06 CLIMATE CHANGE

INTRODUCTION TO CLIMATE CHANGE AND GLOBAL WARMING

The principal greenhouse gases (GHGs) that enter the atmosphere because of human activities are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. From 1750 to 2014, concentrations of CO_2, CH_4, and N_2O have increased globally by 43, 160, and 21 percent, respectively. Other greenhouse gases, such as fluorinated gases, are created and emitted solely through human activities (EPA 2016). Carbon dioxide is the gas that is most commonly referenced when discussing climate change because it is the most commonly emitted gas. While some of the less common gases do make up less of the total greenhouse gases emitted to the atmosphere, some have a greater climate-forcing effect per molecule and/or are more toxic than carbon dioxide.

CARBON DIOXIDE

Carbon dioxide emissions are mainly associated with combustion of carbon-bearing fossil fuels such as gasoline, diesel, and natural gas used in mobile sources and energy-generation-related activities. The U.S. EPA estimates that CO_2 emissions accounted for 76% of greenhouse gas emissions in the United States in 2014 (EPA 2016). The California Energy Commission (CEC) estimates that CO_2 emissions associated with fossil fuel combustion account for 84.3% of California’s anthropogenic (manmade) greenhouse gas emissions (CARB 2016). Total CO_2 emissions in the United States increased by 9% from 1990 to 2014 (EPA 2016).

METHANE

CH_4 has both natural and anthropogenic sources. Landfills, natural gas distribution systems, agricultural activities, fireplaces and wood stoves, stationary and mobile fuel combustion, and gas and oil production fields categories are the major sources of these emissions (EPA 2006). The U.S. EPA estimates that CH_4 emissions accounted for 7.9% of total greenhouse gas emissions in the United States in 2004 (EPA 2006). The CEC estimates that CH_4 emissions from various sources represent 9.0% of California’s total greenhouse gas emissions (CARB 2016). Total CH_4 emissions in the United States decreased by 5.6% from 1990 to 2014 (EPA 2016).

NITROUS OXIDE

Nitrous oxide (N2O) is produced by biological processes that occur in soil and water and by a variety of anthropogenic activities in the agricultural, energy-related, industrial, and waste management fields. While total N2O emissions are much lower than CO2 emissions, N2O is approximately 300 times more powerful than CO2 at trapping heat in the atmosphere (EPA 2016). Since 1750, the global atmospheric concentration of N2O has risen by approximately 21 percent (EPA 2016). The main anthropogenic activities producing N2O in the United States are agricultural soil management, stationary fuel combustion, fuel combustion in motor vehicles, manure management, and nitric acid production

The U.S. EPA estimates that N_2O emissions accounted for 6% of total greenhouse gas emissions in the United States in 2014 (EPA 2016). The CEC estimates that nitrous oxide emissions from various sources represent 2.8% of California's total greenhouse gas emissions (CARB 2016). Total N_2O emissions in the United States decreased by 0.01% from 1990 to 2014 (EPA 2016).

Fluorinated Gases (HFCs, PFCs, and SF_6)

Fluorinated gases, such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6), are powerful greenhouse gases that are emitted from a variety of industrial processes. The primary sources of fluorinated gas emissions in the United States include the production of HCFC-22, electrical transmission and distribution systems, semiconductor manufacturing, aluminum production, magnesium production and processing, and substitution for ozone-depleting substances. The U.S. EPA estimates that fluorinated gas (HFC, PFC, and SF_6) emissions accounted for 3.0% of total greenhouse gas emissions in the United States in 2014 (EPA 2016). The CEC estimates that fluorinated gas emissions from various sources represent 3.9% of California's total greenhouse gas emissions (CARB 2016). Total fluorinated gas emissions in the United States increased by 56% from 1990 to 2014 (EPA 2016).

Sacramento County Emissions

The ICLEI (Local Governments for Sustainability) Clean Air and Climate Protection Model (CACP) was used to estimate unincorporated Sacramento County emissions, along with the emissions of all of the incorporated cities in the County. This complete inventory was done to provide a regional picture, but the County does not have control over incorporated city emissions. The baseline year 2005 was chosen based on availability of information. In cases where 2005 data was unavailable, 2006 or other recent-year data was substituted. The software inventories community GHG emissions for all operations, with a separate government analysis tab that determines GHG emissions of local government operations as a subset of the community analysis. The community analysis divides GHG emissions among residential (energy usage), commercial and industrial (energy usage), transportation (exhaust emissions), off-road vehicle use (exhaust emissions), waste (landfill emissions), wastewater treatment (energy usage), agriculture (fertilizers, enteric fermentation, etc), High GWP (high global warming potential, such are refrigerants), and airport (emissions from County buildings and fleets – does not include fleet owned by airlines) sectors. The government analysis divides emissions among buildings, vehicle fleet, employee commute, streetlights, water/sewage, and waste sectors.

For the community analysis, energy use was obtained for the Sacramento Municipal Utility District (SMUD) and the Pacific Gas and Electric Company (PG&E). Community waste generation for Sacramento County was collected through the California

Integrated Waste Management Board (CIWMB) web site and through consultation with staff of Sacramento County Municipal Services Agency. The SMUD reported its 2005 GHG emissions and an emissions factor for all electricity sold to customers that was verified and certified by the California Climate Action Registry. This emissions factor was input into the model as a replacement for the statewide emissions factor for electricity consumption to generate more accurate GHG emissions estimates for Sacramento County electricity consumption. The analysis also uses localized vehicle miles traveled information using the outputs from the Sacramento Regional Travel Demand Model (SACMET) and the emissions factors from the Emission Factors Model 2007 (EMFAC 2007). The software default emissions factors for other GHGs, which are based on statewide averages, were used in all other instances.

As shown in **Table CC-1**, the County 2005 emission baseline is approximately 5.0 MMT per year, with the transportation sector as the largest contributor at 41% of the total. The emissions per sector drop precipitously from there, with the residential sector emitting only half of the transportation sector total. However, the residential and commercial sectors can be combined to give a more overarching view, because though these sectors operate differently, the source of emissions are the same: private building and interior equipment energy usage. Combining these sectors, transportation accounts for 40% of emissions, and operation of residential, commercial, and industrial buildings accounts for 36% of emissions. The off-road vehicle, waste, wastewater, water, agriculture, and high global warming potential greenhouse gases (High GWP GHG) sectors combined are responsible for only 20% of the County emissions, with the airport as an additional 4%.

Table CC-1: 2005 Community Emissions by Sector

Sector	**CO_2e (metric tons)**	**Percent**
Residential	1,033,142	20.7
Commercial and Industrial	772,129	15.4
Transportation	2,066,970	41.4
Off-Road Vehicle Use	236,466	4.7
Waste	201,350	4.0
Wastewater Treatment	70,662	1.4
Water-Related	5,885	0.1
Agriculture	197,132	4.0
High GWP GHGs	203,528	4.1
Airport	200,404	4.0
Total	**4,987,668**	**100**

REGULATORY SETTING

EXECUTIVE ORDER S-3-05

Executive Order S-3-05 was the precursor to Assembly Bill 32 (AB 32 is described in the next section) and was signed by Governor Schwarzenegger in June 2005. The Executive Order states that California is “particularly vulnerable” to the impacts of climate change, and that climate change has the potential to reduce Sierra snowpack (a primary source of drinking water), exacerbate existing air quality problems, adversely impact human health, threaten coastal real estate and habitat by causing sea level rise, and impact crop production. The Executive Order also states that “mitigation efforts will be necessary to reduce greenhouse gas emissions”. To address the issues described above, the Executive Order established emission reduction targets for the state: reduce GHG emissions to 2000 levels by 2010, to 1990 levels by 2020 and to 80% below 1990 levels by 2050. Currently only the 2020 target has been adopted by the state through legislation (see Assembly Bill 32, below). As a result, all of the impact discussions, mitigation, and strategies are based on meeting the 2020 target, not the longer-term 2050 target.

ASSEMBLY BILL 32

In September 2006, Assembly Bill (AB) 32 was signed by Governor Schwarzenegger of California. AB 32 requires that California GHG emissions be reduced to 1990 levels by the year 2020, just like Executive Order S-3-05. However, AB 32 is a comprehensive bill that requires ARB to adopt regulations requiring the reporting and verification of statewide greenhouse gas emissions, and it establishes a schedule of action measures. AB 32 also requires that a list of emission reduction strategies be published to achieve emissions reduction goals.

SENATE BILL 375

On September 30, 2008, Senate Bill (SB) 375 was signed by Governor Schwarzenegger of California. SB 375 combines regional transportation planning with sustainability strategies in order to reduce greenhouse gas emissions in California’s urbanized areas. Existing law requires each regional transportation planning agency, which in Sacramento County’s case is the Sacramento Area Council of Governments (SACOG), to adopt a Metropolitan Transportation Plan. SB 375 required the California Air Resources Board (CARB) to set performance targets for reduction of passenger vehicle emissions per capita in each of 16 Metropolitan Planning Organizations (MPOs) in the state for 2020 and 2035. For the SACOG MPO, these targets were set at 7% below 2005 per capita emissions for 2020 and 16% below 2005 per capita emissions for 2035. MPOs are not required to meet the greenhouse gas emission targets established by ARB, but if they conclude it is not feasible to do so, they must prepare an Alternative Planning Scenario to demonstrate what further land use and/or transportation actions would be required to meet the targets. SB 375 also requires that the Metropolitan Transportation Plan for each MPO include a Sustainable Communities Strategy (SCS) that integrates the land use and transportation components, and amends CEQA to provide incentives for housing and mixed use projects that help to implement an MTP/SCS that meets the ARB targets.

Endangerment Finding

On December 7, 2009, the U.S. EPA made an Endangerment Finding and a Cause or Contribute Finding related to greenhouse gases. The U.S. EPA Administrator found that the current and projected concentrations of the six key well-mixed greenhouse gases – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) – in the atmosphere threaten the public health and welfare of current and future generations (endangerment). The Administrator also found that the combined emissions of these well-mixed greenhouse gases from new motor vehicles and new motor vehicle engines contribute to the greenhouse gas pollution which threatens public health and welfare (Cause or Contribute).

Sacramento County General Plan

The Land Use Element of the Sacramento County General Plan contains the following applicable policy:

LU-115. It is the goal of the County to reduce greenhouse gas emissions to 1990 levels by the year 2020. This shall be achieved through a mix of State and local action.

Sacramento County Climate Action Planning

In October of 2011 Sacramento County approved the Climate Action Plan Strategy and Framework document (CAP), which is the first phase of developing a community-level Climate Action Plan. The CAP provides a framework and overall policy strategy for reducing greenhouse gas emissions and managing our resources in order to comply with AB 32. It also highlights actions already taken to become more efficient, and targets future mitigation and adaptation strategies. This document is available at http://www.green.saccounty.net/Documents/sac_030843.pdf. The CAP contains policies/goals related to agriculture, energy, transportation/land use, waste, and water.

Goals in the section on agriculture focus on promoting the consumption of locally-grown produce, protection of local farmlands, educating the community about the intersection of agriculture and climate change, educating the community about the importance of open space, pursuing sequestration opportunities, and promoting water conservation in agriculture. Actions related to these goals cover topics related to urban forest management, water conservation programs, open space planning, and sustainable agriculture programs.

Goals in the section on energy focus on increasing energy efficiency and increasing the usage of renewable sources. Actions include implementing green building ordinances and programs, community outreach, renewable energy policies, and partnerships with local energy producers.

Goals in the section on transportation/land use cover a wide range of topics but are principally related to reductions in vehicle miles traveled, usage of alternative fuel types, and increases in vehicle efficiency. Actions include programs to increase the efficiency of the County vehicle fleet, and an emphasis on mixed use and higher density development, implementation of technologies and planning strategies that improve non-vehicular mobility.

Goals in the section on waste include reductions in waste generation, maximizing waste diversion, and reducing methane emissions at Kiefer landfill. Actions include solid waste reduction and recycling programs, a regional composting facility, changes in the waste vehicle fleet to use non-petroleum fuels, carbon sequestration at the landfill, and methane capture at the landfill.

Goals in the section on water include reducing water consumption, emphasizing water efficiency, reducing uncertainties in water supply by increasing the flexibility of the water allocation/distribution system, and emphasizing the importance of floodplain and open space protection as a means of providing groundwater recharge. Actions include metering, water recycling programs, water use efficiency policy, water efficiency audits, greywater programs/policies, river-friendly landscape demonstration gardens, participation in the water forum, and many other related measures.

Consistent with mitigation included in the EIR for the Sacramento County General Plan, publication of a “Phase II” CAP is anticipated to occur within five years of the adoption of the 2030 Sacramento County General Plan (the General Plan was adopted in November 2011). This second phase CAP is intended to flesh out the strategies involved in the strategy and framework CAP, and will include economic analysis, intensive vetting with all internal departments, community outreach/information sharing, timelines, and detailed performance measures.

SIGNIFICANCE CRITERIA

CEQA Guidelines section 15064.4 states that an agency should make a “good faith effort to describe, calculate, or estimate the amount of greenhouse gas emissions resulting from a project”. It is left to the lead agency’s discretion to use a quantitative or qualitative approach. Factors that should be considered when determining significance are:

1. The extent to which the project may increase or decrease greenhouse gas emissions compared to the baseline;

2. whether the project exceeds any applicable significance threshold; and

3. the extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions.

The guidelines do not include a numeric significance threshold, but instead defer to the lead agency to determine whether there are thresholds which apply to the project. With regard to the third item, statewide plans include AB 32 and SB 375, as described in the Regulatory setting. The underlying strategy and assumptions of the AB 32 Scoping Plan were used to develop County thresholds. AB 32 requires emissions be reduced to 1990 levels by the year 2020, which is estimated in the AB 32 Scoping Plan to be 15% below *existing (2005) emissions*. The text is emphasized to note that the goal is not 15% below what is known as “business-as-usual” conditions or unmitigated project emissions; it is 15% below the emissions which were existing in California in the year 2005.

As previously discussed, Sacramento County prepared a GHG emissions inventory for the County, and as an offshoot of that process has published a Draft Climate Action Plan. Thresholds have been developed based on the County inventory (see **Table CC-2**). As shown below, separate thresholds have been included for each sector. The purpose of this division is to provide additional information about the source of emissions. When making a final determination of significance, these thresholds can be combined to generate a total emissions threshold; it is this total threshold that will ultimately determine whether impacts are found to be significant.

Also note that the transportation sector is expressed in per capita, which is not applicable to non-residential projects. The determination was made that, in general, non-residential projects redistribute existing trips made by passenger vehicles – they do not generate new trips. The majority of trips to and from a commercial project are generated by residential uses. Residential projects are already being required to account for transportation emissions, so including them for commercial projects as well would result in double-counting. Therefore, only the truck-trips generated by a commercial project itself will be subject to analysis. An exception to this rule is any commercial project which is a regional draw or unique draw, and thus may cause the redistribution of existing trips in a manner that will increase total existing VMT.

Table CC-2: Greenhouse Gas Significance Thresholds (Annual Metric Tons CO_2e)

Sector	2005 Baseline	2020 Target	Thresholds
Residential Energy	1,033,142	878,275	1.33 per capita
Commercial & Industrial Energy	772,129	656,914	7.87 per Kft^2
Transportation	2,066,970	1,757,236	2.67 per capita
Trucks	*488,806*	*414,470*	*0.10 per 100 VMT*

Thresholds applicable to construction activities have not been developed. Emissions resulting from the usage of off-road vehicles is only 4.7% of the total inventoried emissions in Sacramento County, which includes recreational and other vehicles, not just construction fleets. Furthermore, while emissions from the actual use of newly constructed buildings adds to existing building stock and thus results in a cumulative year-on-year increase in emissions, the amount of construction in a region does not result in cumulative additions. Though construction may increase or decrease in a given year due to market demand, the average amount of construction undertaken does not tend to increase over time. For this reason, even without mitigation the amount of annual emissions resulting from construction is expected to decrease over time as a result of the implementation of existing regulations (such as the low carbon fuel standard) and fleet turnover. An analysis of the data for construction equipment within the EMFAC (Emissions Factor Model) 2011 indicates that construction fleet emissions will reduce by approximately 11% between 2005 and 2020. Standard mitigation applied for the purpose of reducing other air pollutants (see the Air Quality chapter) will further reduce emissions. For the foregoing reasons, it was determined that construction emissions would not contribute to a significant climate change impact, and no threshold is necessary.

METHODOLOGY

For transportation-related GHG emissions, project-specific vehicle miles traveled (VMT) were provided by speed bin (Kimley-Horn Associates, Inc., 2014b). Vehicle emission rates for Sacramento County in 2020 were developed using the California Air Resources Board's EMFAC2011 emissions model (California Air Resources Board, 2013b). Using the EMFAC2011 emission rates, individual rates were estimated by speed bin. Then, for each speed bin, VMT estimates were multiplied by the speed bin specific emission rates, and the results were converted to annual metric tons of CO_2. Finally, emissions were totaled for all speed bins to obtain total CO_2 emissions.

EMFAC2011 does not include emission rates for CH_4 or N_2O. Consequently, CH_4 emissions were estimated by taking the ratio of CH_4 to CO_2 estimated for vehicle emissions by CalEEMod, and that ratio was then multiplied by the EMFAC2011 estimated CO_2 to estimate CH_4 emissions. Emissions of N_2O were assumed negligible because CalEEMod does not show N_2O emissions for vehicles.

Total CO_2 emissions were estimated (assuming a global warming potential of 21 for CH_4), and the total CO_2e was divided by the project's estimated population to obtain an emissions per-capita value. The project's total population was estimated at 1,805 using CalEEMod. The emissions per-capita value was then compared to Sacramento County's emissions per capita threshold of 2.67.

For energy emissions, CaleeMod was used to estimate annual Project's 2020 residential and elementary school GHG emissions from electricity and natural gas consumption. This year represents the earliest year that buildout would occur. Actual buildout could take longer, depending on market conditions. SMUD's 2020 GHG emission factors in pounds per megawatt- hour were also entered into the model (E3, 2010). The Project's building energy use estimates were divided by the estimated Project population to obtain energy-related GHG emissions per capita.

Project emissions are compared to the significance thresholds, and are also compared (in the form of a percentage) to current ARB estimates of statewide emissions and 1990 emissions. Project emissions are also examined in light of existing statewide or County emissions reductions strategies, to determine whether the project would significantly offset anticipated reductions.

IMPACTS AND ANALYSIS

The following section discloses the potential impacts of the proposed project on global climate change, and the potential impacts of global climate change on the proposed project. Mitigation measures have been identified where feasible.

IMPACT: PROJECT GREENHOUSE GAS EMISSIONS

LEVEL OF IMPACT: LESS THAN SIGNIFICANT

Project emissions were estimated as described in the Methodology section. Implementation of the project would contribute to an increase in GHG emissions from mobile sources and utility usage, which are associated with global climate change. **Table CC-3** below summarizes the project's mitigated operational GHG emissions. With the exception of mobile sources, emissions for each category were estimated using CalEEMod2013.2.2. Mobile source emissions were estimated using procedures as described above in the methodology section and in Appendix B of the Air Quality Technical Report, within Appendix B of this EIR. **Table CC-4** compares the project's energy and mobile source emissions to Sacramento County's applicable thresholds; and a comparison of project emissions to regional and state-wide emissions is included in **Table CC-5**.

Table CC-3: Operational GHG Emissions (metric tons per year, mitigated)[1,2]

Category	CO_2	CH_4	N_2O	CO_2e
Area	11.6	0.0	0.0	11.9
Energy	2,123.0	0.1	0.0	2,133.1
Mobile	2,820.0	0.1	0.0	2,961.0
Waste	138.3	8.2	0.0	309.8
Water	129.6	0.1	0.0	144.1
Total	**5,222.5**	**8.5**	**0.0**	**5,559.9**

Notes:
[1] CO_2e based on a global warming potential of 21 for CH_4 and 310 for N_2O. All emission estimates based on CalEEMod2013.2.2 results except for mobile source emissions.
[2] Mobile source emissions based on VMT estimates by speed bin (Weir, M. 2014) and vehicle emission rates generated using EMFAC2011. CalEEMod GHG output file is included in the Appendix B of the Air Quality Technical Report, within Appendix B of this EIR.

Table CC-4: Comparison of Operational GHG Emissions

Category	CO_2e	CO_2e/capita	County Threshold	Exceeds Threshold?
Energy	2,133	1.15	1.33	**No**
Mobile	2,961	1.60	2.64	**No**

Note: Project population estimated at 1,845 based on CalEEMod results.

Table CC-5: Relative CO_2 Emissions (in CO_2 Equivalents)

Source	CO_2	% of State - 2004	% of State - 1990	% of Entire County	% of Unincorporated County
Project	0.005 MMT/yr	0%	0%	0.04%	0.09%
Unincorporated County	5.2 MMT/yr	1.2%	1.3%	43%	
Entire County	12 MMT/yr	2.8%	3.1%		
State – 1990	389 MMT/yr				
State – 2004	427 MMT/yr				

MMT: Million Metric Tons

As illustrated in **Table CC-4** and **Table CC-5**, GHG emissions from the proposed project would not exceed the County's thresholds for energy and mobile source GHG emissions. Therefore, the project would not generate GHG emissions that would have a significant effect on the environment and impacts are less than significant.

Mitigation Measures

None required.

Impacts: Effects to the Project from Climate Change

Level of Impact: Potentially Significant

Global climate change is a complex phenomenon that is influenced by many environmental factors. There are also many different climate or hydrologic modeling tools available, each with strengths and weaknesses. While changes to the existing climate landscape can be demonstrated by looking at the historic record, it becomes challenging to predict future trends. The process must be simplified to some extent. Climatologists and others who model climate change must make certain assumptions, such as establishing a fixed rate of temperature change, in order to proceed with modeling. Therefore, scientists involved in these modeling efforts do not try to be absolutely predictive, but instead use different model types with different sets of assumptions to capture a range of possible scenarios. It is also necessary to update the model with the latest available data on a regular basis in order to sync the models with current conditions. There is no single, certain prediction related to the probability of environmental effects. Scenarios are rated as being very likely if many different models come up with very similar results, and as uncertain if many different models report very different results. The sections below rely on information from several different published sources and provide a qualitative analysis of potential impacts as they affect North America, California, Sacramento County, and the project area.

Temperature

Significant increases in the frequency, intensity, and duration of summertime extreme heat days, defined as the 10% warmest days of summer, are projected due to climate change (Miller et. al., 2007). Temperature change is the driver for climate change, impacting environmental processes that will in turn impact human life. There is strong agreement that many of the most damaging effects of climate change will begin to occur after temperatures increase beyond 2 degrees Celsius into the 3 or 4 degree range. The IPCC Working Group III report determined that reductions of 50 to 80% would be needed by 2050 in order to stabilize temperature rise at no more than 2 degrees Celsius (IPCC, 2007c). The limits set forth in Executive Order S-3-05 and in AB 32 mirror this research.

For California as a whole, the total number of days of extreme heat is projected to *double* relative to historical mean of 12 days per summer, to an average of 23–24 days per summer by 2034. By 2064, this is projected to increase to 27 – 39 days. Aside from this global research, various research papers and technical studies have been produced that look specifically at impacts in California. One of these is a white paper titled “Climate Scenarios for California”, sponsored by the California Energy Commission, which used many of the same assumptions and scenarios as the IPCC reports, but scaled the modeling down to the California level. This paper postulates that the average temperature change from the 1961 – 1990 period to the 2070 – 2099 future will be more marked during the summer months than during the winter months (Cayan et. al., 2006a).

Higher temperatures would have direct effects on the health of many organisms, including humans. It is probable that rising temperatures will cause an increase in the number of humans who die or become ill due to heatwaves, may change the range (geographically or seasonally) of various infectious disease vectors (such as mosquitoes), and increase cardio-respiratory disease prevalence and mortality associated with ground-level ozone (IPCC, 2007b). Many individual plants may also die or become damaged during heatwaves, as even if there is ample water in the soil, water loss through the leaves will outpace the ability of the plant to draw water from the soil. Warmer winters would bring some benefits to some parts of California, where cold-related deaths and illnesses during the wintertime would be reduced. (Cayan et. al., 2006a) However, the greater Sacramento area does not typically experience extreme cold under current conditions, and in any case the stated negative effects would be expected to outweigh this positive effect.

Water Supply and Flooding

Although current forecasts vary, the effects of global climate change on precipitation and temperature regimes in California 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. California also relies heavily on gradual snowmelt from the Sierra Nevada to supply water.

According to the Intergovernmental Panel on Climate Change 2007 report, the annual mean warming in North America is likely to exceed the global mean warming in most areas and snow season length and snow depth are very likely to decrease in most of North America (IPCC, 2007a). These trends have already been observed, as the snow pack in the Sierra Nevada and the Cascade Range has been declining over the last few decades of record, and the average temperature in California has increased one degree Fahrenheit over the past 50 years (Cayan et.al., 2006a). Although these general statements are made, it is recognized that although there is high model agreement on warming trends the agreement among precipitation and hydrologic trend models is not nearly so strong.

The Climate Scenarios for California white paper modeled changes in Snow Water Equivalent as of April 1, when the snow season begins to taper off. Snow Water Equivalent is the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously. The analysis results differ widely depending on which model and emissions scenario is used. As compared to the 1961 – 1990 period of record, the net change in Snow Water Equivalent ranges from +6% to -29% (for the 2005 – 2034 period), from -12% to -42% (for 2035 – 2064), and from -32% to -79% (for the 2070 –

2099 period). These results highlight the lack of agreement found amongst hydrologic models. The ranges of projected change vary widely, and in the near-term some modeling even predicts an *increase* in Snow Water Equivalent. However, in the long-term all of the models do agree that Snow Water Equivalent will be reduced, even though further refinement of the modeling will need to be completed to narrow down the range of reductions. (Cayan et. al., 2006a)

The modeling results indicate that snow losses have greatest impact in relatively warm low-middle and middle elevations between about 3280 feet and 6560 feet (losses of 60% to 93%) and between about 6560 feet and 9840 feet (losses of 25% to 79%). The central and northern portions of the Sierra Nevada contain large portions of this low-middle and middle elevations, and are subject to the heaviest reductions in snow accumulation. (Cayan et. al., 2006a).

The effect of climate change on future demand of water supply remains uncertain (DWR 2006), but changes in water supply are expected. The California Department of Water Resources (DWR) has sponsored or published a number of papers on the interaction between climate change and water supply, and has included a Climate Change Portal on the DWR website (www.climatechange.water.ca.gov). Climate change is also addressed in the 2009 California Water Plan update (public review draft of Volumes 1, 2, and 3 released January 2009). Adaptation is the primary thrust of the strategies outlined in the public review draft, with a focus on reducing water demand, improvements in operational efficiency, and increasing water supply.

The American River and many other major and minor rivers within the County are largely fed by snowmelt within the low-middle and middle elevation range that is expected to suffer the greatest reductions in snowpack. It can be concluded that Sacramento County will see a significant reduction in snowmelt-driven water supply by the end of this century. In the shorter term, it is less clear whether there will be a significant reduction in snowpack. Modeling results indicate that snowpack may either increase by 6% or decrease by as much as 29% by the year 2034. Given this uncertainty, it would be speculative to attempt to provide a quantified analysis of the effects of climate change on current water sources within Sacramento County.

Surface Water Quality

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, and/or shifts 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, although there may be more flood events, the overall stream flow decrease from a lack of summer snowpack could potentially concentrate pollutants and prevent the flushing of contaminants from point sources. The increased storm flows could tax urban water systems and cause greater flushing of pollutants to the Sacramento-San Joaquin Delta and coastal regions (Kiparsky and Gleick 2003). Still, considerable work remains to determine the potential effect of global climate change to water quality.

GROUNDWATER

A shift from snowfall to rainfall could reduce groundwater recharge, even if total precipitation remains constant. However, little work has been done on the effects of climate change on specific groundwater basins, groundwater quality or groundwater recharge characteristics (Kiparsky and Gleick 2003). Research has focused more heavily on solidifying precipitation and streamflow projections, which are both necessary elements to determining which of the many possible groundwater scenarios are most probable. Water recharge could be increased if winters are warmer and wetter, and more water can filter into the soil, or this benefit could be offset by greater rates of evaporation and shorter rainfall seasons. Until more research into groundwater effects is completed, climate change impacts to groundwater will remain highly uncertain.

FISHERIES AND AQUATIC RESOURCES

The health of river ecosystems is highly dependent on water temperatures and stream flows. The IPCC Working Group II report recites a litany of temperature and flow effects on fisheries that have already been observed: the sea-run salmon stocks are in steep decline throughout much of North America (Whoriskey, 2003), Pacific salmon have been appearing in Arctic rivers (Babaluk et al., 2000), and salmonid species have been affected by warming in U.S. streams (O'Neal, 2002). It is probable that increases in average temperatures in the state will cause corresponding increases in water temperatures. Rates of fish-egg development and mortality increase with temperature rise within species-specific tolerance ranges (Kamler, 2002). Also, many fish species migrate into Sacramento County waterways during specific seasons to breed, and these fish rely on increased late-fall and early winter flows in order to complete the migration. If increased flows are delayed, possibly as a result of lessened groundwater recharge or shifts in the onset of the rainy season, this would be a barrier to migration. These potential effects could further endanger the sustainability of aquatic populations that are already listed through the Federal or California Endangered Species Acts, or could cause non-listed species to require listing under the Act.

SEA LEVELS

The IPCC Working Group I report contains a thorough discussion of the current understanding of sea level rise and climate change. As global mean temperatures warm, the rate at which the sea level rises is expected to increase. While there is strong model agreement that sea levels will continue to rise and that the rate of rise will increase, the ultimate amount of rise is uncertain. (IPCC 2007a) A white paper entitled Projecting Future Sea Level, published by the California Climate Change Center, estimated a sea level rise from 4 – 35 inches every century (0.3 – 2.9 feet), depending on the model and assumptions used (Cayan et. al., 2006b).

Although Sacramento County contains no coastal land, the Delta region of Sacramento County is hydrologically connected to the San Francisco Bay and will be directly influenced by sea level rise. Among the more critical potential effects of sea level rise in Sacramento County are threats to flood protection and increased salinity in the Delta (Kiparsky and Gleick 2003). In recognition of this concern, California passed a bond measure intended to finance the process of stabilizing and improving California's levee systems. The California Department of Water Resources is also continuing to study the issue to determine what other system improvements may be necessary to adapt to changes in water surface elevations.

Water for the State Water Project and the federal Central Valley Project is taken from the south Delta. If salt water from the San Francisco Bay backs upward through the Delta system, freshwater supplies could be degraded. There are potential solutions to this problem, should it occur, that continue to be examined by the California Department of Water Resources. A purification process could be implemented, but extracting salt from water tends to be costly. A peripheral canal that would bypass the Delta is another option that was originally suggested in the early 1980's, but remains highly controversial.

Wildland Fire Risk

With climate change, the potential for wildland fires may change due to changes in fuel conditions (transitioning forests to chaparral/grasslands for example), precipitation (longer dry seasons, higher extreme temperatures), and wind (affecting potential spread), among other variables.

Westerling and Bryant (2006) estimated future statewide wildfire risk from a statistical model based on temperature, precipitation, and simulated hydrologic variables. These are conservative estimates because they do not include effects of extreme fire weather, but implications are nonetheless quite alarming. Projections made for the probabilities of "large fires" – defined as fires that exceed an arbitrary threshold of 200 hectares (approximately 500 acres) – indicate that the risk of large wildfires statewide would rise almost 35% by mid-century and 55% by the end of the century under a medium-high emissions scenario, almost twice that expected under lower emissions scenarios. Estimates of increased damage costs from the increases in fire season severity (Westerling and Bryant 2006) are on the order of 30% above current average annual damage costs.

A second study explored, through a case study in Amador and El Dorado Counties, the effects of projected climate change on fire behavior, fire suppression effort, and wildfire outcomes (California Climate Change Center 2006b). Climate and site-specific data were used in California Department of Forestry and Fire Protection (CDF) standard models to predict wildfire behavior attributes such as rate of spread and burning intensity. The study found an increase in the projected area burned (10%–20%) and number of escaped fires (10%–40%) by the end of century, under the drier climate scenarios. However, the less dry model showed little change.

Agriculture

Agriculture, along with forestry, is the sector of the California economy that may be most be affected by a change in climate. Regional analyses of climate trends over agricultural regions of California suggest that climate change is already in motion. Over the period 1951 to 2000, the growing season has lengthened by about a day per decade, and warming temperatures have resulted in an increase of 30 to 70 growing degree days per decade, with much of the increase occurring in the spring. Climate change affects agriculture directly through increasing temperatures and rising CO_2 concentrations, and indirectly through changes in water availability and pests (California Climate Change Center 2006a).

Crop growth models show that a warming from a low to a higher temperature generally raises yield at first, but then becomes harmful. Possible effects of excessively high temperature include: decreased fruit size and quality for stone fruits, premature ripening and possible quality reduction for grapes, reduced fruit yield for tomatoes, increased incidence of tipburn for lettuce, and similar forms of burn for other crops. From a variety of studies in the literature, photosynthesis increases when a plant is exposed to a doubling of CO_2. However, whether this translates into increased yield of economically valuable plant product is uncertain and highly variable. Also, elevated CO_2 levels are associated with decreased concentrations of mineral nutrients in plant tissues, especially a decrease in plant nitrogen, which plays a central role in plant metabolism. Some crops may benefit in quality from an increase in CO_2 while some crops are harmed by an increase in CO_2. Growth rates of weeds, insect pests, and pathogens are also likely to increase with elevated temperatures, and their ranges may expand (California Climate Change Center 2006a).

Over time, new seed varieties could be developed that are better adapted to the changed climate and pest conditions, and entirely new crops may be found to meet pharmaceutical or energy supply needs. However, some of these adaptations may require publicly supported research and development if they are to materialize (California Climate Change Center 2006a).

Rapid 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 (DWR 2006). 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. However, sudden and unexpected changes in climate could leave many of the agencies responsible for management of vulnerable sectors (water supply, levees, health, etc) unprepared, and in extreme situations would have significant implications for California and the health and safety of its denizens. 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 (DWR 2006).

Conclusion

The effects of climatic changes on the Sacramento region are potentially significant, and can only be mitigated through both adaptation and reduction strategies. Sacramento County is requiring that projects within the County mitigate for their emissions. Adaptation strategies related to climate change may involve new water supply reservoirs or other storage options, changes to dam release schedules, changes to medical and social service programs, and other broad-level actions. Most of these strategies are within the auspices of the State of California, not local government. This is recognized within the AB 32 Scoping Plan that has been adopted by the State, as well as publications by agencies such as the California Department of Water Resources. Therefore, by requiring mitigation of projects that may result in significant greenhouse gas emissions, and by adopting County programs and changes in government operations (as described in the Sacramento County Emission Reduction Efforts section), the County is implementing all feasible strategies to reduce the effects of climate change on the region.

It will be challenging for the State to implement appropriate adaptation strategies given that the ultimate severity and type of climate change effects are difficult to model. Furthermore, though the State and many local governments are taking steps to address emissions, the entire world must do likewise in order for serious climate effects to be avoided. This being the case, impacts to the project from climate change remain potentially significant.

Mitigation Measures

None recommended.

Commercial Alternative

Impact: Greenhouse Gas Emissions

Level of Impact: Less Than Significant

Implementation of the project would contribute to an increase in GHG emissions from mobile sources and utility usage, which are associated with global climate change. **Table CC-6** below summarizes the operational GHG emissions for the commercial project alternative. With the exception of mobile sources, emissions for each category were estimated using CalEEMod2013.2.2. Mobile source emissions were estimated using procedures recommended by Sacramento County as described above. **Table CC-7** compares the commercial alternative's energy and mobile source emissions to the Sacramento County's applicable thresholds; and a comparison of project emissions to regional and state-wide emissions is included in **Table CC-8**.

Table CC-6: Commercial Alternative Operational GHG Emissions (metric tons per year, mitigated) [1,2]

Category	CO_2	CH_4	N_2O	CO_2e
Area	9	0.01	0.0	9
Energy	1,756	0.07	0.023	1,765
Mobile	1,954	-	-	2,052
Waste	158	9.4	0.0	355
Water	89	0.05	0.031	100
Total	**3,938**	**9.6**	**0.054**	**4,251**
Notes: [1] CO_2e based on a global warming potential of 21 for CH_4 and 310 for N_2O. CO_2e for mobile saources is assumed to equal 105% of mobile source CO_2e emissions.				

Table CC-7: Comparison of Operational GHG Emissions for the Commercial Alternative

Category	CO_2e	CO_2e/capita	County Threshold	Exceeds Threshold?
Energy	1,765	1.27	1.33	**No**
Mobile	2,052	1.47	2.64	**No**
Note: Alternative population estimated at 1,393 based on CalEEMod results.				

Table CC-8: Relative CO_2 Emissions (in CO_2 Equivalents)

Source	CO_2	% of State - 2004	% of State - 1990	% of Entire County	% of Unincorporated County
Project	0.003 MMT/yr	0%	0%	0.02%	0.06%
Unincorporated County	5.2 MMT/yr	1.2%	1.3%	43%	
Entire County	12 MMT/yr	2.8%	3.1%		
State – 1990	389 MMT/yr				
State – 2004	427 MMT/yr				

MMT: Million Metric Tons

As illustrated in **Table CC-7** and **Table CC-8**, the commercial alternative's GHG emissions would be lower than the applicable energy and mobile source significance thresholds. Therefore, the commercial alternative would not generate GHG emissions that would have a significant effect on the environment and impacts are less than significant.

Mitigation Measure

None required.

Impacts to the Project from Climate Change

Impacts to the commercial project alternative form climate change are identical to those discussed for the preferred project scenario. It will be challenging for the State to implement appropriate adaptation strategies given that the ultimate severity and type of climate change effects are difficult to model. Furthermore, though the State and many local governments are taking steps to address emissions, the entire world must do likewise in order for serious climate effects to be avoided. Impacts to the project from climate change are potentially significant.

Mitigation Measures

None recommended.