

6.13 GREENHOUSE GAS EMISSIONS AND GLOBAL CLIMATE CHANGE

6.13 GREENHOUSE GAS EMISSIONS AND GLOBAL CLIMATE CHANGE

INTRODUCTION

In California, observational trends from the last half century show warmer winter and spring temperatures, decreased spring snow levels in lower- and mid-elevation mountains, up to one month earlier snowpack melting, and flowers blooming one- to two-weeks earlier than under historical conditions.¹ Research suggests that human activities, such as the burning of fossil fuels and clearing of forests, contribute additional carbon dioxide (CO₂) and other heat trapping gas emissions into the atmosphere. Many scientists believe that the human contribution to greenhouse gas emissions in the atmosphere is contributing to a phenomenon commonly known as “the greenhouse effect” and resulting in increased average global temperatures. Future global climate change could have widespread consequences that would affect many of California’s important resources, including its water supply.

This section considers the impacts of the Regional University Specific Plan (RUSP) on greenhouse gas emissions and global climate change and the potential impacts of global climate change on the reliability of the RUSP’s anticipated water supply.

ENVIRONMENTAL SETTING

Existing Air Quality – Greenhouse Gases and Links to Global Climate Change

Various gases in the Earth’s atmosphere, classified as atmospheric greenhouse gases (GHGs), play a critical role in determining the Earth’s surface temperature. Solar radiation enters Earth’s atmosphere from space, and a portion of the radiation is absorbed by the Earth’s surface. The Earth emits this radiation back toward space, but the properties of the radiation change from high-frequency solar radiation to lower-frequency infrared radiation. Greenhouse gases, which are transparent to solar radiation, are effective in absorbing infrared radiation. As a result, this radiation that otherwise would have escaped back into space is now retained, resulting in a warming of the atmosphere. This greenhouse effect is a naturally occurring process that aids in heating the Earth’s surface and atmosphere.

Among the prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO₂), methane (CH₄), ozone (O₃), water vapor, nitrous oxide (N₂O), and chlorofluorocarbons (CFCs). Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for enhancing the greenhouse effect.² Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the industrial/manufacturing,

-
- 1 Cayan, D., E. Maurer, M. Dettinger, M. Tyree, K. Kayhoe, C. L. Bonfils, P. Duffy, and B. Santer. 2006b. Climate Scenarios for California. California Climate Change Center, White Paper CEC-500-2005-203-SF, March.
 - 2 Placer County, *Placer Vineyards Specific Plan, Second Partially Recirculated Revised Draft EIR*, April 2007.

utility, transportation, residential, and agricultural sectors.³ In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation.⁴ California is the 12th to 16th largest emitter of CO₂ in the world and produced 492 million gross metric tons of carbon dioxide equivalents in 2004.⁵

CO₂ is a byproduct of fossil fuel combustion. Methane, a highly potent GHG, results from offgassing associated with agricultural practices and landfills. Consumption of fossil fuels in the transportation sector was the single largest source of California's GHG emissions in 2004, accounting for 40.7% of total GHG emissions in the State.⁶ This category was followed by the electric power sector (including both in-state and out-of-state sources) (22.2%) and the industrial sector (20.5%).⁷ There are also natural processes that absorb and accumulate CO₂, often called CO₂ "sinks." The main removal processes are absorption by seawater and in the process of photosynthesis by ocean plankton and land-dwelling biomass, including forests and grasslands.

Different GHGs have different potential to retain infrared radiation in the atmosphere and contribute to the greenhouse effect. A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential is the "carbon dioxide equivalent." The global warming potential of a GHG is also dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. For example, CH₄ is a much more potent GHG than CO₂. As described in Appendix C, "Calculation Referenced," of the General Reporting Protocol of the California Climate Action Registry,⁸ one ton of CH₄ has the same contribution to the greenhouse effect as approximately 21 tons of CO₂. Expressing GHG emissions in carbon dioxide equivalents takes the contribution of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO₂ were being emitted.

Feedback Mechanisms and Uncertainty

Many complex mechanisms interact within Earth's energy budget to establish the global average temperature. For example, a change in ocean temperature would be expected to lead to changes in the circulation of ocean currents, which, in turn would further alter ocean temperatures. There is uncertainty about how some factors could affect global climate change because they have the potential to both enhance and neutralize future climate warming. Examples of these conditions are also described below.

- 3 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.
- 4 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.
- 5 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.
- 6 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.
- 7 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.
- 8 California Climate Action Registry. 2006 (June). California Climate Action Registry General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions. Version 2.1. Los Angeles, CA. <<http://www.climateregistry.org/docs/PROTOCOLS/GRP%20V2.1.pdf>>. Accessed January 2007.

Direct and Indirect Effect of Aerosols

Aerosols, including particulate matter, reflect sunlight back to space, thus creating a cooling effect that tempers the greenhouse effect to a degree. As particulate matter attainment designations are met, and fewer emissions of particulate matter occur, the cooling effect of anthropogenic aerosols would be reduced, and the greenhouse effect would be further enhanced. Similarly, aerosols act as cloud condensation nuclei, aiding in cloud formation and increasing cloud lifetime. Clouds can efficiently reflect solar radiation back to space (see discussion of the cloud effect below). As particulate matter emissions are reduced, the indirect positive effect of aerosols on clouds would be reduced, potentially further amplifying the greenhouse effect.

The Cloud Effect

As global temperature rises, the ability of the air to hold moisture increases, facilitating cloud formation. If an increase in cloud cover occurs at low or middle altitudes, resulting in clouds with greater liquid water content such as stratus or cumulus clouds, more radiation would be reflected back to space, resulting in a negative feedback mechanism, wherein the side effect of more cloud cover resulting from global warming acts to balance further warming. If clouds form at higher altitudes in the form of cirrus clouds, however, these clouds actually allow more solar radiation to pass through than they reflect, and ultimately they act as a GHG themselves. This results in a positive feedback mechanism in which the side effect of global warming acts to enhance the warming process. This feedback mechanism, known as the “cloud effect,” contributes to uncertainties associated with projecting future global climate conditions.

Other Feedback Mechanisms

As global temperature continues to rise, CH₄ gas currently trapped in permafrost would be released into the atmosphere when areas of permafrost thaw. Thawing of permafrost attributable to global warming would be expected to accelerate and enhance global warming trends. Additionally, as the surface area of polar and sea ice continues to diminish, the Earth’s albedo, or reflectivity, is also anticipated to decrease. More incoming solar radiation will likely be absorbed by the Earth rather than being reflected back to space, further enhancing the greenhouse effect. The scientific community is still studying these and other positive and negative feedback mechanisms to better understand their potential effects on global climate change.

REGULATORY SETTING

This section describes recent state regulations that specifically address greenhouse gas emissions and global climate change. At the time of writing, there are no regulations setting ambient air quality emissions standards for greenhouse gases.

Assembly Bill 1493

In 2002, then-Governor Gray Davis signed Assembly Bill (AB) 1493 (Stats. 2002, ch. 200) (Health & Saf. Code, §§ 42823, 43018.5). AB 1493 required that the California Air Resources Board (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 truck and other vehicles determined by the ARB to be vehicles whose primary use is noncommercial personal transportation in the state.”

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's snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the Executive Order established total greenhouse gas 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 multi-agency effort to reduce greenhouse gas emissions to the target levels. The Secretary will also submit biannual reports to the governor and state legislature describing: (1) progress made toward reaching the emission targets; (2) impacts of global warming on California's resources; and (3) mitigation and adaptation plans to combat these impacts. To comply with the Executive Order, the Secretary of the CalEPA created a Climate Act Team (CAT) made up of members from various state agencies and commissions. CAT 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 Climate Solutions Act of 2006

In September 2006, Governor Arnold Schwarzenegger signed AB 32, the California Climate Solutions Act of 2006 (Stats. 2006, ch. 488) (Health & Saf. Code, § 38500 et seq.). AB 32 requires that statewide GHG emissions be reduced to 1990 levels by the year 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 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.

Senate Bill 1368

SB 1368 (Stats. 2006, ch. 598) (Pub. Util.Code, §§ 8340-8341) is the companion bill of AB 32 and was signed by Governor Schwarzenegger in September 2006. SB 1368 requires the California Public Utilities Commission (PUC) to establish a greenhouse gas emission performance standard for baseload generation from investor owned utilities by February 1, 2007. The California Energy Commission (CEC) must establish a similar standard for local publicly owned utilities by June 30, 2007. These standards cannot exceed the greenhouse gas 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 PUC and CEC.

IMPACTS AND MITIGATION MEASURES

Methods of Analysis

Many scientists attribute to global climate change multiple adverse environmental effects, such as sea level rise, increased incidence and intensity of severe weather events (e.g., heavy rainfall, droughts), and extirpation or extinction of plant and wildlife species. Given the potential for significant adverse environmental effects linked to global climate change induced by GHGs, the emission of GHGs is considered a significant cumulative impact. Emissions of GHGs contributing to global climate change may be attributable in large part to human activities associated with the industrial/manufacturing, utility, transportation, residential, and agricultural sectors.⁹ Therefore, the cumulative global emissions of GHGs contributing to global climate change can be attributed to every nation, region, and city, and virtually every individual on Earth. The challenge in assessing the significance of an individual project's contribution to global GHG emissions and associated global climate change impacts is to determine whether a project's GHG emissions—which, it can be argued, are at a micro scale relative to global emissions—result in a cumulatively considerable incremental contribution to a significant cumulative macro-scale impact.

To determine whether the proposed project's GHG emissions result in a cumulatively considerable incremental contribution to a significant cumulative macro-scale impact, this analysis uses CO₂ emissions as a proxy for all GHG emissions. This approach is consistent with the current reporting protocol of the California Climate Action Registry (CCAR). Calculations of GHG emissions typically focus on CO₂ because it is the most commonly produced GHG in terms of both number of sources and volume generated, and because it is among the easiest GHGs to measure. However, it is important to note that other GHGs have a higher global warming potential than CO₂. For example, as stated previously, 1 lb of methane has an equivalent global warming potential of 21 lb of CO₂.¹⁰ Nonetheless, emissions of other GHGs from the RUSP project (and from almost all GHG emissions sources) would be low relative to emissions of CO₂ and would not contribute significantly to the overall generation of GHGs from the project.

Although the CCAR provides a methodology for calculating GHG emissions, the process is designed to be applied to a single or limited number of entities or operations where detailed information on emissions sources is available (e.g., usage of electricity and natural gas, numbers and types of vehicles and equipment in a fleet, type and usage of heating and cooling systems, emissions from manufacturing processes). Information at this level of detail is not available for the RUSP. For example, the ultimate GHG emissions from the 600-acre University campus could vary substantially depending on the type and number of academic facilities, such as the stadium, gym, aquatics center, and education buildings, that are developed, the density of employees and students in each facility, the hours of operation for each facility, commute times, and other factors. Similar factors would determine the ultimate GHG emissions produced by the commercial portion of the RUSP. Similarly, GHG emissions from the approximately 3,232 residences within the Community portion of the project site, and 1,155 residences within the University campus could vary substantially based on numerous factors, such as the sizes of homes and other buildings, the type and extent of energy efficiency measures that might be incorporated into home and building designs, the type and size of appliances installed in homes and other buildings, and whether solar energy facilities are included

9 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.

10 California Climate Action Registry. 2006 (June). California Climate Action Registry General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions. Version 2.1. Los Angeles, CA. <<http://www.climateregistry.org/docs/PROTOCOLS/GRP%20V2.1.pdf>>. Accessed January 2007.

on any of the residences. Given the lack of detailed design and operational information available at this time for facilities in the RUSP area, the CCAR emissions inventory methodology is not appropriate for estimating GHG emissions from the project.

The traffic analysis conducted for the project in support of the draft environmental impact report (DEIR) provides data that can be used to estimate CO₂ emissions from project-generated vehicle trips. According to the traffic analysis, at full buildout, the RUSP would generate an average of 285,650 vehicle miles traveled (VMT) per day (see Table 6.13-1), or approximately 104 million VMT annually. Assuming an emissions factor for future CO₂ emissions from vehicles of approximately 366 grams of CO₂ per mile,¹¹ approximately 42,000 tons of CO₂ per year would be generated by project-generated vehicle trips. Note that although this future CO₂ emissions factor does assume certain reductions in vehicle emissions due to future vehicle models operating more efficiently, it does not take into account additional vehicle emission reductions that might take place in response to AB 1493, if mobile source emission reductions are ultimately implemented through this legislation.

Cumulative Scenario	VMT ²		Trips/Day ^{2,3}
	Region Total	Project Contribution	
Base Year 2004 Model	7,335,890	N/A	927,868
Regional University 2025 – No Project	19,245,360	N/A	2,159,330
Regional University 2025 – Plus Project	19,441,490	285,650	2,183,780

Notes:
 1. VMT = Vehicle Miles Traveled (daily)
 2. VMT and Trip calculation does not include intrazonal trips; however, it does include external trips traveling through the region.
 3. Trips/Day include trips originating and/or terminating within region boundary; external trips traveling through the region are not included.
 Source: Fehr & Peers Associates, 2007.

It is also important to note that this CO₂ emission estimate for vehicle trips associated with the RUSP is likely much greater than the emissions that will actually occur. The analysis methodology used for the emissions estimate conservatively assumes that all emissions sources (in this case, vehicles) are new sources and that emissions from these sources are 100% additive to existing conditions. This is a standard approach taken for air quality analyses. In many cases, such an assumption is appropriate because it is impossible to determine whether emissions sources associated with a project move from outside the air basin and are in effect new emissions sources in that basin, or whether they are sources that were already in the air basin and just shifted to a new location. However, because the effects of GHGs are global, a project that merely shifts the location of a GHG-emitting activity (e.g., where people live, where vehicles drive, or where companies conduct business) without increasing total emissions would result in no net change in GHG emissions levels globally. To accurately account for carbon dioxide emissions attributable to the project, it would be necessary to differentiate between new sources that otherwise would not exist but for the project, and existing sources that have simply relocated to the project area (presumably, from any place in the world). For example, if a substantial portion of California’s population migrated from the South Coast Air Basin (managed by the South Coast Air Quality Management District) to the San Joaquin Valley Air Basin (managed by the San Joaquin Valley Air Pollution Control District), this population shift would likely result in decreased emissions in the South Coast Air Basin and increased emissions in the San Joaquin Valley Air Basin, but little change in overall global GHG emissions. However, if a person moves from one location where the land use pattern requires substantial

11 California Air Resources Board. 2002. Proposed Methodology to Model Carbon Dioxide Emissions and Estimate Fuel Economy. <<http://www.arb.ca.gov/msei/onroad/downloads/pubs/co2final.pdf>>. Accessed January 2007.

vehicle use for day-to-day activities (commuting, shopping, etc.) to a new development that promotes shorter and fewer vehicle trips, more walking, and overall less energy usage, it could be argued that the new development would result in a potential net reduction in global GHG emissions (not considering any emissions associated with the construction of new infrastructure, buildings, and other human-created features).

It is impossible to know at this time whether residents, employees, students, visitors or others in the Regional University Specific Plan Area will have longer or shorter commutes relative to their existing homes or offices; whether they will walk, bike, and use public transportation more or less than under existing circumstances; and whether their overall driving habits will result in higher or lower VMT. Much of the vehicle-generated CO₂ emissions attributed to the project could simply be from vehicles currently emitting CO₂ at an existing location moving to the project site, and not from new vehicle emissions sources relative to global climate change. Therefore, although it is not possible to calculate the net contribution of vehicle generated CO₂ emissions from the RUSP (i.e., project generated emissions minus current emissions from vehicles that would move to the project site), the net CO₂ contribution would likely be much less than the 42,000 tons of CO₂ per year calculated above.

Although the estimate of 42,000 tons of CO₂ emitted per year from project related vehicle trips is higher than would actually occur, it provides a starting point for further emissions calculations. As identified above in the “Environmental Setting” discussion, fossil fuel consumption in the transportation sector was the single largest source of California’s GHG emissions in 2004, accounting for 40.7% of total GHG emissions in the state.¹² Making the general assumption that the proportion of transportation-sector emissions from the RUSP project at buildout would be similar to the statewide results for 2004, overall CO₂ emissions from the RUSP project would be approximately 103,000 tons per year.

This figure should be considered a very general estimate providing an indication of the order of magnitude of CO₂ emissions from the RUSP. As discussed above, numerous factors that can substantially affect the project’s CO₂ emissions (structural designs, type of building occupants, hours of operation) will not be known until buildout is complete. In addition, the discussion above identifying that net/actual CO₂ emissions from project generated vehicle trips would be much less than calculated also applies to all other emission sources. Every new resident at the RUSP project site would be moving from an existing location where their activities are contributing to CO₂ emissions. It is also reasonable to expect that at least a portion of the businesses at the project site will be moving from an existing location to the project site and are not completely new business or commercial facilities. However, similar to CO₂ emissions from vehicles, it is not possible to calculate the net CO₂ emissions from other sources because information on the existing behavior of individuals or businesses that would ultimately move to the project site cannot be determined. It is unknown whether the homes into which project residents will move will be more or less energy efficient than their existing residences (though new homes are generally more efficient than older homes), how many and which types of businesses on the project site might be new facilities or relocations of existing facilities, and whether facilities and operations of relocated businesses might result in more or less overall CO₂ emissions relative to existing conditions. However, it is certain that much of the CO₂ emissions attributed to project residents and businesses will simply be from emissions sources that move from an existing location to the project site, not from new emissions sources relative to global climate change.

12 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.

Therefore, although the estimate of 103,000 tons of CO₂ emitted annually from the RUSP is very general, and is considered high, it is sufficient to support an evaluation of the project's contribution towards GHG emissions.

It should also be noted that the emissions calculations described above do not take into account reductions in GHG emissions resulting from implementation of AB 32. Stationary emissions sources on the project site and stationary sources that serve the project site (e.g., power plants) will be subject to emissions reductions requirements of AB 32. The extent of these reductions has not yet been quantified by ARB. At the time of project buildout, overall CO₂ emissions attributable to the RUSP could be substantially less than current emissions assumptions might indicate. Similarly, if GHG emissions reductions for vehicles are enacted, through either the requirements of AB 1493 or AB 32 or a federal regulation, CO₂ emissions from the RUSP would be further reduced. If regulations proposed to comply with AB 1493 survive current legal challenges, by project buildout CO₂ emissions from vehicles associated with the project could be 20% to 30% less than under current conditions. If AB 1493 is repealed, it is unclear what vehicle emissions limits might be adopted as part of AB 32.

Emissions reduction requirements associated with AB 1493 and AB 32, SB 1368, and Executive Order S-3-5 would apply throughout California. Therefore, beyond the fact that their effect on the RUSP is unclear, their effect on the overall cumulative context relative to all GHG emissions in California is unknown. Even if California meets its emissions reductions targets, such progress will not by itself significantly alter the current worldwide phenomenon of climate change, as worldwide cooperation will be necessary to achieve real progress.

Significance Criteria

Because climate change regulation is a relatively recent development, no air district in California, including the Placer County Air Pollution District, has identified a significance threshold for GHG emissions or a methodology for analyzing air quality impacts related to greenhouse gas emissions. The State has identified 1990 emission levels as a goal to be achieved through adoption of AB 32. To meet this goal, California would need to generate lower levels of GHG emissions than current levels. However, no standards have yet been adopted quantifying 1990 emission targets. It is recognized that for most projects there is no simple metric available to determine if a single project would help or hinder meeting the AB 32 emission goals. In addition, at this time, AB 32 only applies to stationary source emissions. Consumption of fossil fuels in the transportation sector accounted for over 40% of the total GHG emissions in California in 2004. Current standards for reducing vehicle emissions considered under AB 1493 call for "the maximum feasible reduction of greenhouse gases emitted by passenger vehicles and light-duty trucks and other vehicles," and do not provide a quantified target for GHG emissions reductions for vehicles.

Emitting CO₂ into the atmosphere is not itself an adverse environmental affect. In fact, the generation of CO₂ occurs naturally: natural sources of CO₂ include volcanic eruptions, decay of dead plant and animal matter, evaporation from the oceans, and respiration (breathing). It is the increased concentration of CO₂ in the atmosphere potentially resulting in global climate change and the associated consequences of climate change that result in adverse environmental affects (e.g., sea level rise, loss of snowpack, severe weather events). Although it is possible to generally estimate a project's incremental contribution of CO₂ into the atmosphere, it is typically not possible to determine whether or how an individual project's relatively small incremental contribution might translate into physical effects on the environment. Given the complex interactions between various global and regional-scale physical, chemical, atmospheric, terrestrial, and aquatic systems that result in the

physical expressions of global climate change, it is impossible to discern whether the presence or absence of CO₂ emitted by the project would result in any altered conditions.

Given the challenges associated with determining project-specific significance criteria for GHG emissions when the issue must be viewed on a global scale, a quantitative significance criterion is not proposed for the RUSP project. For this analysis, a project's incremental contribution to global climate change would be considered significant if, due to the size or nature of the project, it would generate a substantial increase in GHG emissions relative to existing conditions.

GHG Emissions Impacts

6.13-1 Development of the RUSP could potentially result in a cumulatively considerable incremental contribution to the significant cumulative impact of global climate change.

In 2003, global emissions of carbon (i.e., only the carbon atoms within CO₂ molecules) solely from fossil fuel burning totaled an estimated 7,303 million metric tons.¹³ This translates to approximately 29,400 million tons of CO₂. This is only a portion of global CO₂ emissions because it addresses only fossil fuel burning and does not address other CO₂ sources such as burning of vegetation. Total estimated CO₂ emissions from all sources associated with the RUSP would be less than 0.00035 percent of this partial global total. CO₂ emissions in California totaled approximately 391 million tons in 2004.¹⁴ Total CO₂ emissions from the RUSP project, as estimated above, would be 0.026 percent of this statewide total.

However, as noted above, the emission calculation methodology treats project emissions as if they were new emissions, and does not correct for the fact that many emission sources associated with the RUSP could simply be moving from an existing location to the project site. Therefore, the project's net contribution of CO₂ to global climate change would be much less than 103,000 tons per year estimated for the proposed project. Similarly, the project's proportion of global and statewide emissions would be less than described above.

Although it is clear that the RUSP's net contribution of CO₂ to global climate change will be less than estimate above, a great deal of uncertainty exists regarding what the net CO₂ emissions would actually be. In addition, it is uncertain how current regulations might affect CO₂ emissions attributable to the project and cumulative CO₂ emissions from other sources in the state. Also, as described previously, it cannot be determined how CO₂ emissions associated with the RUSP might or might not influence actual physical effects of global climate change. For these reasons, it is uncertain whether the RUSP would generate a substantial increase in GHG emissions relative to existing conditions, and whether emissions from the RUSP would make a cumulatively considerable incremental contribution to the significant cumulative impact of global climate change.

Notwithstanding such uncertainty, the RUSP is a relatively large project, which, if evaluated at either a local or regional scale, would emit CO₂ and other GHGs at higher volumes than many other types of development. Therefore, a conservative approach has been used for this analysis, and the RUSP

13 Marland, G., T. A. Boden, and R. J. Andres. 2006. Global, Regional, and National CO₂ Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN, Available <http://cdiac.ornl.gov/trends/emis/meth_reg.htm> accessed June 2007.

14 California Energy Commission. 2006a. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. (Staff Final Report). Publication CEC-600-2006-013-SF. <<http://www.energy.ca.gov/2006publications/CEC-600-2006-013/CEC-600-2006-013-SF.PDF>>. Accessed January 2007.

project is considered to potentially make a cumulatively considerable incremental contribution to the significant cumulative impact of global climate change.

The state's primary source of GHG emissions is the consumption of fossil energy. The proposed RUSP has several components, discussed below, that would reduce consumption of fossil energy within the Plan Area, and thereby reduce potential GHG emissions. These components are consistent with "smart growth" principles developed and promoted by the Sacramento Area Council of Governments (SACOG). SACOG smart growth principles include higher densities and compact development, diversity of land uses, neighborhoods designed to promote walking and biking, and access to regional destinations.

"Smart Growth" Factors

The proposed RUSP has several components and objectives that promote the use of alternative modes of transportation that produce fewer greenhouse gas emissions than single-occupancy vehicle travel or none at all. Portions of the proposed development have been designed to encourage walking and biking. The University campus is designed so that there is limited vehicular access. In addition, the adjoining community provides large sidewalks, multi-use trails, Class II and Class III bicycle trails, parks and open space with connectivity, traffic calming measures, and centrally located commercial areas to help promote walking and biking. The overall design and land use plan of the RUSP creates a development pattern that is more compact than most other development in Placer County. The land use plan also includes a mixed-use component, including some live-work units, which would further encourage less reliance on vehicular transportation within the community. The RUSP is located adjacent to other planned development, such as the West Roseville Specific Plan area, within the southwest Placer County. In addition, SACOG identifies the area as a prime location for dense development, due to its location near employment centers and Sacramento. These factors would help to reduce vehicle miles traveled in the region, reducing the proposed project's contribution of GHGs to the global impact. Please see Chapter 4.0, Land Use, for a more detailed discussion of SACOG smart growth principles.

Traffic Factors

Measures and design components incorporated into the project that decrease stop-and-go driving and idling at intersections will help reduce overall fuel consumption and GHG emissions. The RUSP's transportation and circulation system would also promote non-vehicular travel through the implementation of traffic calming measures that would make roads safer for pedestrians and bicyclists, and therefore promote walking and biking as the preferable means of transportation within the community, rather than vehicular transportation.

Even with the above smart growth factors and traffic design, however, the RUSP would result in a substantial amount of GHG emissions over current emissions. Because it cannot be determined to a reasonable degree of certainty that the GHG emissions generated by the RUSP would not result in a cumulatively considerable incremental contribution to the significant cumulative impact of global climate change, the impacts of the proposed project on global climate change are considered *significant*.

Mitigation Measures

Broadly speaking, climate change mitigation and adaptation strategies fall into three categories: (1) transportation sector strategies; (2) electricity sector strategies, including renewable energy and energy efficiency; and (3) all other adaptation strategies, such as carbon sequestration, participation

in emissions trading markets and research and public education.¹⁵ Implementation of the proposed project's air quality and transportation and circulation mitigation measures will also help reduce potential GHG emissions by smoothing the flow of traffic to allow engines to operate more efficiently. Improvements in vehicle efficiency and alternative fuel vehicles will also help reduce GHG emissions in the project area. Implementation of the following mitigation measures would substantially lessen greenhouse gas emissions within the Plan Area, but would not mitigate them to a level that is less than significant. Therefore, this impact would remain **significant and unavoidable**.

- 6.13-1 a) *Implement Mitigation Measure 6.3-4(a), establishing guidelines for County review of future project-specific submittals for non-residential development within the Specific Plan area in order to reduce generation of air pollutants.*
- b) *Implement Mitigation Measure 6.3-4(b), requiring incorporation of passive solar building design and landscaping conducive to passive solar energy use.*
- c) *Implement Mitigation Measure 6.3-4(c), requiring measures to promote bicycle usage.*
- d) *The following measures shall be used singularly or in combination to accomplish an overall reduction of 10 to 20% in residential energy consumption relative to the requirements of State of California Title 24:*
- *Use of air conditioning systems that are more efficient than Title 24 requirements;*
 - *Use of high-efficiency heating and other appliances, such as water heaters, cooking equipment, refrigerators, and furnaces;*
 - *Installation of photovoltaic rooftop energy systems where feasible; and*
 - *Establishment of tree-planting guidelines that require residents to plant trees to shade buildings primarily on the west and south sides of the buildings. Use of deciduous trees (to allow solar gain during the winter) and direct shading of air conditioning systems shall be included in the guidelines.*
- e) *Transit usage and ride sharing shall be promoted by requiring participation in the development of a regional transit system at such time as a system is established and set-asides of land for park-and ride facilities. Fair share participation may consist of dedication of right-of-way, easements, capital improvements, and/or other methods of participation deemed appropriate. In addition, future project design shall ensure that an adequate number of developers in the plan area provide reservations for future installations of bus turnouts and passenger benches and shelters, to be installed at such time as transit service is established and as demand and service routes warrant. Transit centers shall be connected with the Class I bicycle trail. A public transit development fee may be required for all development projects. The amount of this fee shall be based upon the traffic generation potential of each project. A dial-a-ride transportation system may be established to reduce individual vehicle trips and establish data for the eventual formation of a transit system within the plan area.*

15 California Energy Commission (CEC). 2003. Climate Change and California Staff Report. Prepared in Support of the 2003 Integrated Energy Policy Report Proceeding (Docket # 02—IEO-01).

In addition, the applicant or its successor(s) in interest shall provide each home and business with an information packet that will contain, at a minimum, the following information:

- *Commute options: to inform plan area occupants of the alternative travel amenities provided, including ridesharing and public transit availability/schedules;*
 - *Maps showing plan area pedestrian, bicycle, and equestrian paths to community centers, shopping areas, employment areas, schools, parks, and recreation areas; and*
 - *Information regarding PCAPCD programs to reduce county-wide emissions.*
- f) *Developers of both public and private schools shall be encouraged to incorporate the following measures into the design, construction, and operation of school buildings and facilities:*
- *Install bicycle lockers and racks at all appropriate locations;*
 - *Post signage prohibiting the idling of diesel vehicles for longer than five minutes;*
 - *Construct at least one bus stop at a convenient location to be used for either fixed route service within the plan area or commuter service;*
 - *Provide a community notice board and information kiosk with information about community events, ride-sharing, and commute alternatives;*
 - *Provide preferential parking for carpools and hybrid vehicles (vehicles with self-charging electric engines); and*
 - *Incorporate solar water heating systems and HVAC PremAir or similar catalyst systems in building design.*
- g) *The following measures shall be incorporated into the design, construction, and operation of public park areas:*
- *The pedestrian/bikeway (P/B) master plan shall provide at least one Class I linkage to all school sites;*
 - *Additional Class I and II linkages shall be provided to provide convenient access to/from the park sites;*
 - *Install bicycle lockers and racks at all appropriate locations; and*
 - *Provide a community notice board and information kiosk with information about community events, ride-sharing, and commute alternatives.*
- h) *Prohibit open burning throughout the plan area. Include this prohibition in any project CC&Rs that are established.*
- i) *Implement Mitigation Measures 6.12-1 through 6.12-26 to ease traffic congestion, in order to provide a pedestrian and bicycle-safe transportation and circulatory system within the Plan Area, thereby increasing the chance that residents will walk and ride within the RUSP.*
- j) *Placer County and the project applicant shall work together to publish and distribute an Energy Resource Conservation Guide describing measures individuals can take*

to increase energy efficiency and conservation. The applicant shall provide a portion of the funding necessary to prepare the Guide, along with the developers of other projects in the region. The Energy Resource Conservation Guide shall be updated every 5 years and distributed at the public permit counter.

- k) *The project applicants shall pay for an initial installment of Light Emitting Diode (LED) traffic lights in all Plan Area traffic lights.*
- l) *The project applicants and Placer County shall jointly develop a tree planting informational packet to help project area residents understand their options for planting trees that can absorb carbon dioxide.*
- m) *Prioritized parking within commercial and retail areas shall be given to electric vehicles, hybrid vehicles, and alternative fuel vehicles.*

EFFECTS OF GLOBAL CLIMATE CHANGE ON WATER RESOURCES

Global climate change is projected to affect water resources in California. For example, an increase in the global average temperature is projected to result in a decreased volume of precipitation falling as snow in California and an overall reduction in snowpack in the Sierra Nevada. Snowpack in the Sierra Nevada provides both water supply (runoff) and storage (within the snowpack before melting), and is a major source of supply for the state. Although current forecasts vary,¹⁶ this phenomenon could lead to significant challenges in securing an adequate water supply for a growing population and California's agricultural industry. An increase in precipitation falling as rain rather than snow could also lead to increased potential for floods because water that would normally be held in the Sierra Nevada until spring could flow into the Central Valley concurrently with winter storm events. This scenario would place more pressure on California's levee/flood control system.

Global climate change is expected to influence many interconnected phenomena, which will in turn affect the rate of climate change itself. Faced with this overwhelmingly complex system, scientists who model climate change must make decisions about how to simplify the phenomenon, such as assuming a fixed rate of temperature change or a certain level of aerosol production or a particular theory of cloud formation. These assumptions make the models applicable to particular aspects of the changing ecosystem, given a good guess about how the future will be. Rather than try to be predictive, the models represent possible scenarios that come with a set of presuppositions. Even when results are quantified, such quantifications are meaningless unless viewed in the light of those presuppositions. For these reasons, a range of models must be examined when trying to assess the potential effects of climate change and the resulting analysis is most appropriately qualitative.¹⁷ This section, therefore, provides a qualitative analysis of the impacts of global climate change as they affect water resources in California and in the Specific Plan area.

16 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.

17 Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA 881 pages <http://www.grida.no/climate/ipcc_tar/wg1/index.htm> Accessed February. 2007.

Climate Change and Potential Impacts on California Water Resources of Significance to Placer County

From a statewide perspective, global climate change could affect California's environmental resources through potential, though uncertain, changes related to future air temperatures and precipitation and their resulting impacts on water temperatures, reservoir operations, stream runoff, and sea levels.¹⁸ These changes in hydrological systems could threaten California's economy, public health, and environment.¹⁹ The types of potential climate effects that could occur on California's water resources include those discussed below.

Water Supply. Several recent studies have shown that existing water supply systems are sensitive to climate change.²⁰ Potential impacts of climate change on water supply and availability could directly and indirectly affect a wide range of institutional, economic, and societal factors.²¹ 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.²² Both projections are equally probable based on which model is chosen for the analyses.²³ Much uncertainty also exists with respect to how climate change will affect future demand of water supply.²⁴ 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.^{25,26}

Surface Water Quality. Global climate change could affect surface water quality as well. Water quality is affected by several variables, including the physical characteristics of the watershed, water temperature, and runoff rate and timing. A combination of a reduction in precipitation, the shift in volume and timing of runoff flows, and the increased temperature in lakes and rivers could affect a number of natural processes that eliminate pollutants in water bodies. For example, the overall decrease in stream flows could potentially concentrate pollutants and prevent the flushing of contaminants from point sources. The increased storm flows could tax urban water systems and

-
- 18 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 19 California Energy Commission (CEC). 2003. Climate Change and California Staff Report. Prepared in Support of the 2003 Integrated Energy Policy Report Proceeding (Docket # 02—IEO-01).
- 20 Wood, A.W., and R.N. Palmer. 1997. Assessing Climate Change Implications for Water Resources Planning. *Climatic Change* 37:203-228.
- 21 Gleick, P.H. 1997. Water Planning and Management Under Climate Change.
- 22 Brekke, L.D., N.L. Miller, K. E. Bashford, N. W. T. Quinn, and J.A. Dracup 2004. Climate Change Impacts Uncertainty for Water Resources in the San Joaquin River Basin, California. *Journal of the American Water Resources* 40(1):149-164.
- 23 Brekke, L.D., N.L. Miller, K. E. Bashford, N. W. T. Quinn, and J.A. Dracup 2004. Climate Change Impacts Uncertainty for Water Resources in the San Joaquin River Basin, California. *Journal of the American Water Resources* 40(1):149-164.
- 24 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 25 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 26 Cayan, D., A.L. Luers, M. Hanemann, G. Granco, and B. Croes. 2006a. Scenarios of Climate Change in California: An Overview. California Climate Change Center, White Paper, CEC-500-2005-186-SF, March.

cause greater flushing of pollutants to the Sacramento-San Joaquin Delta and coastal regions.²⁷ Still, considerable work remains to determine the potential effect of global climate change to water quality.

Groundwater. Little work has been done on the effects of climate change on specific groundwater basins, groundwater quality or groundwater recharge characteristics.²⁸ 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 extent to which climate 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.²⁹

Fisheries and Aquatic Resources. In California, the timing and amounts of water released from reservoirs and diverted from streams are constrained by their effects on various native fish, especially those that are listed under the federal and state endangered species acts as threatened or endangered. Several potential hydrological changes associated with global climate change could influence the ecology of aquatic life in California and have several negative effects on cold-water fish.³⁰ For example, if climate change raises air temperature by just a few degrees Celsius, this change could be enough to raise the water temperatures above the tolerance of salmon and trout in many streams, favoring instead non-native fishes such as sunfish and carp.³¹ Unsuitable summer temperatures would be particularly problematic for many of the threatened and endangered fish that spend summers in cold-water streams, either as adults, juveniles, or both.³² In short, climate change could significantly affect threatened and endangered fish in California. It could also cause non-threatened and non-endangered fish to reach the point where they become designated as such.³³

Sea Levels. Global climate change could cause thermal expansion of ocean waters and melting of ice from land surfaces, which in turn could cause sea levels to rise. Among the risks of sea level rise

-
- 27 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 28 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 29 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 30 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 31 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 32 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 33 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.

would be threats to levee integrity and tidal marshes and increased salinity in the Delta region.³⁴ The increased intrusion of salinity from the ocean could degrade freshwater supplies pumped from the Delta, which could require increased freshwater releases from upstream reservoirs to maintain compliance with water quality standards.³⁵

Flood Control. It is difficult to assess implications of climate change for flood frequency, in large part because of the absence of detailed regional precipitation information from climate models and because human settlement patterns and water-management choices can substantially influence overall flood risk.³⁶ Still, increased amounts of winter runoff could be accompanied by increases in flood event severity and warrant additional dedication of wet season storage space for flood control as opposed to supply conservation. This need to manage water storage facilities to handle increased runoff could in turn lead to more frequent water shortages during high water demand periods.³⁷ It is recognized that these impacts would result in increased challenges for reservoir management and balancing the competing concerns of flood protection and water supply.³⁸

Sudden Climate Change. Most global climate models project that anthropogenic climate change will be a continuous and fairly gradual process through the end of this century.³⁹ California is expected to be able to adapt to the water supply challenges posed by climate change, even at some of the warmer and dryer projections for change. Sudden and unexpected changes in climate, however, could leave water managers unprepared and could, in extreme situations, have significant implications for California and its water supplies. For example, there is speculation that some of the recent droughts that occurred in California and the western United States could have been due, at least in part, to oscillating oceanic conditions resulting from climatic changes. The exact causes of these events are, however, unknown, and evidence suggests such events have occurred during at least the past 2000 years.⁴⁰

Climate Change Studies for the Central Valley of California

The following survey summarizes current literature related to the impact of global climate change on water resources in California's Central Valley.

-
- 34 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 35 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 36 Kiparsky, M. and P.H. Gleick. 2003. Climate Change and California Resources: A Survey and Summary of the Literature. The California Water Plan, Volume 4 – Reference Guide. Oakland, CA: Pacific Institute for Studies in Development, Environment, and Security.
- 37 Brekke, L.D., N.L. Miller, K. E. Bashford, N. W. T. Quinn, and J.A. Dracup 2004. Climate Change Impacts Uncertainty for Water Resources in the San Joaquin River Basin, California. *Journal of the American Water Resources* 40(1):149-164.
- 38 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 39 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 40 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.

Progress on Incorporating Climate Change into Management of California's Water Resources: Preliminary Climate Change Impacts Assessment for CVP/SWP Operations

The California Department of Water Resources (DWR)⁴¹ describes progress made in integrating climate change into existing water resources planning and management techniques and methodologies. The report was prepared in response to Executive Order S-3-05 and as an opportunity to begin addressing limitations of the 2005 Update to the DWR California Water Plan. Chapters 4 and 5 of that document are of particular relevance because they focus on climate change impacts on SWP (State Water Project) and CVP (Central Valley Project) operations and on the Delta.

The purpose of the report is to demonstrate how various analysis tools currently employed by DWR could be used to address climate change issues. As DWR explains, all results presented in the report are preliminary and incorporate several assumptions. The results reflect only a limited number of climate change scenarios and do not address the probability of each scenario. DWR cautions, therefore, that the results are not sufficient alone to provide a basis for policy decisions.⁴²

The results of this analysis suggest several climate change impacts on overall SWP and CVP operations and deliveries. In three of the four climate scenarios simulated, CVP north-of-Delta reservoirs experienced shortages during droughts. DWR recommends that future studies examine operational changes that could avoid these shortages. At present, concludes DWR, it is not clear whether such operational changes would be insignificant or substantial. The study also found that changes in annual average SWP south-of-Delta "Table A" deliveries ranged from a slight increase of about 1% for a wetter scenario to about a 10% reduction for one of the drier scenarios. ("Table A" refers to the maximum amounts of water to which State Water Contractors are entitled annually under their water supply contracts with DWR. Such amounts are rarely delivered due to a variety of factors.) Under the three drier scenarios, increased winter runoff and lower Table A allocations resulted in somewhat higher annual average Article 21 deliveries. (Article 21 refers to a provision in State Water Contracts as modified pursuant to the 1995 "Monterey Agreement" between DWR and its contractors. Article 21 allows for delivery of water in excess of Table A amounts when excess water is available in the Delta.) The increase in Article 21 deliveries did not fully offset losses to Table A. In contrast, the wetter scenario with higher Table A allocations results in fewer Article 21 delivery opportunities and decreased annual average Article 21 deliveries. Changes in annual average CVP south-of-Delta deliveries ranged from increases of about 2.5% for the wetter scenario and decreases of up to 10 % for drier scenarios. Future studies will have to address how north-of-Delta shortages could impact south-of-Delta CVP deliveries. For both the SWP and CVP, carryover storage (i.e. water stored from one year over the next) was negatively affected in the drier scenarios and slightly increased in the wetter scenario.

Climate Warming and Water Management Adaptation for California

Tanaka et al.⁴³ explore 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

-
- 41 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 42 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 43 Tanaka, S.K., T. Zhu, J.R. Lund, R.E. Howitt, M.W. Jenkins, M.A. Pulido, M. Tauber, R.S. Ritzema, and I.C. Ferreira. 2006. Climate Warming and Water Management Adaptation for California. *Climatic Change*, Vol. 76, No. 3-4, June 10.

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 Valley agricultural water deliveries and a rise in Valley water scarcity costs by \$1.7 billion. Though 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." Such adaptation would entail changes in California's groundwater storage capacity, water transfers, and adoption of new technology.

Simulated Hydrologic Responses to Climate Variations and Change in the Merced, Carson, and America River Basins, Sierra Nevada, California, 1900-2099

Hydrologic responses of river basins in the Sierra Nevada to historical and future climate changes are assessed by Dettinger et al.⁴⁴ A historical run showed stationary climate and hydrologic variations through the first part of the 20th century until roughly 1975 when temperatures began to warm noticeably and snowmelt and snowflow peaks began to occur progressively earlier. A business-as-usual run (i.e., assuming no successful societal efforts to reduce GHG emissions) showed a continuance of the historical trend though the 21st century with an attendant +2.5EC warming and a hastening of snowmelt and streamflow within the seasonal cycle by almost one month. In contrast, the future control run, in which GHG concentrations were fixed at 1995 levels, showed climate and streamflow timing conditions very similar to those of the 1980s and 1990s throughout its duration.

Potential Implications of PCM Climate Change Scenarios for Sacramento-San Joaquin River Basin Hydrology and Water Resources

VanRheenen et al.⁴⁵ study 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 concludes 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 (i.e., increased storage, conveyance, and groundwater recharge facilities) 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.

Estimated Impacts of Climate Warming on California Water Availability Under Twelve Future Climate Scenarios

Zhu et al.⁴⁶ study 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. Approximate changes in water availability are estimated for each

-
- 44 Dettinger, M.D., D.R. Cayan, M.K. Meyer, and A.E. Jetton. 2004. Simulated Hydrologic Responses to Climate Variations and Change in the Merced, Carson, and American River Basins, Sierra Nevada, California, 1900-2099. *Climatic Change* 62:283-317.
- 45 VanRheenen, N.T., A.W. Wood, R.N. Palmer, and D.P. Lettenmaier. 2004. Potential Implications of PCM Climate Change Scenarios for Sacramento-San Joaquin River Basin Hydrology and Water Resources. *Climatic Change*, 62:257-281.
- 46 Zhu, T., M. W. Jenkins, and J.R. Lund. (in press). Estimated Impacts of Climate Warming on California Water Availability Under Twelve Future Climate Scenarios. *Journal of the American Water Resources Association*, Paper No. 03139.

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.

Trends in Snowfall versus Rainfall in the Western United States

To better understand the nature of the observed changes in snowpack and streamflow timing in the west, Knowles et al.⁴⁷ address historical changes in the relative contributions of rainfall and snowfall. The study documents a regional trend toward smaller ratios of winter-total snowfall water to winter-total precipitation during the period of 1949-2004. The trends toward decreased winter-total snowfall are a response to warming across the region, with the most significant decreases occurring where winter wet-day minimum temperatures were on average warmer than -5 degrees C. The authors suggest that, if warming trends continue, the snowfall fraction of precipitation is likely to continue to decline, which combined with earlier melting of the remaining accumulations of snowpack, will diminish the West's natural freshwater storage capacity. This trend could, in turn, exacerbate tensions between flood control and storage priorities that many western reservoir managers face.

Climate Change Impacts on Water for Agriculture in California: A Case Study in the Sacramento Valley

Joyce et al.⁴⁸ employ the Water Evaluation and Planning (WEAP) system, a hydrologic model that was developed for the Sacramento River Basin. The study found that increasing temperatures could put a strain on the basin's water resources. Assuming an increasing urban demand for water, the effects of climate change could be mitigated if the agricultural sector adapts to the new environment. The authors considered the effect of increased irrigation efficiency and shifts in cropping and found that groundwater pumping between 2070 and 2100 was reduced when these practices were adopted.

Climate Warming and Water Supply Management in California

Medellin et al.⁴⁹ use the CALVIN model under a high emissions "worst case" scenario, called a dry-warming scenario. Under this modeling scenario, climate change would reduce water deliveries 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.

47 Knowles, N.; Dettinger, M.D.; Cayan, D.R.; *Trends in Snowfall versus Rainfall for the Western United States*; American Geophysical Union, Fall Meeting 2005, abstract #GC21A-08, December 2005.

48 Joyce, B., S. Vicuña, L. Dale, J. Dracup, M. Hanemann, D. Purkey, D. and Yates. 2006. *Climate Change Impacts on Water for Agriculture in California: A Case Study in the Sacramento Valley*. California Climate Change Center, White Paper, CEC-500-2005-194-SF, March.

49 Medellin, J., J. Harou, M. Olivares, J. Lund, R. Howitt, S. Tanaka, M. Jenkins, K. Madani. *Climate Warming and Water Supply Management in California*. California Climate Change Center, White Paper CEC-500-2005-195-SF, March.

Climate Scenarios for California

Cayan et al.⁵⁰ consider two GHG emissions scenarios, a medium-high and a low. The study found that California could experience a warming trend from 2000 to 2100, with temperatures rising between 1.7 and 5.8° C, depending on the model and the scenario chosen. This increase in temperature could potentially impact snowpack levels as the state experiences less snow and more rain. The results also indicate that snowpack in the Sierra Nevada could be reduced 32 percent to 79 percent, depending on the model and scenario chosen. The study does not consider the ability of California's water supply system to adapt to these potential changes.

Our Changing Climate - Assessing the Risks to California, California Climate Change Center 2006 Biennial Report

In 2003, the California Energy Commission'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 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 is the product of a multi-institution collaboration among the California Air Resources Board, DWR, CEC, CalEPA and the Union of Concerned Scientists.

With respect to the most severe consequences of global climate change on California's water supplies, the study concludes 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.

Climate Warming and California's Water Future

Lund et al.⁵¹ examine the effects of a range of climate warming estimates on the long-term performance and management of California's water system. The study estimates 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 as follows:

- Methodologically, it is useful and realistic to include a wide range of hydrologic effects, changes in population and water demands, and changes in system operations in climate change studies;
- 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 twenty-first century;

50 Cayan, D., E. Maurer, M. Dettinger, M. Tyree, K. Kayhoe, C. L. Bonfils, P. Duffy, and B. Santer. 2006b. Climate Scenarios for California. California Climate Change Center, White Paper CEC-500-2005-203-SF, March.

51 Lund, J.R., R.E. Howitt, M.W. Jenkins, T. Zhu, S.K. Tanaka, M. Pulido, M. Tauber, R. Ritzema, I. Ferreira (2003). "Climate Warming and California's Water Future," Center for Environmental and Water Resources Engineering Report No. 03-1 Dept. of Civil and Environmental Engineering, University of California, Davis, California, <<http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/>> Accessed February 2007.

- 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 quite 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;
- 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; or
- 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. Even if these strategies are implemented, however, 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.

IMPACTS AND MITIGATION MEASURES

Standards of Significance

Based on Appendix G of the CEQA Guidelines, Placer County has determined that a significant environmental impact could occur if the proposed Specific Plan would:

- Require or result in the construction of new water treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Have insufficient water supplies available to serve the project from existing entitlements and resources, or new or expanded entitlements are needed.
- Substantially deplete groundwater supplies.
- Be inconsistent with the goals and policies of the *Placer County General Plan* adopted for the purpose of avoiding or mitigating environmental effects.
- Be inconsistent with the applicable terms of the Water Forum Agreement (WFA) (January 2000).

The source of the proposed surface water supply and hydrologic-related impacts are discussed in Section 6.14, Water Supply, of the Draft EIR (DEIR).

6.13-2 The impacts of global climate change on water supply and availability could affect future water supply and availability in the Plan Area.

Because considerable uncertainty remains with respect to the overall impact of global climate change on future water supply in California, it is unknown to what degree global climate change will impact future Placer County water supply and availability. However, based on consideration of the recent regional and local climate change studies described in the literature review above, and based on an assessment of water supply under the RUSP, it is reasonably expected that the impacts of global climate change on water supply would be *less than significant*.

As described by the literature survey above, overall, climate change is expected to have a greater effect in Southern California and agricultural users than urban users in the Sacramento Valley/Sierra Nevada area. For example, for 2020 conditions, where optimization is allowed (i.e., using the CALVIN model), scarcity is essentially zero in the Sacramento Valley for both urban and agricultural users, and generally zero for urban users in the San Joaquin and Tulare Basins. Rather, most water scarcity will be felt by agricultural users in Southern California, though Southern California urban users, especially Coachella urban users, will also experience some scarcity. By the year 2050, urban water scarcity will remain almost entirely absent north of the Tehachapi Mountains, although agricultural water scarcity could increase in the Sacramento Valley to about 2%.⁵²

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 handle the projected climate changes, even under dry and/or warm climate scenarios.⁵³ 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.^{54,55,56} Other adaptive measures include better urban and agricultural water use efficiency practices, conjunctive

-
- 52 Medellin, J., J. Harou, M. Olivares, J. Lund, R. Howitt, S. Tanaka, M. Jenkins, K. Madani. Climate Warming and Water Supply Management in California. California Climate Change Center, White Paper CEC-500-2005-195-SF, March.
- 53 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 54 Medellin, J., J. Harou, M. Olivares, J. Lund, R. Howitt, S. Tanaka, M. Jenkins, K. Madani. Climate Warming and Water Supply Management in California. California Climate Change Center, White Paper CEC-500-2005-195-SF, March.
- 55 Tanaka, S.K., T. Zhu, J.R. Lund, R.E. Howitt, M.W. Jenkins, M.A. Pulido, M. Tauber, R.S. Ritzema, and I.C. Ferreira. 2006. Climate Warming and Water Management Adaptation for California. Climatic Change, Vol. 76, No. 3-4, June 10.
- 56 Lund, J.R., R.E. Howitt, M.W. Jenkins, T. Zhu, S.K. Tanaka, M. Pulido, M. Tauber, R. Ritzema, I. Ferreira (2003). "Climate Warming and California's Water Future," Center for Environmental and Water Resources Engineering Report No. 03-1 Dept. of Civil and Environmental Engineering, University of California, Davis, California, <<http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/>> accessed February 2007.

use of surface and ground waters, desalination, and water markets.^{57,58,59} More costly statewide adaptation measures could include construction of new reservoirs and enhancements to the state's levee system.⁶⁰ 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.⁶¹

Although California could potentially experience an increased number of single-dry and multiple-dry years as a result of global climate change, based on current knowledge, it is reasonably expected that such increase would not significantly affect the ability of the Placer County Water Agency (PCWA), with its very substantial upstream storage capacity, to reliably meet the RUSP's build-out water demands. As described by the PCWA Integrated Water Resources Plan (IWRP), PCWA's use of an integrated resources approach will ensure that there is adequate water supply to reliably meet all the projected PCWA western Placer County service area demands, including those of the proposed project, even under single-year and multiple year drought conditions.⁶²

Importantly, each of PCWA's surface water supply entitlements for use in western Placer County has historically demonstrated a high reliability during even multiple-dry years. PCWA's first source of surface water supply is a water supply contract with PG&E for 100,400 acre feet annually (afa) of Yuba/Bear River Water that is delivered through PG&E's Drum Spaulding hydro system. This source of water has a high reliability during normal, single-dry, and multiple-dry years. For example, between 1987 and 1992, California experienced five years of drought, during which many areas in the state had reduced supplies. During that period, PCWA had a full Yuba/Bear River supply each year. Indeed, the only year in which PCWA had to impose drought restrictions on its customers due to reduced PG&E supply was 1977, the driest single year in California's measured hydrologic record. PCWA's second source of water supply (i.e., Middle Fork Project water rights) also has high reliability during even multiple-dry years. Finally, the Agency's third source of surface water (i.e., its federal CVP Municipal and Industrial water supply contract), currently anticipated to be exercised on the Sacramento River, should also be a reliable source of water because under the Agency's Integrated Water Resources Plan, the Agency plans to supplement its CVP contract supply with groundwater in dry years to improve reliability to the point where the full contract amount can be relied upon to serve urban development needs. See below for a discussion of climate change impacts on groundwater supply.

-
- 57 Medellin, J., J. Harou, M. Olivares, J. Lund, R Howitt, S. Tanaka, M. Jenkins, K. Madani. Climate Warming and Water Supply Management in California. California Climate Change Center, White Paper CEC-500-2005-195-SF, March.
- 58 Lund, J.R., R.E. Howitt, M.W. Jenkins, T. Zhu, S.K. Tanaka, M. Pulido, M. Tauber, R. Ritzema, I. Ferreira (2003). "Climate Warming and California's Water Future," Center for Environmental and Water Resources Engineering Report No. 03-1 Dept. of Civil and Environmental Engineering, University of California, Davis, California, <<http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/>> accessed February 2007.
- 59 Tanaka, S.K., T. Zhu, J.R. Lund, R.E. Howitt, M.W. Jenkins, M.A. Pulido, M. Tauber, R.S. Ritzema, and I.C. Ferreira. 2006. Climate Warming and Water Management Adaptation for California. Climatic Change, Vol. 76, No. 3-4, June 10.
- 60 California Energy Commission (CEC). 2003. Climate Change and California Staff Report. Prepared in Support of the 2003 Integrated Energy Policy Report Proceeding (Docket # 02—IEO-01).
- 61 Medellin, J., J. Harou, M. Olivares, J. Lund, R Howitt, S. Tanaka, M. Jenkins, K. Madani. Climate Warming and Water Supply Management in California. California Climate Change Center, White Paper CEC-500-2005-195-SF, March.
- 62 Although the IWRP does not specifically address the effects of global climate change on Placer County's water supply, the IWRP, together with the water supply analysis contained in the DEIR, represent the best available information regarding the effects of single-dry and multiple-dry years on Placer County water supply. For that reason, this analysis relies on the IWRP and the DEIR, in addition to the climate change studies described in this report.

In addition, PCWA's surface water supply entitlements are unlikely to be affected by global climate change because, as indicated by preliminary results from DWR,⁶³ water supply impacts from climate change would be largely reflected in reduced south-of-Delta exports, while existing Delta water quality requirements would continue to be satisfied. It is therefore reasonable to consider that global climate change may have relatively less effect on the Placer County water supply because the PCWA's surface water supplies are based on existing water rights and contract entitlements for in-basin use above the Delta.

Based on current knowledge, global climate change is also not expected to significantly impact groundwater supply for the Plan Area. Western Placer County lies within the northeastern section of the North American Groundwater sub-basin, which lies in the eastern central portion of the Sacramento Groundwater Basin. Preliminary studies indicate that the Sacramento Valley would experience only a small decline in groundwater levels as a result of global climate change.⁶⁴ Although groundwater may be used to supplement surface water supply to the Plan Area during dry years, it is unlikely that such future groundwater pumping would exceed safe yield. The PCWA integrated water resources strategy anticipates that groundwater pumping would not exceed safe yield as long as the long-term (multiple years) average does not exceed 95,000 ac-ft/yr. Although, as discussed above, there is still a great deal of uncertainty with respect to impacts of climate change on future groundwater availability in California, in view of the high reliability of PCWA surface water supplies and the wide variety of integrated water management techniques available to PCWA, long-term average groundwater pumping is not reasonably expected to exceed the 95,000 ac-ft/yr average. Moreover, the planned replacement of agricultural lands in western Placer County with urban development is expected to result in an in-lieu groundwater recharge, thereby further reducing the likelihood of a groundwater overdraft. The impacts of global climate change on groundwater in western Placer County are, therefore, reasonably considered less than significant.

For these reasons, impacts of global climate change on water supply for proposed project are considered ***less than significant***.

Mitigation Measures

None Required.

-
- 63 California Department of Water Resources (DWR). 2006. Progress of Incorporating Climate Change into Management of California's Water Resources, Technical Memorandum Report.
- 64 Vicuña S. 2006. Predictions of Climate Change Impacts of California Water Resources Using CalSim II: A Technical Note. California Climate Change Center, White Paper CEC-500-2005-206-SF, March.