

SCENARIOS FOR SUSTAINABLE CONSERVATION
PLANNING AND DEVELOPMENT IN TEXAS

by

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ABSTRACT
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This thesis reviews sustainable conservation development patterns of land use for potential adoption by Texas cities and counties. It will include a summary literature and professional reports' review, market analyses, and interviews for both existing conservation subdivisions as well as sustainable developments. This information will be balanced with a typical market analysis of future conservation and sustainable development within selected Texas cities and counties, with the intent of properly designating a future land use plan and subsequent zoning maps that can withstand challenges by developers with regard to economic feasibility. Various stakeholders of the development process will be interviewed to determine their assessment of potential sustainable conservation development, including developers, builders, designers, and municipalities. Furthermore, the thesis will include sustainable conservation design and development research of two case studies within Texas: a large urban city as well as an area located within county governance. The purpose of this investigation is to diagnose different sustainable conservation design scenarios, particularly as they pertain to municipal code, county code, and other applicable state laws and development regulations. The overall intent of this thesis is to provide recommendations to municipalities for integrating sustainable conservation developments into the development fabric of Texas.

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CHAPTER 1
INTRODUCTION

1.1 Overview

Texas is a state which has had rapid population growth throughout its history. Recently, the 1990's saw the state's population increase by 22.8% to 20.9 million residents, the largest population growth of any decade. The growth during the 1990's propelled Texas past New York in becoming the second largest state in the nation, behind California. During this period, rural areas of the state showed reduced levels of growth, while metropolitan cities and counties accounted for 91.2% of the state's population increase, and 84.8% of the state's total population (Murdock et al. 2002, 5-6).

The population of Texas is expected to double by the year 2040, increasing to a population of over 42 million residents. Of the 20+ million residents expected during the next 30 years, over 75% are expected to migrate from other states and countries into Texas. Overall, Texas is projected to become larger, while having an older population. (Murdock et al. 2002, 8-12). Texas will have significant challenges to overcome in terms of the size and complexity of resources necessary to meet the population's needs. From a planning and development perspective, significant amounts of infrastructure will be needed to provide access to increasingly larger metropolitan areas.

In addition to meeting increasingly larger infrastructure needs, there will be a strong demand for additional housing units. This is due to the fact that, while the population of the state is increasing substantially, the average Texas household size continues to decrease in size, and is currently 2.7 persons per household (Murdock et al. 2002, 19-20).

In planning for this very large increase in necessary housing units, consider the current path Texas has taken and where it is likely to go if it continues this path. Texas is a state where

low-density suburban sprawl is the predominant development pattern. Suburban sprawl occurs where large amounts of inexpensive land are available, and the majority of developers build single use developments in an auto-centric pattern, in which all users must rely on their automobile for travel. These developers typically comply with municipal codes which mandate this development pattern, or, in cases within Texas county jurisdiction, develop in this pattern without any significant regulation authority by the counties themselves.

The current path of suburban sprawl development in the State of Texas is largely unsustainable in nature. Major reasons for this unsustainability include: resource consumption (lumber, associated carbon footprint, etc.), reliance on non-renewable energy sources, auto-centric design, lost work hours due to traffic congestion, and social problems as a result, such as family problems and increases in stress levels.

The objective of this thesis is to develop a balance in meeting a variety of planning and development ideas:

- Market Reality – The development pattern must make feasible sense economically in the current and future Texas real estate marketplace. Otherwise, it is unlikely that the development will ever get constructed.
- Sustainability – This term must have a definition which is broad enough to encounter the varied elements of sustainability, while being narrow enough to ensure that developments are truly sustainable. The foundation for this assurance has been laid by initiatives such as Leadership in Energy and Environmental Design (LEED) standards, and by organizations such as the Congress for the New Urbanism.
- Conservation – Conservation subdivisions have been developed in the United States for over 20 years. This land use pattern has strong potential in Texas in enabling the preservation of open space. This is crucial, particularly in urban metropolitan areas of the state, where open space is being developed at a rapid rate. Many city park departments

across the country have limited funds available to purchase adequate open space within the growing suburban fringes of metropolitan areas (Sherer 2006, 12).

This balance of economic market reality, sustainability and land conservation is required so that the State of Texas can meet its future challenges. Strictly considering the increased need for housing units and additional infrastructure would, by itself, justify strong shifts toward more sustainable methods of development. However, in addition to these elements, Texas is expected to be presented with another set of challenges in the future:

- Areas of Central and South Texas will likely be confronted by significant water supply shortages, as continued growth in urban areas has drawn down regional river and aquifer levels (Pasley 2008, 1-3).
- Air pollution has increased in Texas to the extent that Dallas, Houston and El Paso are classified as non-attainment areas by the Environmental Protection Agency, limiting their ability to obtain future funding for infrastructure. In addition, lost worker productivity due to respiratory illnesses among residents is a growing concern (Smith 1997, 791-792).
- Transportation problems already occur and may be exacerbated in the future if petroleum reserves are limited or not available, yet development patterns require the use of the automobile.
- The future of agriculture in some regions of Texas is questionable due to the aforementioned water concerns. In addition, agriculture in Texas can cause water problems as well due to fertilizer runoff into local watersheds. Also, the development of land in metropolitan areas will lead to more agricultural land being consumed. Strategic methods of effective agriculture for arid areas of South and Central Texas, possibly in coordination with residential neighborhoods, should be considered (Texas Water Matters Website 2008).
- Housing affordability will be an increasing concern in Texas due to the higher expected increase in population growth as compared to the expected increase in living wages.

Many of the above problems could be reduced by simply applying two land use principles: new urbanism and conservation subdivision development. New urbanist developments allow 'safe' schools, within walking distances from home, and also for building designs that are more compact. In terms of addressing water shortages, new urban villages tend to have smaller lot sizes, thus reducing significant amounts of water consumption for landscaping needs. In addition, some new urbanist developments such as Civano in Tucson, Arizona, have employed mechanisms to preserve water, such as rainwater harvesting techniques. Furthermore, new urbanism addresses pollution by decreasing residents' reliance on automobiles for travel. In new urbanist 'Transit-Oriented-Developments', dense development is placed in nodes adjacent to transit, such as Bus Rapid Transit or light rail, feasibly allowing residents to live without owning a vehicle.

In addressing agricultural concerns, conservation subdivisions yield promise for the state in terms of allowing smaller, more neighborhood scale farms to occur in collaboration with residential development. Finally, affordability can be addressed in both land use patterns, primarily by including a diversity of housing options so as to include units such as duplexes, cottages, and apartment/condo units where possible to increase affordability.

Given these core premises for this thesis, a more in depth analysis is suggested in order to determine the most effective planning methods. Chapter 2 is an analysis of existing sustainable developments and conservation developments in the United States, and describes current research. Chapter 3 focuses on the potential for future sustainable and conservation developments in Texas, and defines 'sustainable conservation development' as a future land use pattern for the State of Texas. Chapter 4 analyzes two 'sustainable conservation development' case studies, one located in a rural area of Texas within county land use jurisdiction, and one located in an urban metropolitan area of Texas within city land use jurisdiction. Finally, Chapter 5 presents both conclusions and recommendations for the future.

CHAPTER 2

OVERVIEW OF EXISTING SUSTAINABLE AND CONSERVATION DEVELOPMENTS

The first element of research conducted in this thesis is an overview of the existing pattern and models of both sustainable and conservation design, nationwide. This research includes literature on these development patterns, professional reports' review, and market analysis of trends of these development patterns.

2.1 Conservation Planning

2.1.1 Summary Literature

Conservation Design was largely started in the Northeast region of the United States during the 1970's. During the past fifteen years, they have been developed in other regions as well, such as the Northwest, Southeast, and in Texas. The origin of what became the conservation subdivision land use pattern was based in an idea of clustering development into pockets, while preserving the most critical areas (Kendig, 2008). However, it was not until the early 1990's that conservation subdivision design came to fruition.

This is a land use pattern in which a site for potential single-family residential development is redesigned with a focus on preserving conservation areas. Typically, 50-70% of the site is conserved as open space, while the remaining 30-50% is developed. The same number of lots is then compressed into the smaller site by relaxing the minimum lot size so that smaller lots can be utilized. Thus, the overall development density remains the same (Arendt 1996, 6-7).

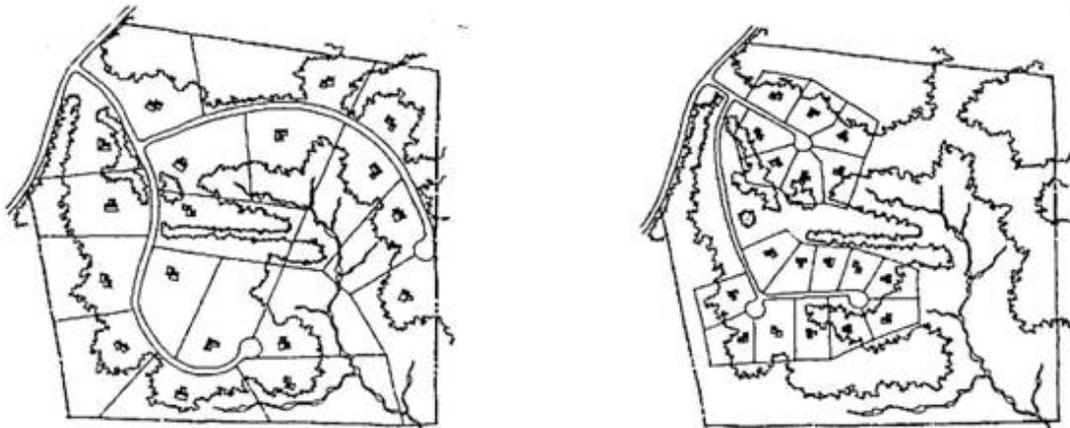


Figure 1 Conventional and Conservation Subdivisions
Source: (Village of Seville Website 2008).

In the example shown above, on a 36 acre site, conventional development (shown at left) yields a development density of 1 unit per 2 acres, thus allowing 18 homes to be developed. With the same site developed as a conservation subdivision (shown at right), 50% of the property will be preserved as a “conservation easement”, while the remaining 50%, or 18 acres, is developed at 1 unit per acre, thus yielding a total of 18 possible houses.

Since this thesis deals directly with conservation, it is important to understand the definition of a “conservation easement”. A typical definition from the Nature Conservancy (2008) is below:

A conservation easement is a restriction placed on a piece of property to protect its associated resources.

The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development from taking place on the land in perpetuity while the land remains in private hands.

An easement selectively targets only those rights necessary to protect specific conservation values, such as water quality or migration routes, and is individually tailored to meet a landowner's needs. Because the land remains in

private ownership, with the remainder of the rights intact, an easement property continues to provide economic benefits for the area in the form of jobs, economic activity and property taxes.

A conservation easement is legally binding, whether the property is sold or passed on to heirs. Because use is permanently restricted, land subject to a conservation easement may be worth less on the open market than comparable unrestricted and developable parcels. Sometimes conservation easements will enable the landowner to qualify for tax benefits in compliance with Internal Revenue Service.

With the conservation subdivision pattern as explained above, there are numerous beneficial elements that enable this development pattern to be a useful and effective solution for municipalities, citizens, and developers alike. Each component within the process is explained below:

2.1.1.1 Landowners

The bottom line for landowners is usually selling their land in order to make a profit, but it is not always so cut and dry. Many development tracts have long histories of farming, ranching, or have features with historical significance. As development creeps into their area, many landowners see the writing on the wall, but are often still reluctant to sell (Pers. Obs. - Clear). However, in a conservation subdivision, although half of the land will be developed as houses, the most scenic and environmentally important parts of the property can be protected. This can be an important mitigation for landowners to know that at least half of their property will remain protected, considering their family may have owned the property for over 100 years or so. It is also worth noting that, in some cases, existing farming or ranching operations can be continued on a smaller amount of the property (Arendt 1999, 93-94).

2.1.1.2 Developers

The strongest potential opportunity for developers is the increased marketplace which conservation design provides as opposed to conventional design. Research has proven that

conservation subdivisions outperform conventional ones by selling for higher prices, by selling faster, and by performing more soundly in down financial markets. Conservation subdivisions have proven to sell for the same price, on average, as conventional lots which are three times larger. Conservation subdivisions have generated an average of 14.4% higher lot prices due to these lots being adjacent to open space, thus termed 'premium lots' (Clear 2005, 1-3).

Other significant benefits to the developer include the decreased infrastructure necessary in conservation subdivisions. Oftentimes, these developments are possible with shorter road lengths, narrower road widths, and grass swales instead of expensive curb and stormwater systems. This can constitute a substantial savings ranging in the tens or hundreds of thousands of dollars, depending on the scale of the project (Arendt 1996, 10). Furthermore, by utilizing conservation subdivisions, municipalities are often willing to permit the developer to provide fewer road connection 'stub outs', and may generally be more supportive of this development pattern in terms of zoning, plan review and permitting considerations (Arendt 1996, 9).

2.1.1.3 Municipalities

Perhaps municipalities benefit the most financially from conservation subdivisions. These developments have proven to have increased real estate value over time versus conventional developments, translating into higher tax appraisals and thus more revenue for cities, counties, and school districts (Arendt 1999, 89-90). They also stand to benefit significantly from increased open space, usable for its citizenry at no cost to the municipality. Oftentimes in conventional developments, cities and counties must purchase parkland as best they can in order to service the community, often made difficult in the common urban sprawl development pattern. Many times parkland acquired is simply undevelopable land which is mostly steeply sloped or in the floodplain. Municipalities also will usually have less infrastructure to maintain, thus reducing costs. In a network of conservation subdivisions extending throughout a municipalities' area, significant interconnected greenway corridors can be created which provide free recreation, scenic benefits, and protection of flora and fauna

habitats. In consideration of areas of groundwater recharge, areas subject to the urban heat island effect, areas which clean polluted runoff water, and areas which prevent downstream erosion, conservation subdivisions strongly benefit communities environmentally (Arendt 1999, 80-81).

2.1.1.4 Citizens

Perhaps the least understood benefits of conservation subdivisions are the benefits to the citizenry. Through the creation of strong communities, citizens can benefit from the strong support that usually complements these communities, such as strong school districts and employment opportunities. (pers. obs. – Clear) Citizens can also benefit from the various intangible benefits of proximity to large amounts of open space. They have the ability to connect to the land in ways which are impossible in conventional developments. Research has proven that proximity to green space can be extremely important in maintaining psychological health (Sherer 2006, 13-14). Modern Americans and their children are largely cut off from the natural world. Conservation subdivisions allow a reconnection to this natural environment, through long term proximity to it.

2.1.2 *Professional Reports' Review*

2.1.2.1 Fields of St. Croix

The Fields of St. Croix is a conservation subdivision located in Lake Elmo, Minnesota, about 20 minutes from downtown St. Paul. It received the 1998 Land Use and Community Award from the Minnesota Environmental Initiative. 60% of the 226 acres was devoted to open space through provision of village greens, playing fields, agriculture, wildflower and native grass prairies, woodlands and ponds (Arendt 1999, 95-97).

The design for this development enabled scenic views of the property. The city enabled the developer to build this project by incorporating an open space development ordinance into its code. The development density was 100 homes on 226 acres. The design included miles of multi-use trails. Sales have been strong, and 80% of the first 45 lots sold within the first six months. Lots range from ¼ acre size to 2.3 acres, and prices range from \$44,000 to \$150,000,

with the most expensive 'premium lots' being located alongside the woodlands, pond and prairie areas (Arendt 1999, 95-97).

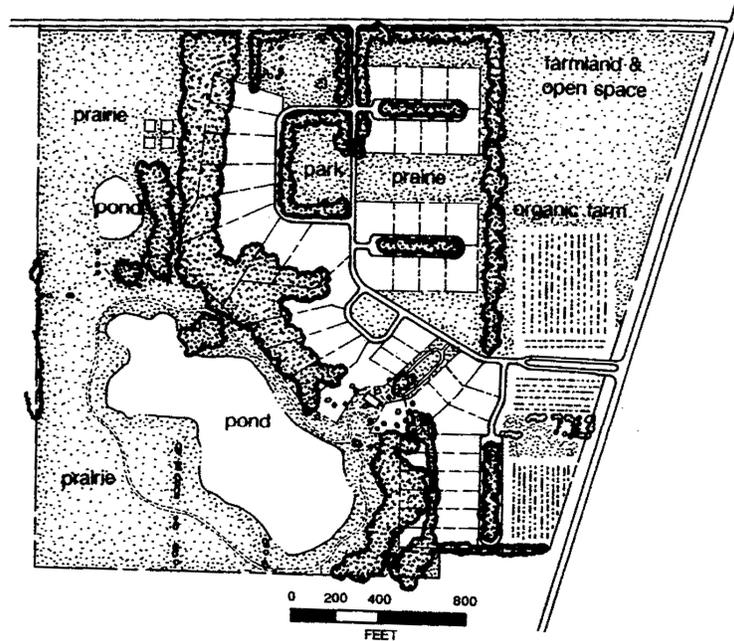


Figure 2 Fields of St. Croix Conservation Subdivision
Source: (Arendt 1999, 96)

A portion of the property is retained as productive farmland. Community-supported agriculture is practiced on this tract, where organically grown vegetables are produced for both residents and other townspeople for a yearly fee. Excess produce is purchased by nearby restaurants. For wastewater treatment, constructed wetlands provide a viable and superior solution to the standard septic system. Open space is owned by the community association, and is protected by easements held by the Minnesota Land Trust (Arendt 1999, 95-97).

2.1.2.2 Prairie Crossing

Prairie Crossing is an Illinois conservation subdivision of 317 single family homes on 667 acres, constructed in the early 1990's. 70% of the property is retained as open space. This open space is comprised of active farmland, wetlands, a lake, 3 ponds, and several community greens. Home lots range from 6,000 to 20,000 s.f. All lots abut open space, a significant feat in conservation subdivision design. Homes are built with superior insulation which cuts the cooling

and heating costs in half. All homes further conform to the US Department of Energy's requirements for energy efficiency through its Building America Program (Arendt 1999, 97-99).

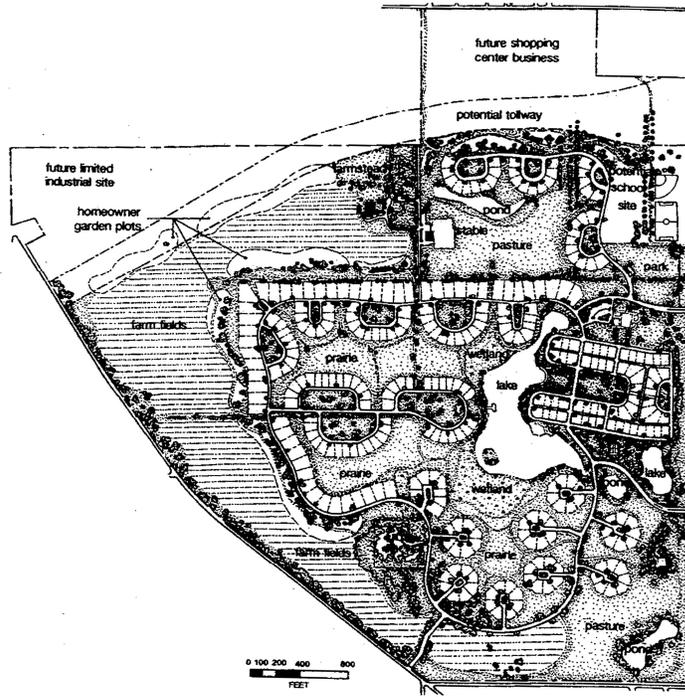


Figure 3 Prairie Crossing Conservation Subdivision
Source: (Arendt 1999, 98)

The open space is maintained through a management plan prepared which delineates the best management practices for the open space. The homeowners association pays these maintenance costs. In addition, an endowment fund receives one half of one percent of the sales price each time a house is sold (Arendt 1999, 97-99).

2.1.2.3 Village Homes

Village Homes is a unique conservation subdivision developed in the late 1970's in Davis, California. One of the first of its kind, it set high standards for green development. The site is composed of 210 single family homes, 30 attached rental units, a business office, restaurant, and 2nd story apartments on 60 total acres. The single family lots average 4,500 s.f., while 40% of the overall land area is protected as village greens, playing fields, orchards and a vineyard (Arendt 1999, 112-114).

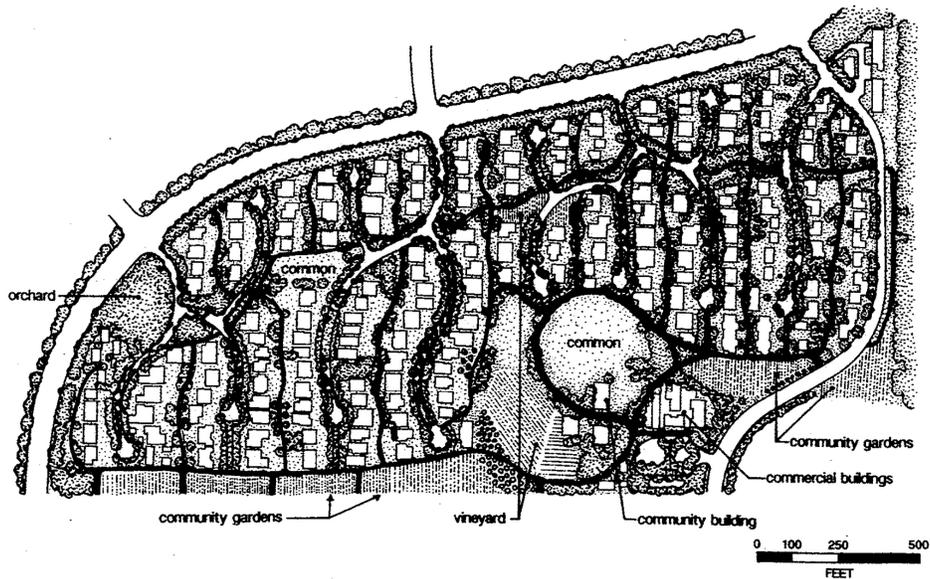


Figure 4 Village Homes Conservation Subdivision
 Source: (Arendt 1999, 113)

House price sales average 13% above those in nearby conventional developments with larger lot sizes. Houses which go on the market at Village Homes, for instance, are sold twice as fast as the average home in Davis. It was acclaimed by Davis' top realtor, Coldwell Banker, as the 'Most Desirable Subdivision in Davis'. Streets were designed along East-West axes in order to ensure solar capture potential. The majority of window glazing faced south, and deep roof overhands to the south prevented summer sun penetration. Winter sun, however, could reach the concrete slab floors in order to provide daytime heating. Solar panels heat the tap water. Overall, 50-75% of heating needs are provided by direct sunlight. (Arendt 1999, 112-114).

Homes are arranged in clusters of eight homes around their own semi-common area. Substantial community gardens, fruit trees, and flower gardens are provided surrounding this common space. The residents regularly host pot-luck dinners for the community, and there is an overall sense of community within the development (Arendt 1999, 112-114).

2.1.3 Market Analysis

Conservation subdivisions have proven successful in the real estate marketplace when competing against conventional subdivisions. Indeed, many of these subdivisions have taken off like a rocket. Realen Homes, a Philadelphia developer, has posted record sales in its 'Farmview' development in Bucks County, Pennsylvania. These lots are also 1/2 to 1/3 of the size of standard homelots. It was the fastest selling subdivision in its price range in the entire United States throughout 1996. Another study, which compared homes in a conservation development to those of a conventional development, determined that the conservation subdivision's homes appreciated at a 22% annual rate, compared to a 19.5% rate for the standard homes, which translated into an average difference of \$17,000 per home. This higher rate of return was in spite of the fact that the conservation lots were typically 1/2 the size of the standard lots (Arendt 1996, 10-12).

Yet another study, conducted by Nichols, found that natural areas had more of a positive impact on the property values of nearby houses than other land uses did. Within 1500' of natural areas, home properties increased by an average of \$10,648, while the added value of other land uses had a lessened affect: \$8,849 increase for golf courses, \$5,657 for specialty parks, and \$1,214 for urban parks (Nicholls 2005, 324-329).

In Austin, three new subdivisions were studied to determine the effect of an adjacent greenbelt on the home's property values. Using regression analysis within a ½ mile distance of the greenspace, property values increased significantly in two out of the three areas. The third area's value declined, although it should be noted that open space in this area consisted of thickly vegetated ravines which lacked attractive views, whereas the others had distant views of stately live oaks. Therefore, it is not enough simply to have adjacent open space, but it must be attractive land which enhances the living experience of the residents (Nicholls 2005, 339). The conclusion of the Austin study was that, from the perspective of urban planning, open space areas "should be recognized as valuable components of well-designed urban areas" (Nicholls 2005, 339-340).

These increased property values eventually translate into added revenues for cities as well. The market data, overall, suggest that conservation subdivision design and the abutment of lots to natural areas are very successful in the real estate marketplace, and therefore very beneficial to the real estate sector as well as municipalities through increased property values in these developments.

2.2 Sustainable Development

2.2.1 Summary Literature

Sustainable development can be a very broad term. In this thesis it is defined as *a method in which resources are conserved to a large degree throughout the development process*. These resources can include energy resources, material resources, and environmental resources during the construction process as well as throughout the life of the development. The goal is to develop in a manner which uses manmade and natural resources efficiently and responsibly. The different elements can be categorized into three scales: *large-scale planning*, *small-scale site design*, and *architectural design*.

Large-scale planning deals with effective land use planning which enables a sustainable pattern of development. An example of sustainable large-scale planning is Transfers of Development Rights which enables higher densities in the inner city and lower densities coupled with open space on the urban fringe, thus enabling an efficient provision of infrastructure resources among citizens. *Small-scale site design* relates to the development site itself by ensuring that there is an effective use of existing resources. An example would be the placement of trees and shrubs in areas around houses in order to maximize breezes while minimizing sun penetration. The third sustainability element is *architectural design*, constituting the majority of sustainable construction aspects. Architectural design includes the choice of materials, the choice of design, and the infrastructure used to serve the building. Below are some examples of sustainable design at the small-scale site design level:

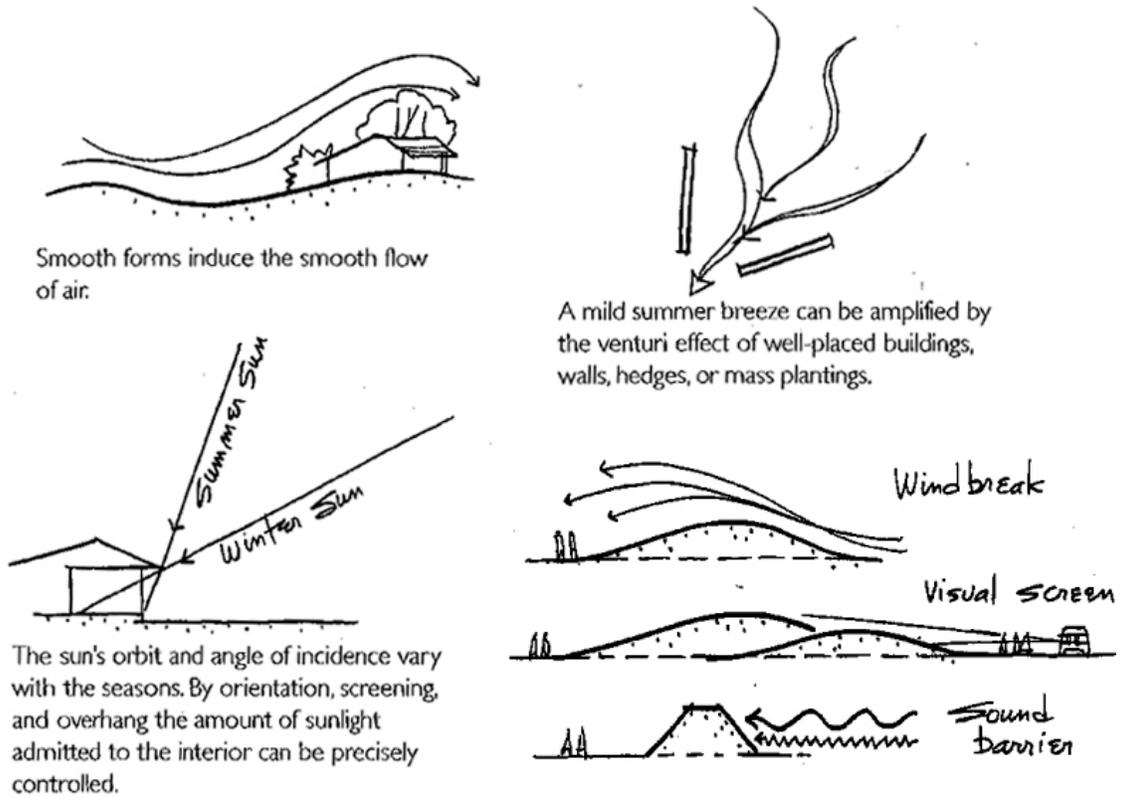


Figure 5 Sustainable Site Design Examples
 (Source: Simonds 1998, 31, 47)

Sustainable development has been practiced, it can be argued, for as long as humans have existed. Cave and cliff-dwelling humans were indeed living in a manner which provided them with an effective and responsible manner of living. Cliff dwellings provided humans with shelter from climatic extremes, and from predatory animals. Also, these habitations already existed and thus took no, or few, resources to create. In other areas of the globe where caves were not abundant or effective shelter, humans built whatever shelter most efficiently and effectively fit their needs. Often, these shelters were a matter of life or death. In the United States, Native American tribes constructed dwellings of many effective materials, including adobe, animal leather, wood and stone. In extreme desert areas of the Southwestern U.S., adobe construction was used to offset the intense daytime heat, nighttime cold, as well as

drying winds and dust storms. Thick walls, high ceilings, wide overhangs, few windows and light-reflective colors were used in order to accomplish this (Waldman 2000, 57-60).

In the warm humid region of the Southeastern United States, dwellings had to withstand heavy rainfall and high humidity levels, and were constructed in order to provide cooling breezes. (Waldman 2000, 59). These primitive dwellings were very effective solutions to the local climate, and took into account all three scales of sustainability. Large-scale planning was used to determine where the tribe located their settlement. In some cases, settlements were temporary such as the 'teepees' of the North Texas Plains, enabling the tribe to move into areas with the most abundant natural resources at that particular season (Waldman 2000, 57). On a small scale, a hut might be placed nearby a stream to provide a water source, and under the shade of large trees. On the architectural design level, the aforementioned materials of adobe, stone, wood or animal skins were used depending on what was available and effective for that particular area (Waldman 2000, 57, 60).

Sustainable construction was also practiced after European settlement of America. Often times this development learned and mimicked the Native American designs by using local materials and building in a practical manner with regard to the local climate. In the San Antonio missions, for example, Native Americans built stone and adobe missions for the Spanish. Over the centuries, however, lumber became more readily available and became the most common building material in the majority of Texas regions. After World War II, the explosion of subdivision development surrounding the central cities meant that many homes were developed quickly and at an affordable price. This fostered the era of cheap building materials, and their proliferation has ensued up to the present time. Over the years, products were manufactured which were cheaper and more shoddily constructed than in years past, spurring numerous problems (Soja 2000, 131-136).

As an overview of recent problems associated with these shoddily constructed homes, consider these brief recent examples: a family who purchased a \$66,000 home then discovered mold four months later. As another example, a homebuyer found crumbling concrete and falling

brick months after purchasing a condominium. As another example An Oklahoma couple faced \$60,000 in foundation and roof repairs in a three year old house they purchased for \$127,000 (McQueen 2004, 26-31).

Construction defect lawsuits are also increasing in the United States. According to Alan Mooney of a consulting firm, 15% of all new homes include serious defects. Mooney suggests that the building boom of the 1990's meant that demand for homes was higher than supply of quality labor and quality materials. In 2002, the top 100 U.S. homebuilders sold 1,000 new homes per day, a total of 1/3 of all new home sales in the U.S. (McQueen 2004, 26-31).

Perhaps in part due to this abundance of shoddily constructed housing, awareness of sustainable building design and construction has become much stronger within the past 20 years. This has been a movement spearheaded by those who have developed these technologies, by architects as well as citizens striving toward a more responsible path to development. The United States Green Building Council (USGBC) developed a program titled 'Leadership in Energy and Environmental Design' (LEED) in which credits could be granted for sustainable developments. The aforementioned wide range of factors in sustainability are each considered in order to credit points for developments. This push for sustainable development arrived in tandem with technological advances which have enabled on-site production of energy resources. These modern elements include solar panels, wind turbines, and numerous other devices. Certain areas of the country, such as California and the Pacific Northwest, have seen the strongest proliferation of construction with advanced sustainable technologies and building materials. In order for that to occur, however, states and municipalities integrated these elements into their development code to allow for alternative building methods.

One of the most important aspects of sustainable design is the choice of the building materials. Many sustainable building materials exist, some of which are relatively new and some of which are very old. These materials are analyzed in Appendix B of this thesis and ranked for their performance in Central and South Texas, and for the state in general. The top four sustainable building materials for the Central/South Texas region are listed below:

1. Compressed Earth Block – Excellent for the Central/South Texas Region
2. Papercrete – Excellent for the Central/South Texas Region
3. Rammed Earth – Above Average for the Central/South Texas Region
4. Strawbale – Above Average for the Central/South Texas Region

2.2.2 Professional Reports' Review

2.2.2.1 Tierra Madre

Tierra Madre is a community of straw bale homes located in Sunland Park, New Mexico. It consists of 20 single-family homes. The beginning of this community was a Catholic Church, built in 1995. Area residents and church members were determined to cooperate on improving the housing situation in the area, which consisted of area residents living in substandard mobile homes with poor insulation and high cooling costs (Bloom 2002).

The homes were constructed of straw bale walls. 60% of the home's labor was provided by the families who purchased them, including painting, roofing, tiling, wall construction, and more. The prices ranged from \$42,000 to \$45,000 for a 1,500 square foot, 4 bedroom, 2 bath home. The mortgage translated to \$200 per month. Homeowners worked 30 hours per week during weeknights and weekends. Homes were inexpensive in large part because the land for Tierra Madre was leased for \$1 from the government for 99 years (Bloom 2002).

Wood was used for load-bearing support, but straw bales comprised the walls, translating into \$2,000 in savings over standard wood-framed homes. The insulating difference is R30 for strawbale construction versus R15 insulating value for conventional stick-built construction. As for heating and cooling costs, they are much lower than in average American homes. This is due to the strawbale material, light colored walls, and roof overhangs which keep out the harsh summer sun. In the winter, the sun is at a lower angle, and shines through the large front windows, thus heating the tile floors which radiates heat into the home (Bloom 2002).

A roof-top solar water heater heats up a 40 gallon water heater, meaning that the home's electric water heater rarely even needs to come on during the wintertime. Another feature of the water system is a separator which diverts black water (toilet waste) from grey water (shower and kitchen effluent). Black water goes into the sewer system but grey water collects from multiple homes and empties into an underground cistern. A solar powered pump irrigates plants with this water on the xeriscaped landscape areas of the subdivision (Bloom 2002).

The finished development will comprise 47 homes on 20 acres. Residents plan to construct a community center, a playground, and a community garden as well (Bloom 2002).

2.2.2.2 Stablewood Springs Resort

Located in Hunt, Texas, Stablewood Springs is a resort facility constructed of sustainable building materials. The main building material is Compressed Earth Block (CEB). In addition to constructing all of the resort 'villas' of CEB, the development also offers 'green' housekeeping products, a linen reuse program, low emission transportation alternatives, and locally grown organic produce in its restaurant (Stablewood Springs Website, 2008). As for the CEB construction, 60-80% of villa building materials were created on site. CEB, researched in detail in Appendix B, was coated with a natural lime plaster mixture which was applied to the interior and exterior. The plaster is breathable, preventing mold by not allowing moisture to build up or cause mold problems (Stablewood Springs Website, 2008). Stablewood Springs Resort is attempting to obtain the U.S. Green Building Council's LEED certification. In addition, the resort has joined the World Conservation Union in adopting its definition of ecotourism (Stablewood Springs Website, 2008).

2.2.3 Market Analysis

There are many factors which existed during the previous generations which would lead to an inability to compare a conventional subdivision to a highly sustainable one. For instance, in terms of cost effectiveness, it is easy to determine the cost of conventional construction. However, it is difficult to determine the environmental footprint of this method, and therefore

does not evenly compare with sustainable materials. In general in Appendix B, sustainable materials were examined for their ability to enable construction which utilizes a very minimal environmental footprint, with a minimal need for powered equipment and a minimal need for labor, thus enabling construction which is affordable, sustainable, and as in Tierra Madre, can even be produced feasibly by a group of individuals looking to build their own community of homes.

Price points are used where possible, such as in the Chapter IV case studies, to indicate the difference between the cost per square foot for a conventional home versus the cost per square foot for a sustainable home. More often than not, however, the highly sustainable homebuilder may use recycled products of one sort or another (i.e. – recycled butcher block countertops) which can eliminate the usefulness or per-square-foot comparisons between the two methods. Also, in Chapter IV, price points are included for sustainable do-it-yourself construction, which are highly unlikely in conventional construction due to the difficulty of the building process. Do-it-yourself construction with sustainable materials, however, is much more feasible due to ease in the construction process. These price points will effectively outperform conventional construction and lead to an overall affordable housing approach (pers. obs. Clear), especially when teamed with the 'incremental housing' approach, described in greater detail in Appendix C.

CHAPTER 3
OVERVIEW OF FUTURE SUSTAINABLE CONSERVATION
DEVELOPMENT IN TEXAS

In this chapter I will delineate future potential of conservation subdivisions and sustainable developments in Texas. In addition, I will define a new development alternative which combines these development patterns.

3.1 Conservation Planning

3.1.1 Analysis

In Texas, the applicability of conservation subdivisions, which have proven their effectiveness in the U.S., is enormous. Possible future conservation designs can be competitive with conventional subdivisions in the real estate marketplace, as they have been in other parts of the country. (pers. obs. - Clear) Conventional development, termed suburban sprawl, is indeed suffering in many Texas markets, and the future is uncertain for this unsustainable land use pattern. It has been proven time and time again that, when conservation subdivisions are built nearby conventional subdivisions, they sell faster and for higher prices. They tend to increase in value over time at higher rates than conventional subdivisions, and they tend to stay on the marketplace for approximately half the time that conventional homes do. Therefore, future conservation subdivisions have these essential advantages to work with in the marketplace. However, more advantages can be uncovered with careful consideration.

One other significant advantage takes place when density is increased through provision of mixed-housing types. Conservation subdivisions, by their very nature, are designed on lots which are significantly smaller than conventional homes. This allows conservation subdivisions to more easily incorporate mixed housing units such as duplexes. Increasing the

number of duplex units in a conservation design can increase profits for the developer, while also offering affordable housing for residents. This is also advantageous to citizens, and meets density needs for future Texans. According to The Center for Demographic and Socioeconomic Research and Education, Texas will have an increasing need for dense development in the near and long term (Murdock 2002, 19-20). Demand is arising from both young, professional 'empty nesters', who are marrying later in life, if at all, and also by the retiring 'baby boomer' generation. This demand naturally fits into a conservation design, since these groups strongly value a dense housing arrangement with a small, low-maintenance or even no-maintenance landscapes.

Another advantage of Conservation Subdivisions, when developed with mixed-housing such as duplexes, is that it is more feasible to add a mixed-use component to the development, such as an area in the development for offices and retail. This enables flexible living, as residents can walk and bike to local shops, as well as an easy 'pedestrian' commute to work. The quality of life possible in this new urbanist pattern allows for significant increases in property values versus conventional subdivisions. In general, residents are willing to pay significantly higher amounts in order to live, work and shop in the same community (pers. obs. Clear).

If the desire is for a mixed-use, mixed-housing conservation design, a few interrelational factors must be considered. First, in a typical conservation design, 50-70% of the land is preserved, with large percentages of homes abutting open space, thus yielding large percentages of premium value lots. When duplexes are added to this mix, it does not significantly affect the layout. However, when office and or commercial development are added to the mixture, it can affect the layout. Commercial and office development does not benefit from the adjacency to open space as does residential development. (pers. obs. - Clear) However, with the aforementioned benefits which they can provide for conservation designs, their incorporation is important if the subdivision can support it. Therefore, it is important to

locate the office and commercial portions in the most reasonable areas within the development, and not necessarily in areas adjacent to open space.

In over viewing these advantages of conservation designs, it is important to also realize the many advantages and versatility of the conservation area itself. There are a multitude of opportunities for the open space, depending on the local geography and climate. In some locations, orchards are feasible; in other areas, vegetable rowcrops work better. In other areas, pure conservation areas can take the form of prairies, wetland bogs, forests, lakes and other forms of conservation. As far as increasing the value of the lots, it has been proven that scenic views and open space yield higher values for adjacent lots than do open space areas which are unattractive (Clear 2005, 2-3).

One alternative, fast growing farming method which yields promise for the State of Texas is the aquaponic farming method. This method allows for agriculture to be concentrated in a small area, using less water, while allowing the remainder of conservation acreage to be managed as undisturbed preserve areas (forests, prairies, etc.). The arrangement can be mutually beneficial to both residents and farmers, and can help farmers to stay in the agricultural trade at a time when the occupation is losing ground to large commercial farms. In South Texas, dryland farming is typically hindered by severe droughts, and often challenged by dwindling groundwater aquifer levels. The aquaponic method yields strong promise as a water saving alternative with production of fresh, lean meats as well as organic vegetables, sold to adjacent residents, and grown for almost the entire year. Aquaponic farming is discussed in further detail in Appendix C of this thesis.

3.2 Sustainable Development

3.2.1 Analysis

Future sustainable development potential in Texas is very strong. As energy costs rise, problems arise with shoddy tract-built housing, people living further away from work and thus increasing commuting requirements, and as sustainable technology advances, the groundwork for a paradigm shift to sustainable development is starting to form. Sustainable development

can occur in many different forms. In the second chapter of this thesis, the different physical manifestations of sustainable development were discussed. These techniques can be applied in different settings as well. In urban settings, for instance, sustainable development is perhaps best thought of as a cycle in which sources must be balanced with resources. Pliny Fisk, environmental scholar and cofounder of the Center for Maximum Potential Building Systems in Austin, terms this approach 'Eco-balance Planning'. It is an approach with strong applicability to urban developments, and has currently been planned for within the Verano development in South San Antonio, Texas

Verano is a large mixed-use planned development in San Antonio, which has not yet broken ground. It is located in the southern part of San Antonio, less than ½ mile to the East of the urban case study site for this thesis. More than 8,000 total residential units and 3,000,000 s.f. of mixed-use retail development is planned. The development is planned as a new-urbanist community, with development divided into urban transects (T4, T5, T6) and more rural transects (T1, T2, T3). The community is planned as a walkable, pedestrian-oriented design, and is adjacent to a large planned Texas A&M campus to the South. The development is receiving credits for sustainable design elements from the City of San Antonio. These sustainable design elements were based on the LEED certification criterion (Fisk 2008). The developers of the project consulted with Pliny Fisk to conduct an ecological sustainability analysis based on the 'Eco-balancing' principle, defined by Fisk (2008) below:

Eco Balance Planning can be defined as a design method based on balancing resource use at various scales from home to community. It incorporates the life cycle structure by balancing between the sourcing and the re-sourcing of given life support needs in an ecological context. We are finding the result of multiple life cycle integration provides a potential level of productivity beyond balance itself.

Balance occurs in many allied disciplines whether we apply it to economics or physics or how we simplify the complex webs in ecosystems. The

initial step in creation of life as we know it is the conversion of sunlight into flora that in turn supports the fauna that converts and re-sources the nutrients back into the plants.

Through utilization of this eco-balancing principle, Fisk has developed a plan for the Verano development in which, on the T3 level (low-moderate density mixed use development), eco-balancing proved successful in generating five crucial energy needs from the site itself: energy, food, water, air and materials. This significantly limits the environmental footprint of this development, effectively to the site itself in some cases.

In terms of air, the development can compensate for many CO₂ emissions which are generated on the site by the planting of numerous trees on site and utilization of existing trees. In terms of water, the development plans to obtain significant amounts of water through the capture of rainwater on building rooftops, and is able to provide all water needs for T3 residents from the site itself. In terms of energy, all energy necessary for T3 residents is produced on the site itself, by provision of solar panels and other technology. In addition, all food needs for T3 residents, assuming they are vegetarian, can be produced on the site as well. Finally, materials can be utilized which are low footprint, in an attempt to construct with as minimal amounts of embodied energy as possible.

Overall, the large determinant for success in balancing these sources and resources, particularly the food resource, is the adjacent planned Texas A&M-San Antonio campus to the south of the site. This campus will include an agricultural research component, able to grow significant amounts of food for Verano residents. Therefore, as identified by Fisk (2008), it is the adjacency of a certain amount of open space nearby this mixed-use new urban development which truly enables eco-balance planning, and the balancing of all resources, to take place.

This planned development signals a dynamic shift in sustainability in American residential construction, if it is built according to the principles of eco-balancing (Fisk 2008). At

current, the plan is to attempt to meet at least two category needs on site: water and energy. The overall financial profit projections for the development, and its economic impact on the surrounding area, are considerably strong, making this planned development a substantial step in the right direction towards sustainable growth and development for Texas. Thus, sustainable design for the urban case study utilized in this thesis will largely base its sustainability considerations on the principles of eco-balance planning.

For rural settings, sustainability needs to consider eco-balancing as well, but substantial differences exist between urban and rural developments as far as how to achieve that goal. For instance, sustainability in rural settings can perhaps best be achieved in some cases by leaving the municipal grid altogether. Termed 'Off-The-Grid' (OTG), this method is defined below:

Off the Grid is not a system of development which is 100 percent independent from municipal utility ties, but it instead defines the use of sources and strategies that integrate one or more systems that are not reliant upon the municipal infrastructure.

(Source: Ryker 2007, 12)

Technologies exist today to enable modern living to take place utilizing stand-alone systems. By not having a connection to the municipal grid, significant expenditures on energy and natural resources can in some cases be avoided. If these costs are typically paid by the developer, or paid jointly by the developer and the municipality, it is a significant savings to be considered. In many cases, an off-the-grid approach enables the developer to either: 1) pass the cost on to the consumer, or, if sustainable affordable housing is the desired goal, 2) to look into local, state or federal grants which are offered for affordable housing or sustainable housing. Currently, significant tax incentives are offered for provision of solar panels and sustainable materials in housing, and it is expected for this tax break trend to continue to increase (Pers. obs. – Clear). However, it should also be noted that an OTG approach is not feasible in all cases, but rather it depends on the particular confines of the site and adjacent infrastructure needs and provisions.

One possible risk to consider with regard to off-the-grid subdivisions, however, is the concern of promoting development in great distances from the urban core areas, thus increasing Vehicle Miles Traveled (VMT), traffic congestion, and thus environmental pollution and a strain of municipal services. This is a significant concern, and against a core tenet of sustainability in general. Dense cities are a very significant aspect of sustainability due to a concentration of resources and services. In fact, it is a valid question to ask whether off-the-grid sustainable development is contradictory to begin with. First and foremost, it is understood that off-the-grid systems are beneficial to developments which are outside of core urban areas, but that they may not be appropriate in urban areas. One reason is because, in dense urban areas, municipalities can construct a square mile of infrastructure to serve a much larger population than in rural areas, making for a more efficient use of resources. It is therefore not practical to have stand alone systems when economies of scale can be created.

When cities plan responsibly for their future energy needs, (such as San Antonio's recent commitment to connect to the West Texas wind power grid as well as their commitment to construct a solar plant in the region) it makes for a sustainable future for urban areas. It can be termed the 'Green Grid', and is more appropriate in urban settings than an off-the-grid urban approach, in which each homeowner must maintain their own solar array, wind turbine, or other system. In some urban areas such as San Antonio, grid intertie systems are permitted, where solar power provided by private users for their homes can be absorbed into the municipal power grid. Utilities in these cities offer buy back programs, where excess energy generated from private systems is purchased by municipalities, thus minimizing energy waste while providing a sustainable power source for additional residents. The difference between what the resident's solar array produces and the resident's overall power needs equals their monthly energy bill. This buy back program eliminates the need for a costly battery bank system which stores energy in solar producing times for use in non-productive times. The battery banks typically cost \$20,000 per home, and will be discussed in greater detail in Appendix F.

In considering the inherent sustainable efficiency of urban areas, we must consider the inherent sustainable inefficiency of rural areas, especially in modern times. Typically in sun belt areas, affordable housing is available in areas of great distance from urban areas, where land is cheaper and more readily available. The notion of driving far enough away from the city to qualify for a mortgage has enabled American homeownership in places far removed from the urban metropolis. This has occurred with increasing frequency during the past 25 years in the Los Angeles region of California, with cities springing up 2 hours away from Los Angeles. Even with affordable housing and cheap gas prices, significant problems still occurred as a result of automobile dependency and long commutes. Parents were spending more time making long, stressful commutes and less time with their families, creating social problems among community youth, such as increases in drug and gang activity. Now that gas prices have increased substantially since the 1990's, homeowners living at great distances from their jobs became prisoners to their cars (Soja 2000, 243-251).

With these problems attributable to the search for the affordable American Dream, at a great distance from the metropolis, the American sprawl pattern was perpetuated. By launching a movement towards off-the-grid, rural subdivisions, the potential for the perpetuation of sprawl's past problems could become strong. Developers, eager to develop rural greenfields which are inexpensive for them to acquire, could also market a 'green message' to the endline consumer. Even if VMT were one day not a concern due to sustainable automobiles (fuel cells, electric), the concerns of traffic and infrastructure needs would yield this plan unsustainable.

Another component that needs to be planned for is the growing potential for at-home employment in this country, utilizing the tremendous technological advances of the last 15 years. This yields great potential freedom financially and time-wise in America. Overall, when an off-the-grid subdivision is planned to be sustainable, affordable, and with conservation areas, the foundation is laid for a pure-health community with an overall sustainable balance. Such communities shall comprehend the full gamut of health which is necessary for life to exist in this balance, including: environmental health, physical health, spiritual/psychological health, and

financial health. For purposes of this thesis, however, we will work towards achieving sustainable ranges of health concerns by targeting the provision of sustainable, affordable conservation subdivisions.

In such a community, since it is rural in nature, driving will likely still be necessary, at least for the most necessary areas such as grocery shopping and taking children to school. In terms of regional planning, allowing growth in rural areas is questionable at best due to the perpetuation of sprawl. In Texas, however, there is no regulatory authority to prevent rural development. Therefore, whether development occurs in rural areas of Texas solely depends on the marketplace. In addition, many rural areas of Texas have seen a depletion of their youth, who have flocked to the state's major metropolitan areas in search of jobs. This disinvestment is coupled with another fact: the presence of substandard housing in rural communities.

In many rural areas, affordable housing consists of only manufactured homes. Many new manufactured homes tend to be expensive once they are finally put in place on a lot. In addition, older manufactured homes tend to be either in need of costly repairs or near the end of their lifespan altogether. In both new and older manufactured homes, utility bills tend to be very high due to the poor insulation values of the construction materials. This increases the costs for those living in manufactured homes. Finally, it is often the case in various parts of the United States that, where an existing manufactured home park is close to nearby new development, land values can increase to such an extent that owners subdivide manufactured home parks into home lots, thus forcing longtime renters to find other housing. Oftentimes, manufactured homes are the most affordable, although inefficient and unreliable, housing alternative that exists for communities (Aued, 2007).

Therefore, in understanding that rural development will likely occur in the future due to the need and demand for rural housing, developing a manner in which rural development can occur in a sustainable manner is a key objective of this thesis, and a rural case study is included in Chapter IV. In the remainder of this section, we will delineate the core foundation for

successful sustainable development of rural areas. In attempting to address better solutions to rural housing than mobile homes offers, the theory of incremental housing is a valuable option to discuss.

Incremental housing, discussed in depth in Appendix C, is a method which allows homes to be constructed which accomplish three major goals for rural communities in Texas:

1. Homes can be constructed for an affordable price, thus enabling affordable housing. These costs can be cheaper than costs for manufactured homes.
2. Homes can be constructed with sustainable materials more easily, allowing for *operationally* affordable housing, as opposed to manufactured homes which tend to have high heating and cooling costs.
3. Homes have appreciating value over time, allowing homeowners to build equity, as well as for municipalities to obtain increased tax revenues over time. Manufactured homes have depreciating value over time, with decreasing equity for homeowners and decreased tax revenues for municipalities.

Given these benefits to rural areas of Texas, the incremental housing method shows its promise as a solution for affordable, sustainable housing in rural areas. This is a method which can also work well when coupled with an off-the-grid (OTG) home. All of the elements of OTG homes, such as electrical production and community septic systems, can occur in incremental subdivisions.

A few considerations can be made, however, when we consider the small initial square footage of the home in this type of development. For instance, instead of capturing rainwater from a standard size home, incremental OTG housing would mean capturing an initial 400-750 square feet of rainwater, depending on the square footage of the home. In addition, utility runs are a consideration as well, enumerated in the interview with architect Lori Ryker (Appendix A). These considerations would require significant conservation practices, and may even necessitate the use of community wells or lakes as an additional water supply. Furthermore, incremental housing is considered as more of a rural method in competing with manufactured

homes in rural areas as opposed to urban areas. In urban areas, it is more practical in most cases to consider a new urban approach in obtaining affordable housing.

In summary, the future development of sustainable communities in Texas depends on different scenarios in urban and rural environments. In urban areas, an approach is necessary which severely limits the community's environmental footprint and which works in a sustainable cycle to use and reuse resources efficiently. In rural areas, an OTG solution is often very practical in limiting the environmental footprint of the development. In addition, incremental housing can be practiced in order to facilitate the process of sustainable rural housing, and it also enables that housing to become affordable.

3.3 Sustainable Conservation Development

3.3.1 Professional Reports' Review

In this thesis, I combine sustainable development and conservation development, previously discussed separately in this thesis, in order to attempt to plan for a better method of overall development in urban and rural areas of Texas. By combining the two development methods, the following goals can be achieved:

1. Use of conservation areas as septic fields
2. Use of conservation areas for water supply (lakes, wells)
3. Use of conservation areas for food supply (aquaponic, ranch, farmland)
4. Use of conservation areas for stormwater runoff and retention
5. Use of conservation areas for marketability and attractiveness
6. Use of conservation areas for preservation of open space
7. Use of conservation areas for rural recreation opportunities
8. Use of conservation areas to maximize breezes and minimize urban heat island effect

It should be noted that these are not the only benefits of conservation areas. Many more have been discovered including psychological benefits and overall quality of life benefits (Moore 1981 17-34; Ulrich 1984, 420-421) However, for purposes of this thesis and in defining

benefits of a sustainable conservation subdivision (SCD), the above-listed benefits are the most crucial in our decision-making process.

With the above benefits listed for combining the two patterns, we will next need to define what we mean by a Sustainable Conservation Development (SCD). An SCD can be defined as:

A method in which resources are conserved to a large degree throughout the development process, including energy resources, material resources, and open space resources.

We can further define an urban SCD from a rural SCD by the following:

1. Urban SCD - Developments of at least 20 total acres which incorporate a mixture of uses and housing types, with an overall density of at least 8 units per acre, and at least 25% of total land preserved in conservation easements.
2. Rural SCD – Developments of at least 15 total acres which have a density at or less than 8 units per acre on residentially developed land, and at least 50% of total land preserved in conservation easements.

Sustainable Conservation Developments can be developed with significant advantages for developers. In the marketplace, they can target an ever-conscious professional segment of the population who are concerned about living sustainably. (Florida 2008, 320-325) This segment, termed the Creative Class, brings with it a powerful position in terms of future economic development of a region. If South and Central Texas were to attract this growing segment of the population, it could bring strong future economic development to this region.

Another advantage developers could market in this type of development is the energy savings that exists over time for future homeowners. By taking away dependence on outside energy for home heating and cooling, homeowners can avoid high utility bills during summer months, and depending on the design, may avoid utility bills altogether. A third advantage of this type of development is the ability for residents to reconnect with the land. By utilizing conservation areas for purposes such as aquaponic farms, farmers markets, and animal

pastureland, subdivision residents can eat organic meat and vegetables produced in their own subdivision, can enjoy and preserve the rural component of the land, and can potentially even work at a farmers market within the community. In all, these subdivisions offer the potential for a strong quality of life for residents and their families, which is difficult to determine the overall value of in objective terms.

3.3.1.1 Urban SCD's

As aforementioned, urban SCD's are considered to have a density of at least 8 units per acre, and an overall conservation area of at least 25% of the site. Putting an SCD together in an urban area will likely include the following elements: multi-family apartments, townhomes, duplexes, possible single-family homes, offices, commercial retail, possible aquaponic farming, rainwater harvesting, solar energy production, etc. When combined, these elements will enable a development to be created which has no precedent in this country. Perhaps the closest example, Prairie Crossing, shows the all around potential of combining these methods. This development has shown strong property value increases, high resale values, and creation of a strong sense of community. Both conservation and sustainability were considered at Prairie Crossing, including the construction of environmentally sustainable homes as well as conservation of 70% of the site as native prairie, lakes, and an organic farm (Arendt 1999, 97-99).

Although the likelihood in this urban SCD scenario is to have between 25%-40% open space (less than a rural SCD), this open space is able to benefit a larger amount of people than a rural SCD due to the increased density. In addition, by incorporating new urbanist elements of mixed-use retail and office elements into our urban SCD, we are both encouraging pedestrian mobility and also increasing the sense of place, and thus the desirability of this pattern of development in the real estate marketplace. Included with these benefits are the aforementioned benefits of adjacent open space. In Chapter IV, the Urban SCD will determine financial and development feasibility in a San Antonio area case study.

3.3.1.2 Rural SCD's

As mentioned, rural SCDs are considered to have a density at or less than 8 units per acre, and an overall conservation area of at least 50% of the site. Putting a rural SCD together will likely include the following elements: single-family incremental housing, duplex housing, possible home-offices, possible small-scale retail, aquaponic farms, possible rowcrops, possible ranchland, rainwater harvesting, solar energy production, community septic systems, pervious paving, etc. The closest rural precedent to this development is perhaps Tierra Madre in New Mexico, a community of straw-bale homes. This development enabled an affordable, sustainable community to be developed (Bloom 2002). Adding conservation to the mixture adds versatility and flexibility for a rural subdivision, in large part by adding acreage which can allow sustainable methods to take place.

These subdivisions utilize a significant amount of open space, which can preserve significant environmental habitat in rural areas, important farm and ranch land, and areas for rural recreation. The homes in these subdivisions are also constructed of sustainable materials which, when combined with the incremental method of housing, enable homes which are affordable and which have affordable energy costs through the life of the house. In Chapter IV, the Rural SCD will determine development and financial feasibility in a South Texas case study.

CHAPTER 4

CASE STUDY RESEARCH

This thesis will be comprised of two case studies: one mixed-use design case study conducted in a large urban city (Urban SCD), and one rural residential design case study conducted within county jurisdiction (Rural SCD). These will be conducted in order to determine the feasibility of sustainable conservation developments directly on the ground in the state of Texas. The case studies will examine site development within a conventional scenario and a sustainable conservation design scenario. The case study will include an overview, a pro forma analysis, the design layout, as well as an overview of the design and pro formas for the scenario.

4.1 Mixed-Use Design in Large Urban City

The site chosen for the first case study is located in the City of San Antonio, in the far southern part of the city. Adjacent land uses in the area include single-family residential to the East and West, industrial and institutional uses to the South, and undeveloped land to the North. The site is currently undeveloped and has been either ranched or farmed for at least the last 100 years. Uses during the early and mid 1900's included a local dairy farm. During the latter part of the 1900's, the property was mostly ranched for cattle. During the past 10 years, however, the property has seen an increase in adjacent vehicle traffic due to the encroachment of San Antonio into the rural county. This has meant increased problems for the landowner. The site was ranched in years past, but numerous accidents have occurred with drivers running into the owner's property, damaging their fence and allowing cattle to escape. This has caused a significant financial hardship, so much so that the owner chooses to no longer ranch the property, but rather to farm hay on a portion of it. Without a reliable water source, this dryland farming method has proven very difficult and financially risky for the owner. With development

encroaching and few other options, the owner will likely sell the property in the next few years to be developed in one fashion or another (Ritchey, 2008).

The City of San Antonio, in 2004, imposed zoning for the property of 'UD' Urban Development District. The district was developed with smart growth principles in order to promote mixed-use, pedestrian-friendly environments. The zoning does not require mixed-use development, but for residential development it does require a mixture of housing types, such as single family, duplexes, townhomes, etc. An adjacent subdivision to the East has utilized these mixed housing types successfully and the first portion of this case study will be to examine this development in this conventional scenario.

It is important to keep in mind in this analysis that the 'UD' zoning district, although not a conventional zoning district, does allow land uses that are relatively segregated from one another, allowing a moderate perpetuation of the sprawl pattern of development. However, this zoning district can be utilized for more pedestrian-oriented, mixed-use communities which decrease automobile reliance and pollution while increasing overall safety. The district is flexible in the sense that it can be utilized for conventional development with a requirement for mixed-housing types, or for very mixed-use, walkable communities.

4.1.1 Conventional Design

This property has 'UD' Urban Development district zoning. Utilizing the base zoning of 'UD' for this property, the developer elects to build single family residential on 133 acres of the property, leaving 10 acres to the West (along an arterial thoroughfare) to be developed for commercial land use. This is permitted utilizing the current 'UD' zoning. Since the site is located completely out of the 100 year floodplain, no further land will need to be taken out as undevelopable. In the 'UD' zoning, the developer can build predominantly single-family housing, but must build at least 20% of units as other housing types. The developer chooses to build 20% of those units as an equal mixture of garden homes, duplexes, and townhomes. As for the single-family housing, the developer chooses to build a variety of lot sizes, with an average lot size of 5,000 s.f.

This development is very similar to other developments which have occurred in the area which utilize 'UD' zoning. In transferring costs and revenues from these developments into an approximate estimate for this conventional design, it is estimated that profit margins will be **13.5%**. This will yield an approximate profit of **\$18,000,000** for the developer, after subtracting total costs. This estimate is based on similar 'UD' projects in the area. This includes all profits for residential development as well as big box and mid-scale retail.

4.1.2 Sustainable Conservation Design

The typical conservation design, as posited by Randall Arendt, will not work in this scenario. This is because the lot sizes are already reduced to a size so small that cutting them in half is not possible. This is a common scenario in urban areas, and is elucidated in the interview with John Friesenhahn in Appendix A. It does not mean that conservation design should be abandoned, but rather that it must be modified in order to be feasible. In this urban case study, we will conserve 33% of the site as open space, instead of 50% or more in a more typical conservation subdivision. This will allow more density to be placed on the development, acceptable in this urban setting. Residential lots will still benefit from adjacency to open space, however, preserving the integrity of the pattern.

This design is sustainable as well. In this urban setting, one tenet of this sustainability is developing a mixed-use project, with a mixture of walkable commercial and residential development. It also utilizes the principle of eco-balancing, as posited by Pliny Fisk of the Center for Maximum Potential Building Systems in Austin, Texas.

This urban case study incorporates a large amount of sustainable components, including the list below, explained in further detail in Appendix D:

Active Strategies

- Green Electrical Grid Power
- Rainwater Collection & Reuse
- Greywater Collection & Reuse

- Condensate collectors

Passive Strategies

- Site Location in proximity to open space areas
- Roof overhangs
- Site-specific landscape location to maximize shading and breeze
- Xeriscaping
- Bioswale

Materials

- Compressed Earth Block (CEB) technology
- Sustainable fly ash/concrete roads
- Recycled Metal roofing

In diagnosing the sustainability within this case study from an eco-balancing approach, lets consider the following factors: air, water, food, energy and materials. With regard to **air**, significant amounts of forestland were protected on site (30.8 acres) in order to offset life-cycle balancing in terms of air. However, not enough habitat is available on site to balance this air element. With regard to **water**, all water needs are produced on-site, in the aforementioned methods. With regard to **food production**, significant amounts of food are produced through a 15,000 s.f. aquaponic greenhouse and 5.8 acres of goat and sheep pastureland. Although this will not produce all food on-site to satisfy resident's food needs, it does produce significant amounts of vegetables, fruits, fish, shellfish, lamb, goat meat, goat milk and goat cheese, a portion of which can be consumed by residents on-site in local farmer's markets, restaurants and schools.

With regard to **energy**, all energy needs are produced on-site through utilization of solar energy resources. This is made significantly feasible due to the decreased energy requirement of compressed-earth-block technology, and to the tremendous potential for solar energy capture in the South Texas region. With regard to building materials, the aforementioned Compressed

Earth Block technology is created with an extremely low embodied energy from on-site materials.

Overall, in terms of eco-balance planning, this has been accomplished through meeting 100% of resource needs in terms of both water and energy. In terms of food needs, it is difficult to place a percentage on the amount of resources met in terms of food needs on site. However, it is important that significant amounts of food can be provided on-site. In terms of air, resource needs for residents are not met on-site, but are mitigated by the 30 acres of forest/canopy habitat provided on-site. In terms of building materials, the buildings are constructed of materials which are as sustainable as possible, produced on-site with very low amounts of embodied energy.

This development can be laid out in a number of different ways. It could be laid out as a conventional development, laying in the lots, then the road layout, along with reservation of a portion of the site by the arterial road for future commercial with no present plan developed. Another option for laying out this development is the approach taken for laying out new-urbanist, form-based developments. Typically, these developments are developed in regional planning terms, with more urban, multi-family development planned in areas with adequate infrastructure and transit options in order to sustainably support them. These areas are termed 'regional centers', and usually contain development which includes commercial and community facilities within a 10 minute walk of every resident. 'Villages' are communities of single and low density multi-family residential uses which contain neighborhood schools and parks within a 5 minute walk of all residences. In general, the preliminary layout for this development is developed with the principles of new urbanism, in which more intense, regional uses are planned to the northern and western edges of the site. Village uses are then planned in the interior, eastern, and southern edges of the site.

Although the general uses were indicated to occur in certain areas of the site, the actual layout of the development is defined using a third layout method: that for laying out conservation subdivisions. Using this method, the first step of the development is to determine

the conservation areas. The site is endowed with over 30 acres of scrub brush forest, and over 100 acres of prairie grass. In laying out the conservation areas, it was critical to protect the majority of the woodland habitat. In designing around these areas, roads were developed adjacent to woodlands in order to enable scenic views from the street, while homesites were located across the road to enjoy scenic woodland views.

In addition, there is an area to the west of the site with a small pond and large oak trees which was also preserved. Another area protected is the lowland prairie area of the site which, although out of the 100 year floodplain, is an area with typical floodplain soils which drains the majority of water off site. This area was converted into a medium-sized lake in order to hold rainwater, as well as to maximize the scenic value of the area while creating habitat and increased value for adjacent residential and commercial uses.

A total of 5.8 acres of prairie grass was conserved in the areas of the site's best and second best soils. In consideration of creating pastureland habitat for a mixture of sheep and goats, this combination of soil enables maximum flexibility in raising these animals, as sheep prefer grass which grows in high quality soils, while goats prefer brush scrub plants which grow in moderate and poorer soils (Menzies 2008). In addition, strong East-West viewsheds were created by the design of these prairie areas, enabling adjacent homesites to have scenic viewsheds of prairie areas.

Another open space component is the preservation of the site's largest hedgerows. The largest hedgerow is preserved as an island in between the site's main road, while other hedgerows were preserved alongside street right-of-ways. Other open space areas include buffers along the edge of the property as well as parkland located in village greens which are fronted by a large number of homesites. Finally, 0.75 acres of the site is developed as an aquaponic greenhouse, counting as part of the conservation area.

Development on the site was designed to create premium lots for single-family residential, multi-family residential, as well as office uses. Overall, 1/3 of the site (47.67 acres) is preserved in conservation areas, while the remaining 2/3 of the site (95.33 acres) is

developed as 614 residential units. Of those 614 units, 179 are developed as single-family residential units, while 54 are developed as duplex units. In addition, 73 units are developed as cottages, in pockets of the development which front greenspace and are marketed for retirement living. 84 units are developed as townhomes, while 224 units are developed as multi-family residential units located over retail and office uses. In addition to the residential component, 511,000 s.f. is developed as retail and office development. In new-urbanist fashion, the majority of retail sites and park areas were designed to be within 5 minutes of the majority of homesites, enabling a pedestrian-oriented, mixed-use, safe and walkable community.

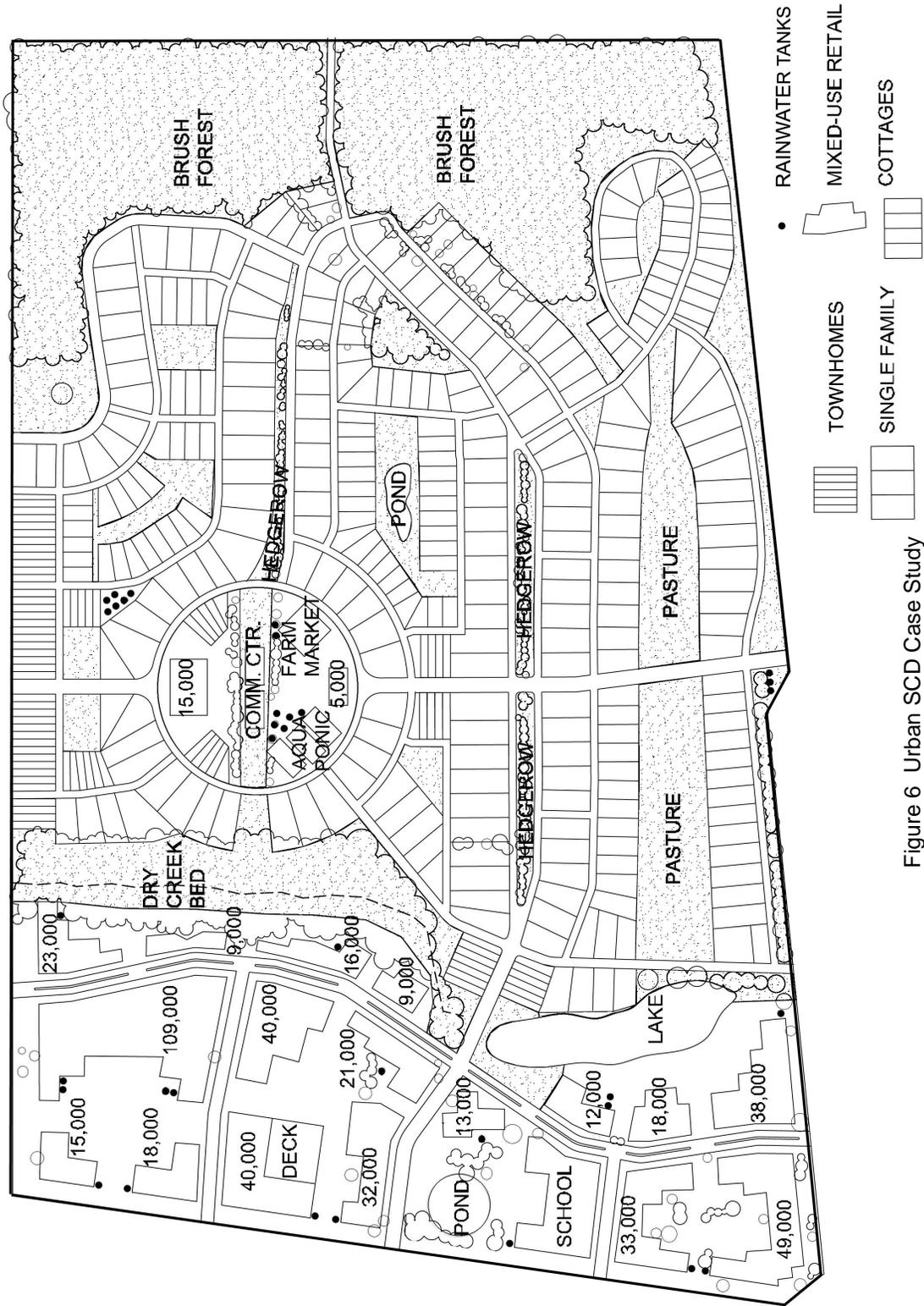


Figure 6 Urban SCD Case Study

Table 1 Urban SCD Pro Forma – Part 1

Development Totals	Units	Base Value (2008)	Revenue
Single Family Units	252	\$209,000	\$52,668,000
Duplex Units	54	\$85,000	\$4,590,000
Townhomes	84	\$192,500	\$16,170,000
Multi Family Units	224	\$99,000	\$22,176,000
Retail Development	454,000 s.f.	\$130 per s.f.	\$59,020,000
Office Development	57,000 s.f.	\$94.50 per s.f.	\$5,386,500
Aquaponic Facility	15,000 s.f.	\$304,545 per year	\$3,350,000
School	50,000 s.f.	\$150 per s.f.	\$7,500,000
Total			\$170,860,500

Phasing Schedule	Units	Revenue	Units	Revenue
Phase 1			Phase 6	
Retail	82000 s.f.	\$10,660,000	SF Units	62 \$12,958,000
Phase 2			Duplex Units	6 \$510,000
SF Units	32	\$6,688,000	Phase 7	
Duplex Units	6	\$510,000	158000	
Phase 3			Retail	s.f. \$20,540,000
SF Units	35	\$7,315,000	MF Units	130 \$12,870,000
Townhomes	13	\$2,502,500	Phase 8	
Duplex Units	18	\$1,530,000	SF Units	47 \$9,823,000
Phase 4			Duplex Units	2 \$170,000
SF Units	25	\$5,225,000	Phase 9	
Duplex Units	4	\$340,000	Townhomes	40 \$7,700,000
MF Units	31	\$3,069,000	Phase 10	
Office	57000 s.f.	\$5,386,500	32000	
Retail	10000 s.f.	\$1,300,000	Retail	s.f. \$4,160,000
School	50000 s.f.	\$7,500,000	MF Units	7 \$693,000
Phase 5			Phase 11	
SF Units	51	\$10,659,000	152000	
Duplex Units	18	\$1,530,000	Retail	s.f. \$19,760,000
Townhomes	31	\$5,967,500	MF Units	56 \$5,544,000
Aquaponic	15000 s.f.	\$304,545 per year		
Retail	20000 s.f.	\$2,600,000		
Total			Total	\$170,860,500

Table 2 Urban SCD Pro Forma – Part 2

Land Acquisition			
			Total
			\$6,500,000
Development Costs			
	\$ Per Unit	Units	Costs
Hard Costs			
Grading	\$1,500,000 LS		\$1,500,000
Paving	\$403,000 per mile	5.4 miles	\$2,176,200
Electric Utilities	\$8,000	614	\$4,912,000
Sewer	\$65 per l.f.	28,500 l.f.	\$1,852,500
Stormwater Rainwater Harvesting	\$37.68 per l.f.	28,500 l.f.	\$1,073,880
Greywater Reuse	1301500 LS		\$1,301,500
Condensate Collection Bldg.	\$3,000 EA	614	\$1,842,000
Materials/Labor	\$3,000 EA	614	\$1,842,000
Parking Deck	\$85 per s.f.	736800 s.f.	\$62,628,000
Landscaping	\$1,800,000 LS		\$1,800,000
Aquaponic Facility	\$300,000 LS		\$300,000
Farmers Market	\$500,000 LS		\$500,000
Community Center	\$50 per s.f.	10,000 s.f.	\$500,000
	\$800,000 LS		\$800,000
Soft Costs			
Consulting Fees	\$8,402,808	10% of Devtpt Cost	\$8,402,808
	\$1,000,000 LS		\$1,000,000
			Total
			\$92,430,888
Interest			
Equity	\$9,893,080		
Debt	\$89,037,808		
Average Balance	\$14,839,684		
Duration	6 years		
Rate (6%)	\$37,264,024		
			Total
			\$136,194,912
		Total Profit	\$34,665,588
		% of Costs	25.45%
		% of Revenues	20.29%

4.1.3 Sustainable Conservation Pro Forma

In this pro forma, lot prices were increased 20% over the estimates for conventional residences in the area. This is due to a blend of increases based on two land use patterns. In conservation subdivisions, lot values are increased by 14.4% on average. In new urbanist developments, studies have shown that lot values are typically increased by 10% over conventional home lots. This would lead to an estimated increase of 24.4% in this development but, in order to estimate conservatively, we will estimate an increase of 20% in home values for this development.

The overall development is divided into 11 phases, each phase estimated to be completed within a 1 year timeframe. The first phase is commercial due to a substantial initial return on investment, as well as the ability for the site to absorb commercial development at this time due to existing nearby households. Overall, **\$170,860,500** in revenues is generated from this development.

The property includes land acquisition costs of **\$6,500,000**, including all legal fees and closing costs. As for the development costs for the property, some costs are substantial while some are minimal, each for a number of reasons. The development costs are discussed in depth in Appendix E of this thesis. The development costs total **\$92,430,888** for the project. In adding in the costs for the loan, total expenditures for the project would add up to \$136,194,912. This leads to a total profit for the project of **\$34,665,558**. This profit is **25.45%** of total project costs, and **20.29%** of total project revenues. The pro forma analysis has shown that this project can be a significantly profitable venture.

The most profitable portion of the development is the mixed-use retail portion of the development, due in large part to a substantial market capture of commercial retail and office space within the development, supported in part by adjacent residents. The current indicated pro forma shows that this mixed-use retail is broken into phases which would occur at scattered periods during the development's construction, with the largest portions of mixed-use retail occurring toward the end of the property's development. By doing this, the developer can

maximize return on investment by capturing the increased values over time which occur with new urbanist and conservation developments, and capture that investment on the most lucrative portion of the overall development, the mixed use retail component.

4.1.4 Urban SCD Benefits to Texas Cities

In consideration of the potential cost savings for Texas cities in this scenario, it is worth investigating the full benefits of the design. Below is an overview of the benefits of this development in order to be aware of the full impact to municipalities as well as their utility and water districts:

1. Municipal water savings
2. Reduction of sewer infrastructure and maintenance costs
3. Overall utility savings
4. Increased parkland/open space at no cost to municipalities
5. Decreased stormwater runoff concerns due to bioswales and other low impact development methods
6. Increased value appreciation and tax revenue. This is due to the merger of conservation design with form-based design, both of which are proven to sell quicker and for higher values than conventional development, while also appreciating in value faster than conventional development.
7. Increased wildlife corridors and habitat
8. Affordable housing (apartments, duplexes, cottages)

This development enables strong profits to be made. However, developments such as this will likely be successful only in the manner of public-private partnerships, for two main reasons. First, these developments, like standard new urbanist form-based projects, require a very high up-front investment into infrastructure that is difficult for private developers to invest in without public incentives, such as TIF financing options and public investment in infrastructure. Secondly, these developments could occur through zoning restrictions, but given the opportunity, most developers would not preserve 1/3 of the site's open space. By engaging into

a partnership with the private developer, cities stand to gain significantly by gaining open space for their residents at no cost to the municipality.

4.2 Rural Residential Design Within County Jurisdiction

The second case study conducted as part of this thesis is located within County jurisdiction in South Bexar County, Texas. Typically, growth has occurred in the area very sporadically, and typically in two different patterns. The first pattern has been large lot residential subdivisions, usually with average lot sizes around 3 acres and either manufactured homes or single family homes constructed. The other pattern of development has been the development of manufactured housing communities on relatively small lot sizes.

The site is 24 acres in size, located in an area approximately 15 miles south of downtown San Antonio. The site is proximate to Interstate 35, which allows easy access into San Antonio's urban core. The area is very rural, with large tracts of agricultural land interspersed with single family and mobile homes on an average lot size of 2-3 acres. There is a desire in the area for two things among rural South Bexar County residents: 1) affordable living and 2) maintaining a rural character of life.

In terms of affordability, residents in the area typically moved there because land was cheap enough to purchase and housing was cheap enough to construct. This is especially true with those living in manufactured homes in rural areas South of San Antonio. In terms of obtaining a rural character, this has been successfully achieved by many who purchase land to build on, because the vast majority of the land is still in agricultural land use.

In this case study, there is no water or sewer in the nearby vicinity. The development jurisdiction is Bexar County, although the City of San Antonio will review the plat and require compliance with some city codes, such as tree preservation and park dedication, since it is within the City's Extraterritorial Jurisdiction. In areas within jurisdiction of Texas counties, land use is not restricted, but density is. In areas without water provisions, 1 unit per 1.5 acres is the minimum density permitted, mandating water wells. In areas with water but not sewer service, 2 units per acre is permitted.

4.2.1 Conventional Design

Without the ability to provide water to this site, the allowable density would be 1 unit per every 1.5 acres. Under that scenario, on this 24 acre site it would yield 14 units, or 65,340 s.f. per lot. This yields an estimated profit for the developer of \$420,000

If the developer provided water to the site, they could develop at 2 units per acre, or 40 units on our 24 acre site. This development can earn an approximate profit of \$815,000 for the developer, with a substantial cost (\$118,000) for providing water to the site.

4.2.2 Sustainable Conservation Design

This case study, when designed as a sustainable conservation development, yields a subdivision which also has 40 lots on the 24 acre site. This design is based on having an adequate lot size, determined to be 7,500 s.f. This is a 75' x 100' lot size, allowing for a decent sized home and adequate space for lighting and ventilation. However, the lot is not too large so as to require a significant amount of resources for property upkeep, such as fertilizer, water, and mowing resources to maintain residential lawns.

The first step of the development is to determine the conservation areas. The site is endowed with over 8 acres of forest and over 9 acres of prairie grass habitat. In laying out the conservation areas, it was critical to protect the majority of the woodland habitat. In the prairie areas, home sites were located so as to maximize the scenic views and open space adjacency. Numerous homesites enjoy views of prairie habitat, while other homes have views of forest areas, while yet others have views of parkland. In all, over 75% of lots can be considered 'premium' lots due to their adjacency to scenic open space.

Overall, 2/3 of the site (16 acres) is held in conservation easements, while the remaining 1/3 of the site (8 acres) is developed as 40 residential lots. Of those 40 lots, 30 are developed as single-family residential homes, while 10 are constructed as duplexes, yielding 20 duplex units. In total, 50 residential units will be constructed on the site. In addition, 0.5 acres are developed as an aquaponic farm, counted as 5% of the total conservation easement.

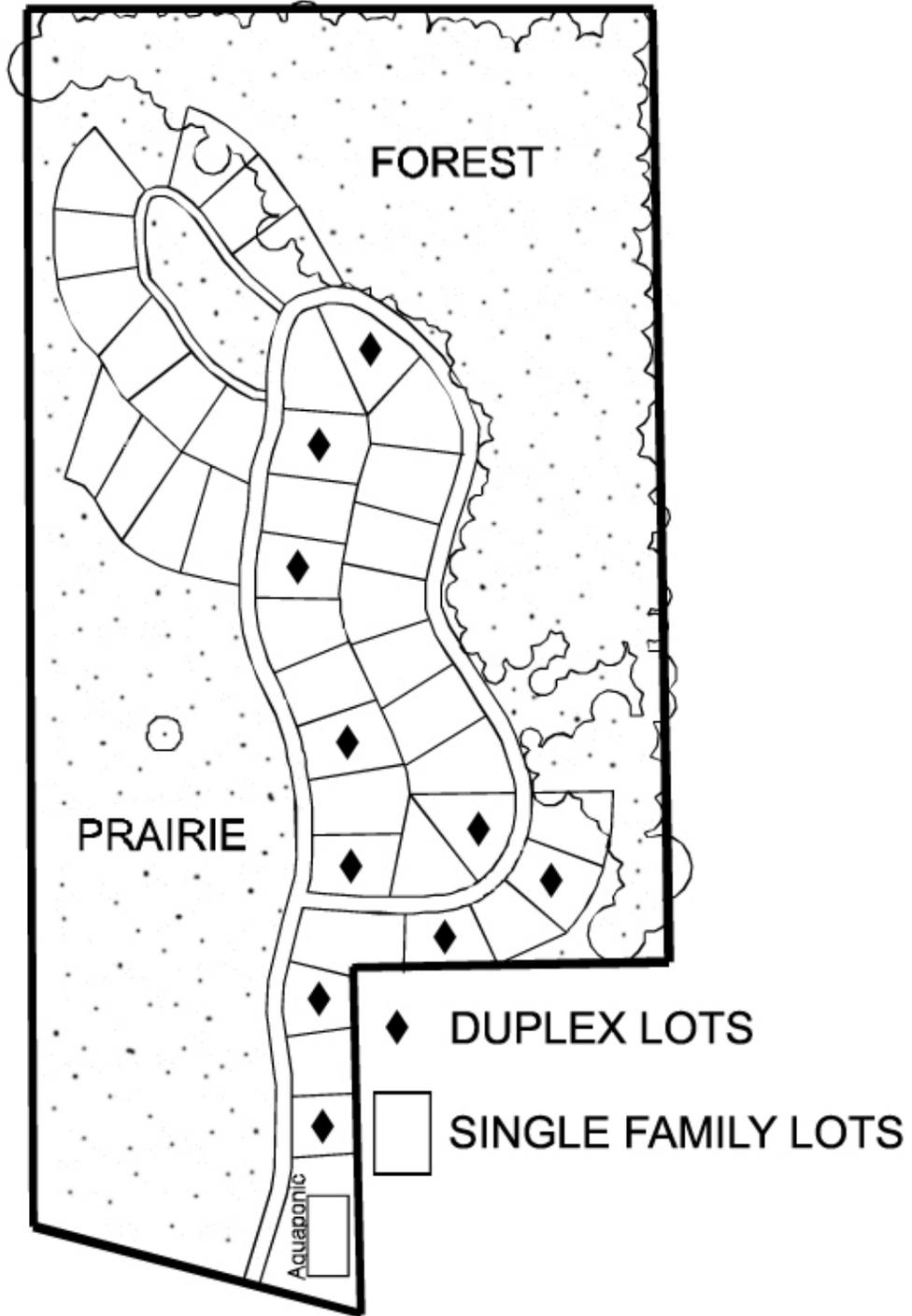


Figure 7 Rural SCD Case Study

Table 3 Rural SCD Pro Forma

Revenue	Units	Avg. Price	Revenue
Phase 1 Aquaponic	1		\$640,000
Phase 2	14	\$180,000	\$1,680,000
Phase 3	18	\$185,000	\$2,670,000
Phase 4	18	\$190,000	\$2,760,000
Total			\$7,110,000

Expenditures	
Land Acquisition	Total \$185,000

Development Costs	\$ Per Unit		Units	
Grading	\$1,500	x	30	\$45,000
Paving	\$45	lf	2689	\$121,005
Electric Utilities	\$2,000	x	40	\$80,000
Septic	\$7,500	x	40	\$300,000
Wells	\$25,000	ea	3	\$75,000
Solar Panels	\$14,000	x	40	\$560,000
Rainwater Harvesting	\$15,000	x	40	\$600,000
Bldg. Materials/Labor	\$112,500	x	30	\$3,375,000
Landscaping	\$30,000	LS		\$30,000
Aquaponic Facility	\$200,000	LS		\$200,000
Consulting	\$548,602	LS		\$548,602
Fees	\$100,000	LS		\$100,000
Total				\$6,034,607

Interest	
Equity	\$150,000
Debt	\$6,069,607
Average Balance	\$3,034,804
Duration	2 years
Rate (6%)	\$375,102
Total \$6,594,709	

Total Profit	\$1,155,291
% of Total Costs	17.52%
% of Total Revenues	14.90%

4.2.3 Rural SCD Pro Forma Overview

The above pro forma information is discussed in detail in Appendix F. Overall, total expenditures for the project would add up to \$6,594,709. This leads to a total profit for the project of **\$1,155,291**. This profit is **17.52%** of total project costs, and **14.9%** of total project revenues. The pro forma analysis has shown that this project can be a marginally profitable venture, but one not without risk. Logical concerns for the development include the interest. The planned buildout for all four phases is 2.5 years. However, if sales are slow, additional interest must be paid, thus cutting into profit margins. One common occurrence in conservation designs, as aforementioned, is the evidence of increased sales velocities when compared with conventional developments, which may help diminish this concern.

Overall, this is a conservative pro forma analysis. It is estimated that the rural SCD case study will earn a profit for the developer. However, given the slim profit margins, it is very likely that this type of project would not be considered by a private developer, and would perhaps not receive funding by a private lending institution. In replacing the solar power and rainwater harvesting systems with conventional infrastructure, significantly less debt can be incurred for this development. However, these elements are core portions of the development's sustainability goals, and should not be removed.

4.2.4 Rural SCD Benefits to Texas Counties

In consideration of the potential cost savings for Texas counties in this scenario, it is worth investigating the full benefits of the design. Below is an overview of the benefits of this development in order to be aware of the full impact to the county:

1. Municipal water savings
2. Reduction of sewer infrastructure and maintenance costs
3. Utility savings
4. Increased parkland/open space at no cost to municipalities
5. Decreased stormwater runoff concerns
6. Increased value appreciation and tax revenues

7. Increased wildlife corridors and habitat
8. Operationally affordable housing (lower monthly bills)

The units in this case study were, by their very nature, priced out of the regional affordability range. On a monthly basis, however, they would be substantially cheaper to live in, with little to no electricity bill, water bill, or sewer service bill. Another aspect that should be discussed in regard to affordable housing is the incremental housing method discussed in Appendix C. This method was not utilized in this rural SCD case study, simply because private developers would not receive a return on their investment. The developer could, however, sell the lots to private owners in order for them to build their own private houses, in which case they could add sustainability elements if they so chose. In this case, these private owners could build their own papercrete homes using material produced on site, for a fraction of the material and labor costs borne by this case study.

The most rational alternative in order to enable these various elements to assimilate and deliver a profitable project with maximum benefit to Texas counties, is for the counties or other agencies to become an integral part of their success. In the Tierra Madre development, discussed in Chapter 2, a local church took the initiative to deliver sustainable housing in the local community. In a similar fashion, then, Texas counties could support private developers in a number of ways in order to enable success. Tax Increment Financing (TIF) districts and Public Improvement Districts (PID's) should be considered, where developers profit from a capture of tax revenue from the development for a set period of time. Such programs can increase the profitability of the development. Additionally, allowing local, state and federal tax credits for sustainability elements can improve the developer's performance numbers as well.

In developing this pro forma, the short term profit goals of the developer need to be merged with the long-term profit potential of such a development. The pro forma only includes projected profits throughout a 2.5 year timeframe. However, by leasing agreements made with local farmers, the developer may negotiate a set-upon profit from the aquaponic facility for the life of the project. In this estimate, a 50%-50% split occurs with regard to the revenues from the

facility, with half going to the farmer leasing the facility and half going to the developer. Additionally, by retaining ownership of the duplex units, the developer can capture market increase potential which traditionally occurs in conservation subdivisions.

Additional elements and recommendations for the rural SCD will be discussed in Chapter 5: *Conclusion*.

CHAPTER 5

CONCLUSION

This is the concluding chapter of the thesis, and includes an overview of the work completed, the benefits of sustainable conservation developments, as well as recommendations for municipalities in stimulating this development pattern within Texas.

5.1 Thesis Overview

Existing conservation subdivisions and sustainable developments were evaluated to determine what components made them successful. In conducting research on successful conservation designs and sustainable developments, certain developments were highly successful largely because they were very attractive to housing consumers. People highly desired to live in these communities, and they were often among the top real estate sales communities within their respective locations.

In addition, the potential for sustainable developments in Texas were analyzed. In consideration of this potential, new development methods need to be created: Sustainable Conservation Developments (SCD's). This methodology is defined in land use planning and development terms, in order for municipalities to utilize in the future. Two such SCD case studies are analyzed: one in an urban area under city jurisdiction, and one in a rural area under county jurisdiction.

In considering the future potential of SCD's, it is important to realize the benefits of combining the conservation aspect with the sustainability aspect. Conservation areas are important in developing sustainable neighborhoods, as the open space areas can be utilized to provide food, to drain water, and to clean air. Sustainable developments are also important for conservation developments in terms of being able to add a 'green' marketing element to the conservation subdivision. The environmentally conscious consumer in America is an ever

growing market presence in American real estate. Typically, this market is highly educated and able to generate substantial property tax revenues and overall economic development for communities.

As discussed in Chapter 3, in order to be effective, sustainable conservation developments are defined for consistent future use in Texas communities. They are defined as:

Developments in which resources are conserved to a large degree throughout the development process, including energy resources, material resources, and open space resources.

These resources are as defined by the governing agency, and may vary depending on the particular site and the particular time of development. As an example, sustainably harvested wood in an Alaskan development is a sustainable building material, but in desert areas of Texas is considered much less sustainable, due to the large energy resources required to develop with wood in a desert climate.

It is also important to define and distinguish Urban SCD's from Rural SCD's, because these developments each have their own distinct considerations with regard to sustainable development. In some areas, rural SCD's are not appropriate in terms of sustainability, while urban SCD's would equally not be appropriate in certain areas. These differences are defined below:

1. **Urban SCD's** – Developments of at least 20 total acres which incorporate a mixture of uses and housing types, with an overall density of at least 8 units per acre on residentially developed land, and at least 25% of total land preserved in conservation easements.
2. **Rural SCD's** – Developments of at least 15 total acres which have a density at or below 8 units per acre on residentially developed land, and at least 50% of total land preserved in conservation easements.

5.2 Urban Sustainable Conservation Developments

As discussed in Chapter 3, it is important to assess the potential in Urban SCD's as well as Rural SCD's. In urban design, there is strong potential for mixed-use developments based on the form-based principles of new urbanism. When we add another component to the mixture, such as aquaponic farms, we see the potential for residents to reconnect to where their food comes from. This can stimulate local retail shops and restaurants who utilize harvested crops from the aquaponic farm.

In an urban case study, 150 acres were analyzed for an urban SCD in South San Antonio, Texas. Under conventional development of the property as a single family residential development with only minimal required open space, with 10 acres of commercial development along the arterial street, a net profit of **\$18,000,000** was estimated. However, in redesigning as an Urban SCD with 33% conservation land and 67% developed land, a net profit for the developer of **\$34,665,558** was estimated. Sustainability elements for the SCD include a rainwater harvesting system, fly ash roads, aquaponic facility, compressed earth block construction, and others. This enables a profit increase of **\$16.6 million**, or **192%** more profit for an Urban SCD than for a conventional development.

The main reason why this development allows such a substantial profit increase versus conventional development is two-fold. First, new urbanist mixed-use development in general has the potential to out earn conventional development due to its creation of places where residents highly desire to live in and will pay a premium for, especially over time. The added density that is typically found, through elements such as residential over retail, enable potent market capture for developers. Second, the added bonus of conservation developments are proven to out earn conventional development by an even higher margin than new-urbanist developments, and maintain higher value increases over the life of the development.

5.2.1 Applicability for Texas Cities

Urban SCD's possess substantial benefits to Texas cities:

1. Municipal water savings and ability to cope with water shortages

2. Energy Savings
3. Increased parkland/open space at no cost to municipality
4. Decreased stormwater runoff and flooding problems
5. Increased value appreciation and tax revenues from SCD developments as well as adjacent areas.
6. Operationally affordable housing (lower monthly bills)
7. Decreased traffic congestion
8. Economic development stimulus for the region

In analyzing the above benefits to Texas cities, it is important to note that, in the likelihood that cities were to undergo a crisis in the future in terms of an inability to provide food, water, or energy to its residents, Urban SCD's would be much less affected than conventional developments due to their inherent self-sustaining independence. In considering that major metropolitan areas of Texas are likely to grow rapidly in the future, they must be able to plan for communities which can supply their own resource needs. The conservation areas are another important component, and allow for strong communities through consistent property value increases over time. Outside of the economic benefits, however, the open space areas also provide ecological habitat, psychological benefits for residents, as well as areas for food production.

Overall, urban SCD's are proven in this thesis to be a viable alternative to conventional development patterns, in terms of increasing revenues for cities, saving resources such as water and energy, meeting housing demand for future Texans, and decreasing regional traffic congestion.

5.3 Rural Sustainable Conservation Developments

Rural SCD's will likely be predominantly single-family developments, but may have duplex and even townhome units as well. The incremental housing method, discussed in Chapter 3, holds great promise in enabling affordable housing in the future in rural areas. Rural SCD's may also have home-offices, possible small-scale retail, aquaponic farms, dryland farms,

dryland ranches, etc. It is important to note that the large amount of open space in rural SCD's enables the viability of agricultural land uses and preservation of other sustainable habitat.

In the rural case study analyzed in Chapter 4, 24 acres were analyzed for a rural SCD in South Bexar County, Texas. Under conventional development of the property as single family residential, a net profit of **\$815,000 million** is estimated for the developer. However, in redesigning as a rural SCD with 33% of the property developed and 67% of the property preserved in conservation easements, a net profit of **\$1.15 million** was estimated. Sustainability components for the SCD included fly ash roads, solar panels, rainwater collection systems and papercrete construction. In full, it is estimated that developing a rural SCD for this property will result in an additional \$335,000 in net profit for the developer versus conventional development of the property.

The units in the rural SCD case study were, by their very nature, priced out of the regional affordability range. On a monthly basis, however, they would be substantially cheaper to live in, with little to no electricity bill, water bill, or sewer service bill. Another aspect in regard to affordable housing is the incremental housing method discussed in Chapter 3. This method was *not* utilized in this rural SCD case study, largely because private developers would not receive a substantial return on their investment. The developer could, however, sell the lots to private owners in order for them to build their own private houses, in which case they could add sustainability elements if they so chose. In this case, these private owners could also build their own papercrete homes using material produced on site, for a fraction of the material and labor costs borne by this case study.

The most rational alternative in order to enable these various elements to assimilate and deliver a profitable project with maximum benefit to Texas counties, is for the counties or other agencies to become an integral part of their success. In the Tierra Madre development, discussed in Chapter 2, a local church took the initiative to deliver sustainable housing in the local community. In a similar fashion, then, Texas counties can support private developers in a number of ways in order to enable success.

In developing this pro forma, the short term profit goals of the developer need to be merged with the long-term profit potential of such a development. The pro forma includes only projected profits throughout a 2.5 year timeframe. However, by leasing agreements made with local farmers, the developer may negotiate a set-upon profit from the aquaponic facility for the life of the project. In this estimate, a 50%-50% split occurs with regard to the revenues from the facility, with half going to the farmer leasing the facility and half going to the developer. This example is important in consideration of future rural SCD's because, with large amounts of open space preserved, developers can arrange to earn additional income over time by leasing conservation easements out to local farmers and ranchers.

5.3.1 Applicability for Texas Counties

In consideration of the potential cost savings for Texas counties in this scenario, it is worth investigating the full benefits of the design. Below is an overview of the benefits of this development in order to be aware of the full impact to the county:

1. Municipal water savings and ability to cope with water shortages
2. Reduction of sewer infrastructure and maintenance costs
3. Utility savings
4. Increased parkland/open space at no cost to municipalities
5. Decreased stormwater runoff concerns
6. Increased value appreciation and tax revenues
7. Increased wildlife corridors and habitat
8. Operationally affordable housing (lower monthly bills)

Counties which promote these patterns of development will be well prepared to deal with future issues, for many reasons. For example, by constructing with sustainable materials and utilizing elements such as solar panels, the operational costs for residents are greatly reduced. This enables more financial gain for residents which can be contributed into the local economy. For regions which were to one day have numerous rural SCD's, it can even enable the counties to decrease regional power plant expenditures.

As another example, the incremental housing method, over one generation (30 years), can enable homeowners to save approximately \$200,000 on mortgage payments over the life of the home (2008 values). This is equal to more than four full years of a San Antonio resident's average salary (\$45,000-2008 values). On a regional scale, with 1,000 rural SCD housing units in the region, this frees up over \$200,000,000 for the local economy, dispersed over the 30 year period. Considering an approximate savings on operational energy costs of \$100 per month, this provides an additional \$36,000,000 in savings for residents.

Overall, rural SCD's are proven in this thesis to be a viable alternative to conventional development patterns, in terms of increasing revenues for counties, saving resources such as water and energy, meeting housing demand for future Texans, all while increasing the functionality and ability to enable affordable housing for future residents.

The analysis in this thesis has proven that, if governing bodies allow for Urban SCDs to occur by enabling them into their zoning and land use ordinances, they can be significantly profitable for private developers. Given the high up-front costs, however, it is in municipalities' best interest to become involved in one way or another. One way in which they can become involved is by funding a portion of the development. For example, a major road in the development which links two existing streets within a city or county would be a functional purchase, enabling the street to connect and thus providing value to all residents. In addition, it is a strong incentive for developers if they can know that municipalities will likely assist them with their development costs. Not only does it allow them to defray some infrastructure costs, but it also decreases the total amount they must pay for their development loans, and could even enable lower loan interest rates.

Another method cities can take to promote this development pattern is to enable Tax Increment Finance (TIF) Districts in order to promote SCD's as a land use pattern within municipalities. The TIF program has been effective in recent years in many Texas municipalities, and would likely be an important tool in promoting SCD's in major metropolitan as well as rural areas of the state. Similarly, counties in Texas currently utilize Public

Improvement Districts (PID's) in order to promote development in county areas. Districts such as this could be granted only for SCD projects, thus encouraging more of these developments, enabling counties to obtain long term value capture.

Counties should also consider a flexible approach to obtaining the land use patterns that they would like to have. As an example, currently Texas counties require a minimum 1/2 acre lot size for residential lots which are served by septic systems. This requirement would prohibit the rural SCD analyzed in this rural case study, which occurs on 7,500 s.f. lots. In other states, conservation subdivisions on septic systems have proven successful on smaller lots, provided the open space areas are receiving areas for the septic discharge, and provided the soil tests to be adequate to receive such discharge. By providing such flexibility to the development community, counties can benefit by a higher likelihood of Sustainable Conservation Development.

Other options which can be considered, but are not directly addressed in this thesis, include potential assistance in promoting these developments from the State and Federal levels of government. Currently, many states in the nation, such as California, attempt to stimulate sustainable development in the state's communities through various legislative measures. In addition, the United States Environmental Protection Agency currently utilizes a Smart Growth Program in order to provide technical assistance grants for communities across the country who attempt to build more sustainable communities.

In all, the work conducted as part of this thesis has determined that Sustainable Conservation Developments offer substantial benefits to both urban and rural areas of Texas. There are many steps that can be taken at all levels of government in order to promote these developments. The long term benefit to Texas, both in its urban and rural areas, can enable the state to become a vibrant economic force in the attraction and recruitment of the creative class of the United States, as well as for baby boomers looking for a first-rate retirement alternative as compared to other areas such as Arizona and Florida.

In conclusion, Texas is a state which will be growing rapidly in the future. As discussed in the introductory chapter, the state will maintain a younger population compared to the U.S. in general, but is estimated to also have a lessened educational attainment compared to the U.S. This will likely be a costly burden with significant necessary expenditures in social services and a large percentage of poor and moderately poor residents. Sustainable Conservation Developments in rural areas, through the incremental housing method, enable these residents to afford and live in first-rate housing which, coupled with economic development in rural areas (such as that seen by the boon in West Texas wind energy production), may enable many working poor residents to move into the middle class. Similarly, in urban areas, the SCD development pattern can be a powerful attraction for both creative class residents as well as baby boomer retirees, thus stimulating economic development for major metropolitan areas of the state, and enabling higher levels of educational attainment in the process. Thus, in consideration of *only* economic concerns in lieu of resource and environmental concerns, the Sustainable Conservation Development pattern should be further analyzed by State of Texas public officials and initiated as a pilot program for use statewide.

APPENDIX A

STAKEHOLDER INTERVIEWS

Interviews with stakeholders involved in the development process have been conducted as part of this thesis, in order to assess their concerns and opinions about conservation design.

A.1 John Friesenhahn, Tract Homebuilder

John Friesenhahn is the president of Imagine Homes, a San Antonio tract homebuilder. In 2008, Imagine Homes was named the 'Single-Family Production Home of the Year' by the National Association of Homebuilders at the 2008 Green Building Awards. Mr. Friesenhahn is also a member of the San Antonio Planning Commission and the San Antonio Technical Advisory Committee.

1. What is your understanding of conservation subdivision design? In general, what do you feel are its benefits and detriments?

It is based on cluster development and higher density development along with the preservation of open space. It is good for preserving large areas of open space. It is bad in that, in San Antonio, the majority of single family lots are zoned 'R6' (minimum 6,000 s.f. lot size), which is too small already. Therefore, how can you go any smaller? Another problem is affordability. In conservation design, homeowners would be paying for land costs to set aside vs. a conventional subdivision.

2. As a homebuilder, do you see any specific advantages or disadvantages in marketing houses in this type of subdivision? Do you see any differences in regard to the housing type?

Being a greenbuilder, smaller sites can be sold if it is developed right. It is important to leave creekways natural. In our Stillwater Ranch development, we used an alternative pedestrian plan which enabled pathways through preserved areas. In a conservation subdivision, we may go with a 'greener' home than we typically do, if there is a market for it.

3. Would data from existing conservation subdivisions regarding increased sales velocities and lot premiums persuade more homebuilders to purchase homes in conservation subdivisions? If so, what types of homes would be more likely, custom or tract-built homes?

Real estate is localized, so it is difficult to apply it. If a study was conducted in a slow market, it would have to be differentiated from a study conducted in other markets.

4. Does conservation subdivision development correlate with sustainable home construction?

Yes. As a green builder, we may be more successful in such a development than a traditional builder. We would likely build a product which is greener than in our usual developments.

5. What level of interest will homebuilders have in subdivisions which include features such as rainwater harvesting and solar panel usage? Is it possible in this region of Texas to one day have a subdivision completely off the grid?

Based on homeowner's cost concerns, these features are still too costly. We have low utility rates in San Antonio, so it is difficult as an incentive. Also, there would need to be significant changes in the city's adopted code to allow for substantial green design elements. It would not be feasible on a large scale such as trying to build an off-the-grid subdivision.

6. Do you ever see the conservation subdivision as the predominant model for development on the fringes of San Antonio? If so, where?

Not necessarily. Maybe in areas in and around San Antonio which are located over the Edwards Aquifer Recharge Zone, or in creekway areas.

7. Do you ever see sustainable construction as the predominant model for development on the fringes of San Antonio? If so, where?

With improvements in technology, yes. It is tough right now to justify the cost spread, but it should be the standard in the industry in 5-10 years for our region.

8. Do you have any other comments you would like to add?

The developer determines the economic effects, which makes it difficult. The city needs to better understand the master planning process.

A.2 Kevin Coleman, Homebuilder

Kevin Coleman is the President of Earth Built Homes, a company that focuses on building commercial and residential structures utilizing compressed earth block.

1. What is your experience regarding sustainable construction? What went right? What went wrong? How do you compare it to conventional construction in Texas and in the U.S. in general?

I have had five years experience building sustainable buildings out of compressed earth block using lime and clay based natural plasters with non-toxic lime based paint.

I wish I could take some credit in having some great foresight in the green building craves that has stuck the U.S. due to global warming. However the truth is... A friend of mine wanted to build an adobe home which I thought was a horrible idea. But after researching adobe and compressed earth block, I found it to be a superior building process in my opinion. I also realized that there was a niche that needed to be filled. I would have to say that it was more dumb luck than anything.

In the beginning, trying to find sub-contractors from "conventional style building" that were willing to adapt to the necessary changes that are needed to construct out of CEB's, referring to plumbers and electricians for the most part. There were also "Doubting Thomases" in the potential clients that were worried about the blocks "melting away in a rain storm". We have since addressed these issues by showing plumbers and electricians alternate ways of running their necessary lines and with the clients we were able to ease their minds by showing them a stabilization process that we use for the CEB's.

As I said before comparing these products, I believe that CEB's are superior building product compared to convention stick building products. If you start to consider mold and maintenance problems as well as flammability and many other issues you find in stick frame construction, it is not hard to see how CEB's are superior.

2. What persuaded you to do a sustainable project? Was it common or against the grain in your area?

It was not me that needed the persuading. Once potential clients were able to view a finished CEB building and get a feel for a phase change material versus the conventional building material, virtually there has not been any resistance.

I would have to say it was totally against the grain seeing as how I am the only G.C. that I know of doing projects of any size compared to the hundreds of the conventional stick builders in South Texas.

3. What code requirements, if any, were in effect? Were there any difficulties in overcoming these requirements?

Normally we refer to the International Building Code due to the fact that local codes have not been implemented using CEB's as a building material.

So far we have not found any substantial resistance once we have show local officials that engineers are willing to sign off on this type of construction.

4. What advice would you give to builders and developers who are considering a green project, but don't have experience with sustainable methods or materials?

Do your homework and find someone that has done multiple sustainable building projects that will either be able to work with you as a joint venture or consult on as a needed base. This will help accommodate you on your learning curve.

5. What advice would you give to municipalities or other governing bodies regarding sustainable methods and materials?

I would ask them to use common sense and look at the oldest existing buildings on Earth and realize that they are of earthen construction. This should help ease their minds on the quality of CEB's or other sustainable building processes.

6. Do you feel that sustainable construction holds more promise in urban environments, rural environments, or equal potential in both? Why?

I believe that it could have equal potential in both as long as we are able to convince local authorities to adapt code requirements that will accept a variety of sustainable building processes.

A.3 Lori Ryker, Architect

Lori Ryker is the executive director and founder of Artemis Institute, a not for profit company that focuses on helping people understand the relationship between nature and culture. She is also the principal and founder of studioryker, an architectural design studio that focuses on design projects, research projects and writing.

She has also taught at Montana State University, North Dakota State University, Texas A&M and Auburn University. Dr. Ryker is the author of Mockbee Coker: Thought and Process and most recently Off The Grid: Modern Homes + Alternative Energy and Off The Grid Homes.

1. What is your experience regarding sustainable construction?

I was a partner in Ryker/Nave Design from 2000-2007 which had a construction component and currently principal of studioryker. Both design studios and construction component focused on sustainable architecture and alternative energy.

What went right? What went wrong? I do not think it is necessarily a question of "right" and "wrong", but degree of achievement or difficulty relative to achieving sustainable construction. In order to achieve sustainable construction one must be diligent to determine what materials are available in the area in which you will build, who the suppliers are. Also, the general contractor must be committed to the concept of sustainable construction, as well as be familiar with sustainable materials and practices.

Just about the only place in the country that is building sustainably to a high degree is the West, from North to South. Based on my research when I have had homes to build in parts of the country other than Montana, sustainable lumber is virtually impossible to locate, as well as flyash concrete mixes (beyond the minimum) for foundation. Both of these materials are typically the base of most construction. Certainly in Montana where most of my work has been built. Based on my experience for building in Texas, outside of Austin, Texas it is quite difficult to find a builder to focus or even have general knowledge of sustainable materials or practices. When the builders do have this knowledge they add a premium to their bids making it difficult for a general (even middle class) client to be able to afford them. Therefore, the best way to make the un-educated builder employ sustainable materials is to know ahead who the supplier is for the product, how to get the product to the builder and the cost. The architect must work beyond their normal responsibilities to achieve sustainable construction.

How do you compare it to conventional construction in Texas and in the U.S. in general? Conventional construction is easier because it does not require a new skill set, or knowledge base, therefore it is cheaper, it is the non-challenging mode for builders. It is important to understand that most architects do not become architects first in order to make a living/profit, but because they have a love of the arts or creativity, which is typically combined with a sensitivity to the natural world. After their love of the arts, they also must make a living. Most builders (like most businesses that are not the arts) are doing what they are doing to make a living. There is typically not a second reason for them to be building. When you approach your work as primarily a money maker you will not go out of

your way to learn new knowledge or methods unless it can bring you a premium profit to your business. Money is the motivation. This attitude will only begin to change as people grow to have a general understanding and acceptance of the compromised position we have put the Earth in, believing in such conditions as global warming.

In general, the United States as a whole is ahead of Texas in terms of developing and following more sustainable construction methods. However, Austin is light years ahead of the United States in implementing strategies and marketing sustainable materials and methods of construction.

2. Do you see marketability as an advantage or disadvantage in Sustainable Construction?

Marketability is absolutely an advantage because marketability is how the American consumer gains general knowledge of a product, as well as understanding an inherent value of a product. For better or worse, we are a consumer society, this method is how we appreciate our cultural practices.

What price range would you want to be able to target for a successful development with Sustainable Construction?

The price range is relative to the market. Market varies across the country with cost of living and cost of construction. It costs much less to build in the south than the North, or in environments where products are not as readily available or weather poses more obstacles. Typically sustainable construction adds 10% to the cost of construction. What must be figured in with this initial cost is the long term returns on lower energy bills and the consideration for not incorporating materials that are limited and non-renewable resources. The first issue is much easier to “sell” and calculate, the second issue is one of ethics. You need a community with such an ethic to accept the value added to the premium cost of construction.

3. Can affordable housing be achieved with sustainable construction?

Again, this is a relative term, but Of course it can be achieved and is being achieved across the country. Some through government incentives, others through a cooperative attitude with the architect, builder and developer.

Is incremental housing (as posed by Richard Burnham) a valid option in the U.S. for building affordably and sustainably?

I do not believe that I agree with the incremental theory, described below. I have given this idea some thought, independent of this author and your question. It would take some serious planning to make this concept affordable because so much cost goes into the infrastructure. And every time the infrastructure is added to (plumbing, waste, A/C) the costs will be more than if the whole house was built at one time. Unless the infrastructure is built in the first round of construction, or there is a pre-design of the end result and the tie-ins have some “soft” connections reducing the costs of tying in to the system with each addition. The best way for this system to work would be to simply add space that requires no tie-ins. No additional bathrooms, kitchens, increase in heating or cooling, or these work on an independent system, such as hot water on demand, composting toilets, solar hot water heaters... But I also fear that people will buy into this and end up living with a family of 4 in 500 sq ft and it will become slum-like from the physical pressure.

4. Would you see potential for a successful collaboration, in terms of marketing and development potential, with a combination of a ‘sustainably constructed’ subdivision and a ‘conservation subdivision’? Why and what factors are involved?

Yes, I think that if people understand the advantage and relationship between the idea it should be a win-win in their mind. However, it is not always the case that people who are interested in sustainable construction/alternative energy will be interested in land conservation. The energy and materials issue can come from a self-fulfilling direction, saving money. Where as land-conservation is typically argued for the benefit of wildlife, which has secondary benefits to people. Certainly there could be an argument made that land conservation provides better “view” corridors and preserves and retains land value

because it has not been built on, and will be an anomaly in the future compared to the typical development model.

5. Is it possible in Central Texas to one day have a subdivision completely off-the-grid (OTG)? Of course

Would that subdivision need to be constructed out of a particular material (papercrete, CEB, etc.) in order to be viable for an OTG subdivision?

I do not believe an off the grid house or subdivision predisposes it to a particular material. However, in order to minimize the energy required for the house/subdivision it is necessary that the construction be a system that is as energy efficient as possible. This means high insulative values and homes oriented to take advantage of passive cooling (prevailing winds) with deep overhangs to allow for minimal use of air conditioning. It will be much easier and efficient/ cost effective to put an entire subdivision off the grid because the subdivision can act like a coop and generate its own energy at a larger scale, rather than each individual home owner buying a small wind turbine and pv solar array. This strategy is the direction we must be moving in (rather than individual homes being off the grid) if we want to make a true difference in our energy consumption, and reduce the stress put on our out of date energy generation systems.

6. Do you see different levels of 'green' construction?

Yes of course there are different levels. For instance, it is much easier to install interior finishes that are "green" such as cork floors and paperstone counters, than find widely available structural members (framing, etc).

In your opinion, what prevents the highest level, or even a medium level of green construction methods and materials from being utilized for the majority of American home construction?

Availability, cost of construction, cost of materials, consumer knowledge of product and benefits. Because we are a free market economy alternative energy products such as pv solar arrays are purchased/supplied to the interested customer, and a high demand can affect availability and drive the price up. IN the instance of pv arrays, Germany and Japan are buying all of the American made pvs, driving the price up and leaving less available for the US. We need to create and support a market such as PVs so they stay in the US.

7. Do you ever see sustainable construction as the predominant model for development in Central Texas?

I see sustainable construction becoming the predominant model for all developed countries, it is a matter of global survival. Central Texas can either lead or be forced to follow.

Does the Central Texas region have particular advantages/disadvantages to building sustainably?

Not that I know, but I am not familiar enough with the micro-climate or local materials.

8. How do you think the retirement of the Baby Boomer generation may coincide with the green development movement?

I am not an expert in the desires of Baby boomers. So my answer is only speculation. But I have read that the baby boomers are more interested in alternative styles of living, and there are a lot of them. There are at least 2 recent developments in Florida that are counting on this the green interests of Baby Boomers to buy into their models. I believe their development had a very small surcharge for the "green" strategies. However the current economy is having a great effect on baby boomers as consumers, and the economy may also create a long term difference in their investments.

9. What can speed up the level of design and development of sustainable housing? (i.e. Congressional action, incentives, etc.)

Government incentive and support of the industries, over the continued support of non-renewable energy methods. Knowledge of what is available to the mainstream public so that green and alternative becomes normal, not unusual. So much of this is cultural mind-set, not economic. If you look at the long term returns most alternative and green pays for itself in 10-15 years. While geo-thermal energy pays for itself in 7 years. With the rising

costs of municipal energy (non-renewables) the payoff is rapidly shortening. The public needs to understand this, but they don't.

10. Do you have any other comments you would like to add?

None

A.4 Stephen Colley, Architect

Stephen Colley is the Green Building Coordinator for the San Antonio Metropolitan Partnership for Energy, and a LEED accredited architect in the San Antonio region.

1. What is your experience regarding sustainable construction? What went right? What went wrong? How do you compare it to conventional construction in your region and in the U.S. in general?

Observing minimal results and not enough participants in the construction and design/architecture industry. Went right – acceptance from the local utilities, city and county government. Went wrong – still facing resistance from the bulk of builders/architects/designers, but I'm not sure why beyond the reluctance by industry to step up in a declining economy and fewer housing starts.

2. Do you see marketability as an advantage or disadvantage in Sustainable Construction? Why or why not?

Yes, but marketing message is aiming for the wrong target. It's currently being driven by word of mouth at the grassroots level, which is still a small percentage of what's needed.

3. What price range would you want to be able to target for a successful development with Sustainable Construction? Can affordable housing be achieved with sustainable construction? Is incremental housing (as posed by Richard Burnham) a valid option in the U.S. for building affordably and sustainably?

See, that's the problem. People are too hung up on initial costs. One cannot build a house cheaper than what's being built without breaking the building code. Initial construction costs are about 20% of the total cost of a building over a 20-30 year period. Average age of a house is 37 years. PEOPLE AT ALL LEVELS STILL DO NOT REALIZE THAT A 5-10% INCREASE IN COST OF INITIAL CONSTRUCTION CAN SAVE 40% OR GREATER OF THE TOTAL LIFE-CYCLE COST OF A HOME. First step is to get everyone to realize this, then we can talk about what a 2% increase in cost can do (energy savings of 15% or better) if people are still hesitant, and then show examples of what can be done with a higher up-front investment in green design and construction. Yes, incremental housing is smart. So is building only what you need and not worrying about "resale" nearly as much as people do.

4. Would you see potential for a successful collaboration, in terms of marketing and development potential, with a combination of a 'sustainably constructed' subdivision and a 'conservation subdivision'? Why and what factors are involved.

The way a conservation subdivision is described in the UDC goes a long way to define a good set of environmentally-responsible development practice. Regarding "sustainability", maybe not so much on the purest definition of the word... unless we decide to keep the most valuable (raw, undeveloped) land alone and concentrate on building in brownfields and closer to the city core where infrastructure already exists.

5. Is it possible in Central Texas to one day have a subdivision completely off-the-grid (OTG)? Would that subdivision need to be constructed out of a particular material (papercrete, CEB, etc.) in order to be viable for an OTG subdivision?

Yes, of course. It would definitely have to be built in considerably different ways from conventional construction. Start with design, basic conventional house designs are wrong for our climate region. The closest I would want to be to stick construction would be a smaller house properly oriented to solar heat gain and prevailing winds with a highly reflective roof and an "unvented attic" with urethane foam insulation in the walls and against

the roof deck and ENERGY STAR appliances, LED lighting, solar powered clothes dryer. Etc... Papercrete would be nice, but that's still a little ways off. I'd be really happy with compressed earth block, but that's a hurdle too. Too bad very few know the many advantages of these kind of construction systems.

6. Do you see different levels of 'green' construction? In your opinion, what prevents the highest level, or even a medium level of green construction methods and materials from being utilized for the majority of American home construction?

Yes. Lack of education on the part of all major players, the public, builders (including sub-contractors), architects, engineers, realtors, lenders, government officials, materials providers, real estate editors, appraisers, insurance underwriters, schools of all levels. Why do we continue to base our most expensive purchase (of a home) on finding the cheapest house per square foot? We don't use that kind of thinking when buying cars or clothes. Why for our houses??? It's just nuts. And it borders on incompetence on the part of industry leaders who should know better.

7. Do you ever see sustainable construction as the predominant model for development in Central Texas? Does the Central Texas region have particular advantages/disadvantages to building sustainably?

Yes, primarily because we will soon no longer have the choice to do stupid things like we do now based on current trends in energy costs. Advantages – moderate winters, decent rainfall (historically), appropriate resources. Disadvantages – the mindset that Texas is an "Oil" state, and that we could drill our way out of high energy prices. We haven't been an energy exporting state since the mid 1990's, and we haven't gotten it through our collective heads yet.

8. How do you think the retirement of the Baby Boomer generation may coincide with the green development movement?

Being a boomer myself, I could only wish my peers could re-discover much of what we used to believe in forty years ago. It's a hell of an opportunity if we could just recognize it.

9. What can speed up the level of design and development of sustainable housing? (i.e. Congressional action, incentives, etc.)

Further upward spikes in energy prices, another national crisis or two in the middle east. Read your history. Depending on Congress? HAH! They are still too beholden to their lobbyists and don't really care much for what's going on in their districts. The amount of energy wasted from all the uninsulated homes in America equals in btu's (energy) to the amount of oil we import from the Middle East. Believe me, insulating all those homes would cost considerably less than what we spend in obtaining oil under the sand of countries who love to have us under their control. Congress does NOTHING until pushed to the edge of disaster, and even then, the first movements occur at the local level.

10. Do you have any other comments you would like to add?

None. These are my personal opinions, and not those of MPE or its funders.

A.5 Pliny Fisk, Sustainability Expert

Pliny Fisk is the Co-Founder of the Center for Maximum Potential Building Systems in Austin, Texas. The Center is recognized as the oldest architecture and planning 501C3 non-profit in the U.S. focused on sustainable design. In addition, Pliny also serves as Fellow in Sustainable Urbanism and Fellow in Health Systems Design at Texas A & M University where he holds a joint position as signature faculty in Architecture, Landscape Architecture and Planning.

Pliny's special contributions in the research field have been principally in materials and methods; from low-cost building systems development referred to as open building, to wide

ranging material development that includes low carbon and carbon balanced cements, and many other low impact materials. He has also developed an alternative land planning and design methodology referred to as Eco-Balance Design and Planning.

- 1. What are the main benefits of eco-balance planning? Do governments stand to gain financially from this method by means such as power plant savings, etc? Can developers obtain short term returns on their investment in eco-balance approaches or is it more long term?**

As we tend to state that projects are 'green' or 'sustainable', this can mean something different versus actually doing zero-energy, zero waste, zero anything. We can actually achieve 'sustainable' design by balancing resources. There is virtually nothing going on now in development that has the framework to pull off balancing. This is disturbing since we have sustainability being pushed, but there is not a balance of cycles. Eco-balancing is a procedure in which this can be done.

Eco-balancing talks about everything, including materials. Different techniques can be utilized, and are all interrelated. Water savings on one hand relates to power plant savings. So the collective eco-balancing of different elements helps the balancing of all units as a whole. Materials, for instance, can be net carbon-negative, or net carbon-positive, so the overall combination of building materials can be carbon-neutral. Also, it is important to consider the construction phase of the building. The amount of energy going into the building may be much larger than any possible operational energy conservation methods. Also, *more* energy is used in water in buildings than in buildings.

- 2. Can governments obtain short term returns on their investment in eco-balance approaches or is it more long term?**

This has never come up. It only comes up with developers who are looking at their numbers

- 3. When we talk about eco-balance planning, particularly in relation to more urban, T-6 type systems, are we going to get there by a majority of public investment, private investment, or an integrated public-private partnership approach?**

It only works if there is a successful collaboration of public and private interests.

- 4. Does South Texas have particular advantages/disadvantages to living sustainably, compared to other areas of the world such as temperate forests or arid deserts?**

The holding capacity in deserts for water is terrible, but is great in forests. So in terms of water resources, South Texas is somewhat in between. It is very important when considering sustainability in South Texas in the future to make water resources a key consideration.

- 5. In my development proposal, I have largely balanced three elements of sustainability: water, energy, and materials through compressed earth block. However, food production and air balancing have presented significant challenges. Is it possible to make these elements more feasible from a financial perspective, or will they always be the most difficult parts of sustainability for urban areas to achieve?**

Compressed Earth Block will not work unless it is insulated on the outside. As to food systems, it may not be possible to balance the food needs onsite as it can be very difficult. Air balancing can also be a significant challenge depending on your site production limitations. At Verano they have chosen two elements to balance: water and energy, and I think those are two of the most important for the region.

- 6. In your opinion, how will we make the most impactful change possible in terms of integrating the eco-balance approach into our public planning and private**

development patterns? (i.e. – congressional action, government incentives, marketing ‘green’, fuel savings)

John Knott has lectured and given spreadsheets on different credit opportunities, and can be a resource for that information. They’ve proven that the economics do not work for projects like this unless these tax credits and other incentives are utilized.

7. **City South is a unique area in Texas where large expanses of open space are located adjacent to a major metropolitan area. In your opinion of this region and others like it, what has the most impactful potential in terms of both life-cycle balancing adjacent to urban areas and in agricultural return on investment? (i.e. – gourd farming, ranching, layered agriculture, etc.)**

Buffalo gourds can be used profitably for ethanol. They grow naturally in Texas. There are a lot of other options, and it depends on soil, microclimate, etc.

8. **Do you have any other comments you would like to add?**
None.

A.6 Randall Arendt, Conservation Design Expert

Randall Arendt is a landscape planner, site designer, author, lecturer, and an advocate of "conservation planning". He is Senior Conservation Advisor at the Natural Lands Trust in Media, Pennsylvania, and is the former Director of Planning and Research at the Center for London. In 2004 he was named an Honorary Member of the American Society of Landscape Architects, and in 2005 he received the American Institute of Architects' Award for Collaborative Achievement. He is the author of more than 20 publications, including Rural by Design: Maintaining Small Town Character, Conservation Design for Subdivisions, and Growing Greener, Crossroads, Hamlet, Village, Town: Design Characteristics of Traditional Neighborhoods.

1. **What are the major benefits to combining sustainable development with conservation subdivisions? Do elements such as rainwater harvesting, and low embodied-energy products correlate to conservation design and development?**
Sustainable development should be defined as having other components: transit friendly, solar orientation, mixed use, etc. The benefit is a better place to live. If they can be near parks, schools, and easy access to transit, it improves the quality of their lives. One question is how to introduce horticulture into urban areas, through community gardens and other means. I’m working on preparing lectures on these topics for Detroit. It is very simple and the research has been conducted: homes near parks appreciate better than homes not near parks.
2. **How can the two methods integrate in order to form the most effective development pattern?**
Every site is different, but we’d be looking for 25-35% open space in an urban setting. It can be integrated in ways that would be marketable and provide useful habitat. If provided with good habitat, unique species of animals can appear. In one design we attracted rare eastern bluebirds to move into an area with a conservation meadow.
3. **Is it feasible, from a financial and land use perspective, to have conservation developments in new urbanist style mixed-use projects, while preserving at least 25% open space? Is there a percentage of open space after which these developments lose their feasibility? (25%, 33%, 40%)**
35-40% can work, but there is market resistance. It requires 3-4 story buildings which is expensive and not desired by people. 60% open space can work with 8 story buildings, but its not feasible. New urbanist developments usually have about 20% open space, if not a bit more.
4. **What key differences exist between conservation subdivisions in urban environments versus those in rural environments?**

More open space in rural areas, as well as higher quality habitat. Larger blocks of land, greater connectivity, higher ecological quality, is available in rural conservation designs.

5. Do particular uses of open space within conservation subdivisions (aquaponic facility, farmers markets, agritourism, equestrian centers, etc.) provide more marketplace advantages for developers than other uses?

Yes. It is more beneficial to the residents to have added amenities, which is not simply open space. The nature of open space in urban designs is smaller and more fragmented, which limits the uses. In rural areas, habitat tends to be my preference as opposed to agriculture, except in very rural areas where you can do both. I would place a premium on bioretention, native retention of species in urban areas, quality of life in adjacency to cafes, etc. Community gardens are great in urban areas.

6. Do you see significant emerging markets for conservation developments in the future, such as baby boomers, young professionals, or general population?

Its already happened. Single parent households are an emerging market also. They don't have a lot of time, so they need a small yard, but they want to relax and enjoy life in their own neighborhoods. Open space and amenities are crucial in achieving that demand.

7. What do you think about the criticism of a limited affordable housing in new urbanist and also in conservation developments?

If they can sell to a higher income group, they always will. Nothing is more inherently expensive in conservation design than in traditional design. In both the new urbanist developments as well as conservation subdivisions in the U.S., what has made them more expensive is that they are highly desired by homebuyers. Affordable housing can be done as a density bonus, but it needs to be a requirement also. We need affordable housing to have balanced developments.

8. Are there any other comments you would like to add?

None.

A.7 Richard Milk, Community Development Coordinator

Richard Milk is the Community Development Coordinator for the City of San Antonio Planning and Development Services Department. He has been integral in implementing a form-based code based on the principles of new urbanism into the City of San Antonio's development code. Prior to this position, he served as Senior Planner for the City of San Antonio managing Tax Increment Financing (TIF) Districts within San Antonio.

1. What is your experience regarding sustainable design and development? What went right? What went wrong? How do you compare it to conventional construction in Texas and in the U.S. in general?

My experience in sustainable design and development includes:

1. Developing codes that support sustainable development, namely the Smart Code / Form Based Zoning District (FBZD).
 - o *Successes:* the City was able to review the Smart Code template, make adjustments, and adopt it as the FBZD in time for it to be used for the Verano / Texas A&M project. The FBZD is a workable transect-based development framework that allows a variety of sustainable greenfield projects to be designed and developed. One of the key innovations (compared to other Smart Code-based codes) is the creation of a "Sustainable Design Option" that allows density bonuses if projects include a significant amount of sustainable design elements.
 - o *Needs improvement:* We were initially unable to adopt the FBZD city-wide, nor include an infill option. We are currently working on filling that gap.
2. Implementing tax increment financing (TIF) project incentives that support sustainability

- *Successes:* At the incentive level, we have aligned our most significant incentive (TIF) much closer to sustainability goals today than 5 years ago. The 2006 TIF manual (of which I was the principal author) required that projects be designed as walkable, compact, mixed-use neighborhoods. A menu of development pattern options (described below) is provided in the TIF Manual. The TIF Manual also prescribes pro-forma analysis and reporting procedures that ensure the long-term fiscal health of the City – a key element to sustainable development. I was principal project plan author and editor for 3 existing reinvestment zones, for which the City was able to attract more than \$77 million of private investment with \$14.5 million of public investment.
 - *Needs improvement:* The next round of TIF program rule revisions is focusing on stronger connections to other programs, more flexible affordable housing provisions, and procedural improvements.
3. Implementing codes that support sustainable development, namely the Urban Development (UD) Zoning District, Infill Development Zoning (IDZ), and various Use Patterns (TND, TOD, Commercial Center, Commercial Retrofit)
- *Successes:* the 2006 TIF manual (as described above) proved a powerful incentive for developers and builders to try something new. These development patterns had already been adopted in the UDC, but few had been attempted. One of the early projects, Hunters Pond, won 2006 Best Residential Project of the year as awarded by the San Antonio Business Journal. Among the project innovations included modern alleys, a highly interconnected street system, and a strong mixture of housing types within the same development: detached houses on large lots, medium lots, and small lots; townhomes; duplexes; and zero-lot-line houses.
 - *Needs improvement:* The menu of development patterns includes some options that have yet to be attempted – Commercial Retrofit, TND, TOD, and Commercial Center. The TOD pattern is being reviewed and revised; the others may also benefit from a closer review for effectiveness.
4. Project-specific design and development review, namely Hunters Pond, Palo Alto Trails, Rosillo Ranch, Verano, River North
- *Successes:* At project levels, we have now worked through many of the review, implementation, and construction details at least once, and are starting to see some development hit the market. Street standards are different than conventional development, so we have worked through street-design questions with traffic engineering and the fire department, as well as inspectors in the field. Hunters Pond has proven to be a strong project, and provided us a chance to work through street tree, sidewalk, and alley implementation procedures. Verano takes sustainability to a completely different level. It is a much larger project, encompassing a full range of neighborhood types, from rural Hamlet to urban Regional Center. Verano also pays much closer attention to stormwater drainage, mixed-use centers, and integration with transit service.
 - *Needs improvement:* Our experience with Hunters Pond and Verano is that the learning curve for developers, engineers, and builders is fairly steep. The amount of work and planning that goes in up front is considerable. The City needs to establish a comprehensive education program to help the private sector overcome the learning curve. Infill projects have also proven to be more difficult to incentivize and work out. Here again, the level of planning work that is required in an infill context is exponentially greater than, and qualitatively different from, even the largest greenfield projects. The City also needs to establish education and community outreach systems specifically to support infill initiatives.
- 2. Is sustainable development common or against the grain in your area? Why?**

The challenge is to reconcile the short-term perspective of builders and developers, who need to make their money in a reasonable time-frame, with the long-term perspective of sustainability.

The conventional development system includes many players who have developed mechanisms to make resources available to developers quickly and cheaply, including lenders and suppliers. However, sustainable development often requires significant changes to this system. Instead of pods of single-family product with a known risk factor and known financing assumptions, lenders now need to evaluate a mixed-use neighborhood where land use, retail type, and housing types are bundled in a way that is new to them. Additionally, there are many additional factors that can come into play with sustainable development (affordability, transit, new street design, or new kinds of infrastructure). The market alone is not just unfamiliar with these issues, but simply not structured to provide them, and government action is necessary to accomplish long-term public goals.

Another way to look at it is to say that sustainable development goes against the grain only if it goes against market forces. Locally, the vast majority of builders respond almost exclusively to market signals; only a handful work on the basis of state tax credits and local incentives. If sustainability goals can be meshed with market activity (such as is being encouraged by the USGBC's LEED ratings), this is the simplest and most effective way to change the quality of 99% of development and construction activity.

3. What code requirements that you are aware of prohibit sustainable development methods and materials within municipalities?

The biggest regulatory hurdles to sustainable development are conventional street design and traffic engineering practices. Many practices in these fields assume that streets are primarily if not exclusively for the efficient use of automobiles, and that higher automotive speeds equal higher efficiency.

These assumptions make it difficult to integrate effective transit, safe bicycle facilities, and significant pedestrian-oriented activities. For instance, some of the UDC regulations for street dimensions assume a design speed of 45 miles per hour, and make no provisions for slower streets. It has been shown, however, that keeping automobile speeds to less than 30 miles per hour makes for a much safer street. Currently, the UDC makes it very difficult to design a slow, safe street.

The ITC recommended practice, Context-Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities, provides a helpful alternative. When the ITC fully adopts this manual, a complete set of planning and design parameters for streets will be made available to traffic engineers – for a wide range of design speeds and contexts. The key idea is that streets should be designed to support immediate contextual activity, balanced against long-distance regional mobility needs.

4. Do you feel that sustainable construction holds more promise in urban environments, rural environments, or equal potential in both? Why?

Sustainability can and should be practiced across the urban-rural spectrum of contexts. It is important to note real differences between contexts, and apply only the tools appropriate to that context. For instance, a green roof program will have a much greater impact in an urban setting with large proportions of impervious cover. Rural settings can take advantage of approaches that are more land-intensive, such as vegetative swales and retention basins.

The creation of urban, mixed-use neighborhoods can have a tremendous impact on carbon emissions. The lowest carbon-footprint per capita is found in highly urbanized areas like New York City or San Francisco. By reducing reliance on private automobiles and thus reducing vehicle miles traveled, urban neighborhoods support regional sustainability targets more than suburban neighborhoods where all trips require automobiles.

5. Do you feel there are key sustainable construction methods and materials that are more important than others, or that there should likely be a mixture? (rainwater harvesting, papercrete, pv array)

As mentioned above, the key methods and materials will vary by context. Our discussions with regulators and developers have led us to take a performance-based approach that is neutral when it comes to specific materials, methods, or techniques. The FBZD, for example, sets performance targets that can be met in a number of different ways that vary according to context, cost, and developer preference. This approach also reduces the number of code edits: a performance-based code allows for future technologies and innovations to be developed and implemented without future code amendments.

6. What do cities need to do to promote sustainable construction methods and materials? What have cities done right/wrong?

The Transect has proven to be a very useful tool. By arranging and presenting six potential contexts on an urban-rural scale, the Transect helps us organize our thinking about the differences between the contexts. The Transect is a good analytical tool, describing what currently exists in a City. It can also be customized to prescribe character unique to specific localities. By looking at all the elements that constitute a sense of place – including street furniture, land use, street types, housing types – the Transect helps ensure consistency of character within each context.

7. Do you have any other comments you would like to add?

San Antonio can benefit from a growing set of national networks related to sustainable development. The Congress for New Urbanism (CNU), the Urban Land Institute (ULI), and the US Green Building Council (USGBC), to name a few, provide valuable resources in the form of case studies, technical assistance, and contacts. All three organizations have growing membership in the San Antonio area.

APPENDIX B

SUSTAINABLE BUILDING MATERIALS

B.1 Compressed Earth Block (CEB)

Compressed earth block is basically an adobe block of clay, sand, chopped straw, lime, and water. However, unlike adobe, the blocks are then pressed using a mechanical press. The result is a block that is not only stronger, but more moisture-resilient than adobe with little to no curing time necessary. Typically, 6-8 persons are required to construct block using a mechanical press, making CEB construction moderate in labor intensiveness. Also, the strength of the blocks enable the walls to be load bearing without wood or steel studs. The R value of the walls are only 0.25 per inch, but the thermal massing values are high, and CEB construction outperforms adobe walls in testing. Thus, due to its all around superior construction performance, CEB earns an **Excellent** score, and eliminates the need for significant consideration of adobe as a material in this thesis (Morony, 2004).

B.2 Papercrete

Papercrete is created as a block, made from re-pulped paper fiber, Portland cement or clay, and silt. The paper is easily obtained from newspapers, lottery tickets, or other readily available materials, and enables the papercrete blocks to be much more lightweight than CEB or concrete block, and very easy to work with. The R value is a very impressive 2.5 per inch, translating into an R35 insulation value for a 14" papercrete wall, vastly outperforming stick-frame construction. The blocks do, however, need structural members of wood or steel for load bearing walls. For smaller rooms, papercrete may be built with a vaulted dome ceiling without these structural members.

Overall, these blocks are highly insulative, sustainable, easy to build with, and allow for a finished product with the look and feel of adobe. For this reason, papercrete earns a score of **Excellent** (Rabon, 2008).

B.3 Rammed Earth

Rammed Earth construction is an application in which earth is mixed with cement and poured into wall forms, approximately 16" thick. Rammed Earth walls provide an R value of only 0.5 per inch. However, it has tremendously high thermal mass properties, similar to adobe. This enables it to be among the best materials in overall home energy efficiency. Rammed earth also utilizes earth as the main building ingredient, enabling a 'green' construction footprint. On the downside, rammed earth construction is highly labor intensive due to the bulk of subsoil required. It typically requires heavy powered moving equipment in order to lift the soil mixture into the forms, as well as mechanical equipment to tamp the soil into the forms. Rammed Earth, overall, is an **Above Average** sustainable building material in the Texas region (Building Green Website, 2008).

B.4 Strawbale

Strawbale is a very useful building material in the Central Texas region and the state in general. It has an R value of 1.25 per inch, better than stick-frame construction. Walls are typically 24", which translates into an overall insulation value of R30, double that of stick frame construction.

Strawbale construction is usually very easy and is among the lowest in labor intensiveness. The straw is harvested annually, purchased inexpensively, and is handled easily due to the light weight of the bales. It is among the easiest material to work with for do-it-yourself homebuilders. However, wood or steel framing is necessary for load bearing walls due to the low strength of the bales. Also, moisture must be kept out of the bales during the construction process, and the finished bale wall must be heavily plastered in order to ensure

protection against moisture penetration, which can cause rot and decay. Overall, straw bale construction is efficient and sustainable for this region, earning it an **Above Average** score (Building Green Website).

B.5 Other Green Materials Considered

Other materials which have been considered for this thesis include the following, with brief notes as to why they were eliminated from consideration for the two case studies:

- **Adobe** – Less strength and moisture performance compared to CEB construction
- **Cob** – Time consuming construction method; requires substantially thick walls
- **Cordwood** – Insulative values not substantially high compared to conventional stick-frame construction
- **Earthbag** – Excessively labor intensive method
- **ICF** (Insulated Concrete Forms) – Significant embedded energy is required for concrete production

(Source: Building Green Website, 2008; Morony 2004)

B.6 Additional Materials

In many cases, recycled materials can accompany our main building materials. These can include, at minimum, recycled steel, recycled metal roofing, recycled windows, recycled materials for countertops, and others. In other areas, the homeowner may elect to purchase new materials which are sustainable in nature. Examples of this would be cork and bamboo flooring, which are harvested sustainably and are both derived from fast-growing, regenerative growth.

APPENDIX C

SUSTAINABLE TECHNIQUES & METHODOLOGIES

C.1 Aquaponic Farming Method

A relatively new arrival in American agriculture, called the aquaponic farming method or aquaculture, brings promise in conservation subdivisions. Aquaponic farming is a method that uses greenhouses to grow crops. The method grows the crops in a water tank filled with fish which can be harvested as well. The vegetables and fish are mutually beneficial to each other through nutrient transfer, and the result is high yields of crops which can be grown organically. (Nelson, 2008). A typical aquaponic farm can be located on as little as ½ acre, as shown in the rural case study in Chapter IV-Case Studies.

In a conservation subdivision, an aquaponic farm can qualify as a conservation easement, due to the flexibility of conservation easements. However, respecting the integrity of a conservation easement would dictate only allowing a small percentage of the conservation area to be taken up by aquaponic structures, approximately 5%.

Aquaponic is discussed in depth here due to the potential it has in conservation subdivisions. One option is for the homeowner's association to maintain ownership of the aquaponic facility and lease it out to local farmers. Farmers can grow crops commercially, while selling excess produce to neighborhood residents. Another option is for farmers to lease the facilities, with management assistance from neighborhood residents, with produce sold to residents for monthly fees.

This pattern produces strong benefits to conservation subdivisions. First, it captures an emerging trend in housing demand: reconnecting to the land and to where food comes from. Also, another trend is organic produce, which is currently in strong demand. Production of healthy food choices such as fish, shellfish, and a plethora of vegetables enables a community which promotes strong health by providing organic, homegrown food, along with subdivision conservation and sustainability. The market demand such types of subdivisions could leverage can be strong indeed. At this time, comparisons can only be made with other conservation subdivisions which have adjacent rowcrops and orchards. In these subdivisions, such as Village Homes and Prairie Crossing, substantial home value increases were seen over time. (Arendt 1999, 97-99, 112-114).

C.2 Incremental Housing Method

Although this thesis does not directly address affordable housing, the sustainable materials discussed here are affordable, and also enable do-it-yourself construction which makes homebuilding even more affordable. This leads us into the incremental approach to housing, where homes are built in small sections as necessary, similar to early American and current third world construction practices. This yields starter homes of 450, 600, or 750 s.f., an efficient living space for a single person or married couple with a baby. These small homes can be built by individuals, groups, or by builders at prices which are affordable to the homebuyer. Then, when family size increases and the funds are sufficient homeowners may expand their houses to 900, 1200, 1500 s.f., or greater (Burnham 1998, 55-58).

The affordability component is best considered for sustainable versus conventional stick-built houses located in rural areas of South Texas:

Conventional Home (1500 s.f.)

1. Purchased a 1500 s.f. contractor-built home for \$150,000 at a 6.0% fixed interest rate for a 30 year term. (\$100 per s.f.)
2. Total cost of **\$323,758** to the homeowner over the life of the home loan.

Incremental Home (1500 s.f.). *(The following estimates are based on past market costs, and are not affected by current market conditions and costs.)*

1. Constructed a 600 s.f. home utilizing a \$30,000 loan at a 6.0% fixed interest rate for a 15 year term. (Total cost of this loan of \$45,568 over the life of the home loan) (\$48.75 per s.f. estimate for 2008 straw bale construction utilizing unskilled labor for wall construction)
2. In year 5, constructed a 450 s.f. addition for \$25,421, paid by cash in full. (\$56.51 per s.f.)
3. In year 10, constructed a second 450 s.f. addition for \$29,480, paid by cash in full. (\$65.51 per s.f.)
4. Over 15 years, with a portion at a 6.0% fixed interest, the total cost of **\$99,340** to the homeowner.

(Sources: Mortgage-Calc Website, 2008; Burnham 1998, 92-97)

In this analysis, the result is a house which is less than 1/3 of the total cost of the same house over a 30 year span. The incremental home would be constructed after 10 years time, meaning that the conventional homeowner would have enjoyment of the entire 1,500 s.f. of the home for the entire 30 year span in which they were paying on the home loan, while the incremental homeowner would not. However, another way to look at this is that the incremental homeowner would not likely *need* that entire 1,500 s.f. until a later date. In the meantime, they would not have to pay heating, cooling and other maintenance costs for the entire 1,500 s.f. Furthermore, they would be able to add on as they chose, in whatever fashion made sense to them in the future, as opposed to the homebuyer who purchases 1,500 s.f. upfront.

APPENDIX D

URBAN SCD SUSTAINABLE METHODS & MATERIALS

D.1 Green Electrical Grid Power

In this case study, the density of the development will dictate that it is more feasible to draw from an electrical grid, particularly when that grid is powered by sustainable sources. In this location, the majority of power supplied from the local utility provider comes from coal-fired power. However, it is possible to purchase wind-generated power from West Texas for a slightly higher monthly cost, currently. In addition, the regional utility provider has made a commitment to the construction of a solar power plant in the near future. Therefore, in this urban setting, supplying each unit with a connection to the electrical grid is more preferable to having each unit produce its own energy needs.

D.2 Condensate Collectors

Air conditioners in the San Antonio region, due to its high humidity and high temperatures over long portions of the day, yield a considerable amount of condensation, which is typically removed from the site via pvc pipes which emit the condensate outside of the home. It is estimated that, in this region and with compressed earth building materials, condensate collection and reuse from residential air conditioners can yield an average of 6 gallons of water per day in San Antonio, with lower yields in winter months and higher yields during peak summer months. On this particular site, however, 511,000 s.f. of retail/office development can also contribute to condensate collection and reuse in the residential subdivision. At an average collection rate of 0.125 gallons per hour per 1,000 s.f., this yields a total of 3,066 gallons per day on average, or 4.9 gallons per day on average for this 614 unit residential subdivision. In total, these residential and commercial condensate collection systems will provide **10.9 gallons** of water per day to each residential unit.
(Source: Wilson, 2008; Kniffen, 2008)

D.3 Greywater Collection and Reuse

Greywater collection is in place on this site. Typically, greywater systems can be utilized to recycle water from sinks, dishwashers, washers, dryers, bathtubs and showers, and reuse it for landscape irrigation. Typically, this can reduce the total household need for water by an average of 30%, or **44 gallons** per day for average San Antonio residents. Since greywater is being created daily by residents, no storage is necessary, and the greywater can be a source of consistent daily irrigation of landscapes.
(Source: Wilson, 2008; Kniffen, 2008)

D.4 Rainwater Collection

Rainwater collection is a vital component of this site, which averages 30" of annual rainfall. San Antonio residents average **147 gallons** of water consumption daily, which is less than the national average of 171 gallons, and less than most Texas metropolitan areas. For this case study, we will consider that greywater systems are utilized, reducing the average daily need for water by 44 gallons. In addition, condensate collection from air conditioners would yield an additional 10.9 gallons of water for each unit. Furthermore, every unit on the site will utilize xeriscape landscaping, which typically saves 25% of total water needs. This results in a total of 36.8 gallons per day. This would mean that, for our site, the average resident would need **55 gallons** of water per day. Although this figure is significantly less than the 147 gallons used on average in the region, this figure is still conservative, as no consideration has been given to residents conserving water for household use in this development versus conventional developments.

The estimate of roofline which can collect rainfall for this site is 50.75 acres, translating into 2,210,670 square feet of water capture ability. The total water capture potential, then, is 5,526,675 cubic feet of water per year. In converting to gallons, this would yield **41,450,063** annual gallons of water utilized via building rooftop collection systems. The total water needs for all uses on the site, including residential, commercial and office uses, is approximately **12,326,000** annual gallons of water. Therefore, all water needs on the site can be obtained via rooftop rainwater collection and reuse systems, with an excess amount of 29,124,000 gallons of water annually, which can safely be stored in local lakes and ponds on site and discharged as necessary. The total capacity for all lakes and ponds on site is 17,500,000 gallons, an adequate amount for both storing water in significantly dry times as well as for ensuring that there are always adequate water levels for outdoor recreation and wildlife usage.

Another necessary element in order to make this system effective is filtration and purification equipment which adds considerably to the cost of the system.
(Source: Gavioli et. al., 2008; Kniffen, 2008; Krishna, 2008)

D.5 Site Specific Landscape Considerations

This subdivision utilizes site specific location design in order to maximize efficiency and comfort for residents. The predominant wind direction in this area comes from the southeast, providing cooling breezes during the majority of months of the year. By careful siting of residential units, this breeze can be maximized, which is very important in this area in order to make outdoor spaces more livable in such a severe climate as San Antonio. To encourage this, the final design includes large greenspace expanses located to the south of residential sites in order to enable maximum wind channeling into residential front and rear yards. Further careful consideration in planting shrubs on site can further channel this breeze into patios and porches as desired by residents on their lot.

In addition, where possible trees are located along the south and southwestern exposures of the house in order to provide maximum shading of residential structures during peak summer months, where sun exposure to south and southwestern facing structures can result in strong energy losses for residents.

D.6 Roof Overhangs

Roof overhangs on the site are a minimum of 2', in order to enable large portions of residential structures to be protected from summer sun, thus reducing heat gain during peak summer months.

D.7 Xeriscaping

Xeriscaping on the site enables residents to save 50-75% of the water typically used to water residential lots, by incorporating native plants into the landscape. In addition, native landscape plants increase useable habitat for native insects and birds for our site, by providing the plants that they need for sustenance, and can contribute indirectly to the preservation of other species in other areas who are linked via the area's food chain.

D.8 Bioswales

This site utilizes bioswale technology, which is a landscape element for removing stormwater pollution on site. It is basically composed of pervious materials covered by landscaping, and contributes to the development's sustainability both by limiting stormwater runoff downstream, as well as stormwater pollution downstream. Bioswales provide a low-cost landscaping solution that contribute strongly to sustainability measures.

D.9 Compressed Earth Block

Compressed Earth Blocks, researched in Appendix B, will be utilized on site for the majority of residential, commercial and office construction. This will enable up to 80% of the building materials for the site to be obtained from the site itself. CEB systems enable the site to be developed with 75% less embodied energy than are used in conventional stick-built structures for residential units, as well as 70% less embodied energy than in conventional concrete block structures used for the mixed-use structures.

All units will enable significant energy savings for residents, businesses, and the school. In addition, insurance costs are reduced for homes and businesses alike with utilization of this material as it has significantly more resistance to fire damage. The upfront costs for building construction will be increased by 5% for compressed earth block construction of all on-site structures.

Compressed Earth Blocks are typically finished out with plaster to give an adobe-like appearance. The blocks can also be sealed to give a natural block-like appearance. In either case, they would likely result in residential, commercial and office units with a distinct Southwestern style appearance. This would blend in character with the regional area of San Antonio, and designs could further be developed in order to blend the structures into a mission style appearance in synthesis with the historic San Antonio missions. This is fitting due to the fact that these original missions were constructed of adobe, the same basic material as compressed earth block.

D.10 Sustainable Fly Ash/Concrete Roads

This site is constructed with concrete as the basic component for all road construction. From a sustainability perspective, concrete has significant advantages over asphalt roads, due to many reasons:

1. Concrete is lighter in color, contributing less to the urban heat island effect.
2. Concrete is a harder surface, enabling better vehicle fuel efficiency.
3. Concrete utilizes basic construction materials utilized in close proximity to construction sites, while asphalt requires both petroleum and significant embodied energy to construct.

Although concrete is superior to asphalt for sustainable road construction, concrete does utilize large amounts of water in order to prepare and construct with. In order to alleviate large amounts of this water, and other embodied energy, this site utilizes roads with 40% fly ash in the road mixture. Fly ash is a byproduct of coal-fired power plants, and enable road construction which has a useful life of 40+ years, rivaling the useful life of all types of road construction. In addition, another benefit of fly ash roads is that they enables road construction costs to decrease by 20%. (Source: Edil and Benson, 2007; Lahtinen, 2008)

Furthermore, this site was designed with a majority of homes being loaded via alleys instead of streets, with many homes facing green landscape expanses. This results in significantly fewer roads necessary. This reduces costs further for the developer, as they can construct alleys which are narrower.

D.11 Recycled Metal Roofing

Recycled metal roofing is a great choice for this thesis due to a number of factors: 1) 100% recycled aluminum roofing is available on the marketplace, as opposed to asphalt roofing which is not recyclable, 2) Metal roofing provides a clean surface for rainwater harvesting to occur, 3) Metal roofing has a longer life than do asphalt shingles, 4) Metal roofing does not utilize petroleum products for production, and requires less embodied energy than does asphalt

roofing, and 5) Metal roofing will allow an architectural style which blends into the overall area and works well with the main building material, compressed earth block.

APPENDIX E

URBAN SCD PRO FORMA DETAILS

E.1 Grading

Grading costs for the site are substantial. Significant land moving equipment is necessary in order to dig the pond and lake areas, as well as for site grading for roads. In addition, extracted earth during the 'cut' process is reused as the principle building material for the majority of on-site structures. Grading costs total \$1,500,000.

E.2 Paving

The paving costs are balanced by different elements. On the one hand, there is a significant road length due to the presence of alleys, which typically increases costs in form-based new urbanist layouts such as this. However, paving costs on site are mitigated by two factors. First, fly-ash is added to the road mixture, which is not only sustainable but also reduces concrete road costs by 20% (Mathur et. al., 2008). Second, the conservation design enables a large amount of homelots to front onto greens as opposed to roads. Compared to most new urbanist designs, this design has fewer roads, thus eliminating costly infrastructure. Therefore, there is an overall mitigation in road costs in this sustainable development as compared to typical form-based new urbanist developments. Total paving costs for the site are \$2,176,200.

E.3 Electric

Conventional electric utilities are placed on each unit on the site. Solar panels, an element added in the rural case study, are not put in place here. Therefore, electric infrastructure costs are the same as conventional development, and in this project total \$4,912,000.

E.4 Sewer

Sewer costs are the same as in a conventional layout, and are not modified in this sustainable development. Sewer costs for this development total \$1,852,500.

E.5 Stormwater

Stormwater costs are reduced by approximately 33% as compared to conventional development, and total \$1,073,880. These are conservatively estimated reductions based on both the existence of 33% open space as well as the use of bioswales.

E.6 Rainwater/Greywater/Condensate Systems

Rainwater/Greywater/Condensate Collection Systems - In full, these systems represent an approximate 33% increase over water infrastructure costs in a conventional development. While a substantial cost, these systems enable complete water independence for this development, a core aspect of sustainability. The overall cost for these systems for the site is \$4,985,500.

E.7 Building Materials/Labor

The compressed earth block structures are constructed at \$85 per s.f. for a total of \$62,628,000, the single-most expensive cost for the development. The building material costs include basic finish out of all for-profit structures on the site. The costs are reduced substantially due to a bare minimum of transportation costs involved. The compressed earth block is produced using on-site materials with small amounts of additional elements as necessary (Nelson, 2008). The overall square foot averages per housing type are listed below:

- Single-Family Units – 1,700 s.f. average
- Duplex Units – 1,000 s.f. average
- Cottages – 900 s.f. average
- Townhomes – 1,100 s.f. average

E.8 Parking Deck

The site is provided with one four-level parking deck, providing a total of 144 parking spaces, at a total cost of \$1,800,000 (Rogers, 2008).

E.9 Landscaping

Landscaping elements on the site include numerous elements. Forest understory and hedgerow areas are selectively cleared in some areas to enable residential viewsheds, with transplanting of trees into residential street trees where possible. In prairie areas, six goats and six sheep are provided with perimeter fencing which allows views into the pasture by adjacent residents. These animals provide goat cheese, goat milk, mohair, lamb meat and goat meat for adjacent residents, sold in the farmer's market. Additional landscape elements necessary include planting of grasses and landscape plants adjacent to lake and pond areas as well as in local parks. The total landscape cost is \$300,000.

E.10 Aquaponic Facility

The aquaponic facility is a considerable upfront cost for the developer, but one which provides sustained revenues through leasing agreements with local farmers. The expenditure for this facility totals \$500,000.

E.11 Farmer's Market

The farmer's market, although it could be owned, operated or sold by the developer, is intended to be an upfront investment by the developer which provides full benefit to the community. The arrangement works through the Homeowner's Association structure, and is flexible. Either the homeowners can lease the facility to local farmers and thereby collect revenues for residents, or the facility itself can be operated by local residents, allowing job creation for the community. The intention is for the developer to be able to market this aspect of revenue creation for residents, as well as the farmer's market itself, enabling stronger home sales. The expenditure for this facility totals \$500,000, in which the developer is providing a public good and receives no compensation in return.

E.12 Community Center

A mixed-use development of this size justifies the construction of a community center. In addition, it is a key 'quality of life' aspect of the development, especially in consideration of cottage homes for retired persons. Possible components which could occur in the community center include a future library, movie room, kitchen, daycare component, and community gathering space. The expenditure for this facility totals \$800,000, in which the developer is providing a public good and receives no compensation in return.

E.13 Consulting Costs

The cost for consultants on the project is the industry standard – 10% of overall development costs, or \$8,402,808 (Lemmon 2007, 1-10).

E.14 Development Fees

Development fees for zoning, platting, permitting and other associated development fees total an estimated \$1,000,000.

The equity footed for the project is \$9,893,080, or 10% of the project costs. Although the amount is significant, funding from a private institution would likely be unavailable without this minimum capital. The development costs, less equity, yield a total debt of \$89,037,808. With a 6 year duration of the loan and a 6% interest rate, the interest totals \$37,264,024 (Lemmon 2007, 1-10).

APPENDIX F

RURAL SCD PRO FORMA DETAILS

F.1 Rural Sustainable Conservation Pro Forma

In this pro forma analysis, all lot prices were increased 14.4% from the estimates for conventional homes in the area, based on the median average of property value increases for conservation lots (Clear 2005, 2-3). The revenue portion of the pro forma details pricing for a total of 30 homes and 20 duplexes. They are divided into 4 phases. Phase 1 includes the development of the aquaponic farm, which is planned to earn a profit during the first year and significant revenue over the development period. Thus, it is constructed first. Phase 2, started in the 1st quarter of the development's 2nd year, includes 10 lots with 6 single family units and 8 duplex units for a total of \$1,680,000 in Phase 2 revenues.

Phase 3 is projected to start in the 3rd quarter of the 2nd year, includes 15 lots with 12 single family units and 6 duplex units for a total of \$2,670,000 in Phase 3 revenues. The development's final phase, Phase 4, includes 12 single family units and 6 duplex units for a total of \$2,760,000 in Phase 4 revenues. Overall, the pro forma for this development yields a total of \$7,750,000 in revenues.

The property includes land acquisition costs of \$185,000, assuming a \$165,000 land cost and \$20,000 for closing costs and legal fees.

The development costs for the property are substantial, largely because of the sustainability elements which are incorporated into the design. However, one sustainability element actually reduced costs over conventional methods. Paving costs totaled \$121,005 for sustainable road construction, saving 20% versus conventional road costs. This includes a road with a large percentage of fly ash in the mixture, a byproduct of power plants, eliminating the need for 40% of concrete used in conventional roads, thus eliminating the cost and energy resources required to produce excess concrete (Lahtinen, 2008).

Grading costs total \$45,000 and include fine grading of home lots with power equipment only on building footprints. This does not compact the earth on the surrounding lot, which occurs in conventional development but which depletes soil resources and stunts vegetative growth in conventional subdivisions. The site is served by a community septic system, with every 5 homes connected to a system which empties into adjacent prairie land, providing nutrients for fertile vegetative growth. The septic costs total \$300,000.

Rainwater harvesting is provided to the site via individual cisterns dug underground adjacent to each homesite. The rainwater is used for the majority of water usage in the home, and includes both a water pump for increasing water pressure as well as water filtration equipment to filter water for all water uses except for drinking water. Additional filtration devices can be purchased by individual homeowners to achieve potable water. The total for the rainwater harvesting system for the site is \$600,000. To offset possible water shortages, 3 wells are provided on the site, at a total of \$75,000. The wells would be used very rarely based on calculation, but are necessary in order to provide emergency water for the site (Kniffen, 2008).

The site's residential units are powered by solar panels. Each individual unit has its own solar power system, for a total cost of \$560,000 for the site. In coordination with the solar power system, conventional electric utility infrastructure is provided. This means that this subdivision is not entirely off-the-grid. However, by bringing electrical utilities to each lot, grid intertie systems are possible. As mentioned in Chapter 2, these systems allow solar power to capture sun during the daytime, with an excess production being sent to the utility company with a credit to the consumer. During nighttime hours or other times when the solar panels are not producing energy, the utility power is then tapped into. This is a useful sustainability element, as it enables homeowners to either avoid the majority of utility bills, or to even make a profit from the utility company during peak production months. The total cost for providing electrical utilities with grid intertie systems is \$80,000.

The predominant construction material for this site is papercrete. As analyzed in Chapter 3, papercrete possesses superior potential as a sustainable material due to many

factors. In this development, utilization of the papercrete will yield a subdivision with a rustic adobe, mission-style appearance, fitting in character with the area as well as increasing marketability. The block is purchased from a papercrete manufacturer as pre-made blocks. The total cost of all constructed units, including all materials and labor required, is \$3,375,000.

Landscaping elements on the site include numerous elements. Forest understory is selectively cleared in some areas to enable residential viewsheds, with transplanting of trees into residential street trees where possible. In prairie areas, five buffalo are incorporated with fencing on the perimeter. Buffalo are more gentle on the grassland than cattle, for numerous reasons. First, they thrive on grasses that cattle will not eat. Also, their hoofprints leave tracks in the earth which collect water, and their dung is a natural fertilizer for grasses (Texas Bison Website, 2008). The total cost of all landscaping, including bison and fencing, is \$30,000.

The aquaponic farm is a state of the art facility constructed on 5,000 s.f. for \$200,000. The facility includes a rainwater harvesting system to provide for all water needs to grow vegetables and fish, as well as a solar powered system for water pumping and energy needs.

Accounting for a 10% consultant fee, which includes marketing costs, this is a total of \$548,602 (Lemmon, 2007). Finally, local development fees, including city and county plat and permitting review, conservatively totals \$100,000.

The equity footed for the project is \$150,000, a very small amount considering the project's debt. The development costs, less equity, yield a total debt of \$6,069,607. The total, with an average balance of 50%, is \$3,034,804. With a 2 year duration of the loan and a 6% interest rate, the interest totals \$375,102.

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