that CO_2 is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs. However, there are no Federal regulations or policies regarding GHG emissions applicable to the Proposed Project, or alternatives under consideration.

EPA Proposed Regulations

In response to the mounting issue of climate change, EPA has taken actions to regulate, monitor, and potentially reduce GHG emissions. Although both actions discussed below are still in the proposal stage, they would have implications on the regulation, monitoring, and reduction of GHG emissions from stationary and mobile sources.

Proposed Mandatory Greenhouse Gas Reporting Rule

On April 10, 2009, EPA published its Proposed Mandatory Greenhouse Gas Reporting Rule (proposed reporting rule) in the Federal Register. The proposed reporting rule is a response to the fiscal year (FY) 2008 Consolidate Appropriations Act (House Resolution 2764; Public Law 110-161), which required EPA to develop "… mandatory reporting of greenhouse gases above appropriate thresholds in all sectors of the economy…" The proposed reporting rule would apply to fossil fuel and industrial GHG suppliers, vehicle and engine manufacturers, and all facilities that would emit 25,000 metric tons of CO_2e or more per year. Facility owners would be required to submit an annual GHG emissions report with detailed calculations of facility GHG emissions. The proposed reporting rule would also mandate record keeping and administrative requirements for EPA to verify annual GHG emissions reports. Owners of existing facilities that commenced operation prior to January 1, 2010 would be required to submit an annual report for calendar year 2010. Owners of new facilities commencing operation after January 1, 2010 would be required to submit an annual report from the facility's commencement date to December 31, 2010. For all subsequent operating years, facility owners would be required to report GHG emissions for the whole calendar year (January 1 to December 31). The comment period on the proposed reporting rule ended on June 6, 2009.

Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Federal Clean Air Act

On April 23, 2009, EPA published their Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the CCA (Endangerment Finding) in the Federal Register. The Endangerment Finding is based on Section 202(a) of the CAA, which states that the Administrator (of EPA) should regulate and develop standards for "emission[s] of air pollution from any class or classes of new motor vehicles or new motor vehicle engines, which in [its] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." The proposed rule addresses Section 202(a) in two distinct findings. The first addresses whether or not the concentrations of the six key GHGs (i.e., CO_2, CH_4, N_2O, HFCs, perflurorocarbons [PFCs], and SF_6) in the atmosphere threaten the public health and welfare of current and future generations. The second addresses whether or not the combined emissions of GHGs from new motor vehicles and motor vehicle engines contribute to atmospheric concentrations of GHGs and therefore the threat of climate change.

The Administrator proposed the finding that atmospheric concentrations of GHGs endanger the public health and welfare within the meaning of Section 202(a) of the CCA. The evidence supporting this finding consists of human activity resulting in "high atmospheric levels" of GHG emissions, which are very likely responsible for increases in average temperatures and other climatic changes. Furthermore, the observed and projected results of climate change (e.g., higher likelihood of heat waves, wildfires, droughts, sea level rise, higher intensity storms) are a threat to the public health and welfare. Therefore, GHGs were found to endanger the public health and welfare of current and future generations.

The Administrator also proposed the finding that GHG emissions from new motor vehicles and motor vehicle engines are contributing to air pollution, which is endangering public health and welfare. The proposed finding cites that in 2006, motor vehicles were the second largest contributor to domestic GHG emissions (24% of total) behind electricity generation. Furthermore, in 2005, the United States was responsible for 18% of global GHG emissions. Therefore, GHG emissions from motor vehicles and motor vehicle engines were found to contribute to air pollution that endangers public health and welfare.

State Plans, Policies, Regulations, and Laws

ARB is the agency responsible for coordination and oversight of state and local air pollution control programs in California and for implementing the California Clean Air Act (CCAA), which was adopted in 1988.

Various statewide and local initiatives to reduce the state's contribution to GHG emissions have raised awareness that, even though the various contributors to and consequences of global climate change are not yet fully understood, global climate change is under way, and there is a real potential for severe adverse environmental, social, and economic effects in the long term. Because every nation emits GHGs and therefore makes an incremental cumulative contribution to global climate change, cooperation on a global scale will be required to reduce the rate of GHG emissions to a level that can help to slow or stop the human-caused increase in average global temperatures and associated changes in climatic conditions.

Assembly Bill 1493

In 2002, then-Governor Gray Davis signed Assembly Bill (AB) 1493. AB 1493 requires that ARB develop and adopt, by January 1, 2005, regulations that achieve "the maximum feasible reduction of greenhouse gases emitted by passenger vehicles and light-duty trucks and other vehicles determined by ARB to be vehicles whose primary use is noncommercial personal transportation in the state."

To meet the requirements of AB 1493, in 2004 ARB approved amendments to the California Code of Regulations (CCR) adding GHG emissions standards to California's existing standards for motor vehicle emissions. Amendments to CCR Title 13, Sections 1900 and 1961 (13 CCR 1900, 1961), and adoption of Section 1961.1 (13 CCR 1961.1) require automobile manufacturers to meet fleet-average GHG emissions limits for all passenger cars, light-duty trucks within various weight criteria, and medium-duty passenger vehicle weight classes (i.e., any medium-duty vehicle with a gross vehicle weight rating less than 10,000 pounds that is designed primarily for the transportation of persons), beginning with the 2009 model year. For passenger cars and light-duty trucks with a loaded vehicle weight (LVW) of 3,750 pounds or less, the GHG emission limits for the 2016 model year are approximately 37% lower than the limits for the first year of the regulations, the 2009 model year. For light-duty trucks with LVW of 3,751 pounds to gross vehicle weight (GVW) of 8,500 pounds, as well as medium-duty passenger vehicles, GHG emissions would be reduced approximately 24% between 2009 and 2016.

In December 2004, a group of car dealerships, automobile manufacturers, and trade groups representing automobile manufacturers filed suit against ARB to prevent enforcement of 13 CCR Sections 1900 and 1961 as amended by AB 1493 and 13 CCR 1961.1 (*Central Valley Chrysler-Jeep et al. v. Catherine E. Witherspoon, in Her Official Capacity as Executive Director of the California Air Resources Board, et al.*). The automobile-makers' suit in the United States District Court for the Eastern District of California, contended California's implementation of regulations that, in effect, regulate vehicle fuel economy violates various Federal laws, regulations, and policies.

On December 12, 2007, the Court found that if California receives appropriate authorization from EPA (the last remaining factor in enforcing the standard), then these regulations would be consistent with and have the force of Federal law, thus, rejecting the automobile-makers' claim. This authorization to implement more stringent standards in California was requested in the form of a CAA Section 209(b), waiver in 2005. Since that time, EPA failed to act on granting California authorization to implement the standards. Governor Schwarzenegger and Attorney General Edmund G. Brown filed suit against EPA for the delay. In December 2007, EPA Administrator Stephen Johnson denied California's request for the waiver to implement AB 1493. Johnson cited the need for a national approach to reducing GHG emissions, the lack of a "need to meet compelling and extraordinary conditions", and the emissions reductions that would be achieved through the Energy Independence and Security Act of 2007 as the reasoning for the denial (Office of the White House 2009).

The State of California filed suit against EPA for its decision to deny the CAA waiver. The recent change in presidential administration directed EPA to reexamine its position for denial of California's CAA waiver and for its past opposition to GHG emissions regulation. California received the waiver on June 30, 2009.

Executive Order S-3-05

Executive Order S-3-05, which was signed by Governor Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra Nevada snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea level.

To combat those concerns, the Executive Order established total GHG emission targets. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80% below the 1990 level by 2050.

The Executive Order directed the Secretary of the California Environmental Protection Agency (CalEPA) to coordinate a multiagency effort to reduce GHG emissions to the target levels. The Secretary will also submit biannual reports to the Governor and State Legislature describing: progress made toward reaching the emission targets; impacts of global warming on California's resources; and mitigation and adaptation plans to combat these impacts. To comply with the Executive Order, the Secretary of the CalEPA created the California Climate Action Team (CCAT) made up of members from various state agencies and commission. CCAT released its first report in March 2006. The report proposed to achieve the targets by building on voluntary actions of California businesses, local government and community actions, as well as through state incentive and regulatory programs.

Assembly Bill 32, the California Global Warming Solutions Act of 2006

In September 2006, Governor Arnold Schwarzenegger signed AB 32, the California Global Warming Solutions Act of 2006. AB 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and a cap on statewide GHG emissions. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on GHG emissions that will be phased in starting in 2012. To effectively implement the cap, AB 32 directs ARB to develop and implement regulations to reduce statewide GHG emissions from stationary sources. AB 32 specifies that regulations adopted in response to AB 1493 should be used to address GHG emissions from vehicles. However, AB 32 also includes language stating that if the AB 1493 regulations cannot be implemented, then ARB should develop new regulations to control vehicle GHG emissions under the authorization of AB 32.

AB 32 requires that ARB adopt a quantified cap on GHG emissions representing 1990 emissions levels and disclose how it arrives at the cap; institute a schedule to meet the emissions cap; and develop tracking, reporting, and enforcement mechanisms to ensure that the state achieves the reductions in GHG emissions necessary to meet the cap. AB 32 also includes guidance to institute emissions reductions in an economically efficient manner and conditions to ensure that businesses and consumers are not unfairly affected by the reductions.

Assembly Bill 32, Climate Change Scoping Plan

On December 11, 2008 ARB adopted its *Climate Change Scoping Plan* (Scoping Plan), which functions as a roadmap of ARB's plans to achieve GHG reductions in California required by AB 32 through subsequently enacted regulations (ARB 2008). The Scoping Plan contains the main strategies California will implement to reduce CO_2e emissions by 169 MMT, or approximately 30%, from the state's projected 2020 emissions level of 596 MMT of CO_2e under a business-as-usual scenario. (This is a reduction of 42 MMT CO_2e, or almost 10%, from 2002–2004 average emissions, but requires the reductions in the face of population and economic growth through 2020.) The Scoping Plan also breaks down the amount of GHG emissions reductions ARB recommends for each emissions sector of the state's GHG inventory. The Scoping Plan calls for the largest reductions in GHG emissions to be achieved by implementing the following measures and standards:

- improved emissions standards for light-duty vehicles (estimated reductions of 31.7 MMT CO_2e),
- the Low-Carbon Fuel Standard (15.0 MMT CO_2e),
- energy efficiency measures in buildings and appliances and the widespread development of combined heat and power systems (26.3 MMT CO_2e), and
- a renewable portfolio standard for electricity production (21.3 MMT CO_2e).

ARB has not yet determined what amount of GHG emissions reductions it recommends from local government land use decisions; however, the Scoping Plan does state that successful implementation of the plan relies on local governments' land use planning and urban growth decisions because local governments have primary authority to plan, zone, approve, and permit land development to accommodate population growth and the changing needs of their jurisdictions. ARB further acknowledges that decisions on how land is used will have large effects on the GHG emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The Scoping Plan states that the ultimate assignment to local government operations is to be determined (ARB 2008).

With regard to local land use planning, the Scoping Plan expects a reduction of approximately 5.0 MMT CO_2e from local land use changes associated with implementation of SB 375, discussed above. Also noteworthy is the fact that the Scoping Plan does not include any direct discussion about GHG emissions generated by construction activity.

Executive Order S-1-07

Executive Order S-1-07, which was signed by Governor Schwarzenegger in 2007, proclaims that the transportation sector is the main source of GHG emissions in California, at over 40% of statewide emissions. It establishes a goal that the carbon intensity of transportation fuels sold in California should be reduced by a minimum of 10% by 2020. This order also directed ARB to determine if this Low Carbon Fuel Standard could be adopted as a discrete early action measure after meeting the mandates in AB 32. ARB adopted the Low Carbon Fuel Standard on April 23, 2009.

Senate Bill 1368

SB 1368 is the companion bill of AB 32 and was signed by Governor Schwarzenegger in September 2006. SB 1368 requires the California Public Utilities Commission (CPUC) to establish a GHG performance standard for baseload generation from investor-owned utilities by February 1, 2007. The CEC must establish a similar standard for local publicly owned utilities by June 30, 2007. These standards cannot exceed the GHG emission rate from a baseload combined-cycle natural gas fired plant. The legislation further requires that all electricity provided to California, including imported electricity, must be generated from plants that meet the standards set by the CPUC and CEC.

Senate Bills 1078 and 107 and Executive Order S-14-08

SB 1078 (Chapter 516, Statutes of 2002) requires retail sellers of electricity, including investor-owned utilities and community choice aggregators, to provide at least 20% of their supply from renewable sources by 2017. SB 107 (Chapter 464, Statutes of 2006) changed the target date to 2010. In November 2008, Governor Schwarzenegger signed Executive Order S-14-08, which expands the state's Renewable Energy Standard to 33% renewable power by 2020. Governor Schwarzenegger plans to propose legislative language that will codify the new higher standard (California Office of the Governor 2008).

Senate Bill 97

SB 97, signed August 2007, acknowledges that climate change is a prominent environmental issue that requires analysis under CEQA. This bill directs the California Office of Planning and Research (OPR) to prepare, develop, and transmit to the California Natural Resources Agency guidelines for the feasible mitigation of GHG emissions or the effects of GHG emissions, as required by CEQA by July 1, 2009. The California Natural Resources Agency adopted those guidelines on December 30, 2009, and the guidelines became effective March 18, 2010.

This bill also removes inadequate CEQA analysis of effects of GHG emissions from projects (retroactive and future) funded by the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006, or the Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1B or 1E) as a legitimate cause of action. This provision will be repealed on January 1, 2010, wherein inadequate CEQA analysis for those projects could then become a legitimate cause of action. This bill would only protect a handful of public agencies from CEQA challenges on certain types of projects for a few years.

Senate Bill 375

SB 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG emission reduction targets, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocation in that MPO's Regional Transportation Plan (RTP). ARB, in consultation with MPOs, will provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every 8 years, but can be updated every 4 years if advancements in emissions technologies affect the reduction strategies to achieve the targets. ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned targets. If MPOs do not meet the GHG emission reduction targets, transportation projects would not be eligible for funding programmed after January 1, 2012.

This bill also extends the minimum time period for the Regional Housing Needs Allocation (RNHA) cycle from 5 years to 8 years for local governments located within an MPO that meets certain requirements. City or County land use policies (including general plans) are not required to be consistent with the RTP (and associated SCS or APS). However, new provisions of CEQA would incentivize qualified projects that are consistent with an approved SCS or APS, categorized as "transit priority projects."

Regional and Local Plans, Policies, Regulations, and Laws

Sacramento County

Sacramento County's Board of Supervisors has approved the first phase of a climate action plan that will provide a framework for reducing GHG emissions. The first phase focuses on the County's overall strategy and goals for addressing climate change (Sacramento County 2009). Key goals in the first phase include a reduction in vehicle miles traveled (VMT) per capita in the region; improving energy efficiency of all existing and new buildings; emphasizing water use efficiency as a way to reduce energy consumption; maximizing waste diversion, composting, and recycling through residential and commercial programs; and protecting important farmlands and open space from conversion and encroachment and maintaining connectivity of protected areas.

El Dorado County

El Dorado County has not developed a climate action plan or similar GHG emissions reduction plan for GHG emission-generating activity in its jurisdiction, nor has El Dorado County began efforts to develop such a plan at the time of writing this EIR/EIS.

City of Folsom

The City of Folsom has not developed a climate action plan or similar GHG emissions reduction plan for GHG emission-generating activity in its jurisdiction. The City of Folsom General Plan does not contain any goals or policies that relate directly to climate change or GHGs City of Folsom 1988). The City is in the early stages of updating its General Plan, which will include multiple policies that directly address climate change and GHG emissions.

ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

Thresholds of Significance

ARB, the Sacramento Metropolitan Air Quality Management District (SMAQMD), and El Dorado County Air Quality Management District (EDCAQMD) have not identified a significance threshold for analyzing GHG emissions associated with a land use development projects. SMAQMD has updated its CEQA guidance, and it released its *Guide to Air Quality Assessment in Sacramento County* in December 2009 (SMAQMD 2009a). However, SMAQMD does not include any particular GHG significance threshold in its guide. Instead, it suggests that lead agencies identify thresholds of significance applicable to a proposed project that is supported by substantial evidence (SMAQMD 2009a, page 6-5). Nevertheless, the primary focus of SMAQMD's guidance for addressing GHG emissions is "to provide guidance about evaluating whether the GHG emissions associated with a proposed project would be a cumulatively considerable contribution to global climate change" (SMAQMD 2009a, page 6-3).

The City and USACE acknowledge that, by adoption of AB 32 and SB 97, the State of California has identified GHG emission reduction goals and that the effect of GHG emissions as they relate to global climate change is inherently an adverse environmental impact. While the emissions of one single project will not cause global climate change, GHG emissions from multiple projects throughout the world could result in a cumulative impact with respect to global climate change.

To meet AB 32 goals, California would need to generate less GHG emissions than current levels. It is recognized, however, that for most projects there is no simple metric available to determine if a single project would substantially increase or decrease overall GHG emission levels.

Although the text of AB 32 applies to stationary sources of GHG emissions, this mandate demonstrates California's commitment to reducing the rate of GHG emissions and the state's associated contribution to climate change, without intent to limit population or economic growth within the state. Thus, to achieve the goals of AB 32, which are tied to GHG emission rates of a specific benchmark year (i.e., 1990), California would have to achieve a lower rate of emissions per unit of population than its current rate. Further, to accommodate *future* population and economic growth, the state would have to achieve an even lower rate of emissions per unit than was achieved in 1990. (The goal to achieve 1990 quantities of GHG emissions by 2020 means that this will need to be accomplished in the face of 30 years of population and economic growth beyond 1990.) Thus, future planning efforts that would not encourage reductions in GHG emissions or not enable land uses to operate in a GHG-efficient manner would conflict with the policy decisions contained in the spirit of AB 32, thus impeding California's ability to comply with the mandate.

Thus, if a statewide context for addressing GHG emissions is applied, any net increase in GHG emissions within state boundaries would be considered "new" emissions. For example, a land development project, such as the Folsom South of 50 Project, does not create "new" emitters of GHGs, but would theoretically accommodate a greater number of residents in the state. Some of the residents that move to the project could already be residents in California, while others may be from out-of-state (or would "take the place" of in-state residents who "vacate" their current residences to move to the new project). The out-of-state residents would be contributing new emissions in a statewide context, but would not necessarily be generating new emissions in a global context. Given the statewide context established by AB 32, the project would need to accommodate an increase in population in a manner that would not inhibit the state's ability to achieve the goals of lower emissions overall.

However, the State of California has established GHG emission reduction targets and has determined that GHG emissions as they relate to global climate change are a source of adverse environmental impacts in California that should be addressed under CEQA. Although AB 32 did not amend CEQA, it identifies the myriad of environmental problems in California caused by global warming (California Health and Safety Code, Section 38501[a]). SB 97, however, did amend CEQA by directing OPR to prepare revisions to the State CEQA

Guidelines addressing the mitigation of GHGs or their consequences. As an interim step toward development of required guidelines, in June 2008, OPR published a technical advisory, entitled *CEQA and Climate Change: Addressing Climate Change through California Environmental Quality Act (CEQA) Review* (OPR 2008). In this technical advisory, OPR recommends that the lead agencies under CEQA make a good-faith effort, based on available information, to estimate the quantity of GHG emissions that would be generated by a proposed project, including the emissions associated with vehicular traffic, energy consumption, water usage, and construction activities, to determine whether the impacts have the potential to result in a project or cumulative impact and to mitigate the impacts where feasible mitigation is available.

OPR's technical advisory also acknowledges that "perhaps the most difficult part of the climate change analysis will be the determination of significance," and noted that "OPR has asked ARB technical staff to recommend a method for setting thresholds which will encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the state." ARB has not yet completed this task at the time of writing this EIR/EIS.

OPR has provided proposed amendments to the State CEQA Guidelines, including Appendix G, to address impacts of GHG emissions, as directed by SB 97 (2007). These proposed amendments were approved by the California Natural Resources Agency (CRNA) on December 30, 2009 and the adopted amendments will not become effective until after the Office of Administrative Law completes its review of the adopted amendments and rulemaking file, and transmits the adopted amendments to the Secretary of State for inclusion in the California Code of Regulations (CNRA 2010). The thresholds for determining the significance of the impact of projected GHG emissions generated by the project for this analysis are based on OPR's proposed additions to Appendix G of the State CEQA Guidelines. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. An impact related to global climate change (i.e., the projected GHG emissions generated by the project) is considered significant if the Proposed Project or alternatives under consideration would do any of the following (OPR's proposed additions to Appendix G):

- generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment; or,
- conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of greenhouse gases.

SMAQMD also recommends that the above two criteria be addressed in the GHG analysis of an EIR (SMAQMD 2009a, page 6-6).

For the purposes of this EIR/EIS, the City and USACE have decided to quantify total GHG emissions from the Proposed Project and alternatives under consideration, and determine whether the associated emissions would substantially help or hinder the state's ability to attain the goals identified in AB 32 (i.e., reduction of statewide GHG emissions to 1990 levels by 2020). The analysis of GHG emissions in this EIR/EIS recognizes that the impact that GHG emissions have on global climate change does not depend on whether they are generated by stationary, mobile, or area sources, or whether they are generated in one region or another. As stated above, the mandate of AB 32 demonstrates California's commitment to reducing GHG emissions and the state's associated contribution to climate change, without intending to limit population or economic growth within the state. Thus, to achieve the goals of AB 32, which are tied to mass GHG emission levels of a specific benchmark year (i.e., 1990), California would have to achieve a lower rate of emissions per unit of population (per person) and/or per level of economic activity (e.g., per job) than its current rate. Furthermore, to accommodate future population and economic growth, the state would have to achieve an even lower rate of emissions per unit than it achieved in 1990. (The goal—to achieve 1990 quantities of GHG emissions by 2020—will need to be accomplished despite 30 years of population and economic growth beyond 1990.) For this reason, land uses need to be GHG "efficient" to attain AB 32 goals while accommodating population and job growth. Thus, the program-level analysis of GHGs for this EIR/EIS focuses on the annual operational GHG emissions per service population (SP), or annual

GHG/SP, where SP is the number of residents accommodated by each alternative plus the number of jobs supported by each alternative. The benchmark for this metric is estimated to be approximately 4.36 metric tons CO_2e/SP/year for the year 2020 and 3.68 metric tons CO_2e/SP/year for the year 2030. These benchmarks were developed and estimated based on future expected growth in the state's population and economy and the mass emissions reduction target mandated by AB 32 for the year 2020 and an interpolated mass emissions reduction target mandated target for the year 2030 that is based on Executive Order S-3-05; assumptions were also made about which emissions sectors of the statewide GHG emissions inventory are affected by land use planning and development design decisions. For instance, GHG emissions produced by the forestry sector are not accounted for in this metric because the Proposed Project and alternatives under consideration would not result in the removal or addition of forests or state forestland. These and other detailed projections and calculations used to estimate this benchmark are presented in Appendix C1.

Additionally, the application of an efficiency-based metric in this analysis is consistent with the discussion in ARB's Scoping Plan of the importance of GHG efficiency in land use planning that must be achieved to attain the mandated reductions in mass annual GHG emission levels (ARB 2008, page ES-12). However, although the Scoping Plan discusses efficiency in terms of (imperial) tons per person, it does not explicitly discuss ways to account for projected growth in the state's population or projected growth in the state's economy. Moreover, the metric of mass GHG emissions per capita would not be useful for understanding the efficiency of nonresidential land uses (e.g., commercial, industrial, educational).

Because the CO_2e/SP/year metric accounts for future population growth, future economic growth, and mass emission targets, future land use development projects that would not be more GHG efficient than "business as usual" would conflict with the spirit of AB 32 policy.

Nonetheless, one of the primary challenges to establishing a reasonable threshold and determining impacts (and mitigation) relates to enactment of AB 32 and other GHG emission-reduction legislations. As previously described, much of this legislation requires ARB and others to establish standards that relate to energy efficiency, carbon levels in fuels, smokestack emissions, and regional transportation planning (i.e., SB 375). These standards are in the development process but may be a few to several years away from implementation. The project, however, would also be in development for multiple decades (±20 years), and during its lifetime would be subject to these as-yet undeveloped thresholds. There is a lag time between enactment of these legislative fixes and the regulations that will implement them. As a consequence, local governmental agencies are left to struggle with trying to discern the extent to which their decisions can and will influence GHG emissions, versus what still-to-be-developed regulations will achieve. For instance, a local lead agency can base a threshold on generation of emissions below some business-as-usual target, but it is difficult to ascertain whether these regulations will largely result in substantial reductions that hit the target, or whether local agencies will need to impose additional measures. This challenge is discussed in more detail in the "Impact Analysis" section below.

Analysis Methodology

At the time of writing this EIR/EIS, neither ARB nor any air district in California (including SMAQMD and EDCAQMD) has formally adopted a recommended methodology for evaluating GHG emissions associated with new development. Though SMAQMD has not developed a threshold of significance for determining whether project-related GHG emissions are considered to be significant, its *Guide to Air Quality Assessment in Sacramento County* does recommend that lead agencies estimate GHG emissions associated with temporary and short-term, project-related construction activities, as well as the long-term, operational emissions associated with a project, including mobile- and area-source GHG emissions and direct, off-site emissions associated with the project's consumption of electricity and water (SMAQMD 2009a, page 6-6).

In the case of the Folsom South of 50 Project, CO_2 emissions associated with project construction and operation were modeled using URBEMIS 2007 version 9.2.4 (Rimpo and Associates 2008); a model widely-used in regional air quality analysis. Indirect emissions associated with energy consumption were estimated using methodology recommended in the current CCAR General Reporting Protocol version 3.1 (CCAR 2009).

It is important to note that all CO_2 emissions from project operation may not necessarily be considered "new" emissions, given that a project itself does not create "new" emitters (people) of GHGs, at least not in the traditional sense. In other words, the GHG emissions for a residential project are not necessarily all new GHG emissions in the local area, state, or world; to a large degree, a new residential development, accommodates household relocations. In this sense, residential development projects can be seen as reacting to increased demand from the growing population and economy, and are not in themselves creators of economic or population growth. Emissions of GHGs are, however, influenced by the location and design of projects, to the extent that they can influence travel to and from the projects, and to the degree the projects are designed to maximize energy efficiency and GHG efficiency.

The methodology used in this EIR/EIS to analyze the project's contribution to global climate change includes a calculation of GHG emissions and a discussion about the context in which they can be evaluated. The lead agencies' purpose of calculating the project's GHG emissions is for informational and comparison purposes, as neither SMAQMD or EDCAQMD have not adopted a quantifiable threshold for evaluating whether project-generated GHG's would be considered a significant impact.

IMPACT ANALYSIS

Impacts that would occur under each alternative development scenario are identified as follows: NP (No Project/Action), NCP (No USACE Permit), PP (Proposed Project/Action), RIM (Resource Impact Minimization), CD (Centralized Development), RHD (Reduced Hillside Development). The impacts for each alternative are compared relative to the Proposed Project Alternative at the end of each impact conclusion (i.e., similar, greater, lesser).

IMPACT 3A.4-1	Generation of Temporary, Short-Term Construction-Related GHG Emissions. *Project-related construction activities associated with development of the project and off-site elements would result in increased generation of GHG emissions. These emissions would be temporary and short-term and would decline over time as new regulations are developed that address medium- and heavy-duty on-road vehicles and off-road equipment under the mandate of AB 32.*

On-Site and Off-Site Elements

NP

Under the No Project alternative, development of up to 44 rural residences could occur under the existing Sacramento County agricultural zoning classification AG-80. If developed, construction of these residences would not be anticipated to require a high number of diesel-powered construction equipment or involve intense levels of earth movement for an extended period of time. Thus, these activities would not conflict with the policy decisions contained in AB 32, and thereby would not impede California's ability to comply with the mandate of AB 32. No off-site water facilities would be constructed in this alternative. As a result, GHG emissions associated with project-related construction under the No Project Alternative would not result in a cumulatively considerable incremental contribution to climate change. This would be a **less-than-significant** impact. ***[Lesser]***

Mitigation Measure: No mitigation measures are required.

On-Site Elements

NCP

The types of emissions-generating construction activities that would occur under the No USACE Permit Alternative would be similar to those that would take place under the Proposed Project Alternative. Construction-generated GHG emissions associated with buildout of the No USACE Permit Alternative were modeled in URBEMIS and are presented in Table 3A.4-1. Refer to Appendix C1 for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

As shown in Table 3A.4-1, estimated GHG emissions from construction during the 19-year buildout of the No USACE Permit Alternative would be approximately 42,664 metric tons of CO_2, which is less than estimated for the Proposed Project Alternative. Similar to the Proposed Project Alternative, GHG emissions generated by construction under the No USACE Permit Alternative would be temporary and short term. Although a new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state, given the information available today, GHG emissions associated with construction of the No USACE Permit Alternative would result in a cumulatively considerable incremental contribution to this **significant** cumulative impact. ***[Lesser]***

Mitigation Measure 3A.4-1: Implement Additional Measures to Control Construction-Generated GHG Emissions.

To further reduce construction-generated GHG emissions, the project applicant(s) of all project phases shall implement all feasible measures for reducing GHG emissions associated with construction that are recommended by SMAQMD at the time individual portions of the site undergo construction. Such measures may reduce GHG exhaust emissions from the use of on-site equipment, worker commute trips, and truck trips carrying materials and equipment to and from the SPA, as well as GHG emissions embodied in the materials selected for construction (e.g., concrete). Other measures may pertain to the materials used in construction. Prior to releasing each request for bid to contractors for the construction of each development phase, the project applicant(s) shall obtain the most current list of GHG reduction measures that are recommended by SMAQMD and stipulate that these measures be implemented in the respective request for bid as well as the subsequent construction contract with the selected primary contractor. The project applicant(s) for any particular development phase may submit to SMAQMD a report that substantiates why specific measures are considered infeasible for construction of that particular development phase and/or at that point in time. The report, including the substantiation for not implementing particular GHG reduction measures, shall be approved by SMAQMD prior to the release of a request for bid by the project applicant(s) for seeking a primary contractor to manage the construction of each development phase. By requiring that the list of feasible measures be established prior to the selection of a primary contractor, this measure requires that the ability of a contractor to effectively implement the selected GHG reduction measures be inherent to the selection process.

SMAQMD's recommended measures for reducing construction-related GHG emissions at the time of writing this EIR/EIS are listed below and the project applicant(s) shall, at a minimum, be required to implement the following:

- Improve fuel efficiency from construction equipment:
  - reduce unnecessary idling (modify work practices, install auxiliary power for driver comfort);
  - perform equipment maintenance (inspections, detect failures early, corrections);
  - train equipment operators in proper use of equipment;
  - use the proper size of equipment for the job; and
  - use equipment with new technologies (repowered engines, electric drive trains).

- Use alternative fuels for electricity generators and welders at construction sites such as propane or solar, or use electrical power.

- Use an ARB-approved low-carbon fuel, such as biodiesel or renewable diesel for construction equipment. (Emissions of oxides of nitrogen [NO_X] emissions from the use of low carbon fuel must be reviewed and increases mitigated.) Additional information about low-carbon fuels is available from ARB's Low Carbon Fuel Standard Program (ARB 2009b).

- Encourage and provide carpools, shuttle vans, transit passes and/or secure bicycle parking for construction worker commutes.

- Reduce electricity use in the construction office by using compact fluorescent bulbs, powering off computers every day, and replacing heating and cooling units with more efficient ones.

- Recycle or salvage non-hazardous construction and demolition debris (goal of at least 75% by weight).

- Use locally sourced or recycled materials for construction materials (goal of at least 20% based on costs for building materials, and based on volume for roadway, parking lot, sidewalk and curb materials).

- Minimize the amount of concrete used for paved surfaces or use a low carbon concrete option.

- Produce concrete on-site if determined to be less emissive than transporting ready mix.

- Use EPA-certified SmartWay trucks for deliveries and equipment transport. Additional information about the SmartWay Transport Partnership Program is available from ARB's Heavy-Duty Vehicle Greenhouse Gas Measure (ARB 2009c) and EPA (EPA 2009).

- Develop a SMAQMD-approved plan to efficiently use water for adequate dust control. This may consist of the use of non-potable water from a local source.

In addition to SMAQMD-recommended measures, construction activity shall comply with all applicable rules and regulations established by SMAQMD and ARB.

Implementation: Project applicant(s) during all project phases and on-site and off-site elements.

Timing: Before approval of final maps and building permits for all project phases, including all on- and off-site elements and implementation throughout project construction.

Enforcement:

1. For all project-related improvements that would be located within the City of Folsom: City of Folsom Community Development Department.

2. For all on- and off-site project-related activities within the City of Folsom and Sacramento County.

3. For the two roadway extensions into El Dorado Hills: El Dorado County Development Services Department.

Mitigation Measure: Implement Mitigation Measures 3A.2-1a and 3A.2-1b.

PP

Heavy-duty off-road equipment, materials transport, and worker commutes during construction of the Proposed Project Alternative would result in exhaust emissions of GHGs. Exact project-specific data (e.g., construction equipment types and number requirements) were not available at the time of this analysis.

GHG emissions generated by construction would be primarily in the form of CO_2. Although emissions of other GHGs, such as CH_4 and N_2O, are important with respect to global climate change, the emission levels of these other GHGs from on- and off-road vehicles used during construction are relatively small compared with CO_2 emissions, even when factoring in the relatively larger global warming potential of CH_4 and N_2O.

Accordingly, total construction emissions for the 19-year buildout period associated with implementation of the Proposed Project Alternative and action alternatives were estimated using the URBEMIS 2007 Version 9.2.4 computer program (Rimpo and Associates 2008). URBEMIS is designed to model construction emissions for land use development projects based on building size, land use and type, and disturbed acreage and allows for the input of project-specific information. Construction-generated GHG emissions were modeled based on general information provided in the project description described in Chapter 2, “Alternatives,” and default SMAQMD-recommended settings and parameters attributable to the proposed land use types and site location. In short, modeling was conducted using the same assumptions for estimating construction-generated emissions of criteria air pollutants and precursors, which are listed in the discussion under Impact 3A.2-1 of Section 3A.2, “Air Quality – Land.”

Development of the SPA would occur over a very large area (approximately 3,510 acres) and construction would require substantial amounts of earthwork and grading. However, a detailed schedule describing the timing and location of construction activities under the Proposed Project and four other action alternatives (Resource Impact Minimization, Centralized Development, Reduced Hillside Development, and No USACE Permit) is not available at the time of writing this EIR/EIS. Construction of the site is anticipated to commence in 2011 and last until approximately 2030. Given that exhaust emission rates of the construction equipment fleet in the state are expected to decrease over time due to ARB- and SMAQMD-lead efforts, annual construction emissions were estimated using the earliest calendar when construction would begin (i.e., 2011) in order to generate conservative estimates. It is anticipated, however, that in later years, advancements in engine technology, retrofits, and turnover in the equipment fleet would result in increased fuel efficiency, potentially more alternatively fueled equipment, and lower levels of GHG emissions. Also, the URBEMIS model does not account for reductions in CO_2 emission rates that would affect future construction activity due to the regulatory environment that is expected to evolve under AB 32. For instance, ARB’s Scoping Plan identifies the need to expand efficiency strategies and low carbon fuels for heavy-duty and off-road vehicles (ARB 2008).

Construction emissions levels associated with the Proposed Project and four other action alternatives would differ in the total number of residential units, commercial square footage, office square footage, and school square footage to be developed. A summary of the GHG emissions generated during buildout of the Proposed Project and four other action alternatives is presented in Table 3A.4-1. Refer to Appendix C1 for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

Table 3A.4-1 Summary of Modeled Greenhouse Gas Emissions (CO_2e) from On-Site Elements for the Proposed Project and Action Alternatives					
Source	CO_2e Emissions by Alternative [1]				
	PP	RIM	RHD	CD	NCP
Construction Emissions over Buildout Period (2011-2030) (metric tons) [2, 3]	50,456	44,979	50,684	47,105	42,664
Operational Emissions at Full Buildout (Year 2030) (metric tons/year)					
Area-Source Emissions [4]	45,478	36,027	46,995	40,062	31,435
Mobile-Source Emissions [4]	111,037	86,171	111,848	108,560	92,043
Indirect Operational Emissions Associated with Electricity Consumption [5]	111,049	96,503	145,454	126,154	99,860
Indirect Operational Emissions Associated with Water Consumption [6]	23,485	18,193	26,399	21,433	16,877
Total Operational Emissions [7]	**291,049**	**236,895**	**330,696**	**296,208**	**240,215**
Operational GHG Efficiency Metrics					
Residential Population Accommodated by Alternative	24,335	19,584	28,084	20,689	15,808
Employment (jobs) Accommodated by On-Site Development	13,209	9,500	14,119	13,574	11,173
Service Population (SP) Supported by Alternative	37,544	29,084	42,203	34,263	26,981
Annual CO_2e/SP (metric tons/year)	7.8	8.2	7.8	8.7	8.9
GHG Efficiency Benchmarks					
Annual CO_2e/SP benchmark that reflects statewide target for Year 2020 (metric tons/year) [8] 4.4					
Annual CO_2e/SP benchmark that reflects statewide target for Year 2030 (metric tons/year) [8] 3.7					

Notes: CO_2e = carbon dioxide equivalent; PP = Proposed Project/Action; RIM = Resource impact Minimization; CD = Centralized Development; RHD = Reduced Hillside Development; NCP = No USACE Permit; GHG = greenhouse gas; SP = Service Population; AB = Assembly Bill; ARB = Air Resources Board; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; VMT = vehicle miles traveled; CCAR = California Climate Action Registry; CEC = California Energy Commission

1 The values presented do not include the full life cycle of GHG emissions that would occur over the production/transport of materials used during the construction of the on-site elements under each build alternative or used during the operational life of the project, solid waste that would be generated over the life of the project, and the end of life for the materials and processes that would occur as an indirect result of the project. Estimating the GHG emissions associated with these processes would be too speculative for meaningful consideration and would require analysis beyond the current state of the art in impact assessment, and may lead to a false or misleading level of precision in reporting operational GHG emissions. Furthermore, indirect emissions associated with in-state energy production and generation of solid waste would be regulated under AB 32 directly at the source or facility that would handle these processes. The emissions associated with off-site facilities in California would be closely controlled, reported, capped, and traded under AB 32 and California ARB programs, as recommended by ARB's Scoping Plan (ARB 2008). Therefore, it is assumed that GHG emissions associated with these life-cycle stages would be consistent with AB 32 requirements. Note that this table does not include the No Project Alternative, because if developed, construction of residences that could be developed under the adopted Sacramento County General Plan and zoning ordinance would not be anticipated to require a high number of diesel-powered construction equipment or involve intense levels of earth movement for an extended period of time.

2 Construction emissions were modeled with the URBEMIS 2007 computer model using the same assumptions and input parameters to estimate criteria air pollutant emissions in Section 3A.2, "Air Quality – Land." The URBEMIS 2007 model does not account for CO_2 emissions associated with the production of concrete or other building materials used in project construction. It also does not estimate GHG emissions other than CO_2, though the levels of these pollutants (i.e., CH_4 and N_2O) are expected to be nominal in comparison to the estimated CO_2 levels, even considering their respective global warming potentials. Estimated values represent the levels of construction-generated GHG emissions that would be generated during the entire 19-year construction period. Construction emission estimates do not account for the fact that the intense level of grading that would occur on the eastern side of the SPA (compared to the intensity of grading that would be performed in other areas of the site) under the Proposed Project, Resource Impact Minimization, Reduced Hillside Development, and No USACE Permit Alternatives, but not the Centralized Development Alternative. This distinction is pertinent because grading is one of the most GHG emission-intensive phases of construction. However, a more detailed analysis is not provided because grading plans were not available for the Proposed Action or the four other action alternatives at the time of the analysis.

3 Construction emission estimates do not account for the fact that the intense level of grading that would occur on the eastern side of the SPA (compared to the intensity of grading that would be performed in other areas of the site) under the Proposed Project, Resource Impact Minimization, Reduced Hillside Development, and No USACE Permit Alternatives, but not the Centralized Development Alternative. This distinction is pertinent because grading is one of the most GHG emission-intensive phases of construction. However, a more detailed analysis is not provided because grading plans were not available for the Proposed Action or the four other action alternatives at the time of the analysis.

4 Direct operational area- and mobile-source emissions were modeled using the URBEMIS 2007 computer model, based on VMT and the number of trips obtained from the traffic analysis, as well as the same assumptions and input parameters used to estimate criteria air pollutant emissions in Section 3A.2, "Air Quality – Land." URBEMIS also does not estimate GHG emissions other than CO_2 emissions, although the levels of these pollutants (i.e., CH_4 and N_2O) are expected to be nominal in comparison to the estimated CO_2 levels, even considering their respective global warming potential.

5 Indirect operational CO2e emissions associated with electricity consumption were estimated using the methodologies and emission factors from the California Climate Action Registry's General Reporting Protocol, Version 3.1 (CCAR 2009).

6 Electricity consumption and direct sources (e.g., mobile sources) associated with the consumption of water, including the conveyance, distribution, and treatment of that water, was estimated by RMC as part the Water Supply and Demand Analysis. See Appendix M for detailed assumptions and calculations of water-related GHG emissions.

7 Totals may not add exactly due to rounding. Actual values for these parameters are expected to be lower for multiple reasons, which are discussed in detail in the impact analysis. This estimate total does not account for the depletion of carbon sequestration associated with the loss of blue oak woodland and individual oak trees that currently exist in the SPA. This impact is discussed in greater detail in Section 3A.3, "Biological Resources – Land".

8 These benchmarks are based on projected increases in the state's population and employment levels and reductions targets established by AB 32.

Source: Modeling performed by AECOM in 2010

As shown in Table 3A.4-1, estimated GHG emissions from construction during the 19-year buildout of the Proposed Project Alternative would be approximately 50,456 metric tons of CO_2. This value accounts only for exhaust emissions of GHGs that would be generated by heavy-duty equipment, haul trucks, and vehicle trips, however. Additional GHG emissions would also be "embodied" in the materials selected for construction and the level of embodied GHG emission can vary substantially according to which materials are selected. This is particularly the case for construction of buildings and infrastructure that involve high quantities of cement, which is a key ingredient of concrete, given that ARB has identified cement production as an energy-intensive, GHG-intensive industry (ARB 2008, page 31). In fact, ARB has included cement plants as separate emissions sector in its demand-based GHG inventory for the state (ARB 2008, pg. 13). Construction-generated exhaust emissions would be temporary and short-term in that they would only occur during the buildout period; they would not continue on an ongoing basis year after year throughout the operational life of the development, as is the case with large stationary-source facilities or the operation of most land use developments. In addition, the regulatory environment that continues to evolve under the mandate of AB 32 is expected to reduce some of the GHG emissions from construction activity. ARB's Scoping Plan does not directly discuss GHG emissions generated by construction activity; however, it does recommend measures for improving the efficiency of medium- and heavy-duty on-road vehicles (1.4 MMT CO_2e) and expended efficiency strategies for off-road vehicles (e.g., forklifts, bulldozers). In addition, existing programs for air quality improvement in California, including the *Diesel Risk Reduction Plan* and the *2007 State Implementation Plan*, will result in the accelerated phase-in of cleaner technology for virtually all of California's diesel engine fleets, including construction equipment (ARB 2008). Measures implemented under these plans are likely to result in future fleets of construction equipment that are more GHG-efficient than existing fleets. For these reasons, levels of GHG emissions associated with construction activity are expected to decrease over time as new regulations are developed under the mandate of AB 32.

Nonetheless, due to the intensity and duration of construction activities under the Proposed Project Alternative, construction-generated GHG emission levels would make an incremental contribution to GHGs that cause climate change. It is presumed that this level of construction-generated GHG emissions would be substantial compared to other construction projects in the region and in the state, particularly given the large size of the project (approximately 3,510 acres) and the intense level of grading that would occur on the hilly, eastern side of the SPA.

Although the construction-generated emissions would be temporary and short-term, and although a new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state, given the information available today, GHG emissions associated with construction of the Proposed Project Alternative would result in a cumulatively considerable incremental contribution to this **significant** cumulative impact.

Mitigation Measure: Implement Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1.

RIM

The types of emissions-generating construction activities that would occur under the Resource Impact Minimization Alternative would be similar to those that would take place under the Proposed Project Alternative. Construction-generated GHG emissions associated with buildout of the Resource Impact Minimization Alternative were modeled in URBEMIS and are presented in Table 3A.4-1. Refer to Appendix C1 for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

As shown in Table 3A.4-1, estimated GHG emissions from construction during the 19-year buildout of the Resource Minimization Alternative would be approximately 44,979 metric tons of CO_2, which is less than estimated for the Proposed Project Alternative. Similar to the Proposed Project Alternative, GHG emissions generated by construction under the Resource Impact Minimization Alternative would be temporary and short term. Although a new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state, given the information available today, GHG emissions associated with construction of the Resource Impact Minimization Alternative would result in a cumulatively considerable incremental contribution to this **significant** cumulative impact. ***[Lesser]***

Mitigation Measure: Implement Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1.

CD

The types of emissions-generating construction activities that would occur under the Centralized Development Alternative would be similar to those that would take place under the Proposed Project Alternative. Construction-generated GHG emissions associated with buildout of the Centralized Development Alternative were modeled in URBEMIS and are presented in Table 3A.4-1. Refer to Appendix C1 for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

As shown in Table 3A.4-1, estimated GHG emissions from construction during the 19-year buildout of the Centralized Development Alternative would be approximately 47,105 metric tons of CO_2. This mass emissions level is less than the level estimated for the Proposed Project Alternative (i.e., 50,456 metric tons), in part, because intense grading would not occur on the eastern side of the SPA. Similar to the Proposed Project Alternative, GHG emissions generated by construction under the Centralized Development Alternative would be temporary and short term. Although a new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state, given the information available today, GHG emissions associated with construction of the Centralized Development Alternative would result in a cumulatively considerable incremental contribution to this **significant** cumulative impact. ***[Lesser]***

Mitigation Measure: Implement Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1.

RHD

The types of emissions-generating construction activities that would occur under the Reduced Hillside Development Alternative would be similar to those that would take place under the Proposed Project Alternative. Construction-generated GHG emissions associated with buildout of the Reduced Hillside Development Alternative were modeled in URBEMIS and presented in Table 3A.4-1. Refer to Appendix C1 for a detailed summary of the URBEMIS modeling assumptions, inputs, and outputs.

As shown in Table 3A.4-1, estimated GHG emissions from construction during the 19-year buildout of the Reduced Hillside Alternative would be approximately 50,684 metric tons of CO_2, which is greater than estimated for the Proposed Project Alternative. Similar to the Proposed Project Alternative, GHG emissions generated by construction under the Reduced Hillside Development Alternative would be temporary and short -term. Although a new regime of regulations is expected to come into place under AB 32 and existing regulatory efforts will help reduce GHG emissions generated by construction activity throughout the state, given the information available today, GHG emissions associated with construction of the Reduced Hillside Development Alternative would result in a cumulatively considerable incremental contribution to this **significant** cumulative impact. ***[Greater]***

Mitigation Measure: Implement Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1.

Off-Site Elements

GHG emissions associated with the construction of the off-site elements were estimated using the URBEMIS 2007 Version 9.2.4 computer program (Rimpo and Associates 2008) and SMAQMD's Road Construction Emissions Model (SMAQMD 2009b). Although the model was developed by SMAQMD, it is also recommended by EDCAQMD and other air districts in the state for estimating emissions generated by construction projects that are linear in nature. While construction-generated emissions of criteria air pollutants are evaluated according to maximum daily emission levels (as discussed under Impact 3A.2-1 in Section 3A.2, “Air Quality – Land”), GHG emission levels from construction activity are typically evaluated according to their annual level or the total level that would be emitted during project construction. However, annual or total levels of GHG emissions associated with construction of the off-site elements could not be accurately estimated due to the lack of information concerning the construction schedule, types and quantities of equipment involved, and types and quantities of construction materials used. Nonetheless, maximum daily GHG emission levels were estimated for each off-site element using these two models. While URBEMIS is designed to model construction emissions for land use development projects, the Road Construction Emissions Model (SMAQMD 2009b) is designed to estimate emissions from heavy-duty construction equipment, haul trucks, and worker commute trips and fugitive PM (particulate matter) dust associated with linear construction projects. For all the elements, it was estimated that the most emission-intensive phase of construction would consist of grading, excavation, and other earth-movement activities, as is typically the case for most construction projects. Because detailed information about the construction of the off-site elements was not available at the time of this analysis, the following conservative projections were used in the modeling:

- the entire site could potentially be graded on a single day, regardless of project size; and
- each off-site element could potentially be constructed as early as the year 2011. This is a conservative assumption because equipment exhaust emissions from subsequent years are anticipated to be lower as new regulations and emissions technologies for off-road equipment come into place.

Emission levels associated with the construction of each of the proposed off-site elements were modeled separately. Model inputs include conservative estimates about size (i.e., dimensions and acreage) of the construction area associated with each off-site element based on the map in Exhibit 2-9 in Chapter 2, “Alternatives,” and default parameters (i.e., equipment types and numbers) from the applicable model. Table 3A.4-2 summarizes the modeled worst-case daily GHG emission levels associated with construction of each off-site element. Refer to Appendix C1 for a detailed summary of the modeling assumptions, inputs, and outputs.

Table 3A.4-2
Summary of Maximum Daily Exhaust Emissions of Greenhouse Gases from Construction of Off-Site Elements

Off-Site Element	Area (acres)[1]	Exhaust Emissions of CO_2 (lb/day)[2]
Detention Basin[3]	3.4	4,159
Prairie City Road Interchange[3]	19.3	4,159
Rowberry Drive Overcrossing[3]	18.7	4,159
Oak Avenue Interchange[3]	46.7	9,122
Sewer Force Main Connection to Existing Pump Station[4]	2.4	9,004
Roadway Extensions into El Dorado County[4]	1.4	4,916

Notes: CO_2 = carbon dioxide; lb/day = pounds per day; GHG = greenhouse gases; SMAQMD = Sacramento Metropolitan Air Quality Management District

1 The area of each off-site element was estimated based on Exhibit 2-9 in Chapter 2, “Alternatives.”

2 Maximum daily construction emissions are representative of a construction day in the earliest construction year (2011). Detailed input parameters and modeling output are included in Appendix C1. Emission level estimated do not include embodied GHG emissions associated with materials used in construction (e.g., concrete).

3 Maximum daily emissions were estimated using the construction module and grading phase in URBEMIS 2007 Version 9.2.4 (Rimpo and Associates 2008).

4 Maximum daily emissions on projects linear in nature were estimated using the Roadway Construction Emissions Model SMAQMD 2009b)

Source: Modeling performed by AECOM in 2009

The estimated GHG emission levels presented in Table 3A.4-2 do not include embodied GHG emissions, which are associated with the types and quantities of materials (e.g., concrete) used to construct each off-site element. Thus, in the discussion of each off-site element below, embodied emissions are addressed qualitatively.

Detention Basin and Sewer Force Main Connection

Based on the map in Exhibit 2-9 in Chapter 2, "Alternatives," grading and excavation activity associated with construction of the detention basin and sewer force main connection to an existing pump station would occur on approximately 3.4 acres and 2.4 acres of undeveloped land, respectively. As shown in Table 3A.2-4, maximum daily exhaust emissions of CO_2 generated by this activity would be approximately 4,159 pounds per day (lb/day) for the detention basin and 9,004 lb/day for the sewer force main connection. However, these estimates of maximum daily emission levels do not necessarily serve as strong indicators of the total level of GHG emissions that would result from construction of these two facilities. Nonetheless, because these two construction projects would be relatively small in acreage, total emissions associated with these activities are not anticipated to be substantial. In addition, levels of embodied GHG emissions are not anticipated to be high because construction of the detention basin and the sewer force main connection are not expected to involve extensive quantities of concrete or other energy-intensive construction materials. As a result, GHG emissions associated with construction of the detention basin and force main connection would not result in a cumulatively considerable incremental contribution to climate change. This would be a **less-than-significant** impact.

Mitigation Measure: No mitigation measures are required.

Prairie City Road Interchange, Rowberry Drive Overcrossing, Oak Avenue Interchange, and Roadway Extensions

Estimated maximum daily exhaust GHG emission levels associated with the construction of the Prairie City Road Interchange, Rowberry Drive overcrossing, Oak Avenue Interchange, and two roadway extensions into El Dorado County are also shown in Table 3A.4-2. The emission levels shown in Table 3A.4-2 for these off-site elements generally correlate with the size (i.e., acreage) of each element because it is estimated that the entire area of each off-site element would be graded in a single day. It is important to note that these estimates of maximum daily emission levels do not necessarily serve as strong indicators of the total level of GHG emissions that would result from construction of these off-site elements. There is the potential, however, that the total level of GHG-emitting equipment, the number of workers, and/or the length of time to build these off-site elements could be substantial. In addition, levels of embodied GHG emissions associated with construction of these off-site elements could be high because they could involve high quantities of concrete, asphalt, and/or other energy-intensive construction materials. Given that detailed parameters about the construction of these infrastructure improvements are not known at the time of writing this EIR/EIS, it is assumed that GHG emissions associated with construction of these elements could result in cumulatively considerable incremental contributions to climate change. This would be a **significant** cumulative impact.

Mitigation Measure: Implement Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1.

Implementation of Mitigation Measure 3A.2-1a and Mitigation Measure 3A.2-1b (see Section 3A.2, "Air Quality – Land") would reduce construction vehicle emissions to the degree feasible, by requiring all SMAQMD-recommended measures that are applicable to the project such as the use of certain engines, following specific criteria, and other requirements. By reducing emissions of criteria air pollutants, GHG emissions also would be reduced. Implementation of Mitigation Measure 3A.4-1 would result in additional reductions in GHG emissions associated with construction activity. Mitigation Measures 3A.2-1a, 3A.2-1b, and 3A.4-1 are programmatic in that they recognize that emission control technologies will continue to evolve and the feasibility of more GHG reductions will likely increase over the 19-year buildout period of the project. They also recognize that a framework for understanding GHG emissions embodied in construction materials (e.g., concrete) may continue to evolve such that embodied emissions can be reduced through project-level mitigation. However, the extent to which feasible technologies and GHG reduction measures will continue to be developed is not known at the time of writing this EIR/EIS. Therefore, this analysis concludes that these reductions would not be sufficient to fully reduce the construction-generated GHGs to the extent that they would not be cumulatively considerable. The regulatory changes that are likely under AB 32 and other legislation may result in additional, more substantial reductions in emissions through the use of low carbon fuels or off-road engine standards. Because of the uncertainty with respect to GHG reductions from regulations that have not yet been developed, and because the GHGs generated by construction of the Prairie City Road Interchange, Rowberry Drive overcrossing, Oak Avenue Interchange, and Roadway Connections to El Dorado County could be considerable, the incremental contribution of GHG emissions from project-related construction would be cumulatively considerable and **significant and unavoidable**.

This significance determination is based according to the program-level analysis presented above. However, an alternate impact conclusion for each of these four off-site elements may be supported by a project-level analysis that is based on detailed project-specific parameters (i.e., schedule, equipment, materials) used to estimate the total GHG emissions level associated with construction of the element and/or conducted in accordance with new guidance provided by ARB or the respective air district (i.e., SMAQMD or EDCAQMD). However, for purposes of this analysis and because additional detail is currently unavailable, a project-level significance determination cannot be made with reasonable accuracy.

IMPACT 3A.4-2 Generation of Long-Term Operational GHG Emissions. *Operation of the project over the long term would result in increased generation of GHGs, which would contribute considerably to cumulative GHG emissions.*

On-Site and Off-Site Elements

NP

Under the No Project alternative, development of up to 44 rural residences could occur under the existing Sacramento County agricultural zoning classification AG-80. Direct area- and mobile-source emissions of GHGs associated with operation of these residences and indirect emissions associated with electricity and water consumption by these residences would not be expected to be substantial. Also, development of these 44 rural residences on the 3,500-acre site would not involve the removal of a substantial number of trees, which are a form of carbon storage and sequester carbon from the atmosphere. In addition, no stationary sources of GHGs would be developed on the site. While the remainder of the undeveloped site would likely continue to be used for livestock grazing, generating substantial quantities of CH_4, this would not be considered a change relative to existing conditions. No off-site water facilities would be constructed under this alternative. Therefore, operational GHG emissions under the No Project Alternative would not result in a cumulatively considerable incremental contribution to climate change. This would be a **less-than-significant** impact. ***[Lesser]***

On-Site Elements

NCP, PP, RIM, CD, RHD

GHG emissions would be generated throughout the operational life of the Proposed Project and the four action alternatives. Operational emissions would be generated by area-, mobile-, and stationary-sources. Area-source emissions would be associated with activities such as combustion of natural gas for space and water heating, maintenance of landscaping and grounds, waste disposal, and other sources. Mobile-source emissions of GHGs would include project-generated vehicle trips for residents, employees, and visitors. In addition, increases in stationary-source emissions could occur at off-site utility providers from electricity generation that would supply power to the proposed land uses. Thus, the GHG’s associated with the consumption of electricity in the SPA is considered an indirect source. On-site consumption of water would also result in indirect GHG emissions because of the electricity consumption associated with the off-site conveyance, distribution, and treatment of that water. In addition, mobile and area source GHG emissions would be generated as a result of the operation and maintenance of on-site water treatment and conveyance facilities.

GHG emissions generated by operation of the proposed land uses under the Proposed Project and four action alternatives would be primarily in the form of CO_2. Although emissions of other GHGs, such as CH_4 and N_2O, are important with respect to global climate change, the emissions levels of these other GHGs from the sources considered for this project are relatively small compared with CO_2 emissions, even when factoring in the relatively larger global warming potential of CH_4 and N_2O.

At the time of writing this EIR/EIS emission factors and calculation methods for GHGs from development projects have not been formally adopted for use by the state, SMAQMD, or EDCAQMD. However, SMAQMD's *Guide to Air Quality Assessment in Sacramento County* does recommend that direct and indirect emissions of GHGs from a project be quantified and disclosed in the respective CEQA document, including area- and mobile-source emissions, and indirect emissions from in-state energy production and water consumption (SMAQMD 2009a, page 6-6). Direct operational CO_2 emissions were calculated using URBEMIS 2007, Version 9.2.4 (Rimpo and Associates 2008). Indirect operational emissions associated with electricity consumption were estimated according to methodologies of the CCAR's *General Reporting Protocol* (CCAR 2009). Indirect operational emissions associated with water consumption were estimated using information provided by the CEC (CEC 2007) as well as CCAR's *General Reporting Protocol* (CCAR 2009). The Proposed Project and four action alternatives would also result in the loss blue oak woodland and individual oak trees, which are a form of carbon storage and sequester carbon from the atmosphere; however, the loss in trees is not quantified for this analysis. The loss blue oak woodland and individual oak trees is discussed further in Section 3A.3, "Biological Resources – Land."

A summary of the operational GHG emissions were estimated for full buildout of the Proposed Project and four action alternatives, in the Year 2030 and are presented in Table 3A.4-1. The annual operational emissions level under the Proposed Project and four action alternatives was estimated using the best available methodologies and emission factors available at the time of writing this EIR/EIS. However, for many operational GHG emission sources GHG emission rates for future years are not yet developed, in part, because regulations continue to evolve under the mandate of AB 32. The URBEMIS model, as well as other GHG estimation protocols, do not yet account for the impact reductions of the future regulatory environment and future technological improvements that will result in GHG efficiencies. Thus, this analysis uses the emissions estimates modeled for full buildout as a proxy for evaluating GHG emissions associated with operation of the Proposed Project and four action alternatives.

As shown in Table 3A.4-1, estimated GHG emissions associated with operation of the land uses proposed under the Proposed Project, Resource Impact Minimization, Centralized Development, Reduced Hillside Development, and No USACE Permit Alternatives would total approximately 291,049; 236,895; 296,208; 330,696; and 240,215 annual metric tons, respectively. At full buildout the size of the residential population accommodated by these action alternatives would be approximately 24,335; 19,584; 20,689; 28,084; and 15,808 residents, respectively; and the number of jobs supported by these action alternatives would be approximately 13,209; 9,500, 13,574; 14,119; and 11,173, respectively. When estimated CO_2e emissions are normalized with respect to service population, the average annual efficiency rate of operations under full buildout of the Proposed Project, Resource Impact Minimization, Centralized Development, Reduced Hillside Development, and No USACE Permit Alternatives would be 7.8; 8.2; 8.7; 7.8; and 8.9 metric tons CO_2e/SP/year, respectively.

However, in many respects the annual CO_2e/SP values in Table 3A.4-1 for the Proposed Project and four action alternatives are representative of each action alternative's GHG efficiency under a business-as-usual scenario and are higher than what would likely occur. First, the level of mobile-source emissions, which was estimated to be 34-38% of the total operational emissions (depending on which action alternative is selected), is overstated because it is based on the VMT estimated by the traffic study, which is conservative. The total VMT estimated by the traffic study includes all trips associated with the proposed project Alternative, including trips that originate or terminate outside the project area. Many of these are trips would occur with or without the project, but in order to be conservative, the traffic study attributes all of them to the project's land uses. Moreover, the estimated level of mobile-source emissions also includes some emissions associated with trips that would merely replace trips that already take place elsewhere in the Sacramento region. For instance, the VMT estimate includes mobile-source emissions associated with workers who would commute to the SPA from outside the area, even though these trips may be replacing the workers' existing commutes to other locations. This point is particularly pertinent to the proposed mix of land use types, because the project includes a large regional employment center (i.e., the regional shopping mall) that is out of proportion with the amount of housing proposed and thus would draw in worker commute trips from outside areas.

The location of a large regional employment center in this location is consistent with the Sacramento Area Council of Governments (SACOG) Sacramento Region Blueprint, which is intended to reduce overall VMT and GHG emissions in the region.

Furthermore, the VMT estimate accounts for only some (not all) of the trip reduction features that would be part of the project design under the Proposed Project and four action alternatives. The Proposed Project and each of the other four action alternatives include some "smart growth" concepts, such as a mix of uses configured for convenient bike and pedestrian access, an extensive network of bike and pedestrian connections and integration of transit infrastructure. The transportation model used in the traffic analysis functions at a regional scale, so all the nuances of the land use planning under the Proposed Project and each of the other four action alternatives are not necessarily reflected in their respective estimates of net VMT. By the same token, the No USACE Permit, Proposed Project, Centralized Development, and Reduced Hillside Development Alternatives, which are consistent with the SACOG Sacramento Region Blueprint, can only go so far in balancing land uses while remaining consistent with the direction from the SACOG Sacramento Region Blueprint to create a large regional employment center in this location – which results in a disproportionately high number of jobs in the SPA. This increases VMT compared to a fully integrated land use plan that has a balanced jobs/housing ratio. In addition, the emissions rates used to estimate mobile-source GHG emissions do not account for GHG reductions that would result from the Low Carbon Fuel Standard, which was adopted as a discrete early-action measure of AB 32, or the CAA waiver that California received from EPA allowing the state to adopt more stringent fuel efficiency standards for passenger vehicles and light trucks (AB 1493, which is discussed in the "Regulatory Framework" section above).

With regard to the other largest category of operational GHG emissions shown in Table 3A.4-1, indirect GHG emissions related to the consumption of fossil fuel-based electricity, these estimated emissions do not account for reductions that will result from future regulatory changes under AB 32. The estimate of these emissions is not discounted to reflect the alternative-energy mandate of SB 107, which requires the Sacramento Municipal Utility District (SMUD) and other electric utilities to provide at least 20% of its electricity supply from renewable sources by 2010 and 30% by 2020; this mandate would be fully implemented before full buildout of the Proposed Project and other four action alternatives. Because SMUD is still procuring enough renewable energy to meet this goal, the estimated rate of GHG emissions from electricity is expected to decrease between now and 2010. In addition, SB 1368 requires more stringent emissions performance standards for new power plants, both in-state and out-of-state, that will supply electricity to California consumers. Thus, implementation of SB 1368 will also reduce GHG emissions associated with electricity consumption. Rates of energy consumption will be further reduced with implementation of the 2010 Green Building Regulations, which will replace Title 24 building standards with more stringent, energy-efficiency requirements.

Further reductions are also expected from other regulatory measures that will be developed under the mandate of AB 32, as identified and recommended in ARB's Scoping Plan (ARB 2008). In general, the Scoping Plan focuses on achieving the state's GHG reduction goals with regulations that improve the efficiency of motor vehicles and the production (and consumption) of electricity. Thus, even with the implementation of no project-specific mitigation, the rate of GHG emissions from development under the Proposed Project and other four action alternatives are projected to decrease in subsequent years as the regulatory environment progresses under AB 32. Additionally, new technology improvements may become available or the feasibility of existing technologies may improve. Nonetheless, a complete picture of the future regulatory environment is unknown at this time. GHG reduction measures promulgated under the AB 32 mandate may not be sufficient to cause future development to achieve ARB's recommended 30% reduction from business-as-usual emissions levels projected for 2020 (as discussed in the Scoping Plan) or the CO_2e/SP/year goals for the years 2020 or 2030 discussed above.

Also worth consideration is that, for the moment, the total annual GHG emissions level associated with operation of the Proposed Project and the other four action alternatives would exceed 25,000 metric tons of CO_2 per year throughout their operational life, which is the mandatory reporting level for stationary sources as part of implementation of AB 32. In comparison to this reporting level, the amount of operational GHG emissions of the Proposed Project and the other four action alternatives would be considered substantial.

Because the total GHG emissions associated with project operations under the Proposed Project and other four action alternatives would be considered substantial, and due to the uncertainty about whether the future regulations developed through implementation of AB 32 would cause operational emissions to be 30% lower than business-as-usual emission levels or achieve the CO_2e/SP/year goals for the years 2020 or 2030, the Proposed Project, Resource Impact Minimization, Centralized Development, Reduced Hillside Development, and No USACE Permit Alternatives would result in a cumulatively considerable contribution to a **significant** cumulative impact related to long-term operational generation of GHGs. ***[According to the annual CO_2e/SP metric for the year 2030 presented in Table 3A.4-1, the extent of this impact for the Resource Impact Minimization, Centralized Development, Reduced Hillside Development, and No USACE Permit Alternatives would be greater than that for the Proposed Project Alternative. The Reduced Hillside Development Alternative's annual CO_2e/SP would be equal to that of the Proposed Project Alternative.]***

Mitigation Measure: Implement Mitigation Measure 3A.2-2.

Mitigation Measure 3A.4-2a: Implement Additional Measures to Reduce Operational GHG Emissions.

Each increment of new development within the project site requiring a discretionary approval (e.g., proposed tentative subdivision map, conditional use permit), shall be subject to a project-specific environmental review and will require that GHG emissions from construction and operation of each phase of development be reduced by 30% from business-as-usual 2006 emissions and as required by the California Global Warming Solutions Act of 2006 (AB 32).

The City shall require feasible reduction measures that, in combination with existing and future regulatory measures developed under AB 32, will reduce GHG emissions associated with the operation of future project development phases and supporting roadway and infrastructure improvements that are part of the selected action alternative by an amount sufficient to achieve the 2020-based goal of 4.36 CO_2e/SP/year for development that would become operational on or before the year 2020 and the 2020-based goal of 3.68 CO_2e/SP/year for development that would become operational on or before the year 2030, if it is feasible to do so. The feasibility of potential GHG reduction measures shall be evaluated by the City at the time each phase of development is proposed in order to allow for ongoing innovations in GHG reduction technologies, as well as incentives created in the regulatory environment.

For each increment of new development, the project applicant(s) shall submit to the City a list of feasible energy efficient design standards to be considered in the project-specific environmental review. These energy conservation measures which will be incorporated into the design, construction, and operational aspects of each increment of development, would result in a reduction in overall project energy consumption and GHGs. The project-specific environmental review shall further identify potentially feasible GHG reduction measures to reflect the current state of the regulatory environment, and which will continuously evolve under the mandate of AB 32 and the resulting CO_2e/SP/year metric. The City will review and ensure inclusion of the design features in the proposed project before the applicant(s) can receive the City's discretionary approval for the applicable increment of development. In determining what measures should appropriately be imposed by the City under the circumstances, the City shall consider the following factors:

- the extent to which rates of GHG emissions generated by motor vehicles traveling to, from, and within the project site are projected to decrease over time as a result of regulations, policies, and/or plans that have already been adopted or may be adopted in the future by ARB or other public agency pursuant to AB 32, or by EPA;

- the extent to which mobile-source GHG emissions, which at the time of writing this EIR/EIS comprise a substantial portion of the state's GHG inventory, can also be reduced through design measures that result in trip reductions and reductions in trip length;

- the extent to which GHG emissions emitted by the mix of power generation operated by SMUD, the electrical utility that will serve the project site, are projected to decrease pursuant to the Renewables Portfolio Standard required by SB 1078 and SB 107, as well as any future regulations, policies, and/or plans adopted by the federal and state governments that reduce GHG emissions from power generation;

- the extent to which replacement of CCR Title 24 with the California Green Building Standards Code or other similar requirements will result in new buildings being more energy efficient and consequently more GHG efficient;

- the extent to which any stationary sources of GHG emissions that would be operated on a proposed land use (e.g., industrial) are already subject to regulations, policies, and/or plans that reduce GHG emissions, particularly any future regulations that will be developed as part of ARB's implementation of AB 32, or other pertinent regulations on stationary sources that have the indirect effect of reducing GHG emissions;

- the extent to which the feasibility of existing GHG reduction technologies may change in the future, and to which innovation in GHG reduction technologies will continue, effecting cost-benefit analyses that determine economic feasibility; and

- whether the total costs of proposed mitigation for GHG emissions, together with other mitigation measures required for the proposed development, are so great that a reasonably prudent property owner would not proceed with the project in the face of such costs.

In considering how much, and what kind of, measures are necessary in light of these factors, the City shall consider and implement as appropriate, the following non-exclusive and non-exhaustive list of measures. GHG emission reduction strategies and their respective feasibility are likely to evolve over time. These measures are derived from multiple sources including the Mitigation Measure Summary in Appendix B of the California Air Pollution Control Officer's Association (CAPCOA) white paper, *CEQA & Climate Change* (CAPCOA 2009a); CAPCOA's *Model Policies for Greenhouse Gases in General Plans* (CAPCOA 2009b); and the California Attorney General's Office publication, The California Environmental Quality Act: Addressing Global Warming Impacts at the Local Agency Level (California Attorney General's Office 2008).

Energy Efficiency

- Include clean alternative energy features to promote energy self-sufficiency (e.g., photovoltaic cells, solar thermal electricity systems, small wind turbines).

- Design buildings to meet CEC Tier II requirements (e.g., exceeding the requirements of the Title 24 [as of 2007] by 35%).

- Site buildings to take advantage of shade and prevailing winds and design landscaping and sun screens to reduce energy use.

- Install efficient lighting in all buildings (including residential). Also install lighting control systems, where practical. Use daylight as an integral part of lighting systems in all buildings.

- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes.

Water Conservation and Efficiency

- With the exception of ornamental shade trees, use water-efficient landscapes with native, drought-resistant species in all public area and commercial landscaping. Use water-efficient turf in parks and other turf-dependant spaces.

- Install the infrastructure to use reclaimed water for landscape irrigation and/or washing cars.

- Install water-efficient irrigation systems and devices, such as soil moisture-based irrigation controls.

- Design buildings and lots to be water-efficient. Only install water-efficient fixtures and appliances.

- Restrict watering methods (e.g., prohibit systems that apply water to nonvegetated surfaces) and control runoff. Prohibit businesses from using pressure washers for cleaning driveways, parking lots, sidewalks, and street surfaces. These restrictions should be included in the Covenants, Conditions, and Restrictions of the community.

- Provide education about water conservation and available programs and incentives.

- To reduce stormwater runoff, which typically bogs down wastewater treatment systems and increases their energy consumption, construct driveways to single family detached residences and parking lots and driveways of multifamily residential uses with pervious surfaces. Possible designs include Hollywood drives (two concrete strips with vegetation or aggregate in between) and/or the use of porous concrete, porous asphalt, turf blocks, or pervious pavers.

- Comply with any applicable water conservation ordinances.

Solid Waste Measures

- Reuse and recycle construction and demolition waste (including, but not limited to, soil, vegetation, concrete, lumber, metal, and cardboard).

- Provide interior and exterior storage areas for recyclables and green waste at all buildings.

- Provide adequate recycling containers in public areas, including parks, school grounds, golf courses, and pedestrian zones in areas of mixed-use development.

- Provide education and publicity about reducing waste and available recycling services.

Transportation and Motor Vehicles

- Promote ride-sharing programs and employment centers (e.g., by designating a certain percentage of parking spaces for ride-sharing vehicles, designating adequate passenger loading and unloading zones and waiting areas for ride-share vehicles, and providing a Web site or message board for coordinating ride-sharing).

- Provide the necessary facilities and infrastructure in all land use types to encourage the use of low- or zero-emission vehicles (e.g., electric vehicle charging facilities and conveniently located alternative fueling stations).

- At industrial and commercial land uses, all forklifts, “yard trucks,” or vehicles that are predominately used on-site at non-residential land uses shall be electric-powered or powered by biofuels (such as biodiesel [B100]) that are produced from waste products, or shall use other technologies that do not rely on direct fossil fuel consumption.

Implementation: The project applicant(s) of all project phases.

Timing: Before approval of final maps and/or building permits for all project phases requiring discretionary approval, including all on- and off-site elements.

Enforcement: City of Folsom Community Development Department.

Mitigation Measure 3A.4-2b: Participate in and Implement an Urban and Community Forestry Program and/or Off-Site Tree Program to Off-Set Loss of On-Site Trees.

The trees on the project site contain sequestered carbon and would continue to provide future carbon sequestration during their growing life. For all trees that are subject to removal, the project applicant(s) of all project phases shall participate in and provide necessary funding for urban and community forestry program (such as the UrbanWood program managed by the Urban Forest Ecosystems Institute [Urban Forest Ecosystems Institute 2009]) in which wood from any removed trees is harvested for an end-use that would retain its carbon sequestration (e.g., furniture building, cabinet making). For all nonharvestable trees that are subject to removal, the project applicant(s) shall develop and fund an off-site tree program that includes a level of tree planting that, at a minimum, increases carbon sequestration by an amount equivalent to what would have been sequestered by the blue oak woodland during its lifetime. This program shall be funded by the project applicant(s) of each development phase and reviewed for comment by an independent Certified Arborist unaffiliated with the project applicant(s) and shall be coordinated with the requirements of Mitigation Measure 3.3-5, as stated in Section 3A.3, “Biological Resources - Land.” Final approval of the program shall be provided by the City. Components of the program may include, but not be limited to, providing urban tree canopy in the City of Folsom, or reforestation in suitable areas outside the City. The California Urban Forestry Greenhouse Gas Reporting Protocol shall be used to assess this mitigation program (CCAR 2008). All unused vegetation and tree material shall be mulched for use in landscaping on the project site, shipped to the nearest composting facility, or shipped to a landfill that is equipped with a methane collection system, or combusted in a biomass power plant. Tree and vegetative material should not be burned on- or off-site unless used as fuel in a biomass power plant.

Implementation: The project applicant(s) of all project phases.

Timing: Before approval of final maps and/or building permits for all project phases requiring discretionary approval, including all on- and off-site elements.

Enforcement: The City of Folsom Community Development Department.

Off-Site Elements

This analysis is similar to the analysis of criteria air pollutant emissions associated with the operation of the off-site elements discussed under Impact 3A.2-2 in Section 3A.2, "Air Quality – Land."

The proposed off-site detention basin, Prairie City Road Interchange, Rowberry Drive overcrossing, Oak Avenue Interchange, sewer force main connection, and the two roadway extensions would not be anticipated to result in a considerable increase in operational GHG emissions beyond those associated with the project. While the road improvement-related elements would accommodate local vehicle traffic, they would not be expected to result in a substantial increase in vehicle trips and associated mobile-source emissions. (A substantial portion of vehicle trips using the proposed roadway infrastructure elements would be generated by the land uses developed in the SPA and associated mobile-source emissions are discussed in the analysis of on-site elements above.) Some of the roadway infrastructure improvements may actually reduce VMT by enabling more direct travel routes between area destinations. Also, it is not anticipated that the detention basin would generate a substantial number of vehicle trips other than the nominal amount of trips associated with routine maintenance of the facility. As a result, GHG emissions associated with operation of the off-site elements would not be cumulatively considerable and this would be a **less-than-significant** cumulative impact.

Mitigation Measure: No mitigation measures are required.

By acknowledging that the regulatory environment will continue to progress and that new GHG reduction technologies will continue to be innovated over time, Mitigation Measure 3A.4-2 requires the implementation of project-specific mitigation measures that are appropriate and feasible during each phase or increment of project development. Although Mitigation Measure 3A.4-2 would require the implementation of all feasible GHG reduction measures known at this time, it is unknown at the time of writing this EIR/EIS whether the selected project-specific measures during each project phase, in combination with the GHG reductions realized from the regulatory environment that exists at that time, would result in attainment of the applicable CO_2e/SP goal.

As the preceding discussion suggests, much of the difficulty in achieving the applicable CO_2e/SP goal through measures imposed by the City reflects the reality that the vast majority of GHG emissions associated with the Proposed Project and the other four action alternatives would be attributable to the combustion of fossil fuels, either in motor vehicles or in electricity-generating power plants. The state, it is clear, must make significant strides in changing the make-up of transportation fuels and power plant fuels if it is to achieve compliance with AB 32. Based on the Scoping Plan adopted by ARB on December 11, 2008, however, it is reasonable to expect that the state should be able to make such strides through regulations and policies adopted pursuant to AB 32. Given the long period of time needed for build-out of the project, these regulations and policies should be effective in reducing GHG emissions from vehicles and power plants during the period of time in which the City approves the vast majority of project-level development entitlements needed for development pursuant to, and consistent with, the Proposed Action or selected alternative. As these regulations and policies gradually become effective, the task of achieving the applicable CO_2e/SP goal should become comparatively easier. However, the precise level of reductions is difficult to calculate for all phases of development, and therefore would be speculative at this time. As a precaution, this EIR/EIS concludes that the No USACE Permit, Proposed Project, Resource Impact Minimization, Centralized Development, and Reduced Hillside Development Alternatives' incremental contribution to long-term operational GHG emissions is **cumulatively considerable** and **significant and unavoidable**.

3A.4.2 Impacts on the Project Related to Global Climate Change

Introduction

This section analyzes the potential impact of global climate change on the project (e.g., effects of increased sea levels, reduced snow pack). Because the potential impacts of global warming have only recently been realized, firm data, commonly accepted thresholds for significance, and firm conclusions are not available. This section therefore draws from a range of studies that analyze global and regional patterns and trends. Given the uncertainties in climate change modeling and prediction there are few or no viable models or studies devoted specifically to the project vicinity. Therefore, in order to increase the data set of information about potential regional changes, some of the studies relied on analyze climate for the entire Central Valley, including both the Sacramento and San Joaquin Valleys.

Since there are no formally accepted methodologies, a lead agency must use its best efforts to find out and disclose all that it reasonably can about the potential adverse environmental effects of a proposed project or on a proposed project. However, the analysis cannot rely on speculation. Speculation that is based on unspecified and uncertain future effects that cannot reasonably be evaluated cannot result in verifiable analyses. Furthermore, such analysis could mislead the decision makers and the public. As indicated in the State CEQA Guidelines, "If after a thorough investigation, an agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact." (State CEQA Guidelines CCR Section 15145.)

The following analysis is based on available information and projections applicable to estimating the types of effects that may occur. While some effects of global climate change are reasonably foreseeable, the extent to which many of these effects would manifest themselves and the potential of other effects to occur, remain speculative. In the interests of fully informing the decision makers, many of the potential effects that are subject to a high degree of speculation are discussed in the following evaluation, despite the fact that it would be too speculative to draw a conclusion as to their significance. The discussion herein focuses on the potential effects of climate change on the project, rather than the potential of the project to contribute to global climate change.

Although there is a strong scientific consensus that global warming/global climate change is occurring and is greatly influenced by human activity, there is less certainty as to the timing, severity, and potential consequences of global climate change. Scientists have identified several ways in which global climate change could alter the physical environment in California (Kiparsky and Gleick 2005, Roos 2005, California Department of Water Resources [DWR] 2006). These include:

- increased average temperatures;
- modifications to the timing, amount, and form (rain versus snow) of precipitation;
- changes in the timing and amount of runoff;
- reduced water supply;
- deterioration of water quality; and
- elevated sea level.

The changes listed above may translate into a variety of other issues and concerns, such as:

- reduced agricultural production as a result of changing temperatures and precipitation patterns;
- changes in the composition, health, and distribution of terrestrial and aquatic ecosystems;
- reduced hydroelectric energy production caused by changes in the timing and volume of runoff; and
- reduced availability of energy because of greater demands associated with increased temperatures.

However, this evaluation of the effects of global climate change on the project does not address climate change associated with energy supply for the following reasons:

- There are many potentially wide-ranging direct and indirect effects of global climate change, such as potential reductions in hydroelectric energy production. These reductions could result from changes in the timing and volume of runoff that would cause reductions in the generation of electricity. However it is too speculative to determine that these potential changes would affect the project because they are both geographically remote and the impact on overall energy supply and markets is unknown. Also, potential changes may be addressed or corrected by other entities (e.g., energy providers increasing generation capacity to meet the increased demand that is not specifically associated with the project; greater development and use of alternative energy sources such as solar to offset capacity losses); and

- The specific measures that would be implemented to address more wide-ranging direct and indirect effects of global climate change cannot be reasonably projected at this time.

This analysis does not suggest that the project would see no effect related to energy supply. Rather, any effects would be the same at the project vicinity, as elsewhere in the county, region, state, nation, and world, and would not result in specific unique impacts in the project vicinity.

This analysis focuses on the effects of global climate change that might have a direct, reasonably foreseeable effect on physical conditions in the project vicinity. Therefore, this analysis gives greatest consideration to climate-change data with more consistency in projections of future conditions, and thus a probability for a greater likelihood of occurring within a reasonable time frame (i.e., approximately 100 years).

Because the impacts of global change would be similar within a regional or local area, this analysis assumes that regardless of whether the No Project, No USACE Permit, Proposed Project, Resource Impact Minimization, Centralized Development, and Reduced Hillside Development Alternatives were implemented, the impact on the project would be substantially similar.

INFORMATION SOURCES

Information on the current state of the science surrounding climate change was derived from research papers, technical memoranda, literature summaries, and studies, including the following:

- United Nations Intergovernmental Panel on Climate Change documents *Climate Change 2001: The Scientific Basis* (IPCC 2001a); *Climate Change 2001: Synthesis Report* (IPCC 2001b); and *Climate Change 2007: The Physical Basis. Summary for Policymakers* (IPCC 2007);

- *California Water Plan Update 2005* (Bulletin 160-05) (DWR 2005a) and accompanying papers *Climate Change and California Water Resources: A Survey and Summary of the Literature* (Kiparsky and Gleick 2005) and “Accounting for Climate Change” (Roos 2005);

- *Progress on Incorporating Climate Change into Planning and Management of California’s Water Resources, Technical Memorandum Report* (DWR 2006); and

- Published reports on aspects of climate change and associated effects (see Chapter 5, “References,” of this EIR/EIS for a listing of all information sources cited in this section).

CHARACTERIZATION OF CLIMATE CHANGE IMPACTS

This section summarizes the current scientific perspective of climate change and associated effects, particularly those that could affect the project. Information is provided for each effect of climate change considered in this document, consisting of:

- increased temperature;
- precipitation volume, type, and intensity;
- runoff volume and timing;
- water supply;
- sea level rise;
- water quality changes; and
- agricultural changes.

For each climate change effect there is a discussion of:

- status of current scientific information and data about past trends;
- projected future changes and the accuracy and variability of modeling results, including identification of results presumed too speculative for conclusive analysis; and
- potential for the environmental effects of climate change to affect the Proposed Project Alternative, based both on the certainty or uncertainty of modeling results and on the physical nature of the effect.

This information is used in this section to consider and evaluate potential environmental impacts of future climate change on the project.

Background

Theories about climate change and global warming existed as early as the late 1800s. It was not until the later 1900s that understanding of the Earth's atmosphere had advanced to the point where many atmospheric and climate scientists began to accept that the Earth's climate is changing (IPCC 2001a, 2001b; DWR 2006).

In recent years, the scientific consensus has broadened to consider increasing concentrations of GHGs, attributable to anthropogenic (human) activities, as a primary cause of global climate change. The United Nations IPCC predicts that changes in the Earth's climate will continue through the 21st century and that the rate of change may increase significantly in the future because of the growing population and associated increase in human activity (IPCC 2001b, 2007). Recent studies confirm the existence of climate change, and emphasize the occurrence of impacts in the next 20–50 years (Backlund, Janetos, and Schimel 2008), but the scope and rate of change remains uncertain.

In recent years, the issue of global climate change has had an increasing role in scientific and policy debates over multiple environmental topics such as land use planning, transportation planning, energy production, habitat and species conservation, use of ocean resources, and agricultural production. Of particular concern are the existing and potential future effects of global climate change on hydrologic systems and water management (e.g., domestic water supply, agricultural water supplies, flood control, water quality). There is evidence that global climate change has already had an effect on California's hydrologic system. For example, historical data indicate a trend toward declining volumes of spring and summer runoff from the Sierra Nevada.

California water planners and managers have been among the first groups in the nation to realize the potential implications of statewide and regional climate change (rather than global-scale changes) on the reliability and safety of their systems. Research and analysis on climate risks facing California water resources began in the early 1980s, and by the end of that decade, state agencies such as the CEC had prepared the first assessments of state GHG emissions and possible impacts on a wide range of sectors. The California Water Plan (Bulletin 160) first addressed climate change in 1993 (DWR 1993). More recently, DWR and the Public Interest Energy Research program of CEC expanded and refined the analysis of climate change effects in California in the 2005 update of the California Water Plan, which explores a wide range of climate impacts and risks, including risks to water resources (Kiparsky and Gleick 2005, Roos 2005). The 2005 update also describes efforts that should be taken to quantitatively evaluate climate change effects for the next Water Plan update (DWR 2005a). DWR has also followed up on these issues with a technical memorandum report that specifically discusses progress on modeling climate change in the state, characterizes the effects of climate change, and incorporates climate change into planning and management of California's water resources (DWR 2006).

Variability in Regional Modeling of Climate Change

Much of the available trend data, modeling, and projections related to climate change are on a global scale. Climate change projections often rely on general circulation models (GCMs). These models develop large-scale scenarios of changing climate parameters, usually comparing scenarios with different concentrations of greenhouse gases in the atmosphere. This information is typically not specific enough to make accurate regional assessments. As a result, more effort has recently been put into reducing the scale and increasing the resolution of climate models through various techniques such as "downscaling" or integrating regional models into the global models (Kiparsky and Gleick 2005, Roos 2005, DWR 2006). However, the level of uncertainty related to regional climate change is generally higher than that related to global projections because these current methodologies add uncertainty.

Variability in the results of climate change modeling is largely based on which global climate model is used, what inputs are selected for the model (world population increases and greenhouse gas emissions), and how the model is downscaled to provide region-specific data. For example, in DWR's report *Progress on Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report* (DWR 2006), four scenarios projecting regional climate change were selected, consisting of combinations of two different global climate models and two different emissions scenarios. These four scenarios provide temperature results ranging from weak warming to relatively strong warming, and precipitation results ranging from modest reductions to weak increases (DWR 2006).

It should be remembered that results of climate change modeling, particularly for regional models, are not specific, quantified predictions. There is a lot of uncertainty about the magnitude of climate change that will occur during this century. It is unlikely that this level of uncertainty will be resolved in the foreseeable future (Dettinger 2005a). Therefore, effects on the environment anticipated under various climate change models should be considered as general projections of potential future conditions, with actual environmental effects likely falling within the range of results provided by a variety of model outputs.

Temperature

Status and Trends

The Earth's climate has had periods of cooling and warming in the past. Significant periods of cooling have been marked by massive accumulations of sea- and land-based ice extending from the Earth's poles to as far as the middle latitudes. Periods of cooling have also been marked by lower sea levels because of the accumulation of water as ice and the cooling and contraction of the Earth's oceans. Periods of warming caused recession of the ice toward the poles, warming and thermal expansion of the Earth's oceans, and rise in sea levels (DWR 2006, IPCC 2007).

The potential for human-induced changes in the Earth's temperature has been tied to increased concentrations of GHGs in the atmosphere, caused primarily by the production and burning of fossil fuels. The primary gases of concern are carbon dioxide, methane, and nitrous oxide (IPCC 2001a, 2001b, 2007). Average temperatures in the Northern Hemisphere appear to have been relatively stable from about the year 1000 to the mid-1800s, based on temperature proxy records from tree rings, corals, ice cores, and historical observations (IPCC 2001a). However, there is a level of uncertainty related to proxy temperature records, especially those extending far back into the past.

The IPCC stated that the Earth's climate has warmed since the preindustrial era and that it is very likely that at least some of this change is attributable to the activities of humans (IPCC 2007). Global average near-surface air temperatures and ocean surface temperatures increased by 0.74 °C ± 0.18°C (1.33°F ± 0.32°F) during the 20th century (IPCC 2007).

Temperature measurements, apparent trends in reduced snowpack and earlier runoff, and other evidence such as changes in the timing of blooming plants indicate that temperatures in California and elsewhere in the western United States have increased during the past century (National Oceanic and Atmospheric Administration [NOAA] 2005, Mote et al. 2005, Cayan et al. 2001).

Projections

Modeling results from GCMs are consistent in predicting increases in temperatures globally with increasing concentrations of atmospheric GHGs resulting from human activity. As discussed above, climate change projections can be developed on a regional basis using techniques to downscale from the results of global models (although increased uncertainty results from the downscaling). One relatively large group of model projections for California that was recently examined provides a temperature rise of about 2.5 to 9°C (4.5 to 16.2°F) for Northern California by 2100. An analysis of the distribution of the projections generally showed a central tendency at about 3°C (5.4°F) of rise for 2050, and about 5°C (9°F) for 2100 (Dettinger 2005b).

Snyder et al. (2002) produced one of the most refined scale temperature and precipitation estimates to date. Resulting temperature increases for a scenario of doubled carbon dioxide concentrations are 1.4 to 3.8°C (2.5 to 6.8°F) throughout California. This is consistent with the global increases predicted by the IPCC (2001b, 2007). In a regional model of the western United States, Kim et al. (2002) projected a climate warming of around 3 to 4°C (5.4 to 7.2°F). Of note in both studies is the projection of uneven distribution of temperature increases. For example, regional climate models show that the warming effects are greatest in the Sierra Nevada, with implications for snowpack and snowmelt (Kim et al. 2002, Snyder et al. 2002).

Effect on the Project

Based on the results of a variety of regional climate models, it is reasonably foreseeable that some increase in annual average temperatures will occur in California, and in the project vicinity, during the next 100 years. Although a temperature increase is expected, the amount and timing of the increase is uncertain. In general, predictions put an increase in the range of 3 to 5°C (5.4 to 9°F) over the next 50–100 years (Kim et al. 2002, Snyder et al. 2002, Dettinger 2005b).

An increase in average annual temperatures, by itself, would have little effect on the proposed land uses other than adjustments in project operations in response to warmer temperatures, such as increased evapotranspiration rates affecting both detention basin areas and landscaped areas, resulting in an increased irrigation demand, and potentially greater overall energy consumption to meet air conditioning needs.

Effects related to water supply is discussed below. Potential outcomes of increased temperature on a global and regional scale, such as changes in precipitation and runoff, also have a potential to substantially affect physical conditions in the project vicinity. These topic areas are also discussed below.

Therefore, although an increase in annual average temperature is a reasonably foreseeable effect of future climate change, this environmental change alone would have little effect on the project.

Precipitation

Climate change can affect precipitation in a variety of ways, such as by changing the following:

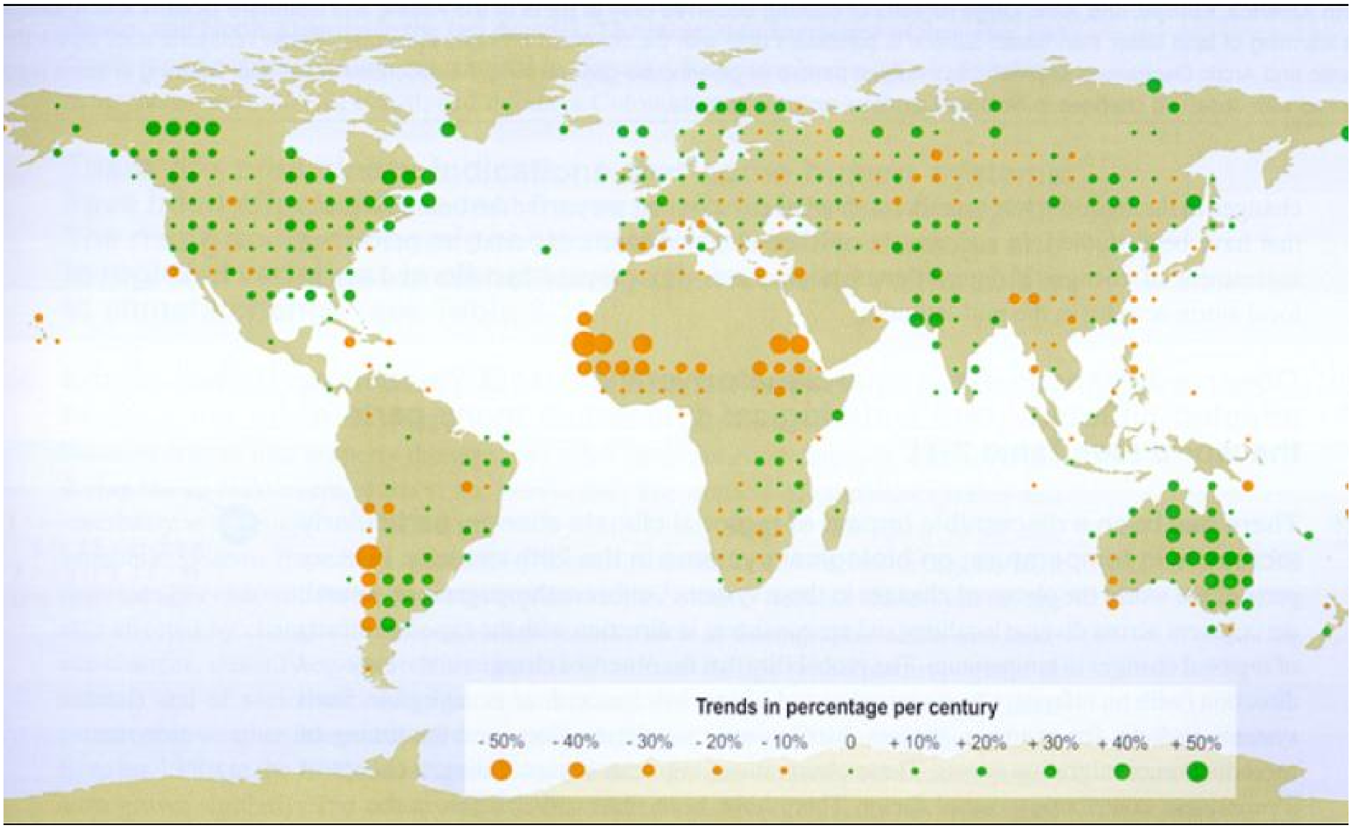
- overall amount of precipitation,
- type of precipitation (rain versus snow), and
- timing and intensity of precipitation events.

Each of these issue areas is discussed below.

Amount of Precipitation

Status and Trends

Worldwide precipitation is reported to have increased about 2% since 1900. While global average precipitation has been observed to increase, changes in precipitation over the past century vary in different parts of the world. Some areas have experienced increased precipitation while other areas have experienced a decline (Exhibit 3A.4-2) (IPCC 2001b, 2007; NOAA 2005). An analysis of trends in total annual precipitation in the western United States by the National Weather Service's Climate Prediction Center provides evidence that annual precipitation has increased in much of California, the Colorado River Basin, and elsewhere in the West since the mid-1960s (DWR 2006). In another study evaluating trends in annual November through March precipitation for the western United States and southwest Canada, the data indicate that for most of California and the Southwest there was increasing precipitation during the periods of 1930–1997 and 1950–1997 (Mote et al. 2005).



Source: Adapted by AECOM in 2009 from IPCC 2001

Global Precipitation Trend for 1900–2000 **Exhibit 3A.4-2**

Former State Climatologist James Goodridge compiled an extensive collection of longer-term precipitation records from throughout California. These data sets were used to evaluate whether there has been a changing trend in precipitation in the state over the past century (DWR 2006). Long-term runoff records in selected watersheds in the state were also examined. Based on a linear regression of the data, the long-term historical trend for statewide average annual precipitation appears to be relatively flat (no increase or decrease) over the entire record. However, an upward trend in precipitation during the latter portion of the record has been noted, but is not conclusive.

When these same precipitation data are sorted into three regions—northern, central, and southern California—trends show that precipitation in the northern portion of the state appears to have increased slightly from 1890 to 2002, and precipitation in the central and southern portions of the state show slightly decreasing trends. All changes were in the range of 1–3 inches annually (DWR 2006). Thus although existing data indicate some level of change in precipitation trends in California, more analysis is likely needed to determine whether changes in California's regional annual precipitation totals have occurred as the result of climate change or other factors (DWR 2006).

Projections

The IPCC predicts that increasing global surface temperatures are very likely to result in changes in precipitation. Global average precipitation is expected to increase during the 21st century as the result of climate change, based on global climate models for a wide range of greenhouse gas emission scenarios. However, global climate models are generally not well suited for predicting regional changes in precipitation because of the large scale of global projections relative to the small scale of regionally important factors that affect precipitation (e.g., maritime influences, effects of mountain ranges) (IPCC 2001a, 2007).

Therefore, while precipitation is generally expected to increase on a global scale as a result of climate change, significant regional variations in precipitation trends can be expected. Some recent regional modeling efforts conducted for the western United States indicate that overall precipitation will increase (Kim et al. 2002, Snyder et al. 2002), but considerable uncertainty remains because of differences among larger-scale GCMs. Where precipitation is projected to increase in California, the increases are mostly in northern California (Kim et al. 2002, Snyder et al. 2002) and in the winter months.

Various California climate models provide mixed results regarding changes in total annual precipitation in the state through the end of this century. Models predicting the greatest amount of warming generally predict moderate decreases in precipitation, while models projecting smaller increases in temperature tend to predict moderate increases in precipitation (Dettinger 2005b). In addition, an IPCC review of multiple global GCMs indicates that fewer than 66% of the models evaluated agree on whether annual precipitation would increase or decrease for much of the State's area. Therefore, no conclusion on an increase or decrease can be provided (IPCC 2007). Considerable uncertainties about the precise effects of climate change on California (and more specifically Sacramento River hydrology and water resources will remain until there is more precise and consistent information about how precipitation patterns, timing, and intensity will change.

Effect on the Project

Although global climate change models generally predict an increase in overall precipitation on a worldwide scale, there is no such consistency among the results of regional models applied to California. Based on the models used and the input assumptions, both increases and decreases in annual precipitation are projected. There is also variability in the results for different parts of the state. Given the uncertainty associated with projecting the amount of annual precipitation, any conclusion regarding significance of potential effects of climate change on precipitation volumes as they relate to reasonably foreseeable direct effects on physical conditions in the project vicinity would be too speculative to be meaningful.

Type of Precipitation – Snowpack

Status and Trends

California's annual snowpack, on average, has the greatest accumulations from November though the end of March. The snowpack typically melts from April through July. Snowmelt provides significant quantities of water to streams and reservoirs for several months after the annual storm season has ended. The length and timing of each year's period of snowpack accumulation and melting varies based on temperature and precipitation conditions (DWR 2006).

California's snowpack is important to the state's annual water supply because of its volume and the time of year that it typically melts. Average runoff from melting snowpack is usually about 20% of the state's total annual natural runoff and roughly 35% of the state's total usable annual surface water supply. The state's snowpack is estimated to contribute an average of about 15 million acre-feet (maf) of runoff each year, about 14 maf of which is estimated to flow into the Central Valley. In comparison, total reservoir capacity serving the Central Valley is about 24.5 maf in watersheds with significant annual accumulations of snow (DWR 2005b).

California's reservoir managers (including State Water Project [SWP] and Central Valley Project [CVP] facilities) use snowmelt to help fill reservoirs once the threat of large winter and early spring storms and related flooding risks have passed. These systems include water management infrastructure within the Sacramento River watershed, where additional water is stored in reservoirs and used to help meet downstream water demands after flows from snowmelt begin to recede. Some of the annual runoff collected in California's reservoirs is held from one year to the next because California's annual precipitation and snowpack can vary significantly from year to year. There may also be decade-scale variation in precipitation over the Sierra Nevada (Freeman 2002), and possibly other parts of California. Carryover storage can help meet water demand in years when precipitation and runoff is low.

Because the importance of the Sierra Nevada snowpack is tied to both the volume of water it holds and the timing of water releases (spring and early summer), simply assessing the amount of precipitation that falls as snow does not convey the full value of the snowpack and the potential effects of climate change on water supply. Measurements of the amount of Sierra Nevada runoff occurring from April to July are a better indicator of the combined interaction between the volume of the snowpack and the time of year that it melts.

Changes in patterns of runoff reveal declining water storage in the form of snowpack. Between 1906 and 2005, the total water year runoff in the Sacramento Valley rivers (including the Sacramento, Feather, Yuba, and American Rivers) has remained about the same (DWR 2006). However, runoff volume for April–July has declined from approximately 43% of total water-year runoff to approximately 34% of total water year runoff (i.e., has declined about 9% as compared to total year runoff). These values represent "unimpaired" runoff, meaning that the effects of runoff detention in reservoirs are removed. These data indicate that although overall precipitation volumes (represented by runoff amounts) showed no change, more runoff occurred as a result of rain during the winter months, and less runoff could be attributed to the melting of accumulated snowpack during the spring and early summer. These trends suggest less accumulation of snowpack and earlier runoff of snow melt.

Projections

As early as the mid-1980s and early 1990s, regional hydrologic modeling of global warming impacts has suggested with increasing confidence that higher temperatures will affect the timing and magnitude of snowmelt and runoff in California (Gleick 1986, 1997; Lettenmaier and Gan 1990; Lettenmaier and Sheer 1991; Nash and Gleick 1991a, 1991b; Hamlet and Lettenmaier 1999). Over the past two decades, this has been one of the most persistent and well-established findings on the impacts of climate change for water resources in the United States and elsewhere, and it continues to be the major conclusion of regional water assessments (Knowles and Cayan 2002, Barnett et al. in prep.).

By delaying runoff during the winter months when precipitation is greatest, snow accumulation in the Sierra Nevada acts as a massive natural reservoir for California. Despite uncertainties about how increased concentrations of greenhouse gases may affect precipitation, there is very high confidence that higher temperatures will lead to dramatic changes in the dynamics of snowfall and snowmelt in watersheds with substantially more snowfall (Kiparsky and Gleick 2005, DWR 2006). An analysis of the impact of rising temperatures on snowpack conducted by DWR (2006) shows that a 3°C (5.4°F) rise in average annual temperature would likely cause snowlines to rise approximately 1,500 feet. This would result in an annual loss of approximately 5 maf of water storage in snowpack. Simulations conducted by N. Knowles and D. R. Cayan (Knowles and Cayan 2002) project a loss in April snowpack in the Sierra Nevada of approximately 5% with a 0.6°C (1.1°F) increase in average annual temperature, an approximately 33% loss with a 1.6°C (3.4°F) rise, and an approximately 50% loss in April snowpack with a 2.1°C (4.9°F) average annual temperature rise. Loss of snowpack was projected to be greater in the northern Sierra Nevada and the Cascades than in the southern Sierra Nevada because of the greater proportion of land at the low and mid-elevations in the northern ranges. With a temperature increase of 2.1°C, the northern Sierra Nevada and the Cascades were projected to lose 66% of their April snowpack, while the southern Sierra Nevada was projected to lose 43% of its April snowpack (Knowles and Cayan 2002).

Future predictions confirm that not only will snowpack form a smaller portion of overall precipitation but it will also melt and runoff earlier in the year in the Sacramento watershed and its constituent subbasins (Gleick and Chalecki 1999). This change will occur as overall precipitation will likely increase slightly. These two trends will most likely cause reduced summer flows in the Sacramento River, reduced summer soil moisture and increased winter flows and flood potential. Higher snowlines will cause a greater proportion of winter runoff and earlier snowmelt times will lengthen the duration of peak winter flows and flood potential.

Effect on the Project

Based on the results of a variety of regional climate models and literature, it is reasonably foreseeable that snowpack will be reduced and/or will melt earlier or more rapidly in watersheds that feed the Sacramento River. The SPA is located in the foothills east of the Sacramento Valley and receives snow very rarely. Consequently, changes in snowfall patterns would not directly affect precipitation in the SPA.

However, changes in snowpack could affect the project indirectly by altering the timing and volume of runoff that eventually feeds into the SPA and into waterways supplying water to the project. The primary water supply alternatives under consideration would rely on Natomas Central Mutual Water Company (NCMWC) surface water rights in the Sacramento River, that would be withdrawn at the Freeport Project diversion. Therefore, impacts to snowpack and associated runoff affecting the Sacramento River watershed are the most salient to proposed land uses in the project vicinity. The runoff sources can be divided into two categories: (1) direct rainfall-fed surface runoff accumulating in channels; and (2) released water from upstream reservoirs that is conveyed by the channels and will be used for groundwater recharge. The first source, direct surface runoff, will vary with large-scale regional changes in precipitation patterns. Because much of the naturally occurring runoff relevant to water supplies for the project originates as rainfall rather than snowfall (much of the Sacramento River watershed occurs in the Sacramento Valley itself and thus below the snowline), changes to the timing and magnitude of naturally occurring rainfall patterns will follow regional changes associated with climate change in the central and northern Sierra Nevada. The second source, released and/or purchased waters stored in upstream reservoirs, will largely depend on regional annual average precipitation accumulations. The management of upstream reservoirs may need to be altered to account for seasonal variations in precipitation type and intensity. However, the total water volumes stored in upstream reservoirs is largely tied to regional trends of annual average precipitation amounts. The predicted shift towards greater precipitation with a larger proportion of rainfall relative to snow will require greater upstream management in reservoirs and other flood control devices to maintain the current level of flood protection. Given the complex system of upstream water management, the impact of predicted climate changes on the project is speculative, but flood potential will probably increase if water management strategies remain the same. However, given that the magnitude and timing of the increase in winter runoff and the associated changes in reservoir use that may occur, the exact impact on the Proposed Project Alternative is speculative. Based on the uncertainty of projected changes it is not feasible or useful to mitigate anticipated changes in current planning.

Timing and Intensity of Precipitation Events

Status and Trends

Variability and extreme weather events are a natural part of any climatic system. The extent of climatic stability or variability is dependent in large part on the time frame examined. Climatic conditions may be characterized as relatively stable over periods of hundreds or thousands of years, but within that time frame there may be severe droughts or flood events that vary widely beyond the overall average condition. Paleoclimatic evidence from tree rings, buried stumps, and lakebed sediment cores suggests that in California the past 200 years have been relatively wet and relatively constant when compared with older records (DWR 2006). These older records reveal greater variability than the historical record, in particular in the form of severe and prolonged droughts, but are not likely to be as reliable as more recent records. Most identified climatic averages and extremes for California are based on the historical climate record since 1900, and cannot be considered fully representative of past or future conditions (DWR 2006).

Extreme weather events are expected to be one of the more important indicators of climate change. Phenomena such as the El Niño/Southern Oscillation, which is the strongest natural interannual climate fluctuation, affect the entire global climate system and the economies and societies of many regions and nations. Direct effects of this climate fluctuation occur in California. The El Niño/Southern Oscillation phenomena for example, strongly influences storms and precipitation patterns. It is unclear how increases in global average temperatures associated with global warming might affect the El Niño cycles. However, the strong El Niños of 1982–83 and 1997–98 and associated flood events, along with the more frequent occurrences of El Niños in the past few decades, have forced researchers to try to better understand how human-induced climate change may affect interannual climate variability (Trenberth and Hoar 1996, Timmermann et al. 1999).

In addition to possible long-term changes in precipitation trends, increased variability of annual precipitation is a possible outcome of climate change. Based on a statistical analysis of California precipitation records, there appears to be an upward trend in the variability of precipitation over the 20th century, with variability values at the end of the century about 75% larger than at the beginning of the century. This indicates that there tended to be more extreme wet and dry years at the end of the century than there were at the beginning of the century (DWR 2006). However, as stated above, paleoclimatic evidence suggests that weather patterns in California have been relatively constant over the last 200 years, which identifies the variable weather patterns toward the latter part of this period as more pronounced. As identified previously in the "Amount of Precipitation" discussion, there has been little change in the average amount of annual precipitation in California over the last 100 years. Therefore, the increased variability between wet and dry years in recent decades appears to oscillate around the same annual average established over a longer time frame.

Projections

While variability is not well modeled in large-scale GCMs, some modeling studies suggest that the variability of the hydrologic cycle increases when mean precipitation increases, possibly accompanied by more intense local storms and changes in runoff patterns (DWR 2006). However, the results of another long-standing model point to an increase in incidents of drought, resulting from a combination of increased temperature and evaporation along with decreased precipitation (DWR 2006). Based on the first model mentioned, this decrease in precipitation would lead to reduced variability in hydrologic cycles.

A study that analyzed 20 GCMs currently in use worldwide suggests that the West Coast may be less affected by extreme droughts than other areas; instead, the region would experience increased average annual rainfall (Meehl et al. 2000). A separate study that reviewed several GCM scenarios showed increased risk of large storms and flood events for California (Miller, Kim, and Dettinger 1999). Conflicting conclusions about climatic variability and the nature of extreme weather events (e.g., droughts, severe storms, or both) support the need for additional studies with models featuring higher spatial resolution (Kiparsky and Gleick 2005, DWR 2006).

Effect on the Project

Although various climate change models predict some increase in variability of weather patterns and an increasing incidence of extreme weather events, there is no consistency among the model results, with some predicting increased incidents of droughts and others predicting increased frequency of severe storm events. Given the uncertainty associated with projecting the type and extent of changes in climatic variability and the speculative nature of predicting incidents of extreme weather events, the effect on the project of changing patterns of storms and other extreme weather remains unclear, and the attempt to reach a significance conclusion would be speculative.

Runoff

Status and Trends

Runoff is directly affected by changes in precipitation and snowpack (see discussions above). Changes in both the amount of runoff and in seasonality of the hydrologic cycle have the potential to greatly affect the heavily managed water systems of the western United States.

As described in the previous discussion of snowpack, data indicate that although overall precipitation volumes (represented by runoff amounts) showed no change, more runoff occurred as a result of rain during the winter months, and less runoff could be attributed to the melting of accumulated snowpack during the spring and early summer (DWR 2006).

Projections

Detailed estimates of changes in runoff as a result of climate change have been produced for California using regional hydrologic models. With input of anticipated, hypothetical, and/or historical changes in temperature and precipitation in to models that include realistic small-scale hydrology, modelers have consistently seen substantial changes in the timing and magnitude, which can be attributed to runoff resulting from projected changes in climatic variables (Kiparsky and Gleick 2005). Model results indicate that as temperatures rise, a declining proportion of total precipitation falls as snow, more winter runoff occurs, and remaining snow melts sooner and faster in spring (Miller, Kim, and Dettinger 1999, Knowles and Cayan 2002, Gleick and Chalecki 1999). In some basins, spring peak runoff may increase; in others, runoff volumes may shift to earlier in the spring and winter months (Kiparsky and Gleick 2005, DWR 2006). If snowpack declines, it is also possible that the incidence or severity of flood events resulting from “rain on snow” conditions could also decline.

As indicated above, hydrology in the lower reaches of the Sacramento Valley is highly dependent on the interaction between Sierra Nevada snowpack, runoff, and management of reservoirs. Potential changes made to the amount of reservoir space retained for flood storage, retained annual carryover volumes, and other reservoir management factors in response to altered Sierra Nevada runoff patterns could substantially alter how those runoff patterns are experienced in downstream in the vicinity of the project vicinity. It is also possible that as climate change continues to progress over the next 50–100 years, new water storage projects (e.g., on-stream or off-stream storage reservoirs, expanding capacity at existing reservoirs) may be put in place to capture additional Sierra runoff. Additional storage capacity could assist in buffering runoff patterns in the lower river reaches from altered flow regimes in higher elevations.

Effect on the Project

Although various climate change models consistently predict reduced spring/summer runoff in the Sierra Nevada as a result of altered snowpack conditions, there is a great deal of uncertainty regarding how these changes would affect runoff patterns in the Sacramento Valley and consequently water dependent land uses in the Sacramento Valley and foothills. Potential modifications in management regimes of existing reservoirs, such as reducing retained annual carryover volumes to increase space available for flood storage, could buffer the Sacramento River and adjacent land uses from changes to runoff patterns at higher elevations. The potential for creation of new water storage capacity, such as on- or off-stream storage reservoirs or expanding capacity at existing reservoirs could also reduce the effects of altered runoff patterns. Given the integrated nature of the water system in California, even increased storage capacity in southern California could benefit the region by allowing reservoirs in northern California to hold less water for domestic or agriculture use and retain more capacity for flood control. Given the uncertainty associated with projecting changes in runoff patterns in water bodies at and upstream of the project vicinity (the Sacramento River watershed is approximately 27,000 square miles, most of which occurs upstream of the project vicinity, and contains numerous subbasins, see also Section 3A.9, “Hydrology and Water Quality – Land”) this potential climate change effect is too speculative to reasonably draw a meaningful conclusion regarding the significance of foreseeable direct effects on physical conditions in the project vicinity.

Sea Level

Status and Trends

One of the major areas of concern related to global climate change is rising sea level. Worldwide average sea level appears to have risen about 0.4 to 0.7 foot over the past century based on data collected from tide gauges around the globe, coupled with satellite measurements taken over approximately the last 15 years (IPCC 2007). Various gauge stations along the coast of California show an increase similar to the global trends. Data specific to the San Francisco tide gauge near the Golden Gate Bridge shows that the 19-year mean tide level (the mean tide level based on 19-year data sets) has increased by approximately 0.5 foot over the past 100 years (Exhibit 3A.4-3). Rising average sea level over the past century has been attributed primarily to warming of the world’s oceans and the related thermal expansion of ocean waters, and the addition of water to the world’s oceans from the melting of land-based polar ice. Some researchers have attributed most of the worldwide rise to thermal expansion of water, although there is some uncertainty about the relative contributions of each cause (Munk 2002).

Effect on the Project

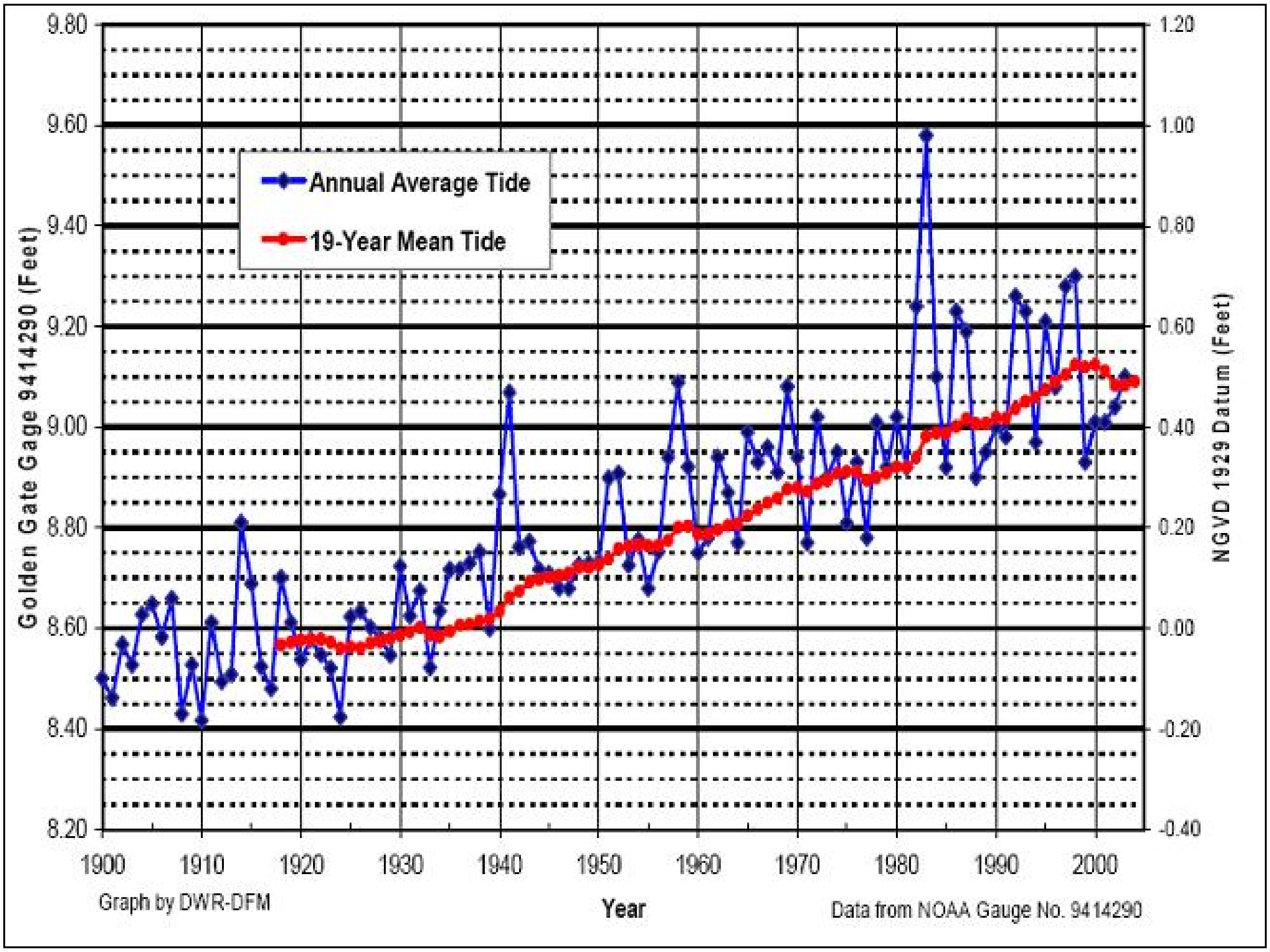
Projections

Various global climate change models have projected a rise in worldwide average sea level of 0.3 to 2.9 feet by 2100 (IPCC 2001a). Updated model results provided by the IPCC in 2007 put the range at 0.6–1.9 feet by 2099 (IPCC 2007). The ranges are narrower than in the Third Assessment Report (IPCC 2001a) mainly because of improved information about some uncertainties in the projected contributors to sea level rise (IPCC 2007).

Although these projections are on a global scale, the rate of relative sea level rise experienced at many locations along California’s coast is consistent with the worldwide average rate of rise observed over the past century. Therefore, it is reasonable to expect that changes in worldwide average sea level through this century will also be experienced by California’s coast (DWR 2006).

A consistent rise in sea level has been recorded worldwide over the last 100 years. Recorded rises in sea level along the California coast correlate well with the worldwide data. Based on the results of various global climate change models, sea level rise is expected to continue. Based on the consistency in past trends, the consistency of future projections, and the correlation between data collected globally and data specific to California, it is reasonably foreseeable that some amount of sea level rise will occur along the California coast over the next 100 years. Although sea level rise is expected to occur, the amount and timing of the increase is uncertain. Predictions published by the IPCC in 2007 indicate an increase in elevation in the range at 0.6–1.9 feet by 2099 (IPCC 2007).

While sea level rise induced by climate change is reasonably certain, the SPA is located far above (over 100 feet above) sea level, and thus sea level rise would not directly affect proposed land uses within the SPA.



Source: Adapted by AECOM in 2009 from DWR 2006

Graph of Annual Average Relative Sea Level and the 19-Year Running Average Sea Level at the Golden Gate Tide Gauge, California, 1900–2003 **Exhibit 3A.4-3**

Water Supply

Status and Trends

Several recent studies have shown that existing water supply systems are sensitive to climate change (Wood 1997). Potential impacts of climate change on water supply and availability could directly and indirectly affect a wide range of institutional, economic, and societal factors (Gleick 1997). Residential, industrial, and agricultural land uses all are affected by the cost and security of water supply. Much uncertainty remains, however, with respect to the overall impact of global climate change on future water supplies. For example, models that predict drier conditions (i.e., parallel climate model [PCM]) suggest decreased reservoir inflows and storage and decreased river flows, relative to current conditions. By comparison, models that predict wetter conditions (i.e., HadCM2) project increased reservoir inflows and storage, and increased river flows (Brekke et al. 2004). Both projections are equally probable based on which model is chosen for the analyses (Ibid.). Much uncertainty also exists with respect to how climate change will affect future demand on water supply (DWR 2006). Still, changes in water supply are expected to occur and many regional studies have shown that large changes in the reliability of water yields from reservoirs could result from only small changes in inflows (Kiparsky and Gleick 2005; see also Cayan et al. 2006).

Little work has been performed on the effects of climate change on specific groundwater basins or groundwater recharge characteristics (Kiparsky and Gleick 2005). Changes in rainfall and changes in the timing of the groundwater recharge season would result in changes in recharge. Warmer temperatures could increase the period where water is on the ground by reducing soil freeze. Conversely, warmer temperatures could lead to higher evaporation or shorter rainfall seasons, which could mean that soil deficits would persist for longer time periods, shortening recharge seasons. Warmer, wetter winters would increase the amount of runoff available for groundwater recharge. This additional winter runoff, however, would be occurring at a time when some basins, particularly in Northern California, are being recharged at their maximum capacity. Reductions in spring runoff and higher evapotranspiration, on the other hand, could reduce the amount of water available for recharge. However, the specific extent to which various meteorological conditions will change and the impact of that change on groundwater are both unknown. A reduced snowpack, coupled with increased rainfall, could require a change in the operating procedures for California's existing dams and conveyance facilities (Kiparsky and Gleick 2005).

Projections

DWR's *Progress on Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report* (2006) focused on climate change impacts on CVP and SWP operations and on the Delta. The results of that analysis suggest several impacts of climate change on overall CVP and SWP operations and deliveries. In three of the four climate scenarios simulated, CVP reservoirs north of the Delta experienced shortages during droughts. DWR (2006) recommends that future studies examine operational changes that could avoid these shortages. At present, DWR concludes, it is not clear whether such operational changes would be insignificant or substantial. Changes in annual average CVP deliveries south of the Delta ranged from increases of about 2.5% for the wetter scenario to decreases of up to 10% for drier scenarios. Future studies will have to address how shortages north of the Delta could affect CVP deliveries south of the Delta. Carryover storage (i.e., water from one year stored into the next year) for the CVP was negatively affected in the drier scenarios and beneficially affected (slightly increased) in the wetter scenario.

The modeling conducted by Gleick and Chalecki (1999) on the Sacramento River Basin strongly suggests that annual levels of water moving through the Sacramento River watershed would increase. While annual volumes of water would increase, summer flows would decrease as a result of projected reductions in snowpack and earlier seasonal melting. Absent any intervention this would result in lower summer surface water flows and higher winter flows. Groundwater recharge may be adversely impacted by lower summer flows, without a commensurate increase because winter recharge rates are already at maximum. Upstream water management structures such as reservoirs could mitigate this by retaining greater winter flows to be released during the summer, thus making for a more constant level of surface water in the Sacramento. The need for adaptive changes in water management infrastructure use suggested by Gleick and Chalecki is confirmed by more recent research.

Tanaka et al. (2006) explored the ability of California's water supply system to adapt to long-term climatic and demographic changes using the California Value Integrated Network (CALVIN), a statewide economic-engineering optimization model of water supply management. The results show agricultural water users in the Central Valley are the most sensitive to climate change, particularly under the driest and warmest scenario (i.e., PCM 2100) predicting a 37% reduction of Central Valley agricultural water deliveries and a rise in Central Valley water scarcity costs by $1.7 billion. Although the results of the study are only preliminary, they suggest that California's water supply system appears "physically capable of adapting to significant changes in climate and population, albeit at a significant cost" (Tanaka et al. 2006). Such adaptation would entail changes in California's groundwater storage capacity, water transfers, and adoption of new technology.

VanRheenen et al. (2004) studied the potential effects of climate change on the hydrology and water resources of the Sacramento-San Joaquin River Basin using five PCM scenarios. The study concluded that most mitigation alternatives examined satisfied only 87 to 96% of environmental targets in the Sacramento system, and less than 80% in the San Joaquin system. Therefore, system infrastructure modifications and improvements could be necessary to accommodate the volumetric and temporal shifts in flows predicted to occur with future climates in the Sacramento-San Joaquin River Basins.

Zhu et al. (2005) studied climate warming impacts on water availability derived from modeled climate and warming streamflow estimates for six index California basins and distributed statewide temperature shift and precipitations changes for 12 climate scenarios. The index basins provide broad information for spatial estimates of the overall response of California’s water supply and the potential range of impacts. The results identify a statewide trend of increased winter and spring runoff and decreased summer runoff, as previously indicated by Gleick and Chalecki (1999). Approximate changes in water availability are estimated for each scenario, though without operations modeling. Even most scenarios with increased precipitation result in a decrease in available water. This result is due to the inability of current storage systems to catch increased winter streamflow to offset reduced summer runoff.

Medellin et al. (2006) used the CALVIN model under a high emissions “worst case” scenario, called a dry-warming scenario. The study found that climate change would reduce water deliveries by 17% in 2050. The reduction in deliveries was not equally distributed, however, between urban and agricultural areas. Agricultural areas would see their water deliveries drop by 24% while urban areas would only see a reduction of 1%. There was also a geographic difference: urban scarcity was almost absent outside of southern California.

In 2003, CEC’s Public Interest Energy Research (PIER) program established the California Climate Change Center (CCCC) to conduct climate change research relevant to the state. Executive Order S-3-05 called for the California Environmental Protection Agency (CalEPA) to prepare biennial science reports on the potential impact of continued climate change on certain sectors of California’s economy. CalEPA entrusted PIER and its CCCC to lead this effort. The climate change analysis contained in its first biennial science report concluded that major changes in water management and allocation systems could be required in order to adapt to the change. As less winter precipitation falls as snow, and more as rain, water managers would have to balance the need to construct reservoirs for water supply with the need to maintain reservoir storage for winter flood control. Additional storage could be developed, but at high environmental and economic costs.

Lund et al. (2003) examined the effects of a range of climate warming estimates on the long-term performance and management of California’s water system. The study estimated changes in California’s water availability, including effects of forecasted changes in 2100 urban and agricultural water demands using a modified version of the CALVIN model. The main conclusions are summarized below.

- A broad range of climate warming scenarios show significant increase in wet season flows and significant decreases in spring snowmelt. The magnitude of climate change effects on water supplies is comparable to water demand increases from population growth in 21st century.

- California’s water system would be able to adapt to the severe population growth and climate change modeled. This adaptation would be costly, but it would not threaten the fundamental prosperity of the state, although it could have major impacts on the agricultural sector. The water management costs represent only a small proportion of California’s current economy.

- Under the driest climate warming scenarios, Central Valley agricultural users could be especially vulnerable to climate change. Wetter hydrologies could increase water availability for these users. The agricultural community would not be compensated for much of its loss under the dry scenario. The balance of climate change effects on agricultural yield and water use is unclear. While higher temperatures could increase evapotranspiration, longer growing seasons and higher carbon dioxide concentrations could increase crop yield.

- Population growth is expected to be more problematic than climate change in Southern California. Population growth, conveyance limits on imports, and high economic value of water in Southern California, could lead to high use of wastewater reuse and substantial use of seawater desalination along the coast. Due to the integrated nature of water management and competition for water resources this could impact water supply in the Sacramento region.

- Under some wet warming climate scenarios, flooding problems could be substantial. In certain cases, major expansions of downstream floodways and alterations in floodplain land use could become desirable.

- California's water system could economically adapt to all the climate warming scenarios examined in the study. New technologies for water supply, treatment, and water use efficiency, implementation of water transfers and conjunctive use, coordinated operation of reservoirs, improved flow forecasting, and the cooperation of local regional, state and Federal government can help California adapt to population growth and global climate change. However, if these strategies are implemented, the costs of water management are expected to be high and there is likely to be less "slack" in the system compared to current operations and expectations.

Effect on the Project

As described by the projections above, overall, climate change is expected to have a greater effect in Southern California and on agricultural users than urban users in the Central Valley, which includes both the San Joaquin and Sacramento Valleys. For example, for 2020 conditions, where optimization is allowed (i.e., using the CALVIN model), scarcity is not expected to be an issue in the Sacramento Valley for both urban and agricultural users, and generally not an issue for urban users in the San Joaquin and Tulare Basins. Rather, most water scarcity will be felt by agricultural users in Southern California. However, it is expected that Southern California urban users, especially Coachella urban users, will also experience some scarcity. By the year 2050, urban water scarcity there will be almost no water scarcity north of the Tehachapi Mountains, although agricultural water scarcity could increase in the Sacramento Valley to about 2% (Medellin et al. 2006; see also Tanaka et al. 2006 and Lund et al. 2003 for further discussion of global climate change impacts on agricultural uses).

Based on the conclusions of current literature regarding California's ability to adapt to global climate change, it is reasonably expected that over time, the state's water system will be modified to be able to address the projected climate changes, e.g., under dry and/or warm climate scenarios (DWR 2006). Although coping with climate change effects on California's water supply could come at a considerable cost, based on a thorough investigation of the issue, it is reasonably expected that statewide implementation of some, if not several, of the wide variety of adaptation measures available to the state, will likely enable California's water system to reliably meet future water demands. For example, traditional water supply reservoir operations may be used, in conjunction with other adaptive actions, to offset the impacts of global warming on water supply (Medellin et al. 2006; see also Tanaka et al. 2006 and Lund et al. 2003). Other adaptive measures include better urban and agricultural water use efficiency practices, conjunctive use of surface and ground waters, desalination, and water markets and portfolios (Medellin et al. 2006; see also Lund et al. 2003, Tanaka et al. 2006). More costly statewide adaptation measures could include construction of new reservoirs and enhancements to the state's levee system (CEC 2003).
As described by Medellin et al. 2006, with adaptation to the climate, the water deliveries to urban centers are expected to decrease by only 1%, with Southern California shouldering the brunt of this decrease.

Given these projections it is difficult to scale regional and state trends down to predict specific impacts in the project vicinity. The project would rely upon surface water rights to the Sacramento River with groundwater pumping within the City of Rancho Cordova area providing backup for dry and critically dry years. As described above for the discussions of snowpack and runoff, the effect of climate change on the Sacrament River watershed remains uncertain. Different models suggest either an increase or decrease in precipitation. While an increase in precipitation may increase potential water supply, existing storage facilities may need to be expanded to effectively capture and transfer such supplies. Additionally, an increase in precipitation may not effectively increase groundwater recharge if the increase occurs during seasons when aquifers are recharging at maximum capacity. Because there is uncertainty with respect to impacts of climate change on future water availability in California, in terms of whether and where effects will occur, and the timing and severity of any such potential effect, conclusions regarding significance would therefore be too speculative for meaningful consideration.

Water Quality

Status and Trends

Water quality depends on a wide range of interacting variables, such as water temperatures, flows, runoff rates and timing, waste discharge loads, and the ability of watersheds to assimilate wastes and pollutants. Surface water quality in the Sacramento Valley has experienced substantial adverse affects from human activities, including contaminant inputs from urban, industrial, and agricultural sources; and increased temperature from removal of shading vegetation. Historic activities such as gold mining in the nineteenth century created long-term impacts on regional water quality by contributing massive quantities of silt, minerals, and, notably, mercury that has settled into river bottom sediments.

Projections

Climate change could alter numerous water quality parameters in a variety of ways. Higher winter flows could reduce pollutant concentrations (through dilution) or increase erosion of land surfaces and stream channels, leading to higher sediment, chemical, and nutrient loads in rivers (DWR 2006). Increases in water flows could also decrease chemical reactions in streams and lakes, reduce the flushing time for contaminants, and increase export of pollutants to coastal areas (Jacoby 1990, Mulholland et al. 1997, Schindler 1997). Decreased summer flows can exacerbate increases in temperature, increase the concentration of pollutants, increase flushing times, and increase salinity (Schindler 1997, Mulholland et al. 1997). Decreased surface-water flows can also reduce nonpoint-source runoff (Mulholland et al. 1997). Increased water temperatures can enhance the toxicity of metals in aquatic ecosystems (Moore et al. 1997). Increases in water temperature alone are often likely to lead to adverse changes in water quality, even in the absence of changes in precipitation (Kiparsky and Gleick 2005).

A review of potential impacts of climate change on water quality concludes that significant changes in water quality are known to occur as a direct result of short-term changes in climate (Murdoch, Baron, and Miller 2000). The review notes that water quality in ecological transition zones and areas of natural climate extremes is vulnerable to climate changes that increase temperatures or change the variability of precipitation. However, it is also argued that changes in land and resource use will have comparable or even greater impacts on water quality than changes in temperature and precipitation. A separate study concluded that changes in land use resulting from climatic changes, together with technical and regulatory actions to protect water quality, can be critical to future water conditions (Kiparsky and Gleick 2005). The net effect on water quality for rivers, lakes, and groundwater in the future is dependent not just on how climatic conditions might change, but also on a wide range of other human actions and management decisions. The most recent studies identify the likelihood that decreased runoff will interact with higher stream temperatures to exacerbate decreases in water quality (Backlund et. al. 2008:8).

Effect on the Project

Although there are various ways in which climate change could affect water quality, effects could be positive or negative depending on a variety of conditions. In addition, current water quality conditions in regional surface waters depend in large part on human activities, and this would continue into the future. The effects of climate change on water quality could be alleviated by, exacerbated by, or overwhelmed by effects directly related to localized human actions. Given the uncertainty associated with projecting the type and extent of changes in water quality attributable to climate change, including trying to project human activities, this potential climate change effect is too speculative to draw a conclusion regarding the significance of any direct effect on physical conditions in the project vicinity.

Agriculture

Status and Trends

Numerous studies indicate that climate change may have a profound effect on agriculture in California. The different climate change forecasting models predict a variety of direct and indirect effects to the sector's agronomic and economic conditions (Tanaka et al. 2006; Howitt, Tauber, and Pienaar 2003). The degree to which climate change will affect agriculture depends on a variety of factors. While there remains uncertainty about what form of climate change will occur in California, the majority of research on the subject has focused on the likelihood that a climate warming pattern will occur (DWR 2006, Lund et al. 2003). While both dry-warm or wet-warm forms of climate warming would affect Californian agriculture, dry-warm climate scenarios are expected to be the most problematic (Tanaka et al. 2006). Dry-warm climate scenarios are expected to affect agriculture at both statewide and regional scales, with the most pronounced effects occurring in the Central Valley (Zhu et al. 2006).

Potential effects include reductions in water supply and water supply reliability, increased evapotranspiration, changes in growing season, and altered crop choices (DWR 2006). As discussed in the previous sections, substantial changes may occur in terms of water supply. As a primary consumer of surface and ground water, the agricultural sector will be faced with significant challenges in the event of supply reductions. Higher levels of evapotranspiration would result from the increased temperatures and decreased humidity of a dry-warm climate scenario (Hildalgo, Cayan, and Dettinger 2005). In turn, evapotranspiration would cause increases in water demand, salt accumulation on plants, soil salinity, and additional water use for reducing saline soils (DWR 2006). Such effects could reduce productivity and create adverse economic repercussions for farmers and ranchers in the State (DWR 2006). Changes to the growing season and altered crop choices may negatively or positively affect productivity, water supply, and profitability, depending on the adaptations farmers choose (Tanaka et al. 2006). For example, the viability and profitability of different crops may change as a result of altered climate, thus changing land use patterns and water demands associated with cover crops, and total revenues.

Projections

Tanaka et al. (2006) demonstrates that agricultural water supplies in the Central Valley are expected to be affected by climate change. In the driest, warmest climate scenario (PCM2100), Central Valley water users would be adversely affected and agricultural water deliveries could be expected to decrease by approximately 24% and water scarcity costs would be $1.7 billion. (Tanaka et al. 2006).

Water scarcity is expected to increase due to both the effects of global climate change and by the effects of population growth and associated increased water consumption. One model (CALVIN) used a dry and warm form of climate change and 2050 population projections. This model determined that water scarcity north of the Tehachapi Mountains (San Joaquin and Sacramento Valleys) was demonstrated to be predominately driven by climate change effects. (Tanaka et al. 2006, Zhu et al. 2006.)

A 15% increase in land fallowing is expected to occur under a dry and warm climate scenario. Land fallowing would reduce agricultural productivity and affect the agricultural economy as well as the rural support economies. Financial implications for individual farm owners would depend on whether compensation was provided for land becoming fallow (Howitt, Tauber, and Pienaar 2003; Tanaka et al. 2006).

Most year 2100 models indicate increased market water transfers from agriculture to urban users (Tanaka et al. 2006). Sector productivity could be maintained if water transfers were balanced with irrigation efficiency improvements.

Though a dry-warm climate scenario would reduce agricultural water deliveries (24% statewide and 26% in the San Joaquin Valley), models demonstrate that agricultural income will only be reduced by 6% and irrigated lands will only be reduced by 15%. It is expected that farmers will adopt changes in crop mix, cropping systems, and irrigation technology. These adaptations are likely to reduce the effect of reduced water deliveries on agriculture (Tanaka et al. 2006).

Increased evapotranspiration rates could have a considerable effect on agricultural water demand in the State (DWR 2006). The International Panel on Climate Change expects a 3 degree Celsius increase in temperature over the next century (IPCC 2007). Research demonstrates that such an increase in temperature will likely result in a 5% increase in plant transpiration, assuming no change in solar radiation (cloudiness) levels and other related variables including wind, humidity, and minimum temperature (Hildalgo, Cayan, and Dettinger 2005). Therefore, evapotranspiration alone could create a 5% increase in agricultural water consumption over the next 100 years or a 0.5% increase per decade. Projected increases in carbon dioxide concentrations are expected to increase plant growth by up to 20% and in turn lead to increased evapotranspiration (Long et al. 2004). A caveat to this is that increased atmospheric carbon dioxide concentrations may work to decrease plant stomatal transpiration rates and thus reduce overall evapotranspiration rates (Ibid).

Effect on the Project

The Proposed Project and action alternatives, with the exception of the No Project Alternative would not contain any agricultural uses. For this reason it is assumed that future climate change impacts on agriculture would not be directly relevant to the project. While the SPA contains grazing land that would be converted to urban uses, this land is not designated as Important Farmland, and therefore mitigation is not required. Because no comparable lands would be protected by conservation easements as mitigation, the impact of climate change on agricultural land uses would not be relevant to the efficacy of mitigation for project impacts. With regard to the No Project Alternative, while effects may occur, adaptation is also expected to allow farmers and ranchers to minimize any potential negative effect on agricultural incomes. Again, the SPA is used for grazing; the site does not contain Important Farmland. Because the potential effects of global climate change on agricultural production are highly speculative at this time, it is not possible to reach a meaningful conclusion regarding significance related to the No Project Alternative.

CONCLUSION

Seven general categories of potential effects of climate change were evaluated in this section:

- increased temperature;
- precipitation volume, type, and intensity;
- runoff volume and timing;
- water supply;
- sea level rise;
- water quality; and
- agriculture.

This analysis concludes that (1) either the climate change effect would not have the potential to substantially affect the project vicinity, or (2) because of significant uncertainty in projecting future conditions related to the climate change effect, it would be too speculative to reach a meaningful conclusion regarding the significance of any reasonably foreseeable direct impact on physical conditions in the project vicinity. Therefore, impacts are too speculative for meaningful consideration.

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