APPENDIX L-1

Greenhouse Gas Methodology and Modeling

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GREENHOUSE GAS METHODOLOGY AND MODELING

1.0 Modeling Background

In response to rising concern associated with increasing greenhouse gas (GHG) emissions and global climate change impacts, several plans and regulations have been adopted at the international, national, and State levels with the aim of reducing GHG emissions. These plans and regulations are aimed at reducing GHG emissions in association with buildout of the Encinitas Housing Element Update (HEU). The following is a discussion of the Federal and State plans and regulations that most influence GHG emissions associated with the ~~Indio GPU~~HEU.

A number of policies and regulations that are either directly or indirectly related to GHG emissions have been adopted at the State and Federal level. In addition to the policies and regulations discussion in Section 4.6, the following are relevant to vehicle efficiency, land use planning, and development.

1.1 Federal

a. Corporate Average Fuel Economy Standards

The project would generate additional vehicle trips. These vehicles would consume fuel and would result in GHG emissions. The Federal Corporate Average Fuel Economy (CAFE) standards determine the fuel efficiency of certain vehicle classes in the U.S. While the standards had not changed since 1990, as part of the Energy and Security Act of 2007, the CAFE standards were increased in 2007 for new light-duty vehicles to 35 miles per gallon (mpg) by 2020. In May 2009, plans were announced to further increase CAFE standards to require light duty vehicles to meet an average fuel economy of 35.5 mpg by 2016. In August 2012, fuel economy standards were further increased to 54.5 mpg for cars and light-duty trucks by Model Year 2025. This will nearly double the fuel efficiency of those vehicles compared to new vehicles currently on our roads. With improved gas mileage, fewer gallons of transportation fuel would be combusted to travel the same distance, thereby reducing nationwide GHG emissions associated with vehicle travel.

1.2 State

a. Climate Change Scoping Plan

As directed by the California Global Warming Solutions Act of 2006, in 2008, CARB adopted the *Climate Change Scoping Plan: A Framework for Change* (*Scoping Plan*), which identifies the main strategies California will implement to achieve the GHG reductions necessary to reduce forecasted business as usual (BAU) emissions in 2020 to the State's historic 1990 emissions level (CARB 2008).

In 2008, as part of its adoption of the *Scoping Plan*, CARB estimated that annual statewide GHG emissions were 427 $MMTCO_2E$ in 1990 and would reach 596 $MMTCO_2E$ by 2020 under a BAU condition. To achieve the mandate of AB 32, CARB determined that a 169 $MMTCO_2E$ (or approximately 28.5 percent) reduction in BAU emissions was needed by

2020. (The 2020 emissions estimate used in the *Scoping Plan* was developed using pre-recession data and reflects GHG emissions expected to occur in the absence of any reduction measures in 2010.)

In 2011, CARB revised its 2020 BAU projections to account for the economic downturn and to account for laws that had taken affect but were not included in the 2008 calculations. With respect to the new economic data alone, CARB determined that the economic downturn reduced the 2020 BAU by 55 Million $MTCO_2E$; as a result, achieving the 1990 emissions level by 2020 would require a reduction in GHG emissions of 21.7 percent (not 28.5) from the 2020 BAU. Further, CARB determined that implementation of Pavley I and the Initial RPS (as defined below) accounted for reductions of 26 $MMCO_2E$ and 12 $MMTCO_2E$, respectively; as a result, achieving the 1990 emissions level by 2020 would require a reduction in GHG emissions of 15.8 percent (not 28.5). Given the refined 2020 forecast of 507 $MMTCO_2E$ per year, CARB determined statewide GHG emissions would need to be reduced by 80 $MMTCO_2E$ (or 15.8 percent of 507 $MMTCO_2E$) by 2020 in order to reach the 1990 emission levels per AB 32. The updated emissions projections and targets were incorporated into the *Scoping Plan* that was approved in 2011.

Most recently, in 2014, CARB adopted the First Update to the Climate Change Scoping Plan: Building on the Framework (First Update) (CARB 2014b). The stated purpose of the First Update is to "highlight[] California's success to date in reducing its GHG emissions and lay[] the foundation for establishing a broad framework for continued emission reductions beyond 2020, on the path to 80 percent below 1990 levels by 2050" (CARB 2014b). The First Update found that California is on track to meet the 2020 emissions reduction mandate established by AB 32, and noted that California could reduce emissions further by 2030 to levels squarely in line with those needed to stay on track to reduce emissions to 80 percent below 1990 levels by 2050 if the State realizes the expected benefits of existing policy goals (CARB 2014b).

In conjunction with the First Update, CARB identified "six key focus areas comprising major components of the State's economy to evaluate and describe the larger transformative actions that will be needed to meet the State's more expansive emission reduction needs by 2050" (CARB 2014). Those six areas are: (1) energy; (2) transportation (vehicles/equipment, sustainable communities, housing, fuels, and infrastructure); (3) agriculture; (4) water; (5) waste management; and (6) natural and working lands. The First Update identifies key recommended actions for each sector that will facilitate achievement of the 2050 reduction goal.

Based on CARB's research efforts, it has a "strong sense of the mix of technologies needed to reduce emissions through 2050" (CARB 2014b). Those technologies include energy demand reduction through efficiency and activity changes; large-scale electrification of on-road vehicles, buildings and industrial machinery; decarbonizing electricity and fuel supplies; and the rapid market penetration of efficient and clean energy technologies.

As part of the First Update, CARB recalculated the State's 1990 emissions level using more recent global warming potentials identified by the Intergovernmental Panel on Climate Change. Using the recalculated 1990 emissions level and the revised 2020 emissions level projection identified in the 2011 Final Supplement, CARB determined that achieving the 1990 emissions level by 2020 would require a reduction in GHG emissions of approximately 15 percent (instead of 28.5 or 15.8 percent) from the BAU conditions.

The First Update included a strong recommendation from CARB for setting a mid-term statewide GHG emissions reduction target. CARB specifically recommended that the mid-term target be consistent with: (i) the United States' pledge to reduce emissions 42 percent below 2005 levels (which translates to a 35 percent reduction from 1990 levels in California); and (ii) the long-term policy goal of reducing emissions to 80 percent below 1990 levels by 2050. However, to date, there is no legislative authorization for a post-2020 GHG reduction target, and CARB has not established such a target.

The First Update discusses new residential and commercial building energy efficiency improvements, specifically identifying progress towards zero net energy buildings by 2020 for residential buildings and 2030 for commercial buildings, as an element of meeting mid-term and long-term GHG reduction goals. The First Update expresses CARB's commitment to working with the California Public Utilities Commission (CPUC) and California Energy Commission (CEC) to facilitate further achievements in building energy efficiency.

The original 2008 Scoping Plan and the 2014 First Update represent important milestones in California's efforts to reduce GHG emissions statewide. The law also requires the Scoping Plan to be updated every five years. The Scoping Plan process, as stated, is also thorough and encourages public input and participation.

b. California Light-Duty Vehicle Greenhouse Gas Standards

AB 1493 enacted July 2002, directed CARB to adopt vehicle standards that lowered GHG emissions from passenger vehicles and light-duty trucks to the maximum extent technologically feasible, beginning with the 2009 model year. CARB adopted these regulations (termed "Pavley I") as a discrete early action measure pursuant to AB 32.

CARB has also adopted a second phase of the Pavley regulations, originally termed "Pavley II" but now called the Low Emission Vehicle III" (LEV III) Standards or Advanced Clean Cars (ACC) Program, that covers model years 2017 to 2025. CARB estimates that LEV III will reduce vehicle GHGs by an additional 4.0 $MMTCO_2E$ for a 2.4 percent reduction over Pavley I. These reductions come from improved vehicle technologies such as smaller engines with superchargers, continuously variable transmissions, and hybrid electric drives. On August 7, 2012, the final regulation for the adoption of LEV III became effective.

It is expected that Pavley I and LEV III regulations will reduce GHG emissions from California passenger vehicles by about 22 percent in 2012 and about 30 percent in 2016, while improving fuel efficiency and reducing motorists' costs (CARB 2013).

c. Low Carbon Fuel Standard

An executive order (EO S-01-07) signed in 2007 directed that a statewide goal be established to reduce the carbon intensity of California's transportation fuels by at least 10 percent by 2020 through a Low Carbon Fuel Standard (LCFS).

CARB adopted the LCFS as a discrete early action measure pursuant to AB 32 in April 2009. The LCFS is a performance standard with flexible compliance mechanisms intended to incentivize the development of a diverse set of clean low-carbon transportation fuel options. Its aim is to accelerate the availability and diversity of low-carbon fuels such as biofuels, electricity, and hydrogen by taking into consideration the full life cycle of GHG emissions.

d. Renewables Portfolio Standard

The RPS promotes diversification of the State's electricity supply and decreased reliance on fossil fuel energy sources. Originally adopted in 2002 with a goal to achieve a 20 percent renewable energy mix by 2020 (referred to as the "Initial RPS"), the goal has been accelerated and increased by EOs S-14-08 and S-21-09 to a goal of 33 percent by 2020. In April 2011, SB 2 (1X) codified California's 33 percent RPS goal. In January 2015, AB 197 was introduced, which, if enacted, would require an electrical corporation or local publicly-owned electric utility to adopt a long-term procurement strategy to achieve a target of procuring 50 (not 33) percent of its electricity products from eligible renewable energy resources by 2030. Renewable energy includes (but is not limited to) wind, solar, geothermal, small hydroelectric, biomass, anaerobic digestion, and landfill gas.

e. Million Solar Roofs Program

The Million Solar Roofs Program was created by SB 1 in 2006 and includes the CPUC's California Solar Initiative and CEC's New Solar Homes Partnership. It requires publicly owned utilities to adopt, implement, and finance solar-incentive programs to lower the cost of solar systems and help achieve the goal of installing 3,000 megawatts of new solar capacity by 2020.

2.0 Modeling Methodology

~~Each housing strategy was evaluated relative to the reduction thresholds established in the City's CAP (25 percent reduction from 2020 business-as-usual emissions, or a 12 percent reduction from 2005 baseline emissions). To evaluate each housing strategy's GHG emissions relative to BAU, emissions were quantified and projected to the year 2020 for both a BAU scenario and actual buildout of the housing strategies. This is because the AB 32, CARB BAU Forecast, associated Scoping Plan, and CAP's GHG reduction targets are projected to a year 2020 horizon. Executive Order S-3-05 identified a GHG reduction target for 2050 but did not identify interim targets for the decades between 2020 and 2050. In April 2015, an executive order was issued to establish an interim California GHG reduction target of 40 percent below 1990 levels by 2030. In this analysis, the GHG emissions~~

~~estimates based on ultimate buildout of the housing strategies are compared to the 2020 GHG reduction goals in order to evaluate significance. In other words, for the purpose of this analysis, buildout for each strategy is projected to occur by 2020. (Buildout of the HEU based on market demand is not actually anticipated to occur until 2030 or beyond). By meeting the 2020 GHG reduction goals, projects would be in line with achieving the 2030 and 2050 reduction goals.~~

For informational purposes, GHG emissions were estimated using the California Emissions Estimator Model (CalEEMod) (CAPCOA 2013). In brief, the model estimates criteria air pollutants and GHG emissions by multiplying emission source intensity factors by estimated quantities of emission sources based on the land use information. All CalEEMod estimates are in terms of total metric tons of CO_2 equivalent ($MTCO_2E$).

Emission estimates were calculated for the three GHGs of primary concern (CO_2, CH_4, and N_2O) that would be emitted from construction and the five primary operational sources that would be associated with HEU buildout: mobile sources, area sources, energy use, water use, and solid waste disposal. ~~To evaluate the reductions in GHG emissions of the housing strategies relative to the BAU 2020 forecast, emissions were estimated for two scenarios: first, the buildout without GHG measures (i.e., buildout under BAU conditions) and, second, the buildout with GHG measures. This allowed for a comparison between the buildout with and without GHG-reducing measures in accordance with the City's 25 percent reduction goal.~~

2.1 Construction Emissions

Construction activities emit GHGs primarily though combustion of fuels (mostly diesel) in the engines of off-road construction equipment and through combustion of diesel and gasoline in on-road construction vehicles and in the commute vehicles of the construction workers. Smaller amounts of GHGs are also emitted indirectly through the energy use embodied in any water use (for fugitive dust control) and lighting for the construction activity. Every phase of the construction process, including demolition, grading, paving, and building, emits GHG emissions, in volumes proportional to the quantity and type of construction equipment used. Heavier equipment typically emits more GHGs per hour of use than the lighter equipment because of their greater fuel consumption and engine design.

CalEEMod estimates construction emissions by multiplying the amount of time equipment is in operation by emission factors. Estimates of the amount and type of construction equipment are based on construction surveys performed by the South Coast Air Quality Management District (SCAQMD) of projects ranging up to 30 acres. As such, CalEEMod construction estimations are not accurate for large projects where project-specific information is required. At a program level, it would be speculative to estimate the schedule and construction requirements of individual projects included in the housing strategies. Thus, this analysis relies on the methodology used in the San Diego County Updated Greenhouse Gas Inventory (San Diego County 2013), which forecasts that between 2015 and 2035 construction emissions would comprise roughly 2.1 percent of total GHG emissions within the county. Therefore, construction emissions are estimated at 2.1 percent of the total operational GHG emissions associated with the project area.

2.2 Mobile Emissions

Transportation-related GHG emissions comprise the largest sector contributing to both inventoried and projected statewide GHG emissions, accounting for 36 percent of the projected total statewide 2020 BAU emissions (CARB 2014b). On-road vehicles alone account for 70 percent of the City's baseline GHG emission (City of Encinitas 2011). GHG emissions from vehicles come from the combustion of fossil fuels in vehicle engines.

The vehicle emissions are calculated based on the vehicle type, the trip rate, and trip length for each land use. The daily trip generation and the City-wide vehicle miles traveled (VMT) were calculated for each housing strategy as a part of the Traffic Impact Statement prepared for the project (Appendix N). The trip generation was calculated based on the buildout projections for each housing strategy, as provided by the City and trip generation rates from the SANDAG's *Guide to Vehicular Traffic Generation Rates for the San Diego Region*. VMT information was provided by SANDAG for each housing strategy. The VMT generated by SANDAG was based upon the methodology recommended by the SB 375 Regional Targets Advisory Committee for allocating VMT to a study area for the purposes of a GHG analysis.

All three housing strategies encourage increased development diversity by increasing the buildout potential for commercial/mixed use and multi-family land uses. Locating different land uses types near one another can decrease VMT, since trips between land use types are shorter and may be accommodated by alternative modes of transportation (CAPCOA 2010). To assist in the evaluation of the three housing strategies, the VMT and trip generation efficiency was calculated and compared to the No Project/Adopted Plan scenario. It was found that housing strategy 3 (MMUP) would have the highest efficiency, followed by housing strategy 1 (RM), housing strategy 2 (BYO), and then the No Project/Adopted Plan scenario, respectively. That is, although housing strategy 3 (MMUP) proposes the greatest amount of development and in turn, the greatest trip generation and total VMT, this housing strategy would be the most efficient because it would reduce the overall average trip length of each individual trip. This can be attributed to housing strategy 3 (MMUP) emphasizing mixed-use development that has the benefits of placing housing in close proximity to retail and employment land uses. Housing strategy 2 (BYO) would be the least efficient of the three strategies because it is more suburban in character. However, each of the housing strategies would be more efficient than the No Project/Adopted Plan scenario.

The average regional trip length is 5.8 miles (SANDAG 2014). As discussed, each of the housing strategies would increase vehicle trip efficiency. Using City-wide daily trip generation and SANDAG VMT calculations for each housing strategy, it was calculated that housing strategies 1, 2, and 3 would reduce average trip length by 0.6 percent, 0.5 percent, and 1.3 percent, respectively. Thus, trip lengths of 5.76, 5.77, and 5.72 miles were used for modeling vehicle emissions associated with housing strategies 1, 2, and 3, respectively.

The vehicle emission factors and fleet mix used in CalEEMod are derived from CARB's Emission Factors 2011 model, which includes GHG reducing effects from the implementation of Pavley I (Clean Car Standards) and the Low Carbon Fuel Standard. Emission factors that include the effects of the Tire Pressure Program and the Low Emission Vehicles III regulations are not available. Therefore, to account for the effects of the Tire Pressure Program (0.6 percent) and the Low Emission Vehicles III (2.4 percent), a total 3 percent reduction was applied to the vehicle emissions calculated in CalEEMod (CARB 2011).

2.3 Energy Use Emissions

GHGs are emitted as a result of activities in buildings for which electricity and natural gas are used as energy sources. GHGs are emitted during the generation of electricity from fossil fuels off-site in power plants. These emissions are considered indirect but are calculated in association with a building's operation. Electric power generation accounts for the second largest sector contributing to both inventoried and projected statewide GHG emissions. Combustion of fossil fuel emits criteria pollutants and GHGs directly into the atmosphere. When this occurs in a building, this is considered a direct emissions source associated with that building. CalEEMod estimates emissions from the direct combustion of natural gas for space and water heating.

CalEEMod estimates GHG emissions from energy use by multiplying average rates of residential and non-residential energy consumption by the quantities of residential units and non-residential square footage to obtain total projected energy use. This value is then multiplied by electricity and natural gas GHG emission factors applicable to the project location and utility provider.

Building energy use is typically 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 types of fixed lighting. Non-building energy use, or "plug-in energy use," can be further subdivided by specific end-use (refrigeration, cooking, office equipment, etc.).

Energy consumption values are based on the California Energy Commission-sponsored California Commercial End Use Survey and Residential Appliance Saturation Survey studies, which identify energy use by building type and climate zone. Because these studies are based on older buildings, adjustments have been made in CalEEMod to account for changes to Title 24 building codes. CalEEMod is based on the 2008 Title 24 energy code (Part 6 of the building code).

~~For a BAU project scenario, the default CalEEMod historic consumption rates were used to generate the emission estimates.~~ For each housing strategy, the effects of the California Building Code were accounted for by reducing the Title 24 electricity and natural gas intensity factors. When compared to 2008, the 2013 Title 24 Energy Code would result in a 23.3 percent decrease in GHG emissions from electricity sources and a 3.8 percent reduction in GHG emission from natural gas sources for multi-family residential uses, and a 21.8 percent decrease in GHG emissions from electricity sources and a 16.8 percent reduction in GHG emission from natural gas sources for non-residential uses (California Energy Commission 2013).

The City is served by San Diego Gas & Electric (SDG&E). Therefore, SDG&E's specific energy-intensity factors are used in the calculations of GHG emissions per kilowatt-hour consumed. As discussed, the State mandate for renewable energy is 33 percent by 2020. However, the energy-intensity factors included in CalEEMod by default only represent a 10.2 percent procurement of renewable energy (SDG&E 2011). To account for the continuing effects of RPS through 2020, the energy-intensity factors included in CalEEMod were reduced by an additional 22.8 percent.

2.4 Area Source Emissions

Area sources include hearths, woodstoves, and landscaping equipment. The use of hearths (fireplaces) and woodstoves directly emits CO_2 from the combustion of natural gas, wood, or biomass, some of which are thus classified as biogenic. CalEEMod estimates emissions from hearths and woodstoves only for residential uses based on the type and size features of the residential land use inputs. By default, commercial land uses do not have any hearths or woodstoves in CalEEMod but can be added for those cases where they may occur such as in restaurants or hotels if such information is known. For this analysis, it was assumed that residential uses would be constructed with natural gas fireplaces.

Additionally, the use of landscape equipment emits GHGs associated with the equipment's fuel combustion. Estimates of the number and type of equipment needed based on the number of summer days given the project's location.

2.5 Water and Wastewater Emissions

The amount of water used and wastewater generated by a project has indirect GHG emissions associated with it. These emissions are a result of the energy used to supply, distribute, and treat the water and wastewater. In addition to the indirect GHG emissions associated with energy use, wastewater treatment can directly emit both CH_4 and N_2O.

GHG emissions associated with supplying and treating water and wastewater are calculated for each housing strategy. The indoor and outdoor water use consumption data for each land use subtype comes from the Pacific Institute's *Waste Not, Want Not: The Potential for Urban Water Conservation in California* 2003 (as cited in CAPCOA 2013). Based on that report, a percentage of total water consumption was dedicated to landscape irrigation. This percentage was used to determine outdoor water use. Wastewater generation was similarly based on a reported percentage of total indoor water use (CAPCOA 2013). Additionally, future projects constructed under each housing strategy would be subject to 2013 Title 24 Part 11 standards, known as CalGreen. Thus, in order to demonstrate compliance with CalGreen, a 20 percent increase in indoor water use efficiency was included in the water consumption calculations for the project. ~~BAU water use calculations do not consider any reduction in water use from these estimates.~~

Additionally, as discussed previously, the energy-intensity factors included in CalEEMod 2013 represent a 10.2 percent procurement of renewable energy. To account for the continuing effects of RPS through 2020, the energy-intensity factors included in CalEEMod were reduced by an additional 22.8 percent.

2.6 Solid Waste Emissions

The disposal of solid waste produces GHG emissions from anaerobic decomposition in landfills, incineration, and transportation of waste. To calculate the GHG emissions generated by disposing of solid waste for the project, the total volume of solid waste was calculated using waste disposal rates identified by California Department of Resources Recycling and Recovery. The methods for quantifying GHG emissions from solid waste are based on the Intergovernmental Panel on Climate Change method, using the degradable organic content of waste. GHG emissions associated with the project's waste disposal were calculated using these parameters.