ENVIRON Climate Change Technical Report: Vista Canyon
(January 2010)

Climate Change Technical Report
Vista Canyon

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Acronyms

^oF	degrees Fahrenheit
AB 1493	Assembly Bill No. 1493
AB 32	California Global Warming Solutions Act of 2006
BAAQMD	Bay Area Air Quality Management District
CARB	California Air Resources Board
CARB 2020 NAT	California Air Resources Board 2020 No Action Taken
C	carbon
CAFÉ	corporate average fuel economy
CAPCOA	California Air Pollution Control Officers Association
CBECS	Commercial Building Energy Consumption Survey
CCAR	California Climate Action Registry
CCR	California Code of Regulations
CEC	California Energy Commission
CEO	Chief Executive Officer
CEUS	California End Use Survey
CEQA	California Environmental Quality Act
CF_4	tetrafluoromethane
CFC	chlorinated fluorocarbons
CH_4	methane
CHP	combined heat and power
CLWA	Castaic Lake Water Agency
CNG	compressed natural gas
CNRA	California's Natural Resources Agency
CO_2	carbon dioxide
CO_2e	CO_2 equivalents
CPUC	California Public Utilities Commission
DC	direct current
DOT	Department of Transportation
EEMIS	Enterprise Energy Management Information System
EIA	United States Energy Information Administration
EIR	Environmental Impact Report
EISA	Energy Independence and Security Act of 2007
EMFAC	emissions estimation software programs
ENSO	El Niño Southern Oscillation
ENVIRON	ENVIRON International Corporation
FCV	fuel cell vehicle
FFV	flexible fuel vehicle
GDP	gross domestic product
GGE	greenhouse gas equivalent
GHGs	greenhouse gases
GRP	General Reporting Protocol
GVW	gross vehicle weight
GWP	global warming potential
HFC	hydrofluorocarbons
HHD	heavy heavy-duty trucks
hr	hour
HR 2764	The Consolidated Appropriations Act of 2008
HVAC	Heating, Ventilation, and Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
ISD	Climate Change Internal Services Department
kW	kilowatt

lbs	pounds
LA	Los Angeles
LCA	Life Cycle Assessment
LCFS	Low Carbon Fuel Standard
LDA	light-duty auto
LDT	light-duty truck
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
LULUCF	Land-Use, Land-Use Change and Forestry
MA	Massachusetts
MN	Minnesota
mpg	miles per gallon
MPO	Metropolitan Planning Organizations
MTC	Metropolitan Transportation Commission
MW	megawatts
N_2O	nitrous oxide
NHTSA	National Highway Traffic Safety Administration
NOP	notice of preparation
O_2	oxygen
OPR	Office of Planning and Research
OVOV	One Valley One Vision
PFC	perfluorocarbon
PHEV	plug-in hybrid electric vehicle
ppb	parts per billion
ppm	parts per million
RASS	Residential Appliance Saturation Study
RCx	Facility Retrocommissioning
RFS	Renewable Fuel Standard
RPS	Renewables Portfolio Standard
RTP	Regional Transit Plan
SB	Senate Bill
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SCWD	Santa Clarita Water Division
SF_6	sulfur hexafluoride
sqft	square feet
TDV	Time Dependent Valuation
tonnes	Metric tonnes; 1,000 kilograms
UEC	unit energy consumption
UNEP	United Nations Environment Programme
URBEMIS	Urban Emissions Model
US	United States
USEPA	United States Environmental Protection Agency
VC	Vista Canyon
VMT	vehicle miles traveled
WCI	Western Regional Climate Action Initiative
WMO	World Meteorological Organization

Executive Summary

Vista Canyon (VC) is a proposed mixed-use, transit-oriented community to be built in Los Angeles County, within and adjacent to the City of Santa Clarita. The applicant is proposing that the project site be annexed into the City of Santa Clarita along with various surrounding, mostly built properties. As currently proposed, VC will result in 1,117 new residential units and up to 950,000 square feet of commercial office, retail, and hospitality land uses. The project also includes the construction of a Metrolink station and bus transfer station, along with various recreational amenities and supporting infrastructure. If implemented, a residential overlay within the Vista Canyon Specific Plan would permit the development of up to 1,350 residential units on the project site. The additional 233 residential units would be permitted in lieu of 250,000 square feet of office uses resulting in a maximum of 700,000 square feet of commercial uses.

This project will result in both one-time and annual direct and indirect emissions of greenhouse gases (GHGs). The term, "direct emissions of GHGs" refers to GHGs that are emitted directly as a result of the project and include land use change and construction emissions. Indirect emissions are those emissions that the project entitlement will enable, but that are not under the immediate control of the project proponent. This report provides an inventory surveying the direct and indirect emissions that would result from approving the VC project. This report also discusses the scientific and regulatory developments surrounding global climate change and provides an inventory surveying the emissions that would result from approving VC.

There is a general scientific consensus that the main contributor to current global warming is the increased emissions of GHGs associated with human activity. The warming that occurs at the earth's surface as a result of increased GHG emissions is called "the greenhouse effect".

Lawmakers at the national, state and local levels have introduced legislation and regulations aimed at better tracking and controlling GHGs. On the national level, there are some incentives for businesses and individuals to take voluntary steps to limit GHG emissions. However, no federal legislation capping GHG emissions has been passed. A federal rule requiring large industrial sources to report GHG emissions was published October 30, 2009.

Nearly three years ago, California enacted the California Global Warming Solutions Act of 2006 (Assembly Bill 32 or AB 32), which established mandatory reductions in state-wide GHG emissions by 2020. The California Legislature since has passed Senate Bill 97 (SB 97), which addresses GHG analysis under the California Environmental Quality Act (CEQA). On December 30, 2009, and pursuant to SB 97 the California Natural Resources Agency adopted guidelines for the mitigation of GHG emissions and their effects.[1] More recently, the Legislature passed Senate Bill 375 (SB 375), which is intended to limit GHG emissions from cars and light trucks by improving the efficiency of regional land development patterns and encouraging new

[1] Senate Bill No. 97. CHAPTER 185. An act to add Section 21083.05 to, and to add and repeal Section 21097 of, the Public Resources Code, relating to the California Environmental Quality Act. http://www.opr.ca.gov/ceqa/pdfs/SB_97_bill_20070824_chaptered.pdf

residential development in areas with accessibility to transit and transportation hubs and supporting commercial and retail uses.

Residents, employees and patrons at VC will use electricity and heating, and will be transported by motor vehicles. These activities directly or indirectly emit GHGs. The most significant GHG emissions resulting from such residential and non-residential developments are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHG emissions are typically measured in terms of tonnes of CO_2 equivalents (CO_2e), calculated as the product of the mass emitted of a given GHG and its specific global warming potential (GWP).

The emissions inventory presented in this report is consistent with the methodologies established by the California Climate Action Registry (CCAR), where possible. The VC emissions inventory considers various categories of GHG emissions including: emissions due to vegetation changes, emissions from construction activities, residential building emissions, non-residential building emissions, mobile source emissions, and municipal emissions. The emissions from construction and land use change are one-time emissions events. The other emissions occur annually throughout the life of the project. The electrical power for the VC project would be supplied by Southern California Edison (SCE). Accordingly, indirect GHG emissions from electricity usage are calculated using the SCE carbon-intensity factor.

A variety of methods are employed to develop a complete GHG emissions inventory. In addition to well-established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several emissions estimation software programs are used. These include EMFAC, OFFROAD, and Urban Emissions Model (URBEMIS).

Emissions from the various aspects of VC are presented in Table ES-1. Both the one-time emissions and emissions that are expected to occur each year after build out of VC are presented. There are 21,292 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to 15,360 tonnes CO_2e/year. Of the annual emissions, approximately 49% result from mobile source emissions; approximately 30% result from energy use in non-residential buildings; 18% result from energy use in residential buildings; approximately 3% result from municipal sources; and less than 1% results from swimming pools, area sources, and the Metrolink station and bus transfer center. If the one-time emissions are annualized assuming a 40-year development life (which is likely low), then the total annual emissions are 15,892 tonnes/year.

Table ES-1
Summary of Greenhouse Gas Emissions for Vista Canyon
Vista Canyon
Santa Clarita, California

Source	**GHG Emissions**		**Percentage of Annual CO_2e Emissions (%)**
Vegetation	tonnes CO_2e total	-105	NA
Construction (Commuting and Vendor Trips)		12,013	NA
Construction (All other construction activities)		9,384	NA
Total (one time emissions)		**21,292**	NA
Residential	tonnes CO_2e / year	2,728	18%
Non-Residential		4,652	30%
Mobile		7,460	49%
Transit Center		49	0%
Swimming Pools		2	0%
Municipal		468	3%
Area		1	0%
Total (annual emissions)		**15,360**	NA
Annualized Total	**tonnes CO_2e / year**	**15,892**	**NA**

Estimated emissions for the residential overlay option are summarized in Table ES-2. The addition of 233 dwelling units and removal of 250,000 square feet of commercial space results in a decrease in one-time emissions (to 19,963 tonnes) and increase in annual emissions (to a total of 16,539 tonnes). The annualized emissions would be 17,038 tonnes/year.

Table ES-2
Summary of Greenhouse Gas Emissions for Vista Canyon: Overlay Option
Vista Canyon
Santa Clarita, California

Source	GHG Emissions		Percentage of Annual CO_2e Emissions (%)
Vegetation	tonnes CO_2e total	-105	NA
Construction (Commuting and Vendor Trips)		10,684	NA
Construction (All other construction activities)		9,384	NA
Total (one time emissions)		**19,963**	NA
Residential	tonnes CO_2e / year	3,245	20%
Non-Residential		3,676	22%
Mobile		9,016	55%
Transit Center		49	0%
Swimming Pools		2	0%
Municipal		550	3%
Area		1	0%
Total (annual emissions)		**16,539**	NA
Annualized Total	**tonnes CO_2e / year**	**17,038**	**NA**

As previously noted, other areas within the immediate vicinity of the project site also may be annexed into the City of Santa Clarita with VC. While some of the proposed annexation already is built out or approved for development, an additional 150 single-family residential units and 436,000 square feet of business park uses may be built. The annual emissions from this undeveloped portion of the annexation area are estimated to be 3,632 tonnes, and are summarized in Table ES-3.

Table ES-3
Summary of Greenhouse Gas Emissions for Vista Canyon: Annexation Area
Vista Canyon
Santa Clarita, California

Source	GHG Emissions		Percentage of Annual CO_2e Emissions (%)
Residential	tonnes CO_2e / year	550	15%
Non-Residential		1,963	54%
Municipal		116	3%
Area		1	0%
Mobile		1,002	28%
Total (annual emissions)		**3,632**	NA

1. Introduction

The Vista Canyon (VC) project will result in one-time and annual (direct and indirect) emissions of greenhouse gases (GHGs). Direct emissions of GHGs refer to GHGs that are emitted directly as a result of the project and include land use change and construction emissions. Indirect emissions are those emissions that the project entitlement will enable, but that are not under the immediate control of the project proponent. This report discusses the scientific and regulatory developments surrounding global climate change and provides an estimate of an emissions inventory that would result from entitling VC. This report also places the emissions inventory from VC into context.

Residents, employees, and patrons of commercial and municipal buildings use electricity, heat their homes and water (typically with natural gas), and are transported in motor vehicles, all of which directly or indirectly emit GHGs. The principal greenhouse gases resulting from such developments are emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). CO_2 is considered the most important GHG, due primarily to the large emissions produced by fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles. CH_4 and N_2O are also emitted by fossil fuel combustion, though their emissions are much less significant than CO_2. CH_4 is also emitted from the transmission, storage, and incomplete combustion of natural gas.

The effect that each of these gases can have on global warming is a combination of the mass of their emissions and their global warming potential (GWP). GWP indicates, on a pound for pound basis, how much a gas is predicted to contribute to global warming relative to how much warming would be predicted to be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent GHGs than CO_2, with GWPs of 21 and 310, respectively.[2] In emissions inventories, GHG emissions are typically reported in terms of pounds (lbs) or tonnes[3] of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific GWP. While CH_4 and N_2O have much higher GWPs than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e, both from residential developments and human activity in general.

The VC project is located within the South Coast Air Quality Management District (SCAQMD) jurisdiction. However, as SCAQMD guidelines for the preparation of GHG inventories have not yet been developed, this inventory has been developed consistent with the methodologies established by the California Climate Action Registry (CCAR) where possible. When guidance

[2] GWP values from IPCC's Second Assessment Report (SAR, 1996) are still used by international convention and are used in this protocol, even though more recent (and slightly different) GWP values were developed in the IPCC's Third Assessment Report (TAR, 2001)

[3] In this report, "tonnes" will be used to refer to metric tonnes (1,000 kilograms). "Tons" will be used to refer to short tons (2,000 pounds).

from the CCAR is lacking, methodologies established by the Intergovernmental Panel on Climate Change (IPCC)[4] and best available science are used. Legislation and rules regarding climate change, as well as scientific understanding of the extent to which different activities emit GHGs, continue to evolve; as such, the inventory in this report is a reflection of the guidance and knowledge currently available.

While the number of proposed residential units and square footage of commercial development for VC is known, the exact design of the residential units, commercial buildings and other project uses are not finalized at the entitlement stage. Even so, the types of buildings and the types of facilities at the future VC site can be used for developing an estimate of the project's anticipated GHG emissions. Energy used in a building depends in part on the built environment; however, actual future emissions from the site will depend heavily upon the future homeowners' and business owners' habits. Because the actual future occupants and their habits are not yet known, average current behavior is assumed. That assumption is likely to be a "worst-case" assumption. Given the current regulatory environment and the media focus on global climate change, it is likely that the actual future occupants will be more sensitive to the GHG emissions caused by their activities and, therefore, their activities will result in lower GHG emissions than average current behavior shows.

1.1 Emissions Inventory

The VC emissions inventory considers the following categories of GHG emissions:

emissions due to land use (vegetation) changes,

emissions from construction activities,

residential building operations emissions,

non-residential building operations emissions,

mobile source operations emissions,

transit center-related emissions,

swimming pool-related emissions,

municipal operations emissions, and

area sources (fireplaces and lawn maintenance) emissions.

In addition, an estimate of "life-cycle" GHG emissions from building materials is presented. Life cycle emissions include all of the emissions caused by the existence of a product or project; for example, GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure. This estimate is to be used for comparison purposes only and is not included in the final inventory as these emissions would be accounted for under California Global Warming Solutions Act of 2006 (AB 32) in other industry sectors. In addition,

[4] The WMO and the UNEP established the IPCC in 1988; it is open to all members of the United Nations and WMO.

life-cycle analyses inherently involve many uncertainties. For example, in a life-cycle analysis for building materials, somewhat arbitrary boundaries must be drawn to define the processes considered in the life-cycle analysis.[5] Although life-cycle emission estimates can provide a broader view of a project's emissions, life cycle analyses often double count emissions that might be attributable to other sectors in a comprehensive analysis. The applicability of information to a specific geographic location, climatic zone and building type can influence the life-cycle GHG emissions. Further uncertainty of life-cycle analyses come from some basic choices, such as the useful life of a building or road, which can substantially change the outcome of the life-cycle analysis.

The inventory does not consider GHG emissions from sources outside of VC that may indirectly service VC residents (e.g., a landfill) or whether the emissions from VC are "new" in the sense that, absent the development of VC, these emissions may not occur. However, emissions from electricity use and construction worker commuting are included.

The timeframe over which GHGs are emitted varies from category to category, which is taken into consideration in the emissions inventory. For most of the categories, GHGs will be emitted every year that the development is inhabited. For these categories (residential buildings, non-residential buildings, mobile sources, municipal services, and area sources), the inventory includes estimates of annual GHG emissions from ongoing development operations. GHG emissions from two of the categories, construction and changes in vegetation, are one-time events that will not be part of the project's ongoing activity. These one-time emissions can be divided by the estimated lifetime of the project to allow direct comparison of these two emissions classes. The inventory presents estimates of these one-time emissions, converts them to annualized estimates, and integrates them into an annual inventory.

It is worth noting that the GHG emissions estimates assume there are no reductions in GHG-generating activities over time. This is clearly unlikely, and presents a conservative analysis, given the expected reductions in GHG emissions from most activities that will take place over the years due to future regulations, greater public awareness and the likely increasing costs of energy. For example, the emissions estimate for electricity consumption assumes that there will not be an increase in energy production from renewables or non-GHG producing sources beyond currently adopted regulations; this is not realistic, given the mandates of AB 32, and other regulatory development, as discussed later in this report.

A variety of methods are employed to develop a complete GHG emissions inventory. In addition to well established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several emissions estimation software programs are used. These include EMFAC, OFFROAD, and Urban Emissions Model

[5] For instance, in the case of building materials, the boundary could include the energy to make the materials, the energy used to make the machine that made the materials, and the energy used to make the machine that made the machine that made the materials.

(URBEMIS). Later sections of the report describe these models and other estimation methods. The major emissions sources that exist in residential developments are described later in this report.

1.2 Comparison of GHG Emissions

To date, the SCAQMD and CARB have not established significance thresholds for GHG emissions under the California Environmental Quality Act (CEQA) [6].

However, the recent amendments to the CEQA Guidelines adopted by the California Natural Resources Agency, and specifically the addition of CEQA Guidelines section 15064.4, subdivision (b), provide[7]:

> A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:
>
> (1) The extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting;
>
> (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;
>
> (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. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

To evaluate VC's GHG emissions, the VC inventory is compared with a California Air Resources Board 2020 No Action Taken (CARB 2020 NAT) scenario to determine if the development is likely to be consistent with rules propagated for California to meet its 2020 emissions reduction goal by the California Air Resources Board (CARB). In addition to absolute emissions, emissions per capita are compared with the current average per capita emissions of California

[6] Both SCAQMD and ARB have recently released proposed significance thresholds, but these have not been finalized at this time.

[7] The amendments to the CEQA Guidelines will not be effective until the Office of Administrative Law completes its review of the adopted amendments and rulemaking file, and transmits the adopted amendments to the Secretary of State for inclusion in the California Code of Regulations.

residents. Finally, to understand the large-scale significance of VC's GHG emissions, the inventory is compared to state, national and global inventories.

1.3 Report Description

This report contains seven sections. Following this introduction, Sections 2 and 3 detail the state of climate change science and the regulatory setting. Section 4 presents the results of the VC GHG Inventory. Section 5 compares these results to various benchmarks to gain perspective on what impact the VC development will have on overall GHG emissions. Section 6 generally discusses Executive Order S-03-5, which sets GHG targets for 2050. Finally, the main findings from the report are summarized in the conclusion, Section 7.

2. State of Science

This section summarizes the scientific issues surrounding climate change and global warming. It also provides a discussion of the actions and phenomena that contribute to climate change and puts into context global, national, and state emissions of GHGs.

2.1 Global Climate Change

Global warming and *global climate change* are both terms that describe changes in the earth's climate. *Global climate change* is a broad term used to describe any worldwide, long-term change in the earth's climate. This change could be, for example, an increase or decrease in temperatures, the start or end of an ice age, or a shift in precipitation patterns. The term *global warming* is more specific than *global climate change* and refers to a general increase in temperatures across the earth. Though global warming is characterized by rising temperatures, it can cause other climatic changes, such as a shift in the frequency and intensity of rainfall or hurricanes. Global warming does not necessarily imply that all locations will be warmer. Some specific, unique locations may be cooler even though the world, on average, is warmer. All of these changes fit under the umbrella of global climate change.[8]

While global warming can be caused by natural processes, there is a general scientific consensus that most current global warming is the result of human activity on the planet.[9] This man-made, or anthropogenic, warming is primarily caused by increased emissions of "GHGs" that keep the earth's surface warm. This is called "the greenhouse effect." The greenhouse effect and the role GHGs play in it are described below.

2.2 The Greenhouse Effect

Greenhouses allow sunlight to enter and then capture some of the heat generated by the sunlight's impact on the earth's surface. The earth's atmosphere acts like a greenhouse by allowing sunlight in, but trapping some of the heat that reaches the earth's surface. When solar radiation from the sun reaches the earth, much of it penetrates the atmosphere to ultimately reach the earth's surface; this solar radiation is absorbed by the earth's surface and then re-emitted as heat in the form of infrared radiation.[10] Whereas the GHGs in the atmosphere let solar radiation through, the infrared radiation is trapped by greenhouses gases, resulting in the warming of the earth's surface.[11] This phenomenon is referred to as the "greenhouse effect".

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[8] Other definitions of "Greenhouse Effect" and "Global Warming" can be found on Merriam-Webster online: http://www.m-w.com/. A definition for "Climate Change" can be found on dictionary.com which uses Webster's New Millennium™ Dictionary of English, Preview Edition (v 0.9.6).

[9] From the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers." Available online at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

[10] All light, be it visible, ultraviolet, or infrared, carries energy.

[11] Infrared radiation is characterized by longer wavelengths than solar radiation. Greenhouse gases reflect radiation with longer wavelengths. As a result, instead of escaping back into space, greenhouse gases reflect much infrared

The earth's greenhouse effect has existed far longer than humans have and has played a key role in the development of life. Concentrations of major GHGs, such as CO_2, CH_4, N_2O, and water vapor have been naturally present for millennia at relatively stable levels in the atmosphere, adequate to keep temperatures on Earth hospitable. Without these GHGs, the earth's temperature would be too cold for life to exist.

As human industrial activity has increased, atmospheric concentrations of certain GHGs have grown dramatically. Figure 2-1 shows the increase in concentrations of CO_2 and CH_4 over time. In the absence of major industrial human activity, natural processes have maintained atmospheric concentrations of GHGs, and, therefore, global temperatures at constant levels over the last several centuries.[12] As the concentrations of GHGs increase due to human activity, more infrared radiation is trapped, and the earth is heated to higher temperatures. This is the process that is described as human-induced global warming.

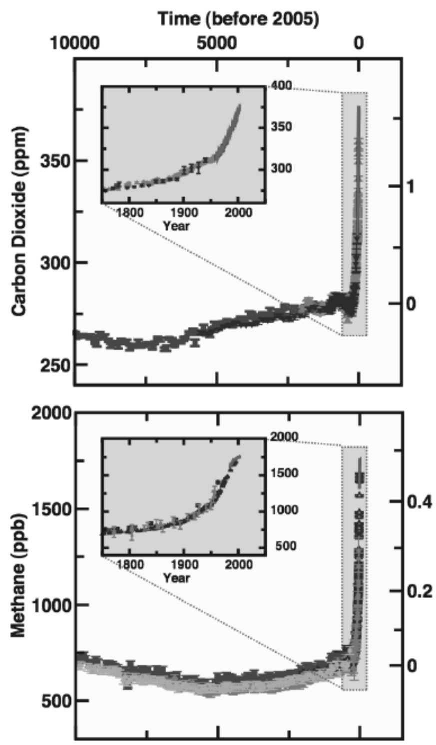

Figure 2-1. Carbon dioxide and methane concentrations have increased dramatically since the industrial revolution.[13]

radiation (i.e., heat) back to Earth.

[12] Examples of natural processes include the addition of GHGs to the atmosphere from respiration, fires, and decomposition of organic matter. The removal of greenhouse gases is mainly from plant and algae growth and absorption by the ocean.

[13] Adapted from figure SPM-1 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers." Available online at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

In 2007, the IPCC began releasing components of its Fourth Assessment Report on climate change. In February 2007, the IPCC provided a comprehensive assessment of climate change science in its Working Group I Report.[14] It states that there is a scientific consensus that the global increases in GHGs since 1750 are mainly due to human activities such as fossil fuel use, land use change (e.g., deforestation), and agriculture. In addition, the report states that it is likely that these changes in greenhouse gas concentrations have contributed to global warming. Confidence levels of claims in this report have increased since 2001 due to the large number of simulations run and the broad range of available climate models.

2.3 Greenhouse Gases and Sources of Their Emissions

The term "GHGs" includes gases that contribute to the natural greenhouse effect, such as CO_2, CH_4, N_2O, and water, as well as gases that are only man-made and that are emitted through the use of modern industrial products, such as hydrofluorocarbons (HFCs), chlorinated fluorocarbons (CFCs), and sulfurhexafluoride (SF_6). These last three families of gases, while not naturally present in the atmosphere, have properties that also cause them to trap infrared radiation when they are present in the atmosphere, thus making them GHGs. These six gases comprise the major GHGs that are recognized by the Kyoto Accords (water is not included).[15,16] There are other GHGs that are not recognized by the Kyoto Accords, due either to the smaller role that they play in climate change or the uncertainties surrounding their effects. Atmospheric water vapor is not recognized by the Kyoto Accords because there is not an obvious correlation between water concentrations and specific human activities. Water appears to act in a positive feedback manner; higher temperatures lead to higher water concentrations, which in turn cause more global warming.[17]

The effect each of these gases has on global warming is a combination of the volume of their emissions and their GWP. GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent than CO_2, with GWPs of 21 and 310, respectively. However, these natural GHGs are nowhere near as potent as SF_6 and fluoromethane, which have GWPs of up to 23,900 and 6,500 respectively.[18] GHG emissions are typically measured in terms of mass of CO_2e. CO_2e are calculated as the product of the mass of a given GHG and its specific GWP.

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[14] Available online at: http://www.ipcc.ch/ipccreports/ar4-wg1.htm

[15] The state of California and the USEPA Federal Reporting rule requires quantification of a seventh class of GHGs, the inorganic trifluorides, best represented by nitrogen trifluoride.

[16] This Kyoto Protocol sets legally binding targets and timetables for cutting the greenhouse-gas emissions of industrialized countries. The US has not approved the Kyoto treaty.

[17] From the IPCC Third Assessment Report: http://www.grida.no/climate/ipcc_tar/wg1/143.htm and http://www.grida.no/climate/ipcc_tar/wg1/268.htm

[18] California Climate Action Registry General Reporting Protocol - Reporting Entity-Wide Greenhouse Gas Emissions. SAR values, Appendix C. http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf

The most important greenhouse gas in human-induced global warming is CO_2. While many gases have much higher GWPs than the naturally occurring GHGs, CO_2 is emitted in such vastly higher quantities that it accounts for 85% of the GWP of all GHGs emitted by the United States.[19] Fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles, has led to substantial increases in CO_2 emissions and thus substantial increases in atmospheric CO_2 concentrations. In 2005, atmospheric CO_2 concentrations were about 379 parts per million (ppm), over 35 percent higher than the pre-industrial concentrations of about 280 ppm.[20] In addition to the sheer increase in the volume of its emissions, CO_2 is a major factor in human-induced global warming because of its lifespan in the atmosphere of 50 to 200 years.

Concentrations of the second most prominent GHG, CH_4, have also increased due to human activities such as rice production, degradation of waste in landfills, cattle farming, and natural gas mining. In 2005, atmospheric levels of CH_4 were more than double pre-industrial levels, up to 1774 parts per billion (ppb) as compared to 715 ppb.[21] CH_4 has a relatively short atmospheric lifespan of only 12 years, but has a higher GWP than CO_2.

Nitrous oxide concentrations have increased from about 270 ppb in pre-industrial times to about 319 ppb by 2005.[22] Most of this increase can be attributed to agricultural practices (such as soil and manure management), as well as fossil-fuel combustion and the production of some acids. Nitrous oxide's 120-year atmospheric lifespan increases its role in global warming.

Besides CO_2, CH_4, and N_2O; there are several gases and categories of gases that were not present in the atmosphere in pre-industrial times but now exist and contribute to warming. These include CFCs, used often as refrigerants, and their more stratospheric-ozone-friendly replacements, HFCs. Fully fluorinated species, such as SF_6 and tetrafluoromethane (CF_4), are present in the atmosphere in relatively small concentrations, but have extremely long life spans of 50,000 and 3,200 years each, making them potent GHGs.

2.4 Current and Projected Climatic Impacts of Global Warming

A strong indication that global warming is currently taking place is the fact that the top seven warmest years since the 1890s occurred after 1997. Furthermore, a warming of about 0.2°C per decade is projected by currently accepted models.

There is a scientific consensus that global climate change will increase the frequency of heat extremes, heat waves, and heavy precipitation events. Other likely direct effects include an increase in the areas affected by drought and by floods, an increase in tropical cyclone activity, a rise in sea level, and recession of polar ice caps. The impacts of global warming have already

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19 Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006, U.S. Environmental Protection Agency. Available online at: http://epa.gov/climatechange/emissions/downloads/08_CR.pdf

20 Page 2 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."

21 Page 4 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."

22 Page 4 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."

been demonstrated by substantial ice loss in the Arctic.[23] Figure 2-2 shows the rise of global temperatures, the global rise of sea level, and the loss of snow cover from 1850 to the present.

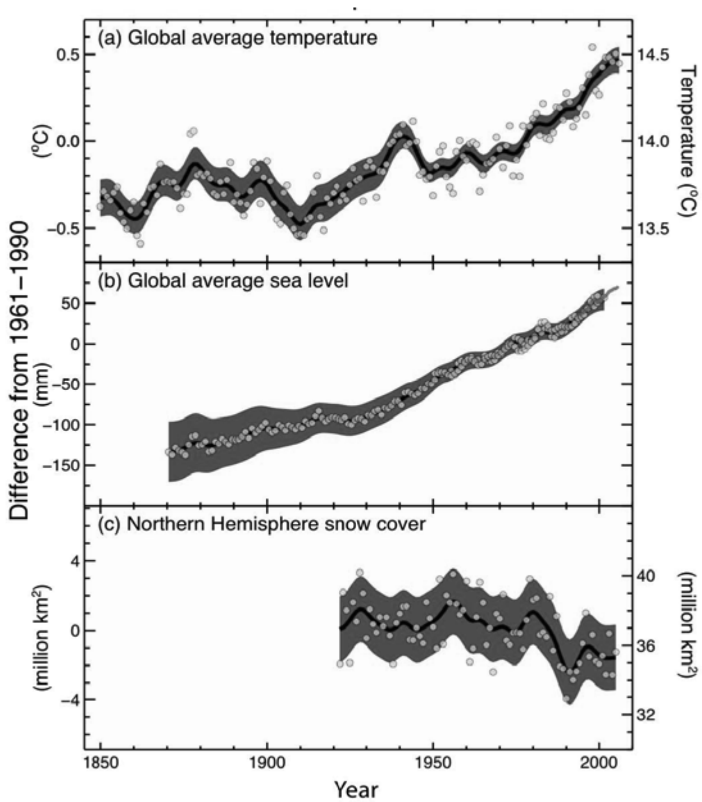

Figure 2-2. Global warming trends and associated sea level rise and snow cover decrease.[24]

2.5 Socioeconomic Impacts of Global Warming

Global temperature increases may have significant negative impacts on ecosystems, natural resources, and human health. Ecosystem structure and biodiversity will be compromised by temperature increases and associated climatic and hydrological disturbances.[25] The availability and quality of potable water resources may be compromised by increased salinisation of ground

[23] Statistics from IPCC Working Group I and II Reports.
[24] Figure SPM-3 of the IPCC "Climate Change 2007: The Physical Science Basis, Summary for Policymakers."
[25] From the IPCC Working Group II Report.

water due to sea-level rises, decreased supply in semi-arid and arid locations, and poorer water quality arising from increased water temperatures and more frequent floods and droughts.[26] These impacts on freshwater systems, in addition to the effects of increased drought and flood frequencies, can reduce crop productivity and food supply.

In addition to compromising food and water resources, there are other means through which climatic changes associated with global warming can affect human health and welfare. Warmer temperatures can cause more ground-level ozone, a pollutant that causes eye irritation and respiratory problems. Ranges of infectious diseases will likely increase, and some areas will face greater incidences of illness and mortality associated with increased flooding and drought events.

In its April 2007 Working Group II Report, the IPCC provided an assessment of the "current scientific understanding of impacts of climate change on natural, managed and human systems, the capacity of these systems to adapt and their vulnerability".[27] Here, the IPCC states that although some people will gain and some will lose because of global climate change, the overall change will be one of social and economic losses. California in particular is an area that could be negatively impacted by global warming. Global warming could alter the seasonal pattern of snow accumulation and snowmelt, which serve as primary sources for California's drinking water and irrigation water supplies. The scientific community projects extensions in the periods of high forest fire risk. Climatic changes would also affect agriculture, a major California industry, which could result in economic losses. For example, the heat wave in July 2006 is estimated to have cost the California dairy industry in excess of one billion dollars.[28]

IPCC Fourth Assessment Report

It is important to recognize that the climatic conditions experienced by the Project over its designed lifetime are likely to be substantially different from those observed over the past century. Consequently, it is useful to consider the implications of changing climatic conditions for Project performance. Scenarios[29] for 2100 modeled in the IPCC Fourth Assessment Report (FAR) include:

Temperature Increase

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[26] From the IPCC Technical Paper VI: "Climate Change and Water". Available online at: http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf
[27] Available online at: http://www.ipcc-wg2.org/index.html
[28] Office of the Governor.
[29] Future GHG emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change. Their future evolution is highly uncertain. Scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including climate modeling and the assessment of impacts, adaptation, and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain. More information on the IPCC's selection of scenarios is available at http://www.ipcc.ch/ipccreports/sres/emission/index.htm.

- Low Emissions Scenario: 1.8°C (best estimate), with a range of 1.1°C to 2.9°C
- High Emissions Scenario: 4.0°C (best estimate), with a range of 2.4°C to 6.4°C

Sea Level Rise

- Low Emissions Scenario: 0.18 to 0.38 meters (range)
- High Emissions Scenario: 0.26 to 0.59 meters (range)

Potential implications for the Project include:

Sea level: Rising sea levels are unlikely to directly impact the proposed Project due to its distance from the coast and relative elevation.

Temperature: Rising temperatures could have a variety of impacts, including stress on sensitive populations (e.g., sick and elderly), additional burden on building systems (e.g., demand for conditioning), and, indirectly, increasing emissions of greenhouse gases and criteria pollutants associated with energy generation. It is not possible to reliably quantify these risks at this time.

Precipitation: Climate change is expected to alter seasonal and inter-annual patterns of precipitation. These changes continue to be one of the most uncertain aspects of future scenarios. For this Project, the most relevant direct impacts are likely to be changes in the timing and volume of storm water runoff and changes in demand for irrigation. It is not possible to reliably quantify the implications of these changes at this time.

Wildfire: Changes in temperature and precipitation may combine to alter risks of wildfire. Changes in wildfire hazard have the potential to impact the Project; however, it is not possible to reliably quantify the implications of these changes at this time.

Water supply reliability: Changes in temperature and precipitation may also influence seasonal and inter-annual availability of water supplies. Consequently, it is reasonable to consider that climate change may affect water supply reliability. It is not possible to reliably quantify these risks for the Project at this time. For more information on the Project's water supply, please refer to Section 5.18, Water Resources, and the Water Supply Assessment in the EIR.

2.6 Impacts from Climate Change

The California's Natural Resources Agency (CNRA)[30] recently prepared a document that discusses the impacts of climate change upon California, as well as California's climate adaptation strategy. The categories below are topics emphasized in the November 2008 Executive Order (S-13-08) which called on state agencies to develop California's first strategy to

[30] 2009 California Climate Adaptation Strategy. Discussion Draft. California Natural Resources Agency.

identify and prepare for these expected climate impacts. Adaptation strategies are addressed in the next section of this technical report.

2.6.1 Rising Temperatures

CRNA described new projections by MIT modelers predict a median probability of surface warming of 5.2 C by 2100, which is much higher than previous modeling completed in 2003. [31] Researchers modeled temperature changes specifically related to California.[32] The model predicted greater temperature increases in summer than winter, and larger increases inland compared to the coast.

2.6.2 Tipping Elements

The CNRA emphasized “tipping elements”, which bring about “abrupt changes that could push natural systems past thresholds beyond which they could not recover”. According to the CNRA, there are four main events that could bring about abrupt environmental changes. Each of these four has a particular tipping temperature at which the event is likely to occur. The consequence of crossing each threshold could cause a 7-12 m rise in sea level over the course of several centuries as shown in the table below.

Tipping elements that could trigger abrupt environmental changes.

Additional Warming (ºF)	Environmental Change	Length of Time
1-3	Rapid Arctic sea ice melt	10 years
2-4	Irreversible melting of the Greenland Ice Sheet	300 years or more
5-9	Irreversible melting of the West Antarctic Ice Sheet	300 years or more
5-7	Amazon forest die-back	None given
6-11	Intensification of El Niño Southern Oscillation cycles	None given

[31] Chandler, D. 2009. Climate change odds much worse than thought: New analysis shows warming could be double previous estimates. MIT News Office. May 19, 2009. Website: http://web.mit.edu/newsoffice/2009/roulette-0519.html

[32] Incorporated by reference. Moser, Susanne, Guido Franco, Sarah Pittiglio, Wendy Chou and Dan Cayan (2008). The Future is Now: An Update on Climate Change Science Impacts and Response Options for California. 2008 Climate Change Impacts Assessment Project - Second Biennial Science Report to the California Climate Action Team, CEC-500-2008-071, Sacramento, CA.

2.6.3 Extreme Natural Events

In addition, CRNA listed extreme natural events are likely to occur, including higher nighttime temperatures and longer, more frequent heat waves overall; 12-35% decrease in precipitation levels by mid- to late-21st century; increased evaporation and faster incidences of snowmelt that will increase drought conditions, and more precipitation in the form of rain as compared to snow that will decrease water storage in California during the dry season and increase flood events during the wet season.[33]

2.6.4 Precipitation Changes and Rivers

CNRA also stated that climate change will intensify California's "Mediterranean climate pattern", with the majority of annual precipitation occurring between November and March and drier conditions during the summer.[34] This will increase droughts and floods and will affect river systems. One of the ways to quantify potential impacts related to river system was through calculating a rise in water temperature and its effects on fisheries resources.[35]

2.6.5 Sea Level Rise

CNRA states that sea level rise can cause damage to coastal communities and loss of land, which could reach tens of billions of dollars per year in direct costs and trillions of dollars of assets in collateral risk.[36] Current calculations of sea level rise from 1900 to 2000 estimate approximately 7 inches along the California coast.[37] Further, up to 55 inches of sea-level rise globally by the end of the 21st century is predicted under the "business as usual" model.

2.6.6 Low Sea Ice Levels

The CNRA states says that substantial sea ice melting from Greenland and the West Antarctic Ice Sheet has the potential to further raise sea levels. The sea ice extent in the Western Nordic Seas (i.e., Greenland, Norway, and Iceland Seas) is at the lowest level observed in the last 800 years. The implication being that a substantial reduction in sea ice in the Arctic sea promotes alterations in atmospheric circulation and precipitation patterns that extend to the mid-latitudes (e.g., the California coast). Additionally, it was reported that the variations in sea ice extent are

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[33] Cayan, Dan, Mary Tyree, Mike Dettinger, Hugo Hidalgo, Tapash Das, Ed Maurer, Peter Bromirski, Nicholas Graham, and Reinhard Flick (2009). Climate Change Scenarios and Sea Level Rise Estimates for the California 2008 Climate Change Scenarios Assessment. PIER Research Report, CEC-500-2009-014, Sacramento, CA: California Energy Commission.

[34] Cayan et al. 2009

[35] Crossin, G.T., S.G. Hinch, S.J. Cooke, D.W. Welch, D.A. Patterson, S.R.M. Jones, A.G. Lotto, R.A. Leggatt, M.T. Mathes, J.M. Shrimpton, G. Van Der Kraak and A.P. Farrell. 2008. Exposure to high temperature influences the behaviour, physiology, and survival of sockeye salmon during spawning migration. Canadian Journal of Zoology. 86(2): 127-140.

[36] Kahrl, F. and D. Roland-Holst (2008). California Climate Risk and Response. Berkeley, CA: University of California-Berkeley, Department of Agricultural and Resource Economics.

[37] Cayan et al. 2009

correlated with changes in sea surface temperatures and atmospheric and ocean heat transport from the North Atlantic.[38]

The West Antarctic Ice Sheet is a marine-based ice sheet with edges that flow into floating ice shelves. Both the main sheet and the surrounding shelves have been showing signs of shrinking and collapsing due to global warming. Researchers have tracked the fate of at least nine shelves that have receded or collapsed around the Antarctic peninsula in the past 50 years.[39]

2.6.7 Ocean Chemistry

The CRNA also notes that an emerging effect from climate change may be acidification of the ocean. In turn, acidification will affect the ability of hard-shelled invertebrates to create their skeletal structures.[40] The implications of this change being major losses to shellfish industries, and shifts in food resources for ocean fisheries. The primary contributing factors were cited as increasing level of CO_2 and weather pattern shifts. Increases in CO_2 result in increased uptake by the oceans, which result in decreased pH (acidification). Weather pattern shifts change the amount of calcium carbonate being delivered by rivers from sources stored in rocks, which further exacerbates the ability of invertebrates to form calcified shells.[41]

One of the main contributing factors to CO_2, outside of human influences, is melting permafrost. When permafrost thaws, it releases carbon into soil or beneath lakes and releases CO_2 and methane into the atmosphere. Scientists are now estimating that there is more than twice the total amount of carbon stored in permafrost as there is in atmospheric carbon dioxide, and "could amount to roughly half those resulting from global land-use change during this century".[42]

2.7 California-Specific Adaptation Strategies

The CNRA[43] discusses California's climate adaptation strategy. General themes from the report regarding adaptation strategies are summarized below although the report also includes many specific examples of how California may adapt to a changing climate.

Because climate change is already affecting California and current emissions will continue to drive climate change in the coming decades, regardless of any mitigation measured that may be

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[38] Fauria, M.M., A. Grinsted, S. Helama, J. Moore, M. Timonen, T. Martma, E. Isaksson, and E. Eronen. 2009. Unprecedented low twentieth century winter sea ice extent in the Western Nordic Seas since A.D. 1200. Climate Dynamics. Published online: 12 June 2009.

[39] Doyle, A. 2009. Antarctic ice shelf set to collapse due to warming. Roche, A. (ed.) In Reuters UK. Thomas Reuters. January 19, 2009. Website: http://uk.reuters.com/articlePrint?articleId=UKTRE50I4G520090119

[40] Risien, J. (ed.). 2009. West Coast Regional Marine Research and Information Needs. Corvallis, Oregon: Oregon Sea Grant. ORESU-Q-09-001.

[41] Griffith, E.M., A. Paytan, K. Caldeira, T. D. Bullen and E. Thomas. 2008. A dynamic marine calcium cycle during the past 28 million years. Science. December 12, 2008.

[42] Schuur, E.A.G. et al. 2008. Vulnerability of Permafrost Carbon to Climate Change: Implications for the Global Carbon Cycle. BioScience. 58(8): 701-714.

[43] 2009 California Climate Adaptation Strategy. Discussion Draft. California natural Resources Board.

adopted, the necessity of adaptation to the impacts of climate change is recognized by the state of California. The *2009 California Climate Adaptation Strategy Discussion Draft* begins what will be on-going process of adaptation, as directed by Gov. Schwarzenegger's Executive Order S-13-08. The goals of the strategy are to analyze risks and vulnerabilities and identify strategies to reduce the risks. Once the strategies are identified and prioritized, government resources would be identified. Finally, the strategy includes identifying research needs and educating the public.

Climate change risks are evaluated using two distinct approaches: (1) projecting the amount of climate change that may occur using computer-based global climate models and (2) assessing the natural or human system's ability to cope with and adapt to change by examining past experience with climate variability and extrapolating this to understand how the systems may respond to the additional impact of climate change. The major anticipated climate changes expected in the State of California include increases in temperature, decreases in precipitation, particularly as snowfall, and increases in sea level, as discussed above. These gradual changes will also lead to an increasing number of extreme events, such as heat waves, wildfires, droughts, and floods. This would impact public health, ocean and coast resources, water supply, agriculture, biodiversity and the transportation and energy infrastructure.

Key preliminary adaptation recommendations included in the *Strategy* are as follows:

- Appointment of a Climate Adaptation Advisory Panel;
- Improved water management in anticipation of reduced water supplies, including a 20% reduction in per capita water use by 2020;
- Consideration of project alternatives that avoid significant new development in areas that cannot be adequately protected from flooding due to climate change;
- Preparation of agency-specific adaptation plans, guidance or criteria by September 2010;
- Consideration of climate change impacts for all significant state projects;
- Assessment of climate change impacts on emergency preparedness;
- Identification of key habitats and development of plans to minimize adverse effects from climate change;
- Development of guidance by the California Department of Public Health by September 2010 for use by local health departments to assess adaptation strategies;
- Amendment of Plans to assess climate change impacts and develop local risk reduction strategies by communities with General Plans and Local Coastal Plans; and
- Inclusion of climate change impact information into fire program planning by state fire fighting agencies.

2.8 Global, National, and California-wide GHG Emissions Inventories

Worldwide emissions of GHGs in 2004 were 26.8 billion tonnes of CO_2e.[44] In 2007, the US emitted about 7 billion tonnes of CO_2e or about 24 tonnes of CO_2e per year per person.[45] Over 80% of the GHG emissions in the US are comprised of CO_2 emissions from energy related fossil fuel combustion. In 2004, California emitted 0.492 billion tonnes of CO_2e, or about 7% of the US emissions.[46] If California were a country, it would be the 16th largest emitter of GHGs in the world.[47] This large number is due primarily to the sheer size of California. Compared to other states, California has one of the lowest per capita GHG emission rates in the country. This is due to California's higher energy efficiency standards, its temperate climate, and the fact that it relies on substantial out-of-state energy generation.

In 2004, 81% of greenhouse gas emissions (in CO_2e) from California were comprised of CO_2 emissions from fossil fuel combustion, with 4% comprised of CO_2 from process emissions. CH_4 and N_2O accounted for 5.7% and 6.8% of total CO_2e respectively, and high GWP gases[48] accounted for 2.9% of the CO_2e emissions. Transportation is by far the largest end-use category of GHG emissions. Transportation includes that used for industry (i.e., shipping) as well as residential use.

2.9 Potential for Reduction of GHG Emissions

In May 2007, the IPCC produced its Working Group III Report on the "scientific, technological, environmental, economic and social aspects" of reducing GHG emissions to alleviate climate change.[49] The report concluded that, even with current policies for sustainable development and mitigation of climate change, global GHG emissions will continue to grow over the next several decades.

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44 Sum of Annex I and Annex II countries without counting Land-Use, Land-Use Change and Forestry (LULUCF) http://unfccc.int/ghg_emissions_data/predefined_queries/items/3814.php For countries for which 2004 data was unavailable, the most recent year was used.

45 2006 Inventory of U.S. Greenhouse Gas Emissions and Sinks. Available online at: http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR6MBLP4/$File/06ES.pdf

46 California Air Resources Board. Note that 2004 is typically the most recent inventory year presented by the ARB; as such, USA- and world-wide emissions from 2004 are presented here to keep the comparison years the same.

47 Anywhere between the 12th and 16th depending upon methodology. Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004. California Energy Commission.

48 Such as HFCs and PFCs.

49 Available online at: http://www.ipcc.ch/ipccreports/ar4-wg3.htm

3. Regulatory Setting

Climate change has only recently been widely recognized as a threat to the global climate, economy and population. As a result, the climate change regulatory setting – federal, state and local – is complex and evolving. This section identifies key legislation, executive orders, and seminal court cases related to climate change germane to VC GHG emissions.

3.1 Federal Action on Greenhouse Gas Emissions

3.1.1 Bush-Era national Policy Goal

In 2002, President George W. Bush set a national policy goal of reducing the GHG emission intensity (tons of GHG emissions per million dollars of gross domestic product) of the U.S. economy by 18% by 2012. No binding reductions were associated with the goal. Rather, the United States Environmental Protection Agency (USEPA) administers a variety of voluntary programs and partnerships with GHG emitters in which the USEPA partners with industries producing and utilizing synthetic GHGs to reduce emissions of these particularly potent GHGs.

3.1.2 April 2007 Supreme Court Ruling

In *Massachusetts et al. vs. Environmental Protection Agency et al.* (April 2, 2007) the U.S. Supreme Court ruled that the Clean Air Act authorizes the USEPA to regulate CO_2 emissions from new motor vehicles. The Court did not mandate that the USEPA enact regulations to reduce GHG emissions, but found that the USEPA could only not take action if it found that GHGs do not contribute to climate change or if it offered a "reasonable explanation" for not determining that GHGs contribute to climate change. On April 24, 2009 the USEPA issued a proposed endangerment finding, stating that high atmospheric levels of greenhouse gases "are the unambiguous result of human emissions, and are very likely the cause of the observed increase in average temperatures and other climatic changes." The USEPA further found that "atmospheric concentrations of greenhouse gases endanger public health and welfare within the meaning of Section 202 of the Clean Air Act." The USEPA announced that the proposed finding was adopted on December 7, 2009; while the finding itself does not impose any requirements on industry or other entities, it does enable the USEPA to adopt regulations designed to reduce greenhouse gas emissions.[50] In late December 2009, a legal action was filed challenging adoption of the endangerment finding.

3.1.3 Corporate Average Fuel Efficiency Standards

In response to the *Massachusetts et al. vs. Environmental Protection Agency et al.* ruling, the Bush Administration issued an executive order on May 14, 2007, directing the USEPA and Departments of Transportation (DOT) and Energy (DOE) to establish regulations that reduce GHG emissions from motor vehicles, non-road vehicles, and non-road engines by 2008. On December 19, 2007, the Energy Independence and Security Act of 2007 (EISA) (discussed

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[50] Available at http://www.epa.gov/climatechange/endangerment.html

below) was signed into law, which requires an increased Corporate Average Fuel Economy (CAFE) standard of 35 miles per gallon for the combined fleet of cars and light trucks by model year 2020. EISA requires establishment of interim standards (from 2011 to 2020) that will be the "maximum feasible average fuel economy" for each fleet. On October 10, 2008, the National Highway Traffic Safety Administration (NHTSA) released a final environmental impact statement analyzing proposed interim standards for model years 2011 to 2015 passenger cars and light trucks. NHTSA issued a final rule for model year 2011 on March 23, 2009.[51]

On May 19, 2009, President Obama announced a national policy for fuel efficiency and emissions standards in the U.S. auto industry. The proposed rulemaking is a collaboration between the DOT and USEPA with the support of the United Auto Workers. The proposed federal standards apply to passenger cars, light-duty trucks, and medium duty passenger vehicles built in model years 2012 through 2016. If finalized, the proposed rule would surpass the 2007 CAFE standards and require an average fuel economy standard of 35.5 mpg in 2016. On May 22, 2009, the DOT and USEPA issued a notice of upcoming joint rulemaking on this issue.[52,53] On June 30, 2009 the USEPA granted the waiver for California for its greenhouse gas emission standards for motor vehicles; this is described in more detail below.

3.1.4 Energy Independence and Security Act of 2007

In addition to setting increased CAFE standards for motor vehicles, the EISA includes other provisions:

- Renewable Fuel Standard (RFS) (Section 202);
- Appliance and Lighting Efficiency Standards (Section 301–325);
- Building Energy Efficiency (Sections 411–441).

Additional provisions of the EISA address energy savings in government and public institutions, promoting research for alternative energy, additional research in carbon capture, international energy programs, and the creation of "green jobs."

3.1.5 Reporting Requirements

Congress passed "The Consolidated Appropriations Act of 2008" (HR 2764) in December 2007, which includes provisions requiring the establishment of mandatory GHG reporting requirements. The measure directs USEPA to publish draft rules by September 2008, and final rules by June 2009 mandating reporting "for all sectors of the economy." The USEPA published draft reporting rules on April 10, 2009, and final reporting rules were published in the Federal Register on October 30, 2009. The rules, effective December 29, 2009, require suppliers of

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[51] See http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.43ac99aefa80569eea57529cdba046a0/
[52] See http://yosemite.epa.gov/opa/admpress.nsf/6fa790d452bcd7f58525750100565efa/451902cb77d4add5852575bb006d3f9b!OpenDocument
[53] See http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.43ac99aefa80569eea57529cdba046a0/

fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions to submit annual reports to the USEPA.

3.2 Regional Agreements

3.2.1 Western Regional Climate Action Initiative (WCI)

The WCI is a partnership among seven states, including California, and four Canadian provinces that are implementing a regional, economy-wide cap-and-trade system to reduce global warming pollution. The WCI will cap the region's electricity, industrial, and transportation sectors with the goal of reducing the heat-trapping emissions that cause global warming 15% below 2005 levels by 2020. California is working closely with the other states and provinces to design a regional GHG reduction program that includes a cap-and-trade approach. CARB plans to develop a cap-and-trade program that will link California and the other member states and provinces.

3.3 California Legislation

California has enacted a variety of legislation that relates to climate change, much of which sets aggressive goals for GHG reductions within the state. However, none of this legislation provides definitive direction regarding the treatment of climate change in environmental review documents prepared under the CEQA. As discussed below, the California National Resources Agency (CNRA) and Office of Planning and Research (OPR) were directed to develop CEQA Guidelines for the mitigation of GHG emissions and their effects; and, the CNRA adopted amendments to the CEQA Guidelines on December 30, 2009, which will become effective at a later date.[54] In connection with these efforts, OPR recently released a guidance document, discussed below, for analyzing GHG emissions under CEQA, but this document is purely advisory and serves as guidance only.

In addition, on October 24, 2008, CARB released a draft staff proposal entitled "Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act" (Draft CARB Thresholds). More detail was provided in another document released on December 9, 2008. The Draft CARB Thresholds provide a framework for developing CEQA significance thresholds for industrial, commercial and residential projects. But as of the release date of this document, many details remain unresolved and the CARB Thresholds document is still in draft form.

The discussion below provides a brief overview of the CARB, CNRA, and OPR documents and of the primary legislation that relates to climate change which may affect the emissions associated with the proposed project.

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[54] See http://ceres.ca.gov/ceqa/guidelines/

3.3.1 Assembly Bill 32 (Statewide GHG Reductions)

The California Global Warming Solutions Act of 2006, widely known as AB 32, requires CARB to develop and enforce regulations for the reporting and verification of statewide greenhouse gas emissions. CARB is directed to set a greenhouse gas emission limit, based on 1990 levels, to be achieved by 2020. The bill sets a timeline for adopting a scoping plan for achieving greenhouse gas reductions in a technologically and economically feasible manner.

The heart of the bill is the requirement that statewide GHG emissions must be reduced to 1990 levels by 2020. California needs to reduce GHG emissions by approximately 28.4% below business-as-usual predictions of year 2020 GHG emissions to achieve this goal. The bill requires CARB to adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective GHG reductions. Key AB 32 milestones are as follows:

- June 30, 2007—Identification of discrete early action greenhouse gas emissions reduction measures. On June 21, 2007, CARB satisfied this requirement by approving three early action measures. These were later supplemented by adding six other discrete early action measures.
- January 1, 2008—Identification of the 1990 baseline GHG emissions level and approval of a statewide limit equivalent to that level. Adoption of reporting and verification requirements concerning GHG emissions. On December 6, 2007, CARB approved a statewide limit on GHG emissions levels for the year 2020 consistent with the determined 1990 baseline.
- January 1, 2009—Adoption of a scoping plan for achieving GHG emission reductions. On October 15, 2008, CARB issued a "discussion draft" Scoping Plan entitled "Climate Change Draft Scoping Plan: A Framework for Change" (Draft Scoping Plan). CARB adopted the Draft Scoping Plan at its December 11, 2008 meeting.
- January 1, 2010—Adoption and enforcement of regulations to implement the “discrete” actions.
- January 1, 2011—Adoption of GHG emissions limits and reduction measures by regulation.
- January 1, 2012—GHG emissions limits and reduction measures adopted in 2011 become enforceable.

3.3.2 Executive Order S-3-05 (Statewide GHG Targets)

California Executive Order S-03-05 (June 1, 2005) mandates a reduction of GHG emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80% below 1990 levels by 2050. Although the 2020 target is the core of AB 32, and has effectively been incorporated into AB 32, the 2050 target remains the goal of the Executive Order.

3.3.3 Low Carbon Fuel Standard (LCFS)

Executive Order S-01-07 (January 18, 2007) requires a 10% or greater reduction in the average fuel carbon intensity for transportation fuels in California regulated by CARB. CARB identified the LCFS as a Discrete Early Action item under AB 32, and the final resolution (09-31) was issued on April 23, 2009.[55]

3.3.4 Senate Bill 1368 (GHG Emissions Standard for Baseload Generation)

Senate Bill (SB) 1368 prohibits any retail seller of electricity in California from entering into a long-term financial commitment for baseload generation if the GHG emissions are higher than those from a combined-cycle natural gas power plant. This performance standard applies to electricity generated out-of-state as well as in-state, and to publicly owned as well as investor-owned electric utilities.

3.3.5 Assembly Bill 1493 (Mobile Source Reductions)

AB 1493 requires CARB to adopt regulations by January 1, 2005, to reduce GHG emissions from noncommercial passenger vehicles and light-duty trucks of model year 2009 and thereafter. The bill requires the CCAR to develop and adopt protocols for the reporting and certification of greenhouse gas emissions reductions from mobile sources for use by CARB in granting emission reduction credits. The bill authorizes CARB to grant emission reduction credits for reductions of greenhouse gas emissions prior to the date of enforcement of regulations, using model year 2000 as the baseline for reduction.

In 2004, CARB applied to the USEPA for a waiver under the federal Clean Air Act to authorize implementation of these regulations. The waiver request was formally denied by the USEPA in December 2007 after California filed suit to prompt federal action. In January 2008 the State Attorney General filed a new lawsuit against the USEPA for denying California's request for a waiver to regulate and limit GHG emissions from these automobiles. In January 2009, President Barack Obama issued a directive to the USEPA to reconsider California's request for a waiver. On June 30, 2009 the USEPA granted the waiver for California for its greenhouse gas emission standards for motor vehicles. As part of this waiver, EPA specified the following provision: CARB may not hold a manufacturer liable or responsible for any noncompliance caused by emission debits generated by a manufacturer for the 2009 model year.

3.3.6 Senate Bills 1078 and 107 (Renewables Portfolio Standard)

Established in 2002 under SB 1078 and accelerated in 2006 under SB 107, California's Renewables Portfolio Standard (RPS) requires retail suppliers of electric services to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 20% by 2010.

3.3.7 Executive Order S-14-08 and S-21-09 (Renewables Portfolio Standard)

California Executive Order S-14-08 (November 11, 2008) mandates retail suppliers of electric services to increase procurement from eligible renewable energy resources to 33% by 2020. This is a further increase in RPS over SBs 1078 and 107. In addition, on September 15, 2009,

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[55] See http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

Governor Schwarzenegger signed Executive Order S-21-09, which requires CARB, under its AB 32 authority, to adopt a regulation consistent with the 33 percent renewable energy target established in Executive Order S-14-08 by July 31, 2010.

3.3.8 Senate Bill 375 (Land Use Planning)

SB 375 provides for a new planning process to coordinate land use planning and regional transportation plans and funding priorities in order to help California meet the GHG reduction goals established in AB 32. SB 375 requires regional transportation plans, developed by Metropolitan Planning Organizations (MPOs) relevant to the project area (including the Southern California Association of Governments [SCAG])[56], to incorporate a "sustainable communities strategy" in their regional transportation plans that will achieve GHG emission reduction targets set by CARB. SB 375 also includes provisions for streamlined CEQA review for some infill projects such as transit oriented development. SB 375 will be implemented over the next several years.

SB 375 is similar to the Regional Blueprint Planning Program, established by the California Department of Transit, which provides discretionary grants to fund regional transportation and land use plans voluntarily developed by MPOs working in cooperation with Council of Governments. The Metropolitan Transportation Commission (MTC) is currently developing its 2009 Regional Transit Plan (RTP) with AB 32 goals in mind, and its 2013 RTP will be its first plan subject to SB 375. The Scoping Plan adopted by CARB in December of 2008 relies on the requirements of SB 375 to implement the carbon emission reductions anticipated from land use decisions.

3.3.9 Energy Conservation Standards

Energy Conservation Standards for new residential and non-residential buildings were first adopted by California Energy Resources Conservation and Development Commission in June 1977 and most recently revised in 2008 (Title 24, Part 6 of the California Code of Regulations [CCR]). The 2008 standards became effective on January 1, 2010. In general, Title 24 requires the design of building shells and building components to conserve energy. The standards are updated periodically to allow for consideration and possible incorporation of new energy efficiency technologies and methods.

California's 2009 Appliance Efficiency Regulations were adopted by the California Energy Commission on December 3, 2008, and approved by the California Office of Administrative Law on July 10, 2009. The regulations include standards for both federally-regulated appliances and non-federally regulated appliances. While these regulations are now often seen as “business as usual,” they do exceed the standards imposed by any other state and reduce GHG emissions by reducing energy demand.

[56] See http://www.scag.ca.gov/region/index.htm

On July 17, 2008, the California Building Standards Commission adopted the nation's first green building standards. The California Green Building Standards Code (proposed Part 11, Title 24) was adopted as part of the California Building Standards Code (Title 24, California Code of Regulations). Part 11 establishes voluntary standards, that will become mandatory in the 2010 edition of the Code, on planning and design for sustainable site development, energy efficiency (in excess of the California Energy Code requirements), water conservation, material conservation, and internal air contaminants.

3.3.10 Office of Planning and Research Advisory on CEQA and Climate Change

In June 2008, the OPR published a Technical advisory entitled *CEQA and Climate Change: Addressing Climate Change Through CEQA* (OPR Advisory). This guidance, which is purely advisory, proposes a three-step analysis of GHG emissions:

1. *Mandatory Quantification of GHG Project Emissions.* The environmental impact analysis should include quantitative estimates of a project's GHG emissions from different types of emission sources. These estimates should include both construction-phase emissions, as well as completed operational emissions, using one of a variety of available modeling tools.
2. *Continued Uncertainty Regarding "Significance" of Project-Specific GHG Emissions.* Each environmental document should assess the significance of the project's impacts on climate change. The OPR Advisory recognizes uncertainty regarding what GHG impacts should be determined to be significant and encourages agencies to rely on the evolving guidance being developed in this area. According to the OPR Advisory, the environmental analysis should describe a "baseline" of existing (pre-project) environmental conditions, and then add project GHG emissions on to this baseline to evaluate whether impacts are significant.
3. *Mitigation Measures.* According to the OPR Advisory, "all feasible" mitigation measures or project alternatives should be adopted if an impact is significant, defining feasibility in relation to scientific, technical, and economic factors. If mitigation measures cannot sufficiently reduce project impacts, the agency should adopt whatever measures are feasible and include a fact-based statement of overriding considerations explaining why additional mitigation is not feasible. OPR also identifies a menu of GHG emissions mitigation measures, ranging from balanced "mixed use" master-planned project designs to construction equipment and material selection criteria and practices.

In addition to this three-step process, the OPR Advisory contains more general policy-level guidance. It encourages agencies to develop standard GHG emissions reduction and mitigation measures. The OPR Advisory directs CARB to recommend a method for setting the GHG emissions threshold of significance, including both qualitative and quantitative options.

3.3.11 Senate Bill 97 (CEQA Guidelines)

SB 97 required that CNRA coordinate on the preparation of amendments to the CEQA Guidelines regarding feasible mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions. Pursuant to SB 97, CNRA adopted CEQA Guidelines amendments on December 30, 2009.[57]

With respect to the significance assessment, newly added CEQA Guidelines section 15064.4, subdivision (b), provides:

> A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:
>
> (1) The extent to which the project may increase or reduce greenhouse gas emissions as compared to the existing environmental setting;
>
> (2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;
>
> (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. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of greenhouse gas emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

The Resources Agency is required to certify and adopt these revisions to the State CEQA Guidelines by January 1, 2010. The Guidelines will apply retroactively to any incomplete environmental impact report, negative declaration, mitigated negative declaration, or other related document.[58]

The amendments also provide that lead agencies should consider all feasible means of mitigating greenhouse gas emissions that substantially reduce energy consumption or GHG emissions. These potential mitigation measures may include carbon sequestration. If off-site or carbon offset mitigation measure are proposed they must be part of reasonable plan of

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[57] The amendments to the CEQA Guidelines will not be effective until the Office of Administrative Law completes its review of the adopted amendments and rulemaking file, and transmits the adopted amendments to the Secretary of State for inclusion in the California Code of Regulations.

[58] Senate Bill No. 97. CHAPTER 185. An act to add Section 21083.05 to, and to add and repeal Section 21097 of, the Public Resources Code, relating to the California Environmental Quality Act. http://www.opr.ca.gov/ceqa/pdfs/SB_97_bill_20070824_chaptered.pdf

mitigation that the agency itself is committed to implementing. No threshold of significance or any specific mitigation measures are indicated.

Among other things, CNRA noted in its Public Notice for these changes that impacts of GHG emissions should be considered in the context of a cumulative impact, rather than a project impact. The Public Notice states:

> "While the Proposed Amendments do not foreclose the possibility that a single project may result in greenhouse gas emissions with a direct impact on the environment, the evidence before [CNRA] indicates that in most cases, the impact will be cumulative. Therefore, the Proposed Amendments emphasize that the analysis of greenhouse gas emissions should center on whether a project's incremental contribution of greenhouse gas emissions is cumulatively considerable."

3.3.12 CARB Preliminary Draft Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases Under the California Environmental Quality Act (Draft CARB Thresholds)

In October 2008, CARB released a draft proposal identifying CEQA thresholds of significance for industrial, commercial and residential developments. The Draft CARB Thresholds propose a framework for developing thresholds of significance that rely upon the incorporation of a variety of performance measures to reduce GHG emissions associated with a project, as well as a numerical threshold of significance above which a project must include detailed GHG analysis in an EIR and incorporate all feasible mitigation measures. Although CARB proposed a 7,000 tons per year threshold for industrial projects, a numerical threshold for commercial and residential projects was not proposed, but is under development. In addition, the Draft CARB Thresholds incorporate SB 375 by providing that commercial and residential projects that comply with a previously approved plan, which, essentially, satisfies SB 375 and for which a certified final CEQA document has been prepared, is presumed to have a less than significant impact related to climate change. As of this time, CARB has suspended its work on CEQA thresholds.

3.4 Local Air Quality Management District (SCAQMD) Policies

On December 5, 2008, the SCAQMD Governing Board adopted its staff proposal for an interim CEQA GHG significance threshold for projects where the SCAQMD is the lead agency. Currently, the Board has only adopted thresholds relevant to industrial (stationary source) projects. To achieve a policy objective of capturing 90% of GHG emissions from new residential/commercial development projects and implement a "fair share" approach to reducing emission increases from each sector, SCAQMD staff has proposed combining performance standards and screening thresholds. The proposed significance thresholds for residential and commercial projects are still in draft form as of this writing.

4. Greenhouse Gas Inventory

This section describes the methods that ENVIRON International Corporation (ENVIRON) used to estimate GHG emissions from VC after development and full build out (the “project scenario”). It includes some aspects that are fully within the control of Vista Canyon Ranch, LLC (“Vista”), such as grading and the placement of utilities; some aspects that are in control of the individuals building the houses and commercial buildings, such as construction emissions; and some aspects for which control over emissions is shared by the developers and the residents, such as energy use in the built environment and emissions from traffic by the development’s future residents and employees in the commercial areas.

Additional calculations using the same methodologies were performed for the residential overlay option (“overlay option”), which includes 1,350 dwelling units and 700,000 square feet of non-residential space (instead of 1,117 dwelling units and approximately 950,000 square feet of non-residential space). Emissions related to the transit center, vegetation, area sources and swimming pools were assumed to be equal in both scenarios.

A third set of operational emission estimates for residential building energy, non-residential building energy, traffic, municipal sources and area sources was developed for the annexation area in the immediate vicinity of the project, where an additional 150 single-family residential units and 436,000 square feet of business park uses may be built. These emission estimates appear at the end of this section.

In addition, an estimate of “life-cycle” GHG emissions (i.e., GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure) is presented. This estimate is to be used for comparison purposes only and is not included in the final inventory as these emissions would be attributable to other industry sectors under AB 32. The inventory does not consider GHG emissions from most sources outside of VC that may indirectly service the residents (e.g., a landfill) or whether the emissions from the development are “new” in the sense that, absent the development, the emissions may not occur. Each aspect of the GHG inventory is described in this section. Actual GHG emissions at full build out at VC are expected to be substantially lower due to regulatory developments; therefore, the GHG emissions reported in this section are a conservative estimate.

4.1 GHG Emissions Baseline

The CEQA Guidelines specify that the physical environmental conditions at the time the notice of preparation (NOP) is published “will normally constitute the baseline physical conditions by which a lead agency determines whether an impact is significant” (CEQA Guidelines § 15125(a)). There is presently one house and an accessory storage yard on the project site. However, the analysis assumes that the project site is undeveloped and therefore has no associated GHG emissions.

4.2 Evaluation of “New” Emissions

Given the global nature of GHG impacts, it is difficult to determine which emissions from a given project are “new” on a global scale. As described in this section, there are methods of estimating emissions from certain aspects of projects, such as that from the additional vehicle travel associated with the project. However, it is not clear how to determine what proportion of those emissions are truly additional, or new, in the global sense, or what proportion of those emissions would have occurred globally without the project.

4.2.1 Differences between criteria pollutant impacts and GHG impacts

Analyses for evaluating the airborne criteria pollutant impacts of new projects for inclusion in environmental documents have already, in a sense, addressed the issue of what is “new”. However, the impacts of GHG emissions differ from those of criteria pollutants in that they are a function of global concentrations rather than local concentrations. Therefore, the specific locations of where emissions occur are less important for GHGs than for criteria pollutants. The calculation of “project” criteria pollutants (oxides of nitrogen, sulfur oxides, carbon monoxide, volatile organic compounds, lead, and particulate matter) in air quality emissions inventories for use in EIRs has a long history. The SCAQMD first published a comprehensive manual on the analysis of air quality impacts in 1993, and the Bay Area Air Quality Management District (BAAQMD) followed in 1999. Other smaller districts have prepared detailed guidance documents that describe the methods that should be used to calculate emissions inventories for EIRs from projects, including residential and non-residential projects.

The goal of estimating emissions of criteria pollutants from projects is to understand whether there are significant new emissions in California’s air basins, which have a limited ability to absorb additional criteria pollutant emissions without adverse air quality impacts. A review of how air quality analyses typically address the issue of whether emissions are “new” is instructive as to how to address the emissions of GHGs. However, unlike with criteria pollutants, the impacts of GHG emissions are a function of their global concentrations, rather than local concentrations. Thus, the question of whether or not a project’s GHG impacts are significant, both on a project basis and on a cumulative basis, must be asked based on global, rather than basin-wide, considerations.

When evaluating the air quality impacts for a new project, such as a residential development, the vehicular emissions associated with the residents as they work and shop within the basin are counted as new emissions in traditional air quality analyses, even if those new residents would have moved from another house in the same air basin. The typical rationale for this approach is that the new residential development represents growth in the basin. As a result, all emissions associated with its residents’ vehicle travel should be counted as new emissions, even if this might lead to some over-counting of criteria pollutant emissions from the project.

For GHGs, if the emissions simply moved from one basin to another, the emissions would not be new on a global scale. To evaluate the sustainability of new non-residential developments, one must ask if the shoppers’ and workers’ travel distances to the new non-residential development are longer or shorter than the distances those same individuals currently travel to their non-residential areas.

4.2.2 Definition of “new” emissions at VC

In the developed world, GHG increases are directly tied to population growth. Therefore, it makes sense to consider operational emissions (including vehicular emissions) from new residences as growth, as residences are rarely removed from the housing supply once constructed. There are exceptions, such as when one housing development replaces another, and, in those cases, the replacement residential development need not be considered growth.

However, it is not clear that non-residential (i.e. office space, retail space, and industrial buildings) development should be considered new growth for vehicular travel and GHG emission purposes. To the extent that non-residential development serves existing residential development, its vehicular travel may not be new. Also, if the new non-residential area serves an area with a high residential-to-non-residential ratio, then this new non-residential growth will reduce shopping and work trip lengths and will reduce GHG emissions associated with mobile sources. If, however, the new non-residential area results in longer trips for its workers and shoppers than they would have previously made, then it adds GHGs emissions. Non-residential development that could potentially increase VMT would be facilities that draw trips from far away that otherwise would not be made. A theme park, for example, may be viewed as such a development.

New businesses accommodate new growth. Therefore, the traffic associated directly with the business (deliveries, etc.) would be considered to be new traffic, whereas travel to the new business, when supported by existing residences, would not be considered new. In this report, it is assumed that the new non-residential area serves an area with a high residential-to-non-residential ratio. Therefore, this new non-residential growth likely will reduce shopping and work trip lengths from existing residences, and can reduce GHG emissions associated with mobile sources.

To the extent that new non-residential development serves new residential development, much of the non-residential vehicle travel would already be counted in the evaluation of the new residential vehicle travel. Yet while the non-residential vehicle trips would be already counted elsewhere, the other operational emissions from the non-residential areas would be considered new, as there are new non-residential buildings that go along with growth in residential areas.

Accordingly, GHG emissions from VMT associated with non-residential land uses will only be counted if the non-residential areas contribute to greater VMT as a result of their locations or if the traffic associated with them result from new residences, as discussed above. In the case of VC, its significant office, retail and transit components will serve to reduce VMT in the surrounding area.

4.3 Units of measurement: Tonnes of CO_2 and CO_2e

The term “GHGs” includes gases that contribute to the natural greenhouse effect, such as CO_2, CH_4, N_2O, and water, as well as gases that are only man-made and that are emitted through the use of modern industrial products, such as HFCs and CFCs. The most important greenhouse gas in human-induced global warming is CO_2. While many gases have much higher GWPs than

CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for 85% of the GWP of all GHGs emitted by the United States.[59]

The effect each of these gases has on global warming is a combination of the volume of their emissions and their GWP. GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent than CO_2, with GWPs of 21 and 310, respectively. GHG emissions are typically measured in terms of mass of CO_2e. CO_2e are calculated as the product of the mass of a given GHG and its specific GWP.

In many sections of this report, including the final summary sections, emissions are presented in units of CO_2e either because the GWPs of CH_4 and N_2O were accounted for explicitly, or the CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from that particular emissions category.

In this report, "tonnes" will be used to refer to metric tonnes (1,000 kilograms). "Tons" will be used to refer to short tons (2,000 lbs).

Additionally, exact totals presented in all tables and report sections may not equal the sum of components due to independent rounding of numbers.

4.4 Resources

To estimate GHG emissions from VC, ENVIRON directly or indirectly relied primarily on four different types of resources: emissions estimation guidance from government-sponsored organizations, government-commissioned studies of energy use patterns, energy surveys by other consulting firms, and emissions estimation software.

4.4.1 Emissions Estimation Guidance

This inventory was developed using guidance from two government-sponsored organizations to assist in the estimation of GHG emissions. The first is the CCAR, which was established by the California Legislature to assist willing parties in estimating and recording their GHG emissions to use as a baseline for meeting future emissions reduction requirements. Publications by the CCAR include not only recommendations on how to compile a GHG emissions inventory, but also relevant data on energy use and emissions that are utilized in this protocol. The second organization is the IPCC, which was established in 1988 by the United Nations Environment Programme (UNEP) and the WMO. The IPCC's main role is to assess information on climate change which is synthesized in IPCC reports, including methodology reports. These reports also include relevant emission factors and specific scientific data that can be used to estimate GHG emissions from various activities.

[59] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, U.S. Environmental Protection Agency. Available online at: http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/RAMR6MBSC3/$File/06_Complete_Report.pdf

4.4.2 Emissions and Energy Use Studies

For estimating emissions based on electrical and natural gas energy use, literature information on patterns of energy use must often be employed. Studies commissioned by the United States Energy Information Administration (EIA) and the California Energy Commission (CEC) provide data on energy use patterns associated with municipal activities, natural resource distribution, and other activities that will take place in VC. These data were used to estimate energy use patterns which were applied to the specific characteristics of VC to estimate GHG emissions. In addition to EIA and CEC studies, studies performed by individual municipalities or scientific organizations are also used in this report.

4.4.3 Emissions Estimation Software

The CARB, the SCAQMD, and other public and private organizations have developed several software programs to facilitate the calculation of emissions from construction, motor vehicles, and urban developments by streamlining emissions estimation from these sources. This inventory was developed using several models to estimate GHG emissions from the VC development. These are the OFFROAD2007 model, the EMFAC model, and the URBEMIS model. The features of each of these models are described below.

> OFFROAD – OFFROAD2007 is the most recent version of a model developed by the CARB to estimate the activity and emissions of off-road mobile emissions sources, such as construction equipment. OFFROAD contains a database of default values for horsepower, load factor, and hours per day of operation and can calculate emission factors based on the type of equipment and year of use.

> EMFAC – EMFAC, also developed by CARB, compiles real fleet data on the county-level for the state of California, including vehicle model year distributions, vehicle class (e.g., light-duty auto (LDA), medium-duty truck, heavy-heavy-duty truck) distributions, and emission rate information to generate fleet-average emission factors for most criteria pollutants and CO_2. EMFAC2007 is the newest version of the program. Emission factors from EMFAC depend on the vehicle class, vehicle technology, speed, year of operation, average ambient air temperature, and relative humidity.

> URBEMIS – The URBEMIS software was created by SCAQMD, although it is used by other air districts as well. It estimates emissions associated with different aspects of urban development. The Operational Data module in URBEMIS calculates emissions from mobile sources operating during the use of a development based on emission factors from EMFAC and traffic use information specific to a development. Mobile source emissions during the construction phase are calculated separately in the construction module of URBEMIS. URBEMIS provides county, air district / air basin, or state wide averages for number of daily trips per housing unit and per student at an elementary school in the absence of more specific information from traffic engineers. URBEMIS also provides air district-specific default values for vehicle fleet characteristics (vehicle class distribution and technology categories) and travel conditions (average trip length, trip speed, and relative frequency of each type of trip). URBEMIS (Version 9.2.4), uses EMFAC2007 emission factors and calculates CO_2 emissions using District-

specific default parameters for various inputs including vehicle fleet characteristics and travel conditions.

In addition to mobile source emissions, URBEMIS can also calculate emissions associated with the construction phase of a development and emissions from area sources, such as fireplaces, once the development is operational. The URBEMIS construction module enables separate emissions calculations from each of the three typical stages of any construction project: demolition, site grading, and building construction. Based on the timing of construction and size of the development, URBEMIS defaults can be used to estimate emissions. Alternatively, the user can override these defaults by entering specific information about the construction project, such as what types and numbers of equipment are going to be used. In terms of area sources, URBEMIS is equipped to estimate GHG emissions from three types of GHG-emitting area sources based either on program defaults or more specific project information inputted by the user. These uses are natural gas fuel combustion, hearth fuel combustion, and landscaping equipment.

4.5 Indirect GHG Emissions from Electricity Use

As noted above, indirect GHG emissions are created as a result of electricity use. When electricity is used in a building, the electricity generation typically takes place offsite at the power plant; electricity use in a building generally causes emissions in an indirect manner. VC will be supplied with power by Southern California Edison (SCE). Accordingly, indirect GHG emissions from electricity usage are calculated using a carbon-intensity factor that is based on the 2007 SCE carbon-intensity factor of 631 lb CO_2e per MW-hr.[60] This emission factor is adjusted to take into account the future mix of energy sources used to generate electricity for SCE. California's RPS requires retail suppliers of electric services to increase procurement from eligible renewable energy resources until they reach 20% by 2010. California Executive Order S-14-08 mandates a further increase in procurement from eligible renewable energy resources to 33% by 2020 but this does not have the force of law. Although the project will be operational in 2030, ENVIRON conservatively assumed that 20% of the electricity would be from renewable resources, consistent with the currently enacted law. When the future legally required renewable energy percentage is considered, the resultant emission factor is 583 lb CO_2e per MW-hr.

4.6 Vegetation Change

This section presents the calculation of the positive and negative GHG emissions associated with vegetation removal and re-vegetation at the VC development. The permanent removal of existing vegetation can contribute to net GHG increases by reducing existing carbon sequestration capacity.[61] Areas that are temporarily disturbed but re-vegetated with the same

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[60] California Climate Action Registry (CCAR) Database. Southern California Edison Company 2007 PUP Report. 2009.

[61] In this section, it is assumed that all mature land-types (at least 20 years old) are at steady-state. See The World

vegetation type are assumed to have no net impact. Following completion of the VC project, some areas will become re-vegetated with trees, shrubs and other vegetation. These areas could potentially sequester more CO_2 from the atmosphere than was sequestered pre-development. The difference between the total before-development sequestered CO_2 and the after-development sequestered CO_2 is the one-time CO_2 released from clearing the vegetation less the CO_2 sequestered by new plantings.[62] The overall CO_2 emissions due to vegetation change will result from two processes: 1) the change in the amount of CO_2 sequestered by vegetation, which would lead to a one-time GHG release, and 2) the amount that can be expected to be sequestered by new plantings. Both issues are discussed in this section.

In this section of this report, the units CO_2 and CO_2e are used interchangeably. CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from vegetation change.

4.6.1 Quantifying the One-Time Release by Changes in Carbon Sequestration Capacity

The one-time release of GHGs due to permanent changes in carbon sequestration capacity was calculated using the following four steps:[63]

1. Identify and quantify the change in area of various land types due to the development (i.e. alluvial scrub, non-native grassland, agricultural, etc.). These area changes include not only the area of land that will be converted to residential units and commercial land use, but also areas disrupted by the construction of roadways and other infrastructure. Areas temporarily disturbed that will eventually recover to become vegetated will not be counted as vegetation removed as there is no net change in vegetation or land use.[64]
2. Estimate the biomass associated with each land type. – For the purposes of this report, ENVIRON has listed the land types that are present at the VC development site and characterized them using the available general vegetation types found in the IPCC publication Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines).[65] This characterization is shown in Table 4-1. The general IPCC vegetation types are as follows:
    - Forest Land;
    - Grass Land;
    - Wetland;

Resource Institute (WRI) "Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting" protocol available online at: http://www.ghgprotocol.org/DocRoot/97hb6BCSAAG2bImO7c9d/LULUCF%20Final.pdf

[62] In this section we assume that mature ecosystems do not have a net influx or outflux of carbon.

[63] This section follows the IPCC guidelines, but has been adapted for ease of use for the VCR development.

[64] This assumption facilitates the calculation as a yearly growth rate and CO_2 removal rate does not have to be calculated. As long as the disturbed land will indeed return to its original state, this assumption is valid for time periods over 20 years.

[65] Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

- Cropland and
- Settlements.

California vegetation is heavily dominated by scrub and chaparral vegetation which may not be accurately characterized by default forest or grass land properties. Consequently, ecological zones and biomass based subdivisions identified in the IPCC Guidelines were used to sub-categorize the vegetation as tree or scrub dominated. The biomass values for each vegetation type are based on these categories which relate the VC vegetation to the IPCC vegetation types. Forest land, grass land and crop land categories and subcategories were used to determine the CO_2 emissions resulting from land use impacts at VC.

3. Calculate CO_2 emissions from the net change of vegetation. – When vegetation is removed, it may undergo biodegradation,[66] or it may be combusted. Either pathway results in the carbon (C) present in the plants being combined with oxygen (O_2) to form CO_2. To estimate the mass of carbon present in the biomass, biomass weight is multiplied by the mass carbon fraction, 0.47.[67] The mass of carbon is multiplied by 3.67[68] to calculate the final mass of CO_2, assuming all of this carbon is converted into CO_2. The results of this calculation are shown in Table 4-2 for each type of vegetation.

4. Calculate the overall change in sequestered CO_2. – For all types of land that change from one type of land to another,[69] initial and final values of sequestered CO_2 are calculated using the equation below.

Overall Change in Sequestered CO_2 [tonnes CO_2]

$$= \sum_i (SeqCO_2)_i \times (area)_i - \sum_j (SeqCO_2)_j \times (area)_j$$

Where:

$SeqCO_2$	=	mass of sequestered CO_2 per unit area [tonnes CO_2/acre]
area	=	area of land for specific land use type [acre]
i	=	index for final land use type
j	=	index for initial land use type

[66] Cleared vegetation may also be deposited in a landfill or compost area, where some anaerobic degradation which will generate CH_4 may take place. However, for the purposes of this section, we are assuming that only aerobic biodegradation will take place which will result in CO_2 emissions only.
[67] The fraction of the biomass weight that is carbon. Here, a carbon fraction of 0.47 is used for all vegetation types from IPCC (2006), default forestland and agricultural land ratio. CCAR assumes a similar value of 0.5 in its Forest Selector Protocol.
[68] The ratio of the molecular mass of CO_2 to the molecular mass of carbon is 44/12 or 3.67.
[69] For example from forestland to grassland, or from cropland to permanently developed.

Table 4-1 shows the effective change in the amount of sequestered CO_2 due to the change in land use of the developed area for each land type. The total equivalent CO_2 emissions attributable to the net change of vegetation are approximately 1,365 tonnes.

4.6.2 Calculating CO_2 Sequestration by Trees

Planting trees in conjunction with development on the project site will sequester CO_2. Changing vegetation as described above results in a one-time carbon-stock change. Planting trees is also considered to result in a one-time carbon-stock change. Table 4-3 presents default annual CO_2 sequestration rates on a per tree basis, based on values provided by the IPCC. An average of 0.035 tonnes CO_2 per year per tree can be assumed for trees planted, if the tree type is not known.

Urban trees are only net carbon sinks when they are actively growing. The IPCC assumes an active growing period of 20 years. Thereafter, the accumulation of carbon in biomass slows with age, and will be completely offset by losses from clipping, pruning, and occasional death. Actual active growing periods are subject to, among other things, species, climate regime, and planting density. In this report, the IPCC default value of 20 years will be assumed. Note that trees may also be replaced at the end of the 20-year cycle, which would result in additional years of carbon sequestration. However, this would be offset by the potential net release of carbon from the removal of the replaced tree.

The exact number and type of trees to be planted at VC has not yet been determined. Based on the number of trees estimated for a similar development, approximately 2,100 new net trees will be planted in the VC community. Planting these trees in the community will sequester approximately 1,470 tonnes CO_2. This sequestration results in a net decrease in CO_2 emissions of 105 tonnes. The net CO_2 emissions from vegetation changes are presented in Table 4-4.

4.7 Construction Activities

This section describes the estimation of GHG emissions from construction activities at VC. There are three major construction phases for an urban development: demolition, site grading, and building construction. The building construction phase can be broken down into three subphases: building construction, architectural painting, and asphalt paving. GHG emissions from these construction phases are largely attributable to fuel use from construction equipment and worker commuting.

CO_2 emissions associated with different aspects of urban development can be estimated using a combination of software programs. The OFFROAD2007[70] and the EMFAC2007[71] models are used to generate emission factor data for construction equipment and motor vehicles,

[70] California Air Resources Board Mobile Source Emissions Inventory Program. December 2006. http://www.arb.ca.gov/msei/offroad/offroad.htm
[71] Emission Factors (EMFAC2007) model (Version 2.3). November 2006. California Air Resources Board. http://www.arb.ca.gov/msei/onroad/latest_version.htm

respectively. These values serve as inputs for the URBEMIS[72] model, which estimates emissions from several different aspects of urban development including from construction sources based on emission factors and information specific to the development.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for diesel construction equipment, soil hauling trucks and vendor trips, because CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from construction equipment. For worker commuting, CH_4 and N_2O are explicitly calculated and therefore CO_2 and CO_2e for worker commuting are not equal.

4.7.1 Estimating GHG Emissions from Construction Equipment

This section describes how emissions from off-road equipment used during fill soil hauling, grading, building construction, and paving are calculated. It was assumed that negligible GHG emissions are produced by architectural painting equipment. It is important to note that GHG calculations are intended to estimate long-term emissions, while air quality emission calculations are intended to estimate worst-case daily scenarios. As such, the methodology presented in this section of the report will be different than the approach described in the corresponding air quality section.

ENVIRON calculated emissions from soil hauling, building construction, and paving using the URBEMIS methodology. ENVIRON estimated the number and type of equipment that will be used in the construction using data provided by Vista Canyon LLC. ENVIRON assumed that each piece of equipment will operate for 8 hours a day, five days a week during a given phase duration. An equipment hour is defined as one hour of a piece of equipment being used. Tables 4-5a and 4-5b contain specifications for each type of construction equipment (horsepower, load factor, and GHG emission factor) provided by OFFROAD2007 and describes the detailed GHG calculations. CO_2 emissions for each type of construction equipment were calculated as follows:

> *Equipment Emissions [grams] = Total equipment-hours * emission factor [grams per brake horsepower-hour] * equipment horsepower * load factor*[73]

The contributions of CH_4 and N_2O to overall GHG emissions from diesel construction equipment[74] are likely small (< 1% of total CO_2e) and were therefore not included in this calculation.

The total GHG emissions from all construction equipment is 7,882 tonnes CO_2.

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[72] Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.4 – 2008). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District. http://www.urbemis.com
[73] Load factor is the percentage of the maximum horsepower rating at which the equipment normally operates.
[74] California Climate Action Registry (CCAR). 2008. *General Reporting Protocol*. Version 3.0. ENVIRON estimates these emissions to be less than 1% of total GHG contributions for diesel fueled equipment.

4.7.2 GHG Emissions from Worker Commuting

Emissions from worker commuting are associated with workers involved in soil hauling, site grading phase and all construction subphases (construction, paving, architectural coating). Emissions related to trips made by vendors were calculated separately (see next section). GHGs are emitted from worker vehicles in two ways: running emissions, produced by driving the vehicle, and startup emissions, produced by turning the vehicle on. The majority of worker commuting emissions are running emissions. Table 4-6a details emission calculations for worker commuting.

Running emissions were calculated using the same general method for the soil hauling, grading, building and paving phases. For the architectural coating phase, both running and starting emissions were assumed to equal 20% of construction phase emissions, which is the URBEMIS default value. Total running emissions from worker commuting during each phase were calculated by estimating the total Vehicle Miles Traveled (VMT) by construction workers, and then multiplying this value by the representative GHG emission factors for the vehicles they are expected to drive. The total VMT by construction workers for a given phase is calculated as follows:

VMT = Number of worker one-way trips x average one-way commute length

For the grading and paving phases, the number of worker roundtrips is equal to the number of worker-days. URBEMIS estimates that the worker-days needed for the demolition, grading, and paving phases is equal to the number of equipment-days multiplied by 1.25; ENVIRON also used this methodology for soil hauling activities. The length of the average one-way commute was assumed to be the URBEMIS default of 12.7 miles.

For the building construction phase, the number of worker trips was determined by the type and number of buildings being constructed. URBEMIS provides trip generation rates based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation, and office/industrial. The total daily roundtrips are the sum of the following:

0.36 * number of multifamily units

0.72 * number of single-family units

0.32 * (commercial/retail/school/recreation sqft)/1000

0.42 * (office/industrial sqft)/1000

After total VMT is calculated, GHG emissions for this development can be calculated from the following equation:

CO_2 emissions = VMT * [0.5 * EF_{LDA} + 0.25 * (EF_{LDT1} + EF_{LDT2})]

Where:

VMT = vehicle miles traveled
EF_{LDA} = emission factor of light duty autos
EF_{LDT1} = emission factor of light duty trucks: up to 6000 GVW
EF_{LDT2} = emission factor of light duty trucks: up to 8500 GVW

The CO_2 calculation involves the following assumptions:

a. URBEMIS defaults assume that half of the workers commute with light duty trucks (LDTs) and half commute in LDAs.[75]

b. Half of the LDTs were assumed to be Type 1 and the other half Type 2.

c. The emission factor depends upon the speed of the vehicle. The URBEMIS default value of 30 miles per hour was used.

d. EMFAC emission factors from the year 2009 were used for EF_{LDA}, EF_{LDT1}, and EF_{LDT2}.

Startup emissions are CO_2 emitted from starting a vehicle. For construction workers during all phases, the startup emissions were calculated using the following assumptions:

a. The number of round trips were equal to the number of worker days,

b. The mix in vehicles was 50% light duty autos and 50% light duty trucks,

c. Two engine startups per day with a 12 hour wait before each startup.[76]

The USEPA recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from on-road light-duty vehicles, taking into account their GWPs.[77] To incorporate these additional GHGs into the calculations, the total GHG footprint was calculated by dividing the CO_2 emissions by 0.95.

Table 4-6a summarizes the emission calculations for worker commuting. The total amount of GHG emissions from worker commuting during all phases is a one-time emission of 5,434 tonnes.

Worker commuting emissions for the overlay option would be slightly different (5,295 tonnes) due to the different number of dwelling units and non-residential square footage, as shown in Table 4-6b.

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[75] Page A-9 of the URBEMIS user manual.
[76] The emission factor grows with the length of time the engine is off before each ignition.
[77] USEPA. 2005. *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle.* Office of Transportation and Air Quality. February.

4.7.3 GHG Emissions from Vendor Trips

Similar to worker commuting trips, GHGs emitted from vendor vehicles trips are based on running and startup emissions. The number of daily vendor trips was based on the size and type of buildings specified and URBEMIS defaults, which are based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation, and office/industrial. The total roundtrips are the sum of the following:

0.11 * number of multifamily units

0.11 * number of single-family units

0.05 * (commercial/retail/school/recreation sqft)/1000

0.38 * (office/industrial sqft)/1000

The total number of daily round trips is multiplied by the number of work days, one-way trip length (8.9 miles) and a factor of 2 to account for roundtrip to give the VMT. After total VMT for VC is calculated, CO_2 emissions from mobile running for this development can be calculated from the following equation:

CO_2 emissions from mobile running = VMT * EF_{HHD}

Where:

VMT = vehicle miles traveled (based on 8.9 miles one-way trip distance)
EF_{HHD} = emission factor of heavy heavy-duty trucks

The CO_2 calculation involves the following assumptions:

a. URBEMIS defaults assume that vendor trips use heavy heavy-duty trucks (HHDs).[78]

b. The emission factor depends upon the speed of the vehicle. The URBEMIS default value of 30 miles per hour was used.

c. EMFAC emission factors from the year 2009 were used for EF_{HHD}.

Startup emissions are CO_2 emitted from starting a vehicle. Startup emissions for vendor trips were calculated using the following assumptions:

a. All vehicles were heavy heavy-duty trucks,

[78] Page A-12 of the URBEMIS user manual.

b. Two engine startups per day with a 12 hour wait before each startup.[79]

The total amount of GHG emissions from vendor trips during building construction for the project is a one-time emission of 6,579 tonnes of CO_2e as shown in Table 4-7a. Table 4-7b shows the vendor trip emissions associated with the overlay option is 5,389 tonnes.

4.7.4 Soil Hauling

Soil hauling involves transporting fill material (soil) to the site. URBEMIS assumes that each soil hauling truck carries 20 cubic yards of material and travels 15 miles roundtrip. Based on URBEMIS defaults, it is estimated that there will be 50,000 soil hauling trips for VC. The number of roundtrips is multiplied by the roundtrip length to determine total VMT. After total VMT for the soil hauling at VC is calculated, CO_2 emissions from mobile running for this development can be calculated from the following equation:

CO_2 emissions from mobile running = VMT * EF_{HHD}

Where:

VMT = vehicle miles traveled (based on 15 miles round trip distance)
EF_{HHD} = emission factor of heavy heavy-duty trucks

The CO_2 calculation involves the following assumptions:

d. Based on URBEMIS defaults, it was assumed that soil hauling trips use HHDs.[80]

e. The emission factor depends upon the speed of the vehicle. The URBEMIS default value of 30 miles per hour was used.

f. EMFAC emission factors from the year 2009 were used for EF_{HHD}.

Startup emissions are CO_2 emitted from starting a vehicle. Startup emissions for soil hauling trips were calculated using the following assumptions:

c. All vehicles are heavy heavy-duty trucks,

d. Two engine startups per day with a 12 hour wait before each startup.[81]

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[79] The emission factor grows with the length of time the engine is off before each ignition.
[80] Page A-12 of the URBEMIS user manual.
[81] The emission factor grows with the length of time the engine is off before each ignition. The 12-hour period represents the average of an 8-hour period between starts during the work-day, and a 16-hour period between the end of the previous work day and the start of the next work day.

The total amount of GHG emissions from soil hauling is a one-time emission of 1,502 tonnes of CO_2e as shown in Table 4-8.

Tables 4-9a and 4-9b show total one-time GHG emissions for construction, including off-road equipment, worker commuting, vendor trips, and soil hauling to be 21,397 tonnes CO_2e for the project scenario and 20,069 for the overlay option, respectively.

4.7.5 Uncertainties in Construction GHG Emissions Calculations

ENVIRON was provided with the phase length and the number of each type of construction equipment used during construction of buildings. However, the number of worker and vendor trips represent URBEMIS default values and settings.

In addition, emissions were estimated assuming "worst day" conditions (i.e., maximum equipment usage, maximum worker and vendor commutes) for the entire phase duration. As a result, the emissions presented here are very conservative.

4.8 Residential Building Energy-Related GHG Emissions

Residential buildings include single-family homes of various sizes, town homes, apartments, and condominiums. This section describes the methods used to estimate the GHGs associated with activities in those buildings.

The amount of energy—and, therefore, the amount of associated GHG emissions emitted per dwelling unit— will vary with the type of residential building. Accordingly, information on the types of residential buildings that are planned for VC is required to estimate GHG emissions. Vista provided data summarizing the main residential building categories for VC. The major types of residential buildings are:

Single-family detached;

Single-family town homes; and

Multi-family attached units.

GHGs are emitted as a result of activities in residential buildings when electricity and natural gas are used as energy sources. Combustion of any type of fuel emits CO_2 and other GHGs directly into the atmosphere; when this occurs in a residential building, it is a direct emission source[82] associated with that building. GHGs are also emitted during the generation of electricity from fossil fuels. When electricity is used in a residential building, the electricity generation typically takes place offsite at the power plant; electricity use in a residential building generally causes emissions in an indirect manner.

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[82] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.0 (April). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf, Chapter 8

While fuel combustion generates CH_4 and N_2O, the emissions of these GHGs typically comprise less than 1% of CO_2e emissions from electricity generation and natural gas consumption.[83] Fuel oil, kerosene, liquefied petroleum gas, and wood can also be used as fuels, but will likely contribute only in small amounts as combustion sources within residential buildings. Wood burning hearths are addressed in the area sources section of this report.

Energy use in residential buildings is divided into (1) energy consumed by the built environment, and (2) energy consumed by uses that are independent of the construction of the building, such as plug-in appliances. In California, Title 24 governs energy consumed by the built environment, including the HVAC system, water heating, and some fixed lighting. Non-building or 'plug-in' energy use can be further subdivided by specific end-uses (refrigeration, cooking, lighting, etc.). Energy use for each was calculated separately, as described in the following sections. The resulting energy use quantities were then converted to GHG emissions by multiplying by the appropriate emission factors, incorporating information on local electricity production.[84] As discussed in sections 3.3.6 and 3.3.7, California's RPS requires retail suppliers of electric services to increase procurement from eligible renewable energy resources until they reach 20% by 2010. California Executive Order S-14-08 mandates a further increase in procurement from eligible renewable energy resources to 33% by 2020. Although the project will be operational in 2030, ENVIRON conservatively assumed that only 20% of the electricity would be from renewable resources, consistent with the currently enacted law. The resulting reduction in the emission factor for SCE was calculated as outlined in Table 4-10 and applied to these calculations.

In this section, the units CO_2 and CO_2e are used interchangeably for residential buildings because CH_4 and N_2O are assumed to contribute a negligible amount of GWP when compared to the CO_2 emissions from residential buildings.

4.8.1 Estimate of Residential Energy Use Intensity

ENVIRON developed CO_2 intensity values (i.e., CO_2 emissions per Dwelling Unit per year) for the residential building types found in VC using the California Energy Commission Consultant Report entitled "California Statewide Residential Appliance Saturation Study (RASS)". Three building types representative of the planned residences at VC were evaluated: single-family detached houses, single-family town homes, and units in multi-family apartment buildings (with five or more units). The methods that were used and the assumptions that were made in estimating energy use are described below.

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[83] Ibid. Tables C1 and C2. The methane and nitrous oxide emission factors are negligible compared to the total CO_2 emission factor for electricity generation in California.

[84] The Southern California Edison specific emission factor for electricity deliveries is 641 lbs CO_2/MWh. From the California Climate Action Registry Database: Southern California Edison Company 2006 PUP Report. 2008. Although this emission factor accounts for only CO_2, the emissions associated with N_2O and CH_4 contribute to less than 1% of the electricity generation CO_2e emissions. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

4.8.2 Energy Use in the Built Environment

New Californian homes must be designed to meet building energy efficiency standards (Title 24). Compliance with Title 24 is determined from the total daily valuation (TDV) of energy use in the built-environment (on a per square foot per year basis). The regulated energy uses include space heating and cooling, domestic hot water heating, and hard-wired lighting. TDV energy use is a parameter that reflects the burden that a building imposes on an electricity supply system. In general, there is a larger electricity demand and, hence, higher stress on the supply system during the day (peak times) than at night (off peak). To account for this variation, the calculation of TDV assigns different weights for energy used at different times. For example, a building that uses a given amount of electricity during the peak mid-day period will have a higher TDV value than a building using an equivalent amount of electricity during off-peak hours. Title 24 determines compliance by comparing the energy use of a modeled (or 'proposed') home to a minimally Title 24 compliant 'standard home' of equal dimensions. Title 24 focuses on building energy efficiency per square foot; it places no limits upon the size of the house or the actual energy used per dwelling unit.

To estimate Title 24-compliant energy use for space heating, space cooling, and domestic hot water systems, data from RASS was used to calculate the total energy use per dwelling unit. Estimates for hard-wired lighting will be discussed later in this section. The study estimates the unit energy consumption (UEC) values for individual households surveyed and also provides the saturation number for each type of end-use. The saturation number indicates the proportion of households that have a demand for each type of end-use category.

The most applicable data provided in RASS was used to estimate the UEC values for dwelling units at VC. Where available, data for multifamily, 5+ unit apartment types in climate zone 9, which is the climate zone in which VC is located, was used. If multifamily or climate zone 9 data was not available, then all household or statewide data was used, respectively. The RASS dataset is comprised of older buildings, which are typically less energy efficient (on a per square foot basis) than newer buildings constructed to meet increasingly stricter efficiency standards. Although the homes used for RASS are likely less energy efficient than Title 24-compliant buildings, the energy use estimates were assumed to represent 2001 Title-24 compliant homes. The Title 24 standards have been updated twice (in 2005 and 2008) since RASS, and CEC has published reports estimating the percentage deductions in energy use resulting from these new standards.[85,86] Because buildings at VC would conform to the most updated (and most stringent) standards, ENVIRON accounted for the reduction in energy use resulting from the

[85] California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF

[86] California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Title 24 updates by deducting the estimated percentage savings from the RASS energy use estimates, shown in Table 4-11.

RASS provides the annual electricity use per dwelling unit for various heating, cooling, and domestic hot water subcategories. ENVIRON calculated the total electricity demand for each category by multiplying the UEC and saturation values and summing the products for each end-use subcategory within each category. End-use subcategories used to calculate the electrical heating UEC value include conventional electric heating, electrical heat pump space heating, auxiliary heating, and furnace fan. Subcategories included in the cooling category include central air, room air, and evaporative cooling. RASS also provides the UEC values for natural gas usage used for heating and domestic hot water. The same method was used to calculate natural gas usage for each Title 24 category as described above. Natural gas subcategories used to estimate natural gas UEC heating values include primary heat and auxiliary heat; domestic hot water natural gas includes conventional gas water heat.

4.8.3 Energy Use from Major Appliances and Plug-ins

Typical major household appliances provided in new residential units include refrigerator, clothes washer and dryer, dishwasher, and cooking range. These are typical appliances provided with a new residential unit that the developer has some control over. Energy demand from using these major appliances is based on UEC and saturations values from RASS. Table 4-12 summarizes the estimated major appliance energy use for dwelling units at VC.

Vista has committed to requiring Energy Star appliances for all major appliances rated by Energy Star in newly built residences. This includes refrigerators, dishwashers, and clothes washers. There is no Energy Star rating for dryers at this time since there is no significant difference in energy use between different dryer models. Energy Star ratings also are not available for cooking ranges. The average energy improvement for Energy Star rated appliances over standard appliances as reported in Energy Star Annual Report was used to determine the percent reduction in energy use from major appliances.

In addition to major appliances, additional loads such as lighting, office equipment, plug-in cooking equipment and electronics other plug-in electricity loads, such as lighting in a miscellaneous category are also part of the anticipated energy use for a residential development. Similar to the major appliances above, energy use values for plug-in appliances are based on the UEC and saturation values for the miscellaneous category in RASS.

Table 4-13 summarizes the combined energy use including the Title 24 systems, major appliances, and plug-ins. All residential units at VC will comply with the 2008 Title 24 standards, which will be in effect beginning January 1, 2010. In addition, Vista has committed to making all new homes 20% more energy efficient than 2008 Title 24 requirements, i.e., 20%

more energy efficient on a TDV basis.[87] Although ENVIRON is aware that annual energy and TDV energy do not necessarily scale linearly with each other, ENVIRON assumed that all sources covered by Title 24 would uniformly use 20% less annual energy. For each type of home, the 2008 Title 24 compliant energy use was calculated as described above. These energy use numbers were then each multiplied by 0.80 to account for Vista's commitment to a 20% energy efficiency improvement over 2008 Title 24.

It should be noted that the estimates for residential plug-in energy-use presented here are likely overestimates. The estimates are based upon technologies that were available during the RASS survey, which was conducted in 2003. Future equipment models are likely to be more energy-efficient than current models. If future VC residents install Energy Star appliances, use more energy efficient equipment, and replace incandescent lights with fluorescent lights, the actual electricity use for plug-ins will be lower than is estimated here. Conversely, future residents may have more small plug-ins (e.g. MP3 player, cell phone, miscellaneous equipment) that could somewhat offset the savings from more energy efficient equipment. However, because refrigerators, lighting, and large appliances contribute to the bulk of the electricity load, and these types of equipment will likely improve in energy efficiency in the future, the estimates presented here are still overestimates.

Table 4-13 shows the calculations for the improvement in energy use from Vista's commitment to a 20% improvement over 2008 Title 24 and their commitment to requiring Energy Star major appliances where available.

4.8.4 Estimation of Annual Greenhouse Gas Emissions from Residential Buildings

Energy use data were multiplied by the emission factors presented in Table 4-10 to generate CO_2 intensity values (i.e., CO_2 emissions per dwelling unit) for each building type (Table 4-14). The emissions per dwelling unit ranges from 2.2 tonnes for multi-family attached units, 2.6 tonnes for town homes, and 3.2 tonnes for detached homes.

Table 4-15a and 4-15b show the yearly CO_2 emissions from VC and the overlay option, respectively, by incorporating the aforementioned emission factors and the number of dwelling units for each building type for Title 24 systems and all plug-in energy. The total emissions in the project scenario would be 2,728 tonnes per year, and for the overlay option would be 3,245 tonnes per year.

4.8.5 Uncertainties in Residential Building GHG Calculations

Several factors lead to uncertainties in the above analysis. As described below, it is believed that these uncertainties result in conservative estimates of the GHG emissions for the residential buildings at VC.

Energy use will vary considerably depending upon the design of the home. The residential units to be built in VC will vary considerably in size, layout, and overall design. Energy use estimates for a given dwelling type were calculated using RASS data for a range of dwelling sizes centered on the average square footage of each dwelling type. The average of the sizes of single-family homes and multi-family units included in the RASS survey are 1,787 sqft and 997 sqft, respectively. The multi-family home average is similar to the multi-family units at VC; however, VC single-family homes may be up to 10.6% larger than the average single-family homes. Thus the energy use estimates for the single family homes in VC homes may be slightly underestimated.

Built environment energy use will vary considerably depending upon the home owners' habits regarding energy use. For instance, homeowners determine the set point of thermostats, the duration of showers, and the usage of air conditioning, among other things. The project applicant will have little, if any, influence over these choices made by the homeowner. Current median behavior attributes were assumed for this report. To the extent that individuals are becoming more energy conscious, this will tend to overestimate energy use in the future.

Plug-in energy use will also vary considerably depending upon the appliances, lights, and other plug-ins installed by the homeowner. The project applicant will have little, if any, influence over these choices made by the homeowner. As above, the current median behavior attributes are represented here. To the extent that individuals are becoming more energy conscious, or appliances are becoming more energy efficient, the estimates provided here will tend to overestimate energy use in the future.

The above estimates for CO_2 emissions from the residential buildings do not take into account the State of California's requirement for builders to offer solar panels as an option to homeowners. It is unknown how many future homeowners will chose this option, therefore, while the exact reduction in CO_2 emissions due to this project design feature can not be quantified it will decrease the CO_2 emissions for those residential buildings that choose to install renewable energy.

4.9 Non-Residential Building Energy-Related GHG Emissions

Non-residential buildings include all structures except residential units that may exist in a development such as government, municipal, commercial, retail, and office space. This section describes the methods used to estimate the GHGs associated with activities in non-residential buildings.

The amount of energy used and the associated GHG emissions emitted per square foot of available space vary with the type of non-residential building. For example, grocery stores are far more energy intensive than warehouses, which have little climate-conditioned space. The project applicant provided data summarizing the general non-residential building categories planned for VC and the area of floor space planned for each building type. For new developments, the exact types of buildings are typically unknown. As such, not all building categories that may actually exist in VC are represented below. However, all of the non-residential building area is accounted for, and the tables provided in this section present the differences in energy intensities from building type to building type. The types of non-residential buildings as provided to ENVIRON are:

- General Office
  - Administrative office (50%)
  - Mixed-use office (50%)
- Community Commercial
  - Retail (50%)
  - Other retail (50%)
- Village Commercial
  - Grocery store (100%)
- Food Service
  - Restaurant/cafeteria (50%)
  - Fast food (50%)
- Hotel
  - Lodging (100%)
- Public Assembly
  - Entertainment/culture (100%)

Similar to the case for residential buildings, GHGs are emitted as a result of activities in non-residential buildings for which electricity and natural gas are used as energy sources. Combustion of any type of fuel emits CO_2 and other GHGs directly into the atmosphere; when this occurs in a non-residential building this is a direct emission source[88] associated with that building. GHGs are also emitted during the generation of electricity from fossil fuels. When electricity is used in a non-residential building, the electricity generation typically takes place offsite at the power plant; electricity use in a non-residential building generally causes emissions in an indirect manner.

While fuel combustion generates CH_4 and N_2O, the emissions of these GHGs typically comprise less than 1% of CO_2e emissions from electricity generation and natural gas consumption.[89]

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[88] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.0 (April). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf, Chapter 8

[89] Ibid., Tables C1 and C2. The methane and nitrous oxide emission factors are negligible compared to the total CO_2

Fuel oil, kerosene, liquefied petroleum gas, and wood can also be used as fuels, but generally contribute only in small amounts as combustion sources within non-residential buildings. As such, these minor emissions are not accounted for here.

Similar to energy use in residential buildings, energy use in non-residential buildings is divided into energy consumed by the built environment and energy consumed by uses that are independent of the construction of the building such as plug-in appliances. In California, Title 24 governs energy consumed by the built environment, mechanical systems, and some fixed lighting. Non-building energy use, or "plug-in" energy use can be further subdivided by specific end-use (refrigeration, cooking, office equipment, etc.). The following two steps were performed to quantify the energy use due to non-residential buildings:

1. Calculate energy use from systems covered by Title 24[90] (HVAC system, water heating system, and the lighting system).
2. Calculate energy use from office equipment, plug-in lighting, and other sources not covered by Title 24.

The resulting energy use quantities were then converted to GHG emissions by multiplying by the appropriate emission factors obtained by incorporating information on local electricity production.[91] The following sections describe the methodologies employed to estimate GHG emissions in greater detail.

In this section of this report, the units CO_2 and CO_2e are used interchangeably for non-residential buildings because CH_4 and N_2O are assumed to contribute a negligible[92] amount of GWP when compared to the CO_2 emissions from non-residential buildings.

4.9.1 Estimate of Non-residential Energy Use Intensity

ENVIRON developed CO_2 intensity values (CO_2 emissions per sqft per year) for building types found in VC using data from the 2003 Commercial Buildings Energy Consumption Survey (CBECS).[93] The methods that were used to estimate these emissions for VC are described below.

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emission factor for electricity generation in California.

[90] Title 24, Part 6, of the California Code of Regulations: California's Energy Efficiency Standards for Residential and Nonresidential Buildings. http://www.energy.ca.gov/title24/

[91] The Southern California Edison specific emission factor for electricity deliveries is 631 lbs CO_2/MWh. From the California Climate Action Registry Database. Southern California Edison PUP Report. 2007.

[92] The Southern California Edison specific emission factor for electricity deliveries is 631 lbs CO_2/MWh. From the California Climate Action Registry Database. Pacific Gas and Electric PUP Report. 2007. Although this emission factor accounts for only CO_2, the emissions associated with N_2O and CH_4 contribute to less than 1% of the electricity generation CO_2e emissions.

[93] US Energy Information Administration (EIA). Public Use Microdata 2003. Data available at http://www.eia.doe.gov/emeu/cbecs/contents.html

4.9.1.1 EIA Database

The overall energy use for the building types was calculated based on data provided by the EIA.[94] The building types and subcategories are shown in Table 4-16a for the project scenario and Table 4-16b for the overlay option. Tables 4-16a and 4-16b also provide the classifications of VC building types to EIA building types.

The EIA data is based on CBECS, which was conducted in 2003. Each building type has a characteristic electricity and natural gas use per square foot of building space. Electricity use per square foot (electricity intensity) for each building sample was extracted from the EIA data for buildings in EIA climate zone 4 (includes CA climate zone 9). Similarly, the natural gas use per square foot (natural gas intensity) for each building sample was also extracted. The energy use estimates were assumed to represent 2001 Title-24 compliant buildings. The Title 24 standards have been updated twice (in 2005 and 2008) since CBECS was performed, and CEC has published reports estimating the percentage deductions in energy use resulting from these new standards. Based on CEC discussion on average savings for Title 24 improvements from 2001 to 2005 the average savings percentages due to the reduction in energy use resulting from the 2005 Title 24 updates are 7.7% for electricity and 3.2% for natural gas. For the 2008 Title 24 updates relative to 2005 Title 24, the improvements are 4.9% and 9.4% for electricity and natural gas, respectively.

Table 4-17 lists the division of electricity use among several end uses for electricity in various non-residential building types. Table 4-18 lists the percentages of total natural gas assigned to different uses in various non-residential building types. The end use data provide an estimate of the percent of the total energy use comprised by Title 24 regulated (built environment) and plug-in electricity or natural gas usage in each building type. The Title 24-regulated electricity use (cooling, space heating, water heating, lighting, ventilation) and the non-built electricity use (office equipment, refrigeration, cooking, etc.) are presented in Table 4-19. The Title 24-regulated natural gas use and the non-built natural gas use (primarily from cooking) are also presented in Table 4-19.

4.9.2 Estimation of Annual Greenhouse Gas Emissions from Non-Residential Buildings

Vista has committed to making all new non-residential buildings 20% more energy efficient than Title 24 2008 standards, or 20% more energy efficient on a TDV basis. Although ENVIRON is aware that annual energy use and TDV energy do not necessarily scale linearly with each other, as discussed in the residential section, ENVIRON assumed that all sources covered by Title 24 would uniformly use 20% less annual energy compared to 2008. These calculations are shown in Table 4-19. Non-Title 24 regulated energy use is assumed to still use the same amount of energy as a minimally Title 24 compliant building. There is no credit taken for any Energy Star appliances in the non-residential building category since it is difficult to determine which

[94] Table 3a and 3b of: http://www.eia.doe.gov/emeu/cbecs/enduse_consumption/pba.html.

appliances may be present in the various non-residential building categories. In addition appliances are generally not supplied with the building. Baseline Title 24 usage rates shown in this table have been adjusted to reflect improvements in Title 24 building codes introduced 2008. CEC discusses average savings for improvements from 2002 to 2005 ("Impact Analysis for 2005 Energy Efficiency Standards"). ENVIRON used these CEC average savings percentages to account for reductions in energy use due to Title 24.

Energy use data from Table 4-19 were multiplied by the emission factors presented in Table 4-10 to generate CO_2 intensity values (CO_2 emissions per square foot building area), which are shown in Table 4-20. These intensity values were then multiplied by the square footage of the respective non-residential land use type to determine CO_2 emissions. As shown in Tables 4-21a and 4-21b the estimated overall CO_2 emissions associated with non-residential energy use before accounting for emission savings from on-site renewable energy is 5,003 tonnes CO_2 per year for the project scenario and 4,027 tonnes for the overlay option. As will be discussed below, non-residential emissions will be reduced to 4,652 and 3,676 tonnes per year, respectively after accounting for on-site renewable energy generation.

4.9.3 Uncertainties in Non-residential Building GHG Calculations

Several factors lead to uncertainties in the above analysis. These are described below.

For new developments, the exact types of buildings are typically unknown. As such, not all building categories that may actually exist in VC are represented in this analysis. However, all of the commercial building area is accounted for and the best available assessment of the building type composition of VC was used. The tables provided in this section present the differences in energy intensities from building type to building type.

Although it is unknown exactly how the buildings will be designed, each building will be Title 24 compliant. Therefore all design features of the building that make it less energy efficient will be offset by design features that make it more energy efficient.

4.10 GHG Emission Reduction from Rooftop Installations

Vista Canyon Ranch, LLC has committed to providing the equivalent GHG emission reduction that would be generated by an 80,000 sqft photovoltaic system. As will be discussed below, there are other types of rooftop systems that could provide the same GHG emission reductions as an 80,000 sqft photovoltaic panels. In this section the emission reduction from an 80,000 sqft PV system is estimated, which will serve as the target reduction for the rooftop system that is ultimately installed.

The following steps were used to estimate the emission savings from this system:

1. Estimate the direct current (DC) power rating based on panel area. This power rating represents the power generated when the panel is exposed to 1-sun insolation (i.e. 1 kWh/m^2 of solar radiation).

2. Estimate the AC power rating based on DC power rating and a derate factor, which accounts for energy losses due to inefficiencies in the DC-to-AC inverter, wiring and other connections; as well as the effects of shading, weather and soil on system

performance. ENVIRON used the default derate factor of 0.77 from the National Renewable Energy Laboratory software program "PVWatts", which can be used to estimate annual energy production for a crystalline silicon PV system, based on site zip code.[95]

3. Estimate the total annual peak sun hours (equivalent to 1-hour exposure to 1-sun insolation) for Santa Clarita. ENVIRON used PVWatts to estimate site-specific values based on zip code.

4. Calculate the total energy generated per year.

5. Using the SCE emission factor for electricity generation, estimate the GHG emissions averted due to on-site renewable energy generation.

The total annual energy generated from an 80,000 sqft photovoltaic system is 1,327 MW-hr per year. As shown in Table 4-22a, the generation of non GHG-emitting energy saves an equivalent amount of electricity from SCE, and results in a total GHG savings of 351 tonnes CO_2e per year.

There are other types of rooftop systems that could generate the same or greater amount of CO_2e reduction as photovoltaic systems covering the same roof area. Solar thermal water heating systems consist of rooftop panels through which water or a secondary heating fluid is warmed by the sun. The heated water moves from through the panel to a hot water tank. Supplemental heating from natural gas or electricity is required to keep the water at its desired temperature when the available solar heating is insufficient.[96] Solar space heating systems operate using the same general principles; the warmed air can be circulated mechanically or via natural convection.[97] Both of these systems reduce the natural gas and/or electricity that would otherwise be used for heating. A comparison of the emissions averted from solar thermal systems, cool roof materials and photovoltaic systems is summarized in Table 4-22b.

There are other solar-powered technologies that can reduce energy use for other end-uses. For example, electricity use for building cooling could be reduced by installing solar thermally-driven air conditioners, which uses the heat to vaporize refrigerant in an absorption chiller system.[98] Solar hybrid lighting systems use rooftop solar concentrators to channel sunlight to light fixtures via fiber optic cables. This sunlight supplements light from the fixtures themselves; there are

[95] National Renewable Energy Laboratory, Renewable Resource Data Center. PVWatts. Available at: http://www.nrel.gov/rredc/pvwatts/. Accessed August 29, 2009.
[96] US Department of Energy - Energy Efficiency and Renewable Energy, Solar Energy Technologies Program. 2003. Consumer's Guide: Heat Your Water With The Sun. DOE/GO-102003-1824. December. Available at: http://www.nrel.gov/docs/fy04osti/34279.pdfhttp://www1.eere.energy.gov/solar/printable_versions/sh_basics_water.html
[97] US Department of Energy - Energy Efficiency and Renewable Energy . Solar Air Heating (webpage). Available at http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12510
[98] National Renewable Energy Laboratory. Distributed Thermal Energy Technologies (webpage). Available at: http://www.nrel.gov/dtet/thermal_air_cond.html.

controls to vary the amount of light supplied by the fixtures according to the amount of light provided by the fibers.[99] It is important to note that these roofing options are not mutually exclusive; for example, it is possible to have hybrid photovoltaic and solar heating installations.

The aforementioned technologies are currently in various stages of development and commercialization. Construction at VC is not projected to begin until 2012 or 2013, at which time these technologies may be more feasibly installed for commercial use. Because there are multiple existing and developing options for on-site rooftop GHG emission reduction, Vista Canyon LLC prefers to retain flexibility in choosing the most suitable technology to achieve a reduction equivalent to an 80,000 sqft photovoltaic system.

4.11 Mobile Sources

This section estimates GHG emissions from mobile sources in VC. The mobile source emissions considered for this project will be from the typical daily operation of motor vehicles by VC residents.

ENVIRON estimated GHG emissions based upon all miles traveled by VC residents regardless of internal or external destinations or purpose of trip. Traffic patterns, trip rates, and trip lengths are based upon data provided by Fehr and Peers.[100]

Mobile source emissions from new residences are considered to be growth, as residences are rarely removed from the housing supply once constructed. There are exceptions, such as when one housing development replaces another, and, in those cases, the replacement residential development need not be considered growth.

However, as indicated earlier in this report, commercial development that reduces VMT should not be considered new growth for vehicular travel purposes. To the extent that commercial development serves existing residential development and/or reduces VMT in the area, its vehicular travel should not be new. For example, the new commercial uses in VC will provide employment and service opportunities for both project residents and residents within the eastern Santa Clarita Valley. Therefore, Vista and its new commercial growth will reduce shopping and work trip lengths and will reduce GHG emissions associated with mobile sources.

On the other hand, a new commercial area that results in longer trips for its workers and residents than they would have previously made, then it adds GHG emissions. Commercial development that could potentially increase VMT would be facilities that draw trips from far away that otherwise would not be made. A theme park, for example, may be viewed as such a development.

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[99] US Department of Energy. 2007. Technology Focus: Hybrid Solar Lighting Illuminates Energy Savings for Government Facilities. May. Available at: www1.eere.energy.gov/femp/pdfs/tf_hybridsolar.pdf

[100] Fehr and Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. August 2009..

As indicated above, the new non-residential uses in the VC development area will not contribute to new mobile GHG emissions. However, the other emissions from the non-residential areas would be considered to be new, as that would reflect growth in non-residential areas that goes along with growth in residential areas.

Accordingly, GHG emissions from VMT serving non-residential areas will only be counted if the non-residential areas contribute to greater VMT as a result of its location. It should be noted that as VC is a mixed-use community, this issue does not directly affect VC VMT calculations; all VMT from future VC residents is calculated regardless of internal or external destinations or purpose of trip.

The CCAR GRP[101] recommends estimating GHG emissions from mobile sources at an individual vehicle level, assuming knowledge of the fuel consumption rate for each vehicle as well as the miles traveled per car. Since these parameters are not known for a future development, the CCAR guidance is too specific to use as recommended.

For mobile sources, CH_4 and N_2O are explicitly calculated, multiplied by their respective GWP, and added to the CO_2 emissions, to result in total CO_2e emissions from mobile sources.

4.11.1.1 Estimation of VMT from Mobile Sources

Fehr and Peers provided ENVIRON with estimates for weekday household VMT to be used for the mobile source emissions estimate. The following summarizes their approach to estimate weekday VMT, as well as ENVIRON's revisions to estimate total annual VMT.

Traditional traffic models focus upon designing roads and planning a development such that traffic delays will be avoided during peak travel hours. Traditional traffic analyses also provide the total number of daily vehicles on a road which can then be used to calculate toxic or criteria emissions that may have localized health effects. Several steps must be taken to go from a traditional traffic model to a set of calculations that describe VMT made by VC residents.

The first step is to disaggregate the traffic information that is contained in the original traffic report into trips made by VC residents and into trips made by non-VC residents, as well as trip lengths for different trip types. The second step is to adjust the traffic report trips to account for project design features (i.e. mix of land uses) and public transit services that reduce trips. As the traditional traffic analysis only predicts weekday driving patterns, the next step is to account for differences in weekend and weekday driving patterns. The final step is to take all of these parameters into account and calculate the final VMT from VC residents.

[101] California Climate Action Registry (CCAR). 2008. *General Reporting Protocol*. Version 3.0. April.

4.11.1.2 Estimation of Daily Trips, Proportions of Trip Types, and Trip Lengths

Using their traffic model, Fehr and Peers provided estimates for the number of home-based work trips, home-based other trips, and non-home based trips made by residents at VC, as shown in Table 4-23a. These trip estimates were based on combined transit mode share and trip internalization of 17%, which is a conservative estimate. Each trip type was further divided into internal trips, which remain within Santa Clarita, and external trips, which extend beyond Santa Clarita. Fehr and Peers also estimated both internal and external trip lengths for each trip type.

4.11.1.3 Weekend Versus Weekday Driving Patterns

Since Fehr and Peers' VMT estimate is based on weekday conditions, ENVIRON calculated weekend traffic by applying differences between the weekend and the weekday traffic based upon a report by Sonoma Technology.[102] Weekend traffic was assumed to be 80% of weekly capacity.[103]

4.11.1.4 Calculation of Total VMT

Total vehicle miles traveled (VMT) were calculated by multiplying the number of trips by the average trip length for each type of trip.

VMT = Number of Trips * Average Trip Length

The value calculated here includes all VMT generated by VC residents commuting within VC and all VMT generated by VC residents commuting to and from VC. The total annual VMT for VC residents is 22,266,313 miles, as shown in Table 4-23a. This VMT was multiplied by the appropriate emission factors in the next section to calculate GHG emissions from mobile sources at VC.

This estimate, again, is likely conservative as studies show that transit use increases in transit-oriented developments ten years after the community is first built and occupied. Increased transit use would in turn reduce the average VMT for a transit-oriented development.

4.11.2 GHG Emissions from Mobile Sources

The CO_2 emissions from mobile sources were calculated with the trip rates, trip lengths and emission factors for running and starting emissions from EMFAC2007 as follows:

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[102] Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

[103] A conservative adjustment for weekend travel was assumed for all the trips since information was not available to distinguish between trips on major highways and trips on small streets. The Sonoma Technologies report gives a range of values, but does not present a weighted value, thus a conservative percent reduction in the number of trips was selected.

CO_2 emissions = VMT * $EF_{running}$

Where:

VMT = vehicle miles traveled
$EF_{running}$ = emission factor for running emissions

The CO_2 calculation involves the following assumptions:

The emission factor depends upon the speed of the vehicle. Here, it was assumed that internal trips were 35 miles per hour and external trips were 60 miles per hour.

EMFAC emission factors from the year 2020 were used for $EF_{running}$ based on Los Angeles County fleet mix, and were decreased by 20% to account for Pavley Vehicle Standards[104].

Startup emissions are CO_2 emitted from starting a vehicle. Startup emissions were calculated using the following assumptions:

The number of starts is equal to the number of trips made annually.

The mix of vehicles was EMFAC fleet mix for Los Angeles County in 2020.

The starting emission factor is based on the weighted average distribution of time between trip starts based on URBEMIS defaults.

Fleet distribution types from EMFAC2007 were used for the year 2020, a year selected to represent full build out.

Table 4-23a shows the CO_2 emissions from vehicles associated with residents of VC as calculated according to the methodology described above. Nitrous oxide, CH_4, and HFCs[105] are also emitted from mobile sources. The USEPA recommends assuming that CH_4, N_2O, and HFCs account for 5% of mobile source GHG emissions, taking into account their GWPs.[106] Therefore, CO_2 emissions in Table 4-23a were divided by 0.95 to account for non-CO_2 GHGs. Vehicles associated with the VC development will emit approximately 7,460 tonnes CO_2e per year.

[104] California has passed AB 1493 (Pavley Standards) requiring reductions in GHG from vehicles. The waiver needed from USEPA to implement AB 1493 (Pavley standards) has been granted. The Pavley standard only regulates emissions up to the year 2016. However, ARB has committed to additional GHG emission reductions through 2020. A report by ARB indicates that in 2020 the statewide impact of these vehicle emission standards will be a 20% reduction in GHG emissions from mobile sources.
California Air Resources Board (ARB). 2008. Comparison of Greenhouse Gas Reductions For the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations.

[105] HFCs can be emitted from air conditioning systems.

[106] USEPA. 2005. *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle.* Office of Transportation and Air Quality. February. (http://www.epa.gov/otaq/climate/420f05004.pdf)

4.11.3 Mobile Source Emissions for Overlay option

The VMT and mobile source emissions for the overlay option were calculated using the estimates for the project scenario. According to Fehr & Peers[107], the VMT per DU would be the same for both scenarios; thus, the total VMT for the overlay option increases in proportion to the increase in dwelling units. ENVIRON assumed that the traffic characteristics (e.g. fleet mix, trip type percentages, proportions of internal and external trips) would also be the same for both scenarios. As a result, the total mobile source emissions for the overlay option would also increase in proportion to the number of dwelling units, relative to the project scenario. Table 4-23b shows that the mobile source emissions for the overlay option are 9,016 tonnes per year.

4.11.4 Uncertainty Analysis

In an effort to evaluate the assumptions described in the section it should be noted that changes in estimated fleet distribution and emission factors will likely improve based on anticipated regulations, over and above those currently enacted in law.

4.12 Transit Center

A transit center consisting of a Metrolink rail station and a bus transfer station is proposed for VC. The new transit center will be larger than the existing Via Princessa Metrolink rail station that it will replace, and will receive City of Santa Clarita Transit buses connecting with the new Metrolink stop. The vehicles that will service the transit center are not attributed to the Vista Canyon development, because they do not solely serve the residents of Vista Canyon. Instead, the transit vehicles will transport people from outside the development to Vista Canyon, and will transport non-residents between points entirely outside of Vista Canyon. In addition, we assume that the addition of new transit vehicles that serve existing areas will reduce GHG emissions over all. Transit center GHG emissions are associated with energy consumption from the transit center parking structure, bus berth area, and rail station platforms. The method used to calculate these emissions is presented below.

4.12.1 Emissions Related to Transit Center Building Energy Use

GHG emissions from energy consumption of building structures were calculated by multiplying the energy usage of the structures with the electricity and gas GHG emission factors presented in Table 4-10, as shown in Table 4-24. Energy consumption was estimated using data provided by the CEC.[108,109] The 2006 Commercial End-Use Survey (CEUS) data is based on a survey conducted in 2002 of existing buildings. ENVIRON used data for Southern California Edison (SCE), Zone 10, which is the sector in which the VC development is located. The CEUS "Miscellaneous" building category includes automobile parking; in addition to the parking

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[107] Based on an email communication with John Gard of Fehr & Peers on October 7, 2009.

[108] Workbooks for "PGE – FCZ10" downloaded from http://capabilities.itron.com/CeusWeb/Chart.aspx for all building categories. Access 8/23/2009.

[109] The CEUS database was chosen for this energy estimate instead of the EIA CBECS database because CEUS provides separate end-use percentages for exterior lighting and interior lighting, whereas the EIA CBECS database provides data for total lighting only.

structure, ENVIRON assumed that the energy use for this category also applies to the bus station and train platforms. The “All Office” data was used for the parking structure security office. Each building type has a characteristic electricity and natural gas use per square foot of building space, as well as characteristic end-use proportions (e.g. heating, cooling, and interior lighting). Of the different end-uses considered by CEUS, only exterior lighting and "miscellaneous" end uses were included for the parking structure, bus transit stop and Metrolink platforms. It was assumed that these structures would not have space conditioning (e.g. heating, cooling, and ventilation), interior lighting, cooking, water heating, office equipment, motors, air compressors, or process-related electricity uses. The existing Via Princessa Metrolink Station will be replaced by the proposed new station. The existing station includes Metrolink platforms and a parking area, but does not include a security office. Analogous to the treatment of the proposed transit center facilities, energy use characteristics of the CEUS "Miscellaneous" building category were assumed to apply to the existing parking area and Metrolink platforms.

Total energy use of the transit center structures was determined by multiplying the CEUS energy use intensities by the net new area of the Transit Center. The size of the parking structure security office was provided by Vista while sizes of the parking structure, the bus transfer station, and the Metrolink station platforms were extracted from the project site plan/tentative tract map prepared by Alliance Land Planning and Engineering (September 2009). The sizes of the existing parking area and Metrolink platforms were estimated from aerial photographs. Energy usage estimates for these structures were obtained from the CEUS database and are presented in Table 4-24.

The total amount of GHG emissions from the transit center is estimated to be 49 tonnes of CO_2 per year.

4.13 Municipal Sources

This section explains estimates for emissions stemming from municipal sources such as drinking water and wastewater supply and treatment, lighting in public areas, and municipal vehicles.

4.13.1 Water and Wastewater Supply and Treatment Systems

In general, the majority of municipal sector GHG emissions are related to the energy used to convey, treat and distribute water and wastewater. Thus, these emissions are generally indirect emissions from the production of electricity to power these systems. Additional emissions from wastewater treatment include CH_4 and N_2O, which are emitted directly from the wastewater.

The amount of electricity required to treat and supply water depends on the volume of water involved. According to Vista, the development would generate a total water demand of 118 million gallons per year. Of this, 78 million gallons per year will be potable water supplied by the

Santa Clarita Water Division (SCWD) of the Castaic Lake Water Agency (CLWA), and 40 million gallons per year will be non-potable recycled water.[110] Three processes are necessary to supply potable water to residential and commercial users: (1) supply and conveyance of the water from the source; (2) treatment of the water to potable standards; and (3) distribution of the water to individual users. After use, the wastewater is treated and reused as recycled water.

Indirect emissions resulting from electricity use were determined by multiplying electricity use by the CO_2 emission factor provided by the local electricity supplier, SCE. Energy use for different aspects of water treatment (e.g. source water pumping and conveyance, water treatment, distribution to users) was determined using the stated volumes of water and energy intensities values (i.e., energy use per unit volume of water) provided by reports from the CEC and a report by Robert Wilkinson on energy use for California's water systems.[111] The emission factors and GHG emissions for all these processes are shown in Table 4-25. The annual emissions from water treatment and distribution, wastewater treatment, and distribution of recycled water are approximately 270 tonnes CO_2e per year. Details on the emissions generated by specific aspects of water treatment and supply systems are provided in the following sections.

4.13.2 Potable Water Source Supply and Conveyance

Water in the Santa Clarita Valley is typically supplied to projects from several sources including the local underground aquifers, the State Water Project, and recycled and reclaimed water.

Supplying and conveying potable water in VC is estimated to account for 150 tonnes of CO_2e emissions per year. VC will draw upon water from the State Water Project and groundwater.[112] The energy needed to supply and convey VC's water will be used to pump this water from the sources and distribute it throughout the development. The CEC estimated that 2,915 kW-hr would be required to extract one million gallons of water from Chino Basin groundwater. Wilkinson estimated that 9,931 kW-hr would be required to extract one million gallons of water from the State Water Project. Using these energy intensity factors, the expected potable water demand, and the SCE carbon-intensity factor, GHG emissions from potable water supply and conveyance were calculated (see Table 4-25). Supplying and conveying water in VC from the State Water Project and groundwater is estimated to account for 126 tonnes and 24 tonnes of CO_2e emissions per year, respectively.

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[110] CLWA-SCWD expects that the potable water for Vista Canyon will be supplied from two different sources: the State Water Project and local groundwater. CLWA-SCWD water supplies information obtained from the 2008 Water Requirements and Supplies report, available at: http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf

[111] CEC 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.

CEC 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.

Wilkinson, Robert. 2000. Methodology for Analysis of the Energy Intensity of California's Water Systems, and An Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures.

[112] Vista Canyon potable water supplies are based on Castaic Lake Water Agency – Santa Clarita Water Division expected sources for the area. According to the CLWA 2008 Water Requirements and Supplies report, 61% of the water supply to Vista Canyon is from the State Water Supply, and the remaining 39% is from local groundwater.

4.13.3 Potable Water Treatment and Distribution

Treating and distributing potable water in VC are estimated to account for 2 tonnes and 26 tonnes of CO_2e emissions per year, respectively.[113] Based on the estimated potable water demand, these energy intensity factors, and the SCE-carbon intensity factor, GHG emissions from potable water treatment and distribution were calculated as shown in Table 4-25.

4.13.4 Wastewater Treatment

Emissions associated with wastewater treatment include indirect emissions necessary to power the treatment process and direct emissions from degradation of organic material in the wastewater. Wastewater treatment indirect emissions in VC are estimated to account for 70 tonnes of CO_2e emissions per year. According to Dexter Wilson Engineering, there will be no or negligible direct emissions of methane or nitrous oxides resulting from onsite wastewater treatment. As a result, no direct CO_2e emissions are anticipated.

Indirect GHG emissions from the electricity necessary to power the wastewater treatment process were calculated for VC. The electricity required to operate a wastewater treatment plant is estimated to be 2,011 kW-hr per million gallons of water.[114] Based on the expected amount of wastewater requiring treatment (133 million gallons per year[115]), this energy intensity factor and the SCE carbon-intensity factor, indirect emissions due to wastewater treatment were calculated as shown in Table 4-25.

4.13.5 Non-Potable Recycled Water Distribution

Non-potable recycled water distribution emissions in VC are estimated to account for 22 tonnes of CO_2e emissions per year. Vista estimates that non-potable water needs will be equal to 40 million gallons of water per year, which will be provided from recycled water. Once treated at the on-site wastewater treatment plant, this water must be re-pumped through the development to the end users. Estimates of the amount of energy needed to redistribute and, if necessary, treat reclaimed water is 2,100 kW-hr per million gallons.[116] Based on the estimated demand for reclaimed water, the estimated electricity demand and the SCE carbon-intensity factor, non-potable reclaimed water redistribution emissions were calculated as shown in Table 4-25.

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[113] The treatment and distribution of potable water is based on the electricity generation emission factor from Southern California Edison and information provided in the following 2006 Navigant Consulting refinement of the 2005 CEC study: California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.

[114] An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory..

[115] Data provided to ENVIRON by JSB Development.

[116] CEC 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.

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VC will generate more recycled water than it has demand; however, in the long term the surrounding area will make use of the recycled water generated by VC. Thus, a reduction in CO_2e emissions to account for surrounding areas being able to use recycled water instead of potable water was taken. This results in a reduction of 4,567 kW-hr per million gallons of water. Based on the estimated electricity savings and the SCE carbon-intensity factor, this is a reduction of 112 tonnes of CO_2e per year.

4.13.6 Water and Wastewater Related GHG Emissions for the Overlay option

Estimates of water demand and wastewater flow for the overlay option were required in order to estimate GHG emissions for these indirect sources. As shown in Table 4-26a and Table 4-26b, the flow rates of water were scaled from the project scenario according to the number of dwelling units and office space square footage. These flow rates were then used to estimate water and wastewater-related GHG emissions using the methods described above. The total water and wastewater supply, treatment and distribution for the overlay option is expected to produce 176 tonnes of CO_2e annually, as shown in Table 4-27.

4.13.7 Public Lighting

Lighting sources contribute to GHG emissions indirectly, via the production of the electricity that powers these lights. Lighting sources considered in this source category include streetlights, traffic signals, area lighting for parks and lots, and lighting in public buildings. The emission factor for public lighting is shown in Table 4-25 and Table 4-27. Data from a report by the City of Duluth shows that the amount of electricity demanded for all types of public lighting is 149 kW-hr per capita per year.[117] Using the Duluth study, the SCE-specific carbon-intensity emission factor and the expected VC population of 3,463 for the project scenario and 4,185 for the overlay option, emissions from public lighting were calculated.[118] Thus, the VC-specific emission factor for public lighting would be 0.039 tonnes CO_2e per capita per year. Public lighting emissions in VC are estimated to account for 136 and 165 tonnes CO_2 per year for the project scenario and overlay option, respectively. These numbers are likely conservative estimates since VC is a master-planned compact community and may require fewer lights than the City of Duluth.

4.13.8 Municipal Vehicles

GHG emissions from municipal vehicles are due to direct emissions from the burning of fossil fuels. Municipal vehicles considered in this source category include vehicles such as police cars, fire trucks, and garbage trucks. The emission factor for municipal vehicles is shown in Table 4-25 and Table 4-27. Data from reports by Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, California[119] show that the CO_2 emissions from municipal vehicles would be

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[117] Skoog., C. 2001. This factor was calculated by summing the total electricity needs for municipal uses and dividing by the Duluth population. The Duluth population was calculated by dividing the city's reported GHG emissions by its reported per capita emissions.

[118] Population estimate provided by JSB Development.

[119] City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf

approximately[120] 0.05 tonnes per capita per year. Using these studies and the expected VC population of 3,463 people for the project scenario and 4,185 for the overlay option, emissions from municipal vehicles in VC were calculated. Municipal vehicle emissions in VC are estimated to account for 173 and 209 tonnes CO_2e per year for the project scenario and overlay option, respectively.

In total, all municipal sources including water, wastewater, public lighting and municipal vehicles for VC are expected to produce 468 tonnes of CO_2e annually for the project scenario, and 550 tonnes per year for the overlay option.

4.14 Area Sources

Area sources emissions stem from hearths (including gas fireplaces, wood-burning fireplaces, and wood-burning stoves) and small mobile fuel combustion sources such as landscaping equipment. Fuel combustion associated with these sources produce direct GHG emissions. Emissions from natural gas-fired stoves and natural gas heating are already included in the residential sources (see Tables 4-11 through 4-21).[121] According to Vista, there will be no fireplaces in the residential units. Thus, the area source emission estimate includes lawn maintenance equipment only. This calculation is based on the URBEMIS method.

Landscaping emissions originate from equipment such as lawn mowers, blowers, trimmers and chain saws.[122] For residential areas, landscape-based GHG emissions are directly related to the number of residential units, the annual equipment usage rate, and landscape equipment CO_2 emissions factors. URBEMIS default values were employed for the annual usage rate. Table 4-28 shows an estimated 0.6 tonnes CO_2 will be generated from area sources per year.

4.15 Private Swimming Pools

VC could have up to six private residential swimming pools, which will generate indirect GHG emissions due to energy use that is mainly attributed to filter pumps. According to Vista, pools at VC will be solar-heated; as a result, ENVIRON assumed that no energy would be required for pool heating. The calculations for pool-related energy are summarized in Table 4-29. Annual pool pump use was estimated as the annual California average provided in a 2004 Davis

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City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf

Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissions.pdf

[120] In an effort to be conservative, the largest per capita number from these four reports was used.

[121] The methods used to calculate natural gas use for heating, water heating, and cooking described in the residential emission calculations are conservative and may cause slight differences in the natural gas usage determined using URBEMIS as was used in the air quality section of the draft EIR for Vista Canyon. Both methods are appropriate for the purpose of the individual sections. URBEMIS is designed for worst day local emissions of criteria pollutants as opposed to total emissions of GHGs.

[122] According to Appendix B of the URBEMIS User's Guide, landscaping emissions from non-residential land uses also includes contributions from air compressors, generators and pumps, which are affiliated with commercial applications.

Energy study (2,600 kWh/year) minus the estimated savings from the 2008 Appliance Efficiency Standards (1,088 kWh/year), according to a 2008 study by Davis Energy.[123,124] The estimated CO_2 emissions from energy use at six residential pools are 2 tonnes per year.

4.16 Uncertainty Analysis

Electricity use by the filter pumps may increase or decrease relative to the estimate presented in this report, depending on pool size and hours of pump operation.

4.17 Emission Inventory for Annexation Area

Annual emissions from the annexation area associated with residential buildings, non-residential buildings, mobile sources, municipal sources and area sources were estimated using the methods described in the preceding sections. The calculations are based on 150 single-family detached homes and 436,000 square feet of office space, which are minimally compliant with 2008 Title 24 building efficiency standards. For the mobile source emission estimate, ENVIRON assumed that the 150 single-family homes would have the same traffic characteristics (VMT per dwelling unit, trip type percentages, proportion of external and internal trips) as the project. As a result, the emissions for the annexation area could be scaled from the project mobile source emissions, based on the number of dwelling units.

For indirect emissions from water and wastewater systems, the water and wastewater flow rates were estimated using the same method employed for the overlay option described in Section 4.13.6. ENVIRON assumed that no water recycling would occur in the annexation area.

Tables 4-30 through 4-34 summarize the annual CO_2e emissions for residential building energy (550 tonnes), non-residential building energy (1,963 tonnes), mobile sources (1,002 tonnes), municipal sources (116 tonnes), and area sources (0.9 tonnes), respectively. The total estimated annual emissions are 3,632 tonnes CO_2e/year, as shown in Table 4-37.

4.18 Emissions Sources Not Quantified in Inventory

Emissions associated with leaks of high global warming potential gases such as from refrigeration leaks were not quantified. At the entitlement stage of development, the degree of uncertainty about the potential facilities with sources that may have refrigeration leaks makes a meaningful quantification of GHG emissions not feasible. In addition, since refrigeration

[123] Davis Energy Group. 2004 Analysis of Standards Options For Residential Pool Pumps, Motors, and Controls. Prepared for Pacific Gas and Electric Company. Available at: http://consensus.fsu.edu/FBC/Pool-Efficiency/CASE_Pool_Pump.pdf. Accessed September 3, 2009.

[124] Davis Energy Group. 2008. Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company. Available at: http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-05-15_workshop/other/PGE_Updated_Proposal_Information_Template_for_Residential_Pool_Pump_Measure_Revisions.pdf. Accessed September 3, 2009.

systems will be new, they are likely efficient and should be designed to reduce the amount of leaks of high global warming potential gases. As a result of this uncertainty, ENVIRON did not quantify these emissions at this time.

4.19 Project Design Features that Reduce GHG Emissions

The VC development incorporates many design features to reduce GHG emissions. This section describes the design features that were incorporated into this analysis either directly or indirectly. This section also lists those features that were not quantified in this analysis, but would likely yield further GHG emissions reductions.

4.19.1 Project Design Features Whose Emissions Reductions were Incorporated into the Analysis

4.19.1.1 Reductions in Emissions From Mobile Sources

Details on the project design features that were considered for the VMT estimates are provided in Fehr and Peers' Transportation Impact Study (August 2009). The mixed land uses at VC collectively create a walkable community that is largely self-supporting with respect to employment, recreation, retail and services.

The project will include a substantial amount of bicycle and pedestrian infrastructure within the project site.

The proposed transit center will encourage residents to use public transportation for longer trips.

The provision of on-site non-residential land uses will allow residents to make shorter trips.

A significant professional office component will create jobs on-site for residents within the region.

4.19.1.2 Vegetation Preservation

Approximately 2,100 trees will be planted within VC.

4.19.1.3 Energy Savings

Residential units will exceed the 2008 Standards for Title 24 Part 6 energy efficiency standards by at least 20%.

Non-residential buildings will exceed the 2008 Standards for Title 24 Part 6 energy efficiency standards by at least 20%.

Where large appliances are offered by residential builders, Energy Star appliances will be installed.

4.19.1.4 Roof-top Features for GHG Mitigation

VC will install rooftop systems on residential and/or non-residential buildings, which collectively reduce GHG emissions by 351 tonnes.

4.19.1.5 Recycled Water Use

VC will use recycled water for landscaping irrigation as well as for toilet facilities in retail, office and commercial spaces.[125]

VC will generate and treat recycled water for use offsite.

4.19.2 Project Design Features Whose Emissions Reductions Were Not Incorporated Into the Analysis

There are number of design features that will result in the reduction of GHG emissions from the project. These cannot be quantified, but they are listed in this section.

4.19.2.1 Vegetation

Approximately 90 acres will be preserved in a natural habitat, as part of the Open Space and Conservation Plan prepared for VC.

4.19.2.2 Reductions in Emissions from Mobile Sources

Fehr and Peers believe that a combined transit mode share and trip internalization of 25% is more representative of average traffic conditions at VC, versus the more conservative 17% that was used for the greenhouse gas inventory.

The project will provide opportunities to live and work within VC, as well as provide commercial services within walking distance of residential units, which will reduce external commuting trips.

According to Fehr and Peers, research on transit-oriented developments such as VC indicates that these areas tend to have lower auto ownership levels than region-wide averages, and smaller household sizes than comparable developments in the same region. These factors are linked to reduced VMT.

4.19.2.3 Water Conservation

VC will incorporate low flow water fixtures.

4.20 Summary of Emissions from VC

The emissions and relative magnitude of emissions from the various aspects of VC project scenario when AB 1493 and the RPS are taken into account are presented in Table 4-35. One-time vegetation emissions are estimated to -105 tonnes CO_2e, indicating a net decrease. One-time construction emissions are estimated to be 21,397 tonnes CO_2e. Emissions from mobile sources are estimated to be 7,460 tonnes CO_2e per year, which represents 49% of annual emissions. Emissions associated with the transit center are estimated to be 49 tonnes CO_2e

[125] Dexter Wilson Engineering, Inc. 2009. Engineering Report for the Vista Canyon Water Factory. July.

per year, or less than 1% of total annual emissions. Emissions from residential buildings of 2,728 tonnes CO_2e per year comprise 18% of the annual project emissions. Emissions from non-residential buildings of 4,652 tonnes CO_2e per year comprise 30% of the annual project emissions, after accounting for the energy savings (351 tonnes) provided by generating on-site renewable energy. Emissions from municipal sources (water distribution, public lighting, and municipal vehicles) are estimated to be 3% of the annual project emissions. Emissions from area sources (fireplaces and lawn maintenance) and private swimming pools are estimated to be 3 tonnes, or less than 1% of annual project emissions. If the one-time emissions are annualized assuming a 40-year development life the annual emissions are 15,892 tonnes per year.

As shown in Table 4-36, the emissions for the overlay option are unchanged from the project scenario for vegetation, transit center, area sources and swimming pools. Annual emissions from non-residential buildings (3,676 tonnes per year) and one-time emissions from construction (20,069 tonnes) are lower than the project scenario due to the decrease in office space. Emissions from the remaining sources are higher than the project scenario due to the increase in dwelling units and thus in population: 3,245 tonnes for residential buildings; 9,016 for mobile sources, and 550 tonnes for municipal sources. If the one-time emissions are annualized assuming a 40-year development life the annual emissions for the overlay option are 17,038 tonnes per year, which is approximately 7.2% greater than the project scenario emissions.

The annexation area has an estimated annual emission of 3,632 tonnes CO_2e, as summarized in Table 4-37. Approximately 54% (1,963 tonnes) is attributed to non-residential building energy use, 28% (1,002 tonnes) is associated with mobile sources, 15% (550 tonnes) is attributed to residential building energy use, and the remaining 3% is associated with area and municipal sources.

As noted in Section 3 of this report, AB 32 requires that GHG emissions from California be reduced to 1990 levels by 2020. This represents a reduction of approximately 28.5% from projected 2020 growth. In addition to reducing overall energy consumption, the goals of AB 32 are likely to be reached by increasing renewable or non-carbon producing electricity production, and changing the transportation system to rely on a set of low carbon fuels. Although some measures that are being implemented as a part of AB 32 are incorporated into the calculations, such as the new fuel efficiency standards and the 20% renewable power standard, other measures that have yet to be implemented are not included. Accordingly, actual emissions are likely to be lower as more measures to implement AB 32 are enacted. Section 5 puts VC emissions in context and includes an analysis of a CARB 2020 NAT scenario compared to VC.

Furthermore, Governor Schwarzenegger's Executive Order S-3-05 set a target to reduce GHG emissions by 2050 to levels 80% less than the 1990 levels. It is likely that future measures will be implemented to reach this goal that similarly may result in reductions of GHG emissions for sources in VC beyond those stated in this report.

4.21 Life Cycle Emissions of Building Materials

An estimate of "life-cycle" GHG emissions (i.e., GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure) is presented in this section and attached as Appendix A. This estimate is to be used for comparison purposes only and is not included in the final inventory as these emissions would be attributable to other industry sectors under AB 32. For instance, the concrete industry is required by law to report emissions and undergo certain early action emission reduction measures under AB 32. Furthermore, for a life-cycle analysis for building materials, somewhat arbitrary boundaries must be drawn to define the processes considered in the life-cycle analysis.[126] Recognizing the uncertainties associated with a life-cycle analysis, the California Air Pollution Control Officers Association (CAPCOA) released a white paper which states: "The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of-life of construction materials would be speculative at the CEQA analysis level."[127]

The calculations and results discussed here and presented more fully in Appendix A are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Technical Report. Life Cycle Assessment (LCA) emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, the analysis is highly uncertain.

Appendix A is an ENVIRON report that evaluates the life cycle GHG emissions associated with the building materials for this project. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. The report then compares the life cycle GHG emissions to the overall annual operational emissions. The materials analyzed in the report include materials for 1) residential and non-residential buildings, and 2) site infrastructure. This report calculates the overall life cycle emissions from construction materials to be approximately 46 to 87 tonnes CO_2 / year. This represents between 0.29% and 0.54% of the annualized GHG emissions from the VC area, assuming a 40 year lifespan of the project as described below.

The report estimated the life cycle GHG emissions for buildings by conducting an analysis of available literature on LCAs for buildings. According to these studies, approximately 3% to 25% of GHG emissions from buildings are associated with energy usage during the operational phase; the balance of the GHG emissions is due to material manufacture and transport. Using the GHG emissions from the operation of buildings, 3% to 25% of building emissions corresponds to approximately 0.03% to 0.29% of the project emissions.

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[126] For instance, in the case of building materials, the boundary could include the energy to make the materials, the energy used to make the machine that made the materials, and the energy used to make the machine that made the machine that made the materials.

[127] CAPCOA. 2008. CEQA & Climate Change: Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act. Available online at: http://www.capcoa.org/ceqa/?docID=ceqa&PHPSESSID=df1348d6f7eff0fc2a8263d19f6d10dd

The report calculated the life cycle GHG emissions for certain components of infrastructure (roads, storm drains, utilities, gas, electricity, and cable). This analysis considered the manufacture and transport of concrete and asphalt only, as ENVIRON assumed that other construction materials such as steel would be present in much smaller quantities. Because the manufacture of concrete has a higher CO_2 emission factor and most construction estimates higher quantities of concrete than asphalt, the majority of the emissions for infrastructure result from the manufacture of concrete. Because the asphalt and concrete are locally sourced, the transportation emissions are relatively small. If a 40-year lifespan of the infrastructure is assumed, the total annualized emissions from embodied energy in infrastructure materials are approximately 0.25% of the project emissions.

The overall life cycle emissions, annualized by 40 years, are 46 - 87 tonnes CO_2 / year, or 0.29% to 0.54% of the annualized GHG emissions from the VC project. The bulk of these emissions are from general life cycle analysis studies and do not reflect specific information from VC.

Again, note that the calculations and results presented in this life cycle report are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Technical Report. LCA emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, and the fact that literature evaluation, not site specific studies were used to analyze the embodied energy, the analysis should be considered to yield highly uncertain results. Additionally, these estimates likely double count emissions from other industry sectors.

5. Inventory in Context

5.1 VC Greenhouse Gas inventory in Context

This section is intended to place the GHG emissions from the proposed mixed-use development in context with respect to intensity, consistency with AB 32 goals, and magnitude. For the intensity comparison, we compare the built environment emissions with that from a CARB 2020 NAT comparison of standard energy use for buildings in California in the same climate zone. In addition, we compare anticipated mobile emissions to Los Angeles County and emissions savings from water usage in the development. For comparison with AB 32 goals, we compare the GHG emissions with the levels likely to be mandated under AB 32.

5.2 Characterization of Emissions

In 2004, 81% of greenhouse gas emissions (in CO_2e) from California were comprised of CO_2 emissions from fossil fuel combustion, with 4% comprised of CO_2 from process emissions. CH_4 and N_2O accounted for 5.6% and 6.8% of total CO_2e respectively, and high GWP gases[128] accounted for 2.9% of the CO_2e emissions. Transportation is by far the largest end-use category of GHGs. Transportation includes that used for industry (i.e., shipping) as well as residential use.

5.3 Comparison with AB 32-Mandated Emissions Limits

As noted earlier, AB 32 requires that statewide GHG emission in 2020 be equal to 1990 levels. California-wide GHG emissions in 1990 were 0.427 billion tonnes.[129] It is projected that emissions in 2020 under a CARB 2020 NAT scenario accounting for growth will be 0.596 billion tonnes[130]. This would require a 28.5% decrease in emissions from CARB 2020 NAT by 2020 to achieve AB 32 goals. The population in California is projected to be 42,210,000 in 2020. In order to achieve AB 32 mandated goals, the per capita emissions would have to be 10.1 tonnes CO_2e (see Table 5-1 for calculation details). VC has estimated emissions of 15,892 tonnes per year, or 4.6 tonnes per capita per year.[131] The overlay option has estimated emissions of 17,038 tonnes per year, 4.1 tonnes per capita per year.[132] It should be noted that the California per capita CO_2 emissions include industries such as heavy industry, refining, and transportation of materials while the VC per capita CO_2 emissions do not include these emissions. AB 32 will be reducing emissions in a variety of different ways, including increasing energy efficiency and introducing more renewable energy sources. It is difficult to compare the Project per capita emissions to the AB 32 goals as it is not clear what fraction of the reduction will be achieved in which sectors, or the apportionment of reduction between energy efficiency and renewable resources. This is discussed more fully below.

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[128] Such as HFCs and PFCs.
[129] http://www.arb.ca.gov/cc/inventory/1990level/1990level.htm. California Air Resources Board.
[130] http://www.arb.ca.gov/cc/inventory/data/forecast.htm#summary_forescast
[131] Based upon 3,463 residents.
[132] Based upon 4,185 residents.

5.4 CARB 2020 NAT Comparison

In order to put the GHG emission inventory into context and justify an improvement heading towards meeting the reduction goals set for 2020, it is necessary to compare the GHG emission inventory expected for VC to the GHG emissions that would occur from a community that would be built today without the project design features and energy reduction commitments made by Vista, and without the regulations that have been promulgated to comply with AB 32. This baseline comparison is referred to as the CARB 2020 NAT scenario. This represents the GHG emission inventory if things were continued to be built according to current standards, and was the scenario that CARB used to estimate the required 28.5% reduction in emissions. The major categories of the GHG emission inventory are considered separately. These include residential and non-residential buildings, mobile sources, municipal lighting, and water sources. The remaining categories include municipal vehicles and area sources. These categories represent a small fraction of the total inventory and do not have appropriate emission factors to quantify the reductions that are likely to occur at VC compared to CARB 2020 NAT.

5.4.1 The Built Environment

The energy use and GHG emissions from the modeled residential units for VC were compared to the energy use and GHG emissions from minimally Title 24 compliant 2005 buildings using the 2007 carbon intensity factor for electricity with no Renewable Portfolio Standard adjustment[133]. It was also assumed that the comparison residential units had standard appliances instead of Energy Star appliances. These comparisons are summarized in Tables 5-2a and 5-2b. VC residential units emit 20% less CO_2e than the CARB 2020 NAT residential units for the project scenario and overlay option.

It is important to recognize that areas in which the project applicant has control over the energy use, building envelope and major appliances, show a marked improvement over CARB 2020 NAT. This comparison does not take into account that the energy use of occupants is expected to change as people become more conscious of energy use and climate change issues, as well as more sensitive to the cost of energy.

Residential units in VC are 20% more energy efficient than 2008 Title 24. As such, VC residential units are heading toward meeting AB 32 goals on a per-dwelling unit basis, without any decrease in GHG intensity from energy production beyond the 20% Renewable Portfolio Standard for 2010, which is likely to occur. This calculation does not account for changes in occupant behavior which will likely further decrease GHG intensity.

A similar comparison for non-residential buildings compares VC non-residential buildings energy use and GHG emissions from a minimally 2005 Title 24 compliant building using the 2007 carbon intensity factor for electricity with no RPS adjustment. Unlike residential homes, the

[133] The 2005 version of Title 24 is what was in effect at the time that ARB developed the Scoping Plan 2020 CARB 2020 NAT.

project applicant has less control over the appliances and plug-in energy use that will occur in the buildings. The CARB 2020 NAT scenario also does not include the energy savings associated with on-site renewable energy generation on building rooftops within the project. When typical plug-in energy use is considered for the non-residential buildings, VC emits 26% lower CO_2e emissions than the CARB 2020 NAT scenario, as shown in Table 5-3a. For the overlay option summarized in Table 5-3b, there would be a 27% reduction in emissions relative to the CARB 2020 NAT scenario. These calculations do not account for non-residential occupants using energy efficient appliances which will likely further decrease GHG intensity.

There are some uncertainties and limitations that need to be pointed out for the residential and non-residential building CARB 2020 NAT comparison. ENVIRON used survey data of existing buildings to represent future building energy use. ENVIRON made an attempt to adjust the baseline energy use value for residential and non-residential buildings based upon CEC reports indicating improvements in Title 24 building codes. The existing building stock is likely less efficient than the requirements for new buildings under Title 24. To the extent that VC's mix changes the calculated savings may differ; however, these changes in mix are likely minor and therefore would not be significant.

5.4.2 Transportation

The emissions associated with passenger vehicles and public transit vehicles and facilities are inter-related. Because of this, the CARB 2020 NAT comparison for transportation should consider the sum of these emissions, rather than their separate contributions. Both components of the transportation emissions inventory are discussed separately below, followed by a discussion of the overall transportation CARB 2020 NAT scenario.

5.4.2.1 Passenger Cars and Trucks

Consistent with one of the options in the OPR Guidance, this section discusses a comparison of project emissions with the goals of AB 32. Vehicle emissions will be reduced in the future regardless of the development location, as the implementation of AB 32 will require improvements in vehicle mileage, increased use of public transit, and the incorporation of low-carbon fuels into the transportation fuel supply.[134] Transportation emissions presented here are based upon EMFAC2007 values, which are based upon past vehicle emission trends and do not incorporate the known regulatory actions as described above. In fact, on a VMT basis, EMFAC2007 assumes that CO_2 emissions in 2030 are slightly higher than they are currently. This is clearly unlikely, given the mandates of AB 32 and the likelihood of federal regulation.

Fehr & Peers estimated the average daily VMT per household associated with the draft One Valley One Vision (OVOV) residential land use designation for the site. OVOV is a joint effort between the LA County, the City of Santa Clarita and Valley communities to create guidelines

[134] The Low Carbon Fuel Standard (LCFS) mandated under Governor Schwarzenegger's Executive Order S-01-07 and currently being developed by the California Air Resources Board (ARB) requires a reduction in carbon intensity of California's transportation fuels by at least 10% by 2020.

for the future build out of Santa Clarita Valley. According to Fehr & Peers, based on this plan there would be no on-site transit center, or non-residential land uses. Using these assumptions, Fehr & Peers estimated average of 71 VMT per day per household.

To evaluate the impact of this increased VMT on total annual mileage, ENVIRON assumed the same number of trips and same proportions of trip types as the proposed project, but increased the trip lengths such that the average VMT per household was 71. Table 5-4a shows a total VMT for the CARB 2020 NAT scenario as 27,257,038 miles per year. In addition, the CARB 2020 NAT scenario would release 11,378 tonnes of CO_2e per year as compared to the project's release of 7,460 tonnes of CO_2e per year (attributable to 22,266,313 vehicle miles traveled), which is approximately 34% lower. The same 34% reduction in mobile source emissions relative to the CARB 2020 NAT scenario (13,751 tonnes) applies to the overlay option.

Additionally, for the CARB 2020 NAT scenario there has been no reduction taken for changes in vehicle emissions anticipated from current regulations. The VC traffic estimation method includes only residential vehicles; however, the VC estimates were developed with different methodologies and different underlying assumptions than were the Los Angeles County estimates. Therefore, they should be used only for an approximate comparison.

The weekday daily VMT per dwelling unit for VC is approximately 58 miles, which equals 21,170 per unit per year (not accounting for weekend adjustment). A 1995 study prepared for CARB determined that annual VMT per dwelling units under "smart growth" principles should be 22,000 to 25,000 miles for sub urban level 3 areas[135]. Thus, VC will generate less VMT on a per-dwelling unit basis as what the CARB report suggests for a "smart growth" development.

5.4.2.2 Transit Center

To be consistent with the assumptions associated with passenger vehicle emissions, the CARB 2020 NAT scenario assumes that there is no transit center at VC. As a result, there would be no additional building energy use beyond what is consumed for the existing Via Princessa Metrolink center. Therefore, there are no emissions associated with the transit center for the CARB 2020 NAT emissions inventory.

When considered in aggregate, total transportation-related emissions for the CARB 2020 NAT scenario are 11,378 tonnes of CO_2e per year, versus the project emissions of 7,509 tonnes of CO_2e per year. For the overlay option total transportation emissions are 9,065 tonnes versus 13,751 tonnes for the CARB 2020 NAT scenario. This indicates that the project emits approximately 34% fewer transportation-related emissions than the CARB 2020 NAT scenario. The overlay option would also emit 34% lower transportation-related emissions than the CARB 2020 NAT scenario.

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[135] JHK & Associates, Inc. 1995. Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study. June.

5.4.3 Water and Wastewater

The CARB 2020 NAT comparison for water and wastewater treatment and distribution was based on a community with the same water demand and wastewater flows as VC. These numbers are based on not implementing project design features and not creating additional recycled water for use in the region. ENVIRON assumed that the recycled water demand is 1.1% of the total water demand, which is the fraction of recycled water in the 2008 Santa Clarita Water Division water supply.[136] No recycled water is sent off-site in this CARB 2020 NAT scenario. Furthermore, the 2007 SCE electricity emission factor was used with adjustment for RPS. Table 5-5a shows that the CARB 2020 NAT scenario results in 364 tonnes of water and wastewater-related CO_2e emissions per year. Therefore, VC represents a 56% reduction in CO_2e emissions from water-related energy use compared to CARB 2020 NAT, and a 32% reduction in total municipal emissions.

A similar analysis was performed for the overlay option, which is summarized in Table 5-5b. CARB 2020 NAT scenario produced an estimated 762 tonnes annual CO_2e of municipal source emissions. The overlay option represents a 28% reduction in emissions from municipal sources than CARB 2020 NAT.

5.4.4 Project Emissions Reduction Relative to CARB 2020 NAT

Table 5-6a summarizes the CARB 2020 NAT analysis for VC project scenario. It shows that, in areas where the project differs from the CARB 2020 NAT scenario, VC shows an improvement of between 20% and 34%. When the total emissions inventories are compared, VC shows a 28.8% improvement over CARB 2020 NAT. Based on this improvement, VC exceeds the 28.5% emissions reduction goal set by AB 32.

The total annualized emissions from the overlay option shown in Table 5-6b represent a 29.4% improvement over CARB 2020 NAT, which exceeds the 28.5% emission reduction goal set by AB 32.

[136] CLWA Santa Clarita Water Division. 2008. Water Requirements and Supplies. http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf

6. Executive Order S-03-05

Executive order S-03-05 mandates that California emit 80% less GHGs in 2050 than it emitted in 1990. As of 2004, California was emitting 12% more GHG emissions than in 1990. For California to emit 80% less than it emitted in 1990, the emissions would be only 18% of the 2004 emissions. Accounting for a population growth from 35,840,000 people in 2004 to approximately 55,000,000 people in 2050, the emissions per capita would have to be only 12% of what they were in 2004. This means 88% reductions in per capita GHG emissions from today's emissions intensities must be realized in order to achieve California's 2050 GHG goals. Clearly, energy efficiency and reduced vehicle miles traveled will play important roles in achieving this aggressive goal, but the decarbonization of fuel will also be necessary.

The extent to which GHG emissions from traffic at VC will change in the future depends on the quantity (e.g. number of vehicles, average daily mileage) and quality (i.e. carbon content) of fuel that will be available and required to meet both regulatory standards and residents' needs. As discussed above, renewable power requirements, the low carbon fuel standard, and vehicle emissions standards will all decrease GHG emissions per unit of energy delivered or per vehicle mile traveled. In this section we discuss the impact that future regulated fuel decarbonization may have on vehicular emissions at VC.

6.1 State Alternative Fuels Plan

The CEC published a "State Alternative Fuels Plan"[137] in which it noted the existence of "challenging but plausible ways to meet 2050 [transportation] goals." The main finding from this analysis is that reducing today's average per capita driving miles by about 5 percent (or back to 1990 levels), in addition to the decarbonization strategies listed below, would achieve S-03-05 goals of 80% below 1990 levels. The approach described below is directly[138] from the CEC report.

An 80 percent reduction in GHG emissions associated with personal transportation can be achieved even though population grows to 55 million, an increase of 50 percent. The following set of measures could be combined to produce this result:

1. Lowering the energy needed for personal transportation by tripling the energy efficiency of on-road vehicles in 2050 with:
    a. Conventional gas, diesel, and flexible fuel vehicles (FFVs) averaging more than 40 miles per gallon (mpg).
    b. Hybrid gas, diesel, and FFVs averaging almost 60 mpg.

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[137] State Alternative Fuels Plan. December 2007 CEC-600-2007-011-CMF. Available online at: http://www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CMF.PDF
[138] Ibid. Page 67 and 68.

c. All electric and plug-in hybrid electric vehicles (PHEVs) averaging well over 100 mpg (on a greenhouse gas equivalents (GGE) basis) on the electricity cycle.

d. Fuel cell vehicles (FCVs) averaging over 80 mpg (on a GGE basis).

2. Moderating growth in per capita driving, reducing today's average per capita driving miles by about 5 percent or back to 1990 levels.
3. Changing the energy sources for transportation fuels from the current 96 percent petroleum-based to approximately:

   a. 30 percent from gasoline and diesel from traditional petroleum sources or lower GHG emission fossil fuels such as natural gas.

   b. 30 percent from transportation biofuels.

   c. 40 percent from a mix of electricity and hydrogen.

4. Producing transportation biofuels, electricity, and hydrogen from renewable or very low carbon-emitting technologies that result in, on average, at least 80 percent lower life cycle GHG emissions than conventional fuels.
5. Encouraging more efficient land uses and greater use of mass transit, public transportation, and other means of moving goods and people.

6.2 Low Carbon Fuel Standard

CARB's Low Carbon Fuel Standard aims to reduce the lifecycle carbon intensity of transportation fuels such as gasoline and diesel by 10%, relative to the year 2010.[139] The LCFS encompasses the life cycle emissions for fuels (i.e., "well-to-wheel"). Thus, not only does it include the vehicle tailpipe emissions from the use of the fuel, it also includes all the energy used to produce, process, and transport the fuel. By design, the implementation of the LCFS would decrease the overall GHG emissions for California. However, its impact on vehicle tailpipe emissions is not obvious. As the VC GHG inventory only considers the vehicle tailpipe emissions, and not the life cycle emissions for transportation, it is difficult to quantitatively assess the impacts of the LCFS on the inventory. The LCFS will directly affect the emission factor and the fuel economy since alternate fuels will have various energy/carbon content.

The measures described above are the types of measures that will yield required reductions. Although these types of measures are expected to occur and are consistent with the VC development plan, VC is not claiming any credit for measures that are not currently promulgated.

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[139] California Air Resources Board. 2009. Proposed Regulation to Implement the Low Carbon Fuel Standard, Volume II Appendices,. March. Available at: http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor2.pdf

7. Conclusion

ENVIRON prepared a greenhouse gas emissions inventory for the VC project. This emissions inventory was prepared consistent with the methodologies established by the CCAR where possible. The VC emissions inventory considers various categories of GHG emissions, including: emissions due to vegetation changes, emissions from construction activities, residential emissions, commercial building emissions, mobile source emissions, municipal emissions, and area source emissions. Emission from recreation centers were not calculated since they are a small fraction of the overall inventory. The emissions from construction and land use change would be one-time emissions events, while the other emissions would occur annually, throughout the life of the project. Three scenarios were considered: a project scenario with 1,117 dwelling units and 950,000 square feet of non-residential space; an overlay option with 1,350 units and 700,000 square feet of non-residential space; and an annexation area with 150 dwelling units and 436,000 square feet of non-residential space.

A variety of methods were employed to develop the GHG emissions inventory. In addition to well established emission factors for certain activities and emission estimates based on similar activities in other representative communities, several different estimation software were used. These included EMFAC, OFFROAD, and URBEMIS.

Emissions from the various components of the VC project are presented in Table 4-35. This table identifies the one-time emissions that would be attributable to project development, and the annual emissions expected to occur each year after the full build out of the development. There are approximately 21,292 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to approximately 15,360 tonnes. Of this amount, 49% result from vehicular emissions, and 48% result from the energy use associated with residential and non-residential buildings. If the one-time emissions are annualized assuming a 40-year development life (which is likely low), then the one-time emissions account for approximately 3.3% of the overall emissions. As discussed below, these figures reflect conservative assumptions that likely overstate the GHG emissions that would result from this project.

The overlay emissions are presented in Table 4-36. There are approximately 19,963 tonnes of CO_2e one-time emissions. The annual emissions from the use of the development amount to approximately 16,539 tonnes. Of this amount, 55% result from vehicular emissions associated with residential and commercial activities, and 42% result from the energy use associated with residential and non-residential buildings. If the one-time emissions are annualized assuming a 40-year development life (which is likely low), then the one-time emissions account for approximately 2.9% of the overall emissions.

The annexation area emissions are summarized in Table 4-37 for residential building energy, non-residential building energy, mobile sources, municipal sources and area sources. Of the 3,632 tonnes CO_2e emitted annually, approximately 54% (1,963 tonnes) is attributed to non-residential building energy use, 28% (1,002 tonnes) is associated with mobile sources, 15% (550 tonnes) is attributed to residential building energy use, and the remaining 4% is associated with area and municipal sources.

Compared to California's CARB 2020 NAT per capita emissions, 14.1 tonnes CO_2e per capita, a 28.5% decrease in emissions by 2020 is required to achieve AB 32 goals. In order to achieve AB 32 mandated goals, the per capita emissions would have to be 10.1 tonnes CO_2e. VC has estimated emissions of 15,892 tonnes per year, or 4.6 tonnes per capita per year.[140] Estimated emissions for the overlay option correspond to 4.1 tonnes per capita per year. This estimate does not include emissions from heavy industry, refining, or commercial transportation.

As a result of the project design features incorporated into the VC project, the development meets AB 32's goal of 28.5% below CARB 2020 NAT overall. As designed, residential units in VC are expected to emit 20% lower emissions than the CARB 2020 NAT scenario, as shown in Table 5-2a. The non-residential or commercial buildings will emit approximately 26% lower emissions, as shown in Table 5-3a.[141] Transportation-related emissions from VC are 34% less than CARB 2020 NAT. The emission savings combined for VC represent a 28.8% reduction from a CARB 2020 NAT situation taking into consideration changes in emission factors due to implementation of two AB 32 scoping plan measures: the RPS and the Pavley regulation. The overlay option meets AB 32's goal with a 29.4% overall emissions reduction, with a 34% reduction in transportation emissions, 27% reduction in non-residential emissions, and 20% reduction in residential emissions. Because the methods to evaluate CARB 2020 NAT emissions for construction, vegetation change, and area source emissions are unclear, it is infeasible at this time to compare these types of emissions to AB 32 mandated goals.

The GHG emission inventory for VC was based on several conservative assumptions. In addition, anticipated state and federal regulatory developments are expected to result in lower GHG emissions from VC than are represented in this analysis.

Thus, while the VC project already results in an improvement over the CARB 2020 NAT scenario equivalent to the 28.5% improvement necessary to achieve AB 32's mandates, upon implementation of existing and anticipated legislative and regulatory mandates, actual emissions associated with the project will likely be considerably lower.

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[140] Assuming a population of 3,463 residents in VC.
[141] Including emission savings from onsite renewable energy.

Table 4-1
CO_2 Sequestration Capacity of Removed Vegetation
Vista Canyon
Santa Clarita, California

Vegetation Type[1]	**IPCC Designation**[2]	**IPCC Sub qualification**	**Tons Dry Matter Carbon/Acre**[3]	**Sequestered CO_2 / Acre**[4]	**Total Impacted Area [acres]**[5]	**CO_2 Sequestration Capacity of Removed Vegetation**
			[tonne/acre]	**[tonne/acre]**		**[tonne]**
Cropland	Cropland		1.9	6.9	0	0
Grassland	Grassland		1.2	4.3	37	158
IPCC - Forest Land - scrub	Forest Land	Scrub	3.9	14.3	30	429
IPCC - Forest Land - trees	Forest Land	Trees	30.4	111.5	6	613
Other	Settlements		-	8.5	19	164
Wetlands	Wetlands		0	0.0	26	0
GRAND TOTAL	-		-	-	**117**	**1,365**

Notes:

1. Land types shown here represent vegetation that will be potentially removed upon development. For the "other" category, sequestered CO_2 per acre was estimated as the average of cropland, grassland and forest land-scrub.
2. Land types are assigned to generalized IPCC Land Designations (IPCC 2006).
3. Dry matter carbon per acre was determined from information contained in Table 4-2.
4. It is conservatively assumed that all carbon is eventually converted into CO_2. Multiply the mass of carbon by 3.67 to calculate the final mass of CO_2 (the molecular mass of CO_2 / the molecular mass of carbon is 44/12 or 3.67).
5. Data provided by Impact Sciences, Inc. in an email to Vista on June 16, 2009.

Sources:

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

Table 4-2
Carbon per Acre for IPCC Land Types
Vista Canyon
Santa Clarita, California

IPCC Designation	Sub qualifitication	Above Ground Biomass[1] [tonne d.m./acre]	Ratio of Above Ground / Below Ground Biomass[2]	Total Biomass [tonne d.m./Hectare]	Total Biomass[3] [tonne d.m./acre]	Tons Dry Matter Carbon/Acre[4] [tonne/acre]
Cropland[5]		-	-	10	4.0	1.9
Grassland[5]		-	-	6.1	2.5	1.2
Forest Land[6]	Scrub	5.7	2.17	-	8.3	3.9
Forest Land[7]	Trees	52.6	4.35	-	64.7	30.4
Settlements		-	-	-	0.0	0.0
Wetland		-	-	-	0.0	0.0

Notes:

1. Numbers listed are used in conjunction with above ground/below ground ratios to calculate total biomass per acre. Values from source converted to tonne/acre.
2. This value is used to calculate total biomass when data for the total biomass is not available for a particular land type.
3. Total biomass is either 1.) Listed directly in the IPCC protocol, or 2.) Calculated from above ground biomass and the Above Ground / Below Ground biomass ratios as follows: Total = Above + (Above / Ratio). Values from source converted to tonne/acre as necessary.
4. Total biomass multiplied by carbon fraction in plant material (0.47) to calculate carbon content. From IPCC (2006), default value for Forest Land (Table 4.3 of IPCC). Here, it is assumed that agricultural vegetation has the same carbon fraction as other vegetation types.
5. Total biomass for grassland corresponds to IPCC value for grassland in warm temperate-dry climates (Table 6.4 of IPCC).
6. The value for the ratio of above ground/below ground biomass for various scrub types corresponds to the IPCC value for temperate mountain/continental systems (other broadleaf above-ground biomass <75 tonnes/hectare)(Table 4.4 of IPCC, p. 4.49). This value is likely to be conservative since scrub is a type of shrub which is likely to have a smaller ratio than for trees. The value for abov ground biomass applied to various scrub types is based on a value of 1,417 g biomass/m 2 (or 5.7 tonne biomass/acre) for coastal sage scrub (Gray and Schlesinger). It is assumed that all scrub types will have similar values.
7. The value for the ratio of above ground/below ground biomass for forest land for various tree types corresponds to the IPCC value for temperate mountain/continental systems (other broadleaf abov ground biomass 75-150 tonnes/hectare)(Table 4.4 of IPCC, p. 4.49). The value for above ground biomass for forest land corresponds to the IPCC value for temperate mountain/continental systems (North and South America > 20 years)(Table 4.7 of IPCC).

Abbreviations:

d.m - dry mass

Sources:

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

Table 4-3
CO_2 Sequestration Capacity of New Tree Plantings
Vista Canyon
Santa Clarita, California

IPCC Tree Species Class Designation	Sequestered CO_2 / Tree[2]	Total Number of Planted Trees[1]	CO_2 Sequestration Capacity of New Trees[3]
Miscellaneous	0.035	2,100	1,470
GRAND TOTAL	-	**2,100**	**1,470**

Notes:

1. Estimated number of trees provided by Vista Canyon Ranch, LLC. Because the number of each type of tree was not specified, average of 0.035 tonne CO_2 per year per tree was assumed.

2. Species class-specific sequestration values are provided in Table 8.2 of "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4". For species that do not appear in Table 8.2, the species was classifed as "miscellaneous" and the average value of all listed data was used.

3. An active growing period of 20 years was assumed for the new trees planted.

Sources:

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

Table 4-4
Change in CO_2 Sequestration Due to Vegetation Removal and New Tree Plantings
Vista Canyon
Santa Clarita, California

CO_2 Sequestration Capacity of Removed Vegetation	CO_2 Sequestration Capacity of New Trees	Net Change in CO_2 Sequestration Capacity[1]
[tonne]	**[tonne]**	**[tonne]**
1,365	1,470	105

Notes:
1. A positive value represents an increase in sequestration capacity and thus a net reduction in CO_2.

Table 4-5a
GHG Emissions from Construction Equipment: Mass Site Grading Phase
Vista Canyon
Santa Clarita, California

Equipment[1]	Total Equipment hours[2]	Quantity (full-time operation)[3,4]	Physical Quantity[5,6]	Horsepower[7]	Load Factor[7]	Emission Factor[7] (g/bhp-hr)	CO_2 Emissions[10,11] (tonnes)
Scrapers	23,737	28.3	29	313	0.72	568.3	3,040
Crawler Tractors	7,770	9.3	10	147	0.64	568.3	415
Rubber Tired Dozers	4,830	5.8	6	357	0.59	568.3	578
Water Trucks	10,290	12.3	13	189	0.50	568.3	553
Graders	3,643	4.3	5	174	0.61	568.3	220
Tractors/Loaders/Backhoes	1,569	1.9	2	108	0.55	568.3	53
Excavators	1,377	1.6	2	168	0.57	568.3	75
Off Highway Trucks	1,806	2.2	3	479	0.57	568.3	280
On-Highway Trucks[8]	1,094	1.3	2	N/A	N/A	N/A	N/A
Crushing/Processing Equipment	420	0.5	1	142	0.78	568.3	26
Rollers	986	1.2	2	95	0.56	568.3	30
Cranes	85	0.1	1	399	0.43	568.3	8
Bore/Drill Rigs	40	0.05	1	291	0.75	568.3	5
Pavers	11	0.01	1	100	0.62	568.3	0
On-Highway Water Trucks[9]	588	0.7	1	189	0.50	568.3	32
Total	**58,246**	***	**79**	***	***	***	**5,316**

Notes:

1. Equipment inventory provided by Vista Canyon Ranch, LLC.
2. An equipment-hour is defined as one hour of use for a given piece of equipment. Total equipment hours are estimated from data provided by Vista Canyon Ranch, LLC.
3. Quantities are determined by dividing the total equipment hours by the total hours per unit. The total hours for each unit are calculated by multiplying the number of days in the grading period (105) by the number of working hours per day (8).
   The phase duration is estimated from data provided by Vista Canyon Ranch, LLC.
4. Fraction indicates that one unit would not operate full-time.
5. This represents the actual minimum number of units (one of which would not operate full-time). More units may be required if they are not operated for the entire grading phase.
6. The quantity of each equipment type estimated here is based on data provided by Vista Canyon Ranch, LLC. Some quantities were rounded up to account for one non-full-time unit.
7. The values of Horsepower, Load Factor, and Emission Factor of each type of equipment are from OFFROAD 2007 defaults.
8. The emission calculations of on-highway trucks are different from other off-road equipment, and do not involve horsepower or load factor data. ENVIRON assumes that the on-highway trucks are used for soil hauling; these emissions are calculated in Table 4-8.
9. The horsepower and load factor of off-highway water trucks (from OFFROAD2007) are assumed to apply to water trucks running under different road conditions.
10. The CO_2 Emission calculation formula for each piece of equipment (except for on-highway trucks) is:
    CO_2 Emission = Equipment Hours x HP x Load Factor x Emission Factor x Unit Conversion Factor
11. Assume CO_2 = CO_2e because the contribution of CH_4 and N_2O to overall GHG emissions is likely small (< 1% of total CO_2e) from diesel construction equipment.

Table 4-5b
GHG Emissions from Construction Equipment: Paving, Building Construction, and Architectural Coating Phases
Vista Canyon
Santa Clarita, California

Equipment	Total # Equipment[1]	Total Equipment Hours[1,2]	Horsepower[3]	Load factor[3]	Emission Factor[3] (g/bhp-hr)	CO_2 Emissions[4,5] (tonnes)
Cranes	1	8,177	399	0.43	568.3	797
Forklifts	3	24,531	145	0.3	568.3	606
Generator Sets	1	8,177	49	0.74	568.3	169
Pavers	1	457	100	0.62	568.3	16
Paving Equipment	2	914	104	0.53	568.3	29
Rollers	2	914	95	0.56	568.3	28
Tractors/Loaders/Backhoes	3	24,531	108	0.55	568.3	828
Welders	1	8,177	45	0.45	568.3	94
Total	**14**	**75,880**	***	***	***	**2,567**

Notes:

1. These values reflect the total pieces of equipment and total hours of operation of each equipment type during the Paving, Building Construction, and Architectural Coating phases.
2. The equipment-hours for each individual equipment is calculated based on the phase duration. ENVIRON assumes that all equipment operate 8 hours a day and five days a week during the corresponding phase duration.
3. The values of Horsepower, Load Factor, and Emission Factor of each type of equipment are from OFFROAD 2007 defaults.
4. The CO_2 Emission calculation formula for each piece of equipment is:
   CO_2 Emission = Equipment Hours x HP x Load Factor x Emission Factor x Unit Conversion Factor
5. Assume CO_2 = CO_2e because the contribution of CH_4 and N_2O to overall GHG emissions is likely small (< 1% of total CO_2e) from diesel construction equipment.

Abbreviations:
bhp - break horsepower
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
hr - hour

Table 4-6a
GHG Emissions from Worker Commuting
Vista Canyon
Santa Clarita, California

Construction Sub-Phase	# Worker One-Way Trips[1]	Total Worker VMT[2]	EF^3_{LDA}		$EF_{LDT1}{}^4$		$EF_{LDT2}{}^4$		CO2 Emissions[5]		Total CO_2 Emissions[6]	Total CO_2e Emissions[6,7]
			Running	Startup	Running	Startup	Running	Startup	Running	Startup		
		miles/year	(g/mile)	(g/trip)	(g/mile)	(g/trip)	(g/mile)	(g/trip)	tonnes			
Mass site grading	20,790	264,033	342	210	423	254	424	259	101	5	106	111
Building construction	826,791	10,500,245							4,018	193	4,211	4,433
Coating	165,358	2,100,049							804	39	842	887
Paving	686	8,709							3	0	3	4
Total	**1,013,625**	**12,873,035**									5,162	**5,434**

Notes:

1. Worker one-way trips were calculated for all Demolition, Grading and Paving phases as follows:
   a. Number of workers per day = 1.25 x number of equipment per day
   b. One-way trips per worker per day = 2 (one round-trip)
   Worker one-way trips during the building construction phase are calculated based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation and office/industrial. The total one-way trips per day are the sum of the following:
   i. 0.36* # multifamily units
   ii. 0.72 * # single-family units
   iii. 0.32 *(commercial/retail/school/recreation square ft)/1000
   iv. 0.42 * (office/industrial square ft)/1000
   Worker one-way trips for Coating phase are 20% of the worker trips for Building Construction Phase.
2. Vehicle Miles Traveled = Worker one-way trips x 12.7 miles per one-way trip, based on URBEMIS default.
3. The running emission factor depends on the speed of the vehicle. The emission factor used in this calculation refers to the URBEMIS 9.2.4 default vehicle speed: 30 MPH.
   The startup emission factor depends on the settling period before driving. The startup emissions were conservatively calculated based on a 12 hour wait before each engine startup.
4. LDT1: up to 6000 GVW; LDT2: up to 8500 GVW
5. GHG Running Emission calculation formula: GHG Emission = VMT x $(0.5 \times EF_{LDA} + 0.25 \times EF_{LDT1} + 0.25 \times EF_{LDT2})_{Running}$
   GHG Startup Emission calculation formula: GHG Emission = Worker Trips x $(0.5 \times EF_{LDA} + 0.25 \times EF_{LDT1} + 0.25 \times EF_{LDT2})_{Startup}$
   URBEMIS 9.2.2 assumes that LDA and LDT have a 50:50 mixing ratio.
6. $CO_2e = CO_2 / 0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from on-road vehicles, taking into account their global warming potentials.
7. The emission factor values for 2009 were used for all calculations.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
EF - Emission Factor
GVW - Gross Vehicle Weight
HFC - hydro fluorocarbons
hr - hour
LDA - Light Duty Auto
LDT - Light Duty Truck
RMDP: the Resource Management and Development Plan
SCP: Spineflower Conservation Plan
MPH: miles per hour
N_2O: nitrous oxide
MPH - Miles per hour
URBEMIS - Urban Emissions Model
VMT - Vehicle Miles Traveled

Table 4-6b
GHG Emissions from Worker Commuting: Overlay Option
Vista Canyon
Santa Clarita, California

Construction Sub-Phase	# Worker One-Way Trips[1]	Total Worker VMT[2]	EF_{LDA}[3]		EF_{LDT1}[4]		EF_{LDT2}[4]		CO2 Emissions[5]		Total CO_2 Emissions[6]	Total CO_2e Emissions[6,7]
			Running	Startup	Running	Startup	Running	Startup	Running	Startup		
		miles/year	(g/mile)	(g/trip)	(g/mile)	(g/trip)	(g/mile)	(g/trip)	tonnes			
Mass site grading	20,790	264,033							101	5	106	111
Building construction	805,203	10,226,081	342	210	423	254	424	259	3,913	188	4,101	4,317
Coating	161,041	2,045,216							783	38	820	863
Paving	686	8,709							3	0	3	4
Total	**987,720**	**12,544,039**									5,031	**5,295**

Notes:

1. Worker one-way trips were calculated for all Demolition, Grading and Paving phases as follows:
   a. Number of workers per day = 1.25 x number of equipment per day
   b. One-way trips per worker per day = 2 (one round-trip)
   Worker one-way trips during the building construction phase are calculated based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation and office/industrial. The total one-way trips per day are the sum of the following:
   i. 0.36* # multifamily units
   ii. 0.72 * # single-family units
   iii. 0.32 *(commercial/retail/school/recreation square ft)/1000
   iv. 0.42 * (office/industrial square ft)/1000
   Worker one-way trips for Coating phase are 20% of the worker trips for Building Construction Phase.
2. Vehicle Miles Traveled = Worker one-way trips x 12.7 miles per one-way trip, based on URBEMIS default.
3. The running emission factor depends on the speed of the vehicle. The emission factor used in this calculation refers to the URBEMIS 9.2.4 default vehicle speed: 30 MPH.
   The startup emission factor depends on the settling period before driving. The startup emissions were conservatively calculated based on a 12 hour wait before each engine startup.
4. LDT1: up to 6000 GVW; LDT2: up to 8500 GVW
5. GHG Running Emission calculation formula: GHG Emission = VMT x $(0.5 \times EF_{LDA} + 0.25 \times EF_{LDT1} + 0.25 \times EF_{LDT2})_{Running}$
   GHG Startup Emission calculation formula: GHG Emission = Worker Trips x $(0.5 \times EF_{LDA} + 0.25 \times EF_{LDT1} + 0.25 \times EF_{LDT2})_{Startup}$
   URBEMIS 9.2.2 assumes that LDA and LDT have a 50:50 mixing ratio.
6. $CO_2e = CO_2 / 0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs account for 5% of GHG emissions from on-road vehicles, taking into account their global warming potentials.
7. The emission factor values for 2009 were used for all calculations.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
EF - Emission Factor
GVW - Gross Vehicle Weight
HFC - hydro fluorocarbons
hr - hour
LDA - Light Duty Auto
LDT - Light Duty Truck
MPH: miles per hour
N_2O: nitrous oxide
MPH - Miles per hour
URBEMIS - Urban Emissions Model
VMT - Vehicle Miles Traveled

Table 4-7a
GHG Emissions from Vendor Trips
Vista Canyon
Santa Clarita, California

Construction sub-phase	# Vendor One-Way Trips[1]	Total Vendor VMT[2]	EF^3_{HHD}		CO_2 Emissions[4]		Total CO_2e Emissions[5]
			Running	Startup	Running	Startup	
		miles/year	(g/mile)	(g/trip)	tonnes		
Building construction	392,043	3,489,182	1,862	211	6,496	83	**6,579**

Notes:

1. Vendor trips only occur during the building construction phase, and they are calculated based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation and office/industrial. The total one-way trips are the sum of the following:
   i. 0.11* # multifamily units
   ii. 0.11 * # single-family units
   iii. 0.05 *(commercial/retail/school/recreation square ft)/1000
   iv. 0.38 * (office/industrial square ft)/1000
2. Vehicle Miles Traveled = Vendor One-way Trips x 8.9 miles per one-way trip, based on URBEMIS default.
3. The running emission factor depends on the speed of the vehicle. The emission factor used in this calculation refers to the URBEMIS 9.2.4 default vehicle speed: 30 MPH.
   The startup emission factor depends on the settling period before driving. The startup emissions are conservatively calculated based on a 12 hour wait before each engine startup.
4. URBEMIS 9.2.4 assumes that all vendors drive heavy-heavy-duty trucks.
   CO_2 Running Emission calculation formula: CO_2 Emission = VMT x $EF_{HHD-Running}$
   CO_2 Startup Emission calculation formula: CO_2 Emission = Vendor Trips x $EF_{HHD-Startup}$
5. The emission factor values for 2009 are used for all calculations.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
EF - Emission Factor
GVW - Gross Vehicle Weight
HFC - Hydro Fluorocarbons
HHD - Heavy-Heavy Duty
hr - hour
MPH - Miles per hour
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

Table 4-7b
GHG Emissions from Vendor Trips: Overlay Option
Vista Canyon
Santa Clarita, California

Construction sub-phase	# Vendor One-Way Trips[1]	Total Vendor VMT[2]	EF^{3}_{HHD}		CO_2 Emissions[4]		Total CO_2e Emissions[5]
			Running	Startup	Running	Startup	
		miles/year	(g/mile)	(g/trip)	tonnes		
Building construction	321,137	2,858,118	1,862	211	5,321	68	**5,389**

Notes:

1. Vendor trips only occur during the building construction phase, and they are calculated based on four general land use categories: multifamily, single-family, commercial/retail/school/recreation and office/industrial. The total one-way trips are the sum of the following:
   i. 0.11* # multifamily units
   ii. 0.11 * # single-family units
   iii. 0.05 *(commercial/retail/school/recreation square ft)/1000
   iv. 0.38 * (office/industrial square ft)/1000
2. Vehicle Miles Traveled = Vendor One-way Trips x 8.9 miles per one-way trip, based on URBEMIS default.
3. The running emission factor depends on the speed of the vehicle. The emission factor used in this calculation refers to the URBEMIS 9.2.4 default vehicle speed: 30 MPH.
   The startup emission factor depends on the settling period before driving. The startup emissions are conservatively calculated based on a 12 hour wait before each engine startup.
4. URBEMIS 9.2.4 assumes that all vendors drive heavy-heavy-duty trucks.
   CO_2 Running Emission calculation formula: CO_2 Emission = VMT x $EF_{HHD-Running}$
   CO_2 Startup Emission calculation formula: CO_2 Emission = Vendor Trips x $EF_{HHD-Startup}$
5. The emission factor values for 2009 are used for all calculations.

Abbreviations:

CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
EF - Emission Factor
GVW - Gross Vehicle Weight
HFC - Hydro Fluorocarbons
HHD - Heavy-Heavy Duty
hr - hour
MPH - Miles per hour
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

Table 4-8
GHG Emissions from Soil Hauling Activities
Vista Canyon
Santa Clarita, California

Volume of Imported Earth[1]	# Soil Hauling One-Way Trips[2]	Total Soil Hauling VMT[3]	EF_{HHD}[4]		CO_2 Emissions[5]		Total CO_2e Emissions[6,7]
			Running	Startup	Running	Startup	
(cubic yards)		miles/year	(g/mile)	(g/trip)	tonnes		
500,000	50,000	750,000	1,862	211	1,396	105	**1,502**

Notes:
1. Based on a phone conversation with Glenn Adamick on June 3, 2009.
2. The number of soil hauling trips is calculated assuming 20 cubic yards per round-trip per truck (URBEMIS default). The result is multiplied by two to obtain the number of one-way trips.
3. Soil hauling VMT is calculated assuming 15 miles per one-way trip (URBEMIS default).
4. The running emission factor depends on the speed of the vehicle. The emission factor used in this calculation refers to the URBEMIS 9.2.4 default vehicle speed: 30 MPH. The startup emission factor depends on the settling period before driving. The startup emissions are conservatively calculated based on a 12 hour wait before each engine startup.
5. URBEMIS 9.2.4 assumes that all demolition haulers drive heavy-heavy-duty trucks.
   CO2 Running Emission calculation formula: CO2 Emission = VMT x $EF_{HHD\text{-}Running}$
   CO2 Startup Emission calculation formula: CO2 Emission = Demolition Hauler Trips x $EF_{HHD\text{-}Startup}$
6. The emission factor values for 2009 are used for all calculations.

Abbreviations:
CH4 - methane
CO2 - carbon dioxide
CO2e - carbon dioxide equivalent
g - gram
GHG - Greenhouse Gas
EF - Emission Factor
GVW - Gross Vehicle Weight
HFC - Hydro Fluorocarbons
HHD - Heavy-Heavy Duty
hr - hour
MPH - Miles pe

Table 4-9a
Overall Construction GHG Emissions
Vista Canyon
Santa Clarita, California

Location	Construction Equipment		Worker Commuting	Vendor Trips	Soil Hauling	Total GHG Emissions
	Grading Phase	Paving, Building Construction, and Architectural Coating Phases				
	(tonnes CO_2e)					
Vista Canyon	5,316	2,567	5,434	6,579	1,502	**21,397**

Notes:

1. See previous tables for calculation details. The table includes emissions from construction equipment, soil hauling, worker commuting and vendor trips.

Abbreviations:

CO2e - carbon dioxide equivalent
GHG - Greenhouse Gas

Table 4-9b
Overall Construction GHG Emissions: Overlay Option
Vista Canyon
Santa Clarita, California

Location	Construction Equipment		Worker Commuting	Vendor Trips	Soil Hauling	Total GHG Emissions
	Grading Phase	Paving, Building Construction, and Architectural Coating Phases				
	(tonnes CO_2e)					
Vista Canyon	5,316	2,567	5,295	5,389	1,502	**20,069**

Notes:

1. See previous tables for calculation details. The table includes emissions from construction equipment, soil hauling, worker commuting and vendor trips.

Abbreviations:

CO_2e - carbon dioxide equivalent
GHG - Greenhouse Gas

Table 4-10
CO_2 Emission Factors for Electricity and Natural Gas Usage
Vista Canyon
Santa Clarita, California

Energy Source	Scenario	Source Units	lb CO_2/source unit
Electricity	CARB 2020 NAT emission factor[1]	(kW-hr)	0.631
	2007 emission factor[1]		0.631
	2010 RPS (20%)[2]		0.583
Natural Gas[3]		(MMBTU)	117.0
		(ccf)	12.0

Notes:

1. Emission factor for electricity provided by Southern California Edison for 2007, obtained from the California Climate Action Registry Database. The same emission factor was applied for the CARB 2020 NAT analysis.
2. Estimated emission factor for total energy delivered after implementation of the Renewables Portfolio Standard. Emission factor has been adjusted to reflect 20% of power provided by renewables by multiplying the SCE 2007 emission factor by (1-RPS renewable %) / (1-SCE 2007 renewable %). RPS renewable % is 20% and the SCE 2007 renewable % is 13%.
3. Emission factor for natural gas was obtained from California Climate Action Registry Reporting Protocol, Table C7.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
kW-hr - kilowatt-hour
lb - pound
MMBTU - million british thermal units

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Table 4-11
Energy Use per Residential Dwelling Unit: Title-24 Regulated Heating and Cooling
Vista Canyon
Santa Clarita, California

	Electricity Delivered (kW-hr/DU/year)							Natural Gas Delivered (MBTU/DU/yr)						
Type[1]	**Heating[2,3]**	**Cooling[2]**	**RASS Total**	**% Reduction due to 2005 standards relative to 2001[4,5]**	**2005 Estimated Total**	**% Reduction due to 2008 vs. 2005 standards[6]**	**2008 Estimated Total**	**Heating[2,3]**	**Domestic Hot Water[2,7]**	**RASS Total**	**% Reduction due to 2005 standards relative to 2001[4]**	**2005 Estimated Total**	**% Reduction due to 2008 vs. 2005 standards[6]**	**2008 Estimated Total**
Multi-family	120	234	354	24.3%	268	19.7%	215	16.3	15.3	31.6	15.7%	26.6	7%	24.7
Single family	158	956	1,114	19.8%	893	22.7%	690	16.3	22.3	38.6	6.7%	36.0	10%	32.4
Town home[8]	107	479	586	24.3%	444	19.7%	356	16.3	19.8	36.1	15.7%	30.4	7%	28.3

Notes:
1. Based on information provided by Vista Canyon Ranch, LLC.
2. Based on the California Residential Appliance Saturation Survey (RASS), which collected data from over 21,100 households statewide. Only RASS data tabulated for the multifamily homes in the climate zone in which Vista Canyon would be located (Climate Zone 9) were considered in this analysis.
3. Homes can be heated using electricity and/or natural gas. The values shown here are averages for the dataset.
4. Reductions are taken with the assumption that the RASS estimate reflects heating/cooling/hot water electricity use for homes that are minimally compliant with 2001 Title 24 Standards (this version was the most current at the time of the RASS study).
More than 90% of the homes that participated in the survey were constructed before 1997. Because older homes tend to use more energy, the numbers shown here may overestimate actual energy use at a new development such as Vista Canyon.
5. Based on report by California Energy Commission on estimated first-year electricity savings due to 2005 standards for single-family, town homes and multi-family homes, relative to 2001 standards.
6. Based on California Energy Commission report on estimated first-year electricity savings due to 2008 standards for single-family, town homes and multi-family homes, relative to 2005 standards.
7. All domestic hot water systems are assumed to use natural gas.
8. Reductions in Title 24 energy use for multi-family homes were applied to townhomes.

Abbreviations:
DU - Dwelling
kW-hr - kilowatt-hour
MBTU - million British thermal units

Sources:
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF
Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.

Table 4-12
Energy Use per Residential Dwelling Unit: Appliances and Plug-ins
Vista Canyon
Santa Clarita, California

		Electricity Delivered (kW-hr/DU/year)[2]								Natural Gas Delivered (MBTU/DU/yr)[2]		
Type	**Type[1]**	**Refrigerator**	**Clothes Washer**	**Clothes Dryer[3]**	**Dishwasher**	**Cooking Range (Electric)[4]**	**Total Major Appliances**	**MELs**	**Total**	**Clothes Dryer (Gas)[3]**	**Gas Cooking Range[4]**	**Total**
Standard Appliances	**Multi-family**	744	4	93	28	101	971	1,405	2,376	2.1	4.6	6.7
	Single family	1,135	121	242	59	123	1,681	2,181	3,861	2.1	4.6	6.7
	Town home	850	48	189	38	106	1,231	1,666	2,898	2.1	4.6	6.7
Energy Star Appliances[5]	**Multi-family**	633	3	93	17	101	847	1,405	2,252	2.1	4.6	6.7
	Single family	965	90	242	35	123	1,457	2,181	3,637	2.1	4.6	6.7
	Town home	723	36	189	23	106	1,076	1,666	2,743	2.1	4.6	6.7

Notes:
1. Based on information provided by Vista Canyon Ranch, LLC.
2. Energy use per residential dwelling unit is based on information in RASS report.
3. Dryers may be either electric or natural-gas fueled. Only electric dryers are included in this value
4. Cooking ranges can be either gas or electric. This value represents the average of the electricity requirements for the two dryer types.
5. Average energy savings above standard products are applied to refrigeration (15%), clothes washer (25%), dishwasher (40%), and lighting (75%) as reported in Energy Star and Other Climate Protection Partnerships 2006 Annual Report Table 10.

Abbreviations:
DU - Dwelling Unit
kW-hr - kilowatt-hour
MBTU - million british thermal units
MEL - Miscellaneous electric load

Sources:
R. Hendron. Building America Research Benchmark Definition. Technical Report NREL/TP-550-4816. December 2008.
Environmental Protection Agency (USEPA). 2006 Annual Report. Energy Star and Other Climate Protection Partnerships. Available at: http://www.epa.gov/appdstar/pdf/AR%202006%20Final.pdf.
Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.

Table 4-13
Energy Use per Residential Dwelling Unit
Vista Canyon
Santa Clarita, California

		Electricity Delivered					Natural Gas Delivered		
Title 24 Compliance	**Dwelling Type**	**Heating and Cooling**	**Hard Wired Lighting[8]**	**Major Appliances[4,6]**	**Plug-ins[5]**	**Total**	**Heating and Domestic Hot Water**	**Gas Dryers and Oven Ranges[4,6]**	**Total**
		[kW-hr / DU / year]					**(MBTU natural gas / DU / year)**		
Minimally 2005 Title 24 Compliant (CARB 2020 NAT)	Multi-family	268	806	971	1,405	3,450	27	7	33
	Single family	893	1,478	1,681	2,181	6,233	36	7	43
	Town home	444	1,016	1,231	1,666	4,358	30	7	37
Minimally Title 24 Compliant (2008)	Multi-family	215	806	971	1,405	3,397	25	7	31
	Single family	690	1,478	1,681	2,181	6,030	32	7	39
	Town home	356	1,016	1,231	1,666	4,270	28	7	35
20% Better Than 2008 Title 24 and Energy Star Appliances[7]	Multi-family	172	645	847	1,405	3,069	20	7	26
	Single family	552	1,183	1,457	2,181	5,373	26	7	33
	Town home	285	813	1,076	1,666	3,841	23	7	29
Percentage Improvement over 2008 Title 24	Multi-family	20%	20%	13%	0%	10%	20%	0%	16%
	Single family	20%	20%	13%	0%	11%	20%	0%	17%
	Town home	20%	20%	13%	0%	10%	20%	0%	16%

Notess:
1. Information provided by Vista Canyon Ranch, LLC.
2. Energy use shown is from a Title 24 compliant house.
3. Estimated using guidance provided by the US Department of Energy (Table 12 of "Building America Research Benchmark Definition, Updated December 19, 2008").
4. Cooking may be performed on an electric range or a natural gas stove. The values shown in these columns are 50% of the energy/heat used for each stove type.
5. "Plug-ins" refers to electricity use associated with plug-in lighting, plug-in appliances, and miscellaneous electric loads. This energy use is calculated based on the RASS report.
6. Dryers and ovens may be electric or gas. The values presented in this table represent 50% of the electricity and/or natural gas use for each equipment type.
7. Vista Canyon Ranch, LLC has committed to a 20% improvement in energy use in the building envelope over 2008 Title 24 standards and inclusion of energy star appliances.
8. According to the CEC, standards for residential lighting did not change significantly in the 2008 version of Title 24.
9. Hard-wired lighting is assumed to be all outdoor lighting and half of the energy for indoor lighting listed under miscellaneous electricity load in the RASS report. The other indoor lighting is assumed to be plug-ins. Lighting is 60% of the miscellaneous electricity load according to the RASS report.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
BARBD - Building America Research Benchmark Definition
DU - Dwelling Unit
kW-hr - kilowatt-hour

Sources:
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF.

Table 4-14
CO_2e Emissions per Dwelling Unit
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Type	Title-24 Systems[1]		Title-24 Systems and Major Appliances		Title-24 Systems and All MELs		Title-24 Systems	Title-24 Systems and Major Appliances	Title-24 Systems and All MELs
		CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Electricity[3]	CO_2 Natural Gas[4]	CO_2 Total	CO_2 Total	CO_2 Total
		(lbs / DU / year)						(tonnes / DU / year)		
Minimally 2005 Title 24 Compliant	Multi-family	677	3,114	1,290	3,895	2,177	3,895	1.7	2.4	2.8
	Single family	1,497	4,212	2,557	4,993	3,933	4,993	2.6	3.4	4.0
	Town home	921	3,561	1,698	4,342	2,750	4,342	2.0	2.7	3.2
Minimally Title 24 Compliant (2008)	Multi-family	595	2,896	1,161	3,677	1,980	3,677	1.6	2.2	2.6
	Single family	1,264	3,791	2,244	4,572	3,516	4,572	2.3	3.1	3.7
	Town home	800	3,312	1,518	4,093	2,489	4,093	1.9	2.5	3.0
20% Better Than 2008 Title 24 and Energy Star Appliances[5]	Multi-family	476	2,316	970	3,098	1,789	3,098	1.3	1.8	2.2
	Single family	1,012	3,033	1,861	3,814	3,132	3,814	1.8	2.6	3.2
	Town home	640	2,649	1,268	3,431	2,239	3,431	1.5	2.1	2.6
Percentage Improvement over 2008 Title 24	Multi-family	20%	20%	16%	16%	10%	16%	20%	16%	14%
	Single family	20%	20%	17%	17%	11%	17%	20%	17%	14%
	Town home	20%	20%	16%	16%	10%	16%	20%	16%	14%

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code
2. Information provided by Vista Canyon Ranch, LLC.
3. Converted from kW-hr to lb CO_2 using emission factor from the California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008
4. Converted from MBTU to lb CO_2 using emission factor from California Climate Action Registry General Reporting Protocol (CCAR GRP)
5. Vista Canyon Ranch, LLC has committed to a 20% improvement in energy use in the building envelope over 2008 Title 24 standards and inclusion of energy star appliances.

Abbreviations:
DU - Dwelling Unit
kW-hr - kilowatt-hour
lb - pound
SF - Square Feet

Sources:

2001 Residential Energy Consumption Survey conducted by the US Energy Information Administarion: http://www.eia.doe.gov/emeu/recs/contents.html
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Table 4-15a
GHG Emissions from Electricity and Natural Gas Usage in Residential Dwelling Units
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title-24 Systems			Title-24 Systems and Major Appliances			Title-24 Systems and All MELs		
			CO_2 Emission Factor	Total CO_2 Emissions		CO_2 Emission Factor	Total CO_2 Emissions		CO_2 Emission Factor	Total CO_2 Emissions	
			(tonne CO_2 / DU / year)	(tonne CO_2 / year)		(tonne CO_2 / DU / year)	(tonne CO_2 / year)		(tonne CO_2 / DU / year)	(tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant	**Multi-family**	579	1.7	996	**2,148**	2.4	1,362	**2,908**	2.8	1,595	**3,413**
	Single family	106	2.6	274		3.4	363		4.0	429	
	Town Home	432	2.0	878		2.7	1,184		3.2	1,390	
Minimally Title 24 Compliant (2008)	**Multi-family**	579	1.6	917	**1,966**	2.2	1,271	**2,698**	2.6	1,486	**3,165**
	Single family	106	2.3	243		3.1	328		3.7	389	
	Town Home	432	1.9	806		2.5	1,100		3.0	1,290	
20% Better Than 2008 Title 24 and Energy Star Appliances	**Multi-family**	579	1.3	733	**1,572**	1.8	1,068	**2,262**	2.2	1,283	**2,728**
	Single family	106	1.8	194		2.6	273		3.2	334	
	Town Home	432	1.5	645		2.1	921		2.6	1,111	
Percentage Improvement over 2008 Title 24	**Multi-family**	579	20%	20%	**20%**	16%	16%	**16%**	14%	14%	**14%**
	Single family	106	20%	20%		17%	17%		14%	14%	
	Town Home	432	20%	20%		16%	16%		14%	14%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Cod
2. Information provided by Vista Canyon Ranch, LLC

Abbreviations:
CO_2 - carbon dioxide
DU - Dwelling Unit
MEL - Miscellaneous electric load
RPS - Renewable Portfolio Standards

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 4-15b
CO_2 Emissions from Electricity and Natural Gas Usage in Residential Dwelling Units: Overlay Option
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title-24 Systems			Title-24 Systems and Major Appliances			Title-24 Systems and All MELs		
			CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant	**Multi-family**	812	1.7	1,396	**2,549**	2.4	1,910	**3,456**	2.8	2,236	**4,055**
	Single family	106	2.6	274		3.4	363		4.0	429	
	Town Home	432	2.0	878		2.7	1,184		3.2	1,390	
Minimally Title 24 Compliant (2008)	**Multi-family**	812	1.6	1,286	**2,334**	2.2	1,782	**3,209**	2.6	2,084	**3,762**
	Single family	106	2.3	243		3.1	328		3.7	389	
	Town Home	432	1.9	806		2.5	1,100		3.0	1,290	
20% Better Than Title 2008 24 and Energy Star Appliances	**Multi-family**	812	1.3	1,029	**1,868**	1.8	1,498	**2,692**	2.2	1,800	**3,245**
	Single family	106	1.8	194		2.6	273		3.2	334	
	Town Home	432	1.5	645		2.1	921		2.6	1,111	
Percentage Improvement over 2008 Title 24	**Multi-family**	812	20%	20%	**20%**	16%	16%	**16%**	14%	14%	**14%**
	Single family	106	20%	20%		17%	17%		14%	14%	
	Town Home	432	20%	20%		16%	16%		14%	14%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code
2. Information provided by Vista Canyon Ranch, LLC

Abbreviations:
CO_2 - carbon dioxide
DU - Dwelling Unit
MEL - Miscellaneous electric loads
RPS - Renewable Portfolio Standards

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 4-16a
Categorization of Non-Residential Land Use
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Total EIA Area[4] (SF)
General Office	646,000	Administrative/professional office	50%	323,000
		Mixed-use office	50%	323,000
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000
Retail - Other than Mall	79,000	Other retail	50%	39,500
		Retail store	50%	39,500
Food Service	39,000	Restaurant/cafeteria	50%	19,500
		Fast food	50%	19,500
Lodging	140,000	Hotel	100%	140,000
Public Assembly	31,000	Entertainment/culture	100%	31,000

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON classifed each Vista Canyon building type the most closely related EIA category.

3. The percentage of each Vista Canyon building type assigned to each of EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly, which represents a movie theater.

4. The product of the area of the Vista Canyon building type and the percentage of each subcategory. The energy use for each building type is presented in the following tables.

Abbreviations:
EIA - Energy Information Administration
CBECS - Commercial Buildings Energy Consumption Survey
SF - Square Feet

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: Building Types Definition: http://www.eia.doe.gov/emeu/cbecs/building_types.html

Table 4-16b
Categorization of Non-Residential Land Use: Overlay Option
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Total EIA Area[4] (SF)
General Office	396,000	Administrative/professional office	50%	198,000
		Mixed-use office	50%	198,000
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000
Retail - Other than Mall	79,000	Other retail	50%	39,500
		Retail store	50%	39,500
Food Service	39,000	Restaurant/cafeteria	50%	19,500
		Fast food	50%	19,500
Lodging	140,000	Hotel	100%	140,000
Public Assembly	31,000	Entertainment/culture	100%	31,000

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON classifed each Vista Canyon building type the most closely related EIA category.

3. The percentage of each Vista Canyon building type assigned to each of EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly, which represents a movie theater.

4. The product of the area of the Vista Canyon building type and the percentage of each subcategory. The energy use for each building type is presented in the following tables.

Abbreviations:
EIA - Energy Information Administration
CBECS - Commercial Buildings Energy Consumption Survey
SF - Square Feet

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: Building Types Definition: http://www.eia.doe.gov/emeu/cbecs/building_types.html

Table 4-17
End-Uses of Electricity for Non-Residential Building Types
Vista Canyon
Santa Clarita, California

Principal Building Activity	Cooling[1]	Lighting[1]	Office Equipment[2]	Refrigeration[2]	Ventilation[1]	Space Heating[1]	Cooking[2]	Water Heating[1]	Other[2]
All Buildings	26%	23%	18%	9%	7%	5%	2%	1%	9%
Education	26%	26%	20%	4%	7%	5%	1%	1%	10%
Food Sales	14%	13%	17%	44%	4%	2%	2%	1%	4%
Food Service	12%	9%	14%	38%	3%	2%	18%	0%	3%
Health Care	35%	22%	17%	3%	8%	3%	1%	0%	9%
Lodging	28%	23%	7%	6%	7%	11%	1%	5%	13%
Mercantile	25%	22%	20%	10%	7%	7%	1%	1%	8%
Retail (Other than Mall)	24%	25%	19%	6%	7%	7%	1%	1%	9%
Enclosed and Strip Mall	25%	20%	20%	13%	7%	6%	2%	1%	7%
Office	29%	22%	26%	1%	7%	6%	1%	1%	8%
Public Assembly	32%	26%	11%	5%	8%	4%	2%	1%	11%
Public Order and Safety	30%	28%	13%	Q	8%	3%	Q	Q	13%
Religious Worship	38%	26%	5%	2%	10%	5%	(*)	(*)	14%
Service	22%	32%	14%	Q	9%	4%	Q	1%	15%
Warehouse and Storage	15%	38%	9%	4%	13%	3%	Q	1%	18%
Other	31%	27%	18%	Q	9%	Q	Q	1%	11%
Vacant	30%	10%	20%	Q	10%	(*)	Q	Q	30%

Notes:
1. Cooling, Lighting, Ventilation, Space Heating, and Water Heating are included in and regulated by California Title 24.
2. Non-built energy uses such as Office Equipment, Refrigeration, Cooking, and Other are not regulated by California Title 24 but still contribute to energy consumption.

Abbreviations:
Q - data withheld, fewer than 20 buildings sampled.
(*) - value rounds to zero in original units.
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Source:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: Calculated from data from Tables 3a and 3b of:
http://www.eia.doe.gov/emeu/cbecs/enduse_consumption/pba.html

Table 4-18
End-Uses of Natural Gas for Non-Residential Building Types
Vista Canyon
Santa Clarita, California

Principal Building Activity	Space Heating[1]	Cooking[2]	Water Heating[1]	Other[2]
All Buildings	73%	14%	10%	3%
Education	81%	8%	4%	6%
Food Sales	71%	13%	13%	Q
Food Service	42%	17%	39%	Q
Health Care	72%	8%	18%	Q
Lodging	53%	30%	9%	4%
Mercantile	76%	10%	9%	6%
Retail (Other than Mall)	78%	11%	Q	9%
Enclosed and Strip Mall	72%	8%	18%	Q
Office	94%	4%	3%	0%
Public Assembly	82%	9%	7%	Q
Public Order and Safety	79%	9%	Q	Q
Religious Worship	85%	8%	5%	Q
Service	73%	25%	Q	Q
Warehouse and Storage	88%	7%	Q	5%
Other	84%	11%	Q	Q
Vacant	95%	5%	Q	Q

Notes:
1. Cooling, Lighting, Ventilation, Space Heating, and Water Heating are included in and regulated by California Title 24.
2. Non-built energy uses such as Office Equipment, Refrigeration, Cooking, and Other are not regulated by California Title 24 but still contribute to energy consumption.

Abbreviations:
Q - data withheld, fewer than 20 buildings sampled.
(*) - value rounds to zero in original units.
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Source:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: Calculated from data from Table 2 of:
http://www.eia.doe.gov/emeu/cbecs/enduse_consumption/pba.html

Table 4-19
Energy Use for Non-residential Building Types
Vista Canyon
Santa Clarita, California

EIA Building Type	Electricity								Natural Gas							
	Title 24-regulated Uses (2001 Title 24)[1,2]	Title 24-regulated Uses (2005 Title 24)[3]	Title 24-regulated uses (2008 Title 24)[4]	20% Improvement over 2008 Title 24 [5]	Non Title 24-regulated Uses	2005 Total Electricity	2008 Total Electricity	Total Electricity with 20% Improvement Over 2008 Title 24	2001 Title 24-regulated Uses[6,7]	Title 24-regulated Gas Uses (2005 Title 24)[3]	2008 Title 24 gas[4]	20% Improvement over 2008 Title 24 [5]	Non Title 24-regulated Uses	2005 Total Natural Gas Use	2008 Total Natural Gas	Total Natural Gas with 20% Improvement Over 2008 Title 24
	(kW-hr / SF / year)								(ccf / SF / year)							
Administrative/professional office	10.13	9.35	8.90	7.12	5.44	14.80	14.34	12.56	0.15	0.14	0.13	0.10	0.01	0.15	0.13	0.11
Mixed-use office	10.65	9.83	9.35	7.48	5.72	15.55	15.06	13.19	0.10	0.10	0.09	0.07	0.00	0.10	0.09	0.07
Grocery store/food market	17.99	16.60	15.79	12.63	35.98	52.59	51.77	48.61	0.16	0.15	0.14	0.11	0.03	0.18	0.17	0.14
Other retail	13.90	12.83	12.20	9.76	7.73	20.56	19.93	17.49	0.16	0.15	0.14	0.11	0.04	0.20	0.18	0.16
Retail store	6.30	5.82	5.53	4.43	3.51	9.32	9.04	7.93	0.07	0.07	0.07	0.05	0.02	0.09	0.09	0.07
Restaurant/cafeteria	12.12	11.18	10.64	8.51	33.01	44.19	43.64	41.52	1.41	1.37	1.24	0.99	0.33	1.70	1.57	1.32
Fast food	28.65	26.44	25.14	20.12	78.04	104.48	103.18	98.15	1.38	1.34	1.21	0.97	0.32	1.66	1.54	1.30
Hotel	12.84	11.85	11.27	9.02	4.64	16.49	15.91	13.65	0.20	0.19	0.17	0.14	0.12	0.31	0.29	0.26
Entertainment/culture	28.38	26.19	24.91	19.93	11.19	37.38	36.09	31.11	0.05	0.04	0.04	0.03	0.01	0.05	0.05	0.04
% Improvement over 2008 Title 24				**20.0%**								**20.0%**				

Notes:

1. Baseline Data is from the 2003 Commercial Buildings Energy Consumption Survey conducted by the US Energy Information Administration. Electricity use is based upon buildings in the EIA CBECS database from EIA climate zone 4 (includes CA climate zone 9). Electricity use per square foot (electricity intensity) for each building sample was first calculated. The electricity intensities were then averaged taking into account the weighting factor for each building in the survey. ENVIRON assumed that these values represent energy intensities for minimally 2001 Title 24-compliant nonresidential buildings.

2. Includes only Title 24-regulated electricity (cooling, lighting, ventilation, space heating, water heating) and excludes non-built electricity (office equipment, refrigeration, cooking).

3. Title 24 data shown in this table have been adjusted to reflect improvements in Title 24 building codes since 2002. CEC discusses average savings for improvements from 2002 to 2005 ("Impact Analysis for 2005 Energy Efficiency Standards"). ENVIRON used these CEC average savings percentages, which are 7.7% reduction in 2005 for electricity and 3.2% reduction in 2005 for gas.

4. Title 24 data shown in this table have been adjusted to reflect improvements in Title 24 building codes since 2002. CEC discusses average savings for improvements from 2005 to 2008 ("Impact Analysis for 2008 Energy Efficiency Standards"). ENVIRON used these CEC average savings percentages, which are 4.9% reduction in 2008 for electricity and 9.4% reduction in 2008 for gas.

5. Vista has committed to a 20% improvement in Title 24-regulated energy use, relative to minimally 2008 Title 24-compliant buildings.

6. Natural gas use is based upon buildings in the EIA CBECS database from EIA climate zone 4 (includes CA climate zone 4). Natural gas use per square foot (intensity) for each building sample was first calculated. The natural gas intensities were then averaged taking into account the weighting factor for each building in the survey.

7. Includes only Title 24-regulated natural gas (space heating, water heating) and excludes non-built natural gas (cooking, other).

Abbreviations:
CA - California
CBECS - Commercial Building Energy Consumption Survey
CEC - California Energy Commission
EIA - Energy Information Administration
kW-hr - kilowatt-hour
SF - Square Feet
ccf - 100 cubic feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:

US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

Table 4-20
CO_2 Emissions Per Unit Area From Energy Use in Non-residential Building Types
Vista Canyon
Santa Clarita, California

EIA Building Type	CO_2e Emissions per Square Foot (Tonnes CO_2e/SF/year)[1]								
	2005 Title 24 Compliant			2008 Title 24 Compliant			20% Better than 2008 Title 24[2]		
	Electricity (Total)	Natural Gas (Total)	Total	Electricity (Total)	Natural Gas (Total)	Total	Electricity (Total)	Natural Gas (Total)	Total
Administrative/professional office	4.23E-03	8.05E-04	5.04E-03	3.79E-03	7.32E-04	4.52E-03	3.32E-03	5.92E-04	3.91E-03
Mixed-use office	4.45E-03	5.48E-04	5.00E-03	3.98E-03	4.98E-04	4.48E-03	3.49E-03	4.03E-04	3.89E-03
Grocery store/food market	1.51E-02	9.84E-04	1.60E-02	1.37E-02	9.07E-04	1.46E-02	1.29E-02	7.58E-04	1.36E-02
Other retail	5.88E-03	1.08E-03	6.96E-03	5.27E-03	9.98E-04	6.27E-03	4.62E-03	8.47E-04	5.47E-03
Retail store	2.67E-03	5.10E-04	3.18E-03	2.39E-03	4.73E-04	2.86E-03	2.10E-03	4.01E-04	2.50E-03
Restaurant/cafeteria	1.26E-02	9.27E-03	2.19E-02	1.15E-02	8.57E-03	2.01E-02	1.10E-02	7.22E-03	1.82E-02
Fast food	2.99E-02	9.09E-03	3.90E-02	2.73E-02	8.40E-03	3.57E-02	2.60E-02	7.07E-03	3.30E-02
Hotel	4.72E-03	1.69E-03	6.41E-03	4.21E-03	1.59E-03	5.80E-03	3.61E-03	1.41E-03	5.02E-03
Entertainment/culture	1.07E-02	2.75E-04	1.10E-02	9.54E-03	2.52E-04	9.80E-03	8.23E-03	2.07E-04	8.43E-03

Notes:
1. Data from the 2003 Commercial Buildings Energy Consumption Survey (see Table 4-19) was multipled by electricity and natural gas emission factors (see Table 4-10) to calculate CO_2 emissions intensities.
2. Vista Canyon Ranch, LLC has committed to a 20% improvement over 2008 Title-24 standards.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
SF - Square Feet
RPS - Renewables Portfolio Standard
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 4-21a
Total GHG Emissions From Energy Use in Non-Residential Building Types
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1]	EIA Building Category[2]	% Area[3]	Related Area[4]	Annual Area Emission Factor			Total Annual CO_2e Emissions							Percent CO_2e Reductions over 2008 Title 24
					2005 Title 24 Compliant (CARB 2020 NAT)	2008 Title 24 Compliant	20% Better than 2008 Title 24	2005 Title 24 Compliant (CARB 2020 NAT)		2008 Title 24 Compliant		20% Better than 2008 Title 24		20% Better than 2008 Title 24 and On-Site Emission Savings[7]	
	(SF)			(SF)	(Tonne CO_2e / SF / year)[5]			(Tonne CO_2e / year)[6]							
General Office	646,000	Administrative/professional office	50%	323,000	5.04E-03	4.52E-03	3.91E-03	1,628		1,461		1,264			
		Mixed-use office	50%	323,000	5.00E-03	4.48E-03	3.89E-03	1,614		1,448		1,257			
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000	1.60E-02	1.46E-02	1.36E-02	241		219		204			
Retail - Other than Mall	79,000	Other retail	50%	39,500	6.96E-03	6.27E-03	5.47E-03	275		248		216			
		Retail store	50%	39,500	3.18E-03	2.86E-03	2.50E-03	126	**6,308**	113	**5,692**	99	**5,003**	**4,652**	**18%**
Food Service	39,000	Restaurant/cafeteria	50%	19,500	2.19E-02	2.01E-02	1.82E-02	427		392		355			
		Fast food	50%	19,500	3.90E-02	3.57E-02	3.30E-02	760		696		644			
Lodging	140,000	Hotel	100%	140,000	6.41E-03	5.80E-03	5.02E-03	897		812		702			
Public Assembly	31,000	Entertainment/culture	100%	31,000	1.10E-02	9.80E-03	8.43E-03	340		304		261			

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON mapped each Vista Canyon building type to an EIA.
3. The percentage of each Vista Canyon building type assigned to each of the EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly.
4. The product of the area of the Vista Canyon building type and the percentage of each subcategory.
5. Emissions per square foot per year as calculated in Table 4-19.
6. Emissions for each building type are calculated as emissions per square foot times square footage.
7. Vista Canyon Ranch, LLC plans to install on-site energy systems that provide greenhouse gas reductions equivalent to the emission savings from 80,000 square feet of solar panels, which is approximately 351 tonnes.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
SF - Square Feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 4-21b
Total CO_2 Emissions From Energy Use in Non-Residential Building Types : Overlay Option
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Related Area[4] (SF)	Annual Area Emission Factor (Tonne CO_2e / SF / year)[5]: 2005 Title 24 Compliant	Annual Area Emission Factor: 2008 Title 24 Compliant	Annual Area Emission Factor: 20% Better than 2008 Title 24	Total Annual CO_2e Emissions (Tonne CO_2e / year)[6]: 2005 Title 24 Compliant (CARB 2020 NAT)	2005 Title 24 Compliant (CARB 2020 NAT): Total	2008 Title 24 Compliant	2008 Title 24 Compliant: Total	20% Better than 2008 Title 24	20% Better than 2008 Title 24: Total	20% Better than 2008 Title 24 and On-site Emission Savings[7]	Percent CO_2e Reductions over 2008 Title 24
General Office	396,000	Administrative/professional office	50%	198,000	5.04E-03	4.52E-03	3.91E-03	998		896		775			
General Office	396,000	Mixed-use office	50%	198,000	5.00E-03	4.48E-03	3.89E-03	989		887		771			
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000	1.60E-02	1.46E-02	1.36E-02	241		219		204			
Retail - Other than Mall	79,000	Other retail	50%	39,500	6.96E-03	6.27E-03	5.47E-03	275		248		216			
	79,000	Retail store	50%	39,500	3.18E-03	2.86E-03	2.50E-03	126	**5,054**	113	**4,567**	99	**4,027**	**3,676**	**19%**
Food Service	39,000	Restaurant/cafeteria	50%	19,500	2.19E-02	2.01E-02	1.82E-02	427		392		355			
Food Service	39,000	Fast food	50%	19,500	3.90E-02	3.57E-02	3.30E-02	760		696		644			
Lodging	140,000	Hotel	100%	140,000	6.41E-03	5.80E-03	5.02E-03	897		812		702			
Public Assembly	31,000	Entertainment/culture	100%	31,000	1.10E-02	9.80E-03	8.43E-03	340		304		261			

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON mapped each Vista Canyon Ranch building type to an EIA category.
3. The percentage of each Vista Canyon building type assigned to each of the EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly.
4. The product of the area of the Vista Canyon building type and the percentage of each subcategory.
5. Emissions per square foot per year as calculated in Table 4-20.
6. Emissions for each building type are calculated as emissions per square foot times square footage.
7. Vista Canyon Ranch, LLC plans to install on-site energy systems that provide greenhouse gas reductions equivalent to the emission savings from 80,000 square feet of solar panels, which is approximately 351 tonnes.

Abbreviations:
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
SF - Square Feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 4-22a
Estimated CO_2 Emission Savings from Photovoltaic Systems
Vista Canyon Ranch
Santa Clarita, California

Total Photovoltaic Panel Area[1] (ft^2)	Namplate DC System Power Rating[2] (kW)	Derate Factor[3]	AC System Power Rating (kW)	Average Annual Insolation[4] ($kWh/m^2/day$)	Equivalent Hours of 1-sun Insolation[5] (hours/day)	Annual Solar Energy Generation (kWh/yr)[6]	CO_2 Emission Factor[7] (lbs/kWh)	Annual CO_2 Savings (tonnes)
80,000	800	0.770	616	5.90	5.90	1,326,556	0.583	351

Notes:

1. Vista will install on-site features that provide 351 tonnes of GHG emission reductions, which is equivalent to 80,000 square feet of photovoltaic panels.
2. According to American Solar Energy Society/Cooler Planet, one square foot of photovoltaic panel generates approximately 10 W electric power at 1-sun insolation (i.e., at 1 kW/m^2 solar radiation).
3. This is the default factor from National Renewable Energy Laboratory Photovoltaic system performance calculator, PVWatts. PVWatts estimates annual energy production and cost savings for a crystalline silicon PV system. The derate factor accounts for energy losses due to inefficiencies in the DC-to-AC inverter, wiring and other connections; as well as the effects of shading, weather and soil on system performance. See http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/derate.cgi
4. The amount of solar energy that is received per unit area per day. This value depends on location; the value here was estimated for Santa Clarita zip code 91350 using National Renewable Energy Laboratory Photovoltaic system performance calculator PVWatts, Version 2. ENVIRON assumed that this value represents an annual average.
5. Number of hours per day of 1-sun insolation (1 kW/m^2 x 5.9 h/day = 5.9 kWh/m^2day)
6. DC and AC power ratings are based on 1-sun insolation. Thus, multiplying the power rating by the number of peak-sun hours per year yields the annual energy generated in kWh. This estimate assumes that the efficiency of the photovoltaic panels does not change with daily fluctuations of insolation.
7. SCE emission factor for 2007, corrected to reflect a 20% renewables portfolio as required by the Renewables Portfolio Standard by 2010.

References:

American Solar Energy Society and Cooler Planet. FindSolar Solar Power Calculator. Available at: http://www.findsolar.com/index.php?page=rightforme

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Masters, Gilbert M. 2004. Renewable and Efficient Electric Power Systems. John Wiley & Sons, Inc.: Hobeken, New Jersey.

National Renewable Energy Laboratory, Renewable Resource Data Center. PVWatts. Available at: http://www.nrel.gov/rredc/pvwatts/. Accessed August 29, 2009.

Table 4-22b

Comparison of Rooftop Greenhouse Gas Mitigation Measures

Vista Canyon

Santa Clarita, California

Roofing Option	Available Area (ft^2)	Electricity Saved ($kwh/ft^2/year$)	Natural Gas Saved ($MMBTU/ft^2/year$)	CO_2 Emission factor (lb/kwh)[2]	CO_2 Emission factor (lb/MMBTU)[2]	CO_2 Averted ($lb/ft^2/year$)	Total CO_2 Averted (tonnes CO_2/year)[8]
Solar Hot Water (Residential)[1]	4,240	--	0.37	--	117	42.7	82
Solar Hot Water (Commercial) (Replacing natural gas)[3]	See details	--	0.37	--	117	42.7	111
Solar Thermal (water, space heating) (Commercial) (Replacing natural gas)[4]	80,000	--	0.37	--	117	42.7	1,549
Solar Thermal (water, space heating) (Commercial) (Replacing electricity)[5]		53.1	--	0.583	--	31.0	1,124
Cool Roof[6]	80,000	0.297	--	0.583	--	0.16	5.8
Photovoltaic Panels[7]	80,000	16.6	--	0.583	--	9.7	351

Notes

1. Assumes each system covers 40 ft^2 and are installed on 106 single-family homes. Assume 1,000 BTU/ft2/day heat provided by panels, based on report by California Solar Energy Industries Association (2009).
2. Emission factor for natural gas from CCAR GRP. Emission factor for electricity from Southern California Edison, adjusted to reflect 20% renewables under the Renewables Portfolio Standard.
3. This estimate is based on the emissions associated with hot water heating in the non-residential buildings at VC. The total CO_2 emissions associated with non-residential natural gas usage for hot water is 148 tonnes/year. According to Lawrence Berkeley National Laboratory, solar water heaters can reduce water heating needs by up to 75%.
4. This is a rough estimate based on the performance of solar water heating systems (see note 1). Additional research is required to determine feasibility and performance of combined water and space heating systems.
5. Assumes 3,400 kwh/year generated by a 64 ft^2 solar thermal system, according to Solar Rating and Certification Corporation (2001).
6. Cooling energy saved (3.2 $kwh/m^2/year$) from Figure 9 of Levinson and Akbari (2009). Does not account for small heating energy penalty (~1% of cooling energy saved) There are Title 24 cool roof requirements for non-residential buildings.
7. Details on PV analysis are provided in a separate table. Cool roof requirements under Title 24 may apply for certain roof-top PV installations, according to California Energy Commission (2005).
8. Estimates of averted emissions are first approximations only.

Sources:

California Energy Commission. 2005. Blueprint No. 83: Q and A on Cool Roofs. December. Available at: http://www.energy.ca.gov/2005publications/CEC-400-2005-053/CEC-400-2005-053.PDF

California Solar Energy Industries Association. 2009. The Value Proposition of Solar Water Heating In California. January. Available at: http://www.seia.org/galleries/pdf/CALSEIA_Report_SWH_Value_Proposition.pdf

P. Denholm. 2007. The Technical Potential of Solar Water Heating to Reduce Fossil Fuel Use and Greenhouse Gas Emissions in the United States. National Renewable Energy Laboratory Technical Report NREL/TP-640-41157. March. Available at: www.nrel.gov/docs/fy07osti/41157.pdf

R. Levinson and H. Akbari. "Potential benefits of cool roofs on commercial buildings: conserving energy, saving money, and reducing emission of greenhouse gases and air pollutants". Energy Efficiency. Published online March 14, 2009Available at: http://www.springerlink.com/content/9r48k34558240825/fulltext.html.

Solar Rating and Certification Corporation. 2001. Solar Thermal Collector Energy Production. October. Available at: http://www.solar-rating.org/solarfacts/energyproduction20011017.pdf

Table 4-23a
Greenhouse Gas Emissions from Vehicles for the Year 2020
Vista Canyon
Santa Clarita, California

Trip Type[1]		Daily One-Way Trips[2] Unadjusted	Daily One-Way Trips[2] Weekend/Weekday Adjustment[3]	Trip Distance[4] (miles)	Daily Adjusted VMT (miles)	Annual Adjusted VMT (miles)	Emission Factor Running (g/mile)[5]	Emission Factor Starts (g/start)[6]	Annual CO_2 Emissions Running (tonne)	Annual CO_2 Emissions Starts (tonne)	Total Annual CO_2 Emissions (tonne)	Total Annual CO_2e Emissions (tonne)[7]
Internal	Home Based Work	281	265	0.25	66	24,166	282	91	7	9	16	16
	Home Based Other	484	456	0.25	114	41,619			12	15	27	28
Total Internal Resident Trips		*765*	*721*		0	*65,785*			*19*	*24*	*42*	*45*
External	Home Based Work	1,592	1,501	20	30,014	10,955,268	307	91	3,367	50	3,417	3,597
	Home Based Other	4,354	4,105	6	24,629	8,989,764			2,763	136	2,900	3,052
Total External Resident Trips		*5,945*	*5,606*		0	*19,945,031*			*6,131*	*186*	*6,317*	*6,649*
Total Non-Home Based Trips (offsite)		*1,092*	*1,030*	*6*	6,179	*2,255,496*	307	91	*693*	*34*	*727*	*766*
Totals		**7,802**	**7,356**		61,004	**22,266,313**			**6,843**	**244**	**7,087**	**7,460**

Notes:

1. The trip type distribution is based on data provided by Fehr & Peers. The distribution of internal to external trips for each trip type is the following:

Trip Type	Internal	External	Proportion of Total Home Based Trips
Home Based Work	15%	85%	28%
Home Based Other	10%	90%	72%

2. Total weekday daily one-way trips data was provided by Fehr & Peers.
3. Daily trips were adjusted to account for differences between weekend and weekday traffic, based on a report by Sonoma Technology. The weekend traffic (internal) was assumed to be 80% of weekly capacity. The weekend traffic (external) was assumed to be 80% of weekly capacity. There has been no weekend adjustment made for mode shifts.
4. Trip distances were provided by Fehr & Peers.
5. Emission factors for vehicles based on EMFAC files for 2020, based on LDA, LDT1, LDT2, MDV, and MCY for Los Angeles County. Speeds of 35 miles per hour for internal trips and 60 miles per hour for external trips and non-home based trips were used to determine emission factors. A reduction in the emission factor of 20% was taken into account for emission reductions due to Pavley Standards.
6. Starting emission factors are based on the weighted average distribution of time between trip starts based on URBEMIS defaults.
7. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions on a CO_2e basis.

Abbreviations:

CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

References:

Fehr&Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. May 15.
NCHRP Report 365. 1998. Travel Estimation Techniques for Urban Planning.
Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

Table 4-23b
Greenhouse Gas Emissions from Vehicles for the Year 2020: Overlay Option
Vista Canyon
Santa Clarita, California

Scenario[1]	Number of dwelling units	Daily Adjusted VMT (miles)	Annual Adjusted VMT (miles)	Annual CO_2 Emissions Running (tonne)	Annual CO_2 Emissions Starts (tonne)	Total AnnualCO_2 Emissions (tonne)	Total Annual CO_2e Emissions (tonne)[3]
Project	1,117	61,004	22,266,313	6,843	244	7,087	**7,460**
Overlay[2]	1,350	73,729	26,910,942	8,270	295	8,565	**9,016**

Notes:

1. The Project scenario and Overlay scenario differ by the number of dwelling units and square footage of office space.

2. For the overlay option it was assumed that all residential mobile source parameters (vehicle miles traveled per dwelling unit, trip length, trip types) were the same as for the project scenario. The estimate presented in this row was scaled from the project scenario based on the number of dwelling units. Thus, VMT and emissions for the project scenario were multplied by a factor of (1,350/1,117) to generate estimates for the overlay scenario.

3. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions on a CO_2e basis.

Abbreviations:

CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
VMT - Vehicle Miles Traveled

References:

Fehr and Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. May 15.
NCHRP Report 365. 1998. Travel Estimation Techniques for Urban Planning.
Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

Table 4-24
Total GHG Emissions from Buses and Buildings at the Proposed Transit Center Building and Structures
Vista Canyon
Santa Clarita, CA

Land Uses[1]	Area[1]	Existing Area[2,3]	Net New Area	CEUS Building Type[4]	CEUS Area	Electricity Usage[5,6]	Natural Gas Usage[5,7]	CO_2 Emissions [tonnes/yr] Electricity	CO_2 Emissions [tonnes/yr] Natural Gas	Total CO_2e Emissions[5]
	[SF]	[SF]	[SF]		[SF]	[KWh/SF/yr]	[kBTU/SF/yr]	[tonnes/yr]		
Parking Structure Security Office	2,000	--	2,000	Miscellaneous	73,500	11.8	4.32	6	0.5	49
Parking Structure	212,000	145,000	67,000	Miscellaneous		2.2	--	39	--	
Bus Transit Stop	4,500	--	4,500	Miscellaneous		2.2	--	3	--	
Metrolink Platforms	22,400	22,400	0	Miscellaneous		2.2	--	0	--	

Notes:

1. Size of the parking structure security office was provided by Vista Canyon Ranch, LLC. Sizes of the parking structure, the bus transit stop, and the metrolink platforms were estimated from a plot plan of the proposed project sent by Vista Canyon Ranch, LLC.
2. The existing Via Princessa Station lot has approximately 395 parking spaces. The size of the parking area was estimated using Geographical Information Systems (GIS) software and aerial photographs.
3. The existing Via Princessa Station has approximately equivalent platform area to that of the proposed station.
4. The CEUS "Miscellaneous" building category includes automobile parking. ENVIRON assumed that bus stop and train platforms will have the same energy usage rate as the parking structure. The CEUS "All Office" category was applied to the parking structure security office.
5. Usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). ENVIRON used data for Southern California Edison (SCE), Zone 10, which is the sector in which the Vista Canyon development is located.
6. Exterior lighting and "miscellaneous" end uses were considered for the proposed parking structure, bus transit stop and Metrolink platforms, as well as for the existing parkign area and Metrolink Platforms. It was assumed that these structures would not have space conditioning (e.g. heating, cooling, ventilation), interior lighting, cooking, water heating, office equipment, motors, air compressors, or process-related electricity uses.
7. ENVIRON assumed that natural gas is used in the security office of the parking structure only.

Abbreviations:

CEC - California Energy Commission
CEUS - California Commercial End-Use
CO2 - carbon dioxide
CO2e - carbon dioxide equivalent
kWh - kilowatt-hour
GHG - greenhouse gas
kBTU - kilo (1000) British thermal units
RPS - Renewables Portfolio Standard
SCE - Southern California Edison
SF - square feet
tonnes - metric tonnes
yr - year

Reference:

California Commercial End-Use Survey. Perofrmed by Itron, under contract to the California Energy Commission. 2006. Available at: http://www.energy.ca.gov/ceus/. Accessed August 24, 2009.

Table 4-25
GHG Emissions for Municipal Sources
Vista Canyon
Santa Clarita, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity	Units	Total CO_2e Emissions [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	149	kW-hr/capita/yr	0.039	tonne CO_2e/capita/year	3,463	residents (capita)	136
						Public Lighting Total:	**136**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	3,463	residents (capita)	173
						Municipal Vehicles Total:	**173**
Water and Wastewater [13]							
Groundwater Supply and Conveyance (Potable)[4,5]	2,915	kW-hr/million gallons	0.77	tonne / million gallons	31	million gallons/year	24
State Water Project Supply and Conveyance (Potable)[4,6]	9,931	kW-hr/million gallons	2.63	tonne / million gallons	48	million gallons/year	126
Water Treatment (Potable)[7]	111	kW-hr/million gallons	0.03	tonne / million gallons	78	million gallons/year	2
Water Distribution (Potable)[8]	1,272	kW-hr/million gallons	0.34	tonne / million gallons	78	million gallons/year	26
On-site Wastewater Treatment (Indirect Emissions) [9,10]	2,011	kW-hr/million gallons	0.53	tonne / million gallons	133	million gallons/year	70
Recycled Water Distribution (Non-Potable)[11]	2,100	kW-hr/million gallons	0.56	tonne / million gallons	40	million gallons/year	22
Decreasing Potable Water Demand for Others[12]	-4,567	kW-hr/million gallons	-1.21	tonne / million gallons	93	million gallons/year	**-112**
						Water and Wastewater Total:	**159**
						Municipal Sources Total:	**468**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor.

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN (Skoog, 2001) and the electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emissions for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. The Castaic Lake Water Agency (CLWA) - Santa Clarita Water Division (SCWD) provides water to Vista Canyon Water supply and conveyance is based on two different sources: State Water Project and local groundwater. According to the 2008 Water Requirements and Supplies report, 61% of the water supply toVista Canyon is from the State Water Supply, and the remaining 39% is from local groundwater.

5. Emission factor for groundwater supply and conveyance is based on information provided in the 2005 CEC report and the electricity generation emission factor from Southern California Edison.

6. Emission factor for the State Water Project is based on information provided by Wilkinson 2000 and the electricity generation emission factor from Southern California Edison.

7. Emission factor for water treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for water distribution is based on a 2006 Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

9. An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory.

10. According to Dexter Wilson Engineering Inc., there will be no direct emissions of methane or nitrous oxide from the wastewater treatment plant.

11. Emission factor for recycled water distribution is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. ENVIRON used the average of the range of emission factors presented in the report.

12. Vista Canyon will make available to other users unused recycled water, offsetting the energy use due to the State Water Project and groundwater which would otherwise supply that water, supply, and conveyance. Of the ~360,000 gallons/day wastewater that is recycled, 109,000 gallons/day (30%) will be used to supply the non-potable demand at Vista Canyon, leaving the remaining 70% recycled water available for sale. The energy saved from the sale equals the energy required to supply, treat, and distribute the groundwater and State Water Project water minus the energy required to treat and distribute the recycled water.

13. Source quantities for water and wastewater are based on the Engineering Report for the Vista Canyon Water Factory.

Abbreviations:

CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kW-hr - kilowatt hour
MW-hr - megawatt hour
USEPA - United States Environmental Protection Agency

Sources:

California Climate Action Registry (CCAR) Database. Southern California Edison Annual Emissions Report. 2008.
California Energy Commission. 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.
City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf
City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf
Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissions.pdf
USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf
Wilkinson, Robert. 2000. Methodology for Analysis of the Energy Intensity of California's Water Systems, and An Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures.
Dexter Wilson Engineering, Inc. 2009. Engineering Report for the Vista Canyon Water Factory. July.
CLWA Santa Clarita Water Division. 2008. Water Requirements and Supplies. http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf

Table 4-26a
Estimated Water Deliveries: Overlay Option and Annexation Area
Vista Canyon
Santa Clarita, California

Land Use (units)	Project[1]			Overlay[2,3]			Annexation Area[2,3]		
	Count	Potable Deliveries	Recycled Water Deliveries	Count	Estimated Potable Deliveries	Estimated Recycled Water Deliveries	Count	Estimated Potable Deliveries	Estimated Recycled Water Deliveries
		gallons/day			gallons/day			gallons/day	
Residential - Single Family (dwelling units)	106	27,610	0	106	27,610		150	39,071	
Residential - Multi-Family (dwelling units)	1,011	147,766	0	1,244	181,821		0		
Commercial (square feet)	981,000	39,649	33,775	731,000	29,545	25,168	436,000	17,622	15,011
Landscape[4]	--	0	36,287			36,287	--		
Park[4]	--	0	9,000			9,000	--		
Bank Protection[4]	--	0	29,867			29,867	--		
TOTAL (gallons/day)		**215,026**	**108,929**		**238,976**	**100,322**		**56,693**	**15,011**

Notes:
1. Project data obtained from Dexter Wilson Engineering "Engineering report for the Vista Canyon Water Factory", draft. July 17, 2009.
2. Overlay and annexation area land use data provided by Vista Canyon Ranch, LLC
3. Water deliveries were scaled from the project scenario based on the number of dwelling units or square footage.
4. Water deliveries for these uses in the overlay scenario were assumed to be equal to the project scenario. No informaton on these land uses was available for the annexation area.

Table 4-26b
Estimated Wastewater Flows: Overlay Option and Annexation Area
Vista Canyon
Santa Clarita, California

		Project[1]		Overlay[2,3]		Annexation Area[2,3]	
Land Use	**Units**	**Count**	**Flow, gpd**	**Count**	**Estimated Flow, gpd**	**Count**	**Estimated Flow, gpd**
Residential - Single Family	DU	106	27,560	106	27,560	150	39,000
Residential - Multi-Family	DU	1,011	157,716	1,244	194,064	0	0
Hotel[4]	rooms	200	25,000	200	25,000	0	0
Commercial[4]	sf	6,000	1,200	6,000	1,200	0	0
Theater[4]	sf	31,000	3,875	31,000	3,875	0	0
Retail[4]	sf	124,000	18,600	124,000	18,600	0	0
Office	sf	646,000	129,200	396,000	79,200	436,000	87,200
Total			**363,151**		**349,499**		**126,200**

Notes:
1. Project data obtained from Dexter Wilson Engineering "Engineering report for the Vista Canyon Water Factory", draft.
2. Overlay and annexation area land use data provided by Vista Canyon Ranch, LLC
3. Wastewater flow was scaled from the project scenario based on the number of dwelling units or square footage.
4. Wastewater flow for these uses in the overlay scenario were assumed to be equal to the project scenario. No informaton on these land uses was available for the annexation area.

Table 4-27
GHG Emission from Municipal Sources: Overlay Option
Vista Canyon
Santa Clarita, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity	Units	Total CO_2e Emissions [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	149	kW-hr/capita/yr	0.039	tonne CO_2e/capita/year	4,185	residents (capita)	165
						Public Lighting Total:	**165**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	4,185	residents (capita)	209
						Municipal Vehicles Total:	**209**
Water and Wastewater [13]							
Groundwater Supply and Conveyance (Potable)[4,5]	2,915	kW-hr/million gallons	0.77	tonne / million gallons	34	million gallons/year	26
State Water Project Supply and Conveyance (Potable)[4,6]	9,931	kW-hr/million gallons	2.63	tonne / million gallons	53	million gallons/year	140
Water Treatment (Potable)[7]	111	kW-hr/million gallons	0.03	tonne / million gallons	87	million gallons/year	3
Water Distribution (Potable)[8]	1,272	kW-hr/million gallons	0.34	tonne / million gallons	87	million gallons/year	29
On-site Wastewater Treatment (Indirect Emissions) [9,10]	2,011	kW-hr/million gallons	0.53	tonne / million gallons	128	million gallons/year	68
Recycled Water Distribution (Non-Potable)[11]	2,100	kW-hr/million gallons	0.56	tonne / million gallons	37	million gallons/year	20
Decreasing Potable Water Demand for Others[12]	-4,567	kW-hr/million gallons	-1.21	tonne / million gallons	91	million gallons/year	**-110**
						Water and Wastewater Total:	**176**
						Municipal Sources Total:	**550**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor.

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN (Skoog, 2001) and the electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emissions for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. The Castaic Lake Water Agency (CLWA) - Santa Clarita Water Division (SCWD) provides water to Vista Canyon Ranch. Water supply and conveyance is based on two different sources: State Water Project and local groundwater. According to the 2008 Water Requirements and Supplies report, 61% of the water supply to Vista Canyon Ranch is from the State Water Supply, and the remaining 39% is from local groundwater.

5. Emission factor for groundwater supply and conveyance is based on information provided in the 2005 CEC report and the electricity generation emission factor from Southern California Edison.

6. Emission factor for the State Water Project is based on information provided by Wilkinson 2000 and the electricity generation emission factor from Southern California Edison.

7. Emission factor for water treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for water distribution is based on a 2006 Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

9. An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory.

10. According to Dexter Wilson Engineering Inc., there will be no direct emissions of methane or nitrous oxide from the wastewater treatment plant.

11. Emission factor for recycled water distribution is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. ENVIRON used the average of the range of emission factors presented in the report.

12. Vista Canyon will make available to other users unused recycled water, offsetting the energy use due to the State Water Project and groundwater which would otherwise supply that water, supply, and conveyance. Of the ~360,000 gallons/day wastewater that is recycled, 109,000 gallons/day (30%) will be used to supply the non-potable demand at Vista Canyon, leaving the remaining 70% recycled water available for sale. The energy saved from the sale equals the energy required to supply, treat, and distribute the groundwater and State Water Project water minus the energy required to treat and distribute the recycled water.

13. Source quantities for water and wastewater are based on the Engineering Report for the Vista Canyon Water Factory.

Abbreviations:

CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kW-hr - kilowatt hour
MW-hr - megawatt hour
USEPA - United States Environmental Protection Agency

Sources:

California Climate Action Registry (CCAR) Database. Southern California Edison Annual Emissions Report. 2008.
California Energy Commission. 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.
City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf
City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf
Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissi
USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf
Wilkinson, Robert. 2000. Methodology for Analysis of the Energy Intensity of California's Water Systems, and An Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures.
Dexter Wilson Engineering, Inc. 2009. Engineering Report for the Vista Canyon Water Factory. July.
CLWA Santa Clarita Water Division. 2008. Water Requirements and Supplies. http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf

Table 4-28
GHG Emissions from Area Sources-Landscape Equipment Fuel Combustion
Vista Canyon
Santa Clarita, California

Land Use Type	Quantity[1]	CO_2 emission factor[2]	Equipment Use Period[3]	Annual CO_2 emission
	(units)	(lbs/unit/day)	(days/year)	(tonne/year)
Single-family residential (DU)[4]	106	0.07	180	0.6
Landscape Equipment Fuel Combustion Total				**0.6**

Notes:
1. Land use information provided by Vista Canyon Ranch, LLC.
2. Emission factors provided by URBEMIS, based on estimates using CARB's OFFROAD2007 model.
3. Use period is assumed to be equal to the summer period of 180 days.
4. Based on estimates using the URBEMIS model, emissions from landscaping are mainly attributed to single-family residential land uses; the total acreage of non-residential land uses did not significantly impact the total landscaping CO_2 emissions. Thus, only landscaping emissions associated with single-family residences are calculated here.

Abbreviations:
DU = dwelling unit

Sources:

South Coast Air Quality Management District. Software User's Guide: URBEMIS 2007 9.2.4 for Windows. Prepared by Jones & Stokes Associates. November. Available at: http://www.aqmd.gov/CEQA/urbemis.html

Table 4-29
Greenhouse Gas (GHG) Emissions from Energy Use for Private Swimming Pools
Vista Canyon
Santa Clarita, California

Annual Energy Use Per Pool[1,2,3] (kWh/yr)	Emission Factor[4] (lb CO_2e/kWh)	Total Emissions Per Pool (tonnes CO_2 / yr)	Total Emissions for Six Pools (tonnes CO_2 / yr)
1,512	0.583	0.40	2

Notes:

1. According to Vista Canyon Ranch, LLC, there may be up to six private swimming pools at Vista Canyon.

2. According to Vista Canyon Ranch, LLC, any pools at Vista Canyon will be solar-heated. ENVIRON assumed that all pool energy use is associated with the pool pump, and no electricity or natural gas would be used for pool heating.

3. Annual pool pump use was estimated as the annual California average provided in a 2004 Davis Energy study (2,600 kWh/year) minus the estimated savings from the 2008 Appliance Efficiency Standards (1,088 kWh/year), according to a 2008 study by Davis Energy.

4. 2007 emission factor for electricity is provided by Southern California Edison, obtained from the California Climate Action Registry Database. The emission factor has been adjusted to reflect 20% renewables, which is required by 2010 under RPS.

Abbreviations:

CO_2 = carbon dioxide
kW-hr = kilowatt-hour
RPS = Renewables Portfolio Standard
yr = year

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (January 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Davis Energy Group. 2004 Analysis of Standards Options For Residential Pool Pumps, Motors, and Controls. Prepared for Pacific Gas and Electric Company. Available at: http://consensus.fsu.edu/FBC/Pool-Efficiency/CASE_Pool_Pump.pdf. Accessed September 3, 2009.

Davis Energy Group. 2008. Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company. Available at: http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-05-15_workshop/other/PGE_Updated_Proposal_Information_Template_for_Residential_Pool_Pump_Measure_Revisions.pdf. Accessed September 3, 2009.

Table 4-30
GHG Emissions from Electricity and Natural Gas Usage in Residential Dwelling Units: Annexation Area
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title-24 Systems		Title-24 Systems and Major Appliances		Title-24 Systems and All MELs	
			CO_2 Emission Factor	Total CO_2 Emissions	CO_2 Emission Factor	Total CO_2 Emissions	CO_2 Emission Factor	Total CO_2 Emissions
			(tonne CO_2 / DU / year)	(tonne CO_2 / year)	(tonne CO_2 / DU / year)	(tonne CO_2 / year)	(tonne CO_2 / DU / year)	(tonne CO_2 / year)
Minimally Title 24 Compliant (2008)	**Single family**	150	2.3	**344**	3.1	**464**	3.7	**550**

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Vista Canyon Ranch, LLC.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2 - carbon dioxide
DU - Dwelling Unit
GHG - greenhouse gas
MEL - Miscellaneous electric loads
RPS - Renewable Portfolio Standards

Sources:

California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 4-31
Total GHG Emissions From Energy Use in Non-Residential Building Types : Annexation Area
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Related Area[4] (SF)	Annual Area Emission Factor (Tonne CO_2e / SF / year)[5]: 2005 Title 24 Compliant (CARB 2020 NAT)	Annual Area Emission Factor (Tonne CO_2e / SF / year)[5]: 2008 Title 24 Compliant	Total Annual CO_2e Emissions (Tonne CO_2e / year)[6]: 2005 Title 24 Compliant (CARB 2020 NAT)		Total Annual CO_2e Emissions (Tonne CO_2e / year)[6]: 2008 Title 24 Compliant	
General Office	436,000	Administrative/professional office	50%	218,000	5.36E-03	4.52E-03	1,169	**2,332**	986	**1,963**
		Mixed-use office	50%	218,000	5.34E-03	4.48E-03	1,163		977	

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON mapped each Vista Canyon building type to an EIA.
3. The percentage of each Vista Canyon building type assigned to each of the EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly.
4. The product of the area of the Vista Canyon building type and the percentage of each subcategory.
5. Emissions per square foot per year as calculated in Table 4-20.
6. Emissions for each building type are calculated as emissions per square foot times square footage.
7. Vista Canyon Ranch, LLC plans to install on-site mitigation systems that provide greenhouse gas reductions equivalent to the emission savings from 80,000 square feet of solar panels.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
GHG - greenhouse gas
SF - Square Feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 4-32
Greenhouse Gas Emissions from Vehicles for the Year 2020: Annexation Area
Vista Canyon
Santa Clarita, California

Scenario[1]		**Number of dwelling units**	**Daily Adjusted VMT (miles)**	**Annual Adjusted VMT (miles)**	**Annual CO_2 Emissions Running (tonne)**	**Annual CO_2 Emissions Starts (tonne)**	**Total AnnualCO_2 Emissions (tonne)**	**Total Annual CO_2e Emissions (tonne)**[3]
Internal	Home Based Work		66	24,166	7	9	16	16
	Home Based Other		114	41,619	12	15	27	28
Total Internal Resident Trips			*0*	*65,785*	*19*	*24*	*42*	*45*
External	Home Based Work		30,014	10,955,268	3,367	50	3,417	3,597
	Home Based Other		24,629	8,989,764	2,763	136	2,900	3,052
Total External Resident Trips			*0*	*19,945,031*	*6,131*	*186*	*6,317*	*6,649*
Total Non-Home Based Trips (offsite)			*6,179*	*2,255,496*	*693*	*34*	*727*	*766*
Project		1,117	61,004	22,266,313	6,843	244	7,087	**7,460**
Annexation Area[2]		150	8,192	2,990,105	919	33	952	**1,002**

Notes:
1. The Project scenario and Annexation area differ by the number of dwelling units and square footage of office space.

2. For the Annexation area it was assumed that all residential mobile source parameters (vehicle miles traveled per dwelling unit, trip length, trip types) were the same as for the project scenario. The estimate presented in this row were scaled from the project scenario based on the number of dwelling units. Thus, VMT and emissions for the project scenario were multiplied by a factor of (150/1117) to generate estimates for the Annexation area.

3. CO_2e=CO_2/0.95: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions on a CO_2e basis.

Abbreviations:
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

References:
Fehr&Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. May 15.
NCHRP Report 365. 1998. Travel Estimation Techniques for Urban Planning.
Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

Table 4-33
GHG Emissions for Municipal Sources: Annexation Area
Vista Canyon
Santa Clarita, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity	Units	Total CO_2e Emissions [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	149	kW-hr/capita/yr	0.039	tonne CO_2e/capita/year	465	residents (capita)	18
						Public Lighting Total:	**18**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	465	residents (capita)	23
						Municipal Vehicles Total:	**23**
Water and Wastewater [12]							
Groundwater Supply and Conveyance (Potable)[4,5]	2,915	kW-hr/million gallons	0.77	tonne / million gallons	8	million gallons/year	6
State Water Project Supply and Conveyance (Potable)[4,6]	9,931	kW-hr/million gallons	2.63	tonne / million gallons	13	million gallons/year	33
Water Treatment (Potable)[7]	111	kW-hr/million gallons	0.03	tonne / million gallons	21	million gallons/year	1
Water Distribution (Potable)[8]	1,272	kW-hr/million gallons	0.34	tonne / million gallons	21	million gallons/year	7
Wastewater Treatment (Indirect Emissions)[9,10]	2,011	kW-hr/million gallons	0.53	tonne / million gallons	46	million gallons/year	24
Recycled Water Distribution (Non-Potable)[11]	2,100	kW-hr/million gallons	0.56	tonne / million gallons	5	million gallons/year	3
						Water and Wastewater Total:	**74**
						Municipal Sources Total:	**116**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor.

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN (Skoog, 2001) and the electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emissions for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. The Castaic Lake Water Agency (CLWA) - Santa Clarita Water Division (SCWD) provides water to Vista Canyon Water supply and conveyance is based on two different sources: State Water Project and local groundwater.

According to the 2008 Water Requirements and Supplies report, 61% of the water supply toVista Canyon is from the State Water Supply, and the remaining 39% is from local groundwater.

5. Emission factor for groundwater supply and conveyance is based on information provided in the 2005 CEC report and the electricity generation emission factor from Southern California Edison.

6. Emission factor for the State Water Project is based on information provided by Wilkinson 2000 and the electricity generation emission factor from Southern California Edison.

7. Emission factor for water treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for water distribution is based on a 2006 Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

9. An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory.

10. According to Dexter Wilson Engineering Inc., there will be no direct emissions of methane or nitrous oxide from the wastewater treatment plant.
11. Emission factor for recycled water distribution is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. ENVIRON used the average of the range of emission factors presented in the report.
12. Source quantities for water and wastewater are based on the Engineering Report for the Vista Canyon Water Factory.

Abbreviations:

CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kW-hr - kilowatt hour
MW-hr - megawatt hour
USEPA - United States Environmental Protection Agency

Sources:

California Climate Action Registry (CCAR) Database. Southern California Edison Annual Emissions Report. 2008.
California Energy Commission. 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.
City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf
City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf
Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissions.pdf
USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf
Wilkinson, Robert. 2000. Methodology for Analysis of the Energy Intensity of California's Water Systems, and An Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures.
Dexter Wilson Engineering, Inc. 2009. Engineering Report for the Vista Canyon Water Factory. July.
CLWA Santa Clarita Water Division. 2008. Water Requirements and Supplies. http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf

Table 4-34
GHG Emissions from Area Sources-Landscape Equipment Fuel Combustion: Annexation Area
Vista Canyon
Santa Clarita, California

Land Use Type	Quantity[1] (units)	CO_2 emission factor[2] (lbs/unit/day)	Equipment Use Period[3] (days/year)	Annual CO_2 emission (tonne/year)
Single-family residential (DU)[4]	150	0.07	180	0.9
Landscape Equipment Fuel Combustion Total				**0.9**

Notes:
1. Land use information provided by Vista Canyon Ranch, LLC.
2. Emission factors provided by URBEMIS, based on estimates using CARB's OFFROAD2007 model.
3. Use period is assumed to be equal to the summer period of 180 days.
4. Based on estimates using the URBEMIS model, emissions from landscaping are mainly attributed to single-family residential land uses; the total acreage of non-residential land uses did not significantly impact the total landscaping CO_2 emissions. Thus, only landscaping emissions associated with single-family residences are calculated here.

Abbreviation:
DU = dwelling unit

Source:

South Coast Air Quality Management District. Software User's Guide: URBEMIS 2007 9.2.4 for Windows. Prepared by Jones & Stokes Associates. November. Available at: http://www.aqmd.gov/CEQA/urbemis.html

Table 4-35
Summary of Greenhouse Gas Emissions for Vista Canyon
Vista Canyon
Santa Clarita, California

Source	GHG Emissions		Percentage of Annual CO_2e Emissions[7] (%)
Vegetation[1]	tonnes CO_2e total	-105	NA
Construction (Worker commuting and vendor trips)[2]		12,013	NA
Construction (All other construction activities)[2]		9,384	NA
Total (one time emissions)		**21,292**	NA
Residential[3]	tonnes CO_2e / year	2,728	18%
Non-Residential[4]		4,652	30%
Mobile[5]		7,460	49%
Municipal[6]		468	3%
Area		1	0.004%
Transit Center[9]		49	0.3%
Swimming Pools[10]		2	0.02%
Total (annual emissions)		**15,360**	NA
Annualized Total[8]	**tonnes CO_2e / year**	**15,892**	**NA**

Notes:

1. Vegetation emissions are one-time emissions resulting from the removal of existing vegetation and planting of new vegetation. The emissions are estimated assuming that all carbon currently sequestered in the biomass of the vegetation is released to the atmosphere upon removal of the vegetation. A negative value means a net decrease in emissions. Data for emissions calculations are primarily from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.
2. Construction emissions are one-time emissions reported in total metric tonnes during the construction period 2009-2013. Emissions are calculated using URBEMIS default values, EMFAC2007 and engineering judgment. Sources of emissions include construction equipment (on-site activities and soil hauling) and vehicles associated with worker commuting and vendor trips (non-building emissions).

3. Residential emissions for single family and apartment dwelling units include emissions associated with electricity and natural gas use. Emissions estimates were developed from California Residential Appliance Saturation Survey (RASS). As specified in the , a total of 1117 dwelling units are considered.

4. Non-Residential emissions account for electricity and natural gas use, minus emissions saved by on-site power generation. Vista will install on-site features that provide 351 tonnes of GHG emission reductions, which is equivalent to 80,000 square feet of photovoltaic panels. Emissions estimates for non-residential buildings were developed from the 2006 Commercial End Use Survey (CEUS), published by the California Energy Commission.

5. Mobile source emissions were calculated using VMT estimate prepared by Fehr & Peers. Mobile source emissions account for residential trips. CO2 emissions were scaled to reflect CO2e emissions based on data from the US Environmental Protection Agency (USEPA).

6. Municipal emissions account for emissions due to energy production associated with water supply, public/street lighting, and municipal vehicles. Energy use estimates for water supply are based primarily on "Refining Estimates of Water-Related Energy Use in California (PIER Final Project Report)", prepared by Navigant Consulting, Inc. (CEC-500-2006-118, December 2006) Emissions from street lighting and municipal vehicles were based upon studies of other cities.

7. Percentages only apply to annual CO_2e emissions; annual and one-time CO_2e emissions cannot be directly compared.

8. One-time emissions (vegetation and construction) are "annualized" in this Total row. This is done by dividing by an annualization factor, 40 years, effectively converting the one-time emission into an annual emission rate. One-time emissions are not annualized in their respective rows above.

9. Transit center emissions include indirect emissions from energy use for structures (parking structure, rail platforms, bus station). Because this center will replace an existing Metrolink station, it was assumed there would be no net new emissions associated with Metrolink train service.
10. Swimming pool emissions are indirect emissions resulting from electricity and natural gas use for the pool filtering and heating systems.

Abbreviations:
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EIA - Energy Information Administration
EIR - Environmental Impact Report
EMFAC - Emission Factors Database
GHG - Greenhouse Gas
N_2O - nitrous oxide
TBD - to be determined
URBEMIS - Urban Emissions Model

Table 4-36
Summary of Greenhouse Gas Emissions for Vista Canyon : Overlay Option
Vista Canyon
Santa Clarita, California

Source	GHG Emissions		Percentage of Annual CO_2e Emissions[7] (%)
Vegetation[1]	tonnes CO_2e total	-105	NA
Construction (Worker commuting and vendor trips)[2]		10,684	NA
Construction (All other construction activities)[2]		9,384	NA
Total (one time emissions)		**19,963**	NA
Residential[3]	tonnes CO_2e / year	3,245	20%
Non-Residential[4]		3,676	22%
Mobile[5]		9,016	55%
Municipal[6]		550	3%
Area		1	0.004%
Transit Center[9]		49	0.3%
Swimming Pools[10]		2	0.01%
Total (annual emissions)		**16,539**	NA
Annualized Total[8]	**tonnes CO_2e / year**	**17,038**	**NA**

Notes:

1. Vegetation emissions are one-time emissions resulting from the removal of existing vegetation and planting of new vegetation. The emissions are estimated assuming that all carbon currently sequestered in the biomass of the vegetation is released to the atmosphere upon removal of the vegetation. Data for emissions calculations are primarily from the Intergovernmental Panel on Climate Change (IPCC) Guildelines for National Greenhouse Gas Inventories.
2. Construction emissions are one-time emissions reported in total metric tonnes during the construction period 2009-2013. Emissions are calculated using URBEMIS default values, EMFAC2007 and engineering judgment. Sources of emissions include construction equipment (on-site activities and soil hauling) and vehicles associated with worker commuting and vendor trips (non-building emissions).
3. Residential emissions for single family and apartment dwelling units include emissions associated with electricity and natural gas use. Emissions estimates were developed from California Residential Appliance Saturation Survey (RASS). As specified by Vista Canyon Ranch, LLC, a total of 1350 dwelling units are considered.
4. Non-Residential emissions account for electricity and natural gas use, minus emissions saved by on-site power generation. Vista will install on-site features that provide 351 tonnes of GHG emission reductions, which is equivalent to 80,000 square feet of photovoltaic panels. Emissions estimates for non-residential buildings were developed from the 2006 Commercial End Use Survey (CEUS), published by the California Energy Commission.
5. Mobile source emissions were calculated using VMT estimate prepared by Fehr & Peers. Mobile source emissions account for residential trips. CO2 emissions were scaled to reflect CO2e emissions based on data from the US Environmental Protection Agency (USEPA).
6. Municipal emissions account for emissions due to energy production associated with water supply, public/street lighting, and municipal vehicles. Energy use estimates for water supply are based primarily on "Refining Estimates of Water-Related Energy Use in California (PIER Final Project Report)", prepared by Navigant Consulting, Inc. (CEC-500-2006-118, December 2006) Emissions from street lighting and municipal vehicles were based upon studies of other cities.
7. Percentages only apply to annual CO_2e emissions; annual and one-time CO_2e emissions cannot be directly compared.
8. One-time emissions (vegetation and construction) are "annualized" in this Total row. This is done by dividing by an annualization factor, 40 years, effectively converting the one-time emission into an annual emission rate. One-time emissions are not annualized in their respective rows above.
9. Transit center emissions include indirect emissions from energy use for structures (parking structure, rail platforms, bus station). Because this center will replace an existing Metrolink station, it was assumed there would be no net new emissions associated with Metrolink train service.
10. Swimming pool emissions are indirect emissions resulting from electricity and natural gas use for the pool filtering and heating systems.

Abbreviations:
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EIA - Energy Information Administration
EIR - Environmental Impact Report
EMFAC - Emission Factors Database
GHG - Greenhouse Gas
N_2O - nitrous oxide
URBEMIS - Urban Emissions Model

Table 4-37
Summary of Greenhouse Gas Emissions for Vista Canyon: Annexation Area
Vista Canyon
Santa Clarita, California

Source	GHG Emissions		Percentage of Annual CO_2e Emissions (%)
Residential[1]	tonnes CO_2e / year	550	15%
Non-Residential[2]		1,963	54%
Municipal[3]		116	3%
Area		1	0.024%
Mobile		1,002	28%
Total (annual emissions)		**3,632**	NA

Notes:

1. Residential emissions for single family dwelling units include emissions associated with electricity and natural gas use. Emissions estimates were developed from California Residential Appliance Saturation Survey (RASS). A total of 150 dwelling units are considered.

2. Non-Residential emissions account for electricity and natural gas use, minus emissions saved by on-site power generation. Emissions estimates for non-residential buildings were developed from the 2006 Commercial End Use Survey (CEUS), published by the California Energy Commission.

3. Municipal emissions account for emissions due to energy production associated with water supply, public/street lighting, and municipal vehicles. Energy use estimates for water supply are based primarily on "Refining Estimates of Water-Related Energy Use in California (PIER Final Project Report)", prepared by Navigant Consulting, Inc. (CEC-500-2006-118, December 2006) Emissions from street lighting and municipal vehicles were based upon studies of other cities.

Abbreviations:
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EIA - Energy Information Administration
EIR - Environmental Impact Report
EMFAC - Emission Factors Database
GHG - Greenhouse Gas
N_2O - nitrous oxide
TBD - to be determined
URBEMIS - Urban Emissions Model

Table 5-1
GHG Emissions in Context: Supporting Calculations
Vista Canyon
Santa Clarita, California

	Tonnes / Year	%
2004 World Emissions	2.68E+10	0.00006%
2004 USA Emissions	7.00E+09	0.0002%
2004 CA Emissions	4.80E+08	0.0033%
Total Project Annual Emissions	1.59E+04	

BAU Projected 2020 CO_2e emissions	5.96E+08	tonnes
CA 1990 CO_2e emissions	4.27E+08	tonnes
Difference	1.69E+08	tonnes
% reduction / increase	28%	%
CA 2020 population	4.22E+07	people
1990 emissions / 2020 population	10.1	tonnes / capita

Vista Canyon Population	3,463

	Tonnes CO_2 / year	Tonnes / capita / year
Vista Canyon Mobile Emissions	7,460	2.2
Vista Canyon Residential Emissions	2,728	0.8
Vista Canyon Municipal Emissions	468	0.1
Vista Canyon Mobile + Residential + Municipal	10,656	3.1
Vista Canyon Total Annualized Emissions	15,892	4.6

Table 5-2a
CARB 2020 NAT GHG Emissions from Residential Building Energy Use
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title-24 Systems			Title-24 Systems and Major Appliances			Title-24 Systems and All MELs		
			CO_2 Emission Factor	Total CO_2 Emissions		CO_2 Emission Factor	Total CO_2 Emissions		CO_2 Emission Factor	Total CO_2 Emissions	
			(tonne CO_2 / DU / year)	(tonne CO_2 / year)		(tonne CO_2 / DU / year)	(tonne CO_2 / year)		(tonne CO_2 / DU / year)	(tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant (CARB 2020 NAT)	**Multi-family**	579	1.7	996	**2,148**	2.4	1,362	**2,908**	2.8	1,595	**3,413**
	Single family	106	2.6	274		3.4	363		4.0	429	
	Town Home	432	2.0	878		2.7	1,184		3.2	1,390	
20% Better Than 2008 Title 24 and Energy Star Appliances	**Multi-family**	579	1.3	733	**1,572**	1.8	1,068	**2,262**	2.2	1,283	**2,728**
	Single family	106	1.8	194		2.6	273		3.2	334	
	Town Home	432	1.5	645		2.1	921		2.6	1,111	
Percentage Improvement over 2005 Title 24 (CARB 2020 NAT)	**Multi-family**	579	26%	26%	**27%**	22%	22%	**22%**	20%	20%	**20%**
	Single family	106	29%	29%		25%	25%		22%	22%	
	Town Home	432	27%	27%		22%	22%		20%	20%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Vista Canyon Ranch, LLC.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2 - carbon dioxide
DU - Dwelling Unit
MEL - Miscellaneous electric loads
RPS - Renewable Portfolio Standards

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 5-2b
CARB 2020 NAT GHG from Residential Building Energy Use: Overlay Option
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Housing Type	# Dwelling Units[2]	Title-24 Systems			Title-24 Systems and Major Appliances			Title-24 Systems and All MELs		
			CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)		CO_2 Emission Factor (tonne CO_2 / DU / year)	Total CO_2 Emissions (tonne CO_2 / year)	
Minimally 2005 Title 24 Compliant (CARB 2020 NAT)	**Multi-family**	812	1.7	1,396	**2,549**	2.4	1,910	**3,456**	2.8	2,236	**4,055**
	Single family	106	2.6	274		3.4	363		4.0	429	
	Town Home	432	2.0	878		2.7	1,184		3.2	1,390	
20% Better Than Title 2008 24 and Energy Star Appliances	**Multi-family**	812	1.3	1,029	**1,868**	1.8	1,498	**2,692**	2.2	1,800	**3,245**
	Single family	106	1.8	194		2.6	273		3.2	334	
	Town Home	432	1.5	645		2.1	921		2.6	1,111	
Percentage Improvement over CARB 2020 NAT	**Multi-family**	812	26%	26%	**27%**	22%	22%	**22%**	20%	20%	**20%**
	Single family	106	29%	29%		25%	25%		22%	22%	
	Town Home	432	27%	27%		22%	22%		20%	20%	

Notes:
1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Vista Canyon Ranch, LLC.

Abbreviations:
CO_2 - carbon dioxide
DU - Dwelling Unit
MEL - Miscellaneous electric loads
RPS - Renewable Portfolio Standards

Sources:
California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 5-3a
CARB 2020 NAT GHG Emissions from Non-Residential Building Energy Use
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Related Area[4] (SF)	Annual Area Emission Factor (Tonne CO_2e / SF / year)[5]: 2005 Title 24 Compliant (CARB 2020 NAT)	Annual Area Emission Factor (Tonne CO_2e / SF / year)[5]: 20% Better than 2008 Title 24	Total Annual CO_2e Emissions (CARB 2020 NAT) (Tonne CO_2e / year)[6]: 2005 Title 24 Compliant (CARB 2020 NAT)		2008 Title 24 Compliant		20% Better than 2008 Title 24		Total Annual CO2e Emissions (Project): 20% Better than 2008 Title 24 and On-Site Emission Savings[7]	Percent CO_2e Reductions over 2005 Title 24 (CARB 2020 NAT)
General Office	646,000	Administrative/professional office	50%	323,000	5.04E-03	3.91E-03	1,628		1,461		1,264			
		Mixed-use office	50%	323,000	5.00E-03	3.89E-03	1,614		1,448		1,257			
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000	1.60E-02	1.36E-02	241		219		204			
Retail - Other than Mall	79,000	Other retail	50%	39,500	6.96E-03	5.47E-03	275		248		216			
		Retail store	50%	39,500	3.18E-03	2.50E-03	126	**6,308**	113	**5,692**	99	**5,003**	**4,652**	**26%**
Food Service	39,000	Restaurant/cafeteria	50%	19,500	2.19E-02	1.82E-02	427		392		355			
		Fast food	50%	19,500	3.90E-02	3.30E-02	760		696		644			
Lodging	140,000	Hotel	100%	140,000	6.41E-03	5.02E-03	897		812		702			
Public Assembly	31,000	Entertainment/culture	100%	31,000	1.10E-02	8.43E-03	340		304		261			

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON mapped each Vista Canyon building type to an EIA.
3. The percentage of each Vista Canyon building type assigned to each of the EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly.
4. The product of the area of the Vista Canyon building type and the percentage of each subcategory.
5. Emissions per square foot per year as calculated in Table 4-19.
6. Emissions for each building type are calculated as emissions per square foot times square footage.
7. Vista Canyon Ranch, LLC plans to install on-site mitigation systems that provide greenhouse gas reductions equivalent to the emission savings from 80,000 square feet of solar panels.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
SF - Square Feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 5-3b
CARB 2020 NAT GHG Emissions from Non-Residential Building Energy Use: Overlay Option
Vista Canyon
Santa Clarita, California

General Building Type[1]	Area[1] (SF)	EIA Building Category[2]	% Area[3]	Related Area[4] (SF)	Total Annual CO_2e Emissions (CARB 2020 NAT): 2005 Title 24 Compliant (CARB 2020 NAT) (Tonne CO_2e / year)[5]		Total Annual CO_2e Emissions (CARB 2020 NAT): 20% Better than 2008 Title 24 (Tonne CO_2e / year)[5]		Total Annual CO_2e Emissions (Project): 20% Better than 2008 Title 24 and On-site Emission Savings[6] (Tonne CO_2e / year)[5]	Percent CO_2e Reductions over CARB 2020 NAT
General Office	396,000	Administrative/professional office	50%	198,000	998	**5,054**	775	**4,027**	**3,676**	**27%**
		Mixed-use office	50%	198,000	989		771			
Retail - Grocery Store	15,000	Grocery store/food market	100%	15,000	241		204			
Retail - Other than Mall	79,000	Other retail	50%	39,500	275		216			
		Retail store	50%	39,500	126		99			
Food Service	39,000	Restaurant/cafeteria	50%	19,500	427		355			
		Fast food	50%	19,500	760		644			
Lodging	140,000	Hotel	100%	140,000	897		702			
Public Assembly	31,000	Entertainment/culture	100%	31,000	340		261			

Notes:
1. Building types and areas provided by Vista Canyon Ranch, LLC.
2. Building types used in EIA 2003 Commercial Buildings Energy Consumption Survey (CBECS) databases. ENVIRON mapped each Vista Canyon Ranch building type to an EIA category.
3. The percentage of each Vista Canyon building type assigned to each of the EIA categories. ENVIRON assumed an equal split when multiple EIA categories were assigned except for public assembly.
4. The product of the area of the Vista Canyon building type and the percentage of each subcategory.
5. Emissions for each building type are calculated as emissions per square foot times square footage.
6. Vista will install on-site features that provide 351 tonnes of GHG emission reductions, which is equivalent to 80,000 square feet of photovoltaic panels.

Abbreviations:
CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CO_2e - Carbon dioxide equivalent
EIA - Energy Information Administration
SF - Square Feet
Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.

Sources:
US Energy Information Administration. 2003 Commercial Buildings Energy Consumption Survey: http://www.eia.doe.gov/emeu/cbecs/contents.html

Table 5-4a
CARB 2020 NAT GHG Emissions from Vehicles for the Year 2020
Vista Canyon
Santa Clarita, California

Trip Type[1]		Daily One-Way Trips[2]		Trip Distance[4]	Daily Adjusted VMT (miles)	Annual Adjusted VMT (miles)	Emission Factor Running (g/mile)[5]	Emission Factor Starts (g/start)[6]	Annual CO_2 Emissions Running (tonne)	Annual CO_2 Emissions Starts (tonne)	Total Annual CO_2 Emissions (tonne)	Total Annual CO_2e Emissions (tonne)[7]
		Unadjusted	Weekend/Weekday Adjustment[3]	(miles)								
Internal	Home Based Work	281	265	0.31	81	29,583	353	114	10	11	21	23
	Home Based Other	484	456	0.31	140	50,948			18	19	37	39
Total Internal Resident Trips		*765*	*721*			*80,530*			*28*	*30*	*58*	*62*
External	Home Based Work	1,592	1,501	24	36,742	13,410,759	385	114	5,169	62	5,231	5,506
	Home Based Other	4,354	4,105	7	30,150	11,004,711			4,241	171	4,412	4,644
Total External Resident Trips		*5,945*	*5,606*		0	*24,415,469*			*9,410*	*233*	*9,643*	*10,151*
Total Non-Home Based Trips (offsite)		*1,092*	*1,030*	*7*	7,564	*2,761,039*	385	114	*1,064*	*43*	*1,107*	*1,165*
Totals		**7,802**	**7,356**		74,677	**27,257,038**			**10,503**	**306**	**10,809**	**11,378**

Notes:

1. The trip type distribution is based on data provided by Fehr & Peers. The distribution of internal to external trips for each trip type is the following:

Trip Type	Internal	External	Proportion of Total Home Based Trips
Home Based Work	15%	85%	28%
Home Based Other	10%	90%	72%

2. Total weekday daily one-way trips data was provided by Fehr & Peers.

3. Daily trips were adjusted to account for differences between weekend and weekday traffic, based on a report by Sonoma Technology. The weekend traffic (internal) was assumed to be 80% of weekly capacity. The weekend traffic (external) was assumed to be 80% of weekly capacity. There has been no weekend adjustment made for mode shifts.

4. CARB 2020 NAT trip distances were increased by approximately 22% relative to the project scenario, to reflect an overall increase in VMT per dwelling unit from 58 to 71 miles per day. According to Fehr & Peers the adjusted

VMT reflects the specifications in Santa Clarita's One Valley One Vision development plan, which excludes the transit center and non-residential land uses of the current project plan. ENVIRON assumed the same number of trips for the CARB 2020 NAT and project scenarios.

5. Emission factors for vehicles based on EMFAC files for 2020, based on LDA, LDT1, LDT2, MDV, and MCY for Los Angeles County. Speeds of 35 miles per hour for internal trips and 60 miles per hour for external trips and non-home based trips were used to determine emission factors. No reduction in the emission factor was taken for any regulatory programs.

6. Starting emission factors are based on the weighted average distribution of time between trip starts based on URBEMIS defaults.

7. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions on a CO_2e basis.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

References:

Fehr&Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. May 15.
NCHRP Report 365. 1998. Travel Estimation Techniques for Urban Planning.
Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

Table 5-4b
CARB 2020 NAT GHG Emissions from Vehicles for the Year 2020: Overlay Option
Vista Canyon
Santa Clarita, California

Scenario[1]	Number of Dwelling Units	Daily Adjusted VMT (miles)	Annual Adjusted VMT (miles)	Annual CO_2 Emissions Running (tonne)	Annual CO_2 Emissions Starts (tonne)	Total AnnualCO_2 Emissions (tonne)	Total Annual CO_2e Emissions (tonne)[3]
Project	1,117	74,677	27,257,038	10,503	306	10,809	11,378
Overlay[2]	1,350	90,254	32,942,705	12,693	370	13,063	**13,751**

Notes:
1. The Project scenario and Overlay scenario differ by the number of dwelling units and square footage of office space.
2. For the overlay option it was assumed that all residential mobile source parameters (vehicle miles traveled per dwelling unit, trip length, trip types) were the same as for the project scenario. The estimates presented in this row were scaled from the project scenario based on the number of dwelling units. Thus, VMT and emissions for the project scenario were multiplied by a factor of (1350/1117) to generate estimates for the overlay scenario.

3. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions on a CO_2e basis.

Abbreviations:
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

References:
Fehr and Peers. 2009. Draft Transportation Impact Study for Vista Canyon Transit-Oriented Development. May 15.
NCHRP Report 365. 1998. Travel Estimation Techniques for Urban Planning.
Sonoma Technology, Inc. 2004. Correction and Analysis of Weekend/Weekday Emissions Activity Data in the South Coast Air Basin. May.

Table 5-5a
CARB 2020 NAT GHG Emissions from Municipal Sources
Vista Canyon
Santa Clarita, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity	Units	Total CO_2e Emissions [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	149	kW-hr/capita/yr	0.043	tonne CO_2e/capita/year	3,463	residents (capita)	147
						Public Lighting Total:	**147**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	3,463	residents (capita)	173
						Municipal Vehicles Total:	**173**
Water and Wastewater [12, 13]							
Groundwater Supply and Conveyance (Potable)[4,5]	2,915	kW-hr/million gallons	0.83	tonne / million gallons	46	million gallons/year	38
State Water Project Supply and Conveyance (Potable)[4,6]	9,931	kW-hr/million gallons	2.84	tonne / million gallons	71	million gallons/year	203
Water Treatment (Potable)[7]	111	kW-hr/million gallons	0.03	tonne / million gallons	117	million gallons/year	4
Water Distribution (Potable)[8]	1,272	kW-hr/million gallons	0.36	tonne / million gallons	117	million gallons/year	43
On-site Wastewater Treatment (Indirect Emissions)[9, 10]	2,011	kW-hr/million gallons	0.58	tonne / million gallons	133	million gallons/year	76
Recycled Water Distribution (Non-Potable)[11]	2,100	kW-hr/million gallons	0.60	tonne / million gallons	1	million gallons/year	1
						Water and Wastewater Total:	**364**
						Municipal Sources Total:	**685**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor.

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN (Skoog, 2001) and the electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emissions for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. The Castaic Lake Water Agency (CLWA) - Santa Clarita Water Division (SCWD) provides water to Vista Canyon Ranch. Water supply and conveyance is based on two different sources: State Water Project and local groundwater.
According to the 2008 Water Requirements and Supplies report, 61% of the water supply to Vista Canyon is from the State Water Supply, and the remaining 39% is from local groundwater.

5. Emission factor for groundwater supply and conveyance is based on information provided in the 2005 CEC report and the electricity generation emission factor from Southern California Edison.

6. Emission factor for the State Water Project is based on information provided by Wilkinson 2000 and the electricity generation emission factor from Southern California Edison.

7. Emission factor for water treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for water distribution is based on a 2006 Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

9. An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of a CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory.

10. According to Dexter Wilson Engineering Inc., there will be no direct emissions of methane or nitrous oxide from the wastewater treatment plant.

11. Emission factor for recycled water distribution is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. ENVIRON used the average of the range of emission factors presented in the report. ENVIRON assumed that the recycled water demand is 1.1% of the total water demand - see Note 13 for more details.

12. Source quantities for water and wastewater are based on the Engineering Report for the Vista Canyon Water Factory.

13. For this calculation, ENVIRON assumed that the recycled water demand is 1.1% of the total water demand, which is the fraction of recycled water in the 2008 Santa Clarita water supply. No recycled water is sent off-site in the CARB 2020 NAT scenario.
The potable water demand was adjusted to give a total water demand of 363,151 gallons/day, consistent with the design of Vista Canyon.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kW-hr - kilowatt hour
MW-hr - megawatt hour
USEPA - United States Environmental Protection Agency

Sources:

California Climate Action Registry (CCAR) Database. Southern California Edison Annual Emissions Report. 2008.
California Energy Commission. 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.
City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf
City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf
Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissions.pdf
USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf
Wilkinson, Robert. 2000. Methodology for Analysis of the Energy Intensity of California's Water Systems, and An Assessment of Multiple Potential Benefits through Integrated Water-Energy Efficiency Measures.
CLWA Santa Clarita Water Division. 2008. Water Requirements and Supplies. http://www.clwa.org/about/pdfs/2008WaterRequirementsadSupplies.pdf
Dexter Wilson Engineering, Inc. 2009. Engineering Report for the Vista Canyon Water Factory. July.

Table 5-5b
CARB 2020 NAT GHG Emissions from Municipal Sources: Overlay Option
Santa Clarita, California

Source[1]	Energy Requirements	Units	Emission Factor	Units	Source Quantity	Units	Total CO_2e Emissions [Tonne CO_2e per year]
Lighting							
Public Lighting[2]	149	kW-hr/capita/yr	0.043	tonne CO_2e/capita/year	4,185	residents (capita)	178
						Public Lighting Total:	**178**
Municipal Vehicles							
Municipal Vehicles[3]	--	--	0.05	tonne CO_2e/capita/year	4,185	residents (capita)	209
						Municipal Vehicles Total:	**209**
Water and Wastewater [12, 13]							
Groundwater Supply and Conveyance (Potable)[4,5]	2,915	kW-hr/million gallons	0.83	tonne / million gallons	48	million gallons/year	40
State Water Project Supply and Conveyance (Potable)[4,6]	9,931	kW-hr/million gallons	2.84	tonne / million gallons	75	million gallons/year	212
Water Treatment (Potable)[7]	111	kW-hr/million gallons	0.03	tonne / million gallons	122	million gallons/year	4
Water Distribution (Potable)[8]	1,272	kW-hr/million gallons	0.36	tonne / million gallons	122	million gallons/year	45
On-site Wastewater Treatment (Indirect Emissions)[9,10]	2,011	kW-hr/million gallons	0.58	tonne / million gallons	128	million gallons/year	73
Recycled Water Distribution (Non-Potable)[11]	2,100	kW-hr/million gallons	0.60	tonne / million gallons	1	million gallons/year	1
						Water and Wastewater Total:	**375**
						Municipal Sources Total:	**762**

Notes:

1. Public Lighting includes streetlights, traffic signals, area lighting and lighting municipal buildings. Emissions from the Water and Wastewater category are primarily due to the energy required for supply, treatment and distribution. GHG emissions attributed to electricity use are calculated using the Southern California Edison carbon-intensity factor.

2. Emission factor for public lighting is based on a study of energy usage and GHG emissions from Duluth, MN (Skoog, 2001) and the electricity generation emission factor from Southern California Edison.

3. Emission factors for municipal vehicles are based on the most conservative number from studies of GHG emissions for four cities of different sizes: Medford, MA; Duluth, MN; Northampton, MA; and Santa Rosa, CA. Population data provided by the US Census (2000).

4. The Castaic Lake Water Agency (CLWA) - Santa Clarita Water Division (SCWD) provides water to Vista Canyon. Water supply and conveyance is based on two different sources: State Water Project and local groundwater. According to the 2008 Water Requirements and Supplies report, 61% of the water supply to Vista Canyon Ranch is from the State Water Supply, and the remaining 39% is from local groundwater.

5. Emission factor for groundwater supply and conveyance is based on information provided in the 2005 CEC report and the electricity generation emission factor from Southern California Edison.

6. Emission factor for the State Water Project is based on information provided by Wilkinson 2000 and the electricity generation emission factor from Southern California Edison.

7. Emission factor for water treatment is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

8. Emission factor for water distribution is based on a 2006 Navigant Consulting refinement of a CEC study on the energy necessary to distribute 1 million gallons of treated water and the Southern California-specific electricity generation emission factor from Southern California Edison. This factor is applied to potable water demand.

9. An emission factor of 1,911 kWh/million gallons for wastewater treatment is based on information provided in the 2006 Navigant Consulting refinement of a CEC study and the electricity generation emission factor from Southern California Edison. An emission factor of 100 kWh/million gallons is also included to account for the energy used in UV disinfection of wastewater, which is specified in the Engineering Report for the Vista Canyon Water Factory.

10. According to Dexter Wilson Engineering Inc., there will be no direct emissions of methane or nitrous oxide from the wastewater treatment plant.

11. Emission factor for recycled water distribution is based on information provided in the 2006 Navigant Consulting refinement of the 2005 CEC study and the electricity generation emission factor from Southern California Edison. ENVIRON used the average of the range of emission factors presented in the report. ENVIRON assumed that the recycled water demand is 1.1% of the total water demand - see Note 13 for more details.

12. Source quantities for water and wastewater are based on the Engineering Report for the Vista Canyon Water Factory.

13. For this calculation, ENVIRON assumed that the recycled water demand is 1.1% of the total water demand, which is the fraction of recycled water in the 2008 Santa Clarita water supply. No recycled water is sent off-site in the CARB 2020 NAT scenario.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken
CEC - California Energy Commission
CO_2e - carbon dioxide equivalent
GHG - greenhouse gas
kW-hr - kilowatt hour
MW-hr - megawatt hour
USEPA - United States Environmental Protection Agency

Sources:

California Climate Action Registry (CCAR) Database. Southern California Edison Annual Emissions Report. 2008.
California Energy Commission. 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
California Energy Commission. 2006. Refining Estimates of Water-Related Energy Use in California. PIER Final Project Report. Prepared by Navigant Consulting, Inc. CEC-500-2006-118. December.
City of Medford. 2001. Climate Action Plan. October. http://www.massclimateaction.org/pdf/MedfordPlan2001.pdf
City of Northampton. 2006. Greenhouse Gas Emissions Inventory. Cities for Climate Protection Campaign. June. http://www.northamptonma.gov/uploads/listWidget/3208/NorthamptonInventoryClimateProtection.pdf
City of Santa Rosa. Cities for Climate Protection: Santa Rosa. http://ci.santa-rosa.ca.us/City_Hall/City_Manager/CCPFinalReport.pdf
Skoog., C. 2001. Greenhouse Gas Inventory and Forecast Report. City of Duluth Facilities Management and The International Council for Local Environmental Initiatives. October.http://www.ci.duluth.mn.us/city/information/ccp/GHGEmissions.pdf
USEPA. 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. #430-R-07-002. April. http://epa.gov/climatechange/emissions/downloads06/07Waste.pdf

Table 5-6a
GHG Emissions Comparison of CARB 2020 NAT to Vista Canyon
Vista Canyon
Santa Clarita, California

Source	**CARB 2020 NAT**	**Vista Canyon Ranch**[7]	**Percentage Improvement over CARB 2020 NAT**[1]
	GHG Emissions (tonnes CO_2e / year)		**(%)**
Vegetation	-105	-105	0%
Construction	21,397	21,397	0%
Total (one-time emissions)	**21,292**	**21,292**	**0%**
Residential[2]	3,413	2,728	20%
Non-Residential[3]	6,308	4,652	26%
Total Transportation[4]	11,378	7,509	34%
Mobile	*11,378*	*7,460*	--
Transit Center	*0*	*49*	--
Municipal[5]	685	468	32%
Area	1	1	--
Swimming Pools	2	2	--
Total (annual emissions)	**21,787**	**15,360**	**29.5%**
Annualized Total[6]	**22,319**	**15,892**	**28.8%**

Notes:

1. The percentage improvement over CARB 2020 NAT is an estimate. There are some source categories where appropriate comparisons are available. It is estimated that this value is conservative.

2. CARB 2020 NAT residential emissions reflect minimally 2005 Title-24 compliant homes without Energy Star appliances.

3. Project scenario assumes 20% improvement over 2008 Title 24 and 351 tonnes GHG reduction from on-site rooftop energy systems. CARB 2020 NAT non-residential emissions reflect minimally 2005 Title-24 compliant buildings and no GHG emission reductions from on-site energy systems.

4. CARB 2020 NAT scenario for transportation assumes no transit center and a VMT of 71 miles per dwelling unit per day, based on Fehr and Peers' analysis of a scenario where no non-residential land uses and no public transit center are present.

5. Municipal emissions included here are related to water treatment, waste water treatment, street lighting, and municipal vehicles. The CARB 2020 NAT scenario assumes that no recycled water will be used onsite or sent for use offsite.

6. One-time emissions are annualized over 40 years and then added to the total annual emissions.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken

Table 5-6b
GHG Emissions Comparison of CARB 2020 NAT to Vista Canyon: Overlay Option
Vista Canyon
Santa Clarita, California

Source	**CARB 2020 NAT**	**Vista Canyon**	**Percentage Improvement over CARB 2020 NAT [1]**
	GHG Emissions (tonnes CO_2e / year)		**(%)**
Vegetation	-105	-105	0%
Construction	20,069	20,069	0%
Total (one-time emissions)	**19,963**	**19,963**	**0%**
Residential[2]	4,055	3,245	20%
Non-Residential[3]	5,054	3,676	27%
Total Transportation[4]	13,751	9,065	34%
Mobile	*13,751*	*9,016*	--
Transit Center	*0*	*49*	--
Municipal[5]	762	550	28%
Area	1	1	--
Swimming Pools	2	2	--
Total (annual emissions)	**23,625**	**16,539**	**30.0%**
Annualized Total[6]	**24,124**	**17,038**	**29.4%**

Notes:

1. The percentage improvement over CARB 2020 NAT is an estimate. There are some source categories where appropriate comparisons are available. It is estimated that this value is conservative.

2. CARB 2020 NAT residential emissions reflect minimally 2005 Title-24 compliant homes without Energy Star appliances.

3. CARB 2020 NAT non-residential emissions reflect minimally 2005 Title-24 compliant buildings and no GHG emission reductions from on-site energy systems.

4. CARB 2020 NAT scenario for transportation assumes no transit center and a VMT of 71 miles per dwelling unit per day, based on Fehr and Peers' analysis of a scenario where no non-residential land uses and no public transit center are present.

5. Municipal emissions included here are related to water treatment, waste water treatment, street lighting, and municipal vehicles. The CARB 2020 NAT scenario assumes that no recycled water will be used onsite or sent for use offsite.

6. One-time emissions are annualized over 40 years and then added to the total annual emissions.

Abbreviations:

CARB 2020 NAT - California Air Resources Board 2020 No Action Taken

Life Cycle Greenhouse Gas Emissions from Building Materials

Prepared for:
Impact Sciences
Camarillo, California

Prepared by:
ENVIRON International Corporation
San Francisco, California

Date:
January 4, 2010

Project Number:
0321288A

Contents

Acronyms

AP-42	Compilation of Air Pollutant Emission Factors
$CaCO_3$	limestone
CaO	calcium oxide
CCAR	California Climate Action Registry
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
ENVIRON	ENVIRON International Corporation
ft^2	square feet
GHG	greenhouse gas
GRP	General Reporting Protocol
kWh/m^2	kilowatt hour per square meter
LCA	life cycle analyses
VC	Vista Canyon
MMBTU	million British thermal units

EXECUTIVE SUMMARY

This report evaluates the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of the Vista Canyon (VC) development. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. This report then compares the life cycle GHG emissions to the overall annual operational emissions of VC. The materials analyzed in this report include materials for 1) residential and non-residential buildings and 2) site infrastructure. This report calculates the overall life cycle emissions from construction materials to be 46 to 87 tonnes per year, or 0.29% to 0.54% of the overall VC project emissions.

ENVIRON estimated the life cycle GHG emissions for buildings by conducting an analysis of available literature on life cycle analyses (LCA) for buildings. According to these studies, approximately 75 - 97% of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 - 25% of the GHG emissions are due to material manufacture and transport. Using the GHG emissions from the operation of VC buildings, 3% to 25% corresponds to 6 to 46 tonnes CO_2 per year or 0.03 – 0.29% of VC project emissions.

ENVIRON calculated the life cycle GHG emissions for infrastructure (roads, storm drains, utilities, gas, electricity, cable) to be equal to a one time emission of 1,616 tonnes CO_2. This analysis considered the manufacture and transport of concrete and asphalt. Based on this analysis, the manufacture of the materials leads to 1,053 tonnes of emissions, and the transport of the materials leads to 563 tonnes of CO_2 emissions. Although VC estimates the need for volume of asphalt approximately three times higher than that of concrete, the majority of the emissions for infrastructure result from the manufacture of concrete because of the higher CO_2 emission factor associated with this process. If a 40-year lifespan of the infrastructure is assumed, the total annualized emissions are 40 tonnes per year or 0.25% of VC project emissions.

The overall life cycle emissions from embodied energy in VC building materials, annualized by 40 years, are 46 to 87 tonnes CO_2 per year. This represents 0.29% to 0.54% of the annualized GHG emissions from the VC project. The bulk of these emissions are based on general life cycle analysis studies and do not reflect the design features of VC. Aspects of the project will tend to drive the life cycle emissions towards the lower end of the range; one example is the emphasis on the use of local construction materials.

1 Introduction

This report evaluates the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of the VC development. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. This report then compares the life cycle GHG emissions to the overall annual operational emissions of VC. The materials analyzed in this report include materials for 1) residential and non-residential buildings and 2) site infrastructure.

1.1 Background on Life Cycle Analysis

LCA is a method developed to evaluate the mass balance of inputs and outputs of systems and to organize and convert those inputs and outputs into environmental themes or categories. In this case, the LCA is related to GHG emissions associated with the different stages of a life cycle. The LCA field is still relatively new, and while there are general standards for goals and general practices for LCAs[1] the specific methodologies and, in particular, the boundaries chosen for the LCA makes inter-comparison of various studies difficult. Simple choices such as the useful life of a building or road, for example, can change the LCA outcome substantially. Additionally, the geographic location, climatic zone and building type significantly influence patterns of energy consumption (and energy efficiency) and therefore determine life cycle GHG emissions, which makes comparisons among different studies difficult.

The calculations and results presented in this report are estimates and should be used only for a general comparison to the overall GHG emissions estimated in the Climate Change Section of the Draft EIR for VC. LCA emissions vary based on input assumptions and assessment boundaries (e.g., how far back to trace the origin of a material). Assumptions made in this report are generally conservative. However, due to the open-ended nature of LCAs, the analysis is not exact and may be highly uncertain.

2 Emissions Estimates

2.1 Life Cycle GHG Emissions from Building Materials

ENVIRON estimated the life cycle GHG emissions for building materials by conducting an analysis of available literature on life cycle analyses (LCA) for buildings. According to these studies, approximately 75 - 97% of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 - 25% of the GHG emissions are due to building material manufacture and transport. Based on the GHG emissions from the operation of VC buildings[2], 3% to 25% corresponds to 221 to 1,845 tonnes CO_2 per year, as shown in Table 1. The specific LCA studies used are discussed in the next section.

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[1] ISO 14044 and ISO 14040

[2] Climate Change Technical Report: Vista Canyon. January 2010.

With the current energy generation mix in the US which relies heavily on fossil fuel based sources, focusing on energy efficiency measures (which ultimately reduces lifetime GHG emissions) is more effective in reducing the overall GHG footprint than focusing on materials with low embodied energy. As the energy generation measures reduce their GHG intensity (shift away from fossil fuel to renewable fuels), material selection will be a more critical factor in a building's GHG emissions over its life cycle.

2.1.1 LCA Studies for Buildings

The LCA literature studies tend to compare the energy used to make and transport building materials, or the embodied energy, with the operational energy use. In this manner, the relative importance of the embodied energy can be assessed. ENVIRON discusses several studies that compare the embodied energy and the operational energy.

A life cycle assessment of a 66,000 ft^2 sustainably-designed university building[3] in the US Mid-west[4] estimated that the GHG emissions associated with its energy use over a 100-year time horizon to be 135,000 metric tonnes of carbon dioxide equivalent (CO_2e), 96.5% of which result from operations phase activities, 3% from material production (of which ⅓ is cement production) and 0.5% from transportation and decommissioning combined. The study also notes that the GHG emissions closely matches the distribution of life cycle energy distributions, indicating that operational energy requirements are the key factor determining overall GHG emissions, especially when considering fossil fuel based energy generation. This building has a longer estimated life than VC buildings, which would lead to a lower comparison of embodied energy to operational energy.

A study of single-family homes in the US Mid-west,[5] one built using standard construction techniques and the second incorporating energy efficiency measures, reached similar conclusions. Over the life cycle of the homes (assumed to be 50 years), the conventional home uses 15,000 MMBTU and the energy efficient configuration uses 6,000 MMBTU of energy, representing a 60% reduction in overall energy. As GHG emissions closely match the distribution of life cycle energy distributions, the energy efficient variant resulted in 63% fewer emissions. Of the total energy use over the structure's life cycle, 91% of the conventional house total energy results from energy consumed in the use stage (e.g., operating energy). This value drops to 74% in the energy efficient home as the energy embodied in the building materials stays the same or is slightly higher than that in the conventional home and operating energy is reduced.

[3] Includes 4 floors of classroom and open-plan offices and 3 floors of hotel rooms, in this evaluation used as a surrogate for a generic commercial structure.
[4] Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings*, **35**(10): p. 1049.
[5] Keoleian, G.A., S. Blanchard, and P. Reppe. (2000) Life-cycle energy, costs, and strategies for improving a single-family house. *Journal of Industrial Ecology*, **4**(2): p. 135.

Similarly, a review of 60 case studies of homes from nine European countries in a variety of climates[6] indicated that operating energy represents the largest part of energy demand by a building during its life cycle. In one evaluation the operating energy is reported as between 92 - 95% for conventional construction and 72 - 90% for low-energy buildings[7] (which are also consistent with other literature references[8]). Sartori and Hestnes[6] also note that buildings constructed with energy efficiency measures may have a higher energy (and concomitant GHG emissions) embodied by the materials used in construction (e.g., more insulation, higher thermal mass), but over the lifespan of the building the overall energy use (operating and embodied energy) is dramatically lower due to the large reductions in operating energy. As an example, the embodied energy was estimated to be 1171 kWh/m^2 for a conventional house and 1391 kWh/m^2 for a passive, energy efficient home, an increase of 220 kWh/m^2 or 19%. Over the lifetime of the building, however, the total energy (operating and embodied) of the conventional house was approximately 22,500 kWh/m^2, while the passive house was roughly 5,500 kWh/m^2, a four-fold decrease in the total energy over an assumed 80 year life cycle.

2.1.2 Energy Efficiency vs. Embodied Energy in Buildings

From our analysis of these assessments, we note the following major conclusions:

- To minimize GHG lifetime emissions, optimization of energy efficiency (both thermal and electrical) for the operational phase of a building should be the primary emphasis for design, especially when the energy supplied is generated from fossil fuel sources.
- Passive design measures such as the orientation of structure to maximize solar heating and daylighting as well as natural ventilation; heavy construction to increase the thermal mass of the structure with materials that have a high capacity for absorbing heat and change temperature slowly; and solar control like window shading[9] should be emphasized[10,11,12] as they have a negligible increase in embodied energy (GHG emissions from material production) and can reduce total energy substantially.[13]
- Active energy efficiency measures (e.g., mechanical ventilation, artificial cooling, free cooling) may as much as double the embodied energy of the structure, but can halve overall energy usage.

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[6] Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings*, **39**(3): p. 249.

[7] Winther, B.N. and A.G. Hestnes. (1999) Solar versus green: The analysis of a Norwegian row house. *Solar Energy*, **66**(6): p. 387.

[8] Adalberth, K., A. Almgren, and E.H. Petersen. (2001) Life Cycle Assessment of Four Multi-Family Buildings. *International Journal of Low Energy and Sustainable Buildings*, **2**.

[9] United Nations Environment Program 2007 Buildings and Climate Change report whole-house system measures are recommended for the Mediterranean and desert climate zones.

[10] Browning, W.D. and J.J. Romm. (1998) *Greening the Building and the Bottom Line*. Snowmass, Colorado: Rocky Mountain Institute.

[11] United Nations Environment Program. (2007) *Buildings and Climate Change: Status, Challenges and Opportunities.*

[12] US Department of Energy Building Technologies Program. (2007) www.eere.energy.gov/buildings/. October.

[13] Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings*, **39**(3): p. 249.

- With the current energy generation mix in the US which relies heavily on fossil fuel based sources, focusing on energy efficiency measures (which ultimately reduces lifetime GHG emissions) is more effective in reducing the overall GHG footprint than focusing on materials with low embodied energy. As the energy generation measures reduce their GHG intensity (shift away from fossil fuel to renewable), material selection will be a more critical factor in a building's GHG emissions over its life cycle.

One cannot evaluate the life cycle emissions of a building product independent of the impact that the building product has on energy use. For example, studies that evaluate the relative embodied energy and GHG emissions associated with the production of structural materials such as steel, concrete or wood generally indicate that the wood products have the lowest GHG emissions as it is produced from a renewable resource that may actually remove CO_2 during its production phase and sequester it during its use phase.[14,15] However, these studies do not account for the effect of the material on overall building energy efficiency, which is often heavily dependent on the climate in which the building is located. In desert climates, the thermal mass of the structure is important for energy savings, as the thermal mass cools at night and keep the house cool during the day during hot weather and conversely heats during the day keeps the house warm during the evening during cool weather. To increase thermal mass, concrete is much more effective than wood. In other types of climates (cooler with less solar heating), wood with insulation has a greater impact at improving overall building efficiency.

For some building products or systems, the net energy savings during the operational portion of the building's life cycle are comparable. If this is the case, then the alternative with the lowest embodied GHG emissions will result in the lowest life cycle GHG emissions.

Building materials with high replacement rates, like carpeting and wiring, can often have a high contribution to the overall GHG emissions as their impact is dependent on renovation schedules. For example, if two building materials have the same embodied energy but one is replaced every 5 years and the second is replaced every 25 years then the first will have five times the embodied energy over the lifetime of the building. As such Scheuer et al.[16] indicate that "[d]esign strategies that maximize the service life of building materials should be maximized." These strategies include designing the structure for minimal material use and choosing materials with low embodied energy, high recycled content, and long life spans.

From our analysis of these product or system specific assessments, we note the following major conclusions:

- Products or systems which have the greatest impact in improving overall building energy efficiency over the building's life cycle should be selected to minimize life cycle GHG

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14 Borjesson, P. and L. Gustavsson. (2000) Greenhouse gas balances in building construction: Wood versus concrete from life-cycle and forest land-use perspectives. *Energy Policy*, **28**(9): p. 575.

15 Lenzen, M. and G. Treloar. (2002) Embodied energy in buildings: Wood versus concrete - Reply to Borjesson and Gustavsson. *Energy Policy*, **30**(3): p. 249.

16 Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings*, **35**(10): p. 1049.

emissions. These alternatives may not necessarily have the lowest embodied GHG emissions.

- When evaluating products or systems that have similar impacts on overall building energy efficiency, alternatives with the lowest embodied GHG emissions should be selected to minimize GHG emissions.
- Materials with high replacement rates (e.g., carpeting, wiring) tend to have higher embodied energy due to their short life cycle, therefore minimizing embodied GHG emissions is most critical for these types of products or systems to minimize overall GHG emissions. Materials with low replacement rates (e.g., piping, air ducts) tend to have lower embodied energy over the life cycle of the building, therefore differences in overall GHG emissions between several alternatives are likely to be small.

2.2 GHG Emissions from Manufacture of Infrastructure Materials

ENVIRON evaluated the embodied energies of materials likely to be found in the infrastructure (roads, storm drains, utilities, gas, electricity, cable) of the VC development. The embodied energies of different materials vary based upon the transportation distance and manufacturing processes. A material that is locally-sourced may require a large amount of energy to be produced and, on the contrary, a material with a relatively low energy intensity may be sourced from farther away. ENVIRON assumed that concrete and asphalt will be among the dominant materials used in the infrastructure and estimated the embodied energies of these two materials. The manufacture of these materials results in overall CO_2 emissions of 1,053 tonnes. Although asphalt is predicted to be used in higher quantities than concrete, almost 78% of these emissions (818 tonnes) result from the manufacture of concrete because the CO_2 emission factor of concrete is over fifty times that of asphalt.

2.2.1 Embodied Energy in Concrete Production

Concrete is composed primarily of cement, water, and aggregate such as sand and gravel, with small amounts of chemical admixtures. A typical concrete mix contains approximately 15% cement by volume.[17] Because the remaining 85% of concrete is composed of water and aggregate, ENVIRON assumed that all of the manufacture-related embodied energy in concrete stems from the production of cement.

There are two main sources of CO_2 emissions from the production of cement: “calcining” emissions and fossil fuel combustion emissions. Calcining emissions result from the chemical conversion of limestone ($CaCO_3$) to calcium oxide (CaO) and carbon dioxide (CO_2). CaO is a precursor to cement and CO_2 is released to the atmosphere. The emissions from fossil fuel combustion vary based on fuel type, but in general slightly more than half of the emissions

[17] Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp

associated with cement production are attributed to calcining emissions and the remainder result from fossil fuel combustion.[18]

ENVIRON used three sources to estimate CO_2 emission factors for the production of cement. The Energy Information Administration (EIA)[19] and AP-42[20] estimate that 0.5 tonnes of CO_2 are emitted from the calcining process for every 1 tonne of cement produced. AP-42 also provides a range (0.75 – 1.19 tonnes CO_2 / tonne cement) of total CO_2 emission factors (including calcining emissions and fossil fuel combustion emissions). The consulting group Battelle[21] estimates a total CO_2 emission factor for cement production in North America of 0.99 tonnes CO_2 / tonne cement. These emission factors are presented in Table 2.

2.2.2 Embodied Energy in Asphalt Production

The manufacture of asphalt is less energy intensive than the manufacture of cement. Asphalt is composed of asphalt cement and aggregate; the aggregate typically constitutes 92% by weight of the asphalt mixture.[22] AP-42 estimates CO_2 emission factors for batch mix (37 pounds CO_2 / short ton asphalt) and drum mix (33 pounds CO_2 / short ton asphalt) hot mix asphalt plants based on fuel usage within the plants.[23] ENVIRON used the average of these two values to represent the embodied energy of asphalt for VC infrastructure.

2.2.3 Embodied Energy in Infrastructure

ENVIRON used the CO_2 emission factors from cement and asphalt to estimate the embodied energy of the infrastructure materials in the VC development. ENVIRON estimated the projected volumes of virgin concrete and asphalt per acre of development based on past projects and engineering judgment, resulting in the predicted material amounts shown in Table 3. The estimated emissions from the manufacture of the infrastructure materials are presented in Table 4. Because concrete is 15% cement by volume,[24] the total volume of concrete in Table 3 is multiplied by 15% to yield the volume of cement presented in Table 4. The emissions from the cement manufacture are assumed to be equal to the emissions from concrete manufacture. One-time emissions from concrete and asphalt manufacture for infrastructure materials are estimated to be 818 and 235 tonnes CO_2, respectively.

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[18] USGS 2005 Minerals Yearbook: Cement. February 2007. pg 16.1-16.2. http://minerals.usgs.gov/minerals/pubs/commodity/cement/cemenmyb05.pdf

[19] EIA Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. August 2007. http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html

[20] EPA AP42 Section 11.6: Portland Cement Manufacturing. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s06.pdf

[21] Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.

[22] EPA AP42 section 11.1: Hot Mix Asphalt Plants. pg 11.1-1. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf

[23] EPA AP42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf

[24] Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp

2.3 Transportation of Materials for Infrastructure

ENVIRON estimated the emissions from the transportation of the infrastructure. ENVIRON selected distances based on an expected trip distance of local manufacturers of cement and asphalt to the VC development.[25] Using the infrastructure material quantities specified in Table 3, ENVIRON estimated emissions of 563 tonnes CO_2 from the transportation of the concrete and asphalt in the infrastructure.[26] Details of the calculations are outlined in Table 5.

2.3.1 Calculation of Emissions from Transportation of Materials for Buildings

Although each particular shipper operates with greater or lesser efficiencies, ENVIRON assumed an average GHG emission rate per tonne-mile[27] for each mode of transportation. Although it is likely that more dense material has a slightly lower GHG shipping intensity than does less dense material, this analysis developed a single emission factor per tonne-mile of material moved, regardless of density, for each mode of transportation.

2.3.1.1 Emissions associated with transporting the material

Emission factors were calculated from DOE EERE energy intensity indicators.[28] EERE data is presented in terms of energy per mile traveled. These were converted using AP-42 conversion factors[29] for energy in different types of fuel, and California Climate Action Registry (CCAR) General Reporting Protocol (GRP)[30] emission factors for mass of CO_2 emitted per gallon of fuel. Trains and trucks are assumed to run on diesel. These emission factors are listed in Table 5. The emission factors developed above were multiplied by the distances traveled by each type of transportation.

2.4 Summary of Emissions from Buildings and Infrastructure

Table 6 presents the summary of the life cycle greenhouse gas (GHG) emissions associated with the building materials used in the construction of the VC development. The life cycle GHG emissions include the embodied energy from the materials manufacture and the energy used to transport those materials to the site. The materials analyzed include materials for 1) residential and non-residential buildings and 2) site infrastructure. This report calculates the overall life cycle emissions from construction materials to be 46 to 87 tonnes per year, or 0.29 to 0.54% of the overall VC project emissions. Aspects of this project such as the emphasis on the use of local construction materials are expected to drive the life cycle emissions toward the lower end of the range.

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25 The distance for concrete and asphalt assumes the use of a local source 100 miles from Vista Canyon.

26 For the estimates of emissions from material transportation, ENVIRON conservatively assumed that the entire concrete mix, not just cement, is transported from the source locations to the development site.

27 A tonne-mile refers to the amount of material (in tonnes) moved a distance of one mile.

28 Grams CO_2 per tonne-mile. See http://intensityindicators.pnl.gov/trend_data.stm Transportation sector data.

29 AP-42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

30 The GRP is available online at http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

Table 1
Life Cycle Greenhouse Gas (GHG) Emissions From Materials[1] Used for Buildings
Vista Canyon
Santa Clarita, California

Residential and Non-Residential Buildings[2]	Embodied Energy as Percentage of Overall Energy[3]	
	3%	25%
(tonnes CO_2 / year)		
7,390	222	1,847

Notes:
1. All materials were analyzed. See references below for more details.
2. Represents CO_2 emissions from electricity and natural gas use. Refer to Tables 4-10 to 4-22 for calculations.
3. Percentages are based upon LCA studies below. The studies compared energy used in the manufacture and transport of materials to energy use from electricity and natural gas. Varying lifetimes of homes were assumed in each study. As homes become more energy efficient, the portion of GHGs from embodied energy increases.

Abbreviations:
CO_2 = Carbon Dioxide
GHG = Greenhouse Gas
LCA = Life Cycle Analysis

Sources:
Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings* , **35**(10): p. 1049.
Keoleian, G.A., S. Blanchard, and P. Reppe. (2000) Life-cycle energy, costs, and strategies for improving a single-family house. *Journal of Industrial Ecology* , **4**(2): p. 135.
Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings* , **39**(3): p. 249.

Winther, B.N. and A.G. Hestnes. (1999) Solar versus green: The analysis of a Norwegian row house. *Solar Energy* , **66**(6): p. 387.

Adalberth, K., A. Almgren, and E.H. Petersen. (2001) Life Cycle Assessment of Four Multi-Family Buildings. *International Journal of Low Energy and Sustainable Buildings* , **2**.

Table 2
Greenhouse Gas (GHG) Emission Factors for the Manufacture of Cement
Vista Canyon
Santa Clarita, California

Data Source	Calcining Emissions[4]	Fossil Fuel Emissions[5]
	(tonnes CO_2/tonne cement)	
EIA[1]	0.5	-
EPA Ap-42[2]	0.5	-
	0.75 - 1.19	
	0.92	
Battelle[3]	0.99	

Notes:

1. From the Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. Calculations are detailed in the Documentation for Emissions of Greenhouse Gases in the United States 2004, pg 35 - 38.

2. From AP-42 section 11.6: Portland Cement Manufacturing. Approximately 500 kg of CO_2 are released per Mg of cement produced during the calcining process; total manufacturing emissions depend on energy consumption (pg 11.6-6). Table 11.6-8 specifies 2,100 lbs CO_2 per ton of clinker produced (ENVIRON used the higher value instead of 1,800 lbs / ton to be conservative). Clinker is a precursor to cement. Using a clinker factor of 0.88 lb clinker/lb cement (from the Battelle report) yields an emission factor of 0.92 tonnes CO_2/tonne cement.

3. From Table 1-2 of the Battelle report. The North American average emission factor is 0.99 kg CO_2/kg cement; the global average is 0.87 kg CO_2/kg cement.

4. There are two main sources of CO_2 emissions from the manufacture of cement: the calcining process and fossil fuel combustion. Calcining emissions result from the chemical reaction of converting limestone ($CaCO_3$) to calcium oxide (CaO) and carbon dioxide (CO_2). CaO is a precursor to concrete and CO_2 is released to the atmosphere.

5. Fossil fuel combustion usually provides the energy necessary to manufacture cement. The emissions from the fossil fuel combustion vary depending on the type of fuel used; in general the combustion accounts for slightly less than half of the CO_2 emissions from the manufacture of cement.

Abbreviations:
AP-42 = Compilation of Air Pollutant Emission Factors
CO_2 = carbon dioxide
EIA = Energy Information Administration
EPA = Environmental Protection Agency
kg = kilogram
NA = Not Available
Mg = megagram = 1,000 kg

Sources:
EIA Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. August 2007. http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html

EPA AP42 Section 11.6: Portland Cement Manufacturing. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s06.pdf

Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.

Table 3
Quantities of Infrastructure Materials
Vista Canyon
Santa Clarita, California

CONCRETE			
Material	**Projected Material Needed[1] (tonnes/acre)**	**Area[2] (acres)**	**Total Weight[3] (tonnes)**
Concrete	48	185	8,811
Total	---	---	8,811
		Total Concrete (cu yd)[4]	4,856
ASPHALT			
Material	**Projected Material Needed[1] (tonnes/acre)**	**Area[2] (acres)**	**Total Weight[3] (tonnes)**
Asphalt	73	185	13,449
Total	---	---	13,449
		Total Asphalt (cu yd)[4]	17,130

Abbreviations:
ft = foot
in = inch
lb = pound
sq ft = square foot
cu ft = cubic foot
cu yd = cubic yard
GHG = Greenhouse Gas

Notes:
1. Estimated materials needed (tonnes/acre) are based on previous experience with similarly sized projects. Calculations are based on the expected need for utilities infrastructure: sewers, water pipes, storm drains, and electric, gas, cable, and telephone conduits etc.
2. Acreage of development provided by Vista Canyon Ranch, LLC.
3. Total material quantities (tonnes) for concrete and asphalt are calculated by converting tonnes/acre of material into mass in tonnes using the acreages of the development.
4. Total material quantities (yd^3) are calculated using densities provided by AP-42.

Sources:
AP-42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

Table 4
Greenhouse Gas (GHG) Emissions from Manufacture of Materials
Vista Canyon
Santa Clarita, California

Material	Emission Factor	Volume of Material	Mass of Material	Emissions from Manufacture of Material
	(tonnes CO_2/tonne material)	(yd^3)	(tonnes)	(tonnes CO_2)
Cement (in concrete)[1]	0.990	728	826	818
Asphalt[2]	0.018	17,130	13,449	235
TOTAL				**1,053**

Abbreviations:
CO_2 = carbon dioxide
yd^3 = cubic yard

Notes:

1. Concrete is composed of cement, water, aggregate, and chemical admixtures; concrete mixtures are approximately 15% cement by volume (Portland Cement Association). Cement accounts for almost all of the CO_2 emissions associated with the manufacture of conrete. The cement emission factors provided by AP-42 cover a wide range of processing technologies and emission factors, so ENVIRON used the cement emission factor provided by the Battelle report.

2. From AP-42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7. ENVIRON assumed an average emission factor from batch mix hot asphalt plants and drum mix hot asphalt plants.

3. Because the manufacture of cement is the main contributor to CO_2 emissions in the production of concrete, ENVIRON assumed that the emissions from the manufacture of cement are equal to the emissions from the overall manufacture of concrete.

Abbreviations:
CO_2 = carbon dioxide
yd^3 = cubic yard

Sources:
Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.
EPA AP42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7.
http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf
Portland Cement Association. Cement and Concrete Basics.
http://www.cement.org/basics/concretebasics_concretebasics.asp

Table 5
Greenhouse Gas (GHG) Emissions from Transportation of Infrastructure Raw Materials
Vista Canyon
Santa Clarita, California

Material	**Total Mass Transported**	**Distance from Source Location[2]**	**Mass-Distance[3]**	**Emission Factor[4,5]**	**Total Emissions**
		Local Source	**Local Source**	**Truck**	
	(tonnes material)	**(miles)**	**(tonne-miles)**	**(grams CO_2/tonne-mile)**	**(tonnes CO_2)**
Concrete	8,811	100	881,103	253	223
Asphalt	13,449	100	1,344,900		340
TOTAL					**563**

Notes:
1. For manufacturing emissions, only the amount of cement is considered; however, for transportation emissions, the entire mass of concrete is considered because the concrete mix is transported from the source locations.
2. The materials are assumed to originate from local sources located 100 miles from Vista Canyon.
3. Mass distance is the mass of material multipled by the distance traveled. ENVIRON assumed that the concrete and asphalt come from local sources.
4. Emission factors for truck calculated from DOE EERE energy intensity indicators. EERE data is presented in Btu / ton mile. These were converted using AP-42 conversion factors for energy in different types of fuel, and CCAR GRP emission factors for mass CO_2 emitted per gallon of fuel. Trucks are assumed to run on diesel.
5. Emissions calculated by multiplying the mass-distance by the emission factor. ENVIRON assumed that all materials will be transported by truck.

Abbreviations:
CO_2 = carbon dioxide

Sources:
DOE EERE energy intensity indicators. http://intensityindicators.pnl.gov/trend_data.stm Transportation sector data.
AP42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

Table 6
Summary of Life Cycle Greenhouse Gas (GHG) Emissions from Buildings, Infrastructure
Vista Canyon
Santa Clarita, California

Emissions Source[1]		Emissions from Manufacture of Materials[3]	Emissions from Transportation of Materials[4]	Total Emissions	Assumed Lifetime of Emissions Source[5]	Total Annualized Emissions[6]	Total Annual Emissions from VCR[7]	LCA Fraction of Total Emissions[8]
		(tonnes CO_2)			(years)	(tonnes CO_2 / year)	(tonnes CO_2 / year)	(%)
Buildings[2]	Low Estimate	222		222	40	6	15,892	0.03%
	High Estimate	1847		1,847		46		0.29%
Infrastructure		1,053	563	1,616		40		0.25%
TOTAL		1838 - 3464		1838 - 3464		46 - 87		0.29% - 0.54%

Abbreviations:
CO_2 = carbon dioxide
LCA = Life Cycle Assessment

Notes:
1. ENVIRON estimated LCA emissions from two sources: buildings, and infrastructure.
2. Emissions from buildings are shown as a range from a low to a high estimate based on the range presented in Table 1. The values in Table 1 are multiplied by the assumed lifetime of 40 years to yield total emissions in tonnes CO_2.
3. Emissions from the manufacture of materials for infrastructure are from Table 4.
4. Emissions from the transportation of materials for infrastructure are from Table 5.
5. The assumed lifetime of emissions source may be adjusted; here ENVIRON has assumed a conservatively short lifetime of 40 years.
6. Total emissions are divided by the assumed lifetime of emissions sources to yield the total annualized emissions.
7. From Table 4-35.
8. The LCA fraction of total emissions is calculated by dividing the total annualized emissions by the total emissions from Vista Canyon.

Greenhouse Gas Emissions: Existing Conditions

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Date:
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Project Number:
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ENVIRON

This appendix summarizes ENVIRON International Corporation's (ENVIRON) estimates for existing greenhouse gas (GHG) emissions associated with the project site.

The site of the proposed project is currently occupied by one, approximately 2,000-square foot, single-family residence, which has an associated yard, roughly 1.5 acres in size, that is used for private storage. In light of the existing conditions, ENVIRON evaluated the following GHG emission sources:

- One Single-Family Residence
  - Building Energy Use
  - Mobile Source Emissions

In general, the main sources of GHG emissions associated with residential land uses are indirect emissions from the generation of building energy, and passenger vehicle exhaust emissions. Although the residence will also have area source and water-related GHG emissions associated with it, these sources are small compared to building energy use and traffic, and thus they were omitted from this analysis. Because the emissions estimate does not fully account for all existing emission sources, the estimate likely understates existing GHG emission levels on the project site.

<u>Indirect emissions from energy use</u>: According to Vista Canyon LLC, no utilities infrastructure (e.g., for gas, water or electricity) is associated with the storage yard; hence, indirect emissions associated with the residence only were quantified. Indirect emissions from building electricity and natural gas usage are calculated as the product of total electricity or natural gas use and an emission factor that quantifies the GHG emissions per unit of energy (electricity or natural gas) used. Because energy use data specific to the existing residence was not available at the time of this analysis, ENVIRON assumed that the residence uses the same amount of natural gas and electricity as a minimally 2005 Title 24-compliant single-family residence. These calculations were performed using data from the California Energy Commission[1], and are summarized in Section 4.8 of the technical report. As shown in Table 1, energy use for a minimally 2005 Title 24-compliant, single-family residence would generate approximately 4.0 metric tonnes (MT) of CO_2e per year.

<u>Mobile source emissions</u>: GHG emissions from traffic are generally calculated as the product of total vehicle miles traveled, and an emission factor that quantifies the GHG emissions emitted per vehicle mile traveled. Information on the number of trips, trip types, and trips lengths is required to estimate GHG emissions from vehicular traffic. In the absence of site-specific trip data for the existing residence, ENVIRON used the Institute of Transportation Engineers'[2] daily

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[1] Kema-Xenergy, Itron, RoperASW. California Statewide Residential Appliance Saturation Study (RASS) Volume 2, Study Results, Final Report. June 2004. 300-00-004.; California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF

[2] Institute of Transportation Engineers. 2008. Trip Generation, 8th Edition. Washington, D.C.

trip rate for single-family detached housing, and the default residential trip types, distributions and lengths for Los Angeles County from URBEMIS.[3] Because the specific types of cars at the existing residence were not known at the time of this analysis, ENVIRON used EMFAC[4] to calculate a weighted average CO_2 emission factor for 2010 based on the County's population of light-duty cars, light-duty trucks, medium-duty trucks and motorcycles. Because this estimate is supposed to represent existing conditions, no reductions in emissions due to future regulations (e.g. Pavley) were incorporated. Finally, the CO_2 estimate was divided by 0.95 to account for other, non-CO_2 GHGs associated with gasoline exhaust.[5] These calculations are summarized in Table 2. The estimated GHG emissions associated with vehicle exhaust associated with the residence is 14 MT CO_2e/year.

Based on this analysis, the total GHG emissions associated with the existing conditions at the Vista Canyon project site is approximately 18 MT CO_2e/year (Table 3).

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[3] Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.4 – 2008). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District. http://www.urbemis.com

[4] Emission Factors (EMFAC2007) model (Version 2.3). November 2006. California Air Resources Board. http://www.arb.ca.gov/msei/onroad/latest_version.htm.

[5] USEPA. 2005. *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle.* Office of Transportation and Air Quality. February. (http://www.epa.gov/otaq/climate/420f05004.pdf)

Table 1
CO_2e Emissions for Single-Family Residence Under Existing Conditions
Vista Canyon
Santa Clarita, California

Title 24[1] Compliance	Type[2]	Energy Use		CO_2 Emission Factor		CO_2 Emissions (lb/year)		CO_2 Total
		Electricity[3] (lb/kwh)	Natural Gas[4] (MMBTU/year)	Electricity[5] (kwh/year)	Natural Gas[6] (lb/MMBTU)	Electricity[3]	Natural Gas[4]	(metric tonnes / DU / year)
Minimally 2005 Title 24 Compliant	Single family (1 unit)	6,268	45	0.583	117	3,654	5,239	4.0

Notes:

1. Title 24 - California Code of Regulations (CCR), Title 24, also known as the California Building Standards Code.
2. Information provided by Vista Canyon Ranch, LLC.
3. Total Title 24 and all miscellaneous load electricity use, as calculated in the Vista Canyon Climate Change Report.
4. Total natural gas use, as calculated in the Vista Canyon Climate Change Report.
5. Converted from kW-hr to lb CO_2 using emission factor from the California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Estimated emission factor for total energy delivered after implementation of the Renewables Portfolio Standard. Emission factor has been adjusted to reflect 20% of power provided by renewables by multiplying the SCE 2007 emission factor by (1-RPS renewable %) / (1-SCE 2007 renewable %). RPS renewable % is 20% and the SCE 2007 renewable % is 13%.
6. Converted from MMBTU to lb CO_2 using emission factor from California Climate Action Registry General Reporting Protocol (CCAR GRP).

Abbreviations:

DU - Dwelling Unit
kWh - kilowatt-hour
lb - pound
MMBTU - million British Thermal Units

Sources:

2001 Residential Energy Consumption Survey conducted by the US Energy Information Administarion: http://www.eia.doe.gov/emeu/recs/contents.html

California Climate Action Registry General Reporting Protocol, Version 3.1 (June 2009). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

California Climate Action Registry Database: Southern California Edison Company 2007 PUP Report. 2008. Available at: Available at: https://www.climateregistry.org/CARROT/public/Reports.aspx

Table 2
Greenhouse Gas Emissions from Vehicles Under Existing Conditions for the Year 2010
Vista Canyon
Santa Clarita, California

Land Use	Trip Characteristics[1]					Daily Undjusted VMT (miles)	Average Daily VMT (weekday/weekend adjusted)[3]	Annual Adjusted VMT (miles)	Emission Factor Running (g/mile)[4]	Emission Factor Starts (g/start)[5]	Annual CO_2 Emissions Running (tonne)	Annual CO_2 Emissions Starts (tonne)	Total Annual CO_2 Emissions (tonne)	Total Annual CO_2e Emissions (tonne)[6]
	Daily Trip Rate[2]	Trip Type	Percentage Trip Type[1]	Trip Distance[1] (miles)										
Single-family residence (1 unit)	9.57	Home Based Work	0.329	12.70		40	38	13,761	392	117	5	0.01	5	6
		Home Based Shop	0.180	7.00		12	11	4,150			2	0.01	2	2
		Home Based Other	0.491	9.50		45	42	15,362			6	0.02	6	6
											13	*0.04*	*13*	***14***

Notes:

1. Trip type distribution and trip lengths are based on URBEMIS default values for Los Angeles County.
2. Average weekday trip rate for single-family detached housing from Institute of Transportation Engineers' Trip Generation Report (2008).
3. Daily trips were adjusted to account for differences between weekend and weekday traffic, based on a report by Sonoma Technology. The weekend traffic (internal) was assumed to be 80% of weekly capacity. The weekend traffic (external) was assumed to be 80% of weekly capacity. There has been no weekend adjustment made for mode shifts.
4. Emission factor for vehicles is based on EMFAC files for 2010, based on LDA, LDT1, LDT2, MDV, and MCY for Los Angeles County. Speeds of 30 miles per hour were used to determine emission factors.
5. Starting emission factors are based on the weighted average distribution of time between trip starts based on URBEMIS defaults.
6. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that CH_4, N_2O, and HFCs are 5% of emissions from gasoline-based exhaust on a CO_2e basis.

Abbreviations:

CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2e - Carbon Dioxide Equivalent
GHG - Greenhouse Gas
HFC - Hydro fluorocarbon
N_2O - Nitrous oxide
URBEMIS - Urban Emissions model
VMT - Vehicle Miles Traveled

References:

Institute of Transportation Engineers. 2008. Trip Generation, 8th Edition. Washington, D.C.

Table 3
Greenhouse Gas Emissions Under Existing Conditions
Vista Canyon
Santa Clarita, California

Source	Annual GHG Emissions (MT CO_2e/yr)
Single Family Residence Building Energy Use	4
Single Family Residence Vehicular Emissions	14
Total	**18**

Abbreviations:
GHG - greenhouse gas
MT - metric tonnes