DONALD BREN SCHOOL OF
ENVIRONMENTAL SCIENCE & MANAGEMENT
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Development of a Sustainable Community in Santa Paula, California

Group Project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management for the Donald Bren School of Environmental Science & Management

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a four-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

JEFF DOZIER

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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LIST OF ABBREVIATIONS

Abbreviation	Definition
AFY	acre feet per year
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BMP	best management practice
BOMA	Building Owners and Managers Association
CFL	compact fluorescent light
CII	commercial, industrial, institutional
CIWMB	California Integrated Waste Management Board
CO_2	carbon dioxide
COP	coefficient of performance
CSI	California Solar Initiative
CSQA	California Stormwater Quality Association
CUWCC	California Urban Water Conservation Council
DX	direct expansion
EER	energy efficiency ratio
EPBI	expected-performance based incentive
ET	evapotranspiration
ft^2	square feet or square foot
GPCD	gallons per capita per day
gpf	gallons per flush
gpm	gallons per minute
HERS	Home Energy Rating System
HOA	homeowners' association
HVAC	heating, ventilating, and air conditioning
IGSHPA	International Ground Source Heat Pump Association
IRR	internal rate of return
kBtu	kilo British thermal unit
kWh	kilowatt-hour
lbm	pounds mass
lbs	pounds
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
mg/L	milligrams per liter
MS4	municipal separate storm sewer systems
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
ppm	parts per million
psi	pounds per square inch
PV	photovoltaic
RCRA	Resource Conservation and Recovery Act
SEER	seasonal energy efficiency ratio

SHGC	solar heat gain coefficient
SPCP	Stormwater Pollution Control Plan
SPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
U.S. EPA	United States Environmental Protection Agency
USBOR	United States Bureau of Reclamation
VCIWMD	Ventura County Integrated Waste Management Division
VOC	volatile organic compound
WTE	Waste-to-Energy

ABSTRACT

Conventional community planning in this country has neglected the long-term environmental, economic, and social impacts of development. As awareness of the importance of balancing these impacts with society's housing needs has grown, there has been increased demand for sustainable development. Our client, The Limoneira Company, has incorporated environmental stewardship into its latest project, the development of East Area 1, a 508-acre community in Santa Paula, California. Limoneira asked us to join their team of planning and design professionals as sustainability experts. We provide specific recommendations of actions to make East Area 1 a sustainable community. Our group conducted site visits to East Area 1 and Santa Paula, consulted with experts, performed a literature review, and used calculations and models to provide 19 recommendations in six sectors: Building Materials, Energy, Landscape Management, Transportation, Solid Waste, and Water. We make three additional recommendations addressing sustainable development as an ongoing process. This endeavor is the first of its kind at this size for Ventura County, and can be a role model for future sustainable urban development projects. Constructing and operating a sustainable development is a dynamic process, and we hope these recommendations are continually evaluated to meet the needs of future generations.

EXECUTIVE SUMMARY

Background Information

The Limoneira Company is planning to develop a 508-acre parcel of land directly to the east of the City of Santa Paula, California as a community with a mix of residential and non-residential uses. This proposed community, East Area 1, is designed to meet the growing need for housing and promote economic growth within the city. The availability of housing in Santa Paula is an ongoing problem that will worsen as the population continues to grow. The Southern California Association of Governments projects that the city will need to add more than 2,000 housing units by 2014 in order to meet demand [*Southern California Association of Governments*, 2007]. Santa Paula currently has the lowest median income of all the incorporated cities within Ventura County [*City of Santa Paula*, 2008b], and therefore, East Area 1 should also attract more affluence and create jobs.

Satisfying these needs for housing and economic growth in Santa Paula will require new land development. Santa Paula is mostly agricultural land use, and there is simply not enough space to meet the projected housing demand by building new developments in the unoccupied spaces within the previously developed parts of the city. At the same time, Santa Paula is only willing to accept development that preserves the city's character and agricultural heritage. As an agribusiness, Limoneira may seem to be an unlikely candidate to be developing real estate, but they have been an integral part of Santa Paula since the company's founding in 1893. Limoneira feels they are in the best position to build a community that takes into account the city's history, culture, and needs [*Limoneira Company*, 2008b]. Moreover, the company has been involved in both residential and commercial real estate development projects in Santa Paula, as well as other parts of California and Arizona, since the early 1900s [*Limoneira Company*, 2008a].

Instead of taking a short-term view and focusing only on satisfying housing needs inexpensively and generating property tax revenue, Limoneira sees the long-term environmental, economic, and social viability of East Area 1 as an integral part of its development plan. As such, they want to incorporate sustainability into the process of designing and developing this community.

Our Role and Objectives

Because land development is not their primary business, Limoneira is working with a team of design professionals to plan the community, create its specific layout, and carry out the actual development of the community. While Limoneira and its team of consultants and engineers have incorporated sustainability into the planning process, producing a conceptual vision of a mixed-use community with pedestrian friendly neighborhoods and districts, they still required guidance on how to implement specific strategies to make East Area 1 a sustainable development. As a result, Limoneira brought our group into the design process as sustainability experts. We worked in conjunction with the rest of the design team to advise Limoneira on how to ensure the long-term environmental, economic, and social viability of the community.

Our objectives for this project are:

- Define what sustainable development means in the context of East Area 1.
- Identify the individual areas, or sectors, of a community that must be addressed for that community to be sustainable.
- Evaluate the environmental, economic, and social impacts of a baseline scenario in which the community is built without sustainability improvements.
- Determine strategies and actions for improving sustainability over the baseline.
- Recommend a set of specific strategies and actions that would make East Area 1 a sustainable community development.

Approach and Methodology

Considering Limoneira's goal to make East Area 1 a sustainable community, we first have to define the concept of "sustainable development" for this project. The foundation of our definition is from the Brundtland Commission, which states that present needs are met without compromising the ability of future generations to meet their needs [*United Nations: World Commission on Environment and Development*, 1987]. Because of the unique conditions of East Area 1, we decided not to pursue an established "green" certification, which can ignore key aspects of local circumstances.

A holistic view of sustainable development considers the environmental, economic, and social impacts of developing this community. To evaluate the issues of sustainability, we divide our analysis into six interconnected sectors: Building Materials, Energy, Landscape Management, Solid Waste, Transportation, and Water. We choose these six sectors because they provide a comprehensive view of sustainable community development. Given our diverse audience, which includes Limoneira, developers, and future East Area 1 residents, and the fact that the Specific Plan is largely conceptual in nature, we determine that the most valuable deliverable we can provide is a set of recommendations clearly stating what actions to take to integrate sustainable practices into East Area 1. Because an index of sustainability standardized across our sectors is not feasible, we are not setting a minimum quantifiable threshold for sustainability. Instead, we set targets and goals based on the particular sector or specific recommendation.

We are concerned with the construction of the community and how it will operate. The sustainability of East Area 1 is inextricably linked to its future maintenance and people's individual and community behavior. Our recommendations need to be actionable and flexible. Construction will likely occur over ten years, so we must consider future legislation and emerging technology. Although it is important for our recommendations to be innovative, they also have to be economically practical. We want East Area 1 to be a progressive community and a role model for Ventura County, but we have to be mindful that construction will begin in only a few years, and developers need to be able to sell these homes.

To evaluate potential recommendations, we used several methodologies. We went on site visits to East Area 1 and Santa Paula to learn about the local conditions and better

understand Limoneira's relationship with Santa Paula. We also consulted with experts to gain their perspectives on relevant issues of sustainability, and we conducted an extensive literature review. Finally, we used models and calculations to support our recommendations for the Energy, Transportation, and Water sectors.

Recommendations

We make 22 recommendations stating how East Area 1 can integrate measures to ensure that its construction and operation follow the principles of sustainable development.

Building Materials

- Use building materials that eliminate or minimize occupants' exposure to indoor chemical and microbial contaminants.
- Select building products using an environmental life-cycle assessment approach.

Energy

- Integrate energy efficiency measures into all buildings so that new construction will exceed Title 24 standards by at least 20 percent.
- Integrate renewable energy technology into buildings, including photovoltaic cells, solar hot water heaters, and geothermal heat pumps.
- Minimize barriers to retrofitting buildings for energy efficiency and renewable energy technology through green leases and energy improvement mortgages.
- Participate in utility and government programs to receive financial incentives and customized recommendations on how to improve the energy performance of buildings.

Landscape Management

- Promote the agricultural heritage of East Area 1.
- Use organic landscaping methods in the design and maintenance of the landscape and agricultural preserves.
- Reduce outdoor light pollution with efficient and effective use of light fixture placement and technology, light shielding, and directed light.

Solid Waste

- Minimize the quantity of solid waste sent to landfills.
- Mandate all companies doing construction in East Area 1 to institute a work site program to divert a minimum of 90 percent of construction and demolition waste from landfills.

Transportation

- Discourage the use of automobiles by promoting walking and bicycling and restricting parking.
- Promote the use of public transit by providing shuttle service to and from transit stops on existing routes and offering residents monthly transit benefits.
- Establish a ride-share program for residents and commuters.

- Introduce a car-sharing program to minimize the need of residents to own a car.

Water

- Maximize pervious surfaces to manage the volume, rate, and pollutant discharge of stormwater runoff and require a plan to manage stormwater during construction.
- Increase indoor water use efficiency by installing best available technology for appliances and fixtures, and construct non-residential buildings to use recycled water for non-potable uses.
- Increase outdoor water use efficiency by using irrigation technology devices, xericscape principles, and irrigating public landscapes with recycled water.
- Install automatic water meters and utility monitoring systems in all buildings. Sub-meter all multi-family units and non-residential buildings.

Operations and Maintenance

- Use Covenants, Conditions, and Restrictions (CC&Rs) with sustainability provisions.
- Create a community website.
- Host a series of public workshops focused on living sustainably.

Our Vision

Our vision for East Area 1 focuses on the people who will live in this community. At the forefront of our vision is a high quality of life that includes enhancing human and environmental health. We want East Area 1 residents and workers to realize the full benefits of this sustainable development through their actions and behavior choices. We imagine a place where people gather in the parks and open spaces, which are beautiful and healthy due to the organic methods used to maintain them. People will be able to use resources efficiently in their homes and workplaces, which will have highly efficient appliances and fixtures. By setting up carpools using the community website, people can reduce their carbon footprint and save on gas money.

Because sustainability is dependent on people's behavior, education and outreach are critical. A future project could evaluate how rules are made and enforced in community developments, thereby providing valuable insight on governance structures, such as the Covenants, Conditions and Restrictions or homeowners associations. Furthermore, an assessment should be conducted after the first construction phase to determine the effectiveness of the implemented recommendations.

Although Limoneira has been involved in developing neighborhoods since its inception, this development is its largest effort thus far. Furthermore, this endeavor is the first of its kind on this size of scale for both Santa Paula and Ventura County. By implementing our set of innovative recommendations, East Area 1 can set a precedent for future urban developments in the County to abandon conventional practices, like suburban sprawl, from the past 60 years and transition to a paradigm of sustainability.

CHAPTER 1
INTRODUCTION

The Limoneira Company is planning to develop a 508-acre parcel of land, called East Area 1, directly to the east of the City of Santa Paula, California, as a community with a mix of residential and non-residential uses. This proposed community is designed to meet the growing need for housing and to promote economic growth within the city. Instead of taking the short-term perspective, focusing only on satisfying housing needs inexpensively and generating property tax revenue, Limoneira views the long-term environmental, economic, and social viability of East Area 1 as an integral part of its development plan. As such, the company wants to incorporate sustainability into the process of designing and developing this community.

A central theme of this report is the concept of sustainable development. Our definition of this concept, taken from the Brundtland Commission [*World Commission on Environment and Development*, 1987], is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Throughout this report, we have taken a holistic view of sustainable development which incorporates environmental, economic, and social factors. Thus, while much of this report concentrates on strategies to improve the environmental performance of the community, the people who will live and work in East Area 1 are also the focus of these strategies.

The availability of housing in the State of California, Ventura County, and the City of Santa Paula is an ongoing problem that will worsen as the population continues to grow. California's current population of 36 million residents is expected to reach 43-46 million residents by 2020, an increase of 22-30 percent [*Landis and Reilly*, 2004]. Similarly, the Southern California Association of Governments (SCAG) projects a 30.8 percent increase in population in Ventura County, where the City of Santa Paula is located, over the same period of time [*Southern California Association of Governments*, 2001].

The City of Santa Paula has experienced growth rates similar to those of Ventura County. Over the 17-year period from 1990 through 2007, the city experienced a 16.4 percent increase in population. That trend is predicted to continue through the next several years [*City of Santa Paula*, 2008b]. SCAG's 2007 Regional Housing Needs Assessment (RHNA) projects a need to add 2,241 more housing units within the city by 2014 in order to meet the housing demand of the city's growing population [*Southern California Association of Governments*, 2007].

In addition to an increasing demand for housing in Santa Paula, there is a need for economic growth in the city. In order to achieve this growth, the city must attract more affluence and create more jobs. Santa Paula currently has the lowest median income of all incorporated cities within Ventura County [*City of Santa Paula*, 2008b]. Moreover, according to the U.S. Census Bureau, Santa Paula's per capita income of $15,736 is significantly below the per capita income of either Ventura County or California [*U.S. Census Bureau*]. Concerning jobs, Santa Paula's 6.8 percent unemployment rate is higher

than the 4.4 percent unemployment rate for Ventura County. In addition, approximately 7,000 of the 12,221 Santa Paula residents who are employed must commute to jobs outside of the city [*City of Santa Paula*, 2008b]. Commuting long distances is more time consuming and expensive for workers than working within Santa Paula. Commuting also has environmental ramifications such as increasing air pollution and greenhouse gas emissions.

Satisfying these needs for housing and economic growth in Santa Paula will require new land development. Santa Paula is a largely agricultural area and there is not enough space available to meet the projected housing demand by building new housing developments in the unoccupied spaces within the previously developed parts of the city. At the same time, Santa Paula is only willing to accept development which preserves the character and agricultural heritage of the city. Reconciling these seemingly conflicting interests will require the use of development practices that deviate from the conventional practices used over the past 60 years in the United States.

Development Practices

Since the end of World War II, the trend in urban development has been to expand outward across large areas of land in order to build low-density communities. The amount of developed land in the United States increased from 18.6 million acres to 74 million acres between 1954 and 1997, a four-fold increase. Although the country's population has also grown over that period of time, the rate of land area development was double the rate of population growth rate [*ICF Consulting*, 2001]. This trend in land development results from increased income, lifestyle choices, and public policy on housing, taxes, and transportation.

Because of this sprawling urban development trend, people live farther away from where they work or go to school, residents are more isolated from each other, and residential neighborhoods have become separated from commercial centers. People have become more dependent on cars as their primary mode of transportation because they must travel greater distances to get to work or to access goods and services. In order to facilitate driving, extensive networks of roads and parking lots have also been built.

Urban sprawl has adversely affected the natural environment and human health. For example, the increase in both the use of cars and the distances those cars travel has caused increased air pollution, water pollution, crop degradation, damage to buildings and materials, respiratory illness, and greenhouse gas emissions [*ICF Consulting*, 2001]. The sheer spread of urban areas has caused wildlife habitat loss and fragmentation.

Furthermore, the increase in impervious surfaces due to urban development is a major contributing factor to water quality problems. Impervious surfaces such as roads, sidewalks, rooftops, and parking lots increase the rate at which stormwater runoff reaches natural waterways. The consequent reduction in infiltration diminishes groundwater recharge and increases the flood hazard. Due to the lack of vegetation to

absorb pollutants, stormwater runoff often has higher concentrations of nutrients and chemicals, which leads to the pollution of natural waterways [*CASQA*, 2003].

In addition to the problems associated with patterns of development, construction practices also have had negative effects on environmental and human health. Developers have tended to focus only on providing housing or commercial space without accounting for the impacts development has on the social and natural environments in which it takes place. Therefore, most building construction minimizes upfront costs with less regard to the structure's long-term environmental and financial costs. As a result, the built environment has significantly contributed to climate change, excessive consumption of fresh water and fossil fuels, and natural resource depletion. In fact, the construction and operation of buildings alone accounts for 38 percent of carbon dioxide (CO_2) emissions, 30 percent of both raw materials waste and landfill waste, and 12 percent of potable water consumption in the United States each year [*Green Communities*, 2008a; 2008b].

Over the past few years, there has been a growing recognition that the built environment affects the quality of the natural environment and vice versa. Ultimately, both the built and natural environments affect people and their quality of life. As such, there has been increasing interest in using development practices that account for the current and future sustainability of development projects. This approach to community development, broadly referred to as sustainable development, aims to ensure that communities are environmentally, economically, and socially viable over the long-term.

The Community

In order to satisfy the demand for additional housing and economic growth in Santa Paula, Limoneira is planning to develop a 508-acre community called East Area 1. In keeping with the company's long-term outlook and commitment to the city, Limoneira intends to make East Area 1 a sustainable community development.

East Area 1 will be a mixed-use community composed of neighborhoods with a variety of housing types, commercial and industrial property, schools, recreational areas, and undeveloped land. The community will be divided into five distinct areas: the East Santa Paula Railroad District, the Foothill Neighborhood, the Haun Creek Neighborhood, the Santa Paula Creek Civic District, and the Santa Paula Creek Neighborhood. Figure I1 shows the layout of the neighborhoods and districts within the community, which Limoneira's team of consultants has designed. Each neighborhood will have a clear center and will have an approximate five-minute walk from its center to its edge.

The residential component of the community will consist of 1,500 new homes including houses, condominiums, and apartments of various styles and for a mix of income types. One of the goals of building East Area 1 is to attract more affluence to Santa Paula in order to promote economic growth in the city. Therefore, the community will include some high-end homes, particularly in the Foothill Neighborhood. However, East Area 1 will serve the needs of current Santa Paula residents who may not be able to afford high-

end homes. Therefore, East Area 1 will also include smaller single-family detached homes, townhomes, apartment buildings and work-live buildings. Moreover, up to 150 of the homes will be affordable housing units. In addition to the 1,500 private homes, there will also be 100 assisted living units.

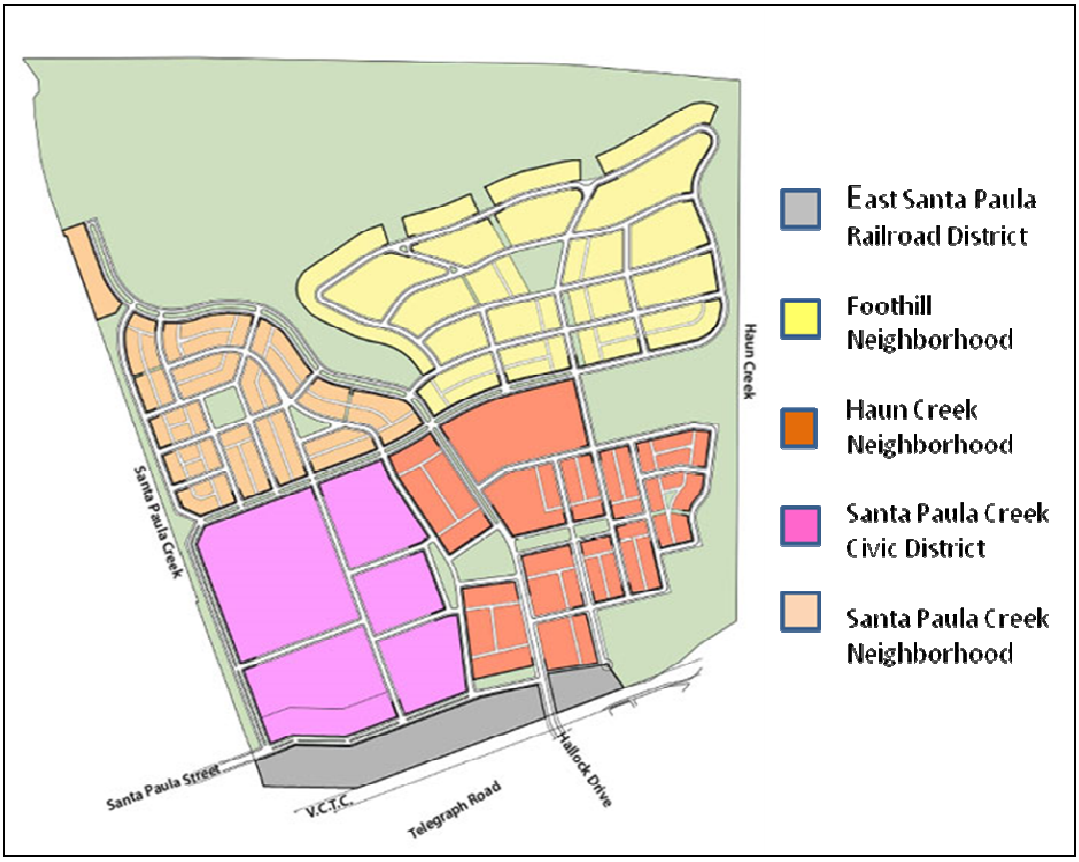

Figure I1: Layout of Neighborhood and Districts in East Area 1

The non-residential component of the community will consist of 285,000 square feet of commercial and retail space and 150,000 square feet for light industrial uses. The commercial and retail space will allow residents of East Area 1 to access the goods and services they need without having to travel outside of the neighborhood. Moreover, the commercial, retail, and industrial businesses are expected to add 1,035 new jobs to Santa Paula. This will help the city's economy grow while also allowing more workers to find jobs locally, thus minimizing the need to commute.

Additionally, in order to serve the needs of East Area 1 families who have children, there will be an elementary school and a high school within the community, as well as a post-secondary educational institution such as a community college or satellite buildings for a university.

Although East Area 1 is a development project, 223 acres of land, almost half of the total area of the project, is to remain undeveloped. The community is organized around a central park between the Haun Creek Neighborhood and the Civic District. This park will serve as communal open space for all residents, workers, and visitors. Two linear park blocks adjacent to the central park complement the historic Well House in order to tie the community to its cultural heritage. There will also be pocket parks in each neighborhood, some of which will serve as neighborhood centers. The civic district will have athletic fields and recreational facilities. In addition, there will be a 55-acre agricultural preserve and 79 acres of open space within East Area 1.

The Land

The Limoneira Company owns the parcel of land where the East Area 1 community will be built. Currently, the land is under agricultural cultivation. As an agricultural business, Limoneira may seem an unlikely candidate to be developing real estate. However, the company has been an integral part of Santa Paula since the company's founding in 1893. As a company whose work force – from the field workers to the CEO – is mostly born, raised, and currently living in Santa Paula, Limoneira feels they are in the best position to build a community that takes into account the city's history, culture, and needs [*Limoneira Company*, 2008b]. Moreover, the company has been involved in both residential and commercial real estate development projects in Santa Paula, as well as other parts of California and Arizona since the early 1900s [*Limoneira Company*, 2008a].

The project site is directly to the east of Santa Paula in an unincorporated area of Ventura County. It is bounded by Santa Paula Creek on the west and Haun Creek on the east. There are railroad tracks along portions of the community's southern border. In addition, the community is located just north of State Highway 126. East Area 1 will connect to the rest of Santa Paula through the extension of an already existing street into the project area. A multi-purpose trail connects to the rest of the city via a foot traffic- and bicycle-only bridge over Santa Paula Creek.

Limoneira initiated the process of planning East Area 1 in 2004. The first few years of the project required the development of a Specific Plan, which establishes the layout and development standards for East Area 1, and the completion of an Environmental Impact Report. In June 2008, the development of East Area 1 was approved by the citizens of Santa Paula, with 83 percent voting in favor of the community [*Limoneira Company*, 2009]. This vote amended the City of Santa Paula's General Plan to include the project site in the city's sphere of influence, thus exempting it from Ventura County's Save Our Open Space and Agricultural Resources (SOAR) initiative. The next step is for the Ventura County Local Agency Formation Commission (LAFCO) to approve the annexation of the project site to the City of Santa Paula. Finally, Santa Paula must also receive a verbal agreement from the City of Fillmore to remove the project site from the Santa Paula – Fillmore Greenbelt. East Area 1 is expected to pass LAFCO and be removed from the greenbelt by 2010 [*Penrod*, 2008].

Our Role

Since land development is not their primary business, Limoneira is working with a team of design professionals to plan the community, create its specific layout, and carry out the actual development of the community. Limoneira and its team of consultants and engineers have incorporated sustainability into the planning process by producing a conceptual vision, the design for the layout of the community, and a set of development guidelines for a mixed-use community with pedestrian friendly neighborhoods and districts. However, they still require guidance on how to implement specific strategies to make East Area 1 a sustainable development. As a result, Limoneira has brought our group into the design process as sustainability experts. We have worked in conjunction with the rest of the design team to advise Limoneira on how to ensure the long-term environmental, economic, and social viability of the community.

Our objectives for this project are as follows:

- Define what sustainability and sustainable development mean in the context of East Area 1
- Identify the individual areas, or sectors, of a community that must be addressed in order for that community to be sustainable
- Evaluate the environmental, economic, and social impacts of a baseline scenario in which the community is built without sustainability improvements
- Determine strategies and actions for improving sustainability over the baseline
- Recommend a set of specific strategies and actions that should be taken to make East Area 1 a sustainable community development

Project Significance

While sustainable communities have been planned and developed elsewhere, East Area 1 is the first effort of its kind on this scale in either the City of Santa Paula or Ventura County. East Area 1 is also the first sustainable community development project for Limoneira.

On the national level, the United States Environmental Protection Agency (U.S. EPA) has developed a program called Green Communities [*United States Environmental Protection Agency*, 2006a] to promote environmentally responsible community development. Several states, including Florida, Massachusetts, Michigan, Minnesota, and Ohio, have adopted their own programs [*Green Communities*, 2008b]. Similarly, more than 40 cities throughout the United States have established sustainability programs [*City of Corvallis*, 2005; *City of Santa Monica*, 2006; *City of Vancouver*, 2008; *Tassos*, 2005].

In addition to state and city sustainability programs, a certification system for sustainable community developments has recently been developed. The Leadership in Energy and Environmental Design (LEED) Rating Systems encourage green building and development practices by establishing design, construction, and operation criteria. However, these certification programs generally apply to individual buildings. In

recognition that additional benefits can be derived from planning a whole community as opposed to a series of individual buildings, a new system called LEED for Neighborhood Development is currently in a pilot phase [*United States Green Building Council*, 2008].

The rapidly increasing number of organizations, programs, and informational resources focused on sustainability is also evidence of the rising interest in sustainable development. In particular, the State of California's Green California program and Ventura County's "Build it Smart!" website are two resources that provide locally relevant information on sustainable development. Throughout this report, we cite many other resources that are specific to certain aspects of sustainable development.

Approach

Considering Limoneira's goal to make East Area 1 a sustainable community, we have to define what the concept of "sustainable development" means for this project. The foundation of our definition is taken from the Brundtland Commission, which states, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [*United Nations: World Commission on Environment and Development*, 1987]

It is also crucial that we consider the unique conditions of East Area 1. Consequently, we do not to pursue an established "green" certification, such as the U.S. Green Building Council's LEED rating system, which can ignore key aspects of local conditions and circumstances. Rather, we take a holistic view of sustainable development that considers the environmental, economic, and social impacts of developing and operating East Area 1.

To evaluate the issues of sustainability, we divide our analysis into six interrelated areas or sectors: Building Materials, Energy, Landscape Management, Solid Waste, Transportation, and Water. We choose these six sectors because they offer a comprehensive view of sustainable community development. Furthermore, these sectors are commonly addressed in many certification programs, including LEED for Neighborhood Development [*United States Green Building Council*, 2008] and Green Communities [*Green Communities*, 2008].

Our role for this project is as sustainability experts. Our project has a diverse audience that includes Limoneira, the developers, their contractors, and the future residents and workers of East Area 1. Additionally, the Specific Plan is largely conceptual in nature. Therefore, the most valuable deliverable we can provide is a set of specific recommendations that clearly state actions to integrate sustainable practices into East Area 1.

We are aware that there is a dynamic relationship between our six sectors, which means that any choice we make in one area will impact the others. Thus, we always return to the holistic view of East Area 1 to make sure recommendations in each sector complement

or augment recommendations in the others. For instance, increased water efficiency also improves energy efficiency and vice versa; therefore, both the Energy and Water sectors account for such interrelated efficiency enhancements in their analyses.

Since an index of sustainability that is standardized across our six sectors is not feasible for this project, we do not set a minimum quantifiable threshold for sustainability. Instead, we set targets and goals based on the particular sector or specific recommendation. For example, Energy Recommendation E1 requires all new construction in East Area 1 to meet or exceed California's standards for energy efficiency building (Title 24) by at least 20 percent.

The sustainability of East Area 1 is inextricably linked to its maintenance and people's individual and community behavior. Therefore, we are concerned with the community's construction and operation. Our recommendations must be actionable and flexible. Construction, which is set to begin in 2011 or 2012, will likely occur over 10 years. Thus, we need to incorporate leeway for future legislation, evolving building standards, and emerging technologies. Finally, our recommendations have to be economically practical, as well as innovative. We want East Area 1 to be a progressive community and a role model for Ventura County. However, we also have to be mindful of the fact that construction is set to begin in only a few years and that developers need to be able to sell these homes.

Methodology

To evaluate potential recommendations, we used several different methodologies. We went on several site visits to East Area 1 and Santa Paula to learn more about the local conditions and to familiarize ourselves with the geography, weather, topography, architectural style, and culture. We also went on site visits to better understand Limoneira's relationship with Santa Paula.

Additionally, we consulted with many experts including developers, architects, engineers, and consultants to gain valuable professional perspectives on the issues of sustainability that are relevant for East Area 1.

We also conducted an extensive literature review of pertinent research, case studies, technologies, and legislation.

For some sectors, we used models and calculations to support our recommendations. In the Energy sector, we used the Sustainable Buildings Industry Council's Energy-10 model to analyze the environmental and economic impact of integrating various energy efficiency strategies in the residential sector. We also used the California Energy Commission's Clean Power Estimator to determine the feasibility of installing photovoltaic cells on East Area 1's buildings. For the Water sector, we performed calculations to evaluate the effects of using highly efficient water fixtures in homes. We also used the URBEMIS model to measure the effects of various transportation mitigation strategies on the emissions of six criteria pollutants and CO_2.

Although the methodology varied somewhat for each of the six sectors (see the Recommendation Chapters for more sector-specific details), we used this basic framework to make 22 recommendations on how East Area 1 can integrate measures to ensure that it will be constructed and operate in a sustainable way far into the future.

CHAPTER 2
BUILDING MATERIALS

Construction significantly alters the environment. The construction industry sector consumes about half of the resources taken from nature worldwide, including 25 percent of the wood harvest [*United Nations Environment Programme*, 2003]. Extracting and harvesting natural resources depletes them, pollutes the environment, consumes energy, produces waste, and contributes to biological diversity loss. Once obtained, transporting raw materials to production facilities and then processing them into building and construction products creates additional pollution and consumes more energy. Transporting materials to distribution facilities and then to a building site consumes more energy. Subsequently, many products generate waste during installation. Some products have short useful lives, which leads to frequent disposal and requires further manufacturing of replacement products. Additionally, some products contribute to unhealthy indoor environmental quality, which can have adverse health impacts on building occupants. Selecting environmentally sustainable building materials is a way to reduce the negative environmental impacts associated with the built environment.

A 2006 poll by the American Institute of Architects showed that 90 percent of U.S. consumers would be willing to pay about 2 percent more to reduce any adverse environmental affects that building their home may have created, if it was not built with environmentally-friendly materials [*Lippiatt*, 2007]. For that reason, environmentally concerned building product manufacturers and designers need to weigh environmental benefits against economic costs in order to satisfy their customers.

Identifying building materials, or building products, that are both environmentally friendly and affordable is not an easy task. The green building decision-making process is often based on little credible scientific data or limited analyses that do not consider the full range of environmental and human health impacts. Environmental impacts like climate change, pollution, and resource depletion are usually considered economic externalities and, therefore, not incorporated into a product's market price. However, even if environmental costs were required to be included in market prices, it would be very challenging to calculate the costs since environmental quality and services is difficult to quantify in economic terms [*Lippiatt*, 2007].

Since East Area 1 will be a large development, it is important to minimize any adverse impacts on the environment and the health of the inhabitants and surrounding Santa Paula community that building materials may cause. The environmental and human health performance of any building in East Area 1 should comply with the Green Building Guidelines described in the East Area 1 Specific Plan. Additionally, this chapter offers actionable recommendations on how East Area 1 can design and construct a healthy built environment for the community.

Methodology

The recommendations for the environmental and health performance of the building materials and the built environment comprise two general categories: the selection of building materials based on an environmental life-cycle assessment approach, and indoor environmental quality. The three methodological approaches used to evaluate the two categories included an extensive literature review, the use of a life-cycle assessment model as a guideline, and consultation with experts.

The extensive literature review included academic literature, case studies, and conventional and green building guidelines. Additionally, the literature review covered reports, documents, and resources published by government agencies, research laboratories, utilities, building industry associations, and non-profit organizations.

The Building for Environmental and Economic Sustainability (BEES) version 4.0 life-cycle assessment software package, technical manual, and user guide served as a guideline to research the methodology and limitations of life-cycle assessment approaches. The Windows-based decision support software is a systematic technique for selecting cost-effective, low environmental-impact building products. The technique is based on consensus standards, and is designed for designers, builders, and product manufacturers

BEES includes environmental and economic performance data for over 230 building products with a variety of functional applications. The methods for life-cycle assessments are defined in the International Organization for Standardization (ISO) 14000 environmental management standards - particularly in ISO 14040 and 14044. BEES measures the environmental performance of building products utilizing the life-cycle assessment approach specified in ISO 14040. All life stages of building products are assessed: raw material extraction, transportation, manufacture, distribution, installation, use, and waste management [*Lippiatt*, 2007].

Additionally, local architects, developers, and building industry professionals provided us with advice about various aspects of green building design and building materials.

Recommendation BM1: Life Cycle Assessment

Select building products using an environmental life-cycle assessment approach to assess the environmental performance of products and services throughout their life spans in order to reduce the negative environmental impacts associated with the built environment. Reduce negative environmental impacts by implementing strategies such as using recycled and renewable materials from local sources, utilizing sustainably extracted and processed materials, and selecting building products with good environmental performance ratings.

A multi-disciplinary approach known as environmental life-cycle assessment (LCA) can comprehensively measure environmental performance. LCA takes into account multiple environmental and economic impacts over the entire life of building products. Common

categories of environmental impacts include global warming potential, acid rain potential, water pollution potential, fossil fuel depletion, habitat alteration, air pollutants, human health, smog, ozone depletion, and ecological toxicity.

A thorough environmental life-cycle assessment is a *cradle-to-cradle* systems approach for measuring environmental performance. Cradle-to-cradle is a full assessment of the entire life-cycle of a product from raw material extraction (cradle) through the use phase until it is recycled into a new product (cradle). An LCA for products that are disposed of and not recycled is a *cradle-to-grave* assessment, where the "grave" refers to the disposal phase (often in a landfill).

Therefore, a full LCA considers each of the following life-cycle stages when using building materials: raw materials acquisition, manufacturing processes, transportation, installation, operation, maintenance, and recycling and waste management. In addition, when taking into account the economic performance of building materials, include the costs of initial investment, replacement, operation, maintenance, repair, and disposal.

Using an LCA approach, one can develop and implement a systematic methodology for selecting building products that balance environmental and economic performance, based on a decision-maker's criteria that consider actual environmental and economic performance data for various building products. The intended result is a cost-effective reduction in building-related contributions to environmental problems.

Since conducting an LCA can be very complicated and can require the use of dedicated software packages, it may not be possible for a builder to perform an LCA on every possible available building product. Fortunately, some building products may be labeled as environmentally friendly or safe for human health. Choose building products with green labels that are based on a life-cycle approach and third-party certification. The following green labels for building products are examples:

EcoLogo develops rigorous and scientifically relevant criteria that reflect the entire lifecycle of products and services. Building products with the EcoLogo label are verified by an independent third party as complying with the criteria. EcoLogo offers a certified product and service directory on their web site at www.greenseal.org.

Green Seal certified construction and building product and service categories are also evaluated using a life-cycle approach. Green Seal offers a certified product and service directory on their web site at www.ecologo.org.

Additionally, there are many green building labels and claims that are based on a single environmental impact or a single life-cycle stage. Although these types of green labels can be useful for selecting environmentally friendly building products, it is important to consider other possible environmental impacts that may not be addressed in these green labels. For example, timber products marked with the Forest Stewardship Council (FSC) label are independently certified to assure consumers that the materials come from

sustainably managed forests; however, FSC certification does not consider the environmental impacts of the manufacturing processes, the transportation of lumber materials, or disposal. The following four green labels for building products are examples of these more narrowly defined green labels:

FloorScore® labeled products are tested for low VOC emissions, and they meet the California Section 01350 requirements for listed VOCs. A current list of flooring products that have earned the Scientific Certification Systems' FloorScore® seal is available at www.scscertified.com.

Forest Stewardship Council (FSC) labels are on timber products from forestry operations that have been certified by the FSC as meeting the highest standards for environmentally appropriate, socially beneficial, and economically viable management. The FSC web site is available at www.fsc.org.

Greenguard certified products improve indoor air quality. All Greenguard Certified products are listed in the Greenguard Environmental Institute's Online Product Guide at www.greenguard.org.

Green Label and Green Label Plus labeled products assure that carpet and adhesive products meet stringent criteria for low chemical emissions. The Carpet and Rug Institute's Green Label web site is available at www.carpet-rug.org.

Since all stages in the life of a product produce environmental impacts and economic costs, an extensive analysis of building materials in not practical in this report. However, some of the environmental impacts associated with concrete and wood products are particularly noteworthy.

Concrete

Use concrete with at least 35–50 percent fly ash content. Worldwide, the cement industry produces 2.2 billion tons of cement annually, which emits about 5 percent of the world's CO_2 emissions. Approximately 0.9 tons of CO_2 are emitted for every 1.0 tons of cement produced [*Mahasenan, et al.*, 2003].

Fly ash concrete requires less concrete than traditional Portland cement, which can lower the cost of utilizing cement by at least 10 percent while reducing CO_2 emissions. Thirty-five percent fly ash concrete emits approximately 19 percent less CO_2 than conventional Portland cement. Correspondingly, fifty percent fly ash concrete emits approximately 27 percent less CO_2 than conventional Portland cement.

Furthermore, using recycled fly ash in cement making diverts its disposal from landfills. Additionally, using fly ash also reduces the demand for extracting and transporting the aggregate gravel, limestone, granite, and sand used in concrete. Both of these benefits can reduce the environmental impacts associated with concrete.

High-volume fly ash can improve the properties of both fresh and hardened concrete by improving workability, heat of hydration, permeability, strength, and resistance to chemical damage. The type of cement, fly ash quality, and the curing temperature affect the strength of fly ash concrete. Nevertheless, fly ash concrete is usually stronger than standard Portland cement when properly cured [*Federal Highway Administration*, 1999].

Moreover, an innovative type of concrete may become available as East Area 1 is built out. Last year, Novacem, a company based in the UK, announced the invention of a new form of CO_2 absorbing concrete. Novacem's concrete uses magnesium silicates, which emit no CO_2 when heated. Its production process also runs at much lower temperatures, which results in total CO_2 emissions of up to 0.5 tons of CO_2 per ton of cement produced. Yet, the Novacem cement formula absorbs about 1.1 tons of CO_2 per ton of cement produced. Therefore, the overall carbon footprint is negative by removing 0.6 tons of CO_2 per ton used. Unfortunately, Novacem has a patent pending on the cement, and the cement is currently unavailable at this time [*Jha*, 2008]. Use Novacem concrete, if it becomes available when constructing East Area 1.

Plastic Lumber

Use recycled-content plastic lumber, instead of wood lumber, wherever applicable, such as in nonstructural decking applications. Plastic lumber reduces the demand for other lumber materials, such as old-growth trees and pressure-treated lumber, which may be associated with considerable environmental impacts. Furthermore, using recycled plastic diverts it from being disposed of in landfills. Most plastic lumber products on the market are produced from recycled polyethylene (available in high and low densities, HDPE and LDPE), the same material used in plastic milk jugs. Some manufacturers are also using polystyrene, polyvinyl chloride (PVC), and a commingled mix of different types of plastics (mostly collected from municipal recycling programs) [*Robbins*, 2002]. PVC and polystyrene use carcinogenic materials and have adverse environmental and human health impacts. Platt et al. [2005] suggest that polyethylene plastic is associated with less negative environmental and human health impacts.

Recycled plastic lumber is more durable than wood, moisture and chemical resistant, splinter free, does not crack, colored throughout and does not need paint or stain, graffiti resistant, impervious to insects, flexible and can be curved and shaped, maintenance free, does not need sealants or preservatives, and does not absorb bacteria [*California Integrated Waste Management Board*, 2008c]. Recycled content differs widely between plastic lumber products. For instance, one half of the products reviewed in one study contained post-consumer plastic content [*Platt, et al.*, 2005].

Although many plastic lumber products can be recycled at the end of their useful life, some other plastic lumber products may also contain other plastics, fiberglass, wood

fiber, or wood flour. These composite products are more difficult to recycle than single resins [*Robbins*, 2002].

Therefore, use single polyethylene resin products instead of lumber made from plastic composites or commingled plastics, whenever possible. Use plastic lumber with high post-consumer recycled content made from high-density and low-density polyethylene (HDPE and LDPE) by producers sourcing resins from local municipal recycling programs. HDPE lumber is available in many colors and well suited for decking and landscape applications. However, the disadvantage to polyethylene is that it may have a lower stiffness than wood for some applications [*California Integrated Waste Management Board*, 2008c].

Avoid using wood-plastic composites because they have limited end-of-life recyclability, can absorb moisture, have poor impact strength under low temperatures, are not completely insect resistant, can become discolored in outdoor applications, may contain metal contaminants, have a much lower stiffness and strength than wood, can degrade, and have poor flexibility [*California Integrated Waste Management Board*, 2008c].

Limit the use of fiberglass-reinforced or polystyrene-blended structural plastic lumber to outdoor structural applications, such as bridge supports, as a less toxic alternative to chemically treated wood. Fiber-reinforced plastic lumber is stiffer than other plastic lumber, and therefore, well suited for support structures. However, it is less flexible than other plastic lumber, and can irritate skin [*California Integrated Waste Management Board*, 2008c].

Avoid using products with multiple commingled recycled consumer plastics since they are less recyclable, and have more contaminants and inconsistent properties. Commingled plastic lumber is only available in earth tone colors, and has a stiffness much lower than wood [*California Integrated Waste Management Board*, 2008c].

Avoid products made with PVC and polystyrene, because they are associated with more chemical pollutants and environmental impacts than other plastics. Avoid using predominantly non-recycled plastics, because alternatives with high-recycled content are commonly available [*Platt, et al.*, 2005].

The Healthy Building Network (HBN) publishes *A Guide to Plastic Lumber* (see Resources below) in order to assist consumers purchase environmentally responsible plastic lumber products. This guide compares and evaluates plastic lumber products from an environmental and public health perspective.

Engineered Wood

Use no or low VOC emitting engineered wood instead of solid-sawn lumber wherever applicable. Engineered wood, or composite wood, includes a variety of derivative wood products that are manufactured by binding together strands, particles,

fibers, or veneers of wood together with adhesives to form composite materials. Thusly, engineered lumber products can come from small-diameter plantation trees and recycled wood, thereby reducing the demand for old-growth timber and some of the negative environmental impacts associated with timber harvesting and logging activities. Examples of engineered lumber products include oriented strand board (OSB), laminated veneer lumber, laminated strand lumber, parallel strand lumber, and glue laminated timber. Engineered lumber is appropriate for beams and headers, insulated headers, floor web trusses, I-joists, and studs.

Engineered wood products may perform better than solid wood in some applications. Since composite wood is manufactured, its design can meet application-specific performance requirements. Furthermore, small diameter trees and wood with defects can be used to produce composite wood products, thereby reducing the demand for more expensive large diameter trees in building construction. Engineered wood products can be straighter, stronger, more durable, and less prone to humidity-induced warping than some solid wood products.

Nevertheless, engineered wood products have some disadvantages. Engineered wood products require more energy for their manufacture than solid lumber. Most composite boards need treatment with sealant or paint to prevent them from absorbing water. The adhesives, sealants, and paints used to produce composite wood products can contain and emit formaldehyde and other VOCs. However, low VOC and low formaldehyde emitting engineered lumber is available.

Forest Stewardship Council (FSC) Wood Products

Use Forest Stewardship Council (FSC) wood products in the construction of East Area 1 where wood framing, decking, flooring, or authentic wood finishes are required. The FSC uses lumber certification as a tool to promote environmentally, economically, and socially responsible forest management worldwide. FSC maintains chain-of-custody certification throughout the cutting, milling, and delivery of timber products.

Using FSC lumber products can help mitigate environmental degradation and reduce social inequity. For instance, FSC certification helps identify and protect high conservation value forests, improves aquatic and river areas, and helps protect threatened and endangered species [*Newsom and Hewitt*, 2005]. Further, FSC certified forest concessions can experience significantly less deforestation and occurrences of wildfires than in protected non-certified forests [*Hughell and Butterfield*, 2008]. FSC forest concessions also can be used to mitigate climate change through carbon sequestration [*Subak*, 2002]. FSC certification programs benefit timber industry workers by increasing their involvement in decision making processes and by improving their health and safety [*Meidinger, et al.*, 2003]. Furthermore, FSC forest management benefits society by promoting indigenous peoples' interests in local environmental and community issues [*Cashore, et al.*, 2006].

Recommendation BM2: Indoor Environmental Quality

Use building materials that eliminate or minimize occupants' exposure to indoor chemical and microbial contaminants such as volatile organic compounds, formaldehyde, dioxins, mold, and allergens. Use effective source control, ventilation, and filtration to remove or reduce the concentration of indoor air contaminants that may occur in or around the built environment.

Building products can expose occupants to harmful chemical and microbial contaminants such as volatile organic compounds, formaldehyde, dioxins, plasticizers, radon, carbon monoxide, mold, bacteria, allergens, aerosols, particulate matter, and other chemical contaminants. Exposure to indoor environmental pollutants can occur through contact with air, surfaces, and water. Although the term 'indoor environmental quality' is often used to refer to indoor air quality, it is also used this chapter to refer to the exposure to contaminants through contact with surfaces and water.

Americans spend about 90 percent of their time indoors, where concentrations of air pollutants are frequently much higher than those outside. For instance, U.S. EPA studies show that air pollution levels inside the home are frequently two to five times higher than outdoor levels. Exposure to poor indoor air quality and environmental contaminants can have many adverse human health impacts, including cancer, immune system disorders, liver and kidney damage, neurological disorders, eye and respiratory problems, mental dysfunction, allergies, asthma, headaches, and other chronic illnesses [*United States Environmental Protection Agency*, 2007b].

Furthermore, poor indoor air quality can also cause sick building syndrome, which is a variety of illnesses associated with occupying buildings with poor indoor air quality. Sick building syndrome is associated with poor indoor air quality due to air contaminants and the lack of adequate air filtration, ventilation, and inefficient HVAC systems [*Tyrrell*, 1996].

Litigation is also associated with mold, contaminants, and other indoor environmental quality related issues. Litigation and the consequential increasing cost of liability coverage cost builders billions of dollars. However, builders can utilize a range of construction practices and technologies to reduce the risk of poor indoor environmental quality in their new homes. According to the EPA, consumers are willing to pay up to $5,000 more for these improvement measures [*United States Environmental Protection Agency*, 2007b].

Low Emission Building Products

Use building products that have been tested for low-emissions using the California Integrated Waste Management Board's Section 01350 requirements. Selecting building products that meet the California Integrated Waste Management Board's Special Environmental Requirements: Specifications Section 01350 standards can reduce or eliminate occupants' exposure to indoor air contaminants. The State of California developed the Section 01350 standard to test for emissions of formaldehyde

and 80 other individual VOCs from interior finish products. The standard establishes threshold levels for approval of the manufacture of those products.

Section 01350 is a standard, and not a certification process. However, many certification programs for evaluating long-term exposure risks from formaldehyde and other VOC emissions are based on Section 01350 [*California Integrated Waste Management Board*, 2008d]. This includes the testing protocol for the following certification programs:

- California Gold Sustainable Carpet Standard
- Collaborative for High Performance Schools Low Emitting Materials Table
- FloorScore®
- Greenguard Children and Schools
- Green Label Plus
- Indoor Advantage Gold
- Institute for Market Transformation to Sustainability SMART Building Product Standard.

Section 01350 practices apply to materials generally used within an indoor environment such as paints, building coatings, adhesives, sealants, wall and floor coverings, wood paneling, and furniture components used in public and commercial office buildings, schools, medical buildings, residences and other building types.

It is important to note that the Section 01350 standard does not set a conservative safe emission level for formaldehyde, because formaldehyde tests use one-hour acute reference exposure levels rather than the long-term chronic exposure levels used for the other chemicals. Therefore, it is not particularly reliable for evaluating long-term exposure to formaldehyde emissions. Yet, formaldehyde is a known carcinogen with no known safe level of exposure. For this reason, products with positive formaldehyde emissions that are within the Section 01350 limits can still be a cancer risk [*California Integrated Waste Management Board*, 2008d]. As such, builders should not rely on Section 01350 certification to guide their selection of products that may contain formaldehyde.

Building Design and Products

Use a certification program, such as the EPA's Energy Star Indoor Air Package, as a guideline to reduce or eliminate occupants' exposure to indoor air contaminants. The EPA created the Energy Star Indoor Air Package to assist builders meet the increasing consumer demand for homes with improved indoor air quality and energy efficiency. Homes that meet the specifications can offer reduced risks of indoor air problems, lower utility costs, superior comfort, and enhanced durability. Builders can implement over 70 home design and construction features in the Indoor Air Package to help protect homes from moisture and mold, chemicals, and other air contaminants.

The Indoor Air Package specifications protect homeowners and distinguish homes equipped with a comprehensive set of recommended indoor air quality features. Homes that comply with these specifications and that are subsequently verified with a completed Indoor Air Package Verification Checklist can use Indoor Air Package certification as a complementary label to Energy Star for homes. Although only Energy Star-qualified homes are eligible for this label, builders can successfully use the Indoor Air Package specifications as guidelines without having to become Energy Star or Indoor Air Package certified. Although the Indoor Air Package specifications are intended for homes, many of the specifications and strategies apply to other types of buildings including commercial, industrial, and institutional structures.

The construction practices and technical specifications included in the Energy Star Indoor Air Package can contribute to better indoor air quality in new homes compared with code-built homes. Nevertheless, these improvement measures cannot guarantee that residents will not experience indoor air quality problems in their homes. More precisely, the Indoor Air Package is a means to reduce the possibility of experiencing such concerns. For instance, homeowner behavior will affect indoor air quality and the performance of the measures specified in the Indoor Air Package.

The Indoor Air Package includes the following categories of design and construction features: moisture control, HVAC systems, combustion systems and garage isolation, radon control, building materials, pest barriers, and home inspection. These control features address a range of indoor environmental problems, including:

Mold

Moisture promotes the growth of mold. Moisture accumulation inside buildings can occur from condensation due to improper ventilation, water penetrating areas of the building envelope, plumbing leaks, or the penetration of ground moisture. Moisture can also collect in building materials that are prone to absorb moisture. Mold mildew can proliferate where cellulosic materials such as paper, wood, or drywall become moist and fail to dry within a couple days. Mold can cause allergenic reactions, respiratory problems, and may provoke episodic symptoms in people with asthma [*World Health Organization*, 2007].

Mold growth can be prevented and controlled by incorporating the moisture control features specified in the Indoor Air Package, such as minimizing the risk of water leakage and material damage in areas with high risk for plumbing leaks, and managing surface water to move water away from building foundations. The Indoor Air Package also recommends that builders install drain tile systems at all footings, capillary breaks below concrete slabs, flashing or equivalent drainage system at the bottom of exterior walls, continuous drainage planes behind exterior wall cladding, deck ledger board drainage systems, step and kick-out flashing at roof-wall intersections, and minimum No. 30 roof felt underlayment or equivalent. Furthermore, builders are directed to make below grade walls damp-proof; fully flash windows and doors; air seal sump pump covers; leave crawl spaces unvented, insulated, and conditioned; and prevent condensation problems (e.g.

mold and rot) related to air leakage in exterior wall assemblies and at attic-ceiling interfaces. For further details, refer to the Indoor Air Package specifications.

Volatile Organic Compounds

Volatile organic compounds (VOC) are a category of thousands of different chemicals, such as formaldehyde and benzene, which evaporate easily into the air. Long-term exposure to VOC emissions can increase the risks of developing cancer, liver and kidney damage, and neurological disorders. Short-term exposure can aggravate asthma and cause dizziness; headaches; and eye, nose, and throat irritation [*United States Environmental Protection Agency*, 2009a].

Avoid or minimize occupants' exposure to VOCs. Use no or low VOC building products. Follow the Indoor Air Package specifications for proper air filtration, ventilation, and source control.

Formaldehyde

Formaldehyde is a type of VOC that is a common component of adhesives used in carpeting, particle board, and furniture. Further, sheathing products are frequently made of wood, which emits formaldehyde. Formaldehyde is classified as a Toxic Air Contaminant by the California Air Resources Board, because it is carcinogenic and may cause other adverse health problems [*United States Environmental Protection Agency*, 2009a].

Different composite wood products, such as oriented strand board (OSB) and softwood plywood, have various levels of formaldehyde emissions. Composite wood products using urea-formaldehyde adhesives have higher formaldehyde emissions than those that utilize phenol-formaldehyde adhesives. Most OSB is produced using a methylene diphenylisocyanate (MDI) binder. OSB using an MDI binder emits no formaldehyde, except for the insignificant amount that naturally occurs in the wood itself [*Wilson and Malin*, 1996]. Softwood plywood has very low indoor formaldehyde emissions, because low emission phenol-formaldehyde binders are used, and because it is mainly installed on the exterior shell of buildings [*American Institute of Architects*, 1996].

Avoid or minimize occupants' exposure to formaldehyde. Use no or low formaldehyde building products. Follow the Indoor Air Package specifications for proper air filtration, ventilation, and source control.

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and metabolic processes in humans, animals, and plants. Outdoor levels of carbon dioxide are typically 300 - 400 parts per million (ppm). Carbon dioxide levels are often greater inside a building than outside. Carbon dioxide levels should be between 600 - 1,000 ppm in properly ventilated buildings. The floor or building average should be of 800 ppm or less. If carbon dioxide levels are greater than 1,000 ppm, health complaints may occur. Excessively high levels of indoor carbon dioxide may cause occupants to become drowsy, develop headaches, or otherwise function at lower activity levels [*Illinois Department of Public Health*, 2007].

Proper ventilation and effective HVAC systems can reduce carbon dioxide levels in buildings. Certified carbon dioxide detectors should be installed in buildings that use HVAC systems, but that have no natural ventilation or operable windows, such as industrial and office buildings.

Carbon Monoxide and Other Combustion Gases

Exposure to gases generated from the combustion and incomplete combustion of fuels can have adverse health effects. Sources of combustion gases include combustion fueled heating equipment, furnaces, water heaters, fire places, fuel burning appliances, exhaust from gasoline powered motors and engines, and tobacco smoke. Toxic and other harmful substances in combustion gases include carbon monoxide, nitrogen oxides, sulphur dioxide, polycyclic aromatic hydrocarbons, aldehydes, hydrocarbons, and particulates. The composition and characteristics of combustion gases, and the severity of their effect on building occupants, depend on several factors, including the type of fuel being burned and the characteristics of the combustion system [*Consumer Product Safety Commission*, 2008].

Exposure to these gases can cause health problems ranging from headaches and severe illnesses to carbon monoxide poisoning and death. Chronic exposure can cause low-grade ailments and the deterioration of occupants' health [*Consumer Product Safety Commission*, 2008].

Avoid or minimize occupants' exposure to carbon monoxide and other combustion gases by installing proper ventilation, and efficient fuel burning systems. Garages should be ventilated and sealed from buildings to isolate and remove the emissions from stored chemicals and other fuel burning devices. Certified carbon monoxide alarms should be installed outside each sleeping area. Follow the Indoor Air Package specifications for proper air filtration, ventilation, and source control.

Ozone

Ozone is a respiratory irritant created by equipment that uses high voltage electricity, such as photocopiers and ion generator air cleaners [*United States Environmental Protection Agency*, 2008d]. Do not install equipment that intentionally produces ozone. Adequate ventilation can minimize occupants' exposure to ozone. Follow the Indoor Air Package specifications for proper ventilation and source control.

Radon

Radon is a cancer-causing naturally occurring radioactive gas. Radon is the leading cause of lung cancer among non-smokers, and the second leading cause of lung cancer in America. In addition to being found in the ground in some areas, radon can be emitted by some building materials [*United States Environmental Protection Agency*, 2009b]. Homes built in U.S. EPA Zone 1 and Zone 2 radon areas should be constructed with approved radon-resistant features as applicable by law. Provide owners of homes in U.S. EPA

Zone 1 and Zone 2 radon areas with radon test kits. See the Indoor Air Package specifications for further details regarding effective radon mitigation strategies.

Particulates

Although particulates result from the combustion of fuel, they can also be produced by building materials. Particulates are classified as either respirable (less than 5 micrometers in diameter) or nonrespirable (greater than 5 micrometers in diameter). Respirable particles can penetrate into and harm the lower lung. Nonrespirable particles can lodge in the upper respiratory system and cause irritation. The U.S. EPA National Ambient Air Quality Standard (NAAQS) for particulates 2.5 to 10 micrometers in diameter (PM_{10}) is 150 micrograms of particulates per cubic meter of air. The NAAQS for particulates 2.5 micrometers in diameter or less ($PM_{2.5}$) is 65 micrograms of particulates per cubic meter of air. Maintaining air contaminant levels less than the NAAQS would ensure superior indoor air quality [*United States Environmental Protection Agency*, 2007c; 2008e].

Insulation products are a particular concern for indoor air quality, because of the health impacts of hazardous chemicals, fibers, and particles released from some insulation products. Fiberglass products are listed by the International Agency for Research on Cancer as a "possible carcinogen" and are currently required to display cancer-warning labels. In response, the fiberglass industry has developed fiberglass products that reduce the amount of loose fibers escaping into the air [*Wilson, et al.*, 1995]. Some fire retardant chemicals and respirable particles in cellulose products are also hazardous to human health. Additional, mineral wool may emit fibers and chemicals that are health irritants [*Wilson, et al.*, 1995]. Using insulation products that do not include fiberglass, like Icynene, a non-toxic blown-in insulation, can reduce harmful particulate concentrations in buildings. To read about Icynene, see the HVAC Efficiency and Envelope section under Recommendation E1 in the Energy Sector chapter.

However, health risks to building occupants from these products can be minimized, if they are installed according to manufacturers' recommendations [*Wilson, et al.*, 1995]. Furthermore, proper ventilation and air filtration can minimize exposure to particulates. Air-handling equipment and ducts should be clean and provide proper airflow. Follow the Indoor Air Package specifications for proper air filtration, ventilation, and source control.

Pests

Indoor pests can contribute to indoor environmental quality problems by infesting the living space, introducing dust and dirt, and by spreading diseases. Furthermore, the pesticides used to control indoor pests can emit harmful chemicals into the built environment. Permanent structural pest controls can prevent pests from entering homes and other buildings. Seal penetrations and joints in and between foundation and exterior wall assemblies. Install corrosion proof rodent and bird screens in all building openings that cannot be fully sealed and caulked. Install termite shielding along the foundation slabs where termites can enter the structure. We recommend following the Indoor Air Package specifications for proper termite barrier installation.

The Indoor Air Package specification can be downloaded from the Energy Star website. For more information, visit www.energystar.gov/homes.

For further recommendations regarding thermal comfort and the use of passive ventilation, HVAC, and mechanical ventilation systems, see the HVAC Efficiency and Envelope section under Recommendation E1 in the Energy Sector chapter.

Polyvinyl Chloride

Do not use polyvinyl chloride (PVC) plumbing or building materials. Polyvinyl chloride (PVC) plastic is commonly known as vinyl or vinyl chloride. The production, use, and disposal of PVC releases persistent pollutants such as cadmium, dioxins, lead, organotins, and phthalate plasticizers. PVC and its associated pollutants are known to cause cancer, impair reproduction, cause birth defects, impair childhood development, disrupt the endocrine system, damage the brain, disrupt the immune system, and cause endometriosis and neurological damage. PVC and its related pollutants can be emitted into the air and leach into water from PVC products. Exposure can also occur through direct contact [*Thornton*, 2002; *Woolley and Kimmins*, 2000].

Many of the pollutants emitted from the production of PVC, especially dioxins, occur throughout the world and are present in detectable levels in the bodies of most Americans. In particular, dioxins can cause cancer, impair reproduction, cause birth defects, impair child development, and disrupt the endocrine system. Dioxin is a particular concern because it is a persistent bioaccumulative toxic chemical. That is to say, it does not degrade rapidly, it is stored in fatty tissue, and accumulates in higher concentrations as it goes up the food chain. Alarmingly, dioxins can be found in high concentrations in American mothers' breast milk [*Thornton*, 2002; *Woolley and Kimmins*, 2000].

PVC can be found many types of building materials, including: piping, vinyl siding, vinyl flooring, roof membranes, wall coverings, carpet backing, window and door frames, shades and blinds, furniture, shower curtains, flues, gutters, down spouts, water stops, weather-strip, flashing, moldings, electrical wire insulation, conduit, and junction boxes.

Fortunately, there is a wide range of cost-effective and safer alternative materials [*Thornton*, 2002]:

- For piping: cast iron, steel, concrete vitrified clay, copper, and plastics (e.g. high-density polyethylene).
- For siding: fiber-cement board, stucco, recycled or reclaimed or FSC certified wood, oriented strand board, brick, and polypropylene.

- For roofing membranes: TPO (thermoplastic polyolefin), EPDM (ethylene propylene diene monomer), NBP (nitrile butadiene polymer), and low-slope metal roofing.
- For flooring and carpets: linoleum, bamboo, ceramic tile, carpeting made with natural fiber backing or polyolefins, reclaimed or FSC certified wood, cork, rubber, concrete, and non-chlorinated plastic polymers.
- For wall coverings and furniture: natural fibers (e.g. wood and wool), polyethylene, polyester, and paint.
- For electrical insulation and sheathing: halogen free LLDPE (linear low-density polyethylene), XLP and XLPE (thermoset crosslinked polyethylene).
- For windows and doors: recycled or reclaimed or FSC certified wood, fiberglass, and aluminum.

Resources

Building for Environmental and Economic Sustainability (BEES): http://www.bfrl.nist.gov/oae/software/bees.
The free BEES Version 4.0 LCA software includes environmental and economic performance data for 230 building products.

EPA Energy Star Indoor Air Package (IAP): http://www.energystar.gov.
The IAP indoor air quality certification is a complementary set of guidelines and labeling to Energy Star for homes.

Healthy Buildings Network: http://www.healthybuilding.net.
This advocacy group offers many resources and publications on green building guidelines for buildings and building materials, and an online evaluation tool for building materials.

CHAPTER 3
ENERGY

To make East Area 1 a sustainable community, it is essential to consider its potential energy consumption. Although Santa Paula's electricity mix has more renewable energy sources than the national average, 55.4 percent is still generated from fossil fuels [*United States Environmental Protection Agency*, 2008a]. When burned, fossil fuels emit greenhouse gases, which cause global warming. We are already experiencing some of the effects of climate change, including sea level rise, changes in precipitation patterns, more droughts and wildfires in California, and shifts and constrictions of species ranges. To prevent further environmental degradation, the use of greenhouse gas-emitting energy must be minimized in communities around the world, including in East Area 1 [*Energy Information Administration*, 2008].

Improving energy performance makes sound economic sense. Energy prices, which can be very volatile, will likely rise in the future. California already has one of the highest electricity rates in the country [*Reuters*, 2008]. Integrating energy efficiency measures and renewable energy technology into buildings in East Area 1 will help reduce monthly utility bills and protect the community from energy price hikes. Additionally, high-performing "green" buildings are more marketable than traditional buildings [*California Energy Commission*, 2009b], which is a benefit that is even more crucial in the current economic and real estate market.

Adopting the recommendations in this report may also help East Area 1 stay ahead of future legislation. For example, the 2030 Challenge Stimulus Plan, which mandates building performance standards for fossil fuel-based energy usage, could be adopted by President Obama's administration [*PRNewswire*, 2009].

In 2007, residential and commercial buildings consumed about 40 percent of all of the energy used in the United States [*Energy Information Administration*, 2007]. These types of buildings will be the focus of the recommendations in this chapter, because they are the dominant building types in East Area 1. Additionally, energy use from transportation is addressed in the Transportation Recommendations, and energy efficiency for outdoor lighting and streetlights is discussed in the Landscape Management chapter.

All four recommendations in this chapter provide actionable items on how East Area 1 can most effectively improve energy efficiency and integrate renewable energy systems into the built environment. They address both the construction and operation of buildings. Moreover, they also address the necessary flexibility to reduce barriers to retrofitting and incorporating emerging technologies in the future.

Methodology

Several methods were used to evaluate the feasibility and the economic and environmental impacts of our potential recommendations. We performed an extensive literature review of case studies, existing green building guidelines (especially Built Green Santa Barbara), and other resources from utilities, non-profit organizations, governmental departments, private companies, and research laboratories. Additionally, we consulted with local experts, including architects, engineers, developers, and builders.

We used two models to assess energy performance strategies. Employing the California Energy Commission's Clean Power Estimator [*California Energy Commission*, 2009a], we evaluated the economic feasibility and potential electricity output of installing photovoltaic panels on residential units and commercial buildings in East Area 1.

Energy-10 Version 1.8 is a software tool developed by the National Renewable Energy Laboratory Center for Building and Thermal Systems, the Sustainable Buildings Industry Council, Lawrence Berkeley National Laboratory, and the Berkeley Solar Group [*National Renewable Energy Laboratory*, 2008a]. With this model, the user can analyze the energy consumption of buildings less than 10,000 square feet (ft^2), and the impacts of various energy efficiency strategies. It also requires relatively few inputs. Therefore, it is well suited for use in the early design stages. Energy-10 has been verified using the Building Energy Simulation TEST procedure, which was developed by the National Renewable Energy Laboratory's Center for Building and Thermal Systems and adopted by the Department of Energy as the accepted method for confirming the accuracy of computer simulation models.

We modeled two residential building types – a two-bedroom apartment and a four-bedroom detached single-family house. The square footages and baseline home prices for each dwelling type are the averages of apartments/townhouses/condominiums and single-family houses sold in Santa Paula from January 2008 to September 2008 as found on www.trulia.com, a real estate search engine. We determined that the apartment was 961 square feet and cost $176,824, and the single-family house was 1,695 square feet and $420,360.

Models were run for a one- and two-story single-family house. For the apartment, we assumed that one wall would be shared with the adjacent unit and would therefore have no windows. Thus, there were four different window placements. However, we averaged the data, as there was little difference between the four configurations. The baseline condition was set to only meet California's minimum energy efficiency standards, Title 24 for 2008, which is a state standard that is revised and made more stringent every few years [*California Energy Commission*, 2008]. The baseline and the energy efficiency scenarios all had window placements that maximized passive solar heating and cooling. Energy efficiency strategies were then added to analyze their impacts on energy use, carbon dioxide (CO_2) emissions, utility bills, and the construction costs of each dwelling type. For more information on the baseline condition, the scenarios, and the inputs and

assumptions of the model, see Tables E1 and E2 in Recommendation E1, as well as Appendix A.

Recommendation E1: Energy Efficiency

Integrate energy efficiency measures into all buildings so that new construction will exceed Title 24 standards by at least 20 percent. Strategies include applying passive solar heating and cooling; improving daylighting; installing utility monitoring systems; and minimizing the energy used for space conditioning, lighting, and appliances.

Several cities in California have passed Green Building Ordinances, which include energy efficiency requirements [*California Department of Justice*, 2008]. In Santa Monica, all new construction and major renovations must exceed California's building standards for energy efficiency (Title 24) by 10 percent [*Santa Monica Green Building Program*, 2008]. In Santa Barbara, the energy consumption of single-family houses and major residential additions must exceed Title 24 by 20 percent [*Gabel*, 2007]. Instituting an ambitious and measurable benchmark in East Area 1 will force builders to integrate energy efficiency measures into construction. It will also increase the marketability of buildings and help establish this community as a sustainability leader in Ventura County.

Although all recommendations in this sector strive to minimize the energy consumption of buildings in East Area 1, this recommendation focuses on energy efficiency strategies that can be help meet or exceed Title 24 standards by 20 percent.

Orientation and Layout

Design buildings with layouts that integrate passive solar heating and cooling, and daylighting. In traditional housing developments, dwelling units tend to be uniform with little regard to orientation. However, a well thought out building layout can improve the energy efficiency of a home and make it a more inhabitable and comfortable space. Likewise, designing non-residential buildings with an eye toward smart window placement and daylighting strategies will improve energy performance and occupant comfort. Some of the documented benefits of daylighting and passive solar design include increased worker and student productivity, reduced absenteeism, and improved human health [*Dobrovolny*, 2008; *Heschong Mahone Group Inc.*, 2003].

Residential

Residential units should strive to have a very open floor plan with as few walls as possible. This design will allow sunlight to transmit more freely throughout the space and improve natural ventilation (*note*: an exception to this guideline would be a home with rarely used rooms that could be segregated, and thus, neither actively cooled nor heated).

Having the maximum allowable window area as determined by the existing Title 24 standards and positioning windows strategically on the east, west, and south walls will

create a light and airy feel and increase marketability. It will also provide daylighting, thereby decreasing the energy demand for artificial lighting. Proper window placement can also improve natural ventilation and reduce the energy demand for mechanical heating, ventilating, and air conditioning (HVAC) system needs.

All dwelling units in East Area 1 should have many windows on the southern wall to provide passive solar heating. Having the longer side of the house run east-to-west will maximize the amount of incoming sunlight (and heat) in the winter [*Chiras*, 2002]. The prevailing winds in Santa Paula are westerly, so homes should have the maximum number of windows on west-facing walls, which will improve indoor air quality, reduce air-conditioning needs, and let in direct sunlight in the afternoon. Placing windows on east-facing walls will allow cross-ventilation and direct morning sunlight.

Besides window placement, a home can employ several other strategies to improve daylighting. For example, skylights can be installed. If a homeowner is concerned about excess solar gain from skylights, materials are available that can diffuse light without transmitting direct sunlight [*Jayamaha*, 2007].

Although traditional skylights provide more visual connection with the outdoor environment, light tubes (also known as tubular skylights) provide some distinct advantages. They transmit sunlight more effectively, and they have better insulation against heat loss in the winter and heat gain in the summer. Moreover, they do not have the condensation problems of conventional skylights. They are also easier to install, and there is more flexibility in where they can be placed [*Santa Barbara Contractors Association*, 2007].

Furthermore, using light-colored paint and building ceilings that slope away from where the windows are located can help increase the brightness of the indoor surface areas [*Ander*, 2008].

Non-residential

Many of the strategies outlined for the residential sector are also appropriate for many non-residential buildings, especially offices, retail stores, and schools. Although this sector may be more constrained with window placement, window area should still be maximized. With large offices and schools, the techniques to bring natural light to non-perimeter areas are even more important than in the residential sector.

Commercial buildings should have operable windows, which have many documented benefits. Occupants are able to tolerate a wider range of temperatures in a naturally ventilated building [*Brager*, 2000], and sick-building syndrome is rarer [*Hedge, et al.*, 1989]. Research has also shown that integrating the HVAC system with operable windows can result in significant energy savings. Researchers in Merced, California (which has a hotter, more humid climate than Santa Paula), ran a simulation of a theoretical office building in which the HVAC system was configured to automatically turn off when the windows were open. They found that the building's annual energy usage was 37 percent

lower than a building that was sealed and only used mechanical ventilation and cooling [*Daly*, 2002]. East Area 1 commercial buildings should implement this kind of integrated system, whose benefits in terms of environmental and human health impacts and lower utility bills far outweigh the higher construction costs of more extensive HVAC zoning.

Proper window glazing and shading techniques can help improve passive solar heating and cooling, and daylighting for all buildings (see the "HVAC Efficiency and Envelope" section of this Recommendation for more detail).

Utility Monitoring and Zoning

Install sub-meters for multi-family housing and the commercial sector. Installing sub-meters will allow all residents and businesses in East Area 1 to know how much energy they are using each month. Sub-metering will also help them see the impact of their energy choices, as well as the value in altering their behavior to conserve energy and implement their own energy efficiency strategies (e.g. switching from a desktop to a laptop computer) [*Energy Conservation Services Corporation*, 2007]. Sub-metering also elucidates the benefits of renting a space that is highly energy efficient.

Install utility monitoring systems in all buildings. All residential and non-residential units should be equipped with a utility monitoring system, preferably a dashboard that is Web-enabled. By providing detailed and near-instantaneous information on a building's energy usage patterns, residents and business owners will be able to determine both when and how they use energy and will therefore be better equipped to change their consumption patterns. Most systems that provide real-time feedback claim that they can reduce energy consumption by about 20 percent

A utility monitoring system should have certain features, including:

- Detailed, real-time monitoring of energy use (electricity and natural gas)
- Ability to track energy costs
- User-friendly interface that uses Web-based software
- Carbon footprint calculator

Although many of the more sophisticated dashboards are not yet available on a commercial scale, they will likely become more widely available during the 10-year construction process of East Area 1. Therefore, they will become more feasible for the residential sector and smaller commercial buildings in the future. The AgileWaves Resource Monitor provides detailed information on energy usage by floor, room, or appliance, and it can monitor electricity, natural gas, water usage, and elements like a "green" roof or a geothermal pump [*Agilewaves*, 2008]. Greenbox's home energy monitoring system can suggest energy efficiency strategies. Additionally, it allows users to anonymously compare their usage patterns to other homes similar to their own. Greenbox has not yet priced their system, but it plans on offering it on commercial scale by late 2008 or early 2009 [*Greenbox*, 2008].

Several simpler home energy monitoring systems are currently widely available, and they may be a good choice for some residential units. These systems provide real-time feedback, but they do not generally provide information on carbon emissions or detailed data and graphs. For example, Blueline Innovations' PowerCost Monitor ($150) is a simple wireless device that displays real-time electricity usage and costs [*Blueline Innovations*]. The Energy Detective ($145) is a very similar system, although it also has a data-logging software option [*The Energy Detective (TED)*, 2007].

Larger commercial buildings should consider using one of the dashboards in conjunction with a Building Automation System, which is able to monitor multiple systems such as HVAC, lighting, electrical, security, and fire protection. This type of system already has many features and settings that can help reduce energy consumption, including a scheduling feature, equipment interlock (allows multiple systems to be turned off together), demand lighting (lighting energy demand can be kept below a specified target), and alarms that inform the user when equipment requires maintenance [*Jayamaha*, 2007].

Southern California Edison plans to replace some of the electricity meters in its service area with new "smart" meters between 2009 and 2012. By allowing two-way communication between the smart meter and the utility, building owners can have access to more detailed and comprehensive information on their electricity usage. Smart meters also allow pricing structures that more accurately reflect demand [*Southern California Edison*, 2009]. Smart meters will make utility monitoring even easier and probably more cost effective. Google even has a prototype program called PowerMeter, which can be downloaded at no charge. PowerMeter allows homeowners who are connected to smart meters to easily decipher their consumption patterns [*Google*, 2009].

Install programmable thermostats and HVAC "smart" zoning control systems in residences. Each residential unit should have an Energy Star qualified programmable thermostat, which provides residents with a large degree of control and flexibility. These thermostats have at least two programs (one for weekdays, one for weekends), four temperature settings, and a hold feature [*Santa Barbara Contractors Association*, 2007]. Strategic use of a programmable thermostat can save residents about 10 percent on their heating and cooling bills [*United States Department of Energy*, 2008g]. Programmable thermostats are affordably priced (about $30–$250), and should pay for themselves in one to two years [*Partnership for Advancing Technology in Housing*, 2008e].

Install an HVAC "smart" zoning control system, which uses zoning technology that has been around for decades in the commercial and industrial sectors. This system partitions the home into two to three zones, each of which has its own programmable thermostat. The control panel conveys information between the indoor climate, the programmable thermostat, and the positions of the dampers on the ducts. This provides residents with more control over the space conditioning of their home. This system, which costs about $1,200–$2,000 to install, can reduce a home's heating and cooling energy use by 10–20

percent when used with proper temperature setbacks [*Partnership for Advancing Technology in Housing*, 2008b].

HVAC Efficiency and Envelope

Institute the energy efficiency measures described in Scenario C from the Energy-10 model (see below for description), which are estimated to exceed Title 24 by 35.9–49.2 percent. Energy-10 modeling software was used to simulate the energy consumption of a two-bedroom apartment and a four-bedroom detached single-family house in Santa Paula. The baseline case meets the minimum 2008 Title 24 standards, and has the window configurations shown in Table E1 to maximize passive solar heating and cooling, and daylighting.

Scenario A incorporates efficiency improvements to the HVAC system and reductions in duct leakage. Scenario B builds on Scenario A and includes a reduction in the effective leakage area and window glazing improvements. Scenario C includes all of the previously mentioned strategies, as well as exterior window shading, enhanced insulation, and thermal mass. See Table E2 for more detailed descriptions of the scenarios and Appendix A for more information on the assumptions and inputs of the model.

Table E1**:** Window Placement and Square Footages for the Dwelling Units Run in the Energy-10 Model. These configurations were used for the baseline and all three scenarios.

	Square footage	Maximum allowable window area (ft^2)	Maximum number of windows (3 feet by 4 feet)	Number of windows on each wall (North/East/ South/West)
Two-bedroom apartment	961	192.2	16	0/6/6/4, 4/0/8/4, 4/8/0/4, 4/4/8/0
Four-bedroom house	1695	339.0	28	4/4/12/8

Although Scenario B achieves the target energy reduction of 20 percent (Figure E1), the more comprehensive energy efficiency strategies in Scenario C significantly decrease energy usage without adding major costs. The apartment and house consumed 35.9–49.2 percent less energy and emitted 31.3–43.1 percent less CO_2 (Figure E2) than the baseline. Although more expensive than Scenario A or B (Figure E3), Scenario C added less than three percent to the cost of a dwelling unit.

A family living in a Scenario C home can expect to pay about $400–$600 less per year in energy costs than a family in a baseline home that is merely compliant with Title 24 (Figure E4). This reduction assumes an electricity cost of $0.1191 per kilowatt-hour

(kWh) and a natural gas price of $0.9711 per therm. If energy prices increase, this reduction will become even more dramatic.

Table E2: Descriptions of Scenarios Run in the Energy-10 Model for the Residential Sector. HVAC system is a direct expansion (DX) cooling unit with gas furnace (ducted, split system). See Appendix B for a glossary of selected terms in this table.

	Baseline	Scenario A	Scenario B	Scenario C
HVAC gas furnace	78% efficiency	97% efficiency	97% efficiency	97% efficiency
HVAC compressor	11.1 energy efficiency ratio (EER)	14 EER	14 EER	14 EER
HVAC forced air	15 percent fan efficiency	35 percent fan efficiency	35 percent fan efficiency	35 percent fan efficiency
Duct leakage	6 percent	2 percent	2 percent	2 percent
Effective leakage area	0.00092 ft^2/ft^2 of gross wall area	0.00092 ft^2/ft^2 of gross wall area	0.00025 ft^2/ft^2 of gross wall area	0.00025 ft^2/ft^2 of gross wall area
Window glazing	U 0.40, solar heat gain coefficient (SHGC) 0.40	U 0.40, SHGC 0.40	U 0.26, SHGC 0.17	U 0.26, SHGC 0.17
Shading	None	None	None	Overhangs on south-facing windows, sized for 36° latitude
Walls	2x4 frame, R 13.03	2x4 frame, R 13.03	2x4 frame, R 13.03	2x6 frame, R 23.09
Floors	2x4 frame slab on grade, R 19.05, f-factor 0.9	2x4 frame slab on grade, R 19.05, f-factor 0.9	2x4 frame slab on grade, R 19.05, f-factor 0.9	2x4 frame slab on grade, R 14.10, f-factor 0.2
Roof	R 30.20	R 30.20	R 30.20	R 38.18
Doors	Wood, U 1.43	Wood, U 1.43	Wood, U 1.43	Foamcore, U 0.18
Thermal mass	None	None	None	0.5 of floor area, 8-inch concrete

Furthermore, homes built later in East Area 1's 10-year construction horizon (and beyond) will likely have to comply with stricter energy efficiency standards. For example, a house built with Scenario C strategies in 2010 may exceed Title 24 by 40 percent, but that same house built in 2017 may only exceed Title 24 by 15–20 percent. Detailed results are in Appendix C, and further elaboration follows on some of the energy efficiency measures outlined in Table E2.

HVAC System

The HVAC system modeled in Energy-10, a DX system with gas furnace and forced air distribution, is advantageous because it is widely used and inexpensive, and it will be easy to find installation contractors. Additionally, as shown in the Scenarios above, the energy used for heating and cooling can dramatically decrease with this system when the proper energy efficiency strategies are applied.

The HVAC systems employed for large multi-family and commercial, industrial, and institutional (CII) buildings will likely be much more complex than those used for single-family homes. There are many possible HVAC systems for these buildings. Some may use geothermal heat pumps (see "Geothermal Heat Pumps" under Recommendation E3). Others may be cooled using chillers or packaged rooftop units.

There are several other ways to improve the energy efficiency of these types of systems. An economizer allows the building to cool its interior using outside air. A variable air volume system (as opposed to constant air volume) increases fan efficiency by allowing the supply air to increase or decrease depending on the building's cooling requirements. Chillers can be consolidated for further energy savings [*Jayamaha*, 2007].

All HVAC systems must allow utility meters to be individually read (see "Utility Monitoring and Zoning" under this recommendation). It is also essential that HVAC systems are properly maintained and correctly sized. Oversizing will cause the system to turn on and off frequently, resulting in inefficiencies, shorter equipment life, and poor control of the indoor environment. Small residential systems should be sized using the Air Conditioning Contractors of America Manual J Residential Load Calculations [*Partnership for Advancing Technology in Housing*, 2008c].

Insulation

Increasing the R-value of walls, roofs, and floors will tighten the building's seal and reduce energy losses from heating and cooling. Although 2x6 framing will significantly increase the performance of wall insulation, other steps can be taken to achieve higher R-values, including replacing some of the stick framing elements with structural insulated panels or insulating concrete forms. Blown-in insulation that does not negatively affect indoor air quality can also be used for this purpose. For example, Icynene is a non-toxic blown-in insulation with low thermal conductivity that has better penetration than fiberglass. Minimizing the number of framing members that completely bridge the interior and exterior surfaces will also improve thermal performance [*Santa Barbara Contractors Association*, 2007].

To reduce solar gain from the roof, East Area 1 buildings should use the cool roof color materials that are being developed by the Oak Ridge National Laboratory and Lawrence Berkeley National Laboratory. Unlike conventional cool roof products, this paint will reflect solar energy in the infrared spectrum, thus allowing roofs to be any color. These paints, which will have a solar reflectance of 35–40 percent, should be available for homes within three to five years [*Lawrence Berkeley National Laboratory*, 2008].

With a tightly sealed building, it is important to maintain good ventilation for occupant comfort and indoor air quality. Thus, in addition to having operable windows, buildings should be equipped with a ventilation control system whose performance is periodically verified. There are many economical choices, including central air handler fan controls, and integrated exhaust fan and microprocessor control systems [*Partnership for Advancing Technology in Housing*, 2008g].

Windows

Although solar gain can be reduced by decreasing the SHGC and the U-factor, thermal performance can also be improved by using low conductance spacers between the layers of glazing [*University of Minnesota : Efficient Windows Collaboration*, 2004] and fill gases. For example, argon or krypton can be used instead of air [*Jayamaha*, 2007]. This technology is rapidly evolving, so windows should be easily upgradeable.

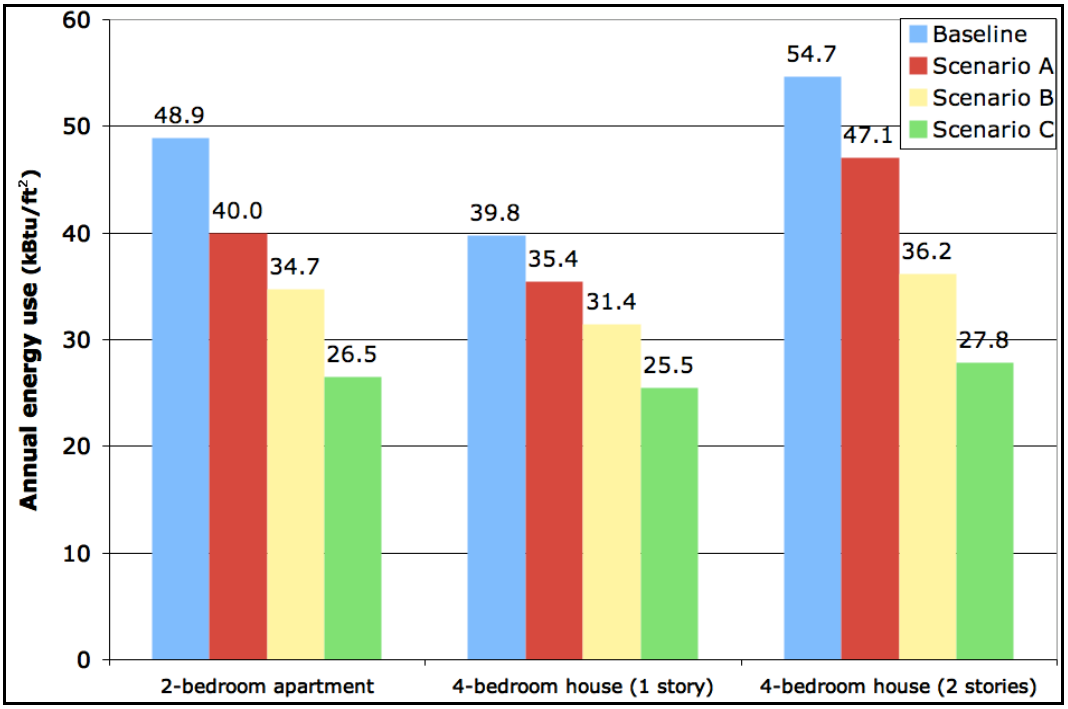

Figure E1: Annual Energy Use for the Residential Sector, Energy-10 Analysis. "Energy" includes electricity and natural gas, and "kBtu" is kilo British thermal units.

Although there are several emerging "smart windows," electrochromic technology is particularly promising. By applying low voltage power to photovoltaic thin films located on the outer glass pane, these windows are able to vary the amount of daylight and heat coming through [*National Renewable Energy Laboratory*, 2008b]. Additionally, they do not need to run a constant voltage, and occupants can easily control the tint by using a switch [*McGrail*, 2005].

Shading

In addition to exterior shading structures for south-facing windows, we recommend interior shading. Although less effective than exterior methods, blinds, shades, and drapes offer a large degree of occupant control. Well thought out landscaping can also reduce the energy used for space conditioning by 20–50 percent. Vegetation on the west and northwest sides of a building can provide useful shading and reduce cooling costs, and deciduous trees near the south-facing wall can shade the building in the summer and will not block the sunlight (and heat) in the winter [*Santa Barbara Contractors Association*, 2007] [*McPherson, et al.*, 2000].

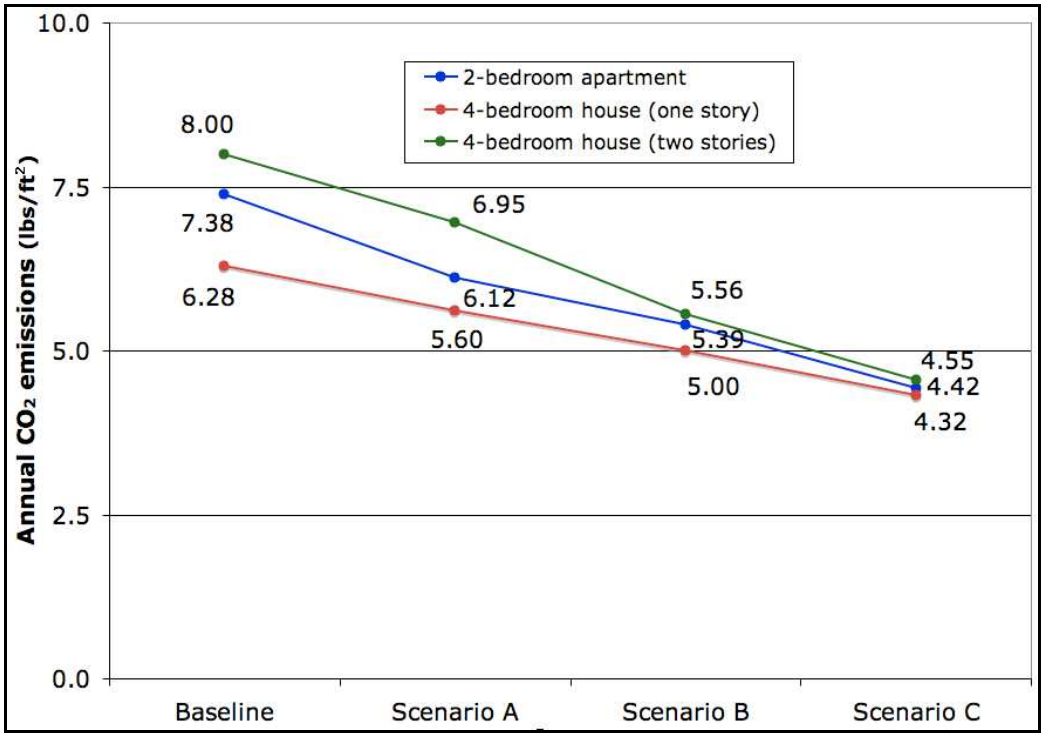

Figure E2: Annual CO_2 Emissions for the Residential Sector, Energy-10 Analysis. CO_2 emissions only include those emissions from generating electricity and natural gas, and "lbs" is pounds.

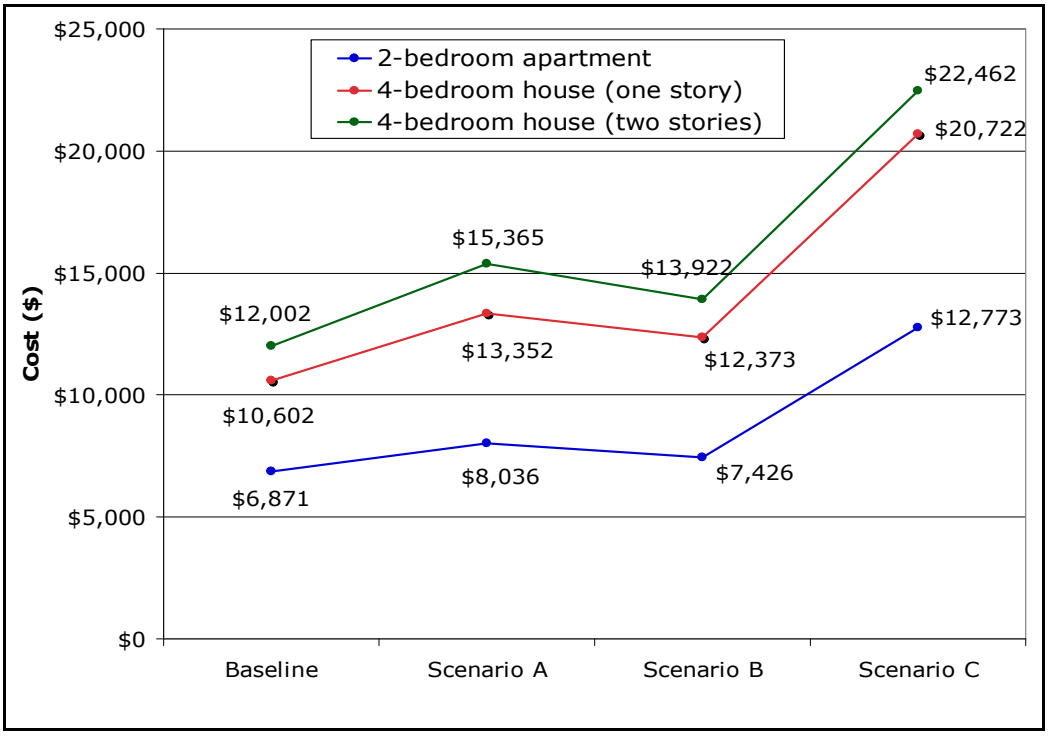

Figure E3: Construction Costs for Installing the HVAC System and Energy Efficiency Strategies for the Residential Sector, Energy-10 Analysis.

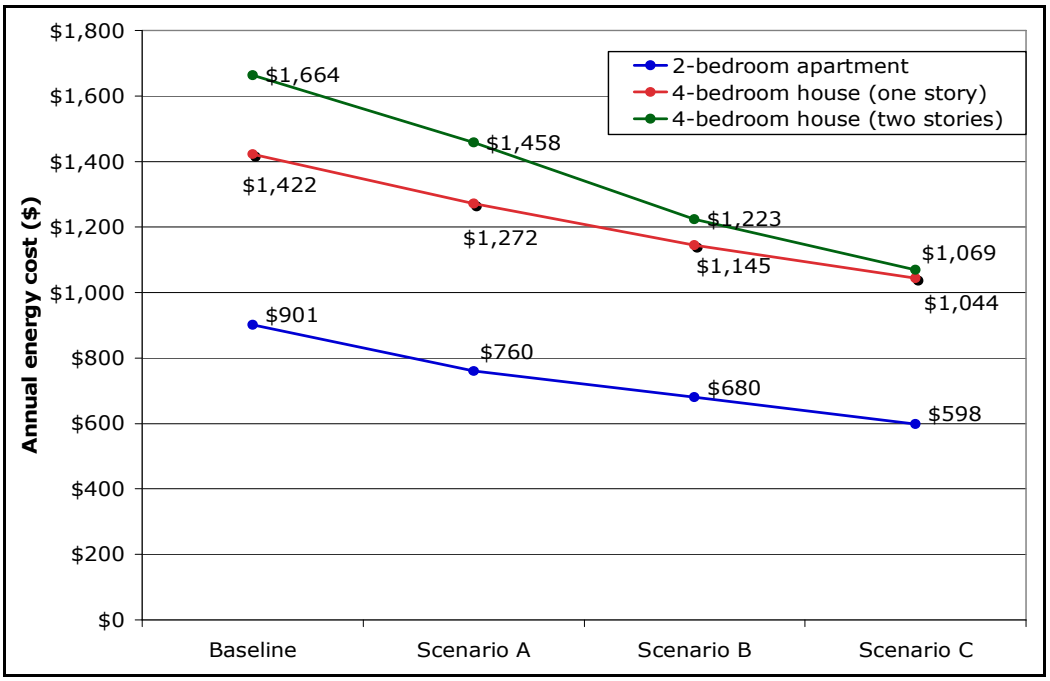

Figure E4: Annual Energy Costs for the Residential Sector, Energy-10 Analysis. Energy includes electricity and natural gas.

Lighting

Integrate energy efficiency measures to reduce the lighting load in all buildings. Lighting is estimated to consume about five to 10 percent of the total electricity used in a home and 33–50 percent for office buildings [*Santa Barbara Contractors Association*, 2007]. To reduce the lighting load, the amount of natural daylight coming into the building should first be maximized (see "Orientation and Layout" under this Recommendation for daylighting strategies). In addition to effective daylighting strategies, other measures can reduce the lighting load.

Residential

Install dedicated compact fluorescent light (CFL) fixtures. CFLs last 10 times longer and use 75 percent less energy than incandescent fixtures [*United States Department of Energy*, 2008c]. Use Energy Star labeled CFLs. Light-emitting diode (LED) lamps use very little energy (0.83–7.3 watts) and have a useful life of up to 50,000 hours. LED lamps are very durable and are appropriate for some residential applications. They are very good at providing focused, directional lighting. Therefore, they should be considered for indoor task lighting (e.g. under cabinets and in hallways) and for recessed downlights (lights in the ceiling that are directed downwards) [*Partnership for Advancing Technology in Housing*, 2008d] [*United States Department of Energy*, 2008d]. Even though LED lamps are still expensive, this technology is rapidly advancing. The Department of Energy has a goal to develop high efficacy LEDs (160 lumens per watt) that are cost effective and market ready by 2025 [*United States Department of Energy*, 2006b].

Dimmers are recommended for ceiling and wall-mounted lighting for LEDs and CFL fixtures if proper dimming ballasts and lamp holders are installed. Infrared occupancy sensors, which turn off lights when they do not detect motion or heat [*Jayamaha*, 2007], should be installed in rarely-used areas or rooms whose lights are frequently left on.

Non-residential

There are many opportunities to reduce the energy used for lighting in the non-residential sector, especially in office buildings. Ceiling-mounted lighting should be minimized in favor of more targeted task lighting for specific workspaces.

Nevertheless, there are many ways to improve the energy efficiency of overhead fluorescent tube lighting. Use T5 lamps, which are more efficient than T8 or T12 models. T5 lamps also only come equipped with electronic ballasts [*Knisley*, 2003], which are 30 percent more efficient than magnetic ones. Reflectors can also be used to increase usable light; new materials like anodized specular aluminum and vacuum-deposited specular silver have reflectivities of 85–95 percent [*Jayamaha*, 2007]. Fluorescent fixtures could also be dropped a few inches to achieve 360-degree illumination. Infrared sensors should be placed in areas like conference rooms, office kitchens and bathrooms, and corridors.

There are many possible applications for LEDs in the commercial sector. For example, replacing a fluorescent exit sign with an LED sign will pay for itself in less than 18 months [*Jansson*, 2006]. In addition to recessed downlighting, LEDs could be used in retail display windows and cases [*Freyssinier, et al.*, 2006], elevators, hallways, and for other indoor task lighting [*Alliance for Solid-State Ilumination Systems and Technologies*, 2002].

For information on maximizing outdoor lighting efficiency, see Recommendation LM3.

Appliances

Install energy efficient appliances in all buildings. Appliances meeting Energy Star's energy efficiency guidelines should be installed wherever possible. Energy Star is a credible and respected joint program of the Environmental Protection Agency and the Department of Energy. Its well-known label will improve the marketability of homes equipped with these appliances.

Energy Star refrigerators use at least 20 percent less energy than the federal standard (10 percent for freezers) [*Energy Star*, 2008d]. To further improve efficiency, buy a model that has the freezer on top, a manual defrost setting, and no automatic icemakers or dispensers [*Santa Barbara Contractors Association*, 2007].

Energy Star washing machines use at least 37 percent less energy than the federal standard [*Energy Star*, 2008a]. Horizontal-axis models use 30 percent less energy than vertical-axis ones [*Santa Barbara Contractors Association*, 2007]. The Southern California Gas Company also offers a $30–$35 rebate for Energy Star clothes washers meeting certain energy and water efficiency requirements [*Energy Star*, 2008e].

Energy Star dishwashers use at least 41 percent less energy than the federal standard [*Energy Star*, 2008b]. Models with a light load option and the ability to use non-heated air for drying are more efficient than models lacking these options [*Santa Barbara Contractors Association*, 2007].

There is no Energy Star label for clothes dryers, although models with moisture sensors, which automatically shut down when clothes are dry, and higher spin speeds are more energy efficient than conventional dryes [*American Council for an Energy-Efficient Economy*, 2007].

For information on maximizing the water efficiency of appliances, see Recommendation W2.

Recommendation E2: Renewable Energy

Integrate renewable energy technology into buildings, including photovoltaic cells, solar hot water heaters, and geothermal heat pumps.

Improving energy efficiency is an important step in making East Area 1's built environment more sustainable. Nevertheless, renewable energy technology must be integrated into buildings to further reduce their environmental impacts, lessen their dependence on fossil fuels, and protect residents from rising energy prices. Although renewable energy comes in many forms, photovoltaic cells, solar hot water heaters, and geothermal heat pumps are recommended for East Area 1 because they are established technologies that make both economic and environmental sense.

Photovoltaic Cells

Install pre-wiring for photovoltaic (PV) cells in all residential and non-residential buildings, and encourage property owners to install PV cells. A PV cell converts solar energy into usable electricity. When sunlight hits the panel, a semiconductor material (usually silicon) absorbs the photons. Electrons are knocked loose and can flow in one direction, creating an electric current that can be used as electricity [*Knier*, 2002].

All buildings in East Area 1 should be pre-wired for PV cells. Additionally, property owners should install PV cells. Not only does Santa Paula have a very favorable climate for solar energy systems – Ventura County has 258 annual days of sunlight [*Real Estate Harmony*, 2008] – but PV cells are financially viable right now.

Through the Emergency Economic Stabilization Act of 2008, there is no longer a cap on the federal tax credit for residential installations [*Energy Star*, 2008c]. Furthermore, the California Solar Initiative (CSI), as part of California's Million Roofs Program, has set a target of creating 3,000 megawatts of new electricity from solar energy by 2017. As such, it is offering large incentives for PV solar electric installations in both the residential and commercial sector. However, this incentive will decrease as the state nears its goal [*California Public Utilities Commission*, 2008a]. Since both the federal tax credit and the CSI incentive are set to expire or seriously decrease about halfway through the overall construction process of East Area 1, property owners are advised to install PV systems soon to take advantage of them.

Residential

Using the California Energy Commission's Clean Power Estimator, we evaluated the feasibility of installing PV panels on residential units and commercial buildings (see Appendix D for specific inputs). Figure E5 and Table E3 show the estimated electricity output of residential PV installations in East Area 1. There is great value in installing PV panels on a home that is highly energy efficient. For example, a home with a monthly electricity bill of $150 would need a 3,000-watt system to meet half of its needs, whereas a home with an $80 bill would only require a 2,000-watt system. This decrease in system

size would save a homeowner about $9,500 in upfront installation costs (before incentives).

Figure E6 and Table E3 clearly illustrate the benefits of the 30 percent federal tax credit and the expected performance-based incentive (EPBI) offered through the California Energy Commission's New Solar Homes Partnership. The EPBI, which is part of CSI, offers $2.50–$2.60 per watt for qualifying homes. The financial effects of the EPBI are quite substantial; the simple payback period is 7.6–11.1 years longer without it. It is important to note, though, that the EPBI comes with several stipulations. For instance, homes must exceed existing Title 24 standards by at least 15 percent and all appliances must be Energy Star [*California Energy Commission*, 2007]. Implementing Energy Recommendation E1 should fulfill these conditions.

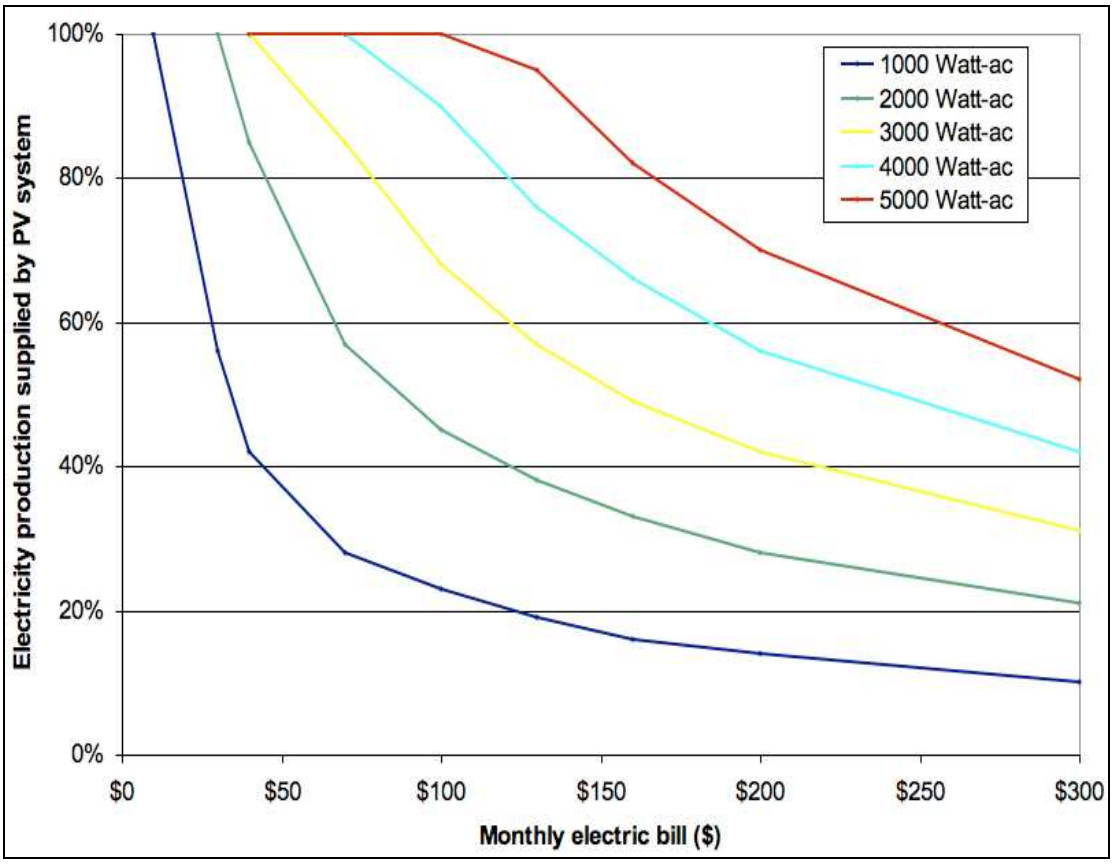

Figure E5: Proportion of Electricity Needs Met by the PV System in the Residential Sector, Clean Power Estimator Analysis. Assumes 1.5 percent utility rate escalation.

Table E3: Financial and Environmental Impacts of a PV Installation in the Residential Sector, Clean Power Estimator Analysis. Assumes 1.5 percent utility rate escalation.

System size (watt-ac)	PV electricity production (kWh/year)	CO_2 emission reduction (pounds/year)	Electricity savings (first year)	System cost (before incentives)	CSI SCE incentive	Federal tax credit	Net system cost
1,000	1,671	1,191	$199	$9,500	$2,500	$2,850	$4,150
2,000	3,343	2,384	$398	$19,000	$5,000	$5,700	$8,300
3,000	5,014	3,575	$597	$28,500	$7,500	$8,550	$12,450
4,000	6,686	4,767	$796	$38,000	$10,000	$11,400	$16,600
5,000	8,357	5,959	$995	$47,500	$12,500	$14,250	$20,750

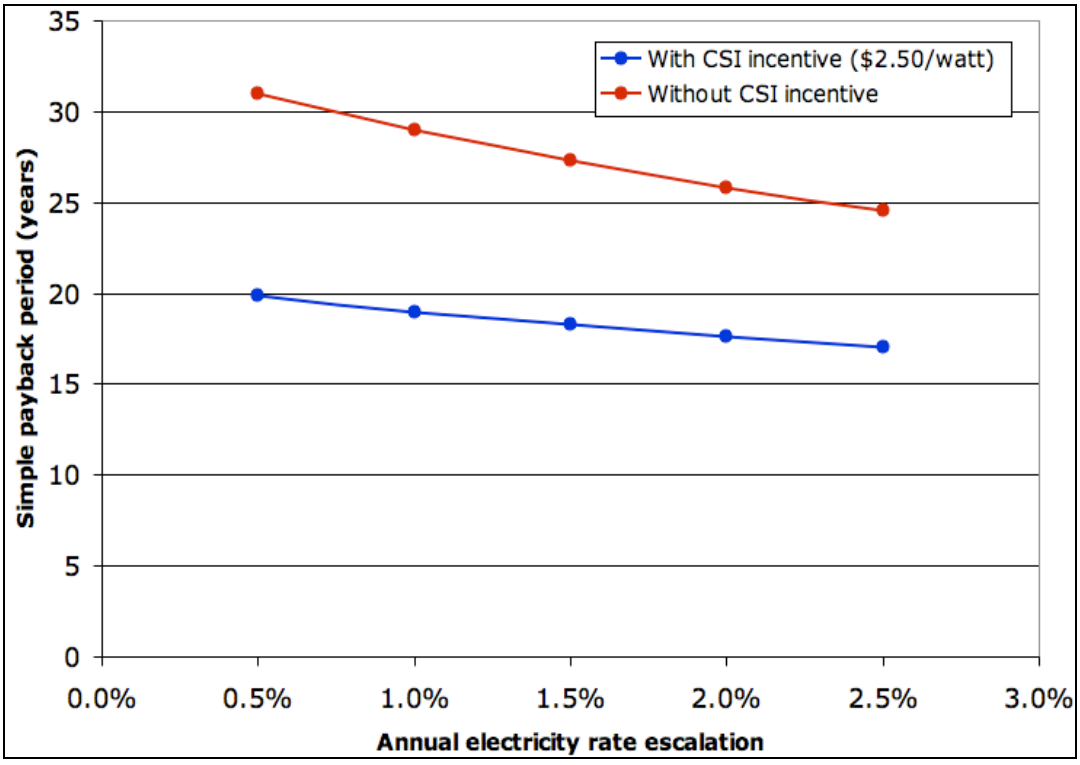

Figure E6: Effect of CSI Incentive on the Payback Period of a Residential PV System, Clean Power Estimator Analysis

Non-residential

The Clean Power Estimator was also run for PV installations on commercial buildings. There was a linear relationship between monthly electric bill and the proportion of electricity provided by PV. For example, a commercial building with a monthly electric bill of $1,000 would need a 5,000-watt system to provide about 10 percent of its electricity needs, and a building with monthly costs of $10,000 would require a 50-kilowatt system.

Like the residential sector, these PV systems also qualify for a federal tax credit of 30 percent of the installation costs with no cap. For systems under 50 kilowatts, there is also a CSI Expected Performance-Based Buydown incentive of $0.92 per kWh produced annually (*note*: tax-exempt entities do not qualify for this incentive). However, commercial entities with systems less than 50 kilowatts have to pay a federal tax increase of $0.31 per kWh produced by the PV system upon its installation. Nevertheless, PV systems are quite profitable ventures for commercial buildings, because they have short payback periods (less than 20 years), high net present values (NPV), and high internal rates of return (IRR) (Table E4).

Table E4: Financial Evaluation of PV Systems for the Commercial Sector, Clean Power Estimator Analysis. See Appendix D for input assumptions.

System size (kilowatt-alternating current)	NPV	IRR	Payback (years)
5	$5,242	10%	18.2
10	$10,914	10%	17.9
25	$27,069	10%	17.9
50	$68,064	10%	16.7
100	$142,181	11%	16.2
250	$368,340	11%	15.9

When installing solar cells in either the residential or the non-residential sector, there is much to consider for a specific application in East Area 1: the PV cell technology (which is advancing at a rapid pace), the proper size and placement, and other technical details. It is essential to thoroughly research different contractors in the area. Many will offer free site evaluations and can provide assistance in the going through the process of obtaining financial incentives. Solar-Estimate.org provides some tips on choosing a contractor, and Table E5 shows a list of contractors in the Santa Paula area who pass this website's qualifying criteria and can install both residential and commercial/large PV systems [*Solar-estimate.org*, 2009].

Table E5: PV Contractors within 25 Miles of Santa Paula.

Company	Location	Website	Phone
Advanced Solar Electric, Inc.	Thousand Oaks	www.advancedsolarelectric.com	805-214-9960
California Solar Electric	Ojai	californiasolarelectric.com	805-640-7903
Coastal Constructors	Ojai	coastalconstructors.com	805-427-1368
Galaxy Plumbing and Solar, Inc.	Oak Park	www.galaxyplumbing.com	818-612-8772
Globenetics	Simi Valley	www.globeticsusa.com	805-583-3578
Pacifico	Camarillo		805-377-7520
Prime Solar Company	Ojai	www.prime-solar.com	805-646-8383
REC Solar, Inc.	Ventura	www.recsolar.com	888-657-6527
Scott and Sons Electric	Ventura		805-642-8547
Solar Electrical Systems	Westlake Village	www.solarelectricalsystems.com	805-497-9808
SolarPerfect, Inc.	Moorpark	www.solarperfect.com	805-517-1600

Solar Hot Water Heaters

Install solar hot water heaters for residential units. Water heating consumes about 14–25 percent of a home's total energy [*United States Department of Energy*, 2008i]. Installing solar hot water heaters in East Area 1 residences is a financially viable way for homeowners to reduce their utility bills and carbon footprint.

A solar hot water system usually consists of a solar collector, where the sun heats water running through small tubes, and a well-insulated storage tank. Some systems also have temperature controls and electric circulating pumps [*County of Ventura: Build it Smart*]. We used the Energy-10 model to simulate the installation of a simple solar thermal collector/liquid storage system that could meet 50 percent of the hot water load for a two-bedroom apartment (961 ft^2) and a four-bedroom single-family house (1,695 ft^2).* For both residential types, the addition of a solar hot water system reduced annual energy use by 5.8 kBtu/ft^2, resulting in annual cost savings of $54 for the apartment and $97 for the house. When compared to the baseline, this figure represents a 10.6–14.6 percent decrease in total yearly energy consumption. It also saves 644 and 1,134 lbs CO_2 from being emitted each year for the apartment and house, respectively (0.67 lbs CO_2/ft^2).

A solar hot water heating system generally costs about $4,000–$6,500 to install in a one-story home [*County of Ventura: Build it Smart*]. Since Santa Paula has a sunny climate and

* Energy-10 calculates the required collector area using the target solar fraction, an annual average system efficiency of 39.4 percent, and an average daily solar resource of 2,030 Btu/ft^2-day (Christensen and Barker, 2004; Kreith and Krieder, 1978). It estimates the storage capacity based on 15 pounds mass (lbm)/ft^2 of water for the target collector area and a 90°F maximum storage to storage-collector temperature difference.

few days when temperatures dip below freezing, a solar hot water system in East Area 1 would not need some of the extra design requirements needed in a colder climate. Thus, the initial costs may be on the lower end of the price spectrum [*Partnership for Advancing Technology in Housing*, 2008f].

Solar hot water systems constructed before 2018 also qualify for a 30 percent federal tax credit (up to $2,000) [*Energy Star*, 2008c]. Furthermore, the Solar Water Heating and Efficiency Act of 2007 authorized the California Public Utilities Commission to create an incentive program across the state, with the funding coming from gas ratepayers. There is already a pilot program in San Diego, which is run by the CSI [*California Public Utilities Commission*, 2008b]. If a more widespread incentive program does expand, then solar hot water heaters would presumably become even more financially feasible for the residents of East Area 1.

A solar hot water heater can generally provide up to 70 percent of a home's water heating needs [*County of Ventura: Build it Smart*]. Therefore, we recommend that homeowners install a demand water heater, also known as a tankless or instantaneous water heater, as a booster. By heating water directly without a storage tank, these systems avoid the standby heat losses of traditional water heaters. There are limits to the flow rate of a tankless system, but when coupled to a solar hot water heater that can offset much of the load, a demand water heater would probably be 24–34 percent more energy efficient than a conventional storage tank water heater [*United States Department of Energy*, 2008a]. A tankless water heater also lasts about five to 10 years longer than a storage tank water heater [*California Energy Commission*, 2009d].

There are many design details to consider when installing a solar hot water heater. There are three types of collectors: flat-plate collectors, integral collector-storage systems, and evacuated-tube solar collectors. Homes can install either active systems, which can utilize direct or indirect circulation, or less expensive passive systems. Collectors can be free-standing or placed on roofs. As a result, the system size may be limited by the size and orientation of the roof, and there may be a tradeoff in deciding whether to dedicate roof space to PV cells or a solar hot water system [*United States Department of Energy*, 2008f].

It is very important to install the correct solar hot water system for the conditions and to size it properly. Solar-Estimate.org provides some tips on choosing a contractor, and Table E6 shows a list of contractors in the Santa Paula area who pass this website's qualifying criteria and can install and service residential solar hot water heaters [*Solar-estimate.org*, 2009].

Table E6: Residential Solar Hot Water Heater Contractors within 25 Miles of Santa Paula

Company	Location	Website	Phone
Advanced Solar Electric, Inc.	Thousand Oaks	www.advancedsolarelectric.com	805-214-9960
Coastal Constructors	Ojai	coastalconstructors.com	805-427-1368
Galaxy Plumbing and Solar, Inc.	Oak Park	www.galaxyplumbing.com	818-612-8772
Globenetics	Simi Valley	www.globeticsusa.com	805-583-3578
Pacifico	Camarillo		805-377-7520
Prime Solar Company	Ojai	www.prime-solar.com	805-646-8383
Solar Electrical Systems	Westlake Village	www.solarelectricalsystems.com	805-497-9808

Geothermal Heat Pumps

Install geothermal heat pumps for buildings with large contiguous plots of land. Geothermal heat pumps use the constant temperature of the earth as an exchange medium. They have been used since the 1940s to heat and cool buildings. The ground temperature generally varies from seven to 21°C (45–70°F) and is warmer than the air above it during winter and cooler than the air above it in summer. Thus, the geothermal heat pump can exchange heat with the ground, thereby effectively heating and cooling buildings. A geothermal heat pump system offer several benefits [*United States Department of Energy*, 2008b]:

- Uses 25–50 percent less electricity than conventional HVAC systems. Homeowners can save 30–70 percent in heating costs and 20–50 percent in cooling costs.
- Uses a renewable energy source and has low environmental impact.
- Allows exceptional space conditioning by zone.
- Equipment is highly durable, reliable, and requires little maintenance.
- Long system life: 25 years for indoor components, 50+ for outdoor group loop.
- Lowers peak energy demand.
- Can be equipped with a "desuperheater," which can heat water.

In East Area 1, the ground loop system would most likely be a closed-loop configuration constructed of high-density polyethylene pipe. The other option is an open loop system, in which groundwater is used as the heat exchange fluid and is pumped into and out of the building. Open loops are far less common than closed loops, and they are not really applicable in California [*California Energy Commission*, 2006].

The two major ground loop configurations are horizontal or vertical. Vertical loops require holes to be drilled 100–400 feet deep [*United States Department of Energy*, 2008b], but since the bedrock underlying East Area 1 is only 50 feet below the soils, this is not a

viable option. A horizontal ground loop, which usually requires parallel pipes in trenches that are only three to six feet deep, is the best choice. Although the installation costs for a horizontal loop system are significantly lower than those for a vertical loop (up to 50 percent less) [*Bloomquist*, 2001], the horizontal loop system is more subject to seasonal soil temperature variations [*Geo4VA*], and they require more land than vertical loops. The length of a typical loop is 400–600 feet per ton of heating and cooling [*California Energy Commission*, 2006] and requires about 750–1,500 square feet per ton [*Haley Mechanical*].

Given these constraints, the most viable application of geothermal heat pumps in East Area 1 would be for buildings that have large contiguous tracts of land. Horizontal looping could be installed under a school's athletic fields or beneath the parking lot of an office building or retail complex. The installation costs and large land requirements of horizontal looping could be reduced to 500–800 square feet per ton using the Slinky™ method, which allows for more piping in a shorter trench [*Geo4VA*].

The capital costs to install a geothermal heat pump can be greater than those for a conventional HVAC system. For a residential unit, the initial costs can be $1,300– $3,700 more per ton when compared to an air-source heat pump [*Partnership for Advancing Technology in Housing*, 2008a]. Yet, the extra initial cost can be recovered in as little as five to 10 years [*United States Department of Energy*, 2008b], because residential buildings with geothermal heat pumps use up to 40 percent less energy than those with conventional HVAC and have lower maintenance costs [*United States Department of Energy*, 2002].

The economic benefits of a geothermal heat pump system are even more dramatic for buildings in the non-residential sector. The installation costs for a geothermal heat pump are actually lower than those of a conventional cooling tower/boiler system [*Bloomquist*, 2001; *Bose*, 2005]. When compared to conventional HVAC systems, Bloomquist [2001] found that geothermal heat pump systems in the non-residential sector had 18–41 percent lower energy costs and 21–69 percent lower maintenance costs. Geothermal heat pumps also allow more targeted zoning, which could result in further savings. A geothermal heat pump can also be equipped with variable fans and two-speed compressors, making them even more efficient and quieter [*United States Department of Energy*, 2008b]. The Emergency Economic Stabilization Act of 2008 also created a new 10 percent federal tax credit, up to $2,000, for geothermal heat pumps [*United States Department of Energy: Office of Energy Efficiency and Renewable Energy*, 2008].

In deciding to install a geothermal heat pump in East Area 1, it is important to hire a qualified engineering firm to perform a site-specific feasibility study, drill test bores, and conduct soil thermal-conductivity testing [*Tennessee Valley Authority*]. We recommend an Energy Star geothermal heat pump with a coefficient of performance (COP) of at least 2.8, or an EER of at least 13. Table E7 shows a list of installers within three hours of Santa Paula who are accredited by the International Ground Source Heat Pump Association (IGSHPA). Stephen Best from Earthbound Energy Resources was

commissioned for the geothermal heat pump installed in the Santa Barbara Courthouse, and he is particularly well known in the Central Coast area.

Table E7: IGSHPA Accredited Geothermal Heat Pump Installers Near Santa Paula.

Individual	Company	Location	Phone
Mike East	REHAU, Inc.	Corona	719-510-0271
Gigi Marie	American Well Technologies	Fontana	717-919-8515
Daniel Meyer	Gregg Drilling	Garden Grove	714-530-8872
Bjorn Adams	Adams Engineering, Inc.	Rancho Santa Fe	858-756-4568
Brad Cote	B. Radiant Heating & A/C	Redondo Beach	310-937-1800
Ronald Rodriguez Jr.	B. Radiant Heating & A/C	Redondo Beach	310-937-1800
Stephen Best	Earthbound Energy Resources	San Luis Obispo	805-543-4717
Darin Gooley	Alpha Plumbing & Heating	Santa Maria	805-614-2888

Recommendation E3: Retrofitting

Minimize the barriers to retrofitting buildings for energy efficiency and renewable energy technology by instituting green lease language for rental units and encouraging homebuyers to take out energy improvement mortgages.

By constructing buildings that exceed Title 24 standards by at least 20 percent and incorporating renewable energy systems, East Area 1 is committing to an impressive standard for energy performance. Nevertheless, the energy sector is rapidly advancing and emerging technologies will become more cost effective in the future. As a result, the process of retrofitting should be made as easy as possible.

This recommendation includes two strategies for minimizing particular barriers to retrofitting. Instituting green lease language strives to eliminate the issue of "split incentives" in retrofitting rental properties. Using energy improvement mortgages lessens the financial burden associated with the upfront capital costs of implementing energy efficiency strategies.

Green Leases

Implement appropriate green lease language in the leases for all residential and commercial rental properties. With rental properties, there are often significant barriers to ensuring that the buildings operate in a sustainable and energy efficient way. Additionally, there are also barriers to retrofitting the building to incorporate energy efficiency strategies and renewable energy systems.

Leases are usually either "gross" or "net." In a gross lease, also known as a full-service lease, the landlord pays all expenses, including utility bills. This is in contrast to the net lease, in which the tenant is responsible for all expenses. Here arises the problem of "split incentives." With a gross lease, the landlord has an incentive to improve the

efficiency of the building, but the tenant does not since he would not see any of the cost savings. Conversely, a tenant in a net lease would be incentivized to conserve energy and perhaps implement some energy efficiency measures, although the landlord would not [*California Sustainability Alliance*, 2008b]. However, using a green lease can help mitigate this problem and balance the interests of both tenant and landlord. Although they have slowly been gaining in popularity in North America, Scandinavia, and the United Kingdom, green leases are well-established in Australia where the government uses eight different green lease schedules to improve the operation of its buildings and ease the retrofit process [*California Sustainability Alliance*, 2008a].

The Building Owners and Managers Association (BOMA), an international real estate industry group, has modified their standard lease document to create "The Guide to Writing a Commercial Real Estate Lease, Including Green Lease Language" [*Teitelbaum*, 2008]. For each clause, this document suggests language to green the standard BOMA lease, which is widely used in the United States. All commercial property owners in East Area 1 are encouraged to employ this guide, which will help ensure that buildings operate sustainably for their entire lifetime. It is available for purchase online at: shop.boma.org (members: $49, non-members: $69).

Some key features of the BOMA green lease:

- Although based on a typical triple net lease, it can be modified for a gross lease.
- Building owners can pass on the costs of capital improvements (e.g. for retrofits to improve energy efficiency) as long as the tenants' operating costs will decrease. Other pass-through costs include those associated with maintaining, managing, reporting, commissioning, and re-commissioning the building to conform to a green certification or rating program.
- Outlines responsibilities for the tenant and building owner. Example obligations for the tenant: must use proven energy and carbon reduction measures, provide the landlord with energy consumption data, and not use energy-intensive equipment. Example responsibilities for the landlord include: must use green cleaning products, only install Energy Star appliances, and ensure that any alterations must conform to the green lease stipulations.
- Ratings-system neutral to allow for more flexibility. However, the lease does specify which improvements will lead to certification by a particular scheme, such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), Green Globes, or Energy Star.
- Emphasizes communication. Building owners should continually convey the benefits of the green lease and how tenants are contributing through tenant councils and benchmarking.
- Suggests a tenant handbook and an energy management plan. Goals should be set (e.g. energy efficiency targets) and progress should be measured.
- Enforcement of green practices is no different from enforcement of traditional lease provisions.

The proposed clause changes are only suggested, and the specifics of the green lease would have to be negotiated between the landlord and tenant. Although there is no comprehensive guide on how to modify a standard residential lease to become a green lease, the same basic principles of the BOMA alterations for the commercial lease could be employed in East Area 1.

Energy Improvement Mortgages

Encourage East Area 1 homeowners to take out energy improvement mortgages to finance retrofits. Although the homes built in East Area 1 will likely be state-of-the-art and very energy efficient when they are constructed, technology is progressing very rapidly. Therefore, certain measures which are not feasible today may become a possibility for the average homeowner in the future. By taking out an energy improvement mortgage, a lender can increase the mortgage amount to pay for energy efficiency strategies. Thus, residents can finance the improvements though the savings on their utility bills. These mortgages require no additional income qualification, present no added risk to the lender, do not delay the closing of the loan, and do not increase in the amount of the down payment [*Baden*].

Energy improvement mortgages are offered by all national secondary mortgage markets (both conventional and federally insured programs), and they can be secured at the time of sale of a home or when a home is refinanced [*Baden*]. After a lender is secured, an evaluation of the home's energy usage is performed, often using the Home Energy Rating System (HERS), in which a certified rater assigns the home a score from one to 100, with 100 being the most energy efficient. California Home Energy Efficiency Rating Services, based in Huntington Beach [*California Home Energy Efficiency Rating Services*, 2007], has been accredited through the Mortgage Industry National Home Energy Rating System Accreditation Standard to perform these services [*Residential Energy Services Network*, 2008].

After the home is given a rating, the rater will recommend cost effective energy efficiency improvements, their expected impact on the home's energy use and utility bills, and the expected payback period. The consumer then decides which strategies to employ, chooses a contractor to implement them, and presents this plan to the lender [*Baden*].

Homeowners should also research whether they would qualify for any state, local, utility, or federal incentives for performing a retrofit. The Database of State Incentives for Renewable and Efficiency (www.dsireusa.org) maintains comprehensive and up-to-date information on such financial incentives, and the Ventura County Energy Resource Center can provide assistance (see Recommendation E4).

Recommendation E4: Utility and Government Programs

Participate in utility and government programs to receive financial incentives and customized recommendations on how to improve the energy performance of buildings.

Although all of the recommendations in this chapter are prudent guidelines on how to make the built environment more energy efficient and less dependent on energy from fossil fuels, there are many other valuable programs available to the residents, businesses, and schools of East Area 1. As plans for individual buildings develop, it is important to expand on the recommendations in this chapter and take advantage of the myriad of local resources which can provide design assistance, technical expertise, and financial incentives specific to particular projects.

Ventura County Energy Resource Center

- *Contact*: http://www.vcenergy.org (805) 289-3335
- *Who qualifies*: All sectors.
- *Benefits*: The Ventura County Energy Resource Center is a valuable source of information and educational resources on energy efficiency. They can inform East Area 1 residents and businesses on the details, requirements, and benefits of the many energy assistance programs offered by the utilities and the government, including the ones listed below. The Center offers training sessions and workshops on a variety of topics for homeowners associations, business owners, and residents. They also host community events, including energy efficiency expos and recycling events.

California New Homes Program

- *Contact*: http://www.sce.com/b-rs/bb/cali-new-homes (818) 325-3130
- *Who qualifies*: Residential (single-family and multi-family dwellings).
- *Benefits*: Through this program, Southern California Edison provides free technical support, training opportunities, and marketing resources to residents wishing to improve the energy performance of their homes. They also offer financial incentives for homes that exceed Title 24 standards by at least 15 percent. Incentives range from $200–$2,000.

Advanced Home Program

- *Contact*: http://www.socalgas.com/construction/ahp (866) 563-2637
- *Who qualifies*: The California Energy Star New Homes Program and the High Performing New Homes Program are open to all single- and multi-family new construction, with three stories or fewer. The High Rise Multifamily Program is for multi-family buildings with four stories or more.
- *Benefits*: The Southern California Gas Company offers free design assistance and educational resources to residents. To qualify for financial incentives, homes must exceed Title 24 standards by at least 15 percent, and benefits range $300–$2,100.

Savings by Design

- *Contact*: http://www.savingsbydesign.com (805) 654-7447
- *Who qualifies*: Any non-residential new construction or major renovation.
- *Benefits*: This program offers free design assistance, which can include a design review, efficiency recommendations, model/simulation analysis, and integrated building design options. Buildings that meet minimum performance benchmarks can qualify for financial incentives of up to 50 percent of the energy efficiency measures (maximum $150,000).

Bright Schools Program

- *Contact*: http://www.energy.ca.gov/efficiency/brightschools (916) 651-9857
- *Who qualifies*: All publicly funded K-12 school districts and non-profit K-12 schools.
- *Benefits*: The California Energy Commission offers technical assistance up to $20,000 of their consultants' costs. Services can include design consultation, identification of energy efficiency strategies, simulation model analysis, review of construction plans, and system commissioning assistance.

Energy Partnership Program

- *Contact*: http://www.energy.ca.gov/efficiency/partnership (916) 654-3838
- *Who qualifies*: Cities, counties, special districts, public and non-profit colleges and universities, public and non-profit hospitals, public and non-profit public care facilities.
- *Benefits*: The California Energy Commission offers technical assistance up to $20,000 of their consultants' costs. Services can include design consultation, identification of energy efficiency strategies, simulation model analysis, review of construction plans, and system commissioning assistance.

Resources

Architecture 2030: http://www.architecture2030.org
Architecture 2030 is an advocacy group dedicated to reducing the building sector's contribution to global climate change. The 2030 Challenge sets ambitious targets for reducing greenhouse gas emitting energy use in buildings.

California Energy Commission: http://www.energy.ca.gov
This state agency is responsible for energy planning and policy. The Commission develops the Title 24 standards and is involved with other initiatives.

California Public Utilities Commission: http://www.cpuc.ca.gov/puc
This commission regulates privately owned utilities. It has developed many programs, including the California Institute for Climate Solutions and a greenhouse gas standard.

Energy Star: http://www.energystar.gov
A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, Energy Star is a well-known energy efficiency standard.

Go Solar California: http://www.gosolarcalifornia.org
A joint program of the California Energy Commission and the California Public Utilities Commission, Go Solar California administers the California Solar Initiative. It has information on incentives, tax credits, and rebates for solar cell systems.

Institute for Energy Efficiency: http://www.iee.ucsb.edu
The Institute for Energy Efficiency researches buildings, lighting, computing and electronics, production and storage, and economics and policy.

Lawrence Berkeley National Laboratory: http://www.lbl.gov
This is a U.S. Department of Energy national laboratory. The Environmental Energy Technologies branch researches technology for energy efficiency building.

Partnership for Advancing Technology in Housing: http://www.pathnet.org
Coordinated by the U.S. Department of Housing and Urban Development, this organization promotes the widespread adoption of advanced building technologies.

Santa Barbara Contractors Association: http://www.sbcontractors.org
The Santa Barbara Contractors Association manages Built Green Santa Barbara, a program that promotes sustainable building practices. They have developed the Built Green checklists for buildings and communities.

U.S. Green Building Council: http://www.usgbc.org
This non-profit organization supports green building practices, and they developed the Leadership in Energy and Environmental Design guidelines.

CHAPTER 4
LANDSCAPE MANAGEMENT

Santa Paula's history and identity are closely connected with the landscape and its natural resources. With the hills in the north, a creek bordering its east and west ends, and the Santa Clara River to the south, East Area 1 is nestled at the edge of Santa Paula. The Specific Plan conserves the natural open space while integrating the new mixed-use community into this setting. The plan seeks to preserve East Area 1's rich agricultural heritage while offering its community a high quality of life that protects both its inhabitants and the environment. Based on the principles of Smart Growth, Sustainable Development, and Traditional Neighborhood Design, the Specific Plan reduces urban sprawl and promotes a town-centered and pedestrian-oriented development. Principles include walkable neighborhoods, mixed land uses, preserved open space and landscape, energy efficient and environmentally-friendly building design, alternative transportation options, and a strong sense of place.

East Area 1 is over 508 acres. Of that area, there are 223.4 acres of undeveloped land that include 79.4 acres of open space preserves, 65.8 acres of parks and greenways, 23.2 acres of shared athletic fields, and 55 acres of agricultural preserve. The 508-acre development will include three neighborhoods and two districts that are interconnected and integrated to maximize walkability, encourage outdoor activities, and promote a strong sense of community. Small playgrounds and large parks are distributed throughout the area. Trails and open space surround the neighborhoods. Buildings are located to positively shape and activate public spaces. In addition, each neighborhood is organized around public spaces that define it with a particular context and character, thereby adding identity and a sense of place within the overall community.

The Specific Plan Landscape Standards specify that the goal for the overall landscape is that it is aesthetically pleasing, unified, and harmonious environment. The design integrates sustainable concepts that restore the natural functions and processes of the environment.

We consider how to promote the agricultural heritage of East Area 1 by providing the residents with community gardens, fruit trees in their yards, and public harvesting events in order to support a high quality of life, and to encourage social involvement, environmental awareness, social equity, and community pride.

In order to offer the inhabitants of East Area 1 a safe and healthful outdoor environment, we analyze how organic landscaping principles can optimize the health and productivity of the interdependent communities of plants, animals, and people. Our recommendations on organic landscape methods are based on the premise that managing the entire landscape organically will produce an attractive and functional landscape that will support and enhance the health of the community and the local ecosystems.

In order to preserve the natural landscape of East Area 1, we analyze how to reduce the adverse ecological and human health impacts associated with outdoor light pollution. Light pollution is excessive and misdirected use of lighting. Besides having harmful health affects, outdoor artificial light at night can over-illuminate neighborhoods, brighten the sky, and obscure the stars. This over-illumination is a traditional sign of urbanization at night [*Rich and Longcore*, 2006]. In order to preserve the landscape and preserve the country feel of East Area 1, we offer a suite of strategies to mitigate light pollution while maintaining a safe and pleasant nighttime environment for the community.

Methodology

Landscape management comprises three categories for our analysis: agricultural activities and heritage, the management of the physical landscape, and outdoor light pollution. These broad categories are defined in the context of the Specific Plan and the local conditions and history of Santa Paula and East Area 1. We used three methods to assess each of these issues: site visits to East Area 1 and Santa Paula, consulting with experts, and a literature review.

Site visits to East Area 1 and Santa Paula allowed us to understand the local environment and the cultural values and heritage of the community. The Director of Southern Operations for the Limoneira Company offered his insights and the knowledge of his personal experiences operating the agricultural activities in East Area 1. The landscape architect in charge of designing the landscape for East Area 1 provided her expertise on the local environmental conditions and the problems with developing a successful landscape design for a community in Southern California.

The extensive literature review included academic literature; case studies; conventional and green building guidelines; reports and other documents and resources published by government agencies, research laboratories, utilities, and non-profit organizations.

Recommendation LM1: Agricultural Heritage

Promote the agricultural heritage and food security of East Area 1 by providing open space for community gardens and preserving as many lemon and avocado trees as possible in residential neighborhoods, and by holding community events to allow residents to harvest produce from the agricultural preserve.

Promoting the agricultural heritage of East Area 1 by involving the residents in gardening and harvesting can provide the community with a superior quality of life and encourage community pride. Community gardens, fruit trees in yards and public parks, and occasional agricultural preserve harvests can enhance nutrition, physical activity, and public health. Furthermore, they can promote social involvement, improve quality of life, promote social equity, enhance property values, raise environmental awareness, reduce the negative environmental impacts associated with importing food, lower food costs, and improve food security.

Community Gardens

Provide open space for neighborhood community gardens. Offer priority plot assignments in the community gardens to residents without home garden space. Community gardens enhance nutrition, physical activity, social involvement, property values, and promote public health by improving quality of life, raising environmental awareness, reducing negative environmental impacts associated with importing food, lowering food costs, and improving food security. In addition, green waste from the community can be used to make compost and mulch in community gardens [*Asomani-Boateng*, 2007]. Although food production is vital to many community gardens, some also serve as flower and butterfly gardens, small orchards, art gardens, and educational centers.

Garden plot sizes can vary widely. Some inner city gardens on small lots offer plots as small as 5 ft x 5 ft or 10 ft x 10 ft. In larger gardens in parks 20 ft x 20 ft is a common plot size, although some plots can be as large as 50 ft x 50 ft in some cities [*American Community Gardening Association*, 2009]. Make community garden plot sizes at least 10ft x 10 ft up to 20 ft x 20 ft.

Let the homeowners' association (HOA) choose the organizational structure of garden management. For example, gardens can be managed as a cooperative by the gardeners or by a non-profit agency. Plot holders follow a set of rules and generally pay modest annual fees (typically $80 – 100). The American Community Gardening Association and other organizations' websites offer information and resources that can provide ideas for designing an appropriate management system to set-up and maintain the gardens.

Community gardens enhance community food security by reducing the demand for importing food of domestic consumption and lowering household food costs. In the United States, food travels an average of 1300 miles from field to plate. Locally grown food reduces the demand for transporting foods across such long distances [*Roberts*, 2005]. Urban gardens increase food security by offering residents a local food supply that can supplement household food requirements in the event of a natural or human-caused disruption in the national or regional food market supply and distribution [*McCullum, et al.*, 2005].

Urban gardens are sites for the production of conventional and ethnic vegetables and herbs. Small well-tended plots of land can yield a substantial amount of produce. In a 130-day temperate growing season, most of a household's total yearly vegetable needs can be provided by a 33 ft x 33 ft plot [*Patel*, 1996; *Sommers and Smit*, 1994]. Another study found that 1,900 community gardens in lots on 30 acres in Newark, New Jersey, yielded approximately $915,000 of food value in one year, and nearly $4 million over 5 years [*Patel*, 1996]. Moreover, approximately every $1 invested in a community garden plot yields approximately $6 worth of vegetables [*Hynes*, 1996].

In a study of the yield of 151 garden plots in the Philadelphia Urban Gardening Project, garden sites yielded an average of $160 ($240 in US$ 2007) worth of produce, an annual savings of $700 ($1050 in US$ 2007) per family. Gardeners ate vegetables considerably more frequently; and milk products, sweet foods and drinks less frequently [*Patel*, 1996]. Adults with a household member who were involved in a community garden consumed fruits and vegetables 1.4 more times per day than those who did not participate. Moreover, they were 3.5 times more likely to consume vegetables and fruits at least five times per day [*Alaimo, et al.*, 2008].

All people, notably the elderly and children, can benefit from the physical and social activities involved in the participation in community gardens [*Burton, et al.*, 1999]. Gardening is associated with reducing risks of obesity in children and adults [*Kien and Chiodo*, 2003; *Reynolds and Anderson*, 2004]; glycemic control problems and diabetes in adults, elderly men, Mexicans, and Mexican-Americans [*Reynolds and Anderson*, 2004; *Wood*, 2004]; coronary heart disease in adults and the elderly [*Beitz and Doren*, 2004; *Reynolds and Anderson*, 2004]; and occupational injuries in railway workers [*Chau, et al.*, 2004]. Furthermore, gardening benefits mental health, mental outlook, and personal wellness [*Brown, et al.*, 2004]. Health professionals use gardening to help patients with mental illness improve self-esteem and social skills [*Brown, et al.*, 2004].

Community gardens can improve the appearance of urban streetscapes [*Landman*, 1993; *Simson and Straus*, 1998], promote community pride [*Pottharst*, 1995] [*Langhout, et al.*, 1999], establish community social networks for neighborhood improvement, and to address important neighborhood issues including urban decline and criminal activity [*Jamison*, 1985; *Linn*, 1999; *Schmelzkof*, 1996]. The occurrence of vegetable gardens in inner-city neighborhoods is positively correlated with decreases in crime, mental illness, violent deaths, juvenile delinquency, fires, and trash dumping [*Patel*, 1993]. Additionally, gardeners, especially older ones, feel safe and have more motivation for leaving their homes to engage in outdoor activities [*Milligan, et al.*, 2004].

Urban gardening is positively associated with community involvement, interracial integration, and life satisfaction [*Shinew, et al.*, 2004; *Wakefield, et al.*, 2007]. Furthermore, community gardens host many social, cultural, and educational, events including neighborhood and church gatherings, children's activities, school tours, holiday parties, concerts, health fairs, and voter registration drives [*Glover, et al.*, 2005; *Saldivar-Tanaka and Krasny*, 2004].

Furthermore, community gardens increase surrounding property values. In New York City, urban gardens raised neighboring property values within 1000 feet of the gardens by as much as 9.4 percentage points within five years of the garden's opening [*Voicu and Been*, 2008].

There is no way to predict the demand for community garden plots in East Area 1. However, the following graph approximates how much land in East Area 1 would supply demand for community garden space (see Figure LM1). First, we assume that all

single-family units will have enough private backyard space for gardening. Then, we assume that all the 627 multifamily units and the 100 assisted living units will not have any backyard space for gardening.

In these scenarios, we compare the space requirements for two sizes of plots (10 ft x 10 ft and 20 ft x 20 ft). Each urban garden may require additional space for footpaths to access the plots. We assume that 3 ft-wide paths flank two sides of each plot. The area of the two plot sizes combined with path areas will be 160 ft^2 and 520 ft^2, respectively.

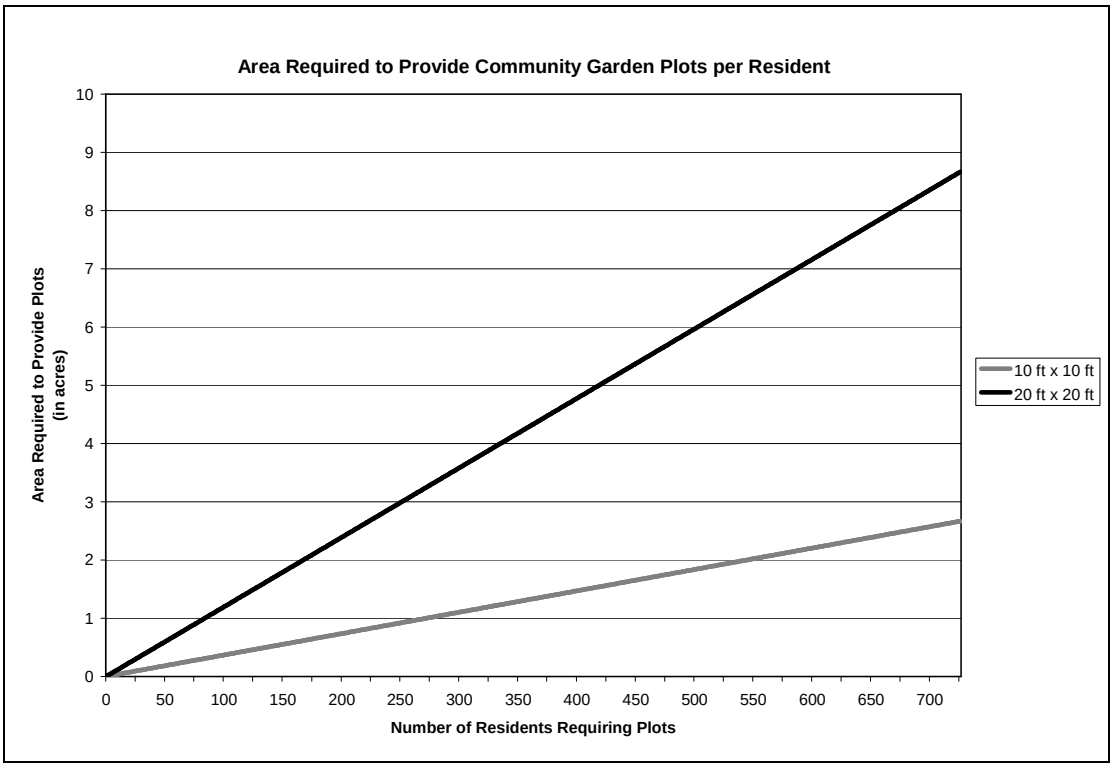

Figure LM1: Area Required to Provide Community Garden Plots per Resident. The area (in acres) required to provide multifamily unit households and assisted living residents of East Area 1 with community garden plots.

We can see that for the 10 ft x 10 ft plots, East Area 1 would need approximately 0.5 acres, 1.0 acres, and 2.7 acres of land for 138, 274, and 727 households respectively. Whereas, for the 20 ft x 20 ft plots, East Area 1 would need about 1.6 acres, 3.3 acres, and 8.7 acres of land for 138, 274, and 727 households respectively.

If all 727 households needed garden plots, it would only require 2.7 acres to supply the demand with 10 ft x 10 ft plots. However, it is not likely that all 727 households will need urban garden plots. In the event of a low to moderate demand for plots, the required acreage could range from less than 0.7 acres up to 4.4 acres.

Community gardens can conveniently be located in the margins of the 64.4 acres devoted to passive parklands. Many, if not all, single-family units will have yard space sufficient for private gardens. Therefore, build urban gardens within short walking distances of the residential units that will lack private yards. Community gardens can be distributed throughout East Area 1 in the following parks:

- Santa Paula Neighborhood Park 1
- Hallock Trailhead Park
- The north and west sides of the Civic District Shared Fields
- Foothill Neighborhood Park

In addition, community gardens can be placed in the margins or street side borders of both the Dual Use Detention/Recreation Basin 1 and Dual Use Detention/Recreation Basin 2. Although the Dual Use Detention/Recreation Basins will hold floodwater, floods will be infrequent. Nevertheless, gardens installed below the height of the maximum flood line will be at risk of flooding. Therefore, gardens should be installed above the height of the maximum flood line to minimize the risk of flood damage to garden plots.

In addition to serving the Santa Paula Creek Neighborhood, the Civic District Shared Fields can provide garden space for the 70 work/live units in the East Santa Paula Railroad District. Parks not otherwise mentioned above are either not conveniently located near the residential units that would most likely need them, or they are not suitable or appropriate for urban garden sites (e.g. Central Park and the plazas).

Not all the recommended neighborhood parks need to have large urban gardens. For example, twenty to forty 10 ft x 10 ft plots would only require 3,200 ft^2 to 6,400 ft^2 (0.07 to 0.15 acres), and could fit discretely into any of the neighborhood parks without using much land.

Provide space for school gardens at the educational facilities in East Area 1. Install educational school gardens in the East Area 1 primary, secondary, and post-secondary educational facilities in order to enhance academic achievement, a healthy lifestyle, environmental stewardship, and community and social development. The cost of school gardens will depend on the scope of the program, and if the school chooses to employ staff. Given that there may be uncertainty in whether the schools will want to start and maintain educational gardens, there are three approaches for providing garden space. The first approach would be to consult with the schools' administration in order to determine how many garden plots would be required. The second approach is to leave some portion (less than half an acre) of the school's campus undeveloped in order to accommodate future garden plots. Lastly, the developer can provide community garden space off-campus for educational garden programs.

Use the California School Garden Network (CSGN) for resources and information to assist school programs in setting up and running educational gardens. The CSGN functions as a central organization to distribute school garden information, resources and support throughout California. CSGN members represent a variety of educational institutions, state agencies, private companies, and non-profit organizations dedicated to the mission of creating and sustaining gardens in every willing school in California. The CSGN web site offers a complete source of school gardening resources by creating publications for teachers and others working in school gardens, and by serving as a hub for the various organizations dedicated to supporting school gardens in California. The CSGN web site is at www.csgn.org.

Preserve Existing Fruit Trees

Preserve original lemon and avocado orchard trees wherever possible in residential and non-residential neighborhoods. Fruit trees on residential property can supplement and enhance nutrition by providing residents with a relatively low-maintenance supply of fresh produce. Additionally, the presence of fruit trees can increase property values.

The conserved orchard trees can provide the community with a unifying aesthetic landscape standard, which supports the East Area 1 Specific Plan Landscape Standards for promoting and preserving sustainability and the aesthetic character and value of the community by having consistency in tree species and spacing to establish strong neighborhood identities [*HDR Town Planning*, 2007a]. Furthermore, the presence of the original fruit trees will preserve the memory of the agricultural heritage of Santa Paula and East Area 1.

Community Harvest Events

Hold community events to allow residents to harvest produce from the agricultural preserve. Community harvest events can promote social inclusion, community pride, and promote awareness of Santa Paula's agricultural heritage. Further, community harvest events can enhance social involvement, increase property values, raise environmental awareness, teach people about agricultural production, and reduce the negative environmental impacts associated with importing food.

The Limoneira Company will own and maintain the agricultural preserves. Therefore, the company will have to be involved in the organization of the event. As an annual or semi-annual event, Limoneira and the HOA can decide to expand the harvest event to include a local fair to celebrate the community and agricultural heritage of Santa Paula.

Recommendation LM2: Organic Landscaping

Use organic landscaping methods in the design and maintenance of the landscape and agricultural preserves. Avoid or minimize the use of synthetic pesticides and fertilizers by using strategies such as green waste and compost; integrated pest management; and the selection of drought-resistant, native, and native-like plant species.

The manufacture and application of pesticides (insecticides, herbicides, fungicides, rodenticides, antimicrobials) and synthetic fertilizers pose human and ecological health risks and depletes natural resources; therefore, avoid or minimize their use in East Area 1. Restrict external landscape inputs, and use preventive techniques appropriately. Organic methods for pest management and soil fertilization – such as the use of green waste and compost, integrated pest management, and the selection of drought-resistant, native-like plant species – can eliminate or reduce the need for synthetic chemical use and excessive irrigation (see Water Sector Recommendations for more information about efficient irrigation) on the landscape.

The principal objective of organic horticulture is to optimize the health and productivity of interdependent communities of plants, soil life, animals, and people. Organic landscaping is not simply concerned with producing an attractive and functional landscape, but also with the whole system used to produce and maintain the landscape. Organic landscaping is a holistic production management system that supports and enhances ecosystem health, including soil biological activity. The approach of organic horticulture is to minimize the use of external inputs such as synthetic pesticides and fertilizers [*Codex Alimentarius Commission*, 2001].

The systemic approach of organic agriculture and its avoidance of agro-chemicals prevent natural resource degradation, reduce the energy used to produce and transport synthetic chemicals, and decrease the loss of the productive potential of the land. However, organic horticulture practices cannot ensure that the landscape is entirely free of chemical residues, because of the contribution of general environmental pollution. Nevertheless, organic methods are utilized to minimize pollution of soil, air, water, and community [*Codex Alimentarius Commission*, 2001].

Sustainable organic landscaping offers many social and environmental benefits by addressing issues of human health, soil management and conservation, pest management, biodiversity conservation, water quality, climate change, energy conservation, and labor. Sustainable landscaping practices can reduce water and fertilizer costs, and lower hauling expenses and disposal fees. Appropriate watering and fertilizing, combined with Integrated Pest Management can promote healthy disease-resistant plants while reducing the quantity of pesticide and fertilizer runoff that contaminates soil, ground and surface water, surrounding ecosystems, and the inhabitants of the surrounding community [*California Integrated Waste Management Board*, 2009b].

Organic landscaping also contributes to maintaining biological diversity; and, biodiversity contributes to landscape ecosystem stability. Animal communities, including arthropods (e.g. beetles, ants, spiders), associated with the landscape perform various ecosystem functions including pollination and the biological control of pests and diseases. In organic systems some of the associated wild plants can also be beneficial, because they provide a diverse range of ecological services such as protection from soil erosion and providing shelter and food resources for beneficial organisms and pollinators [*Altieri*, 1999].

Furthermore, organic landscapes also promote biodiversity of other organisms such as birds, bats, and small mammals. Many of these animals feed on insects, rodents, and other pests. For instance, bird densities are higher in organic landscapes due to better breeding habitats, better food conditions, the absence of synthetic pesticides, more semi-natural habitats (hedges, field margins), and higher species diversity. An abundance of bird species can contribute to better natural pest control [*British Trust for Ornithology*, 1995; *Christensen, et al.*, 1996; *Codex Alimentarius Commission*, 2001].

Looking into the future, organic landscape systems can be more stable and resilient in response to climate disruptions, such as severe drought and flooding, caused by climate change [*Codex Alimentarius Commission*, 2001]. Organic systems offer a superior composition of water-stable aggregates in organic soils and decrease soil compaction. This results in the enhanced performance of organic landscapes under flood and drought conditions [*Fliessbach, et al.*, 2001].

Organic landscape projects sometimes require more labor input than conventional landscaping to replace external capital inputs such as fertilizers, pesticides, and herbicides. However, the degree of input depends on the intensity of the operation and level of landscape capitalization. Species diversification on organic landscapes and the associated different planting and maintenance regimes can distribute labor demand through the year. This can stabilize employment, reduce turnover, and facilitates the spread of overhead payroll costs per employee. Furthermore, organic landscaping reduces landscapers exposure to harmful synthetic pesticides [*Codex Alimentarius Commission*, 2001].

The benefits of organic landscaping result from maintaining the natural ecological balance of the environment through the implementation of organic pest management, soil amendment, and species selection strategies. The Limoneira Company has experience using organic landscaping methods, and may be a good resource for expert advice on the implementing some of these practices.

Pest Management

Use organic pest management methods to maintain the landscape and agricultural preserves. Avoid or minimize the use of synthetic pesticides by using strategies such as integrated pest management, and by selecting naturally resistant plant species that are appropriate for the local landscape conditions. Pesticides are commonly used in horticulture and urban landscape management. They include an extensive range of compounds used in pest control including insecticides, rodenticides, herbicides, fungicides, and antimicrobials. External and indirect costs of pesticides include monitoring for soil, water, and food contamination; toxic exposure to applicators, landscapers, community members, and food consumers; and impacts on non-target organisms such as bees, beneficial insects, birds, and soil biota [*Codex Alimentarius Commission*, 2001].

The active ingredient of a pesticide is the chemical in a pesticide formulation that destroys or interferes with the target pest or performs the desired function. In 2001, an estimated 213 million pounds (24 percent of the total applied in the U.S.) of active ingredient were applied in the non-agricultural market sector (home and garden, industry, commercial, government), or approximately 0.75 pounds per person. Herbicides are the most used pesticides in the home and garden sector with more than 90 million pounds applied on lawns and gardens per year [*Kiely, et al.*, 2004]. Suburban lawns and gardens receive 3.2 – 9.8 pounds per acre of pesticide applications, as compared to the agriculture sector, which averages about 2.7 pounds per acre [*Pimentel*, 1991].

Calculating the external costs of pesticide use for the application of the various formulations of different pesticides is challenging. Although it is common knowledge that many pesticides harm and degrade the environment and human health, there is a nearly complete lack of a full costing of a single product [*Pretty and Waibel*, 2005].

Pimentel et al. [2005] estimate that the indirect costs of pesticide use are approximately $8 billion annually. Further, they estimate the public health impacts of pesticide use cost $787 million each year. These costs are from human pesticide poisonings and illnesses, hospitalization, outpatient treatment, lost work time, the treatment of pesticide-induced cancers, and fatalities. However, the authors emphasize that the chronic health effects of pesticides are especially difficult to assess.

Pretty et al. [2001] estimate the external costs of pesticides for the United States by analyzing: pesticides in sources of drinking water; pollution incidents, fish deaths, and monitoring costs; biodiversity and wildlife losses; bee colony losses; and acute effects of pesticides to human health (see Table LM1). Nonetheless, the authors do not consider the cost of chronic health impacts due to the difficulty of assessing and quantifying these effects.

Pesticides are harmful and can cause death at high doses to humans [*Forget*, 1991]. At lower doses and in chronic exposure, pesticides cause reproductive and developmental

disorders [*Bell, et al.*, 2001a; 2001b; *Garry, et al.*, 2002; *Garry, et al.*, 2003], immunotoxicity [*Colosio, et al.*, 1999; *Vial, et al.*, 1996], cancers [*Barthel*, 1981; *Clavel, et al.*, 1996; *De Roos, et al.*, 2003; *Fleming, et al.*, 2003; *Kristensen, et al.*, 1996; *McDuffie, et al.*, 2001; *Zheng, et al.*, 2002], and induce neurological disorders [*Baldi, et al.*, 2003a; *Baldi, et al.*, 2001; *Baldi, et al.*, 2003b]. Low levels of exposure to lawn pesticides are also associated with increased rates of miscarriage, and the suppression of the nervous, endocrine, and immune systems [*Greenlee*, 2004]. Furthermore, pesticides can pass from mother to child through umbilical cord blood and breast milk [*Pohl*, 2000].

Table LM1: Estimated External Costs of Pesticides for the U.S. in 1996 Converted to US$ 2005/2006 (adapted from Pretty et al. [2001])

Source	Cost US$ 2005/2006
Pesticides in sources of drinking water	1,008,288,605
Pollution incidents, fish deaths and monitoring costs	144,771,168
Biodiversity/wildlife losses	185,647,733
Bee colony losses	129,442,456
Acute effects of pesticides to human health	149,880,738
Total	**1,618,030,701**

Children are at a higher risk for non-occupational pesticide exposure than adults are. Young children play and crawl on lawns, recreational areas, and other types of urban landscapes. Furthermore, children perform object-to-mouth and hand-to-mouth behavior that increases their exposure [*Kien and Chiodo*, 2003; *O'Rourke, et al.*, 2000; *Reynolds and Anderson*, 2004]. The National Academy of Sciences estimates that 50 percent of lifetime pesticide exposure can occur during the first 5 years of life [*National Research Council*, 1993] [*Pretty, et al.*, 2001]. Yet, children ages 6-11 have higher levels of lawn chemicals in their blood than all other age categories [*Pohl*, 2000]. Residential use of pesticides is correlated with increased rates of cancers in children such as brain cancer, leukemia, and non-Hodgkin's lymphoma [*Bouvier, et al.*, 2005; *Meinert, et al.*, 2000; *Zahm and Ward*, 1998]. Further, pesticides are associated with hyperactivity, developmental delays, behavioral disorders, and motor dysfunction [*Guillette*, 1998].

Families and children of occupationally exposed workers particularly are at risk, which means landscape staff and their families may be especially vulnerable [*Fear, et al.*, 1998; *Feychting, et al.*, 2001; *Garcia, et al.*, 1998; *Meinert, et al.*, 2000; *Weidner, et al.*, 1998].

Pesticides also negatively affect domestic animals and wildlife. For instance, dogs exposed to herbicide-treated lawns and gardens have twice the risk of developing canine lymphoma and 4-7 times the risk of developing bladder cancer [*Glickman*, 2004] [*Hayes*, 1991]. Out of 30 commonly used lawn pesticides, 16 are toxic to birds, 24 are toxic to fish and aquatic organisms, and 11 are lethal to bees [*Beyond Pesticides*, 2005]. Lawn and

garden pesticides are also poisonous to non-target species and can harm beneficial insects and soil microorganisms essential to a naturally healthy lawn [*Restmeyer*, 2003].

Unlike occupational exposure, population exposure is uncontrolled, diffuse, and has been studied less. Pesticide absorption can occur by inhalation, ingestion, or through contact with the skin and eyes. Proximity to a pesticide-treated area can be an important contributor to exposure, because of air drift and dust deposition inside homes and non-residential buildings [*Bouvier, et al.*, 2005; *Loewenherz, et al.*, 1997]. Pesticides are used on flowers and plants in landscaping and inside and outside the home. Adults, children, and pets can transport pesticide residues into homes on their skin and clothes [*Bouvier, et al.*, 2005]. Therefore, avoiding the use of synthetic pesticides should be a major concern for East Area 1.

Strategies such as integrated pest management (IPM) can maintain the community's landscape while minimizing environmental and human health impacts. IPM is an ecological approach to pest control that utilizes a diverse range of biological, mechanical, and chemical management techniques in three stages: prevention, observation, and intervention. IPM programs protect against weeds, diseases, and other pests that interfere with the management goals of a landscape or agricultural project.

In addition, installing pest barriers in building structures can prevent pests, such as rodents and insects, from infesting buildings. With the threat of infestation eliminated or significantly reduced by pest barriers, building occupants will have a reduced need for using pesticides, such as rodenticides and insecticides (see Building Materials Recommendation BM2).

Do not apply pesticides and herbicides that are toxic to humans and wildlife in the agricultural preserves. Do not spray pesticides, such as avermectin, in the agricultural preserve when the wind is blowing toward East Area 1. Provide the community access to information about what types of pesticides and herbicides are used, and how and when they are applied. Limoneira sprays avermectin-based insecticides on its orchard crops. The avermectins are compounds used to control the insect and mite pests of citrus, avocado, and other tree crops. Therefore, the agricultural preserve in East Area 1 will likely be sprayed with avermectin-based insecticides or other types of pesticides.

The prevailing winds in Santa Paula are westerly. Consequently, it is extremely important that Limoneira does not spray its crops on the days that the winds blow over the agricultural preserve into East Area 1. The Santa Paula Creek and Foothill Neighborhoods may be particularly vulnerable to spray drift.

Additionally, the people, pets, and wildlife that use the open space trails that run through the agricultural preserves may be exposed to pesticide and herbicide spray or residues. Therefore, it is important that Limoneira posts signs or closes off the agricultural

preserve whenever it applies pesticides on its crops, until the threat of exposure has ended.

Although avermectin can rapidly degrade after its application, the pesticide can be highly toxic to humans. It is known for its carcinogenicity, reproductive and developmental toxicity, neurotoxicity, and acute toxicity. Furthermore, it is likely an endocrine disruptor [*Extoxnet*, 1996]. At very high doses, avermectins can cause nervous system depression, tremors and lethargy in mammals. Very high doses can also cause death from respiratory failure. Chronic exposure in mammals can also have reproductive, teratogenic, mutagenic, and carcinogenic effects [*Extoxnet*, 1996]. Furthermore, avermectins are highly toxic to insects, fish, and aquatic invertebrates [*Extoxnet*, 1996].

Fortunately, avermectins rapidly degrade in soil. At the soil surface, it is subject to rapid photodegradation, with half-lives of 8 hours to 1 day [*Extoxnet*, 1996]. Therefore, the community may not be particularly vulnerable to long-term exposure to pesticide residues. However, frequent applications and exposure to fresh avermectin spray or residue can contribute to acute and chronic exposure.

Despite the relatively short half-life of avermectin, Limoneira should not use avermectin-based pesticides in the agricultural preserves. Instead, use organic pest control, such as integrated pest management, or less toxic pesticides when necessary.

Furthermore, it is important that the community have access to information about the pesticides and herbicides used in the agricultural preserve. Even if Limoneira applies pesticides or herbicides to the agricultural preserves that are not particularly harmful to humans, pets, and wildlife, residents and hikers may not understand the possible harmlessness or toxicological effects of the pesticides. This information will help alleviate any potential fear and misunderstandings between the community and the Limoneira Company. Post this information on the East Area 1 website (see Recommendation OM2) and provided to each resident in East Area 1.

Soil Amendment

Use organic fertilizer and soil amendment products, such as green waste and compost, on the landscape and in the agricultural preserves. Avoid or minimize the use of synthetic fertilizers. A soil amendment is a material added to soil to improve plant health and growth. Manufactured organic fertilizers include compost, bone meal, fish meal, blood meal, seaweed extracts, and natural enzyme digested proteins. Other organic fertilizers include manure, slurry, worm castings, peat, seaweed, and guano. Further, minerals such as mine rock phosphate, sulfate of potash, and limestone are also organic fertilizers.

Organic fertilizers, compost, mulch, and other forms of soil amendment can be produced onsite from some of the organic waste and landscape green waste collected from the landscapes of parks and public spaces, including tree leaves, grass clippings,

pruning, bark, and wood collected in East Area 1. However, since residential green waste is collected curbside and brought to Gold Coast Recycling in Ventura, there is no provision in the waste management services to do onsite composting and reuse. On the other hand, compost and other soil amendment products are readily available from Agromin, a local producer of soil products, or potentially from Gold Coast Recycling.

Compost can be used for fertilizer, soil amendment, and to prevent soil erosion. Mulches conserve soil moisture, moderate soil temperature, and prevent soil erosion. Mulch also can control weed growth by covering the soil. Some mulches add organic matter to the soil as they breakdown, and promote soil fungi and root growth [*Bush-Brown and Bush-Brown*, 1996].

Soil is one of the chief natural resources for all agricultural activity. The building and maintenance of soil fertility is a central objective of organic horticulture [*International Federation of Organic Agriculture Movements*, 2000; *Stolton, et al.*, 2000]. Fertilization and soil improvement strategies in organic horticulture apply substances such as compost, plant residues, and commercial organic nitrogen fertilizers. Organic horticulture improves soil organic matter content and biological activity, prevents soil acidification, and reduces soil erosion [*Codex Alimentarius Commission*, 2001].

Organically managed soils have substantially higher biological activity (bacteria, earthworms, fungi, microorganisms) than conventionally managed ones. Consequently, nutrients are processed more rapidly and soil structures are enhanced [*Codex Alimentarius Commission*, 2001; *Fliessbach, et al.*, 2001; *Pfiffner and Mäder*, 1997]. Moreover, organic management promotes the development of soil fauna such as earthworms and above-ground arthropods, which improve the growing conditions of the landscape [*Fliessbach, et al.*, 2001].

Synthetic nitrogen fertilizers can also contaminate local potable ground and surface water supplies with nitrates. Avoiding the application of synthetic nitrogen fertilizer in the landscape will help prevent groundwater contamination.

Species Selection

Plant drought-resistant, native and native-like plant species. Native-like species are non-native plant species that have similar characteristics to local native plant species. Selecting a diversity of native and native-like species that are compatible with the local environment will suppress soil-borne pests and diseases in an organic landscape. Diverse horticultural landscapes assure a better uptake of nutrient elements and water from the soil due to varying spatial and temporal root growth and leaf dispersion. Drought-resistant, native-like plants that are adapted to the warm and dry regional climate will require less irrigation (see Water Recommendations for information about irrigation), soil amendment, pesticides, and herbicides while being more resistant to local pests and diseases [*Codex Alimentarius Commission*, 2001].

Do not introduce plant species that can escape from the community landscape to invade the local wild lands. Invasive or introduced species are native and non-native species that heavily colonize a particular habitat. The general traits of invasive species traits include the ability to reproduce rapidly, grow quickly, disperse widely, and tolerate a wide range of environmental conditions. The estimated cost from the damage and for control of invasive species in the U.S. is greater than $138 billion annually [*Pimentel, et al.*, 2005].

Approximately 80 percent of endangered species worldwide may experience population or habitat loss by competition with or predation by invasive species [*Pimentel, et al.*, 2005]. The Draft Environmental Impact Report for East Area 1 lists 22 special-status plant species, 14 sensitive plant communities, and 40 special-status wildlife species documented in the project region (see Table 4.7-1: Special-Status Plant Species and Sensitive Plant Communities Known to Occur in the Project Area; and Table 4.7-2: Special-Status Wildlife Species Known to Occur in the Project Region) [*P&D Consultants*, 2007b]. Therefore, landscapers must assess the potential invasiveness and environmental impacts that introduced non-native plants can have on the special-status and sensitive plant and wildlife species and communities in the region.

In general, invasive plant species are better adapted to a wide range of growing conditions and can compete with native plant species for nutrients, growing locations, and other resources. Since invasive plants often can reproduce rapidly, they can replace many native plant populations. Consequently, this can reduce species diversity, decrease suitable breeding and nesting habitat for common and special-status wildlife species, change the adjacent riparian ecosystems, and reduce the quality of local habitats [*P&D Consultants*, 2007b; *Pimentel, et al.*, 2005].

Tamarisk (*Tamarix*) is an example of a non-native that can access deep-water sources with a long taproot. Tamarisk can disturb the stability and composition of native plant populations. Moreover, tamarisk can degrade native wildlife habitat by out competing native plant species, depleting water resources, increasing soil salinity, and increasing the frequency and intensity of fires [*Mack, et al.*, 2000].

Table 4.7-4 in the Environmental Impact Report for the East Area 1 Specific Plan provides a list of plant species to avoid in the landscape in the East Area 1 project site, including Tamarisk. In addition to following these regulations, landscapers should consider the potential invasiveness of plant species that may not be included on this list before planting them in East Area 1.

Recommendation LM3: Light Pollution

Reduce outdoor light pollution with efficient and effective use of light fixture placement and technology, light shielding, directed light, and dark-sky friendly certified fixtures.

Light pollution is excessive or obtrusive artificial light that has no specific purpose or task. Artificial light pollution, particularly light at night, poses significant risks to human and ecological health, negatively affects quality of life, and interferes with astronomical observations and stargazing. Inefficient use of lighting wastes energy, and accelerates climate change and environmental degradation from excessive fossil fuel consumption. Furthermore, by reducing light pollution and allowing the starry night sky to be more visible, East Area 1 will be able to maintain a country feel at night.

Light that escapes upward, except where intercepted by a structure, will scatter in the atmosphere and brighten the night sky. Moreover, light directed downward or at a specific target will also reflect upward and outward from the intended surface. Even a single light can be a disruptive source of light pollution. A bright point source of light can disturb neighbors, obscure the local view of the sky, confuse nocturnal animals and migrating birds, and spoil scenic views.

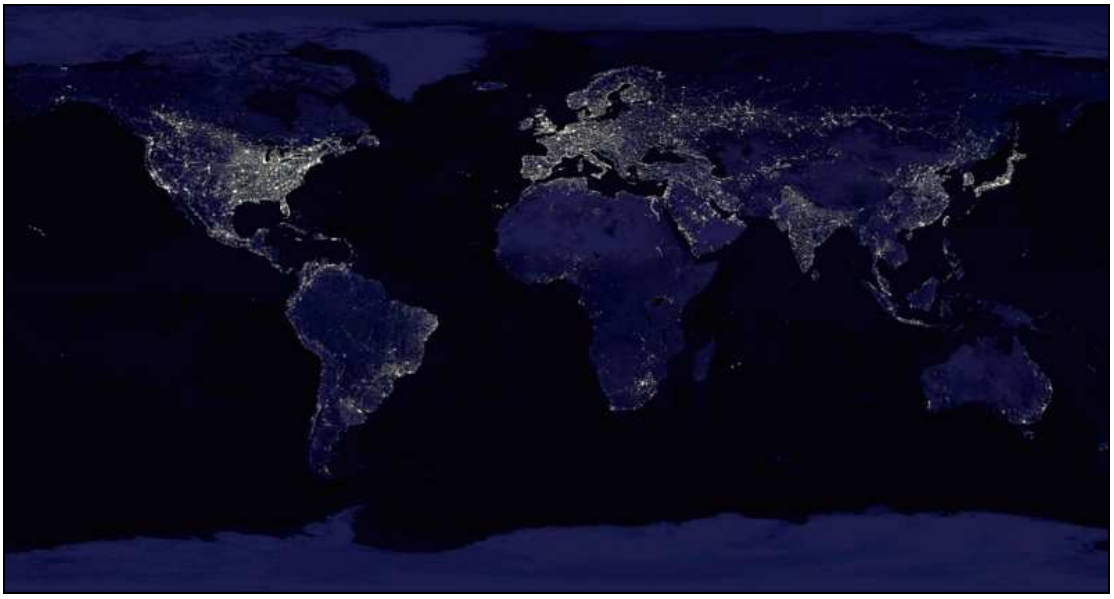

Figure LM2: A Composite Image of the Earth's Surface Night Taken from Orbit. This image shows wasted artificial light escaping into the sky. [Source: *NASA/Goddard Space Flight Center Scientific Visualization Studio*, 2001]

Sources of artificial outdoor light include street lamps, traffic lights, building exterior lighting, interior lighting that shines through windows, landscape lighting, outdoor advertising, commercial and industrial facilities, offices, floodlights, illuminated sporting

venues, fires and flares, and sky glow. Further, a significant source of light pollution is from outdoor lights that aim upwards or sideways (see Figure LM2 and LM3).

Specific categories of light pollution are light trespass, glare, light clutter, and sky glow. Light Trespass occurs when light falls where it is not wanted or needed, typically across property boundaries. Light can shine across property lines into neighboring property, buildings, windows, landscapes, and observatories (see Figure LM3).

Glare can occur by excessive contrast between bright and dark areas in the field of view. Glare can cause discomfort, temporary blindness, or loss in visual performance and visibility. The degree of glare depends on such factors as the position, size, brightness of the source, and on the brightness level to which the eyes are adapted.

Clutter relates to groupings of lights that may cause confusion and distract from obstacles, which can potentially cause accidents. Clutter is particularly dangerous near roads where poorly designed streetlights and brightly lit advertisements surround the roadway.

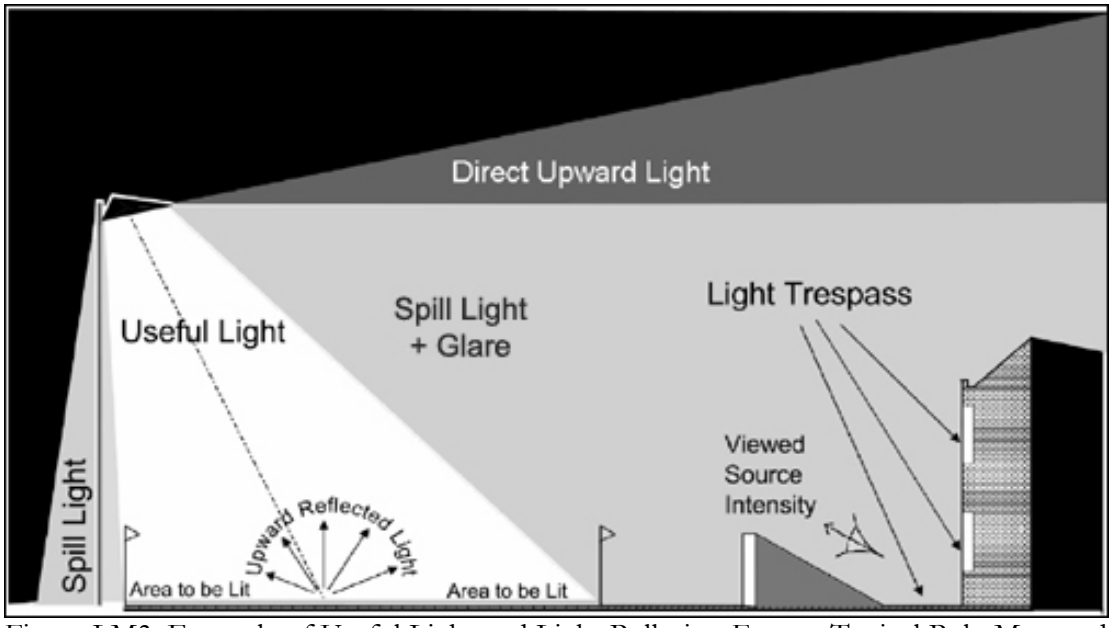

Figure LM3: Example of Useful Light and Light Pollution From a Typical Pole-Mounted Outdoor Light Fixture. [Source: *Institution of Lighting Engineers*, 2005]

Sky glow is the brightening of the night sky due to artificial lighting. In every outdoor lighting system, some sky glow results from light reflected from the ground (see Figure LM4). The excess light that escapes into the sky is scattered by the atmosphere in all directions. Populated areas are the main source of sky glow. Sky glow obscures the night sky to migrating animals, stargazers, and astronomers.

Light pollution can have adverse affects on human and ecological health. Exposure to light at night and ill-timed artificial lighting can alter and disturb the circadian rhythm (CR) of humans, animals, and plants. The CR is an approximately 24-hour daily cycle in the biochemical, physiological, and behavioral processes of living organisms. This internal biological clock is responsible for organizing the timing of the entire body by regulating multiple body functions such as the immune system, sleep patterns, body temperature, and the production and release of hormones from the pituitary gland [*Pijnenburg, et al.*, 1991]. The timing, duration, intensity, and color of light exposure can advance, delay, or otherwise disrupt the CR, primarily through the retinal ganglion cells in the eyes. In this way light at night, ill-timed artificial lighting, and lack of sunlight act like a drug in its capacity to disrupt the biological clocks of living organisms [*Rich and Longcore*, 2006].

Figure LM4: Skyglow Over Mexico City at Night. [Source: *Tomás*, 2005]

Prolonged disruption of the CR can cause colorectal or breast cancer [*Filipski, et al.*, 2006], induce immune system disorders [*Knez*, 2001], interfere with hormonal development [*Pijnenburg, et al.*, 1991], lower the age of the onset of puberty in children [*Pijnenburg, et al.*, 1991], cause sleep disorders and hypertension [*Noel, et al.*, 2000], and contribute to aggressive and violent behavior [*Hartung*, 1978]. Furthermore, light pollution can exacerbate circadian rhythm fluctuations in the elderly. With advancing age, the daily fluctuations of circadian rhythms deteriorate, which leads to disrupted cycles, sleep disturbances, and mood disorders [*Hoogendijk, et al.*, 1996].

Artificial night lighting can affect mammals, birds, reptiles, amphibians, insects, aquatic organisms, and plants by disrupting their circadian rhythms and other biological clocks. The effects of artificial night lighting on animals are similar to that of humans, and include increased cancer rates, hormonal disruption, altered sleep and behavior patterns, increased predation risk, disruption of foraging patterns, decreased food consumption, increased mortality on roads (i.e., road kill), altered survival and reproductive behavior, and the disruption of dispersal movements and migration through artificially lighted landscapes [*Rich and Longcore*, 2006]. In plants, artificial lighting can affect growth rates, fruit development, reproduction, and dormancy [*Rich and Longcore*, 2006]. Additionally, artificial night lighting affects local ecosystems by affecting multiple interdependent species. For example, streetlights and exterior lighting often attract insects, which in turn, attract insect eating animals like bats and reptiles.

Light pollution can affect animals from a distance. For instance, hundreds of species of birds migrate at night. Artificial night lighting can attract local and migrating birds and disrupt their dispersal movements and migration, which can lead to increased migration

mortality. Since Santa Paula is 15 miles inland from the coast and surrounded by rural and wild land, the City's sky glow can affect birds migrating overland and along the California coast. Reducing the bright lighting sources and sky glow in East Area 1 will reduce the City's overall light pollution impact in the area.

Shielded and Directed Lighting

Locate, aim, and shield all outdoor light fixtures in order to minimize light pollution. Use full-cutoff outdoor lighting fixtures wherever possible. Use cutoff or semi-cutoff fixtures only when necessary to illuminate target areas. All outdoor lighting fixtures that have full-cutoff, cutoff, or semi-cutoff restrictions should be installed and maintained in such a manner as to be horizontal to the ground so that the cutoff characteristics of the fixture are preserved.

Shield all temporary lighting, such as that used at construction sites, outdoor events, or other activities of a temporary duration. Aim temporary lighting to minimize glare and light trespass to adjacent properties. Turn off temporary lighting at the end of work shifts and at the completion of the specific project or event.

Full-cutoff outdoor lighting fixtures emit 0 percent of its light above 90 degrees and 10 percent above 80 degrees from horizontal plane above level ground (see Figure LM6). Cutoff outdoor lighting fixtures emit no more than 2.5 percent of its light above 90 degrees and 10 percent above 80 degrees from horizontal. Semi-cutoff outdoor lighting fixtures emit no more than 5 percent of its light above 90 degrees and 20 percent above 80 degrees from horizontal. Non-cutoff, or unshielded, fixtures distribute their light in all directions, and include globe-shaped lamps mounted on lampposts (see Figure LM5). Table LM2 summarizes the percentage of light emitted above the horizontal plane over level ground.

Table LM2: Percentage of Light Emitted Above the Horizontal Plane over Level Ground

Degrees Above Horizontal That Light Is Emitted	Full-Cutoff	Cutoff	Semi-Cutoff	Non-Cutoff
90^0	0%	< 2.5%	< 5%	100%
80^0	< 10%	< 10%	< 20%	100%

By directing the illumination and reducing waste light, a smaller wattage bulb is adequate. In a common unshielded light fixture, approximately 50 percent of the light shines upward, and approximately 40 percent of the light shines downward to illuminate the target area (see Figure LM5 and LM7). Light emitted horizontally can create glare. Shielded light fixtures eliminate the upward light and reduce glare.

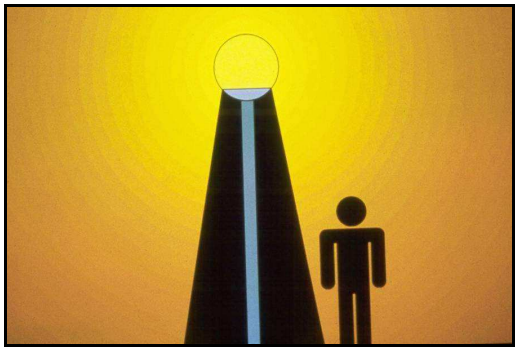

Figure LM5: Unshielded Light Fixture. This globe fixture causes light pollution. [*International Dark-Sky Association*, 2008]

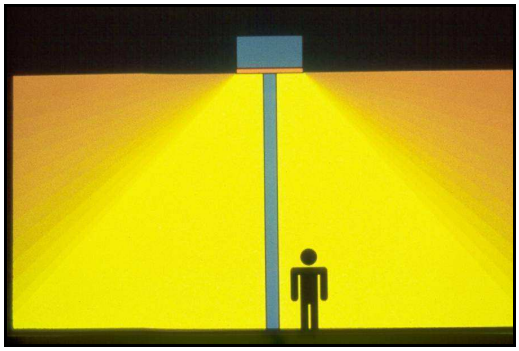

Figure LM6: Shielded Light Fixture Minimizes Light Pollution. The plane of the horizontal is the dark edge parallel to and above the ground at the height of the shielding. [*International Dark-Sky Association*, 2008]

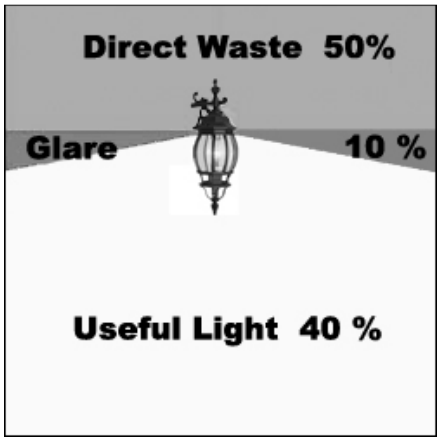

Figure LM7: Distribution of Light Emissions From an Unshielded Fixture.

A full-cutoff fixture, when correctly installed, reduces the chance for light to escape above the horizontal plane over the ground (see Figures LM6, LM8, and LM9). Light released above the horizontal often serves no purpose. Full-cutoff fixtures can reduce glare, sky glow, and light trespass by focusing light toward the ground, which prevents most of the light from escaping, except for what the ground reflects. The use of full-cutoff fixtures can allow for the use of lower wattage lamps in fixtures while producing the same or superior lighting.

Streetlighting should use full-cutoff light fixtures to eliminate or minimize light trespass, glare, and sky glow (see Figures LM8 and LM9). Reduce glare by properly aiming and shielding fixtures so that pedestrians and cyclists are clearly visible to drivers. Prevent streetlights from shining onto private property and homes. The East Area 1 Specific Plan Streetlighting Standards specifies the design for typical streetlights [*HDR Town Planning*, 2007c]. The single- and double-head column streetlights illustrated in the standards (see Figure LM10) may be unshielded, and therefore, might allow light to escape sideways and upward. These styles of streetlights should be modified or replaced with full-cutoff fixture designs.

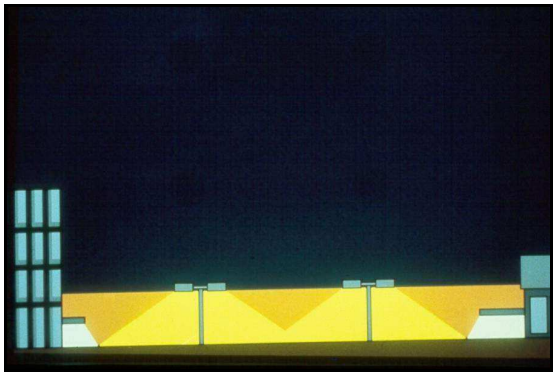

Figure LM8: Full-Cutoff Streetlights. Note that the building entrances have directed lighting under the eaves.
[*International Dark-Sky Association*, 2008]

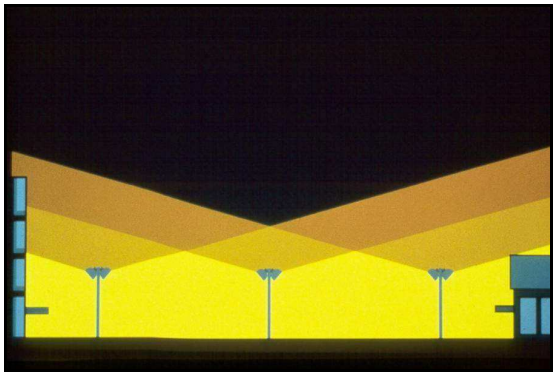

Figure LM9: Non-Full-Cutoff Streetlights.
[International Dark-Sky Association, 2008]

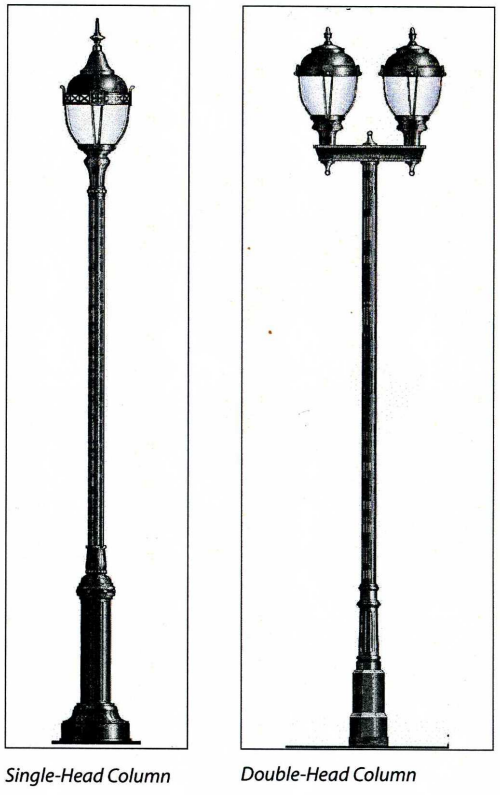

Figure LM10: Typical Streetlights Illustrated in the East Area 1 Specific Plan Streetlighting Standards. On the left is a single-head column. On the right is a double-head column. [Source: *HDR Town Planning*, 2007c]

Use shielding and proper light placement on exterior lighting for residential and non-residential buildings (see Figure LM11), and recreational sports facilities. Avoid lighting building facades and flags (see Figure LM12). See the International Dark-Sky Association Model Lighting Ordinance for prescriptive and technical methods for shielding and proper light placement, available online at www.darksky.org.

Maximum Maintained Illumination Levels

Use the lowest wattage necessary for lamps. Do not over-illuminate public spaces and building exteriors and interiors. Using lower wattage bulbs will lower energy costs and reduce the environmental impacts associated with energy production. Over-illumination enhances the effects of biological clock disruption by light pollution [*Pijnenburg, et al.*, 1991]. Glare, light trespass, and skyglow can be further reduced by using the lowest wattage necessary for lamps [*NYSERDA*, 2002]. Do not install outdoor

lighting that exceeds the maximum maintained illumination levels as recommended by the Illuminating Engineering Society of North America (IESNA) for the intended activity. When the maximum level is not defined by IESNA, do not install lighting that exceeds 175 percent of the minimum maintained illumination levels as recommended by the IESNA for the selected activity [*Keith*, 2000].

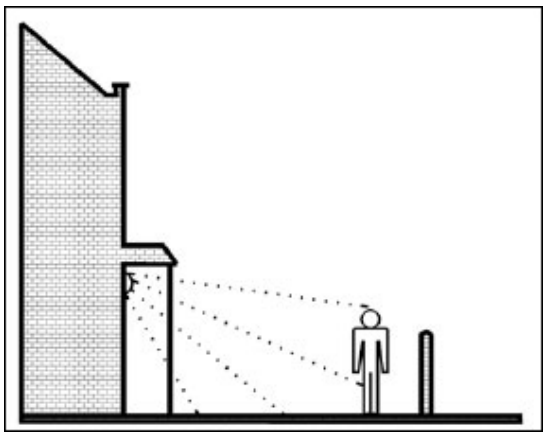

Figure LM11: Fixture Installed Under Overhang Minimizing Light Pollution. [Source: *Institution of Lighting Engineers*, 2005]

Figure LM12: Illuminated Facade. Light pollution caused by an office building illuminated by high pressure sodium (HPS) lamps shining upward. Much of the light shines into the sky and neighboring apartment blocks. [Source: *Skatebiker*, 2007]

Timers

Install timers in exterior lighting systems to turn lights off when not needed. Reducing artificial light use with timers can conserve energy, reduce the environmental impacts of energy production, and minimize light pollution. During the late night and early morning hours, timers can turn off lights during periods of low traffic in public and private areas. For example, timers can turn off non-essential streetlights, lights in public areas, landscape lighting, and exterior building lighting after business hours and late at night when traffic volume is low and while most residents sleep.

Photosensors, Motion and Occupancy Sensors

Install photosensors and motion and occupancy sensors in residential and non-residential buildings, in public areas and parks, and on pedestrian paths to turn off lighting when not needed. Using photosensors (light sensors) and motion and occupancy sensors can conserve energy, reduce the environmental impacts of energy production, and minimize light pollution. Photosensors combined with light dimmers on streetlights and other outdoor lighting can provide adequate lighting without over-illuminating the target area. Moreover, motion sensors may improve safety and reduce crime by alerting people of movement in the area at night. Do not install motion sensors

in areas with significant animal or wildlife traffic, such as in the undeveloped areas of the foothills.

Light-Emitting Diode (LED) Lamps

Use light-emitting diode (LED) lamps for streetlighting and other outdoor lighting instead of conventional lamp bulbs. A LED lamp is a type of solid-state lighting that uses light-emitting diodes (LEDs) as the light source. The applications for LED lighting in exterior applications include lighting for streetlights, parking lots, parking garages, security lighting, lighting bollards, landscape lighting, and traffic signals. LED lamps are safer for human health and the environment than many standard outdoor light bulbs, because no mercury is present in the bulbs [*Steele*, 2006].

LED streetlight fixtures, or luminaires, are more energy efficient than other conventional light sources. For instance, LED streetlight fixtures use 30-90 percent less electricity and have 3-5 times the life expectancy of regular High Pressure Sodium (HPS) fixtures. According to Haitz's Law of LED technology development, the light output of LEDs will increase by a factor of 20 every 10 years, while the cost will decrease by a factor of 10 over the same period of time [*Steele*, 2006]. Therefore, the performance quality of LEDs will improve rapidly over the next several years while the cost will go down.

On average, white LED luminaires have a useful life of at least 50,000-100,000 hours (approximately 12.5-25 years at 12 hours per day everyday). Nonetheless, the electrical and thermal design of LED fixtures will determine how long LEDs will last and how much light they will supply [*Steele*, 2006].

Although the electrical savings are substantial, LED luminaires currently have a higher initial cost than HPS. However, due to the durable nature of LED technology, the LED luminaires have zero regular maintenance cost over the span of their useful life. Consequently, the payback period for LED luminaires are approximately 10-15 years, depending on the maintenance costs associated with the municipality. However, given the expected rise in energy costs in the coming years, the payback period of LED streetlight fixtures will decrease [*Steele*, 2006].

In three case studies that we reviewed, three cities replaced standard HPS streetlight fixtures with LED luminaires. Each city reduced its energy consumption for those luminaires as compared with the original HPS fixtures. Furthermore, they all improved color rendering and night visibility, and reduced glare and light pollution. The results in the reduction in energy consumption are summarized in Table LM3 [*Cook, et al.*, 2008; *GlobalGreen Energy Corporation*, 2007; *Sustainable Public Lighting*, 2008].

Compared to standard HPS streetlights, LED streetlights increase overall illumination uniformity while reducing undesirable over-illumination and glare as compared to the HPS luminaires. In the Oakland study, the local residents generally preferred the LED streetlights. Based on the opinion survey for the study, 85 percent respondents stated

that the LED streetlights were at least as preferable as the old streetlights, if not significantly better. Further, all respondents that had noticed the new streetlights stated that that the LED streetlights maintained or improved their neighborhood's overall appearance, nighttime visibility, and nighttime safety.

Table LM3: Energy Consumption of LED Streetlights as Compared to Standard HPS Fixtures

City (fixture type)	Energy Consumption of LED Luminaires as Compared to Standard HPS Fixtures
Oakland, California (cobrahead fixture)	64%
Yakima, Washington (cobrahead fixture)	52.2 %
Ann Arbor, Michigan (cobrahead fixture)	80%
Ann Arbor, Michigan (globe fixture)	50%

Dark-Sky Compliant Fixture Labels

Use light fixtures with the International Dark-Sky Association Fixture Seal of Approval. The Fixture Seal of Approval provides third-party certification for a wide range of fixtures that minimize glare, reduce light trespass, diminishes sky glow, and lessens light pollution. The International Dark-Sky Association web site lists products and manufacturers that have the Fixture Seal of Approval program for fixtures that minimize light pollution, and is at www.darksky.org.

Lighting Code

Adopt an outdoor lighting code that defines required lighting practices that all designers, architects, engineers, and lighting installers are required to follow. A lighting code that is applied to the current and future design, construction, operation, and maintenance of East Area 1 can help reduce light pollution and maintain a high quality of life for the community. The International Dark-Sky Association and the Illuminating Engineering Society of North America (IESNA) Joint Task Force has developed a Model Lighting Ordinance to address the need for strong, consistent outdoor lighting regulation in the United States. Furthermore, International Dark-Sky Association offers an extensive list of lighting ordinances in their online directory of state, municipal, and international lighting codes. The Model Lighting Ordinance and the directory of lighting ordinances are available on the International Dark-Sky Association website: www.darksky.org.

The developer, designers, architects, engineers, lighting installers, businesses, and HOA should adopt this lighting code. In addition, this lighting code should also apply to community activities. Furthermore, provisions for a lighting code should be included in Covenants, Conditions, and Restrictions (CC&Rs) for East Area 1 (see Recommendation

OM1). In order to maximize compliance, this lighting code should be easily available to the community so that all residents, business owners, and workers in East Area 1 can comply.

Resources

California School Garden Network (CSGN): http://www.csgn.org
The CSGN functions as a central organization to assist school programs in setting up and running educational gardens, and to distribute school garden information, resources and support throughout California.

American Community Gardening Association (ACGA):
http://www.communitygarden.org
The ACGA supports community gardening by facilitating the formation and expansion of state and regional community gardening networks and educational programs.

International Dark-Sky Association (IDA): http://www.darksky.org
The IDA mission is to educate and find solutions for preventing light pollution. An online list of products labeled with the IDA Fixture Seal of Approval lists luminaires that minimize light pollution. The Model Lighting Ordinance and an extensive directory of lighting ordinances are also available online.

CHAPTER 5
SOLID WASTE MANAGEMENT

Solid waste management is an important aspect for the sustainability of East Area 1. Solid waste can cause environmental damage, including air and water pollution and soil contamination, as well as adverse human health impacts. Disposing of solid waste can be very expensive, consume large tracts of land, and may involve transporting the waste over long distances. It is inevitable that solid waste will be generated in East Area 1, but if managed properly the magnitude of its impacts will diminish.

Solid waste, also known as garbage or trash, is defined as any solid or semi-solid material that, after being consumed by humans, is discarded with no intention of being used further. Solid waste includes dry, non-edible items such as paper, boxes, furniture, and product packaging, as well as organic matter such as food scraps, grass clippings, and dead plants [*McKinney and Schoch*, 1998]. Garbage from households and non-industrial waste from businesses are commonly referred to as municipal solid waste. Other types of solid waste include construction and demolition debris, industrial waste, and municipal wastewater treatment sludge. Solid waste does not include wastewater itself, nor does it include hazardous waste material such as toxic chemicals and heavy metals [*United States Environmental Protection Agency*, 2008c].

Solid waste management is the process of dealing with waste once it has been generated [*McKinney and Schoch*, 1998]. The ultimate goal for East Area 1 regarding solid waste management is to minimize the quantity of disposed waste. Minimizing follows three simple steps: reduce, reuse, and recycle. In particular, East Area 1 can distinguish itself as a sustainable community by taking action to maximize municipal solid waste recycling, and by working with the builders and construction companies to reuse and recycle the waste generated from the construction process.

The majority of solid waste in Santa Paula, and throughout the United States, ends up being disposed of in sanitary landfills. These are typically giant holes where solid waste is contained, compacted, and then covered with dirt. Sanitary landfills are usually lined with plastic or clay in an attempt to prevent the waste, its byproducts, and rain and runoff water from entering the surrounding environment [*Zero Waste California*, 2006].

The waste sitting in landfills can be problematic in many ways. As waste breaks down in a landfill, it produces methane gas. Methane gas is the main constituent of natural gas, but it is also a climate change causing greenhouse gas. Methane has a global warming potential of 72 over 75 years. That is to say, methane is 72 times more potent as a greenhouse gas over a 75-year period than carbon dioxide (CO_2). Over 100 years, methane has a global warming potential of 25 as compared to CO_2 [*Intergovernmental Panel on Climate Change*, 2007]. While some newer landfills have installed technology to capture methane, these technologies are expensive, and none of the landfills that service Santa Paula use them.

Furthermore, when water from rain, runoff, or groundwater percolates through the landfill it creates leachate, a toxic substance which can contaminate the soil and pollute groundwater sources. While the main landfill that will serve East Area 1 is lined and has pipes and drains installed to control the leachate, it is still possible for the lining to tear or develop holes, which would allow leachate to escape from the landfill [*McKinney and Schoch*, 1998].

Eventually, a landfill fills and must close. In this case, either waste must be transported, sometimes over long distances, to another landfill that has remaining capacity, or a new landfill must be built. The process of transporting waste requires the waste be packed onto trucks or trains, leading to emissions of air pollutants. Building a new landfill requires a large tract of land with appropriate geological characteristics. Due to the potential harm to human and environmental health, building a landfill also requires a series of permits from local, state, and federal agencies [*California Integrated Waste Management Board*, 2008b]. Therefore, finding a suitable location and a municipality that is willing to host a new landfill can be difficult. The result is that as old landfills close, new ones are not being opened as replacements. For example, between 1988 and 2007, the number of landfills in the United States decreased from 7,924 to 1,754, a drop of nearly 80 percent [*United States Environmental Protection Agency*, 2008c].

Because of these environmental, human health, and land use concerns, cities must pay considerable fees to dump their solid waste in landfills. These fees, referred to as tipping fees, can range anywhere from $30 to $85 per ton[*California Integrated Waste Management Board*, 2009e]. In 2007, the City of Santa Paula paid over $40,000 in fees to dispose of its solid waste in landfills [*California Integrated Waste Management Board*, 2009a].

The first method of reducing the quantity of waste disposed of in landfills is to reduce the quantity of waste generated, also known as source reduction. Though much of the waste generated in the U.S. results from the manner in which products are manufactured and packaged [*California Integrated Waste Management Board*, 2007b], it is difficult for individual communities to influence manufacturing practices. The most effective way for a community to influence source reduction is by educating the public and increasing awareness of the importance of avoiding the creation of waste by consuming less [*McKinney and Schoch*, 1998].

Another method of reducing the quantity of waste disposed is to divert waste that otherwise would go to a landfill. One way to divert solid waste is by reusing products whenever possible. Reusing products instead of discarding them not only diverts solid waste from entering the waste stream, but is also a form of source reduction [*Zero Waste California*, 2009]. The reused product is a substitute for a new product, and therefore, prevents the need for additional consumption. For example, one beverage container can be reused 50 times.

The most popular way of diverting solid waste from a landfill is recycling. Recycling involves recovering used materials from the waste stream and processing those materials

into new products [*California Integrated Waste Management Board*, 2009d]. The environmental benefits of recycling include reducing air and water pollution, reducing energy consumption, and reducing the consumption of raw materials. Though the recycling process itself requires energy, and recyclables often must be transported over long distances to reach the processing facilities, the net effects of recycling are positive. The California Integrated Waste Management Board (CIWMB) estimates that in 2007 recycling in California saved enough energy to power 1.4 million homes for the year and reduced greenhouse gas emissions by an amount equal to removing 3.8 million cars from the road [*California Integrated Waste Management Board*, 2008a].

Recycling also has economic benefits. As discussed earlier, disposing of solid waste at landfills can be very expensive. Reducing the quantity of waste sent to the landfill reduces the total amount of fees that must be paid. Furthermore, in California and some other states, it is possible for individuals to receive money from bringing certain goods to recycling centers. Recycling has developed into its own industry by creating jobs and a market for recycled materials. The CIWMB estimates that the recycling industry accounts for 85,000 jobs within the state, and produces $10 billion worth of goods and services each year [*California Integrated Waste Management Board*, 2008a].

Other diversion methods include composting and sending solid waste to a waste-to-energy (WTE) facility. Composting is a specialized form of recycling in which organic matter, such as grass clippings and leaves, decomposes into a rich, organic soil amendment. Composting can be done in a safe, clean, and odor-free manner on a municipal level or in a backyard [*California Integrated Waste Management Board*, 2009c]. In Santa Paula, yard and other green waste is collected and composted while other cities, such as San Francisco, also allow food scraps and food-soiled paper to be collected for composting [*Platt*, 2002].

WTE facilities typically use chemical processes to decompose solid waste, and then capture the heat or other forms of energy created when the solid waste is broken down for use in generating electricity [*McKinney and Schoch*, 1998]. Unlike incineration, modern WTE facilities do not create toxic air pollution. However, currently the cost of these facilities is prohibitively high for most communities [*Waste-to-Energy Research and Technology Council*, 2009].

In an effort to reduce the negative impacts associated with solid waste, the federal and state governments have enacted legislation and developed programs aimed at reducing the amount of waste sent to landfills. The U.S. Congress passed the Resource Conservation and Recovery Act (RCRA) to promote recycling through public education. One outcome of that legislation was the United States Environmental Protection Agency's (EPA's) Resource Conservation Challenge, which established a goal that at least 35 percent of the municipal solid waste generated in the United States be recycled each year [*United States Government Accountability Office*, 2006]. The State of California has set even higher minimum diversion rates into law. The Integrated Waste Management Act of 1989 mandates that each jurisdiction divert at least 50 percent of its waste stream.

However, each jurisdiction has the authority to determine the best way to reach that level. Recently, California has adopted the Zero Waste California program. This program is based on the concept that solid waste is an inefficient use of resources and aims to change the way products are designed and manufactured in addition to maximizing reuse and recycling [*Zero Waste California*, 2009].

Methodology

In order to assess how solid waste can be managed sustainably in East Area 1, the composition and size of the community's potential waste stream must be understood. It is reasonable to assume that without the implementation of sustainability initiatives, the composition of the solid waste stream for East Area 1 will be similar to that of Santa Paula. As part of its charge, the CIWMB maintains a waste profile for every incorporated city in the state of California. The waste profile for Santa Paula includes basic demographic information about the city, a list of what waste management programs operate in the city, and information about the size and composition of the city's waste stream [*California Integrated Waste Management Board*, 2009a]. In order to keep the waste profile up to date, each city is required to submit an annual report, which must be reviewed for accuracy and approved by the Board. The city planning department provided the 2006 Santa Paula Annual Waste Report to our group.

Projecting the size of East Area 1's potential waste stream is more challenging. The Draft Environmental Impact Report for the East Area 1 Specific Plan [*P&D Consultants*, 2007a] projects the quantity of solid waste generated based on generation rates provided by the Ventura County Integrated Waste Management Division (VCIWMD), formerly known as the Ventura County Solid Waste Management Department. In a personal communication with the VCIWMD, we were informed that these, or any other waste generation rates, are no longer considered reliable for detailed data analysis [*Goldstein*, 2008]. The CIWMB also provides a list of rates for estimating solid waste generation, but includes a disclaimer that while these rates may be useful for providing general estimates, the Board does not officially endorse any of the listed rates and cannot verify their accuracy [*California Integrated Waste Management Board*, 2007a].

The City of Santa Paula will oversee solid waste management in East Area 1. While the annual waste report and the waste profile provide information about current waste management practices in Santa Paula, East Area 1 will be built over several years. Therefore, it is important to understand how the City plans to improve its waste management practices over the next few years. We consulted with Jon Turner, Interim Director of Public Works for the city, to determine the city's short- and long-term solid waste management plans.

The next step is analyzing the city's waste profile to determine which aspects of solid waste management in Santa Paula are deficient. From there, it is possible to identify opportunities for solid waste to be managed more sustainably in East Area 1. Ultimately, beyond identifying areas for improvement, it is necessary to develop strategies for

achieving improvement, requiring a literature review to identify waste management practices and strategies that other communities have successfully employed.

Finally, in order to demonstrate how sustainability will improve, the impact of these mitigation measures must be measured. A thorough review of the literature revealed that the impact of a particular strategy varies on a case-by-case basis, and no standard rates exist. Moreover, while off-the-shelf models capable of identifying optimal diversion rates based on environmental and economic factors exist [*Thornloe, et al.*, 2006], we found no off-the-shelf models capable of identifying how to achieve those rates. Instead, we use case studies to provide a range of estimated effectiveness.

The recommendations in this report are constrained by the fact that solid waste management services for East Area 1, such as collection, transporting, processing, recycling, and disposal, will be coordinated by Santa Paula in conjunction with the services it provides to the rest of the city. Therefore, it is not practical to recommend strategies which require collection services not already provided by the city, as this is outside the control of East Area 1. For example, many cities have significantly increased diversion rates by making recycling mandatory [*Langston*, 2006]. Enforcing mandatory recycling requires that garbage carts be spot checked for recyclables during the collection process. As the City coordinates collection services, it is outside the control of East Area 1 to enforce mandatory recycling.

Similarly, the City collects garbage and recyclable materials and sends them to offsite facilities, where they are either processed or stored. While a municipal food scrap collection program could increase diversion by as much as five percent [*Platt*, 2002], the facility where Santa Paula sends its green waste does not currently accept food scraps or food-soiled paper. It is not cost effective for East Area 1 to coordinate its own waste collection services in order to send compostable waste to a different facility. Therefore, it is not realistic to recommend a food scrap composting program in East Area 1.

Recommendation SW1: Residential and Commercial Recycling

Minimize the quantity of solid waste sent to landfills. Strategies include providing all residents and businesses clear written instructions, in both English and Spanish, about which materials can be recycled, making public recycling bins available, hosting community drop-off events, and requiring recycling bins for all commercial, industrial, and institutional entities.

The City of Santa Paula generated 57,547 tons of solid waste in 2006, the latest year for which data are available. Of that total, 38 percent was diverted from the landfill by recycling and composting. The remaining 35,547 tons were disposed in landfills [*City of Santa Paula*, 2008a]. Figure SW1 shows the city's rate of diverting waste from landfills over an 11-year span. The 38 percent diversion rate represents the highest diversion rate for the city since reporting began in 1995. That rate, however, is still significantly short of California's mandated rate of at least 50 percent diversion for every city.

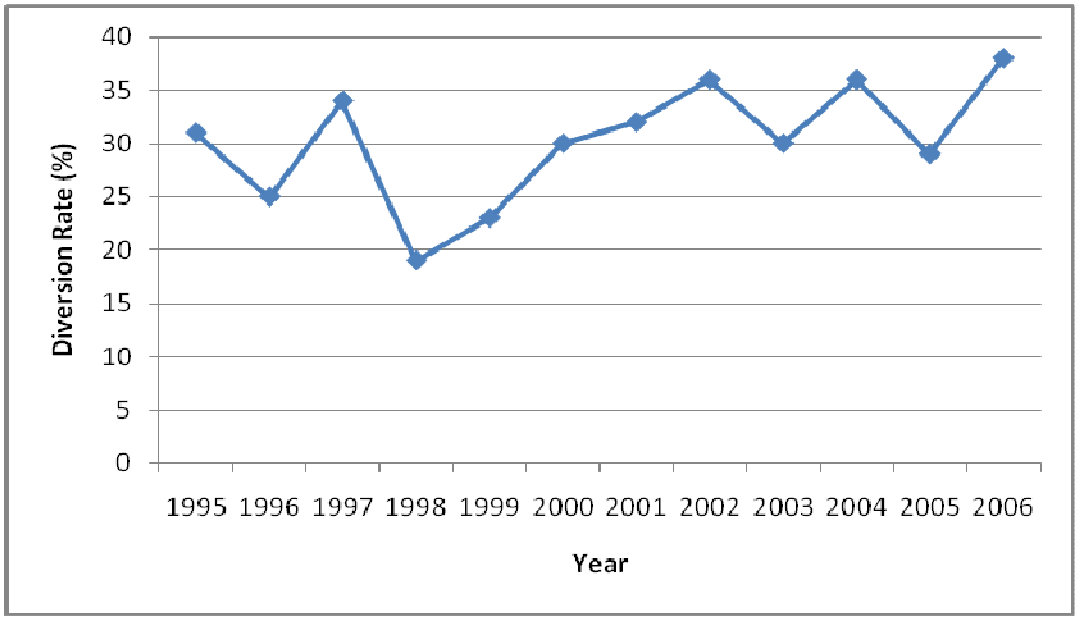

Figure SW1: Diversion Rate for Santa Paula, 1995-2006 [Source: *California Integrated Waste Management Board*, 2009a]

Residential waste comprised 26 percent of Santa Paula's total waste stream in 2006, with businesses contributing the other 74 percent. The constituents of both waste streams include organic material, paper, plastic, metal, construction and demolition debris, glass, mixed residue, household hazardous materials, and special waste including industrial waste, wastewater treatment sludge, and treated medical waste. Figures SW2 and SW3 show how much each category of waste contributes of the residential and business waste streams.

As discussed above, projections of the quantity of waste generated in East Area 1 are rough estimates. Using the VCIWMD generation rates, an estimated 7,701 tons will be generated each year in East Area 1. Of this total, residential customers will generate 32.7 percent (2,514.5 tons) and commercial, industrial, and institutional customers will generate the remaining 66.3 percent (5,186.5 tons).

Solid waste management in East Area 1 will involve mostly municipal solid waste and construction and demolition debris. The City of Santa Paula will coordinate the solid waste management services such as collection, transportation, processing, recycling, and disposal of solid waste for East Area 1. Single-family residences will use a color-coded three-cart system to sort their waste into garbage (black cart), commingled recyclables such as bottles, cans, and newspaper (blue cart), and yard waste (green cart). Each cart has a 96-gallon capacity, and all carts are collected curbside, with garbage collected weekly and recyclables and yard waste collected every other week. The carts will be provided to residents by the city for a small fee ($27.50 as of 2008) upon registering for curbside pickup service [*Turner*, 2008].

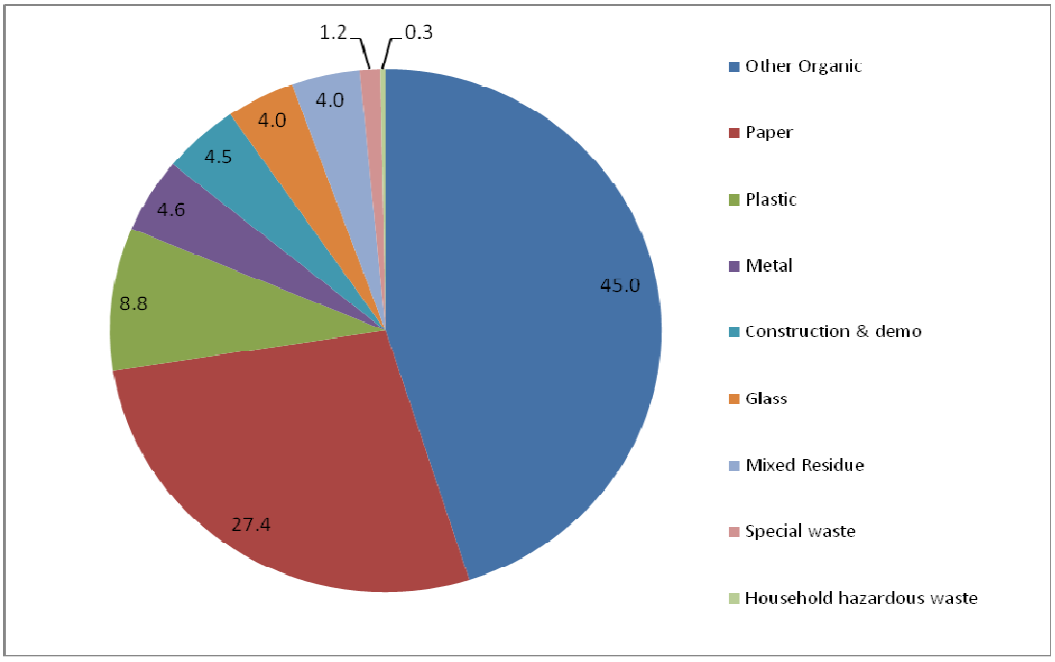

Figure SW2: Percent Composition of Residential Waste Stream for Santa Paula
[Source: *California Integrated Waste Management Board*, 2009a]

Currently, one of two commercial haulers with whom the city contracts, Consolidated Disposal Services or E.J. Harrison and Sons, provides solid waste collection from multi-family units and businesses. These commercial haulers collect garbage and commingled recycling but not yard waste. Santa Paula is planning to provide curbside service to businesses within the next few years, before construction on East Area 1 is completed. The city would also like to begin providing waste collection services to multi-family units within the next few years [*Turner*, 2008].

The primary destination for garbage collected by the city is the Toland Road Landfill. This landfill currently accepts 1,500 tons of solid waste per day, its maximum allowed quantity. At the current rate, this landfill will reach capacity and close in May 2027 [*P&D Consultants*, 2007a]. Therefore, the city will either need to find a new landfill to haul solid waste to or face increased tipping fees to dispose of the garbage generated in East Area 1. Thus, it is critical to maximize the amount of solid waste diverted from the landfill.

Source reduction is the first step toward minimizing the quantity of solid waste East Area 1 disposes in landfills. Short of implementing a policy to regulate the goods manufactured in East Area 1, it is difficult for East Area 1 alone to affect the way products are manufactured and packaged. It is neither practical nor feasible to regulate the products consumed in East Area 1 based on the way they are manufactured or packaged.

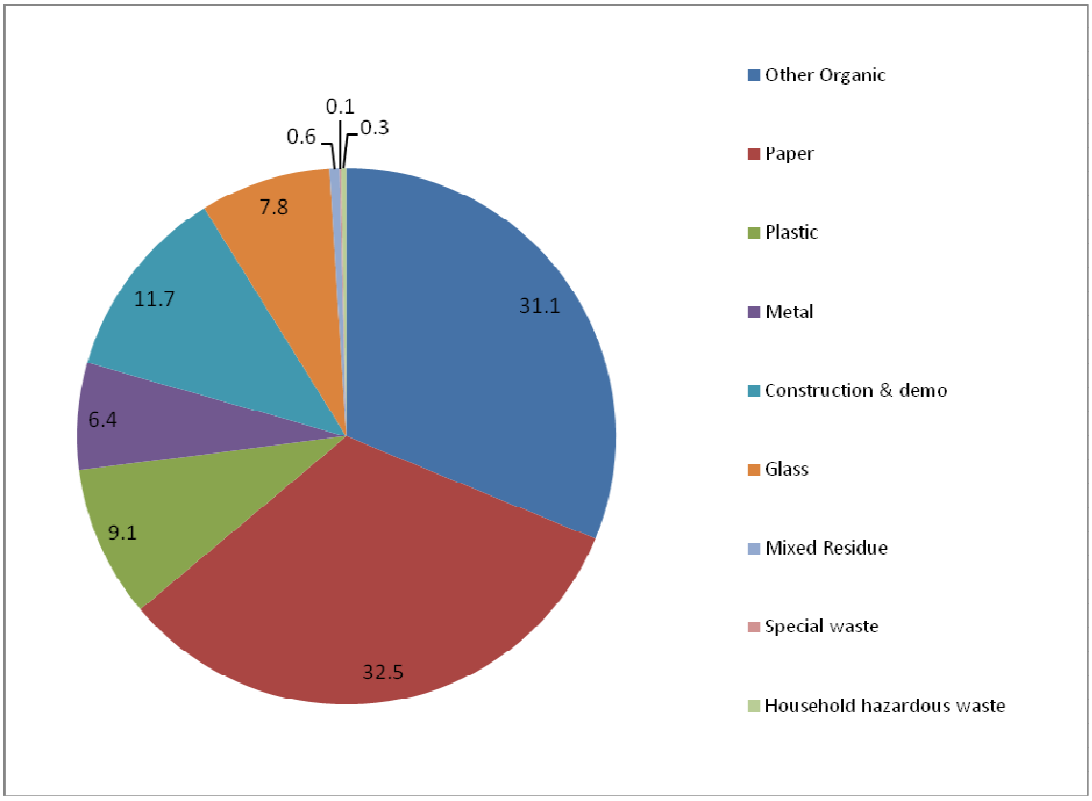

Figure SW3: Percent Composition of Business Waste Stream for Santa Paula
[Source: *California Integrated Waste Management Board*, 2009a]

The other strategy for achieving source reduction is to reduce the quantity of products consumed by the residents, workers, and visitors of East Area 1. One way to accomplish this is through education. Including information on the East Area 1 website (see Recommendation OM2) about the importance of source reduction, and holding a public workshop (see Recommendation OM3) on how to reduce consumption are two strategies for educating people in East Area 1. Additionally, implementing the recommendations in this report will generally raise awareness of sustainability, in turn leading people to be conscious about the choices they make about product consumption.

Managing solid waste sustainably in East Area 1 will also require diverting more waste from landfills than is currently diverted by the rest of Santa Paula. Recyclable materials collected by the city are taken to Gold Coast Recycling and Transfer Station in the City of Ventura. Santa Paula currently accepts 17 materials for curbside collection including glass and plastic bottles, newspapers, phone books, magazines and junk mail, and empty cleaning supply product containers [*Turner*, 2008]. Additionally, residents can self-haul anti-freeze, batteries, oil, paint, tires, and electronic waste to Gold Coast Recycling and Transfer Station. However, individuals must pay a fee to drop off these kinds of materials [*Gold Coast Recycling Incorporated*, 2009].

Instructions

Provide all residents and businesses clear instructions about which materials can and cannot be recycled in order to raise awareness and eliminate confusion. In order to make sure information about recycling reaches every community member, all instructions must be available in both English and Spanish and include pictures. Provide residents with instructions on a laminated page to ensure the durability of the instructions. Encourage residents to post the instructions inside their homes above or near the bin they use for recyclables. Provide all businesses with instructions on posters to display above or near both indoor and outdoor recycling bins.

Written instructions help educate the public about the recycling programs available in East Area 1. Furthermore, written instructions can eliminate confusion about whether a certain product is recyclable. They also inform community members whether a recyclable material will be picked up curbside or if it will need to be brought to a drop-off location. When equipped with the proper information, it is easier for people to make decisions that support sustainability.

A survey of recycling coordinators from throughout the United States found that education and public outreach were consistently listed among the three most important strategies for improving diversion rates [*United States Government Accountability Office*, 2006]. In particular, San Francisco, which has a diversion rate of 70 percent [*Cote*, 2008], cites the instructional brochures it distributes in three languages as one of the most important aspects of its solid waste management program [*United States Government Accountability Office*, 2006].

Similarly, the U.S. EPA reported [*United States Environmental Protection Agency*, 1999] that in 18 communities across the country highlighted for implementing innovative strategies to achieve high rates of diversion, education and public outreach were key to the success of the recycling program in each of these communities. Diversion rates varied across the communities, but education and public outreach improved them by as much 10 percent.

Beyond distributing recycling instructions, there are several other strategies to promote solid waste management education and public outreach. Strategies include featuring East Area 1's recycling program on the community website, advertising in local publications, making presentations in the schools, and holding public workshops. Education and public outreach efforts should inform community members about how the solid waste management system works, including the three-cart system for single-family residences and separating trash and commingled recycling at businesses. In addition, these efforts must explain why recycling is important and what its benefits are.

Public Recycling Bins

Make clearly marked public recycling bins available next to all public trash bins. Public recycling bins not only reduce the quantity of recyclable materials that end up in public trash bins, but also send a clear signal that recycling is important to the community. It is especially important to put public recycling bins in mixed-use neighborhoods, particularly in areas where people gather to eat lunch and near retail establishments.

Public recycling bins must be well marked and clearly distinguished from trash bins. The color of recycling bins should be different from that of trash bins and should have a distinct marking such as the international recycling symbol. Figure SW4 shows a distinctly marked public recycling bin next to a public trash bin. In order to prevent contamination with non-recyclable materials, affix a sign to the front of the recycling bin that states which materials can be deposited in the bin. It is also important that the recycling bins be located next to trash bins. Otherwise, people may just assume that the bin is for trash.

The City of Santa Barbara has put public recycling bins in areas where there is heavy foot traffic, as well as in some public parks and the community golf course. The city estimates that the public recycling bins have directly increased the diversion rate for the entire city by close to one percent and have indirectly contributed to the city's image as a leader in sustainability [*Johnson*, 2008].

Figure SW4: Clearly Marked Public Recycling Bin and Public Trash Bin [Source: *City of Santa Barbara Environmental Services*, 2009]

In Boise, Idaho, public recycling bins are in areas where commuters exit their cars, public transit stations, and a downtown park where many office workers enjoy their lunches. Although Boise initially experienced high rates of contamination and low general use of the public recycling bins, a public outreach campaign corrected the problems. Boise's public recycling bin program has now expanded to cover more areas of the city. It is estimated to have increased recycling for the entire city by two to three percent [*Kershner*, 2008].

In 2007, New York City instituted a pilot public recycling program with separate bins for paper and commingled glass, plastic, and aluminum. The public recycling bins were placed in six parks throughout the city, and in several transit hubs[*New York City Department of Sanitation*, 2007]. New York implemented the program in response to a 2004-2005 Waste Characterization Study report which found that 47 percent of waste from trash bins on the street was recyclable [*New York City Department of Sanitation*, 2006]. In general, the results showed that the paper recycling worked well, but commingled recycling suffered from high rates of contamination. Although the total quantity of

materials collected in the pilot program was negligible compared to the total amount of solid waste in the city, that total is more a reflection of the size of the program than the success of the program. While a public recycling bin program in East Area 1 will have very different considerations than a program in New York City, the pilot program provides a valuable insight on where to locate recycling bins.

Community Drop-Off Events

Host community drop-off events for recyclable materials that are not collected curbside. Some materials such as electronic waste, old tires, furniture, and large metal objects cannot be collected curbside. While many recycling centers allow people to self-haul their recyclables, most people do not go to the trouble of doing this. Community drop-off events would make it easier for residents to recycle these materials. A commercial hauler would transport these materials to a recycling center. Community drop-off events must be regular, such as every three or six months, so residents do not have to store their recyclable materials for too long. It is also important that these events be well publicized, via announcements on the East Area 1 website, in local publications, and through flyers posted in public spaces.

Commercial, Industrial, and Institutional Recycling

Require all commercial, industrial, and institutional (CII) facilities to provide recycling bins for employees, customers, and students. The first step to encouraging recycling is making it possible for people to do so. Many non-residential entities such as offices, retailers, restaurants, and schools either do not offer recycling or do not have adequate containers. Increasing recycling in CII facilities can have a huge impact on a community's overall recycling rates [*United States Government Accountability Office*, 2006].

Non-residential customers made up 74 percent of Santa Paula's waste stream in 2006 [*California Integrated Waste Management Board*, 2009a]. While the city's waste profile and annual waste report do not provide separate diversion rates for residential and non-residential customers, recycling rates are typically lower for non-residential customers. Mandating CII facilities to provide recycling bins will have an immediate and significant impact on the amount of recycling in the community. The presence of recycling bins also reinforces East Area 1's commitment to sustainability among workers, customers, and students. Moreover, displaying posters with instructions, in both English and Spanish, on which materials can and cannot be recycled above or near all recycling bins reminds people in those facilities that recycling bins are available and should be used.

Recommendation SW2: Construction Site Recycling

Mandate all companies doing construction in East Area 1 to institute a work site program to divert a minimum of 90 percent of construction and demolition waste from landfills. Each diversion program must detail where separated construction waste will be reused or hauled, and designate a person who is responsible for overseeing and maintaining the separation of construction waste materials.

An important part of managing solid waste sustainably in East Area 1 is to divert the waste generated from the construction and building process. 22 percent of California's waste stream in 2004 was construction and demolition materials [*California Integrated Waste Management Board*, 2006]. The National Association of Home Builders estimates that the average new home generates about four pounds of waste per square foot, or three tons for a 1,500-square-foot home [*Ventura County Integrated Waste Management Division*, 2009]. Almost all of these materials can be diverted from landfills by reuse or recycling. Additionally, reusing and recycling materials from construction further mitigates environmental harm by minimizing the need to extract, process, transport, and consume virgin resources.

Construction Site Diversion Program

Require each builder and construction company working in East Area 1 to develop a plan for diverting the waste generated at that work site. The first step to successfully prevent construction and demolition debris from going to a landfill is to identify what types and quantities of waste materials will be generated from this particular construction project [*California Integrated Waste Management Board*, 2006]. Once the projected waste has been inventoried, a plan to identify where the various waste materials will be hauled or how they will be reused must be implemented.

There are many facilities which accept construction waste throughout Ventura County but some only accept certain types of materials. Therefore, it is important that the plan identify where each material will be sent. Table SW1 is a list of facilities in Ventura County that accept construction and demolition waste and what type of waste they accept. The CIWMB also maintains a database of all the construction and demolition recycling facilities in the state and lists which materials they accept. For materials that are not accepted by any facilities in Ventura County, the builder should contact the CIWMB, VCIWMD, or the City of Santa Paula for help in identifying a strategy for diverting that material from the landfill.

Each builder or construction company should coordinate plans with the City's construction waste hauler, E.J. Harrison and Sons, to arrange for transport and fees. Some facilities can arrange for their own hauler to pick up construction waste in case E.J. Harrison and Sons is unable to haul certain types of waste. In the event E.J. Harrison and Sons cannot haul a certain material to a facility that does not have its own collection service, the city or county may be able to arrange for an alternative hauling service to transport those materials.

Construction Site Recycling Coordinator

Designate an on-site recycling coordinator to oversee the separation and proper handling of all waste. This includes making sure there are proper containers and adequate space to temporarily store waste on-site [*Community Environmental Council, et al.*, 2006]. The recycling coordinator will also be responsible for documenting quantities, types, and destinations of waste materials. The most important aspect of a construction diversion program is making sure different waste materials are properly separated [*Eckberg*, 2008]. This requires diligent oversight and a commitment on the part of the builder. It is especially important that the recycling coordinator work with sub-contractors to ensure they are complying with the diversion plan. Ultimately, the contracted construction company is responsible for all the construction waste generated on their site. As such, diversion plans will need approval before a company can begin construction. Furthermore, diversion plans must be enforced in order to be effective.

The goal of each plan must be to divert a minimum of 90 percent of construction waste from the landfill. Though ambitious, this is an achievable goal. The Limoneira Company was able to divert 99 percent of the waste generated from a solar energy project in Santa Paula in 2008 [*Key*, 2008]. Ventura County Ordinance 4357 mandates that at least 60 percent of waste materials from construction projects in the unincorporated areas of the county be recycled. Many construction sites end up with diversion rates of 80 percent or higher [*Ventura County Integrated Waste Management Division*, 2009]. East Area 1 can do even better. Setting a goal of at least 90 percent diversion will reduce the impacts of the construction waste from East Area 1 and set a standard for future sustainable communities.

Resources

California Integrated Waste Management Board: www.ciwmb.ca.gov
The CIWMB, an office of the Governor of California, is a clearinghouse of information and data related to solid waste management.

United States Environmental Protection Agency Office of Solid Waste:
http://www.epa.gov/osw/index.htm
The U.S. EPA's Office of Solid Waste is a clearinghouse of information and case studies of effective solid waste management strategies throughout the United States.

Ventura County Integrated Waste Management Division:
http://portal.countyofventura.org/portal/page?_pageid=876,1126077&_dad=portal&_schema=PORTAL
The VCIWMD contains relevant local information about solid waste management. Though it serves the unincorporated parts of the county, this department has much useful information, particularly about construction site waste management.

Table SW1: Ventura County Construction and Demolition Debris Recycling Facilities

Facility Name	Phone Number	City	Materials Accepted
Alco Pallet Recycling	(805) 385-0095	Oxnard	Pallets
Cal Wood – Agromin Organics	(805) 650-1616	Oxnard	Green waste; tree logs; wood; pallets; fences; sawdust
Cal Wood – Agromin Organics	(805) 650-1616	Santa Paula	Brush; grass; leaves; wood
Camarillo Recycling, Inc.	(805) 987-0226	Camarillo	Aluminum; brass; copper; stainless steel
Cemex	(800) 654-4435	Moorpark	Concrete; asphalt
Eddie's Recycling	(805) 486-5607	Oxnard	Aluminum; brass; copper
Furia Transport	(805) 240-7898	Oxnard	Pallets
M Maintenance and Construction Clean-Up	(805) 485-1267	Oxnard	Concrete; concrete block; asphalt; lumber; brush; pallets
Ojai Valley Organics	(805) 640-9194	Ojai	Brush; grass; leaves; wood lumber; pallets; wood chips; tree trimmings
Oxnard Metal Company, Inc.	(805) 483-0512	Oxnard	All metals
Oxnard Pallets	(805) 487-8458	Oxnard	Plastic and wood pallets
P.W. Gillibrand Co.	(805) 520-8720	Simi Valley	Concrete; asphalt; concrete block
Santa Clara Organics	(805) 524-2751	Fillmore	Green waste; tree logs; wood pallets; root balls; fences; sawdust
Simi Valley Base/Transit Mix	(805) 520-3595	Simi Valley	Concrete; concrete block; asphalt; rock; toilets
Simi Valley Landfill	(805) 579-7267	Simi Valley	Concrete; asphalt; dirt; brick; brush; grass; leaves; wood lumber; pallets; wood chips; tree trimmings
Simi Valley Recycling Center	(805) 527-4033	Simi Valley	All metals
Tapo Rock and Sand	(805) 526-2899	Simi Valley	Concrete; concrete block; asphalt; dirt; brick
Vulcan	(805) 647-1121	Oxnard	Concrete; asphalt; concrete block

[Source: *Ventura County Integrated Waste Management Division*, 2008]

CHAPTER 6
TRANSPORTATION

One sector in which East Area 1 can distinguish itself as a sustainable community is in transportation. The transportation sector is a major source of air pollution in California and throughout the United States. Automobiles and light trucks, such as sport utility vehicles (SUVs), are the two largest mobile sources of air pollutant emissions. They are typically used as personal vehicles for the everyday transportation needs of individuals and their families [*Science Applications International Corporation*, 2007]. Automobiles and light trucks emit local air pollutants listed as criteria pollutants under the Clean Air Act such as reactive organic gases (ROG), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (PM_{10} and $PM_{2.5}$); non-criteria toxic pollutants such as benzene and 1,3- Butadiene; as well as greenhouse gases such as carbon dioxide (CO_2).

Local air pollutants directly affect human and environmental health. For example, ROG and NO_x react with sunlight to create tropospheric ozone, also known as smog, which is linked to lung and respiratory system damage [*Surface Transportation Policy Project*, 2003]. Particulate matter has been found to cause pulmonary diseases such as asthma and lung cancer, cardiovascular issues such as atherosclerosis and heart disease [*Peng*, 2008; *Pope, et al.*, 2002] and premature death [*Mokdad*, 2004]. CO reduces the capacity of blood to carry oxygen to the brain, heart, and other parts of the body, impairing the ability of those organs and tissues to function properly. NO_x and SO_2 are precursors of acid rain, which adversely impacts plants and animals by causing the acidification of soil, streams, and lakes [*Schlesinger*, 1997].

Emissions from mobile sources also cause environmental harm on a global scale. CO_2, a greenhouse gas, is a major driver of climate change. According to the U.S. Department of Energy [*United States Department of Energy*, 2006a], 33 percent of total greenhouse gas emissions in the United States come from transportation. Furthermore, as shown in Table T1, greenhouse gas emissions from mobile sources grew almost 29 percent between 1990 and 2004 [*Science Applications International Corporation*, 2007]. Although it is only one of many greenhouse gases, CO_2 represents about 95 percent of transportation related greenhouse gas emissions [*United States Environmental Protection Agency*, 2006b], and reducing CO_2 emissions is the key component of many efforts to mitigate human-induced climate change.

Air pollutant emissions from transportation are affected by three components: the type and content of fuel used to power the vehicle, the fuel efficiency of the vehicle, and the vehicle miles traveled (VMT) or amount vehicles are driven [*Ewing, et al.*, 2008]. While the first two components are technological issues related to the vehicles themselves, VMT is a product of urban and community planning.

The assumption underlying urban planning since the end of World War II is that people will use cars as the primary mode of transport. This has led to a trend of developing low-density communities that spread across larger areas of land. The amount of developed land in the United States increased from 18.6 million acres to 74 million acres between 1954 and 1997, a four-fold increase [*ICF Consulting*, 2001]. As a result, people live farther away from where they work or go to school, and farther away from each other. Another outcome of planning based on car travel has been a separation of residential neighborhoods from commercial centers, which has forced people to travel greater distances to access the goods and services they require.

Table T1: Greenhouse Gas Emissions from Mobile Sources in U.S., 1990-2004

Source	1990	1995	2000	2004	Percent change (1990-2004)
Cars (Teragrams CO_2 eq.)	646.9	618.3	660.1	658.7	1.8
Light Trucks (Teragrams CO_2 eq.)	331.3	413.2	482.5	543.6	64
Other mobile sources (Teragrams CO_2 eq.)	545.2	608.5	727.7	756.7	38.8
TOTALS	**1523.4**	**1640.0**	**1870.3**	**1959.8**	**28.6**

[Source: *United States Department of Energy*, 2006a]

This trend in urban planning has caused society to largely depend upon personal vehicles to satisfy its transportation needs. In turn, the increasing dependence on cars has allowed development to continue expanding outward, further reinforcing the need to drive. For example, VMT in the United States increased 63 percent between 1980 and 2005. This growth rate is almost three times greater than population growth during the same time period and twice the rate of new vehicle registrations [*Ewing, et al.*, 2008; *United States Department of Transportation*, 2007]. Figure T1 shows the rate of increase for VMT, vehicle registrations, and population over the past 25 years.

As a neighborhood development designed to integrate sustainability into the fabric of the community, East Area 1 has been planned to reduce the need for residents, visitors, and workers to depend on cars as the primary mode of transportation. This design incorporates a variety of development densities; a mix of residential, commercial, and civic uses; local serving retail; and pedestrian-friendly streets that blend into the natural

landscape of the region. Consequently, this plan provides a good foundation upon which East Area 1 can achieve its goal of having a sustainable transportation sector.

While the conceptual planning framework is a crucial element of sustainability, the community must be constructed in a way which will allow it be sustainable once people are living and working in it. This objective requires specific actions during the construction phase and appropriate services once the community is operating, in order to ensure that the concepts laid out during the planning process are realized.

Conceptually, East Area 1 has a sustainable transportation sector through a compact design, homes located within walking distance of schools and retail stores, integration of the built environment into the natural terrain, and thoroughfares which connect the community to the rest of the City of Santa Paula. In practice, a sustainable transportation sector in East Area 1 requires streets that pedestrians and automobiles can safely share, infrastructure which supports the use of bicycles, transit services, carpools, and occasional access to cars without having to own them.

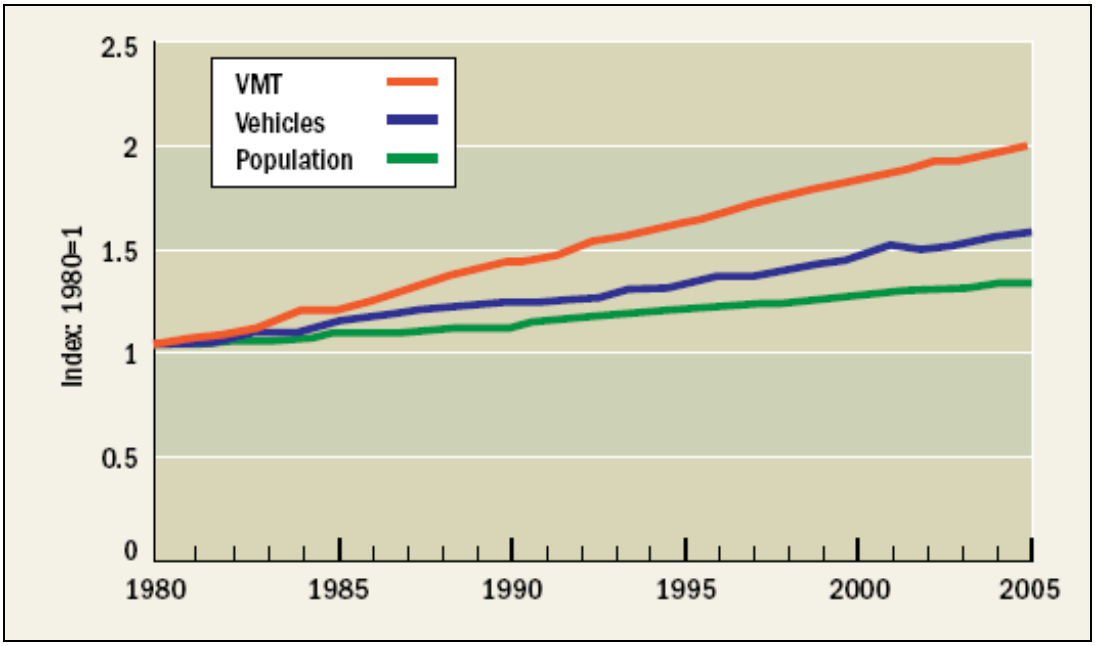

Figure T1: Population, VMT, and Vehicle Registration Growth in U.S. Indexed to 1980 [Source: *Ewing, et al.*, 2008]. Used with permission.

Constructing East Area 1 in accordance with the conceptual vision laid out in the Specific Plan and carrying out the specific actions recommended in this report mitigates the adverse environmental impacts from transportation in this community. Implementing mitigation measures such as a mix of residential and non-residential uses, local serving retail, enhanced infrastructure for pedestrians and cyclists, access to public transit, carpooling, and car sharing leads to decreased transportation-related emissions of all assessed pollutants in East Area 1 (see Appendix E for a full list of mitigation

measures). The baseline for comparing mitigation measures is a similarly sized community built in the same geographical area according to the conventional planning standard of expansive, low-density neighborhoods segregated from commercial and retail centers.

Figure T2 shows the cumulative impact of the mitigation measures implemented in East Area 1 on annual emissions for each pollutant. PM_{10} and $PM_{2.5}$ emissions are reduced by 8.3 tons and 1.6 tons. Furthermore, CO and CO_2 emissions decrease by 27.9 tons and 4,443.6 tons each year. Emissions declined by 15-18 percent for each pollutant except SO_2, which declined by 8.7 percent. A complete list of transportation-related emissions results can be found in Appendix F.

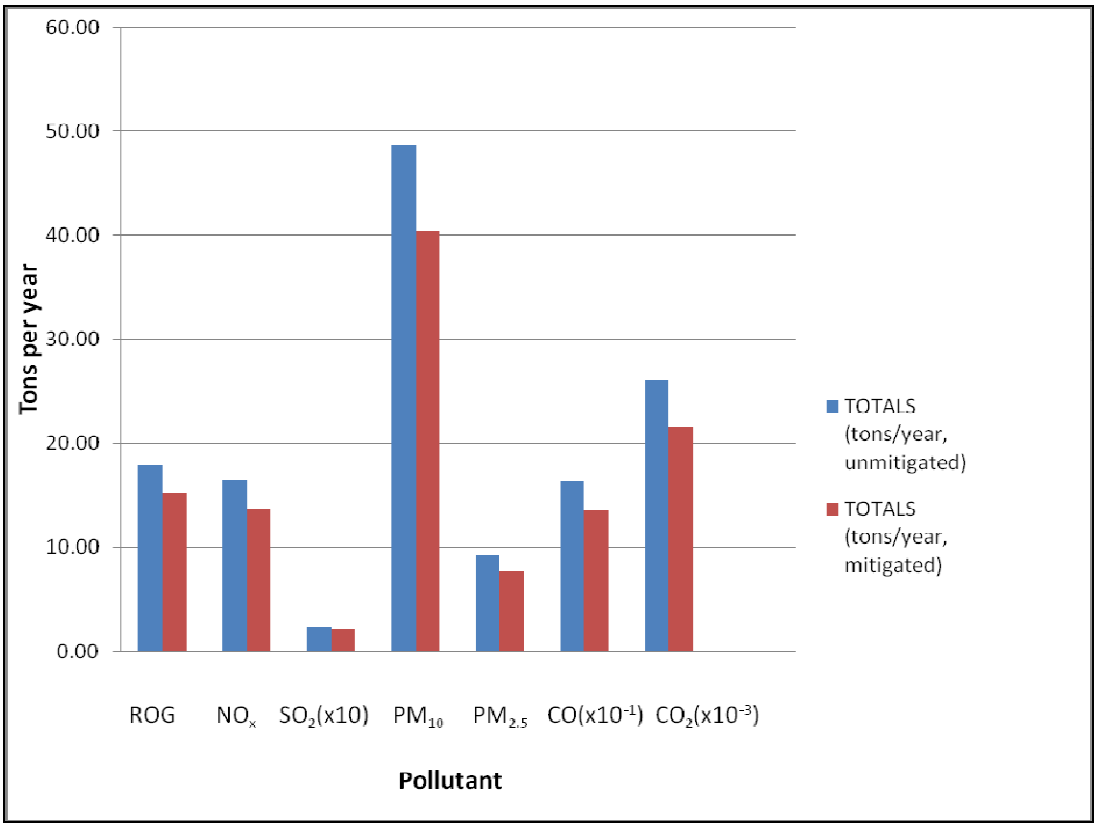

Figure T2: Estimated Annual Vehicle Emissions in East Area 1

Reductions in emissions are directly attributable to a reduction in the number of car trips taken in East Area 1. The cumulative impact of the mitigation measures prescribed above results in 19.85 percent fewer car trips. In particular, the mix of residential and non-residential uses including schools, athletic fields and recreational areas, commercial and industrial workplaces, and local serving retail have a significant impact on the number of car trips taken. When factored together, these two mitigation measures decrease the number of car trips by 11 percent, corresponding to 2,866 fewer tons of CO_2 emissions annually.

Similarly, the cumulative impacts of the mitigation measures implemented in East Area 1 cause a decrease in the quantity of each pollutant emitted on a daily basis. Daily emissions are measured in pounds per day. Due to differences in the content of the gasoline used in summer and the gasoline used in winter, the quantity of each pollutant emitted varies during these two seasons. Therefore, data are provided for daily emissions during summer and winter. In general, the mitigation measures substantially reduced the total daily emissions during both seasons. For example, Figure T3 shows the percent reduction in daily emissions of each pollutant during winter. Reductions are comparable for each pollutant, with emissions being reduced by 16.6 to 17.1 percent. There is a similar range of percent reductions in summer. A complete list of transportation-related emissions results can be found in Appendix F.

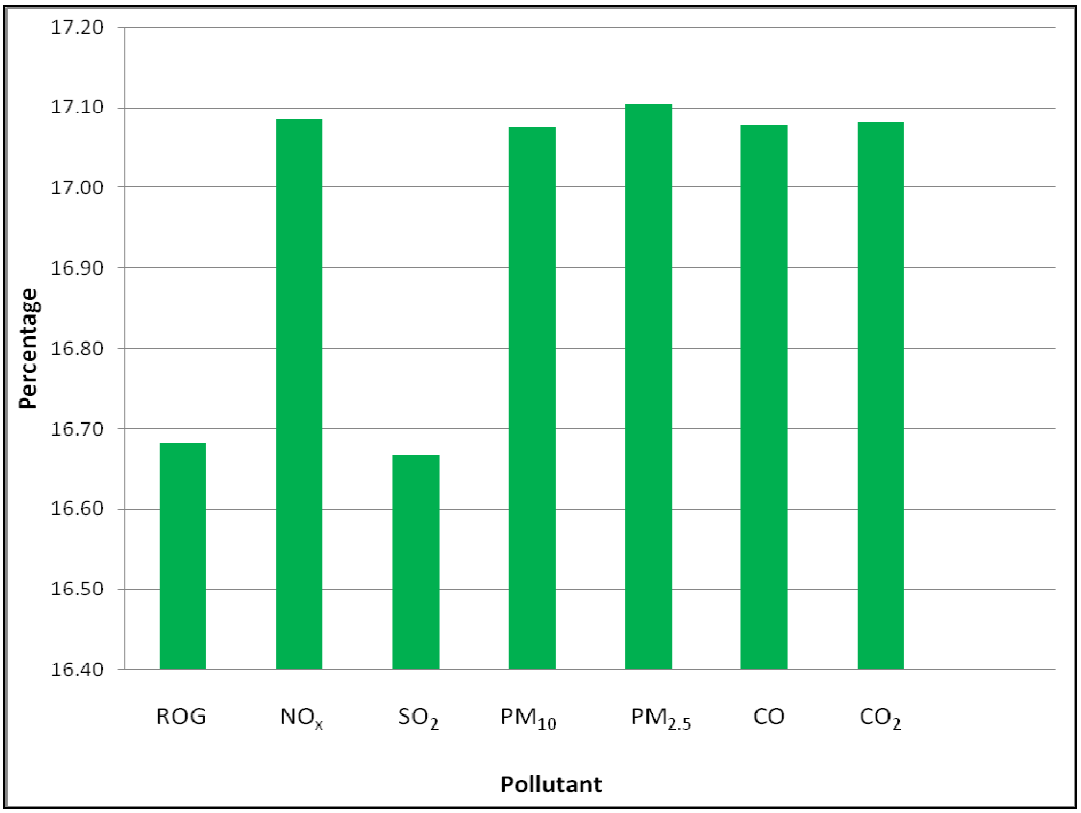

Figure T3: Percent Reduction in Daily Emissions from Mitigation Measures, Winter

Methodology

In order to assess the sustainability of the transportation sector in East Area 1, we used URBEMIS 2007 (version 9.2.4) air quality monitoring software. URBEMIS estimates air emissions from land use development projects based on user-defined project parameters [*Rimpo and Associates Inc.*, 2008]. The model allows the user to forecast emissions from the construction process, transportation, and area sources such as natural gas combustion. This assessment only analyzed transportation related emissions. Further, this analysis

used the parameters for on-road vehicle emissions from the California Air Resources Board (CARB) EMFAC2007 version 2.3 model; trip generation rates are from the Institute of Transportation Engineers (ITE) Trip Generation Manual, 7th Edition; regional climate and ambient air quality data are from the Ventura County Air Pollution Control District; and assumptions about the mix of vehicles in the fleet come from CARB for 2020, the year construction is currently scheduled to be completed.

The URBEMIS model provides emissions data for the criteria pollutants ROG, CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and the greenhouse gas CO_2. Output data are presented as pounds emitted per day during summer and winter and tons emitted per year. Estimates of baseline transportation emissions are based on land use data, including the total area of the project, number and type of residences, areas of open space, recreational areas, and educational facilities, and areas dedicated to commercial, industrial, and retail uses. Once the user selects and sets parameters on mitigation measures, the impact of those measures on total emissions can be assessed.

Recommendation T1: Pedestrian and Bicycle Friendly

Discourage the use of automobiles by promoting walking and cycling, and by restricting parking. Make sidewalks 8-12 feet wide, well-lit at night, and shaded; install crosswalks and pedestrian crossing signals at heavily trafficked intersections; provide sufficient bicycle lanes, paths, and racks; and restrict parking in the commercial and civic districts.

Making East Area 1 a community where drivers, walkers, and cyclists can all share the road can have significant positive environmental impacts. The number of car trips can be reduced by nearly 5 percent by building sidewalks and crosswalks in conjunction with interconnected street blocks, bicycle lanes along roadways; and dedicated bicycle paths. These pedestrian oriented mitigations reduce emissions of all air pollutants on a daily and annual basis, as shown in Table T2.

Table T2: Percent Reduction in Emissions from Pedestrian-Oriented Mitigations

	ROG	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO	CO_2
Daily, Summer	4.22	4.95	5.15	4.96	4.94	4.96	4.96
Daily, Winter	4.84	4.94	5.3	4.96	4.94	4.96	4.96
Annual	4.47	4.84	4.35	4.98	4.77	4.97	4.96

Walking

Promote walking in East Area 1 by building and maintaining 8-12 foot wide, well-lit, aesthetic sidewalks and paseos, landscaped to provide shade. One outcome of the car dependent post-World War II urban planning model has been a significant decline in the ability of people to travel by walking. Even where an individual lives closely enough to walk to a destination, many streets lack sidewalks, allow cars to travel at high speed, and are wide and difficult to cross. Moreover, many intersections do not have cross walks or pedestrian crossing signals. Therefore, in many cases it is neither practical nor safe to travel by walking.

Walking is an important part of making a community both environmentally and socially sustainable. Environmentally, air pollution and dependence on fossil fuels are decreased when people choose to walk instead of drive [*Smart Growth Network*, 2009]. In terms of the social aspect of sustainability, walking can help increase physical fitness; reduce the likelihood of obesity and other health problems exacerbated by inactivity [*Local Government Commission*, 2007]; and enhance the ability of children, the physically disabled, and low income individuals to travel independently [*Burden*, 2001].

Walking can also help increase business in communities, such as East Area 1, which have storefronts on the street level. An individual who is walking on a sidewalk may enter a store because he sees something in a window. A person in a car, on the other hand, would have a more difficult time seeing that product because he would be farther away from the store and traveling at a faster speed. Furthermore, it is easier for a walker to stop in to a store than it would be if he were driving because he would have to find a parking space before he could shop [*Local Government Commission*, 2005b].

Walking also has important cultural ramifications. A pedestrian directly interacts with the landscape and community and is able to interact with fellow walkers. By interacting with their surroundings and neighbors, people often feel more connected to their community. Moreover, they regard neighborhoods as a social environment, and not just as a geographical location. Consequently, people take greater pride in the appearance, functionality, and safety of the community [*Burden*, 2001].

In order for individuals to be willing to walk, they must feel comfortable doing so. All too often sidewalks are not sufficiently factored into the planning process, and therefore, are not practical for travel. All streets must have sidewalks, and the network of sidewalks must be continuous throughout the community. Once sidewalks are built, it is important that they be maintained. Sidewalks must be regularly swept and cleared of debris and, when necessary, must be repaired in a timely fashion.

Sidewalks need to be wide enough to allow at least two people to walk side-by-side in one direction. As such, sidewalks in East Area 1 should be 8-12 feet wide and no less than five feet in width. Additionally, landscaped buffer strips should be included between the roadway and the sidewalk to provide separation between pedestrians and

cars. Four to six foot buffer strips give the perception of increased width and make pedestrians more comfortable [*Burden*, 2001].

Furthermore, sidewalks and buffer strips must be appropriately landscaped. Planting flowers and street trees makes sidewalks more inviting and aesthetically pleasing. Street trees not only increase the aesthetic appeal of sidewalks but also provide shade from the sun [*Burden*, 2008]. This is particularly important for East Area 1, which receives sunlight year-round, and experiences very warm temperatures throughout the summer.

All sidewalks must have streetlights to increase safety at night. However, as discussed in the Landscape Management chapter, lights should not contribute to light pollution.

In addition to being able to walk safely and comfortably along streets, individuals must be able to cross streets safely. All intersections within the more heavily trafficked areas of East Area 1 should have crosswalks painted on the road. Particularly heavily trafficked areas in East Area 1 include the Haun Creek Neighborhood, Santa Paula Creek Civic District and East Santa Paula Railroad District. Any intersection with a traffic light should have a pedestrian crossing signal. Furthermore, crossing guards should be present before and after school at each intersection directly adjacent to the elementary school, so children can safely walk to school.

The street layout is another important factor in making East Area 1 a pedestrian-friendly community. Creating a network of short, interconnected streets makes navigation easier and creates the perception of a smaller, more walkable community [*Smart Growth Network*, 2009]. People will also be more comfortable walking, if cars are traveling at slower speeds. Short blocks help to calm traffic, as do streets that are narrow and have tight turn radii.

Cycling

Encourage the use of bicycles by designating four to five foot wide bicycle lanes along roadways, building dedicated bicycle paths, and providing bicycle racks throughout the community. Cycling is another mode of transportation that contributes to a sustainable community. Riding a bicycle allows an individual to cover longer distances in shorter amounts of time than walking. Therefore, cycling is well suited for travel between East Area 1 and other parts of Santa Paula, or even other nearby cities. Cycling provides an alternative to car travel while providing cyclists great exercise.

Unfortunately, conventional urban planning has generally not accounted for bicycle use as a mode of transportation. As a result, cyclists must use car lanes as thoroughfares, thereby placing them at considerable risk of being hit by automobiles. Moreover, streets designed to allow cars to travel at high speeds increase the chances that motor vehicle-bicycle accidents will critically injure or kill the cyclist. One study found that a pedestrian hit by a car traveling at 15 miles per hour has a 96 percent chance of surviving. However,

survival rates decrease to 17 percent if the car is traveling at 45 miles per hour [*Local Government Commission*, 2005a]. There are an estimated 5,000 accidents involving bicycles and cars each year in the United States. Additionally, approximately 800 people in the United States die while riding a bicycle each year, though not all of those fatalities are attributable to collisions with cars [*Bluejay*, 2009].

The American Association of State Highway and Transportation Officials recommends that designated on-road bicycle lanes should be four to five feet in width in order to provide for the safety of cyclists and motorists [*American Association of State Highway and Transportation Officials*, 1999]. Including designated bicycle lanes on roads during construction requires minimal additional infrastructure and significantly improves the safety of cyclists. Constructing dedicated bicycle paths off roadways requires additional infrastructure but drastically enhances safety by removing cyclists from the roadway all together [*American Association of State Highway and Transportation Officials*, 1999].

In addition to improved safety, cyclists must be able to park their bicycles securely while they are shopping, at work, or attending school. Therefore, it is necessary that a sufficient number of bicycle racks be provided throughout the Haun Creek Neighborhood, Santa Paula Creek Civic District, and East Santa Paula Railroad District. In particular, multiple bicycle racks should be available at the schools, the Community Center, athletic fields and recreational areas, and around retail stores.

Restricted Parking

Restrict the availability of parking throughout the Haun Creek Neighborhood and the East Santa Paula Railroad District in order to encourage alternatives to traveling by car. Parking can be restricted by limiting the number of on-street spaces in these two areas, and by installing parking meters at all parking spots. Parking can also be restricted by requiring that all private parking lots are subject to size limitations.

Restricting parking will decrease the amount of driving in East Area 1 because people are less likely to drive if they know that it will be difficult to find a parking space. However, it is important that parking restrictions do not adversely affect local retail businesses. Additionally, parking restrictions should not significantly decrease the desirability of East Area 1 as a location for commercial and industrial enterprises by making the community difficult to access. Therefore, providing pedestrian-friendly infrastructure which makes it easy for people to access the community is essential for restricted parking to be an effective strategy for achieving sustainability.

Another strategy for reducing car travel to the commercial and civic districts is the installation of parking meters at all parking spaces. Parking spaces are a market good whose price should be driven by customers' willingness to pay. Having to pay a fee to park a car increases the marginal cost of each car trip. By providing free parking in East Area 1, the City of Santa Paula is subsidizing drivers, and therefore, giving them an incentive to drive. When that subsidy is removed, the incentive to drive is diminished

[*Shoup*, 2005]. Therefore, installing parking meters will both reduce driving and provide a source of revenue for Santa Paula.

Recommendation T2: Public Transit

Promote the use of public transit by providing shuttle service to and from transit stops on existing routes, and offering residents monthly transit benefits for their first year living in the community.

Public transit serves as another alternative to car travel, particularly for long trips and for disabled and elderly individuals. The benefits of public transit over automobiles include reduced emissions of air pollutants, reduced road congestion, a decreased likelihood of being involved in a transportation-related accident, and decreased travel costs [*ICF Consulting*, 2007].

Heightened awareness of these benefits has led to a trend of increasing use of public transit both within Ventura County and on the national scale. Gold Coast Transit, which services parts of Ventura County, but not the City of Santa Paula, had a 67 percent increase in ridership between 2002 and 2006 (SCAT/GCT 2008). Nationally, approximately 10.1 billion public transit trips were taken in 2006 [*Millar*, 2007], an increase of more than 25 percent compared to 8.1 billion trips in 1995 [*ICF Consulting*, 2007]. This rate of growth slightly outpaced the 24 percent rate of growth for highway use over the same time [*Millar*, 2007].

Unfortunately, there are limited transit services currently available in Santa Paula, and none of those transit lines service East Area 1. The major commuter service in Santa Paula is the Ventura Intercity Service Transit Authority (VISTA) Highway 126 bus line, which runs between the City of Ventura and the City of Fillmore and includes stops at Santa Paula City Hall and the K-Mart Shopping Plaza. VISTA also provides the Santa Paula Commuter Bus for local students, and a Dial-A-Ride service which runs on request only.

Additionally, there are two train lines, Metrolink and Amtrak, which have stations in the City of Ventura. The Metrolink, which runs south to Los Angeles, is a commuter train. While there is an on-going movement to modify the schedule of the Amtrak line running north to Santa Barbara and San Luis Obispo to better accommodate commuters [*Hadly*, 2008], this Amtrak train is not set up as a commuter train line.

Shuttle Service

Provide shuttle service between East Area 1 and stops on existing transit routes because no existing transit lines service the site of East Area 1. Despite a current lack of services, public transit has the potential to contribute to a sustainable transportation sector in East Area 1. The success of public transit, however, depends on the ability of residents, workers, and visitors to East Area 1 to access these services.

A shuttle service should operate between East Area 1, the nearest VISTA Highway 126 bus stop at Santa Paula City Hall (approximately 1.5 miles), and the Metrolink Montalvo Station (approximately 14 miles). Additionally, the shuttle should occasionally run to the Amtrak Ventura Station (approximately 17.5 miles). The schedule of the shuttle should be coordinated with the schedule of the VISTA Highway 126 route to facilitate use of this service. The shuttle vehicles can be vans or minibuses, and a small fee will help cover capital costs, operation, and maintenance expenses.

In the following scenario (Scenario 1), shuttle service is provided to existing transit stops, assuming the current level of transit service, and transit benefits are provided to residents and workers. Public transit in this scenario can reduce the number of car trips to and from East Area 1 by approximately 1.2 percent. There is a corresponding reduction in the emissions of all air pollutants on a daily basis. Table T3 shows the reductions in pounds per day emitted during winter, if existing transit services were accessible to East Area 1. Winter data are selected for demonstration. The reductions in daily emissions of all pollutants during summer are similar to the reductions achieved in winter.

An alternative to providing a shuttle is working with VISTA to add a stop along the Highway 126 route in East Area 1. This bus route already passes close by the site of East Area 1, so adding a stop would not require the bus to take a different route. Although this solution does not directly provide access to the rail lines, commuters could take the Highway 126 bus into the City of Ventura where they could transfer to the train lines.

Table T3: Daily Emissions Reductions from Transit Services, Winter

	ROG	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**CO_2**
No transit services (lbs./day)	100.88	109.03	1.32	267.09	50.57	932.91	132,883.54
Scenario 1 mitigation (lbs./day)	99.87	107.92	1.30	264.39	50.08	923.47	131,535.74
Reduction (lbs./day)	**1.01**	**1.11**	**0.02**	**2.70**	**0.49**	**9.44**	**1,347.80**

In another scenario (Scenario 2), shuttle routes expand beyond existing transit stops to provide service throughout East Area 1 and to downtown Santa Paula and other parts of the city. In this case, the shuttles themselves become a form of public transit. A shuttle program of this kind would benefit East Area 1 and all of Santa Paula. The downside to expanded shuttle service is a significant increase in project costs. As a service that everyone in Santa Paula could use, it is best to develop an expanded shuttle program in partnership with the city or with VISTA. Working in a partnership can help ensure that this service is optimal for everyone in Santa Paula while helping to defray costs.

If the East Area 1/citywide shuttles in Scenario 2 ran every half hour 12 hours per day, with shuttles coming every 15 minutes during the peak morning and afternoon hours (7-9am and 4-6pm), the environmental benefits would be double the benefits from transit-oriented shuttles alone. There are 2.52 percent fewer car trips to and from East Area 1 than if there were no shuttles. Additionally, air pollution emission is reduced. Table T4 illustrates the reductions in pounds per day emitted during winter. The results for summer are comparable to the winter results.

Table T4: Daily Emissions Reductions from Transit Services and East Area 1/Citywide Shuttle, Winter

	ROG	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**CO_2**
No transit services (lbs./day)	100.88	109.03	1.32	267.09	50.57	932.91	132,883.54
Scenario 2 mitigation (lbs./day)	98.75	106.69	1.29	261.35	49.48	912.88	130,024.38
Reduction (lbs./day)	**2.13**	**2.34**	**0.03**	**5.74**	**1.09**	**20.03**	**2,859.16**

Transit Benefits

Provide transit benefits to all residents of East Area 1, upon request, for the first year of residence in the community in order to encourage the use of public transit. The mode of transportation an individual uses for routine trips, such as commuting to work, is often a result of habit. If a person is accustomed to driving to work, it may be difficult to get them to switch to a different travel method such as public transit [*ICF Consulting*, 2007]. Therefore, it is extremely important that sustainable lifestyle choices be adopted from the outset when residents move into East Area 1.

Transit benefits are one way to encourage sustainable lifestyle choices for transportation. Receiving free or heavily discounted passes gives residents an incentive to use public transit. When the full cost of driving is accounted for, a trip on public transit costs substantially less than a trip by car [*ICF Consulting*, 2007]. If Limoneira provides transit benefits from the time a resident begins living in East Area 1, the resident will be more likely to get into the habit of using public transit to travel to and from the community.

Similarly, businesses that operate in East Area 1 should be encouraged to offer transit benefits to their employees. This will increase public transit ridership by people commuting to East Area 1 from outside communities. Businesses have the option of either directly providing transit passes as an employee benefit, or implementing a program where employees can take pre-taxed income out of their regular paycheck and pay it into a transportation account. The second option is equivalent to an employee flex plan for medical related expenses. Furthermore, businesses should be encouraged to

offer flexible work schedules, in which employees have the option of working 40 hours over four days instead of five, thus cutting down on the number of trips each employee takes per week. Employers should also be encouraged to permit employees to work from home, or telecommute, in order to eliminate the need to travel to work.

The above data demonstrate that the use of public transit provides significant environmental benefits to the transportation sector in East Area 1. Additionally, increased use of public transit to and from East Area 1 sends a signal to Santa Paula, Ventura County, and the surrounding region that public transit is a popular option and that transit services should expand. In this sense, East Area 1 residents and commuters have an opportunity to lead by example and to affect change throughout the region.

In an optimal scenario (Scenario 3), interest in public transit will lead to the addition of a new bus line in Santa Paula, the conversion of northbound train routes into commuter train lines, and an East Area 1/citywide shuttle that also provides service to stops on existing transit routes. This optimal scenario reduces the number of car trips by 3.12 percent over the baseline of no transit services and reduces daily emissions for all air pollutants more than the other mitigation scenarios. Table T5 shows the daily reductions in emissions of all pollutants during winter. Daily reductions in summer are similar to daily reductions in winter.

Table T5: Daily Emissions Reductions from Increased Interest in Public Transit, Winter

	ROG	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**CO_2**
No transit services (lbs./day)	100.88	109.03	1.32	267.09	50.57	932.91	132,883.54
Scenario 3 mitigation (lbs./day)	98.26	106.14	1.28	259.96	49.22	908.09	129,340.22
Reduction (lbs./day)	**2.62**	**2.89**	**0.04**	**7.13**	**1.35**	**24.82**	**3,543.32**

As shown in Table T6, a comparison shows that each scenario improves the environmental sustainability of the transportation sector in East Area 1, as compared to a situation where residents and commuters have no access to public transit. Therefore, we recommend that Limoneira provide shuttle service to stops on existing transit routes and transit benefits to residents for up to one year. In addition to the range of environmental benefits, there is also a different cost consideration associated with each scenario. However, it is not possible to do an extensive cost analysis at this time since these mitigations will not be in place for several years. Nevertheless, the environmental benefits and costs must be carefully weighed to determine which scenario is most appropriate for East Area 1.

Table T6: Comparison of Daily Emissions Reductions across Mitigation Scenarios, Winter

	ROG	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO	CO_2
Scenario 1 Reduction (lbs./day)	1.01	1.11	0.02	2.70	0.49	9.44	1,347.80
Scenario 2 reduction (lbs./day)	2.13	2.34	0.03	5.74	1.09	20.03	2,859.16
Scenario 3 Reduction (lbs./day)	2.62	2.89	0.04	7.13	1.35	24.82	3,543.32

Recommendation T3: Carpooling

Establish a ride-share program for residents and commuters. Administer the program online, and offer incentives such as priority parking or monthly prizes in order to encourage participation in the program.

A ride-share program, also referred to as a carpool, is an efficient way to reduce the number of car trips taken to and from East Area 1. Decreasing the number of cars driving in East Area 1 reduces emissions of air pollutants, decreases road congestion, and improves pedestrian safety. Ride-sharing also helps to promote social interaction and develop a sense of community among East Area 1 residents and commuters [*Victoria Transport Policy Institute*, 2008]. The ride-share program can connect residents who live in East Area 1 and work elsewhere, as well as people who work in East Area 1 but live in outside communities.

Administering the program by creating a ride-sharing portal online, through the East Area 1 website (see Recommendation OM2), will make it easy for people to sign up, manage their accounts, and find a carpool to join. An online ride-sharing portal is a dynamic environment which affords people the flexibility to find a carpool on short notice or to set up a regularly scheduled ride, if they prefer. People will also be able to send instant messages in order to coordinate schedules with other people throughout the day.

Although the convenience of an online ride-sharing portal facilitates participation, it is also important to publicize the program so people are aware it exists. For example, Ventura County is currently partnering with four other counties in southern California to provide an online ride-sharing program called Ridematch.info [*Commute Smart*, 2009]. Although the program is available to anyone who lives and works in Santa Paula, it is under-utilized because many people are unaware of the program. The ride-share portal must be prominently displayed on the East Area 1 website and the program should be

advertised in the local newspaper, and on flyers posted in local businesses and the Community Center. In addition, employers should inform employees that they can take advantage of this program.

Another strategy for encouraging participation is to provide incentives such as priority parking for ride-share cars. Participants can display permits, which will allow them to park in reserved spots or to be able to park at parking meters without paying the fee. Another type of incentive is to enter participants in the ride-share program into a monthly raffle where they can win gift certificates or other prizes. Santa Barbara County's Travel Solutions ride-share program [*Santa Barbara County Association of Governments*, 2009] is an example of a program that has used raffles as a successful way to encourage participation.

A ride-share program will produce a 2 percent reduction in the number of car trips taken to and from East Area 1. Correspondingly, over 215 pounds of CO_2 emissions will be prevented on a daily basis during summer. Though not as significant as the emissions reductions from other mitigations, a ride-share program results in lowered emissions of all air pollutants on a daily basis. Although the emissions reductions from a ride-share program are relatively modest, establishing and managing a ride-share program is an inexpensive and easy to administer way to realize environmental and social benefits.

Recommendation T4: Car-Sharing

Introduce a car-sharing program, such as ZipCar or City CarShare, in order to minimize the need of residents to own a car. Members of the program will be able to access cars parked in reserved spaces throughout the community to use on an hourly basis as needed for a small fee.

A car-sharing program is a strategy which allows people to enjoy access to a private vehicle without having to own a car themselves. Members of the car-sharing program will be able to use cars on an as-needed basis. These cars will be owned and maintained by the program, and will be parked in designated parking spaces throughout East Area 1. Members will be able to use the car on an hourly or short-term basis.

According to carsharing.net [*Carsharing.net*, 2009], there are 18 organizations operating car sharing programs in nearly 60 cities and universities across North America. Some of these organizations, such as ZipCar and City CarShare, operate in multiple cities while others are specific to one location. We recommend that East Area 1 partner with an existing organization rather than create its own car-sharing program.

In order for the car-sharing program to be most effective, East Area 1 residents and commuters will also need to have access to public transit. Car-sharing services are not intended for people who use a car everyday to get to and from work. Instead, these services are most commonly used by people who only need to use a car on occasion or as a substitute for a family's second car [*Cohen, et al.*, 2008].

It is difficult to quantitatively assess the potential environmental benefits from a car-sharing program alone, because its effectiveness is dependent upon access to transit and the ability for residents to access retail services without a car. When these other variables are considered, a car-sharing program can reduce the number of car trips to and from East Area 1 by 0.5 to 1 percent.

In addition to the direct reduction in car trips, participants in other car sharing programs have reported a higher degree of environmental awareness after joining the program [*Cohen, et al.*, 2008]. Participation in a car-sharing program reinforces the importance of making sustainable lifestyle choices about transportation, and sends a signal to the community that it is not necessary for each person to own a car.

Car sharing also promotes economic sustainability. It typically costs between $4 and $11 per hour to use car-share vehicles. Furthermore, membership includes full liability and collision coverage on the organization's insurance policy, which eliminates the need for drivers to own personal car insurance. Each car usually comes with a gas card so members do not even need to pay for fuel [*Cohen, et al.*, 2008].

The American Automobile Association estimates that car ownership costs approximately $500 per month, nearly 20 percent of the average family's monthly income [*American Automobile Association*, 2008]. Participating in a car-sharing program frees would-be car owners from the burden of routine maintenance, major repairs, and depreciation in value. Moreover, a car-sharing program allows low-income individuals to benefit from the use of a car without having to assume the full costs of car ownership.

Resources

Smart Growth Network: www.smartgrowth.org
A resource with guiding principles and publications on communities oriented around non-automobile travel.

Walkable Communities: www.walkable.org
An organization dedicated to making communities more pedestrian friendly.

American Public Transportation Agency: www.apta.org
This national organization provides information and statistics on the use of mass transit in the United States. Additionally, they provide suggestions on how to promote the use of public transit within communities.

Carsharing.net: www.carsharing.net
This organization offers information on the car sharing programs which are operating throughout the country, as well as the benefits gained by implementing a car sharing within a community.

CHAPTER 7
WATER

Water management in East Area 1 is one of the main means to achieving a sustainable community development. As a vital resource, both the quantity and quality of water affect human life and the natural environment. Urban development can diminish water supplies and degrade its quality. However, East Area 1 does not need to negatively affect the water supply. Furthermore, the long-term operation of East Area 1 is critical to sustainable water management.

East Area 1 is located within the Santa Clara River watershed, which is an area of land that drains water into the river. This watershed encompasses 1,600 square miles. The river flows for approximately 86 miles from the San Gabriel Mountains to the Pacific Ocean. Located in the California South Coast ecoregion, this watershed is a part of a Mediterranean-type ecosystem. Mediterranean-type landscapes and climate support many animals and plants found nowhere else in the world, and they have supported long-term agricultural production [*The Nature Conservancy*, 2008]. Watershed processes retain water in the ground and on the surface, filter out sediment and pollutants, and support beautiful landscapes [*Daily*, 1997]. Development of East Area 1 can protect these processes and use water efficiently so that a reliable and clean water supply will be available for future generations.

Water management begins with managing the water that enters the community from precipitation, also called stormwater. Urban development impacts water runoff quality by removing soil and vegetation that allow for the infiltration of stormwater by replacing those penetrable surfaces with impervious asphalt and buildings [*United States Environmental protection Agency Nonpoint Source Control Branch*, 2007]. Conventional developments have dealt with stormwater by designing conveyance systems that remove runoff from the site as quickly as possible [*Prince George's County Maryland Department of Environmental Resource Programs and Planning Division*, 1999]. Water that moves quickly picks up more constituents and adversely affects downstream users and ecosystems. Therefore, stormwater is one of the main sources of pollution to streams, rivers, lakes, and oceans. In addition to degraded water quality, the rate at which runoff leaves a development is much faster than in a natural system [*Prince George's County Maryland Department of Environmental Resource Programs and Planning Division*, 1999; *United States Environmental protection Agency Nonpoint Source Control Branch*, 2007].

Strategies to manage stormwater can be implemented at different scales, from the watershed level to the neighborhood and home level. Almost any component of an urban development can contribute to stormwater management including open spaces, streets, parking lots, roofs, and sidewalks. Furthermore, combining strategies can enhance overall stormwater management [*Kennedy/Jenks Consultants*, 2007].

In accordance with California Senate Bill 221, a Water Supply Assessment must verify that there is a sufficient water supply available for East Area 1. The Limoneira Company

has water rights for up to 3,173 acre feet per year (AFY) from the adjudicated Santa Paula Groundwater Basin. Limoneira also has overlying and appropriative groundwater rights to the Fillmore Basin. On average, Limoneira has pumped 329 AFY from the Fillmore Basin [*City of Santa Paula*, 2008c]. The total water demand for East Area 1 is estimated to range between 1,174.7 and 1,359.2 AFY. This breaks down to 853.6 to 983.5 AFY drawn from the Santa Paula Basin and 320.7 to 375.3 AFY taken from the Fillmore Basin [*HDR Town Planning*, 2007b].

As part of the development agreement between Limoneira and the City of Santa Paula, water rights will be given to the city to meet this demand plus 25 percent as a buffer. After the first construction phase is completed, water usage will be monitored. If the demand is less than the projected amount, then the subsequent construction phases will use the smaller amount. The City of Santa Paula will give back those rights for the excess water; however, the 25 percent buffer is required for the new total water demand [*City of Santa Paula*, 2006]. Therefore, the Water Supply Assessment confirms that the water supply for the next 20 years is adequate to meet the projected demand [*City of Santa Paula*, 2008c].

The East Area 1 development is in a rather unique situation in comparison to other developments and municipalities across California that have to search for water sources and ways to stretch water use. However, other factors will drive water use efficiency in Santa Paula and East Area 1. California Assembly Bill 2175, mandates the urban water sector reduce consumption by 20 percent by 2020. The reduction is indoor and outdoor use combined [*Laird and Feuer*, 2008]. Furthermore, the interconnectedness between energy use in pumping, treating, distributing, and heating water calls for the efficient use of water in order to reduce energy demand and production. As a state, 19 percent of all electricity and 30 percent of all natural gas used is related to water consumption [*California Energy Commission; Klein*, 2005].

Furthermore, water use in the energy sector is substantial. Water use is necessary throughout all phases of energy production such as extraction, processing, generation, storage, and conveyance [*U.S. Department of Energy*, 2006]. Therefore, energy efficiency measures and renewable energy technology implemented in East Area 1 can contribute to an overall decrease in total demand of water (see Energy Chapter for recommendations). California Assembly Bill 32 states that efficient buildings can reduce the use and generation of energy, water, waste, and transportation to decrease greenhouse gas emissions [*California Air Resources Board for the State of California*, 2008].

Finally, the City of Santa Paula is restructuring its water rate structure. A tiered rate structure will charge residents more as they use more water. This new rate system is anticipated to take effect beginning July 2009 [*Powers*, 2008]. The options for efficient water use both indoors and outdoors continue to expand due to regulation and technology advances. Furthermore, the market for these technologies will be larger for East Area 1, because its construction will not begin for a few years, and the whole build-out will take several years.

A final component to water management is the reuse of water. Just as water is recycled through a natural system, reuse can enhance water efficiency in a development. In California, graywater is defined as household wastewater from bathtubs, showers, wash basins, and clothes washing machines (but not from toilets) that is used in an underground irrigation system for watering landscapes [*Wilson, et al.*, 1995].

Although graywater is a source of water that decreases the demand for potable or consumptive water, there are health risks if people do not know how to use graywater systems. Therefore, our recommendations do not include installing a graywater piping system in each home, because the ability of future residents to use this water source properly is unknown. Wastewater that is piped to a treatment facility, and goes through regulated treatment processes, can then be reused for various non-potable uses such as landscape irrigation, toilet flushing, or in industrial processes. This treated wastewater is called recycled or reclaimed water, and the two terms are used interchangeably. East Area 1 will have a separate pipe system laid underneath the community that is used only for recycled water [*HDR Town Planning*, 2007b].

Methodology

In order to determine the best water management practices for East Area 1, we had to analyze the phases of water in the community. The water cycle can be broken up into three phases: stormwater management, water use, and water reuse. Addressing how each of these phases of water will be managed and used in the development is necessary to identify sustainable practices. The four methods used to evaluate each phase were site visits to East Area 1 and Santa Paula, a literature review, contacting experts in this field, and conducting calculations for indoor water use.

Site visits to East Area 1 and Santa Paula provided opportunities to understand the local situation and gain insight into the culture and values of the local community. Additionally, a meeting with the City of Santa Paula Public Works Department provided an overarching view of water management in the city. The literature review included searching the academic literature, finding applicable regulations and statutes, investigating case studies of other developments, and utilizing reports and other documents released by agencies and organizations. We backed up this information by consulting with experts to learn about current and future practices and technologies in community developments.

The projected per capita water use for East Area 1 is based on current residents' water use in Santa Paula. The city's Urban Water Management Plan 2005 states average daily per capita use is 163 gallons [*Kennedy/Jenks Consultants*, 2006]. This daily water use amount provided a baseline to compare with calculations of East Area 1 per capita use with efficiency measures. These calculations show potential water savings by implementing water efficiency strategies in homes. We calculated indoor water use by multiplying water volume used per device by the daily usage per capita, and then aggregating for the projected population of this development. This method to calculate

indoor water use has been utilized by other developments such as a recent development, Alamo Creek, located in northern California [*Maddaus*, 2008]. The Alamo Creek development also calculated outdoor water use. However, it had more information about the exact size of landscapes and turf area of each residence. This information is still speculative for East Area 1. Therefore, we relied on literature review of case studies and technologies for our analysis of outdoor water efficiency.

Recommendation W1: Stormwater Management

Maximize pervious surfaces throughout the community by implementing a suite of Low Impact Development practices in order to manage the volume, rate, and pollutant discharge of stormwater runoff. Require a plan to manage stormwater during the construction process, and designate a person who is responsible for implementing this plan.

Development removes absorbent land, such as soils and vegetation, and replaces it with impervious surfaces, such as pavement and buildings. Decreased infiltration affects the natural water cycle by reducing groundwater recharge, increasing the volume and rate of stormwater runoff, and adding pollutants and sediment to the runoff load [*Anderson, et al.*, 2008].

According to the Clean Water Act, stormwater runoff is a non-point source of pollution. Moreover, in 1987, it was incorporated into the National Pollutant Discharge Elimination System (NPDES) under the NPDES Municipal Stormwater Program. Therefore, cities and counties operating municipal separate storm sewer systems (MS4) must manage their stormwater runoff [*Anderson, et al.*, 2008]. Currently, Ventura County is updating its MS4 permit. The most recent draft, from April 2008, requires the implementation of the Low Impact Development (LID) approach to reduce development impacts [*California Regional Water Quality Control Board Los Angeles Region*, 2008].

The LID approach works to mitigate the impacts of development by preserving or imitating natural hydrology. The foundation of this approach is to minimize stormwater generation through conservation of watershed resources, reduction of development impacts, and employment of a suite of management practices [*Low Impact Development Center*, 2007]. Figure W1 depicts an illustration of a natural stormwater runoff hydrograph versus an urbanized runoff hydrograph. The goal of the LID approach is to employ principles and practices that result in a similar hydrograph to the natural system [*Community Design + Architecture, et al.*, 2005]. There are a range of practices incorporated in the LID approach including, but not limited to, vegetated filter strips, permeable pavements, planter boxes, green roofs, and dry wells [*Geosyntec Consultants*, 2008].

The United States Environmental Protection Agency (U.S. EPA) released a study in December 2007 that analyzed 17 case studies of developments across the nation using LID practices. The conclusion of the report states that LID techniques not only improve

environmental quality, but also reduce project costs. Depending on the practice, total capital savings ranged between 15 and 80 percent in comparison to conventional storm water management costs [*United States Environmental protection Agency Nonpoint Source Control Branch*, 2007].

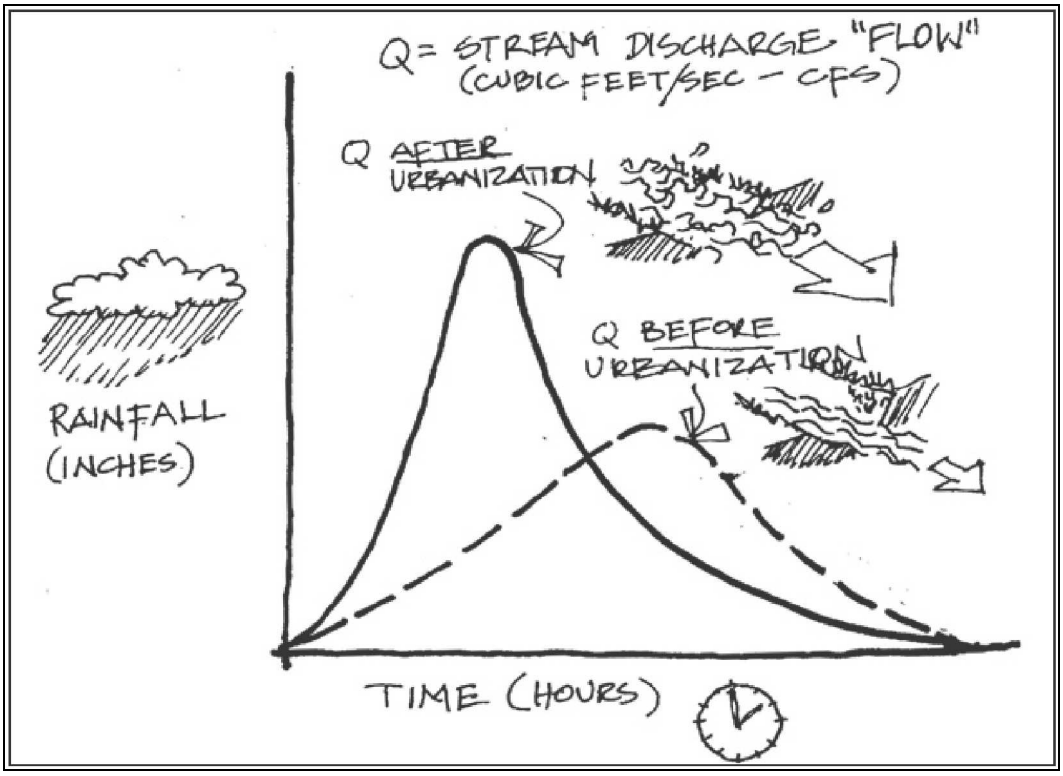

Figure W1: Hydrograph Comparison Between Natural and Urban Systems
[Courtesy of City of Emeryville]

Construction Process

Use the California Stormwater Quality Association Stormwater Best Management Practice Handbook for Construction to develop a Stormwater Pollution Prevention Plan/Stormwater Pollution Control Plan. Designate a person to implement this plan during the construction phase. The construction process of East Area 1 is a potentially major contributor to increased stormwater runoff and water quality degradation. Multiple regulations address stormwater management during the construction process, including Ventura County NPDES Permit No. CAS004002, the State's General Construction Permit [*Ventura Countywide Stormwater Quality Management Program Public Works Agency*, 2000] and the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan [*California State Water Resources Control Board*, 2000].

The California Stormwater Quality Association (CSQA) works to assist entities required to manage stormwater. They have developed a series of handbooks, which include one specific to the construction process. This handbook guides the user through the

mandated regulation affecting construction. It also describes the Stormwater Pollution Prevention Plan/Stormwater Pollution Control Plan (SPPP/SPCP), and the various best management practices (BMPs) to implement a SPPP/SPCP. The handbook is extensive and provides overarching guidance. In order to achieve site-specific stormwater management, a designated person needs to analyze the BMPs and choose a collection of practices that will most effectively manage stormwater in East Area 1 [*California Stormwater Quality Association*, 2003b].

Preserve the infiltration of soils underlying planned open spaces during the grading process. Soil excavation for construction, movement, and grading has the potential to significantly influence natural infiltration capacity. The Natural Resources Conservation Service provides soil analysis online and generates reports on various soil properties. The infiltration information shows that the majority of soils underlying East Area 1 are categorized as "soils having a moderate infiltration rate when thoroughly wet" [*NRCS*, 2008]. Although soil grading and compaction are critical to ensure building foundation stability, it does not make economical sense to grade and compact soils to this degree where the land will remain in open space. Therefore, set a maximum relative compaction of soils at 85 percent for open space areas [*Haslinger*, 2008].

Pervious Surfaces

Implement a suite of LID practices that in combination enhance stormwater management and reduce runoff volume, rate, and pollutant load. LID practices are implemented at various scales from the individual home to the community level. Although there are layout design aspects to the LID approach, we focus on techniques to implement in East Area 1.

Practices that decrease the amount of stormwater leaving the community include disconnecting downspouts on residential homes and directing roof runoff to pervious landscape areas, installing permeable pavement in areas with low traffic, placing contained planters and planter boxes on patios or sidewalks, and strategically directing runoff from neighborhoods into dry wells that are three to 12 feet deep. A dry well is an infiltration trench designed to hold stormwater temporarily. Stormwater in a dry well is cleaned by filtration through the soil and taken up by organisms or plants in the soil, or it slowly percolates down to recharge the groundwater.

The amount of runoff into the community's stormwater conveyance system can be decreased by disconnecting downspouts on residential homes and directing the runoff to landscaped area. Additionally, place a splash block, which is a gravel splash pad, on the ground where the water from the downspout will hit the ground in order to prevent erosion. This practice mimics the natural system by retaining stormwater while providing a valuable source of irrigation for landscape water demand [*Geosyntec Consultants*, 2008; *Kennedy/Jenks Consultants*, 2007];[*Prince George's County Maryland Department of Environmental Resource Programs and Planning Division*, 1999].

Like impervious pavements, permeable or porous pavements make both a smooth and continuous surface. However, the difference is that permeable pavements have void spaces. Figure W2 shows a comparison of the two pavements. Water is able to pass through the void spaces to a permeable sub-base consisting of porous materials like gravel. This process contributes to improved stormwater retention by allowing water to infiltrate into the soil. It is possible for virtually all stormwater that falls on the permeable pavement to infiltrate, which results in no runoff to the stormwater drainage system. For instance, one study found that only three percent of the stormwater during major precipitation events over short periods of time left the permeable parking lot [*Brattebo and Booth*, 2003].

Permeable pavement is ideal for areas with low traffic, such as parking lots, driveways, plazas, parks, or low traffic roads [*Brattebo and Booth*, 2003; *City of Santa Monica*, No date; *Geosyntec Consultants*, 2008; *United States Environmental Protection Agency Office of Water*, 2000]. In parking lots specifically, we recommend a hybrid approach. The aisles need to be durable to withstand concentrated traffic, but the vehicle stalls are only for vehicle maneuvering. In this case, use standard asphalt in the parking aisles, but use pervious concrete or porous asphalt in the parking stalls[*California Stormwater Quality Association*, 2003c].

FigureW2: Comparison of Permeable Versus Standard Asphalt. [Courtesy of Truckee MeadowsRegional Stormwater Quality Management Program and Kennedy/Jenks Consultants]

The long-term effectiveness of this practice depends on the maintenance of the permeable pavement. In order for water to continue to infiltrate through the permeable surface, the void spaces must be maintained. Use a vacuum-type street cleaner a few times a year to ensure spaces remain open [*City of Santa Monica Environmental & Public Works Management*, No date; *Geosyntec Consultants and City of Santa Barbara*, 2008; *United States Environmental Protection Agency Office of Water*, 2000]. Long-term studies have shown that installing permeable pavement and the associated maintenance costs are up to 25 percent less in comparison to traditional pavement construction and the underground pipework associated with it [*California Stormwater Quality Association*, 2003c].

Contained planters and planter boxes are a good technique to employ in places where infiltration practices are impractical, such as alongside buildings with sidewalks. Additionally, the planters can enhance the aesthetic value around a building. If planter boxes are installed, an underdrain needs to be built to collect and route excess water to a

stormwater conveyance system [*Community Design + Architecture, et al.*, 2005; *Geosyntec Consultants*, 2008; *Kloss*, 2006].

One practice to implement on the neighborhood-scale is dry wells. These are small, excavated pits backfilled with pea gravel or stone, typically three to 12 feet deep, that function as infiltration systems. They hold and slowly release stormwater thereby absorbing, trapping, and filtering pollutants and bacteria [*Prince George's County Maryland Department of Environmental Resource Programs and Planning Division*, 1999]. This practice is dependent on the conditions of the site. Strategically placed dry wells collect runoff from a neighborhood. This practice does not function properly on steep slopes nor in poor infiltrating soils; therefore, do not construct a dry well on the steep hillside of East Area 1 where both of those conditions occur.

A few of the practices discussed thus far also contribute to filtering and retaining pollutants. However, a couple more LID practices address stormwater quality issues specifically. Biofiltration involves planting vegetation in strips or swales in order to filter out pollutants and hold onto sediment. Additionally, green roofs cleanse and retain stormwater before it can reach a stormwater conveyance system.

The process of biofiltration holds onto pollutants and infiltrates runoff into the ground by passing stormwater slowly over biofilters that are planted with vegetation in a swale or strip [*Ventura Countywide Stormwater Quality Management Program*, 2001]. Vegetation retains or absorbs pollutants, organisms in the soil biodegrade constituents as they pass through the soil, and the soil particles themselves hold onto pollutant particles [*Geosyntec Consultants*, 2008].

Figure W3: Photo of Biofiltration System in Seattle, WA [Courtesy of Truckee Meadows Regional Stormwater Quality Management Program and Kennedy/Jenks Consultants]

The International Stormwater Best Management Practice Database began in 1996 as a collaboration between multiple organizations to provide scientifically defensible information about stormwater BMPs. An analysis completed in June 2008 evaluated a group of BMPs to determine the effectiveness of these practices. The biofilters practice demonstrated a statistically-significant difference between influent and discharge for dissolved copper, dissolved zinc, dissolved lead, nitrate nitrogen, total nitrogen, and total suspended solids [*Geogyntec Consultants; Wright Water Engineers*, 2008]. This demonstrates that biofilters are a successful practice to remove multiple constituents that we add to the environment.

Detention basins in two areas in East Area 1 will mitigate peak storm discharge. Vegetation planted for biofiltration will enhance these areas by improving water quality and infiltration. Other locations in the community where this practice can be implemented include the spaces between sidewalks and streets (see Figure W3), and around buildings, parking lots, and road shoulders. The vegetation will need to be maintained just as with any other landscaping to ensure the long-term functionality of these biofiltration systems [*Kennedy/Jenks Consultants*, 2007].

Limoneira has taken the lead by installing one of the first green roofs in the area (see Figure W4 for green roof illustration). Although irrigation water demand can be a significant concern to implementing green roofs, in this case, Limoneira coincided the timing of the completion of the green roof with the beginning of the rainy season for the region. This helped to decrease irrigation water demand and allow the plants to set. The current irrigation schedule only requires watering twice a week for 15 minutes beginning at 5:00am. Because Limoneira planted species native to California, irrigation demand is anticipated to decrease to zero as the plants set [*Key*, 2008].

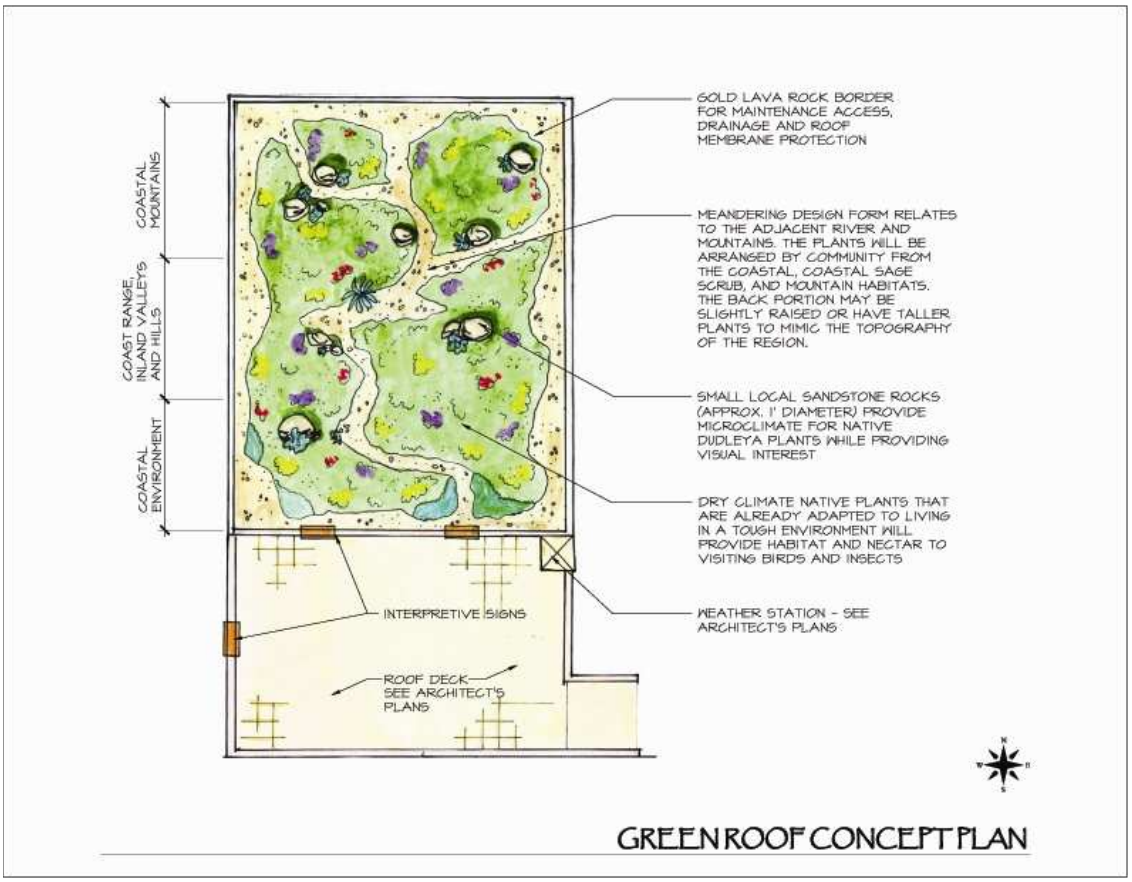

Figure W4: Green Roof Drawing for the Limoneira Company
[Courtesy of the Limoneira Company]

Green roofs make sense for a larger roof, such as on a school or civic building, and provide an educational opportunity for both students and city residents. Maximize this opportunity by informing residents about urban impacts and mitigation practices for stormwater management and providing tours of green roofs.

Recommendation W2: Indoor Water Use Efficiency

Increase water use efficiency by installing best available technology for appliances and fixtures in all buildings. The appliances to focus on are dishwashers, faucets, toilets, clothes washers, and showerheads. Construct commercial, industrial, and institutional buildings with a dual piping system in order to use recycled water for flushing toilets and any other non-potable water use, such as cooling towers.

The appliances, fixtures, and processes that use water in buildings consume large quantities of water every day [*United States Environmental Protection Agency*, 2008b]. Furthermore, urban water use is a cost-effective sector in which to achieve increased efficiency because many low water use appliances and fixtures are currently available in the market [*Freeman*, 2008; *Gleick, et al.*, 2003]. Legislation has begun to mandate the installation of water efficient appliances and fixtures in buildings. For example, California recently passed legislation requiring a 20 percent decrease in urban per capita water use by 2020 from current use [*Laird and Feuer*, 2008]. Estimated indoor water use for California by appliance and fixture is illustrated in Figure W5 [*Gleick, et al.*, 2003].

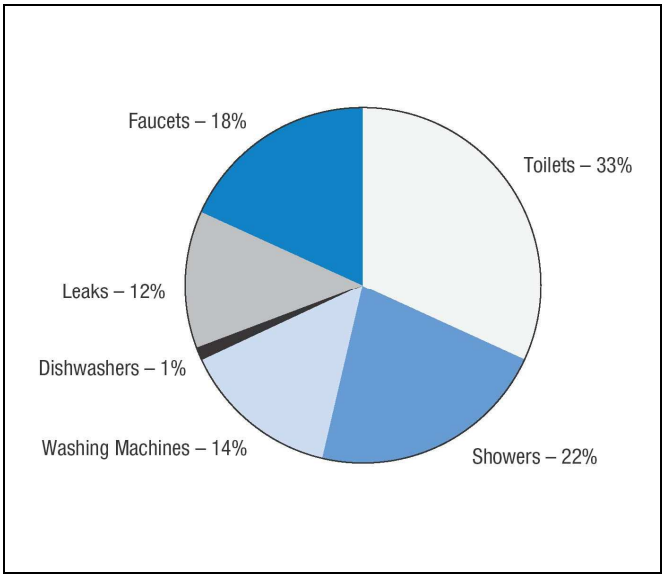

Figure W5: Percentage Breakdown of Estimated California Residential Water Use by Appliance and Fixture in 2000 [Courtesy of Pacific Institute and Gleick et al. 2003]

We anticipate that very efficient appliances and fixtures will become a maximum threshold for water use in the future, as technological advances occur. Therefore, we used very efficient appliances and fixtures that are currently available in our calculations due to the time horizon for construction and build out of East Area 1 (see Table W1).

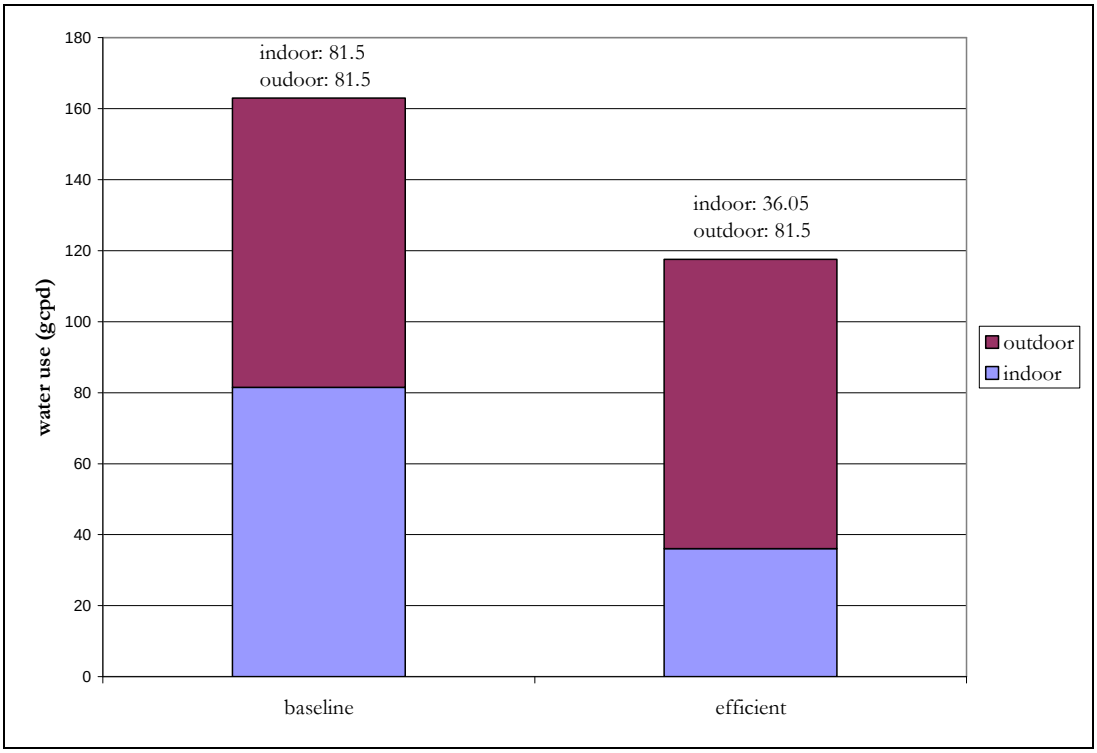

Figure W6: Comparison between Current Santa Paula Indoor Residential Water Use and Calculated Efficient Indoor Residential Water Use in East Area 1
Units: gpcd – gallons per capita per day

Table W1: Indoor Residential Water Use per Person

INDOOR RESIDENTIAL	Efficiency	Source: REUWS (1999)	gpcd*
Dual flush toilet	0.8 gpf* & 1.6 gpf*	5 flushes/person/day	5.6
Showerhead	1.5 gpm*	5 minutes/person/day	7.5
Faucets	1.5 gpm*	8 minutes/person/day	12
Bath	24 gallons/bath	0.2 baths/person/day	4.8
Clothes washer	15 gallons/load	0.37 loads/person/day	5.55
Dishwasher	6 gallons/cycle	0.1 cycles/person/day	0.6
INDOOR WATER USE (GPCD*)			**36.05**

* Units: gpcd – gallons per capita per day; gpf – gallons per flush; gpm – gallons per minute

In support of our calculations, other studies have shown similar results. In the Handbook of Water Use and Conservation, 35 percent water savings were calculated by installing efficient appliances and fixtures [*Vickers*, 2001]. The U.S. EPA sponsored a retrofit study in three cities that calculated water savings in homes by replacing old appliances and fixtures with very efficient technologies currently available. The study resulted in a 39 percent decrease in residential indoor water use [*United States Environmental Protection Agency*, 2005]. Furthermore, a recent report, which will be

presented at The International Water Efficiency Conference in April 2009, found that a 45 percent decrease in residential water use is possible by upgrading certain fixtures and appliances [*Harris*, 2009].

Our calculations result in an overall savings of 19.92 percent from the total water demand for East Area 1. Moreover, assuming 50 percent of the current Santa Paula per capita water demand (163 gallons per person per day) is used indoors [*Mayer and DeOreo*, 1999], our calculations show a 55.77 percent savings from current Santa Paula indoor residential water use (see Figure W6). Table W1 shows the water use volume by appliance and fixture, and the aggregate for the daily indoor usage per capita for East Area 1.

Residential and Non-Residential Buildings

Require residential and commercial, industrial, and institutional (CII) dishwashers to meet a maximum water factor of 6.0 gallons per cycle. A water factor number indicates how many gallons of water are used per load [*Koeller, et al.*, 2007]. As of 2007, 71 percent, or 346 of the 486 Energy Star Qualified models, comply with a 6.5 water factor. Legislation is anticipated to update the dishwasher water factor approximately every five years, beginning with a 6.5 water factor in 2011, and reaching a 6.0 water factor by 2025 [*Koeller, et al.*, 2007]. Additionally, the 2007 Annual Best Management Practices Report published by the California Urban Water Conservation Council (CUWCC) states that installing water efficient dishwashers is cost-effective for new residential construction [*Koeller, et al.*, 2007]) (Due to the interrelation between energy and water use, please see Energy Management chapter for further discussions about the energy to heat water).

Require lavatory faucets in all buildings to flow at the inlet at a maximum of 1.5 gpm at 60 pounds per square inch (psi) and a minimum of 0.8 gpm at 20 psi. There is a lack of consensus about specifications for kitchen faucets. At this time, our recommendation is to follow national standards allowing a maximum 2.2 gpm at 60 psi for kitchen faucets. U.S. EPA's WaterSense product labeling program is working to set standards for kitchen faucets [*United States Environmental Protection Agency*, 2007a]. This labeling program is the first national attempt at lowering the current national standard [*California Urban Water Conservation Council*, 2008a].

Faucet aerators are also an inexpensive way to conserve water in kitchens and lavatories. An aerator reduces flow by mixing air with water so that the user feels the sensation of ample water even though less water is flowing out. Aerators that restrict water flow to 1.5gpm and lower are available. This could be an alternative solution to faucet water conservation if faucets are prohibitively expensive [*Vickers*, 2001].

Install high-efficiency toilets in residences and buildings. Furthermore, install waterless urinals in CII buildings [*Harris*, 2009; *Koeller & Company*, 2005; *Vickers*, 2001]. Toilets are the single largest indoor water consuming appliance or fixture [*Gleick,*

et al., 2003]. Therefore, installing efficient toilets provide the largest single opportunity for improved water use efficiency. In addition, water used for toilet flushing is unlike other water uses in buildings, because it only removes waste, thus providing an opportunity to use non-potable water for toilet flushing in CII buildings.

Install showerheads with a maximum water flow of 1.5 gpm. Showers use almost one quarter of indoor water [*Gleick et al. 2003*]. Multiple studies have shown water efficiency improvements by installing low-flow showerheads [*Aquacraft Inc. Water Engineering and Management*, 2008; *DeOreo*, 2008; *Harris*, 2009; *Santa Barbara Contractors Association*, 2007; *Vickers*, 2001]. The U.S. EPA Retrofit Report, published in 2005, demonstrated with statistical significance that increasing the water efficiency of showerhead flow from 2.5 to 1.75 gpm did not increase the time spent in the shower. Therefore, the concern that a lower showerhead flow rate will increase shower time is unproven [*United States Environmental Protection Agency*, 2005].

Set a maximum 6.0 water factor for clothes washers. The water factor for a clothes washer indicates how many gallons of water the washer uses per cubic foot of capacity [*California Urban Water Conservation Council*, 2008b]. The other measurement used to evaluate efficiency of clothes washers is the Modified Energy Factor developed by the Consortium for Energy Efficiency. Due in part to the Consortium for Energy Efficiency Residential Clothes Washer Initiative, hundreds of different models from all leading retail outlets are available in the market [*Shel Feldman Management Consulting; Research Into Action*, 2001]. Clothes washers are typically the second largest water-use appliance in homes [*Vickers*, 2001], and therefore provide an opportunity to gain efficiency in both water and energy use.

Commercial, Industrial, and Institutional Buildings

Construct CII buildings with dual-pipe systems in order to use recycled water for flushing toilets and any other non-potable water uses, such as cooling towers. In addition to the appliances and fixtures in CII buildings, there are a few specific areas in this sector where further water efficiency is attainable in East Area 1. According to the City of Santa Paula Urban Water Management Plan 2005, the city's new Recycled Water Facility, which will open in 2010, will produce recycled or reclaimed water for non-potable uses [*Kennedy/Jenks Consultants*, 2006]. The terms "recycled" and "reclaimed" are used interchangeably to mean wastewater that is treated to tertiary standards suitable for non-potable reuse. The planned treatment process in Santa Paula's Recycled Water Facility will treat wastewater to a tertiary level using a membrane bioreactor. This process meets all regulatory requirements for non-potable uses of recycled water, such as on landscaping, toilet flushing in CII buildings, and industrial processes that do not have any risk of human consumption [*Matthews*, 2009; *Nick*, 2009].

Furthermore, the Specific Plan for East Area 1 lays out a map of purple pipe, which transports recycled water from the facility to the community. Various water districts across California, such as the Goleta Water District and the Inland Empire Utilities

Agency, have been using recycled water for non-potable uses like toilet flushing [*Goleta Water District*, No date; *Inland Empire Utilities Agency - A Municipal Water District*, No date].

Conserve water in water decorations, fountains, and pools. Although the most efficient way to save water in this area is to not construct water decorations or install pools, there are plans for both in the Specific Plan for East Area 1 [*HDR Town Planning*, 2007b]. Require pool covers for any home or community pool in order to both reduce water evaporation and the energy required to heat the water. Pool covers have been shown to save between 8,000 and 10,000 gallons annually [*Koeller and Company*, 2004]. For example, a 30-foot by 15-foot pool that is five feet and exposed to a temperature of 78°F with 30 percent relative humidity will lose three inches of water depth per week, or five percent of the total water volume. Covering this pool for 12 hours when it is not in use will save approximately 750 gallons per week or 39,000 gallons per year [*Calabro*, 1996; *Harris*, 2009; *Vickers*, 2001].

Require community water decorations and fountains to recirculate water. Water decorations and fountains can use reclaimed water in order to decrease potable water use for decorative water features. Other municipalities that restrict decorative water sources to reclaimed water or groundwater include San Francisco in California, and Chandler, Mesa, and Phoenix in Arizona [*The Bruce Company*, 1993; *Vickers*, 2001]. Signs need to be posted to explain that people cannot consume water from the fountain.

Diminish the use of Total Maximum Daily Load (TMDL) pollutants by mandating the use of less harmful products that contain little or no TMDL pollutants. The TMDL pollutants of concern in the Santa Clara River watershed are chloride and other salts, and nutrients such as nitrogen [*California Environmental Protection Agency Los Angeles Regional Water Quality Control Board*, 2007]. Alternatives are available for most product classes such as chemical fertilizers, pesticides (see Landscape Management chapter), cleaning solutions, automotive and paint products, janitorial chemicals, and consumables (e.g. batteries and light bulbs). Consider including in the lease agreements product purchasing guidelines and procedures, standard operating procedures, preferred or approved product and supplier lists, product and supplier evaluation criteria, and fact sheets for employees [*California Stormwater Quality Association*, 2003a].

Furthermore, the California Department of Water Resources has specified appliances or technologies that recommend water conservation. These include: ice machines, pre-rinse nozzles, garbage disposers, commercial laundries, cooling towers, and photo and X-ray processing devices [*California Department of Water Resources*, 2009a; b; c]. Other commercial businesses or technologies to require water use efficiency are: vehicle washing and automatic car washes, steam sterilizers, autoclaves, process washing and rinsing, commercial kitchens and restaurants, evaporative coolers, equipment cooling systems, boilers and steam generators, and humidifiers [*Vickers*, 2001].

Recommendation W3: Xericscaping and Efficient Irrigation

Use irrigation technology devices and xericscape principles in order to minimize water use outdoors. Use recycled water for all landscape irrigation except for residential backyards and the agricultural preserve.

Landscaped areas in the community are important for aesthetics, recreation, mitigation of heat island effects, and erosion control. However, outdoor water use in the urban sector is the single largest use of water [*Bickel, et al.*, 2006]. Landscape irrigation can use up to 75 percent of the urban sector's water demand [*Vickers*, 2001]. Furthermore, excessive use of water for irrigation increases water utility costs, pollutant runoff of landscape chemicals, and maintenance requirements [*Vickers*, 2001].

There are numerous options currently available for increasing water efficiency outdoors. Landscape design, landscape management practices (see Landscape Management chapter), and irrigation control devices can all contribute to decreased water use for landscaping. California can cost-effectively reduce current water demand by an estimated 32.5 percent by improving landscape management practices and implementing available irrigation control devices [*Gleick, et al.*, 2003].

Since the 1990s, state legislation has regulated water use for landscaping. Most recently, the Water Conservation in Landscaping Act of 2006 mandated that the Department of Water Resources update the Model Water Efficient Landscape Ordinance. The most current version of the updated ordinance from November 2008 requires managers of landscape areas at least 2,500 square feet in size to calculate the Maximum Applied Water Allowance. Additionally, a plan must be made for the landscape area's irrigation schedule so that the Maximum Applied Water Allowance is not exceeded annually [*State of California Department of Water Resources Office of Water Use Efficiency and Transfers*, 2008].

Irrigation

Require the installation of irrigation control devices (sensor- or signal-based) at all CII buildings that will have landscapes that requires irrigation, and at all parks and open spaces maintained by the City of Santa Paula. Require residents to use some kind of irrigation controller that is based on soil moisture, rainfall, or weather stations to ensure efficient water use on residential landscapes. There are many irrigation control devices available in the market. As of 2007, there are nearly 30 manufacturers, and others are quickly emerging. In general, irrigation control devices either use weather or soil moisture information to set watering schedules [*United States Bureau of Reclamation*, 2007].

One of the more advanced systems is a controller that uses pager technology to link it to a network of local weather stations. The controller internally adjusts the irrigation schedule as it receives information about the current weather conditions, and thus only waters the landscaping when the plants demand water. These controllers can also be set

up to water different areas of the landscape based on the specific plant types in each area [*Aquacraft Inc. Water Engineering and Management*, No date].

Another type of controller uses information about the loss of water from soil by evaporation and from plants by transpiration to determine when irrigation is necessary. Evapotranspiration (ET) is the result of water loss from soils and plants combined. ET is calculated from weather data including temperature, humidity, wind, and solar radiation. The California Department of Water Resources uses a network of weather stations around the state to collect weather data and calculate ET at each station. Then this information is available freely online for people to use to set their irrigation controllers [*State of California Department of Water Resources*, 2000].

Another device measures soil moisture and schedules irrigation when necessary to maintain steady soil moisture levels. Plants need the soil moisture level to be somewhere between the wilting point as the minimum and the field capacity as the maximum. This type of device can be a stand-alone controller or an add-on piece to a controller with an existing clock to set irrigation schedules. A valuable resource to utilize for specific device information and technical reviews is the United States Bureau of Reclamation (USBOR) Weather and Soil Moisture Based Landscape Irrigation Scheduling Devices Technical Review Report – Second Edition [*United States Bureau of Reclamation*, 2007]. According to USBOR's website, new versions of this technical report are planned to keep information current as products evolve and new devices become available [*United States Bureau of Reclamation*, 2008].

Numerous case studies from municipalities around California and the nation have shown that water efficiency increases when irrigation control devices are installed. Table W2 shows the results of a few of these studies.

Table W2: Irrigation Control Device Studies and Percentage Water Saved

Location	Control device	Percentage water saved
Sonoma[1]	ET-based	22
Valley of the Moon[1]	ET-based	28
Irvine Ranch[2]	weather-based	20
San Fernando Valley[3]	weather-based	17
San Fernando Valley[3]	weather, add-on	28
Four sites Southern California[4]	ET-based	35
Boulder, Colorado[5]	soil moisture-based	27

[Sources: *Aqua Conserve*, 2002[1]; *Bamezai*, 2004[3]; *Gelinas and Brant*, 1995[4]; *Lessick*, 2000[2]; *Qualls, et al.*, 2001[5]; *Vickers*, 2001[2, 4]].

Use recycled water for all landscape irrigation needs including neighbor-shared landscaping and community gardens, but do not use reclaimed water on the agricultural preserve. East Area 1 will connect to the City of Santa Paula for its water supply. The process to treat water to potable standards is three times as costly as the process to treat water to recycled water standards [*Haslinger*, 2008]. Furthermore, both potable and recycled water will travel the same distance in order to be treated and distributed to East Area 1. Therefore, the energy used to transport either type of supply of water to and from East Area 1 will be the same. The water demand predicted for landscape needs, excluding the agricultural preserve, total 197.6 AFY [*HDR Town Planning*, 2007b]. Utilizing recycled water can alleviate this demand on the groundwater supply for the City of Santa Paula.

The tertiary treatment process that will be used in the City of Santa Paula's Recycled Water Facility is a membrane bioreactor followed by a final disinfection with ultraviolet light [*Nick*, 2009]. This tertiary treatment process eliminates the risk of microbe contamination to meet regulatory requirements [*McKee*, 2004].

This additional use of recycled water is safe and efficient. The Monterey Regional Water Pollution Control Agency operates a water recycling facility. They manage the distribution system under contract from the Monterey County Water Resources Agency to treat and distribute recycled water for irrigation use on over 12,000 acres of farmland. They have been irrigating crops with recycled water that are eaten raw for over ten years without incidence of any type of bacterial or viral infection [*Harris*, 2008]. Additionally, other municipalities are using tertiary-treated water to irrigate fruits and vegetables. For example, the city of Santa Rosa irrigates approximately 6,000 acres, and the city of Visalia irrigates walnut orchards with recycled water [*Wong, et al.*, 1999].

Like all plants, crops have varying tolerances for salt concentrations and other nutrient loads. Avocados are very sensitive to chloride concentration in water. A chloride concentration of over 100 milligrams per liter (mg/L) in the leaves will begin to injure the plant. Avocados are also sensitive to sodium concentration [*Ayers and Westcot*, 1985b]. Additionally, one stretch of the Santa Clara River has a TMDL permit to comply with for chloride concentration. This part of the river is east of Santa Paula, and is called "Santa Clara River Reach 3" [*The Nature Conservancy*, 2008]. It is predicted that water leaving the Recycled Water Facility will have a chloride concentration at 100 mg/L [*Finley*, 2009]. It will be necessary to monitor the chloride concentration in recycled water in East Area 1 due to the sensitivity of avocados and the regional regulatory requirements.

There are options for decreasing salt concentrations if they become a concern. Flushing an irrigated area as climate conditions warrant (which may not be necessary during wet years) with either recycled water or potable water has been shown to remove salts [*Ayers and Westcot*, 1985a; *Monterey Regional Water Pollution Control Agency*, 2006]. Another option is to apply a mixture of recycled water and another water source. Flushing or blending water will not only reduce the level of chloride, but also the other salts in recycled water.

For East Area 1, avocado is an indicator for other plants and crops that will grow in landscapes and gardens. Healthy avocado trees indicate that salts in the irrigation water are not affecting the other vegetation. Moreover, irrigation control devices on all landscaping can help realize the most efficient amount of irrigation water.

Limoneira currently uses irrigation water very efficiently on the agricultural preserve, and due to the location of these 55 acres up on the hillside, it does not make environmental or economical sense to pump recycled water up the hill to irrigate the preserve

Xericscape

Mandate that xericscaping principles be used for all landscapes. There are many terms to describe approaches to water-efficient landscaping, and xericscaping is defined as "quality landscaping that conserves water and protects the environment" [*United States Environmental Protection Agency*, 2008f]. In 1982, Nancy Leavitt, an environmental planner in Denver, Colorado, coined the term "xericscape". Later in the 1980s, the term was trademarked by Denver Water [*Aquacraft Inc. Water Engineering and Management*, 2000]. Xericscape principles do not strictly require native plants; they also allow other compatible drought-tolerant species that do not pose an invasive threat.

Among the many advantages to choosing plants that are native or adapted to the local region is that they require little or no irrigation beyond normal rainfall [*United States Environmental Protection Agency*, 2008f]. When selecting plants, additional factors besides water use should be considered including plant maintenance requirements, blooming time, and aesthetic value. Work with Limoneira and other local landscape experts to determine xericscape plant species. (For further discussion about plant species selection, see the Landscape Management chapter).

A study of more than 1,000 single-family homes in the East Bay Municipal Utility District in California found that those homes with water-conserving landscapes used 42 percent less water than those with conventional landscapes [*Vickers*, 2001]. Although xericscape programs are available in more than 40 states and numerous demonstration projects have been documented, few systematic conversion studies have been done to calculate and predict water use by conventional versus xericscape landscapes. In 1996, the Southern Nevada Water Authority and the USBOR teamed up to conduct a study in the Las Vegas, Nevada area to track exact water usage for turf versus xericscape landscapes. Their model of outdoor water demand predicts that irrigation water demand will decline by 34 gallons per year for each square foot of turf landscape changed to xericscape [*Aquacraft Inc. Water Engineering and Management*, 2000].

There are also economic benefits to landscaping with xericscape principles. A study conducted for a proposed development in Chula Vista, California, found that over a ten-year period the benefit-to-cost ratio for using water-efficient landscaping was 1.2 and that using xericscape principles resulted in a ratio of 1.1 [*Sheikh and City of Chula Vista*, 2002]. Similarly, a study in Brodhead, Wisconsin, found that the 20-year cost of

maintaining native vegetation was approximately $3,000 per acre compared to more than $20,000 per acre of conventional nonnative turf [*Vickers*, 2001].

Recommendation W4: Utility Monitoring Systems

Install automatic water meters and utility monitoring systems in all buildings. Sub-meter all multi-family units and commercial, industrial, and institutional buildings.

In many municipalities across California, residents receive a water bill only six times per year. Therefore, information about water usage is not available until one to two months after usage occurs. Water use behavior cannot be expected to change unless more timely information is accessible [*Bohlig*, 2008]. In order to use water efficiently over time, users need to have access to information about their usage. Water meters are considered the most effective tool to spur more efficient water use [*Nelson, et al.*, 2007]. Additionally, building monitoring systems can provide real-time information on resource use and help users identify immediate efficiency improvements. For example, fixing leaks can reduce average daily water use by 12 percent [*Gleick, et al.*, 2003; *Petersen*, 2007].

Meters

In accordance with the City of Santa Paula's Urban Water Management Plan 2005 update, install automatic water meters in all newly constructed buildings [*Kennedy/Jenks Consultants*, 2006]. Additionally, sub-meter all multi-family units and CII buildings where there are multiple tenants. Automatic water meters have radio antennae that transmit signals. The water utility company can equip its vehicles with an on-board laptop or use hand-held computers to read the meters when in range of the signal [*Federal Energy Regulatory Commission*, 2007]. This system reads water usage to within one-eighth of a gallon, thus improving the accuracy of water bills and significantly reducing the time to read meters. For example, the City of Conroe, Texas, changed all of its 11,500 meters to automatic water meters. Historically, it took nine to 10 days to read 4,000 to 5,000 meters, whereas now it takes three to four days to read all the meters [*Siemens Building Technologies Inc.*, 2008]. The time saved to read meters would help to alleviate the addition of multiple meters at multi-family units and CII buildings. It will also save on the labor costs spent to read meters.

Residents living in multi-family units typically do not pay for their water usage directly; rather, a fixed cost is incorporated into the rent. Some argue that sub-metering multi-family units does not increase water conservation, because multi-family units typically use less water than single-family homes because of lower outdoor water use demand. Additionally, the argument asserts that water conservation in multi-family units cannot improve, because indoor water use is essential for sanitation, bathing, cooking, and cleaning. However, if tenants receive an individual water and sewage bill, the potential for behavior changes is greater [*Vickers*, 2001].

By submetering multi-family units, residents gain more control over their total living expenses.. Submetering informs people of their habits, and enables them to make behavior changes. Additionally, residents are more likely to report leaks to prevent a high water bill.

In the long term, water conservation contributes to a larger effort that helps decrease future water rate increases to adjust for increasing demand. Submetering saves 15.3 percent in annual water use, in comparison to traditional metering of multi-family units. This national study is based on 10 sites across the nation including three in California: the City of San Diego, the East Bay Municipal Utility District, and the Irvine Ranch Water District [*Mayer, et al.*, 2004]. Submeters in the CII sector can help monitor large sources of water use and identify opportunities for conservation [*Vickers*, 2001].

Utility Monitoring Systems

In schools and other institutional buildings, install building monitoring systems, such as building dashboards, in order to provide real-time displays of building utility usage. At the residential level, install leak detectors that include both a flow sensor and a mechanism to close the water connection when a suspicious flow is detected. A building monitoring system tracks all building energy management systems, data loggers, utility meters, and automation systems over the Internet to acquire constant data about the building's resource use and performance. The data are available to view online or on installed screen displays. The data can be downloaded into a spreadsheet format. This type of system allows occupants to instantly know their water or energy use, which provides the opportunity to immediately make efficiency improvements.

Dormitories at college campuses are currently installing monitoring systems. They are also starting competitions between individual dorms to see which can become the most resource-efficient building. For example, Oberlin College in Oberlin, Ohio conducted a study between dorms equipped with the monitoring systems and those without them. Electricity use decreased by 32 percent and water consumption by three percent in those with monitoring systems [*Petersen*, 2007].

The Green Building Research Center at the University of California at Berkeley developed a monitoring system to provide both real-time display of data and monthly information about energy, water, and other resource use. Every building on campus has a monitoring system; and a beta version of this system was released in April 2007 [*Green Building Research Center at UC Berkeley*, 2007]. (Please refer to Energy Management chapter for a further discussion of building utility monitoring).

As buildings and infrastructure age, one issue that arises is the risk of leaks. According to the Residential End Uses Water Study, 13.7 percent of residential water use is from leaks [*Mayer and DeOreo*, 1999]. The average loses 9.5 gallons per capita per day due to leakage, the majority of which is from toilets. Additionally, an estimated 1.5 percent of 1.6-gpf toilets leak an average of 200 gallons per day. In a CII building that has a jammed or

malfunctioning flush-valve, toilets can leak about 35 gpm or 2,100 gallons per hour when locked in the open position [*Vickers*, 2001]. Furthermore, the Insurance Information Network of California reported that water damage was responsible for approximately 30 percent of all California homeowners' insurance claims made in 2001 [*Insurance Information Network of California*, No date].

There are various types of leak detectors currently available, and this industry will expand by the time East Area 1 is under construction. One type of leak detector is a meter monitor that is programmed to the water meter. The monitor has a magnet on the back so that it can be displayed on a refrigerator or some central location in the home. A sensor light flashes when suspect flows are detected, but it does not pinpoint the location of the leak. At this time, the monitor is not connected via the Internet, therefore, someone has to be in the home to be alerted to possible leaks [*DeOreo*, 2008]. Meter monitors are typically sold to water districts or city public work departments that either sell or rent out the monitors to its customers. Monitors cost approximately $67 [*Lozano*, 2009].

Another type of leak detector works by reading data from any pulse-generating meter and transmitting the data to a server. This data can be retrieved via the Internet, which makes it possible to respond to a leak at any time [*DeOreo*, 2008]. This system currently costs approximately $700 [*Obvius*, 2009].

Finally, the Leak Defense System is an advanced system that includes a flow sensor attached to the water line wherever it enters the buildings. It also includes an in-home monitor for homeowners to set how long continuous water can flow before the alarm is alerted. Furthermore, an electric ball valve closes the system when a suspicious flow is detected [*DeOreo*, 2008]. This system costs between $2,000 and $2,500 [*Sentinel Hydrosolutions*, 2008].

Resources

Certain state and national programs are very useful resources for information on current technologies, appliances, and fixtures. These programs will continue to be available during the build out of East Area 1. They may be valuable resources to help determine the best available technologies at the time of installation.

U.S. Environmental Protection Agency WaterSense: http://www.epa.gov/watersense/
This program, sponsored by the U.S. EPA, has created a label for quality, water-efficient products.

California Urban Water Conservation Council: http://www.cuwcc.org/
This council is a partnership between urban water agencies, private entities, and public interest organizations with a mission to increase water efficiency and to facilitate the integration of BMPs into the urban sector.

Consortium for Energy Efficiency: http://www.cee1.org/
This group, based in the United States and Canada, works on approaches to advance energy efficiency. They collaborate with other industries, government agencies, and trade associations.

Energy Star: http://www.energystar.gov/
This joint program between the U.S. EPA and the U.S. Department of Energy is a voluntary label to promote energy-efficient products.

Alliance for Water Efficiency: http://www.allianceforwaterefficiency.org/
This non-profit organization works to improve the efficient and sustainable use of water. They provide information on water efficiency and conservation, assist with conservation efforts, and support efficient products and programs.

Santa Barbara Built Green: http://www.builtgreensb.org/home.html
This is a group of professionals in the development industry working together to improve the quality of life in Santa Barbara.

Collaborative for High Performance Schools: http://www.chps.net/
This collaborative helps to facilitate all phases of the design and operation of high performance schools so that they use resources efficiently and provide a healthy environment for students.

CHAPTER 8
OPERATIONS AND MAINTENANCE

The complementary recommendations in the six sectors in this report are intended to minimize adverse impacts on the environment and the health of the inhabitants of East Area 1. Although East Area 1 will use innovative design and construction methods to ensure superior environmental performance and a quality standard of living for the community, these measures alone will not guarantee that residents and community members will live sustainably. For example, homeowner behavior may negatively affect the performance of buildings or even the entire community. Therefore, East Area 1 must operate in a sustainable manner in order to realize the community's intended purpose. In essence, sustainability is a way of life.

In order to provide a holistic and comprehensive suite of suggestions for the design and operation of East Area 1, we provide three additional recommendations that encompass all six sectors. These recommendations suggest ways to perpetuate sustainability and sustainable living. Since sustainability is an on-going and ever-evolving process, these recommendations are flexible to account for future advancements in our understanding of how best to achieve sustainability.

Recommendation OM1: CC&Rs

Require Covenants, Conditions, and Restrictions that include provisions for maintaining and improving sustainability within East Area 1 to be placed on builders, individual homes, and properties. Covenants, Conditions, and Restrictions must be flexible to allow for upgrades and improvements as new technology becomes available, but also specific enough to ensure that sustainability measures are implemented.

Most planned communities make use of Covenants, Conditions, and Restrictions (CC&Rs) in order to manage the appearance and operation of the community. CC&Rs, also referred to as restrictive covenants, are legally binding documents that either require homeowners to take certain actions to maintain their home and property, or restrict homeowners from taking actions which are perceived to degrade the quality of the entire community [*Weintraub*, 2009]. Well-crafted CC&Rs address the development of an individual property, including the construction of the home, as well the maintenance of the home and property. Communities with properly drafted and enforced CC&Rs have been shown to retain higher property values, be safer, and have improved relations with local governments as compared to communities that have no CC&Rs [*FindLaw*, 2009].

CC&Rs commonly include provisions that address fences, pets, restrictions on outdoor noise, the appearance of homes, and the maintenance of tidy and kempt yards [*FindLaw*, 2009]. While the concept of CC&Rs is neither new nor unique for East Area 1, the

inclusion of sustainability provisions within these documents is not yet a common practice.

Limoneira and its team of design professionals have committed significant time, effort, and capital to develop this community sustainably. Throughout this report, we have recommended specific actions that will significantly contribute to the sustainability of East Area 1. However, as we have mentioned throughout this report the sustainability of East Area 1 ultimately depends on the actions and behavior of the people who live and work in the community. Including sustainability provisions within CC&Rs offers a way for Limoneira to ensure that the recommendations in this report are followed and the community operates sustainably.

The sustainability provisions in the CC&Rs must address both buildings and landscapes. Moreover, they must apply to the construction and development process, as well as the way in which people operate within the community. Perhaps most importantly, the CC&R sustainability provisions must be specific enough to minimize adverse environmental impacts in all sectors of the community, while also being flexible enough to allow for future innovations that may improve the community's environmental performance. In this context, it is necessary that the CC&Rs "run with the land," to subject the property, instead of the owner of the property, to the conditions and restrictions prescribed in the document. This type of CC&R ensures that the owner of the property must abide by the conditions and restrictions, even if the property is sold to a new owner [*FindLaw*, 2009].

The recommendations throughout this report serve as the basis for the sustainability provisions in East Area 1's CC&Rs. Requirements for builders should include such measures as building energy efficient homes and buildings, creating a construction site recycling program, managing stormwater and preventing erosion on construction sites, using environmentally friendly building materials, installing utility monitoring systems in homes and buildings, and planting regionally-appropriate landscaping in public areas and private lots.

In addition to the sustainability provisions that apply to the construction of the community, the CC&Rs must also govern the actions of the people within the community. Example provisions include requiring all irrigation systems in the community to include evapotranspiration monitors, establishing irrigation schedules to prevent overwatering, mandating all appliances to be energy and water efficient, requiring landscapes to be managed organically, and restricting the direction and intensity of outdoor lighting. CC&Rs must also not prohibit the implementation of sustainability measures such as the installation of solar panels or the maintenance of backyard compost piles.

These are our recommendations for incorporating sustainability into CC&Rs. However, the specific language of sustainability provisions and CC&Rs is beyond the scope of this

report. Limoneira should consult a legal professional for the writing of the CC&Rs, as they are legally binding documents.

Recommendation OM2: Community Website

Create a community website which includes a section on living sustainably, a calendar of current events and public workshops, a ride-sharing portal, and an online forum for discussion and posting classified ads.

Although East Area 1 is to be a sustainable community, it is essential that residents and community members are able to operate and live in their community sustainably. A community website can be an invaluable resource to provide the community access to information and online services that will help them live in East Area 1 sustainably while promoting community pride and involvement. This website can be used by residents, the homeowners' association (HOA), businesses, and other community members to keep everyone involved in neighborhood affairs and in the decision making process.

A section on living sustainably should include practical information to promote environmental awareness and healthful living. This may be the most important feature of a community website for East Area 1. Although the innovative design and construction of East Area 1 may minimize the environmental and human health affects of the built environment, this will not be enough to ensure that the community will live sustainability. Therefore, this section will be a crucial resource, because East Area 1 must be lived and operated in a sustainable manner in order for it to be a truly sustainable community. For example, this section can include methods and guidelines for organic landscaping, using energy and water efficiently, maintaining good indoor air quality, making compost, reducing waste, sorting recyclables, reducing one's carbon footprint, and organizing community events and workshops. Furthermore, this section can provide information on the local wildlife, trails, and natural areas in order to help residents and visitors appreciate and protect the local wildlife and natural resources.

The website should also include a calendar of current events and public workshops and an online forum for community-related discussions and posting classified ads. Residents and workers can use an online ride-share portal in East Area 1 to arrange carpools, which would help facilitate some of the transportation recommendations made in this report. The homepage can contain important announcements, news and upcoming events, and other content that fits the community's needs. Furthermore, online forms can allow residents to apply to use community resources, such as community gardens and public facilities for events. Also, provide sections for helpful articles, resources, and other websites of interest, including links to schools, utility companies, and government websites.

The community website should offer electronic versions of homeowners' manuals, community rules and regulations, a community resources guide and directory, resident surveys, photographs of the community, and a section to welcome new residents.

Additionally, the website can show details and photographs of each neighborhood's amenities, including neighborhood maps that show the layout of lots, roads, pedestrian and bicycle paths, and trails. Google Maps for aerial views of the community can also be integrated in this section.

This website can provide a means for communication between the HOA and the community by posting community announcements, newsletters, and meeting minutes and archives on the website. Provide online forms and documents in order to provide residents and other community members access to the most current resources and information. This includes posting bylaws, covenants, architectural review forms, and other important documents. Online surveys and voting can allow community members to take polls and vote online for official association matters such as rule changes and elections. Additionally, association dues can be collected online. All these features can reduce printing, mailing, and administrative costs while providing residents, business owners, and other community members convenient access to community information and administrative processes.

Residents should be able to contact the HOA board directly or submit messages through the website to a single point of contact such as a property manager. Provide online fill-in forms in order to give community members a method to submit information to the board or property manager conveniently. Furthermore, include committee contact information and post special reports from each committee. Board member details should include officer names, contact information, photographs, and other details. If appropriate, include property manager details and contact information.

The website can include information for visitors to East Area 1, including sections for publishing the community's mission statement, and describing the history and sustainability elements of East Area 1. This visitor's section should also include a section for home sales and property rentals.

Moreover, provide a section for crime watch and emergency information and the contact information to report specific types of crimes or emergencies. Special notices and alerts can be mass emailed to the community.

Most importantly, the community website should be in both English and Spanish. The website should be designed with user-friendly navigation and features for both website visitors and administrators that require no or minimal technical knowledge or special software to install. For example, all sections of the website should be within two clicks of the mouse to ensure intuitive navigation so website visitors can quickly find what they are looking for. It is also very important that the website not become outdated.

A few examples of community websites include:

Rackheath Eco-Community:
www.rackheatheco-community.com

Limestone Springs Community Website:
www.limestonesprings.org/community_information.html

St. Charles Community Website:
www.st-charles.il.us/index.htm

Raintree Village Homeowners Association:
www.raintreevillage.com

Turner Downs Community Website:
www.turnerdownsnc.com

Recommendation OM3: Public Workshops

Host a series of public workshops focused on living sustainably. Examples of potential workshops include, but are not limited to, reducing indoor energy consumption, installing rainwater cisterns, using irrigation control devices, xericscaping, backyard composting, and home gardening.

A workshop is a brief intensive course, seminar, public outreach program, or a series of meetings in order to educate or provide information on specific topics and issues. Although East Area 1 is to be a sustainable community, it is imperative that residents and community members understand how to operate and live in their community sustainably. Workshops can help create public support for and awareness of sustainability practices and issues while encouraging a greater sense of community.

Workshops can be offered by a variety of people and organizations including residents, the HOA, public interest groups, the local government, the Limoneira Company, and other private or not for profit organizations. Workshops should be open to anyone who may be interested or would benefit from the program. Workshops can be held in public facilities such as a community center. Workshops can be advertised through the community website, email service, and newsletters. Furthermore, they can be announced by posting notices in the community and by postal mail.

For example, a workshop could explain how to operate irrigation control devices to reduce water consumption. Although these devices might be installed in residential landscapes, homeowners may not set the controllers properly to deliver the appropriate amount of water, because homeowners may not know how often or how much to water throughout the year. Consequently, homeowners may over-water their landscapes, which would waste water and raise their water bills. A workshop on using irrigation control

devices can help homeowners learn how to properly adjust and operate their control devices throughout the year in order to efficiently water their landscapes. Such a workshop can be offered by the HOA or the manufacturer or installer of the irrigation control devices.

Additionally, this workshop on the efficient use of irrigation control devices can be part of a series of workshops on sustainable landscaping in East Area 1. Subsequently, workshops on xericscaping, organic gardening, and backyard composting could be offered in this series.

CHAPTER 9
OUR VISION

At this point in the development of East Area 1, our recommendations focus mainly on the infrastructure, technologies, and other actions to implement during the design, installation, and operation of homes, buildings, and landscapes. However, our vision for this community development has always focused on the people that will live in East Area 1. At the forefront of our vision is a high quality of life that includes both maintaining and enhancing human and environmental health. We want the people who live and work in this community to realize the full benefits of this sustainable development through their daily actions, behavior, and decisions.

The time horizon of this project allowed us to be innovative in our recommendations. Furthermore, impending legislation combined with the demand for housing and the consequences of climate change make it essential that this development is able to adapt. Thus, our group worked to incorporate flexibility into the design of East Area 1 so that as time passes, the community is able to update the ways it functions in order to meet the needs of future generations. We want our recommendations to embody our vision, which is that a sustainable development is fundamentally about the people in the community.

We imagine a place where people gather in the parks and open spaces, which are beautiful and healthy landscapes due to the organic methods used to maintain them. People will have the opportunity to use energy and water efficiently in their homes and workspaces. This vision also includes economic savings for residents and workers who may use the community website to set up carpools in order to save gas money, for example.

Nevertheless, this vision is also dependent on people's behavior. Therefore, education and outreach are critical to achieving sustainability. For example, our recommendation to host public workshops (Recommendation OM3) is one way to engage residents in learning about how their actions can significantly contribute to the sustainability of this community. Additionally, as people begin living and working in East Area 1, future research projects can evaluate various facets of sustainability.

Importantly, one research area to analyze is how human behavior changes. This analysis could include a survey to learn about residents' perceptions of a sustainable development. Subsequently, a tailored educational outreach program can be developed to teach people about sustainability.

An evaluation of how rules are made and enforced in community developments could also provide valuable information about how governing systems can affect human behavior. For example, a review could be conducted of the effectiveness of our recommendation about CC&Rs containing sustainability provisions to affect human behavior.

Finally, an assessment after the first phase of construction is complete and people have moved in could help measure the effectiveness of our recommendations. Data about the actual utility usage and other resources could provide information about how to improve upon our recommendations for the next phases of build out. Academic research groups or consultants could work in conjunction with the City of Santa Paula to collect data on resource use and transportation patterns. The research group or consultant could provide an analysis of the data with recommendations for targeting efficiency improvements. Updates to measure progress could be conducted every three to five years, for example.

Although the Limoneira Company has been involved in developing neighborhoods since its inception, the development of East Area 1 is its largest effort thus far. Furthermore, this endeavor is the first of its kind on this scale for both Santa Paula and Ventura County. This community can set a precedent for future urban developments in the county to leave behind conventional practices, like suburban sprawl, in order to transition to a paradigm of sustainability.

Limoneira has planned this project strategically. It is now in its fifth year of planning. The company has gathered input from local Santa Paulans to ensure their ideas are part of the vision for East Area 1. Limoneira is also garnering the expertise of various professionals to push innovation. Most recently, our group has been asked to provide cutting-edge research and guidance on how to implement specific actions. Considering Limoneira's vision to maintain the long-term viability of East Area 1, our group provides recommendations that will significantly contribute to realizing a sustainable community development. The process of achieving sustainability is ongoing, and we hope these recommendations do not lie stagnant and are instead continually evaluated and updated to meet the needs of future generations.

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APPENDIX A
INPUTS AND ASSUMPTIONS FOR ENERGY-10 ANALYSIS

- All simulations used the weather data from California Climate Zone 9, which is where East Area 1 will be located. This zone has both interior and coastal influences, with inland winds carrying hot, dry air and marine air bringing in moist, cool air. It has hot summers, and frosts are extremely rare. The total annual energy demands for heating and cooling are about equivalent, as there are as many heating degree-days as cooling degree-days, assuming a base temperature of 65°F. For example, if the average temperature for a particular day is 57°F, then this is an 8 heating degree day (65–57=8) [*Pacific Gas & Electric*].
- The HVAC system was a DX cooling unit with gas furnace (ducted, split system, single zone). This is the most common HVAC system in new California homes [*California Energy Commission*, 2008].
- The lighting intensity was assumed as 0.3 watts/ft^2. We chose this value because it resulted in 5–10 percent of the total annual energy use of the baseline condition coming from lighting. This percentage is in line with the findings from Built Green Santa Barbara.
- The cost figures for the energy efficiency strategies are data from 2005 from the National Renewable Energy Laboratory [*Weaver*, 2009].
- The electricity rate, $0.1191 per kWh, was the residential (Schedule D) baseline rate from Southern California Edison in July 2008.
- The natural gas rate, $0.9711 per therm, was the residential baseline rate from Southern California Gas Company in September 2008. We assumed that natural gas is used for heating.
- The pollution coefficient for CO_2 from generating electricity in Santa Paula was calculated from the Environmental Protection Agency's Power Profiler [*United States Environmental Protection Agency*, 2008a]. It was determined to be 0.713 lbs CO_2 for every kWh of electricity. We used Energy-10's default value for natural gas (11.5738 lbs CO_2 for every therm of fuel).
- The heating temperature was 70°F, and the cooling temperature was 78°F. We simulated no setback for either the baseline or any of the scenarios.
- Energy-10 automatically sized the HVAC system depending on the building's parameters and any efficiency strategies. The oversize factor was set to the default, 1.2.
- Energy-10 did not take prevailing winds or natural ventilation into account when calculating energy use.
- All simulations were run assuming that the ventilation rate was 0.35 air changes per hour, which is the standard recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) [*United States Department of Energy*, 2008h].

APPENDIX B
GLOSSARY OF SELECT TERMS: RECOMMENDATION E1, TABLE E2

EER: Energy efficiency ratio. This is a measure of the efficiency of the air conditioner, and a larger EER corresponds to a more efficient system. The minimum EER for an Energy Star split system is 11.5 [*Energy Star*, 2008f], and the current best available technology is 14 [*Consortium for Energy Efficiency*, 2008]. Another measure of an air conditioner's efficiency is the seasonal energy efficiency ratio (SEER).

U-factor: The U-factor is the rate of heat loss. U-factor ratings usually range from 0.20 to 1.20 Btus/hour/ft^2, and a lower value means a higher resistance to heat flow (better at insulating). The inverse of the U-factor is the R-value (see below) [*Building Energy Codes Resource Center*, 2009b].

SHGC: Solar heat gain coefficient. The SHGC is the fraction of the sun's energy that a window transmits. Thus, it can range from 0 to 1, and a window with a lower value is better at blocking the heat from the sun [*Building Energy Codes Resource Center*, 2009a].

R-value: The R-value is a measure of a material's heat flow resistance. A higher R-value means the material is a more effective insulator. The inverse of the R-value is the U-factor (see above) [*United States Department of Energy*, 2008e].

F-factor: The f-factor is the rate of perimeter heat loss from slab-on-grade floors. It is measured in British thermal units per hour per degree Fahrenheit, and it is analogous to the U-factor for windows [*Building Energy Codes Resource Center*, 2008].

Thermal mass: Thermal mass is a common feature of passive solar design. By making a building less susceptible to outdoor temperature fluctuations, it reduces energy used for mechanical heating and cooling. Although many types of materials can be used as thermal mass, a concrete slab foundation is rather common [*California Energy Commission*, 2009c].

APPENDIX C
DETAILED OUTPUT FROM ENERGY-10 ANALYSIS

	AVERAGE - 2 BEDROOM APARTMENT			
	Baseline	**Scenario A**	**Scenario B**	**Scenario C**
Dwelling unit size (ft^2)	961	961	961	961
Annual energy, total ($kBtu/ft^2$)	48.9	40.0	34.7	26.5
Annual energy, heating ($kBtu/ft^2$)	20.8	14.1	10.2	2.2
Annual energy, cooling ($kBtu/ft^2$)	4.5	3.0	1.9	1.8
Annual energy, lighting ($kBtu/ft^2$)	4.3	4.3	4.3	4.3
Annual energy, other ($kBtu/ft^2$)	19.4	18.5	18.3	18.2
Fixed construction cost	$176,824	$176,824	$176,824	$176,824
Energy efficiency strategies cost	$0	$185	$1,135	$7,549
HVAC installation cost	$6,871	$7,851	$6,291	$5,225
Total construction cost (includes HVAC installation and energy efficiency strategies)	$183,695	$184,860	$184,250	$189,597
Annual fuel cost	$285	$223	$186	$112
Annual electric cost	$616	$537	$494	$487
Total annual energy cost	$901	$760	$680	$598
Annual emissions (lbs CO_2)	7,089	5,877	5,182	4,247
Annual emissions (lbs CO_2/ft^2)	7.3767	6.1158	5.3923	4.4194

	4-BEDROOM HOUSE - ONE STORY			
	Baseline	**Scenario A**	**Scenario B**	**Scenario C**
Dwelling unit size (ft^2)	1,695	1,695	1,695	1,695
Annual energy, total ($kBtu/ft^2$)	39.8	35.4	31.4	25.5
Annual energy, heating ($kBtu/ft^2$)	12.0	9.5	6.8	1.1
Annual energy, cooling ($kBtu/ft^2$)	4.3	3.2	2.0	2.0
Annual energy, lighting ($kBtu/ft^2$)	4.3	4.3	4.3	4.3
Annual energy, other ($kBtu/ft^2$)	19.2	18.4	18.2	18.2
Fixed construction cost	$420,360	$420,360	$420,360	$420,360
Energy efficiency strategies cost	$0	$355	$1,957	$11,662
HVAC installation cost	$10,602	$12,997	$10,415	$9,060
Total construction cost (includes HVAC installation and energy efficiency strategies)	$430,962	$433,712	$432,733	$441,082
Annual fuel cost	$359	$317	$273	$179
Annual electric cost	$1,064	$955	$871	$865
Total annual energy cost	$1,422	$1,272	$1,145	$1,044
Annual emissions (lbs CO_2)	10,649	9,498	8,482	7,318
Annual emissions (lbs CO_2/ft^2)	6.2826	5.6035	5.0041	4.3174

	4-BEDROOM HOUSE - TWO STORIES			
	Baseline	**Scenario A**	**Scenario B**	**Scenario C**
Dwelling unit size (ft^2)	1,695	1,695	1,695	1,695
Annual energy, total ($kBtu/ft^2$)	54.7	47.1	36.2	27.8
Annual energy, heating ($kBtu/ft^2$)	27.0	21.3	11.7	3.6
Annual energy, cooling ($kBtu/ft^2$)	4.0	3.0	1.9	1.7
Annual energy, lighting ($kBtu/ft^2$)	4.3	4.3	4.3	4.3
Annual energy, other ($kBtu/ft^2$)	19.4	18.5	18.3	18.1
Fixed construction cost	$420,360	$420,360	$420,360	$420,360
Energy efficiency strategies cost	$0	$321	$2,426	$12,927
HVAC installation cost	$12,002	$15,044	$11,496	$9,535
Total construction cost (includes HVAC installation and energy efficiency strategies)	$432,362	$435,725	$434,282	$442,822
Annual fuel cost	$606	$512	$353	$221
Annual electric cost	$1,058	$947	$870	$849
Total annual energy cost	$1,664	$1,458	$1,223	$1,069
Annual emissions (lbs CO_2)	13,560	11,773	9,421	7,716
Annual emissions (lbs CO_2/ft^2)	8.0000	6.9457	5.5581	4.5522

APPENDIX D
INPUTS AND ASSUMPTIONS:
CLEAN POWER ESTIMATOR ANALYSIS

	Residential	Commercial
City, state	Santa Paula, California	Santa Paula, California
Utility	Southern California Edison	Southern California Edison
PV system cost[1]	$9,500/kW-ac	$9,000/kW-ac
PV tilt[2]	35°	35°
PV orientation[3]	South	South
PV output adjustment	-10 percent	-10 percent
Operations and maintenance cost[4]	Not an input	$0.01/kWh produced
Utility rate escalation	Varies	1.5 percent
Payment	Home equity loan	Loan
Down payment[5]	10 percent	N/A
Loan life	30 years	30 years
Loan rate[6]	5.75 percent	5.75 percent
Tax status	Married, filing jointly	N/A
Taxable income[7]	$50,000 per year	Varies

[1] [*Wiser, et al.*, 2006]
[2] [*Convert Units*, 2009]
[3] [*County of Ventura*]
[4] [*Public Renewables Partnership*]
[5] [*Mortgage QnA*, 2008]
[6] [*HSH Associates Financial Publishers*, 2009]
[7] [*IDcide: Local Information Data Server*, 2009]

APPENDIX E
MITIGATIONS USED FOR TRANSPORTATION ANALYSIS

1) Mix of residential and non-residential uses

2) Presence of local serving retail

3) Transit enhancing infrastructure measures (public transit)
    a. Number of daily weekday buses stopping within ¼ mile
    b. Number of daily rail or rapid transit busses stopping within ½ mile
    c. Number of dedicated daily shuttles

4) Bicycle and pedestrian measures
    a. Number of intersections per square mile
    b. Percent of streets with sidewalks on one side
    c. Percent of streets with sidewalks on both sides
    d. Percent of arterials or collectors with bicycle lanes or, where suitable, direct parallel routes

5) Affordable housing

6) Transportation Demand Measures
    a. Free transit passes
    b. Secure bicycle parking
    c. Car-sharing
    d. Information provided on transportation alternatives (bus schedules, maps, etc.)
    e. Carpool matching
    f. Preferential carpool/vanpool parking

APPENDIX F
URBEMIS OUTPUT FOR TRANSPORTATION ANALYSIS

Project Name: East Area 1
Project Location: Ventura County APCD
On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006
Off-Road Vehicle Emissions Based on: OFFROAD2007

Operational (Vehicle) Emissions Estimates: Annual Summary

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (tons/year, unmitigated)	17.90	16.53	163.33	0.23	48.75	9.22	26,012.03
TOTALS (tons/year, mitigated)	15.17	13.73	135.43	0.21	40.41	7.64	21,568.47
Percent Reduction	15.25	16.94	17.08	8.70	17.11	17.14	17.08

Operational (Vehicle) Emissions Estimates: Daily Summary, Summer

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	96.72	81.42	875.82	1.36	267.09	50.57	147,355.76
TOTALS (lbs/day, mitigated)	82.71	67.53	726.14	1.12	221.48	41.92	122,183.55
Percent Reduction	14.49	17.06	17.09	17.65	17.08	17.11	17.08

Operational (Vehicle) Emissions Estimates: Daily Summary, Winter

	ROG	NOx	CO	SO2	PM10	PM2.5	CO2
TOTALS (lbs/day, unmitigated)	100.88	109.03	932.91	1.32	267.09	50.57	132,883.54
TOTALS (lbs/day, mitigated)	84.05	90.40	773.58	1.10	221.48	41.92	110,183.17
Percent Reduction	16.68	17.09	17.08	16.67	17.08	17.11	17.08