1998

Affordable housing for artists: a sustainable prototype

Maureen Ann Ness
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Affordable housing for artists: A sustainable prototype

by

Maureen Ann Ness

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF ARCHITECTURE

Major: Architecture
Major Professor: Mikesch Muecke

Iowa State University
Ames, Iowa
1998

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Graduate College
Iowa State University

This is to certify that the Master’s thesis of
Maureen Ann Ness
has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy
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INTRODUCTION

Although many architects and builders feel that designing for both sustainability and affordability is impossible, I believe that the only way we can afford to live is sustainably. Through the design of housing for artists, this thesis will demonstrate how a building can both meet the needs of its inhabitants and practice sustainable principles in a beautiful design. This Austin, Texas model can be used as a prototype for similar housing in other cities and for other environmentally friendly buildings.

Sustainability is a crucial issue for the energy-guzzling United States. “One BTU in twelve of world energy production is used to heat and cool the U.S. building stock.” Natural resources are limited, thus it is important for designers to be educated so they are able to choose building materials and systems which have the least possible impact on the fragile environment. The Rocky Mountain Institute states that the biggest energy consumers in the US “are not cars, but homes. In 1990, for example, American households consumed $110 billion worth of energy.” This project investigates means to design a building that uses as little energy as possible while maintaining a high quality of life.

Austin is an ideal site because of its commitment to building sustainably, as established by the Austin Green Builder Program which “assists owners and designers to develop sustainable business practices” and offers an environmental rating system for residential construction. The Green Building Conference defines sustainability as, “products, systems, buildings, and land planning that create and promote an environment for healthy human living which can be sustained into the future-unpolluted by its waste or byproducts; thus, preserving and maintaining our natural resources for future generations.”

As an architecture student, I am intrigued by the issue of architecture as art. Looking beyond the narrow view of architecture as merely form manipulation to a broader base which considers the needs of the building’s inhabitants and its impact on the earth, in addition to its form, is essential. As a former art major, I am interested in helping artists achieve a quality lifestyle by providing a space where they can afford to live and produce their art.

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2 Rocky Mountain Institute, A Primer on Sustainable Building (Snowmass, CO: Rocky Mountain Institute, 1995), 5.
3 City of Austin, “Green Building Program” (City of Austin, Austin, 1997, photocopy).
The struggle for artists to earn a living is a common theme throughout the history of art. The shortage of affordable housing in American cities further contributes to their plight. My goal is to create housing that is efficient, less expensive to operate, and therefore, more affordable. This thesis studies different types of community living and precedents for both artist housing and affordable housing in the US. I will advance these models further in the direction of energy efficiency without sacrificing their beauty or socio-cultural significance in my design for a community of 16-21 artists.

Culturally, Austin, the capital of Texas and a city of 514,000, is rich in its combination of American, Hispanic, and Latino heritage. Music is the most prevalent form of artistic expression in Austin, with at least fifty venues playing live music every night. Many small art galleries are spread throughout the city, and a new Austin Museum of Art is presently being designed by Venturi Scott Brown which will help to revitalize the downtown district.

The site I chose for this project is located at the edge of the downtown area in a lively residential district, with many amenities within walking distance. Austin’s climate is very hot and humid during the spring, summer, and fall months. The average rainfall is thirty-two inches a year.\(^5\) Thus, cooling and water issues are important considerations in this project. Given the site context, Austin’s history, the programme, and my own engagement with sustainable practices, I will contend that this thesis is a project of complexity.

The on-line version of The Sustainable Building Sourcebook is exactly the same as the printed version.
AUSTIN

My interest in environmentally responsible design led me to Austin, Texas, a city dedicated to becoming “green.” A sprawling city of 232.3 square miles,6 this capital draws 300 new residents every day.7 With such a large increase in population come many urban planning issues, most notably an attempt to revitalize the downtown area. A new Austin Museum of Art by Venturi Scott Brown will be one of the focal points of the development. Other additions to the downtown include a new Children’s Museum and Marketplace, a shopping and cinema complex which is only a few blocks from my site.

History

Austin’s rich architectural history began in 1839 when the city was founded by the President of the Republic of Texas, Mirabeau Lamar, who chose to create the capital city at the edge of the settled area of the Republic. Kenneth Hafertepe states, “It was a farsighted, almost visionary move: what was the edge of Texas in 1839 was to become, in less than a century, the center of a great state.”8 “The country,’ wrote Frederick Law Olmsted in 1854, ‘is rolling and picturesque, with many agreeable views of distant hills and a pleasant sprinkling of wood over prairie slopes.”9 Figure 1 illustrates an early plan of the city.

Lamar chose Edwin Waller to survey the city. Roxanne Kuter Williamson notes the influence of Washington, D.C.’s plan on Waller’s design:

The Texas capital was not to be given Washington’s exciting plan of diagonal designs and circles with radiating avenues. But in emphasizing principal buildings through their dramatic placement in the landscape, Austin reflects the influence of the national capital’s design. The standard grid plan was superimposed over the hills of Austin with sensitivity, and building sites were designated in an integrated and balanced overall scheme. A square grid-fourteen blocks deep, fourteen blocks wide-was centered on a narrow valley, or broad ravine, that ran most of the depth of the specified number of acres and led to a prominent hill at the far end. Rather than create the customary center square, Waller reserved the land on this hill for the future Capitol.10

Congress Avenue, 120 feet wide, leads uphill from the Colorado River to the Capitol Square. Williamson asserts, “Outside the city limits, on the next hill behind the Capitol grounds, forty

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9 Ibid.
acres were reserved for the future University of Texas (the core of the present campus). It is remarkable to what extent this original plan continued to be respected...The 1839 plan is still represented in the heart of Austin.” Hafertepe further states that:

Austin is often thought of, at least by old-timers, as an informal, casual, ‘laid-back,’ city, and so it frequently has been, both in architectural style and in lifestyle. But there is, as well, a strong counter-current, evident in the classicism of Abner Cook, the Renaissance dome of the 1888 State Capitol, the Beaux-Arts classicism of the University of Texas campus, and even in many contemporary projects.  

Examples of these styles are shown in Figures 2 and 3.

Figure 1. Map of Austin, 1873 (Roxanne Kuter Williamson, Austin, Texas: An American Architectural History. (San Antonio: Trinity University Press, 1973), 5.)

One of the most beautifully preserved examples of historic architecture in Austin is the Driskill Hotel. Utilized by visiting politicians and parents of the university students, the Driskill was built at the corner of Brazos and Sixth in 1885. Hafertepe states, “The architect, the ubiquitous Jasper N. Preston, gave Austin a monumental Richardsonian Romanesque building with great rounded arches and heavy rustication in the stonework.”

Elisabet Ney’s studio-residence is an intriguing example of a unique artist’s home of the late nineteenth century. Williamson describes the artist and her abode which combines a castle turret with a classical porch:

11 Ibid.
Everything about her - the trouser-like garments and togas and short hair, her persistence in calling herself ‘Miss Ney,’ and the man with whom she lived, ‘Dr. Montgomery,’ - delighted, shocked, and fascinated the people of Austin. Her combination studio and residence were equally individualistic, although perhaps not quite as unusual. A suburban area had grown up around the university in the [eighteen] seventies and eighties. ... It was here, on Waller Creek, at the very edge of the tract, that Miss Ney built her studio in 1892. ...The plan is extremely functional and totally personal, bearing no relationship to standard house plans of the period.¹⁴

Today, the studio is an interesting museum of her life and work, which includes many sculptures of European royalty, most interestingly, King Ludwig II of Germany, who also loved castles. The studio is a landmark of the popular Hyde Park neighborhood (Figure 4).

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Figures:

**Figure 2.** *Texas State Capitol* (Roxanne Kuter Williamson, *Austin, Texas: An American Architectural History*. (San Antonio: Trinity University Press, 1973), 92.)

**Figure 3.** *The Old Main Building, University of Texas campus* (Roxanne Kuter Williamson, *Austin, Texas: An American Architectural History*. (San Antonio: Trinity University Press, 1973), 92.)

Statistics

Two of the most interesting aspects of Austin are its cultural diversity and its highly educated population. Table 1 illustrates Austin's ranking among the 77 U.S. cities with populations of more than 200,000.\(^\text{15}\)

Climate

The data in Table 2 and Figures 5, 6, 7, and 8 indicate Austin’s hot and humid climate.\(^\text{16}\)

Table 1. Austin Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Austin</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 Population</td>
<td>514,013</td>
<td>23</td>
</tr>
<tr>
<td>African American</td>
<td>12.4%</td>
<td>52</td>
</tr>
<tr>
<td>Hispanic</td>
<td>23%</td>
<td>19</td>
</tr>
<tr>
<td>Asian</td>
<td>3%</td>
<td>28</td>
</tr>
<tr>
<td>Population per square mile</td>
<td>2260</td>
<td>61</td>
</tr>
<tr>
<td>Growth since 1990</td>
<td>10.4%</td>
<td>8</td>
</tr>
<tr>
<td>Over age 65</td>
<td>7.4%</td>
<td>71</td>
</tr>
<tr>
<td>Speak language other than English at home</td>
<td>22.4%</td>
<td>26</td>
</tr>
<tr>
<td>Over age 25 with a college degree</td>
<td>34.4%</td>
<td>4</td>
</tr>
<tr>
<td>Families headed by one parent</td>
<td>25.5%</td>
<td>49</td>
</tr>
<tr>
<td>Median household income (1996 est.)</td>
<td>$34,000</td>
<td>46</td>
</tr>
<tr>
<td>Households receiving public assistance</td>
<td>4.5%</td>
<td>72</td>
</tr>
<tr>
<td>Below Poverty Level</td>
<td>17.9%</td>
<td>41</td>
</tr>
<tr>
<td>Housing built before 1939</td>
<td>5%</td>
<td>67</td>
</tr>
<tr>
<td>Housing renter-occupied</td>
<td>59.4%</td>
<td>10</td>
</tr>
<tr>
<td>Workers using public transportation</td>
<td>5.1%</td>
<td>36</td>
</tr>
<tr>
<td>Increase in labor force (1980-90)</td>
<td>43.9%</td>
<td>9</td>
</tr>
<tr>
<td>Women in labor force</td>
<td>65.6%</td>
<td>5</td>
</tr>
<tr>
<td>Violent crimes per 10,000 residents (1996)</td>
<td>71</td>
<td>74</td>
</tr>
<tr>
<td>Property crimes per 10,000 residents (1996)</td>
<td>711</td>
<td>41</td>
</tr>
<tr>
<td>All major crimes per 10,000 residents (1996)</td>
<td>782</td>
<td>46</td>
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http://www.austin360.com/news/aas/thisis/97thisis/primer/vitals.html This table lists the U.S. Census Bureau and the FBI as its primary sources.

Table 2. Climate Information

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Average last freeze</td>
<td>February 26</td>
</tr>
<tr>
<td>Average first freeze</td>
<td>December 2</td>
</tr>
<tr>
<td>Average number of days below freezing</td>
<td>21 (most: 44 in 1939-40)</td>
</tr>
<tr>
<td>Average number of days 100 degrees and above</td>
<td>10 (most: 40 in 1963)</td>
</tr>
<tr>
<td>Average snowfall</td>
<td>.9 inches</td>
</tr>
</tbody>
</table>

Figure 5. Average high and low temperatures (degrees Fahrenheit)

Figure 6. Average relative humidity percentages
Site

The site I chose for this project is located on a side street, two blocks from Lamar Avenue, one of the major thoroughfares. Amenities within walking distance include Whole Foods grocery (organic and bulk foods), Book People (a large, comfortable bookstore), a bakery, several cafes, a video store, a liquor store, Amy’s Ice Cream (a local chain), several card and gift shops, Waterloo Records (an excellent music store), the new Marketplace, and access to many bus routes. West Seventh Street borders the site to the north while an alley
defines the south side. Directly across the street to the north is a small apartment complex. A flimsy, motel-style apartment building sits to the west along the alley. Two-story older homes line the rest of Seventh Street. Across the alley to the south is a parking lot for one of the cafes. Topographically, the site is very steep, rising over 60 feet in height across its 165 foot width. Figures 9-25 are images of the site.

Because I am greatly opposed to the car’s typical domination of design, this program will not include any parking areas, although on-street parking may be available. “Paolo Soleri calculates that over 70 percent of the land in the Los Angeles metropolitan area is devoted to the car.”17 Austin is a similarly sprawling city, and I have chosen a site within walking distance of many amenities and bus routes in order to discourage residents from owning cars. In addition, laundry facilities, a coffeehouse, and a used clothing shop will be located on the site so basic needs are met. US Housing and Urban Development (HUD) Secretary Andrew Cuomo asserts, “…The basic principles of New Urbanism…bring sustainable development down to the street, block, and lot level. This means human-scaled, pedestrian-friendly streets; development of grocery and retail stores to meet everyday needs within a comfortable walking distance; links to mass transit; and public spaces.”18

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17 Ibid.
18 “Housing Maverick,” Architecture, August 1997, 44.
Figure 11. Topographical Map of Site
Figure 12. Bakery and shops on Sixth Street, one block from site

Figure 13. Waterloo Video and Amy's Ice Cream on Sixth Street

Figure 14. Book People and Whole Foods at the corner of Lamar and Sixth
Figure 15. Waterloo Records and Ice House, around the corner from Amy’s

Figure 16. Apartment complex across the street to the north of the site

Figure 17. Apartment building to the west of the site
Figure 18. Photo showing steep slope of site, road to the north

Figure 19. Rocks remaining on site from previous construction
Figure 20. Site, looking south

Figure 21. Site, looking north

Figure 22. Site, looking northwest
Figure 23. Site plan

Figure 24. Site context, view from northwest

Figure 25. Site context, view from southeast
SUSTAINABILITY

“Every living system in the world is in decline,” Ray Anderson, the CEO of Interface Corporation informed the 1997 Green Building Conference in Austin, Texas.\(^{19}\) Because of this, Anderson has dedicated himself to making his carpet manufacturing company completely sustainable by 2000. Like Anderson, it is essential that we realize that the negative impact of humans on natural biological processes is now at a critical point where we must make a change in our lifestyles and the way we design. Architecture has a significant impact on the depletion of our natural resources, but it need not be so. William Becker, director of the Department of Energy’s Center of Excellence for Sustainable Development states, “Buildings account for a third of all the energy consumed in the US, and two thirds of all our electricity.”\(^{20}\) The Texas State Energy Conservation Office provides these alarming figures:\(^{21}\)

- Texas relies on petroleum for 46% of its total energy.
- At 1994 consumption rates, the US will run out of oil within 23 years.
- “Although Texas is home to only 7 percent of the US population, the state accounts for about 12 percent of the nation’s total energy consumption.”
- “Texas uses more electricity, natural gas, coal, and oil than any other state.”

The need for a reduction of consumption, especially in Texas led me to design an artists’ community which demonstrates how to replace some of these damaging behaviors with more sustainable practices.

Early this century, agriculture and forestry became the first disciplines to employ the concept of sustainability through renewable resource management and sustainable yield.\(^{22}\) Presently, the concept focuses on the needs of humans in addition to biological processes. In 1987, the Brundtland Commission, a division of the World Commission on Environment and Development, produced a report that developed this now common definition of sustainability, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”\(^{23}\) Since then, this vague definition has aroused much discussion. Some people, such as Bill Reed, Treasurer of the US Green Building Council


\(^{23}\) *Ibid.*
(USGBC), love the common definition, although Reed believes that most people prefer the phrase “quality of life” to describe the concept of sustainability.\textsuperscript{24}

In his 1986 book, \textit{Sustainable Communities}, Sim Van der Ryn, President of the Ecological Design Institute and Van der Ryn Architects, states, “a sustainable community exacts less of its inhabitants in time, wealth, and maintenance, and demands less of its environment in land, water, soil, and fuel.”\textsuperscript{25} Eleven years later at the Green Building Conference, Van der Ryn expressed his opinion that we need to stay away from the word sustainability, as it is “too broad to be operational.”\textsuperscript{26} He encourages the development of tools and processes rather than spending time discussing the definition.

Pliny Fisk, guru of green building and co-founder of the Center for Maximum Potential Building Systems in Austin, agrees that we must move forward in the sustainability movement. Fisk suggests that we need to embark on the difficult task of developing an international, life-cycle based language of sustainability. He believes that sustainability is based on acquiring good information and an understanding of the entire life cycle of resources: their source, transport, distribution, processing, use, and re-use.\textsuperscript{27} Understanding the resources of the local context is essential to sustainability. Urban, rural, arid, mountainous, coastal, and forested regions all rely on and impact different ecosystems.

No matter which interpretation, sustainability is about achieving a quality lifestyle. In order to reach the goal of a sustainable world, it will be essential for the transition to a higher quality lifestyle to include replacing many of our society’s highly consumptive, destructive behaviors with healthier ones that demand less from our global resources. In order to really live sustainably, it will be necessary to live with less than our society teaches us to want. Orr quotes Wendell Berry, “‘We must acquire the characteristics and the skills to live much poorer than we do. We must waste less. We must do more for ourselves.’”\textsuperscript{28} The key is to produce considerate, efficient designs which are in harmony with nature in the first place, rather than struggling to deal with waste later.

These principles of designing sustainably are not new. The Rocky Mountain Institute states,

\textsuperscript{24} Bill Reed, lecture at the 1997 Austin Green Building Conference, 31 October 1997.
\textsuperscript{25} Sim Van der Ryn and Peter Calthorpe, \textit{Sustainable Communities} (San Francisco: Sierra Club Books, 1986), ix.
\textsuperscript{26} Sim Van der Ryn, lecture at the 1997 Austin Green Building Conference, 31 October 1997.
\textsuperscript{27} Pliny Fisk, lecture at the 1997 Austin Green Building Conference, 31 October 1997. See Appendix A for a life cycle analysis of the resources used in this project.
It is only in the past century or so, as cheap energy, large sheets of glass, and air conditioning appeared, that architecture lost its moorings and forgot the ancient truth that the most important building covenants are dictated by the earth. A building designed to heed its surroundings will naturally be more energy efficient and will make elegant and frugal use of local materials.  

One ancient example in the Southwest US is the Anasazi cliff dwellings. Passive solar principles were already being used in the south-facing caves with massive walls which provided heat in the winter and protection from the summer sun. Using what was locally available was the only option and a sensible one.

David Wann, a political analyst for the Environmental Protection Agency, uses the title of his book, *Biologic*, to explain how we should use the logic that nature (biology) already has perfected as a basis for design. Wann asserts,

> We live with limits and natural guidelines such as gravity, friction, soil fertility, microbiological capabilities, sun, thermodynamics, genetic information, life span, and the ability to communicate. We need to use these guidelines and our own equipment to accomplish the major purpose of the game: a secure give-and-take *marriage between nature and culture*. More than anything else, what our world needs is careful, thoughtful design.

I agree that we, as designers, should look to nature, which has functioned well for so much longer than humans have been in existence, to create a framework for a healthy lifestyle which minimizes waste, pollution, and the destruction of the earth. Wann states, “From this point on, like participants in addiction [recovery] programs, we have to agree not to tolerate design that perpetuates our addiction to cheap resources and energy or we'll never kick the habit.”

Malcolm Wells, the well-known pioneer of ecological design, published the book *Gentle Architecture* in 1981. Wells never uses the term “sustainable,” yet his entire book is about producing a “gentle” architecture which respects the natural environment in order to achieve the same high quality of life for both people today and future generations. Wells raises the issue of architecture as art and states that designing in harmony with nature *is* art, “But architecture must be more than just a balanced budget. It must, in every sense, be art as well. The appropriate almost always is.” This thesis attempts to be an example of Wells’ statement, proving that efficiency and affordability can be byproducts of a beautiful design.

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29 Rocky Mountain Institute, *A Primer on Sustainable Building* (Snowmass, CO: Rocky Mountain Institute, 1995), 30.
30 Ibid.
32 Ibid.
An architect that must be mentioned when discussing architecture and nature is Frank Lloyd Wright. Wells asserts, “Wright, who lived his long life in an age when the world’s supply of low-cost fuel and natural resources seemed endless, nevertheless experimented with passive solar heating, earth cover, berming, and task lighting.” Like Wells, Reyner Banham praises Wright for his inventiveness in heating and cooling. In *The Architecture of the Well-tempered Environment*, Reyner Banham states, “By any standards, [Wright] must be accounted the first master of the architecture of the well-tempered environment” and describes the Larkin Building as a “masterpiece of the architecture of the well-tempered environment.” In addition, Nancy Clanton, an expert on lighting design, used the Larkin Building as an example of maximum usage of daylighting in her talk at the Green Building Conference.

My interest in sustainability led me to Austin, Texas, a city dedicated to becoming “green,” by implementing the Green Building Program, which won one of twelve awards at the 1992 Earth Summit in Rio de Janeiro. In 1990, the city received a grant from the US Department of Energy (DOE) to begin the program. Jill Mayfield explains the mission of the organization, “We’ve always tried to keep it simple and back up the program with hard science. We didn’t just say, ‘let’s try to protect the environment,’ but have tried to show how people could do that.” The Residential Program rates buildings on a 1-4 star system with respect to their use of sustainable practices. Their brochure states, “Understanding the nature of the interdependence of the human and natural environment is paramount to understanding sustainability.” Technical guidance and marketing assistance are provided to building professionals in exchange for promoting green building practices in residential construction. Assistance, as well as cash incentives are offered to architects, builders, and owners designing commercial buildings. In addition, financial assistance for environmental system analysis using computer modeling is available.

In 1996, “green building hit ‘mainstream’ when a sub-division called The Meadows at Walnut Creek became the first large-scale development to integrate Green Builder criteria on all

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34 Ibid.
36 City of Austin, “Green Building Program” (City of Austin, Austin, 1997, photocopy).
39 City of Austin, “Green Building Program” (City of Austin, Austin, 1997, photocopy).
94 of the first phase homes, which were priced at $70-75,000. These reasonable prices demonstrate that affordability is an important aspect of sustainability. Literature for the Green Building Program is based on saving money, proof that green building is definitely more cost effective than conventional design. The Program’s brochure states the following results of using green building principles:

- save money, materials and reduce urban sprawl
- reduce overhead
- generate income and reduce waste
- increase worker productivity
- support the local economy and conserve natural resources

Through 1996, approximately 1700 homes have received a rating from the Green Building Program, evidence of its popularity. In addition to the Green Building Program, Austin is proving its commitment to sustainability with the Sustainable Communities Initiative which began in October 1996 and is doing “sustainability assessments of all city departments and is developing a ‘sustainability matrix’ for proposed city projects.”

**Design Components of Gentle Architecture**

In order to determine which sustainable practices to use in the artists’ community, I looked to both the Green Building Program checklist and Malcolm Wells’ wilderness-based checklist for gentle architecture. Listed below are the items from Wells’ list and the ways in which my design for the artists’ community achieves these goals. Figure 26 is a south view of the design of the entire complex. A north view is shown in Figure 27.

1. Creates pure air

Trees, which remove carbon dioxide from the air, release oxygen, filter dust, cool the air, and provide shade, especially for late afternoon sun, will be planted around the site and existing trees will remain. Xeriscaping, which comes from the Greek, “xeros,” meaning dry, is the practice of using plants native to the location, meaning in Texas landscaping that uses little water. In addition, xeriscaping protects the environment and reduces the need for chemical fertilizers that lawns require. Thirty-six percent of household water normally goes

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41 City of Austin, “Green Building Program” (City of Austin, Austin, 1997, photocopy).
42 Ibid.
to irrigating the lawn and garden, and xeriscaping will reduce that requirement by putting oxygen back into the air. In the Edwards Plateau region which includes Austin, the best trees to use include: mesquite, Bur oak, Chinquapin oak, cedar elm, Chinese pistache, Mexican buckeye, Mexican plum, Texas Persimmon and Texas rosebud. Good shrubs for xeriscaping are: Buford, Chinese, Yaupon holly, Nandina, mountain laurel, and yucca.⁴⁵ Although these

plants may cost more initially than the typical lawn, the savings in water, fertilizers, and mowing labor will balance the real and environmental costs.

No paints or carpeting will be used in this project, thus no harmful volatile organic compounds (VOCs) will be emitted in the interior air. Jim Motavalli, the editor of E magazine states, “According to a special report to the Massachusetts legislature, as much as fifty percent of all illness is attributable to indoor air pollution.”46 Instead of carpeting, earth floors made of caliche will be used in all of the buildings. The many advantages of using earth include its low-cost, its mass which is ideal for passive solar, the fact that humidity cannot be trapped as in carpet fibers, and its beauty. Caliche can be stained and scored to look like ceramic tile.

2. Creates pure water

I will replace the word “creates” with “conserves” for the purpose of this project because water is scarce during several months of the year in Texas. The breakdown of domestic water use is as follows: Showers and baths-20%, drinking and cooking-9%, clothes and dishwashing-16%, toilets-19%, lawn and gardening-36%.47 These numbers demonstrate the importance of installing water conserving fixtures like faucets, showerheads, and toilets in all of the buildings. These items have small initial costs and save both water and money. I have also chosen to use water conserving washing machines in the laundry facility. Front loaders use water and energy much more efficiently than top loaders-28 gallons as compared to 47 gallons. Although they initially cost from $150-450 more, the cost will be covered by the people who pay to use the machines, as they are in a laundromat.48

Considering life-cycle costs, a European model dishwasher which uses 2 1/2-5 gallons less per wash than American brands but cost from $120-530 more will be utilized. Most of the energy used by dishwashers is as hot water from the water heater, so the solar water heater in this design will help to make all models more efficient. Dishwashers actually use less hot water than handwashing as long as the dishes are not rinsed before they are put in the dishwasher.49

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49 Ibid.
Another method of conserving water is the process of reclaiming graywater, wastewater from faucets, washing machines, and bathtubs.\textsuperscript{50} Graywater will be used in this design for irrigation and toilet bowl water—55 percent of domestic water use. Although the additional plumbing necessary to separate graywater from blackwater (wastewater from dishwashers, toilets, and kitchen sinks) raises costs slightly, the water requirements will be cut in half from graywater use alone.

3. Stores rainwater

Harvested rainwater will be stored on the site in cisterns under the family unit building and the community studio building. The roofs are sloped so as to direct the rainwater to collection pipes which carry it to one of these cisterns. Rainwater is a free resource and should be retained on the site for both irrigation and indoor uses.

Austin has an average rainfall of 32 inches a year. 600 gallons can be harvested from a 1000 square foot area from just one inch of rain.\textsuperscript{51} Table 3 shows the average indoor water for one person using water-conserving fixtures.\textsuperscript{52} The daily total times 365 days equals 14,746 gallons per person per year. With an estimated 21 people in the community and 32 inches of rain a year, 16,128 square feet of roof collection space is necessary to provide for all indoor needs. The total roof space of the project is approximately 8000 square feet which could meet half of the people's needs for the entire year, thus saving a tremendous amount of money and conserving a very precious resource. Figures 28 and 29 show details of the design for the water harvesting system.

Table 3. Water usage

<table>
<thead>
<tr>
<th>ITEM</th>
<th>USE RATE</th>
<th>FLOW RATE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet</td>
<td>4.0 flushes per day</td>
<td>1.6 gallons</td>
<td>6.4 gallons</td>
</tr>
<tr>
<td>Shower</td>
<td>4.8 minutes per day</td>
<td>2.5 gallons</td>
<td>12 gallons</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>0.30 loads per day</td>
<td>40 gallons</td>
<td>12 gallons</td>
</tr>
<tr>
<td>Faucets</td>
<td></td>
<td>3 gal.(estimated)</td>
<td></td>
</tr>
<tr>
<td>Baths</td>
<td>0.14 per day</td>
<td>50 gallons per bath</td>
<td>7 gallons</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>40.4 gallons</td>
</tr>
</tbody>
</table>

gallons per person per year. With an estimated 21 people in the community and 32 inches of rain a year, 16,128 square feet of roof collection space is necessary to provide for all indoor needs. The total roof space of the project is approximately 8000 square feet which could meet half of the people's needs for the entire year, thus saving a tremendous amount of money and conserving a very precious resource. Figures 28 and 29 show details of the design for the water harvesting system.


\textsuperscript{51} Tim Blonkvist, lecture at the 1997 Austin Green Building Conference, 1 November 1997.

Keeping rainwater from running off the site is important for allowing the natural process of filtration through the soil, recharging groundwater aquifers (water below the surface of the earth that supplies springs and wells), preventing erosion and flooding, and saving money by permitting less runoff in the storm sewers. Pervious paving stones allow the "water
to enter the ground by virtue of their porous nature.”

Pathways will be designed throughout the site in order to enable wheelchairs to move easily about without creating surfaces for runoff. The pavers will be made from mesquite tiles which make use of “the scrubby mesquite tree [which] is regarded as a nuisance and ruthlessly cleared away [in Texas].”

4. Produces its own food

A garden for the artists to grow some of their own food will be located next to the screen porch and community kitchen (Figure 30). Besides enabling the inhabitants to grow fresh food at a low cost, the garden will help to develop the community atmosphere among the occupants who enjoy working there, and will create a beautiful natural space on the site. A few pecan trees, common in the area, will also be planted.

5. Creates rich soil and
6. Consumes its own wastes

Composting food scraps and landscape clippings creates a good fertilizer to re-use in the garden and in landscaped areas on the site. In addition, composting saves plastic garbage

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http://www.greenbuilder.com/sourcebook/perviousmaterials.html
bags, energy for transporting garbage, and landfill space. A compost heap will be located outside of the community kitchen, near the garden (Figure 31).

Recycling does not actually consume the community’s wastes, but it does save energy and landfill space. Designated recycling areas will be designed into the kitchens of each unit and in the community kitchen and community studio building. Recyclable materials will be collected by the City of Austin’s waste management department. Because the re-use of materials is actually more important than recycling, I plan to use the stones left on the site from the buildings that were previously there to build the retention walls in the courtyard. They will be dry-laid to conserve mortar.

![Figure 31. Compost](image)

7. Uses solar energy and
8. Stores solar energy

Energy from the sun is inexhaustible and completely free. Although Austin’s climate is mild, some heating may be necessary from November through March, when the low temperature averages 50 degrees. My calculations indicate that the internal loads of the building in combination with the high R-values of the walls, windows, and roofs may render solar heat useless. Cooling dominates in this climate, but the technology for passive solar cooling is not yet well developed. However, the thermal mass of the walls combined with

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55 See Appendix B for R-values and Appendix C for heating calculations.
night purging (when the humidity permits) will eliminate the need for air conditioning, except for dehumidifying and circulating fresh air.56

Unfired caliche block, the building material I chose for all of the buildings, meets the criteria for thermal mass as well as several other sustainable principles including its abundance around Austin, low embodied energy, durability, and low cost. Traditionally used in road construction, caliche is found throughout Texas in bedrock, in biological sources such as shellfish, and, most desirably, in soil calcium carbonate.57 The Caliche Report states, “Good building qualities in earth and caliche blocks are: 1) strength, 2) low moisture absorption, 3) limited shrink/swell reaction, 4) resistance to erosion and chemical attack.”58 A map indicating the location of caliche deposits in Texas is shown in Figure 32.

It is possible that the site may contain caliche in its soil, but since I cannot actually test for it, caliche may also be purchased locally, at a low cost and molded into building blocks on

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56 See Appendix D for cooling calculations.
58 Ibid.
the site. The process for making the blocks is very similar to producing adobe bricks, and semi-skilled labor can be used. I plan to employ some of the day laborers who line the streets of the Day Labor area in downtown Austin. Mostly Hispanic men, these workers wait to be picked up by an employer and work for the day. Hundreds of people are around in the morning and by mid-morning they are gone, so the system appears to work. The following are the steps for block production from The Caliche Report:59

1. Extraction of the caliche with bull dozer and/or front end loader.

2. Transport to production site in large trucks

3. Dry the caliche material and control the compositional variation by spreading the material in a 6-12 inch blanket over a large area on the ground. The first layer should be allowed to dry in the sun for several hours before the next layer is laid over the first.

4. The material is then removed from the layered pile from one end so that material from each layer is thoroughly mixed.

5. This material is then sifted through 1/4 or 3/8 hardware cloth or wire mesh. It may then be desirable to crush the waste and sift the material again.

6. Store the sifted material in a dry place away from moisture, so as to prevent clumping of the material and reaction with any chemicals in water.

7. Mix the components in a mortar mixer or concrete mixer according to the proper formula, keeping a constant check on the moisture content.

8. Lay a sheet of 4 mil plastic under the mold.

9. Lubricate the mold with a little water every 4 or 5 batches, or coat with an application of wax.

10. With shovel or wheelbarrow, dump mix into the mold.

11. Spread the mix evenly in the form. Shake the form to help the mix to settle into the corners.

12. After the form is filled, remove it by lifting it up-move on and repeat the procedure.

13. After 1-2 days the block may be rotated to their long edge for curing.

14. Blocks should ideally damp cure 4-5 days before stacking or moving. Blocks should cure (air dry) 10-14 days before transporting or laying in the wall.

15. The blocks need to be protected from direct sunlight for the first 5 days, and protected from rain during the entire curing process.

59 Ibid.
Two people using a gang mold which forms many blocks at a time and a wheelbarrow can produce approximately 500, 4"x10"x14", 39 pound blocks per day. Due to the poor insulative value of earth materials, the caliche walls in this project will be eleven inches thick, with a layer of three inch rigid insulation sandwiched between two four inch caliche block walls. Mud plaster, also locally available and installable by day laborers, will finish both the interior and exterior walls to allow the caliche to breathe. The plaster is inexpensive and eliminates the need for harmful paints as it can be stained with pigments to achieve the desired color. These thick walls are designed to create a feeling of stability and security, as well as being useful as thermal mass for passive solar heating in the winter and storage of coolth in the summer. A section of the caliche wall is shown in Figure 33. Overhangs will let in the low rays of the winter sun while blocking the high summer rays.

Figure 33. Wall section

Ibid.
Passive solar energy can also be used to heat water in order to provide 50-80 percent of all hot water needs, depending on the season. Although the initial cost of the solar hot water heater is $1000-3500 for domestic uses, if the hot water loads are reduced by insulating the piping and installing water conserving fixtures, costs can be minimized. Solar heaters “can show paybacks of four to seven years depending upon the fuel displaced (electric or gas),” according to The Sustainable Building Sourcebook.\textsuperscript{61} Solar collectors will be located at a 42 degree angle atop the community studio and gallery buildings. Distilled water is pumped in pipes through the insulated panels and is then stored in a large hot water tank at the corner of the building until it is pumped to the washing machines and apartment units. This system will provide the hot water for the laundromat and part of the requirements for the units. Ten to fifteen square feet per person for the collectors and twenty to thirty gallons of storage per person is required.\textsuperscript{62} The 1000 square feet of collectors and 1200 gallon storage tank provide for approximately half of the community’s hot water needs (Figure 34).

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{collectors.png}
\caption{Collectors}
\end{figure}

Daylighting is another way to take advantage of the sun’s resources. People seem to love light, and it is especially important for most artists. According to Nancy Clanton, light has been proven to increase productivity, encourage creativity, promote retention of information, and calm people.\textsuperscript{63} Most of the natural light in all of the buildings on the site will come from windows on the south walls and high clerestory windows which allow light to enter without direct solar gain. All windows will be argon-filled, double pane glass, with a low-e

\textsuperscript{62} Ibid.
\textsuperscript{63} Nancy Clanton, lecture at the 1997 Austin Green Building Conference. 31 October 1997.
coating which will reflect “40-70 percent of the heat that is normally transmitted through clear
glass while allowing the full amount of light to pass through.” Walls and ceilings will be
light-colored to reflect the light and aid its effectiveness. Light shelves will be used when
needed to prevent glare.

When it is necessary to use electrical lighting, fluorescent lights will be used because of
their extremely high efficiency and low heat emittance. Daylighting ballasts will be used in the
gallery building and community studio to vary the electric light output according to the amount
of natural light each room receives. These ballasts are inexpensive and will save electricity and
money by only providing the amount of light needed. In outdoor lighting, motion sensors will
be utilized so that spaces are only lit when people are around.

9. Creates silence

Besides the previously mentioned advantages of caliche, the 11 inch walls will not
allow sound to penetrate and the units should be quiet spaces in which to live and work.
Another space for solitude will be the sculpture garden in the courtyard around the lap pool
(Figure 35). The stepped retention walls will shelter the space, and the works of art will create
a place for contemplation and reflection.

Figure 35. Sculpture garden and pool

10. Maintains itself

I interpret this statement to mean that the space creates a self-sustaining environment. Several examples of this concept are evident in the design of the community, most obviously the combined living and working studio spaces. Instead of leaving the site to go to work, the artists remain and create their work within the community. Growing food is another example. The xeriscaped landscape requires little if any maintenance. Renting out retail space in the gallery building generates income for the community and helps to sustain it (Figure 36). Because the community is partially self-sustaining and serves as both a living and working environment, there is the danger of the residents becoming isolated from the community of Austin. In order to achieve a greater interaction with the larger community, the residents may begin a mentoring/apprenticeship program to teach children about the arts.

![Figure 36. Retail space in the gallery building](image)

11. Matches nature’s pace

Wells’ description of this criteria is eloquent:

Our twenty-year cycles of construction bear no relation to life’s grand, century-by-century pace. We must move toward the use of permanent architectural shells within which we can make our restless changes without damaging the land around or above them. The rhythm of the seasons is part of our heritage whether we like it or not. The current way of dealing with it is to fight, but that’s one fight we cannot win.⁶⁵

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By using durable caliche blocks, this design is intended to last for as long as it is continued to be used and maintained, which will require the reapplication of the mud plaster every several years. When its useful life is over, most of the materials can return to the soil from which they came. Interior spaces will be designed for flexibility so that the complex may provide for new occupants in the future. In addition, I have attempted to disturb the formation of the land as little as possible. All of the buildings are supported by columns so as to maintain the wonderfully steep slope of the site. The only excavated areas are the central courtyard, and small spaces for the studio building and west apartment building (Figure 37).

Figure 37. *Excavated land*

12. Provides wildlife habitat

Retaining the existing trees will help to lessen the disturbance to the ecosystem and planting more trees may bring in additional wildlife.

13. Provides human habitat

Eleven units for single people and five units for families provide human habitat in this complex (Figures 38, 39, and 40). In order to conserve land, energy, materials, and money, the individual units are small and stacked so that floors, walls, and ceilings are shared. Although these private spaces are modest in size, the public spaces are generous.
Laundry facilities, storage space, and space for works in progress and critiques will be designated in the community studio building at the northeast corner of the site (Figures 41, 42, and 43). The gallery building at the northwest corner will be a place for the artists to showcase their work to the public and will also provide a coffeehouse and a used clothing shop for the artists’ community and entire neighborhood (Figures 44 and 45). As previously mentioned, the central courtyard will include a sculpture garden around the lap pool, which will be a place for exercise, another aspect of a healthy lifestyle. Although the pool, with its large water requirement, may not be completely in harmony with nature, I believe that its value as a place for exercise and retreat from the summer heat justifies its addition to the complex. In addition, the large body of water will create cooler air around the courtyard due to evaporation. Adjacent
to the courtyard is a screened porch and kitchen which will be gathering spaces for the community during the spring, summer, and fall. Another opportunity for gathering (away from work) will occur on the stepped slope which faces a large screen that can be pulled down to view movies--possibly the work of resident artists--in the evenings (Figure 46).

Figure 41. *Community studio building*

Figure 42. *Laundry facilities*
Figure 43. Interior view of studio

Figure 44. Gallery

Figure 45. Coffeehouse
14. Moderates climate and weather

Besides providing beauty, oxygen, and shade, each tree is able to reduce the cooling load by evaporating water from the air. "A single tree can 'provide the same cooling effect as ten room-size air-conditioners working twenty hours per day.'"66 The combination of shade trees and a light-colored roof "can lower the building's cooling load by 30%."67 A light colored, high recycled content steel roof will be used in this design. Although steel has a high embodied energy, the fact that it is partially recycled and can easily be recycled again lowers the energy requirements. In addition, the roof is lightweight and much more durable than asphalt shingles which last only 20-30 years.68 Roof overhangs which block the high summer sun but let in the lower winter rays will be included in the design of all of the roofs in this project.

In order to further minimize the cooling load, a radiant barrier and ridge and soffit venting system will be utilized. The Sustainable Building Sourcebook describes a radiant barrier as "a layer of metallic foil that blocks radiated heat. Most foil type radiant barriers have an emissivity of .05 or below which means 95 percent of the radiant heat is being blocked. Temperature reductions of ten degrees or more are typical during peak summer days." The

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67 Rocky Mountain Institute, A Primer on Sustainable Building. (Snowmass, CO: Rocky Mountain Institute, 1995), 77.
cost is reasonable at ten cents per square foot. The Sourcebook describes the ridge and soffit venting system as “a continuous, weather-shielded opening at the peak of the roof in combination with continuous screened openings along the eaves” which provides passive air movement under the roof and cools the attic at a cost of $2-3.50 per square foot.

Finally, two inexpensive methods will help to moderate high summer temperatures. First, ceiling fans, with prices starting at $30, are a cheap way to reduce cooling requirements and costs. “Ceiling fans permit raising the thermostat setting on an air conditioning system 4 to 6 degrees.” And, “in the heating season, ceiling fans can help bring the warmer air that stratifies near the ceiling down to where the occupants are located.” Second, borrowing a custom from Middle Eastern architecture, ceramic pots filled with water will be placed along the pedestrian walkways to cool the air as natural breezes pass the water.

15. And is beautiful

The diagram in Figure 47 reiterates how environmental elements were addressed in the project. Table 4 is Wells’ wilderness graph. A score of twenty-five means seldom, fifty-sometimes, seventy-five is usually, and one hundred-always. For my design, I calculated a negative score, out of a possible 1500, of -25. The positive score is 1050; the total: 1025.

Epilogue

Sustainability encompasses much more than the environmental issues I have addressed in relation to my design. David Orr states that we cannot “deal with issues of sustainability without simultaneously confronting issues of peace, equity, cultural diversity, and the structure of political institutions.” I believe that addressing these issues will require widespread education, grassroots efforts by citizens, and a willingness to live with less than our society teaches us to want. Orr asserts, “If large numbers of people do not understand the environmental facts of energy, resources, land, water, and wildlife, there is little hope for

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69 Ibid.  
70 Ibid.  
72 Ibid.  
building sustainably at any level.”75 This is where a change in the practice of architecture by rethinking the way we design can have a great impact on the education of the public and on our society’s lifestyle choices.

Van der Ryn’s three concepts of conservation (“doing more with less”), stewardship (“knowing and caring for place”), and regeneration (“restoring and designing with the web of life”) create a framework for rethinking conventional architecture which is based on short-sighted minimum level design with maximum return of investment for profit.76 Van der Ryn’s three concepts are integral to my design for the creation of a living and working community which provides artists with a conducive environment in which they can sustain the quality of artistic expression in Austin, thus sustaining the quality of life for patrons of the arts, as well. By creating a community in harmony with nature, I hope to encourage the artists to preserve this harmony in their work.

Figure 47. Design elements

75 Ibid.
<table>
<thead>
<tr>
<th></th>
<th>-100</th>
<th>-75</th>
<th>-50</th>
<th>-25</th>
<th>25</th>
<th>50</th>
<th>75</th>
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</thead>
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<tr>
<td>Destroys pure air</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Creates pure air</td>
</tr>
<tr>
<td>Destroys pure water</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Creates pure water</td>
</tr>
<tr>
<td>Wastes rainwater</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stores rainwater</td>
</tr>
<tr>
<td>Produces no food</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Produces its own food</td>
</tr>
<tr>
<td>Destroys rich soil</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Creates rich soil</td>
</tr>
<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Uses solar energy</td>
</tr>
<tr>
<td>Stores no solar energy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Stores solar energy</td>
</tr>
<tr>
<td>Destroys silence</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Creates silence</td>
</tr>
<tr>
<td>Dumps its wastes unused</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Consumes its own wastes</td>
</tr>
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<td>Needs cleaning and repair</td>
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<td>X</td>
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<td></td>
<td></td>
<td>Maintains itself</td>
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<td>Disregards nature’s cycles</td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
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<td>Matches nature’s cycles</td>
</tr>
<tr>
<td>Destroys wildlife habitat</td>
<td>X</td>
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<td>Provides wildlife habitat</td>
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<td>Destroys human habitat</td>
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<td>X</td>
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<td>Intensifies local weather</td>
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<td>X</td>
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<td></td>
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<td>Is ugly</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Is beautiful</td>
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ARTISTS

Today’s art world is filled with mixed media creations that are thought-provoking and often disturbing. At a recent exhibition at the Austin Museum of Art, I experienced a thought-provoking showing of the work of Jaune Quick-to-See Smith, a Native American Artist who uses drawing, painting, and collage to stimulate viewers’ thoughts about the government and the situation of Native Americans, a people who are traditionally very respectful of the land and environment. One of Smith’s works is shown in Figure 48.

Ideally, the artists who live in my designed community will practice art which encourages viewers to think about how they treat the earth. “Arrested Rivers: Paintings by Chuck Forsman,” an exhibition which began in 1994 at the University of Colorado at Boulder

Figure 48. “Homes have different floor plans” (Jersey City Museum, Subversions/Affirmations: Jaune Quick-to-See Smith (Jersey City Museum, 1996), 24.)
is an example of the work of a growing group of environmental artists. Forsman’s oil paintings of the Western landscape focus on dams, reservoirs, and controversial water issues of the West (Figure 49). Included with the paintings are writings inspired by the work. Michael Crane, Director of CU Art Galleries states, “Their quest is pragmatic, they seek to change how we see and what we think about water in the West, and by inference what we do to the land everywhere.” Forsman’s strong feelings about the environment are clearly transferred through his work. He asserts, “Yet, my heart insists, and I want very much for these paintings to convey, that the real crime, the one for which we all have hell to pay, is that we have destroyed so many beautiful, magical, even perfect, places. Arrested rivers are lifeless. Like clogged arteries, they hasten our mortality.”

Another example of art which addresses environmental issues is the work of Mierle Ukeles, “the first artist-in-residence of the New York City Department of Sanitation.” Van der Ryn describes her project, Flow City, which has been in progress at one of the garbage transfer stations in New York since 1983:

Figure 49. “Lizard” (Chuck Forsman, Arrested Rivers (Niwot, CO: University of Colorado Press, 1994), 30.)

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78 Ibid.
The ‘Passage Ramp’ presents a vast panorama of recycled art to the intrepid visitor. Along this ramp, ‘the materials of glass, metal, and plastic are separated, suspended, and composed in a spiraling format....Ukeles’ space introduces the concept that waste is a false cultural construct; every item is inherently valuable if only our traditional thinking about garbage can be changed.’ At the end of the 248-foot passage, the visitor can walk out on the ‘Glass Bridge’ to see trucks dumping their contents onto waiting barges. Ukeles describes this space as ‘the violent theater of dumping.’ The ‘Glass Bridge’ terminates in the ‘Media Flow Wall,’ an installation of twenty-four video monitors displaying live and prerecorded images of the Hudson River, landfill operations and restoration efforts at Fresh Kills, and everyday recycling efforts.80

Artists who live in my designed community will also be encouraged to use sustainable practices in their work. For example, photographers are encouraged to use digital cameras, high-end scanners, energy efficient computers with recycled parts, and software such as Photoshop to produce their images while avoiding the harmful chemicals previously required to develop negatives and prints. “Throw Out the Brushes” discusses the use of computers instead of paintbrushes and pastels. The article states that computer art is popular with commercial artists who create illustrations for books and ads because their work must be duplicated on a computer anyway. These artists say that the ease of changing an image is a great advantage, although the increased speed of working has both positive and negative aspects. “One book-jacket illustrator reports that she can do a jacket in half the time it used to take - but, what with prices coming down as work becomes more efficient, she now has to do twice as many jackets to make the same living.”81 This example reemphasizes the necessity of providing affordable places for artists to live.

In addition, the above example raises the complex issue of technology’s relationship with nature. Orr asserts:

The cumulative effects of technology extend human power over nature so that we can transcend the limits of gravity, space, time, biology, and now, with computers, those of mind. In the process, we remove ourselves further and further from the natural conditions, both good and bad, that previously constrained human development... Technology is our declaration of independence from nature.82

But in this case, technology allays pollution from toxic chemicals and reduces material needs.

Artists who use other sustainable practices include Tony Raven and Anita Pelenzia of San Antonio. Displayed in the South Texas Blood and Tissue Center, Raven’s work is a compilation of used desktops from an old school, etched with scenes from the Alamo.

80 Ibid.
81 Claudia Kalb, “Throw Out the Brushes,” Newsweek, 1 September 1997, 76.
Polenzia also uses recycled materials to create a mobile out of origami-like fragments of recycled aluminum cans.

In my design, each artist will have a private studio in their residence which will allow space for painting, drawing, sculpture, ceramics, and digital media. A community studio building is located at the northeast corner of the site for artists who enjoy working together, for critiques, and for very large projects. A raku firing space will be adjacent to the community building (Figure 50). Two rooftop studios - one above the gallery, the other atop the screened porch - may be used for creating sculpture (Figures 51 and 52).

![Figure 50. Raku firing space](image)

A tenant association will oversee the management of the community and the selection process of the new residents. Instead of having one off-site manager, the association allows for input from those in direct contact with the workings of the complex and allows for change over time. The selection of artists will give preference to those using non-toxic media, but the purpose of the community is not to control the inhabitants' lifestyle choices. By providing operable windows and outdoor work spaces, the design encourages a sustainable approach in the artists' work but does not mandate one.

The need for artists to have a place to live and work goes back to 1857, when Richard Morris Hunt designed the Tenth Street Studio Building in New York City, the first known
apartment building designed specifically for artists in the United States (Figure 53). As well as functioning as studios, the apartments opened to form a gallery space for public exhibitions. In her book *New York New York*, Elizabeth Hawes investigates the influence of the New York apartment building upon life in the city between 1869 and 1930. She describes Tenth Street:

The ornamental brick and stonework building was planned in the form of a hollow square, with a domed, skylighted two-story exhibition room placed at center like a courtyard, and surrounded by three floors of large and lofty studios, many with adjoining bedrooms at half-level. With serious and elegant workrooms, cheap and convenient domestic accommodation, and a built-in social aspect- the doors connecting studios could open to provide a flowing space for the gala receptions and open houses that soon characterized life within- the building was an immediate success and filled quickly with the amazing nucleus of New York’s art world.\(^83\)

A group of artists-in-residence were known as the Hudson River School and included Frederic Church, Albert Bierstadt, Eastman Johnson, and Winslow Homer.\(^84\) Hunt’s experiment influenced the creation of several more studio buildings in New York.

In 1903, Henry Ward Ranger, a landscape painter, had the idea to form a cooperative to build and subsidize a large apartment building on West 67th Street, the first attempt to provide affordable housing for artists. The luxury apartments in half the building subsidized the rental of ten studio apartments on the other half at a lower cost to artists. The builder, William J.

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\(^{84}\) *Ibid.*
Taylor, went on to build six more of these co-ops in the city. Affordability was a critical factor in the design of 25 West 67th. Hawes states:

To maximize light and air and to minimize cost, the Cooperative Studios had been cleverly manipulated into an interlocking scheme of duplex apartments and smaller two- and three- room simplex apartments for rental...the interior design was straightforward and unpretentious, for the resident community was determined not to waste money on ‘useless or tawdry decoration’...Its ingenious use of space was appealing. In volume alone, its studios were sumptuous. And to a populace who had only very recently been swept off its feet by the premiere of Puccini’s *La Boheme*, its very raison d’être was romantic.

Ranger’s studio is shown in Figure 54.

**Figure 53.** *The Tenth Street Studio Building* (Elizabeth Hawes, *New York New York* (New York: Henry Holt and Company, 1993), 124.)

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85 Ibid.
86 Ibid.
These early artist communities are a precedent for my project in Austin. Like Tenth Street, which was designed with its version of the communal hearth represented by the courtyard, my complex is designed around a central courtyard space. The gallery, community studio building, apartments, and porch encircle an open space designed for gathering and activity.

The idea of structuring the living area around a communal space was strongly influenced by the Italian Renaissance palazzo. William Waldorf Astor, a millionaire with large investments in real estate in New York in the early twentieth century, had a powerful influence on the development and design of the city. Thus, writes Hawes, “Astor’s endorsement of the Beaux-Arts courtyard building was early and expansive. Under his auspices, the form matured impressively in less than a decade.”

Figure 55 shows the Belnord Courtyard as an example of this new style.

These large, luxury buildings housed as many as 100 families, therefore a sense of community was difficult to achieve. The courtyard space allowed for families to gather and interact. Hawes asserts, “The courtyard was a ceremonial space, like the ones the Romans carved into their buildings to prevent a sense of overcrowding. It offered tenants room to breathe freely, to stroll idly, to see the sky, and it made them feel protected and privileged.”

With the growing population, land in the city soon became scarce and created one of the problems we continue to struggle with today: providing communal greenspace. States Hawes,

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87 Ibid.
88 Ibid.
“Only a handful of other examples would be built before it would be deemed unrealistic to consecrate such valuable urban acreage to something as arcadian as a sense of privacy or peace of mind.” Fortunately, advocates of sustainability are pushing for and achieving a resurgence of the importance of greenspace in urban areas.

Figure 55. The Belnord Courtyard, 1908 (Elizabeth Hawes, *New York New York* (New York: Henry Holt and Company, 1993), 140.)

Austin has made the preservation of greenspace one of its priorities. Outdoor recreation areas are especially significant in a climate that allows outdoor activity during most of the year. Van der Ryn comments on the necessity of communal spaces and the need for a connection to nature:

Beyond material efficiencies and simple conservation, our communities must express a reverence for the nature of a place...we need to move towards a sense that our place is a habitat within, rather than a settlement beyond the ecosystem. The other aspect missing is the notion of the commons, that the public domain must become richer as the private domain becomes more frugal; that success and well-being must be a shared, rather than a private, affair. It is the missing sense of ecology and the commons that makes places real, turns ‘housing’ into dwelling, ‘zones’ into neighborhoods, ‘municipalities’ into communities, and ultimately, our natural environment into a home.  

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90 Sim Van der Ryn and Peter Calthorpe, *Sustainable Communities* (San Francisco: Sierra Club Books, 1986), xvii.
Unfortunately, the early precedents of artist housing did not survive and the need for affordable places to live is even greater today. My research indicates that affordability is a concern for artists all across the country. "The SoHo Syndrome" discusses the problems that artists face when they move into an affordable section of a city only to find that when they develop the area into an "artsy" neighborhood, it becomes outrageously expensive and artists can no longer afford to live there.91 A recent article by Marina Isola proves that the problem is not yet solved. Isola describes the West Chelsea Arts Building as one affordable (750 square feet for $750/month) solution for New York artists. Raymond Naftali, a retired Romanian émigré who made his money in the garment industry turned an empty warehouse he owned into living and working spaces for artists.92 This is obviously a solution which benefits the artists, but it requires developers who are willing to rent to artists for less than market value because they want to support the arts.

A recent issue of StreetWise, a newspaper distributed by Chicago’s homeless population, describes the controversy surrounding John Podmajersky III, a Chicago developer who provides low-rent lofts and gallery space to artists in the Pilsen neighborhood but is also being accused of discriminating against other needy, mostly Mexican, people in the area. Podmajersky and his family own over 100 buildings in the neighborhood and are accused of being slumlords, but Kari Lyderson states, "For the artists who enjoy the Podmajerskys’ reportedly laid-back rent collection methods and attention to architectural aesthetics, the family is an ideal landlord."93 One controversial move was Podmajersky’s renovation of a brewery into a “mixed media arts center” which is said to have taken away jobs and housing opportunities in the area.94 In this case, creating affordable housing and jobs for one population seems to come at the expense of an even lower income group of people. Who is to say what is right? As one tenant states, “I hear people say that [Podmajersky’s] a gentrifier and he hates Mexicans, but that hasn’t been my experience at all. If he was just out for money, he’d be renting to yuppies.”95

One very successful attempt at affordable housing for artists is Artspace in Salt Lake City which was founded in 1979 by Stephen Goldsmith, a sculptor, who could not find a place where he could afford to live when he moved to the city (Figure 56). He raised money, went

94 Ibid.
95 Ibid.
to the city council, and was permitted to renovate an old tire company warehouse in a high crime area into affordable housing for the city's artist community. Reusing the old building in the crime-ridden area accomplished much more than just providing habitat; the neighborhood was transformed and sustainable building practices were utilized. Artspace provides a safe playground for the children in the area and runs a mentoring program for the residents to teach children about the arts. Instead of having a run-down warehouse in the neighborhood, a beautiful building helps to create community pride. Artspace literature also mentions, "The effort has since spread to other warehouse spaces, and facilities in the neighborhood now include a daycare center for homeless children (Our House), galleries (including Art Access, exhibition space for disabled/special needs artists), a community garden and more."  

Twenty-three living spaces and thirty galleries are housed in the 81,000 square foot building at 325 West Pierpont Avenue that is 100 percent occupied and maintains a waiting list. Rent is on a sliding scale from $180-600/month.  

This chapter considered the needs of artists and precedents for the artist community. In the final chapter, I will discuss housing types and the design of affordable housing which will meet these needs while considering the impact to the environment.

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**Figure 56. Artspace in Salt Lake City**

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97 Ibid.
AFFORDABLE HOUSING

Affordable housing is generally defined as housing with a cost lower than one third of one’s net income. Despite this, HUD Secretary Andrew Cuomo states that, “The demand for affordable housing, the need, is growing. Over five million American families spend more than fifty percent of their income on rent.” In his book, *The Architecture of Affordable Housing*, architect Sam Davis raises the question of whether low incomes are the real problem of affordable housing. This chapter will address these issues.

The answer to Davis’ question is that the lack of affordable housing and low incomes are both big problems. “Since 1995, the federal housing budget has shrunk by 25 percent.” This figure illustrates that there is definitely a lack of money going towards combating the issue of housing. In addition, a recent AIA survey found that “only 500 of its 58,000 members (fewer than one percent) identified affordable housing as a primary interest.” If the experts on designing housing are not willing to face the problem, it is unlikely to be solved anytime soon. On the other hand, low incomes for artists are mainly a result of the lack of support for the arts in the United States.

Davis brings up another problem with affordable housing: although it is usually subsidized, administrative costs associated with implementing subsidies is one of the main reasons for difficulties in keeping costs down. Thus, it is imperative that the architect design thoughtfully and efficiently. Davis enforces the point that affordable housing should be attractive in order to give the inhabitants a sense of dignity and to change the public’s perception of affordable housing. Davis lists choice, fit, and flexibility as the three important aspects of dignity. Choice allows the occupants to make their own decisions about things such as furniture placement. Fit refers to the relationship between the design and the inhabitants’ living patterns. Flexibility relates to the sustainable goal of how the home can be used in the future as the occupants’ needs change. Davis asserts, “One reason loft space works so well for artists is its generous volume and incredibly loose fit. There are no obstructions, no walls--just light and space.”

Davis includes one of San Francisco architect Donald MacDonald’s designs in his

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102 Ibid.
103 Ibid.
book. The "Monopoly-box configuration is particularly efficient, because it encloses the most space for the least amount of surface material, is conventionally and simply constructed and is easily replicated." Features include eliminating hallway space, good lighting with windows near the corners of rooms to reflect light, and rooms with outside views to enlarge the space and enable one to supervise children outside while working inside.

In my design of the apartment units, I have attempted to allow for choice, fit, and flexibility, while also using a layout for the kitchen and bathroom that repeats throughout the sixteen apartments to decrease costs. The plan clusters the kitchen and bathroom in the smaller part of the apartment so that the artist can arrange the studio how he or she wishes. In the smaller units, the bed is located on a loft above the bathroom, and in the larger apartments, hinged walls on tracks and a murphy bed can move to form a bedroom or can be folded away to allow for a larger studio (Figures 57-60). A loft is again above the bathroom for an additional sleeping space. Lots of light enters each unit through the clerestory windows and the south windows provide great views that enlarge the space. The only permanent walls are the bathroom walls.

Figure 57. Plan of a small apartment

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104 Ibid.
Figure 58. *Interior of a small apartment*

Figure 59. *Plan of a larger apartment*
Thoughtful aesthetic features can enhance the beauty of a building without greatly increasing the cost. Davis states:

Giving special care, attention, and detail to the elements of a building that people actually encounter helps to create a human scale in a cost-effective way. People sit under a trellis that covers a patio and creates shade; they pass alongside gates and fences that can either be solid walls or offer glimpses of life beyond and they walk into buildings under awnings or on porches.\textsuperscript{105}

In my design, the thick caliche walls chosen for their thermal mass and local availability also give the perception of stability and security. Attention to the landscape design of the site creates a pleasant exterior space without a significant increase in cost. A small trellis defines the entrance to each apartment to create a sense of ownership of one’s doorway and to provide a threshold between the outside and inside of the home (Figure 57).

Davis’ book provided a discussion on the needs of the inhabitants of affordable housing, while Chris Hanson’s \textit{The Cohousing Handbook} gave me several ideas about how to relate aspects of affordable housing to community-style living. Cohousing is a housing type which is not defined as “affordable” but definitely incorporates cost-saving elements which can be implemented to differing degrees. The main feature of cohousing is a centrally located common house which is shared by all of its residents. Cohousing’s philosophies about community and shared space are directly related to this thesis.

Hanson provides a brief history, “Cohousing started in Denmark in the late 1960s when a group of dual income professional families were searching for better child care and a

\textsuperscript{105} \textit{Ibid.}
Figure 61. *Trellis*

way to share evening meal preparation. ...Cohousing is a means for people to make a major step toward community without giving up their privacy, or control over their personal lives.\textsuperscript{106}

According to the September/October 1997 issue of *In Business*, "More than forty cohousing projects are now completed, several dozen are under construction, and over 150 groups are in various stages of planning or development."\textsuperscript{107} The four main elements of cohousing include:\textsuperscript{108}

- a centrally located common house which may include a kitchen, dining space, children's play area, mail pick-up, storage, laundry, lounge, and guest rooms
- the separation of the car from the residence
- pedestrian pathways which link the access of each residence
- locating the kitchen on the pedestrian pathway side of the house in order to look outside while working and supervise children

My design uses cohousing as a model for some of its features. A community kitchen and screened porch is located adjacent to the central courtyard for people who choose to eat meals together. One way to reduce costs could be to purchase grocery staples collectively. Laundry facilities (which generate revenue by being open to the public), storage space, and a shared studio space are located in the community studio building.


Although my goal is to enable the artist community to be largely self-sufficient, I do not want it to be completely cut off from the larger community of Austin. By creating some public spaces such as the coffeehouse, gallery, and sculpture garden, I hope to design an inviting place for the public to enjoy as well. Van der Ryn asserts, "Economically a thing of the past, these small retail shops played an important role in sustaining local identity as well as providing personal service and convenience."\(^{109}\)

The third element of cohousing, linking the pedestrian pathways has been largely accomplished, although my design requires pathways at different levels. All of the paths (except two) face the courtyard to encourage activity and a means of supervision and security (Figure 62). In addition, two of the roofs on the courtyard side are meant for gathering spaces at yet another level (Figure 63). Regarding the fourth element, because only the units in the west building are large enough to house families, the kitchens were not designed with supervision in mind. Although the units of cohousing are generally market-rate and unsubsidized, Hanson’s manual includes several ideas for making the individual houses more affordable:  

- increase the number of units so that costs are distributed
- reduce the size of the personal unit and increase the size of the common area
- shared walls rather than free-standing units
- stacking units saves the costs of additional foundations and roofs
- some units may be shared by single people
- standardize kitchen and bathroom designs
- consider life cycle costs

\[\text{Figure 62. Shaded pedestrian pathway}\]

\(^{109}\) Sim Van der Ryn and Peter Calthorpe, *Sustainable Communities* (San Francisco: Sierra Club Books, 1986), xv.

I have attempted to include all of these cost-saving measures in my design. Expenses will be distributed over sixteen units. Units in the east apartment building are very small at only about 450 square feet and in the west apartment building at 550 square feet. The community studio, gallery building, kitchen and porch, and rooftop studios increase the communal spaces. Flooring and roofing materials have been conserved by stacking the units and most units share one major wall. All of the bathroom and kitchen designs are essentially the same.

Life cycle costs have been considered in the choice of materials. The thermal mass of the caliche block combined with the insulative value of the 1/4 inch argon-filled, low-e windows, and the radiant barrier have easily paid for themselves by eliminating the need for a heating and cooling system. Because of this great savings, the cost of the rainwater cistern can be justified. Other measures that will quickly pay for themselves are the solar heated water system, the energy efficient appliances, and the durable, low-maintenance caliche blocks and recycled-content steel roofs.

Although the idea is not yet widely accepted by the building industry, it is now possible to build an affordable and ecologically sensitive home. Alice Horrigan’s article, “Affordable by Design,” lists several examples across the U.S.:

• “The Hickory Consortium, a group of Boston developers, builders, architects and manufacturers, is working with the DOE to design ‘Eco-Dynamic’ housing. Using a modular approach (factory-built pieces shipped for on-site assembly), two recently completed energy-efficient and nontoxic homes were approximately 20 percent less expensive to build than comparable conventional ones.”

• “In Dallas, architect Betsy Pettit and engineer Joe Lastiburek designed a 12-house development, ‘Esperenza del Sol,’ with 1270-square-foot, three-bedroom homes that maximize winter solar gain and natural lighting, shading and ventilation. The $80,000 homes are heavily insulated and have controlled ventilators to ensure circulation of fresh air.”112

• “In Chicago, Shaw Homes is experimenting with a resource-efficient inner city development with 1670-square-foot homes for about $90,000.”113

• Pliny Fisk is experimenting in Austin with “...A studio apartment-style house that ‘grows’ incrementally with the intended ease of an erector set. ...The estimated building cost, including the adaptable kitchen, dinette, loft, porch, bathroom, wastewater system and nontoxic interior finishes, is $8000 to $10,000. Additional bedrooms are estimated at $4000 each.”114

• Affordable green design is being promoted in the nonprofit sector by the group Global Green USA. “Global Green is helping to teach Habitat [for Humanity] affiliates the fundamentals of simple passive solar design, hazardous paints disposal, and waste recycling from construction sites, and to broaden the concept of affordable housing to include issues such as ongoing expenses for utilities, availability of transportation and ability to grow food. At least 20 Habitat affiliates are presently building low-cost houses incorporating green concepts. The average cost of a Habitat home, in the area of 1400 square feet, is $3800—including land, permitting costs, skilled subcontractors and materials at market value, but not including general labor, which for Habitat is all volunteer.”115

The need for affordable housing is clear. Through the precedents discussed and my design, I have shown that both the issues of affordability and sustainability can be addressed in one design. By using common sense, a thoughtful design which maximizes materials and space and considers life-cycle costs can create a beautiful, low-cost, eco-home or housing complex. A west view of the complex is shown in Figure 64.

112 Ibid.
113 Ibid.
114 Ibid.
115 Ibid.
Figure 64. West view
APPENDIX A. LIFE CYCLES OF RESOURCES

Table 5. Caliche

<table>
<thead>
<tr>
<th>Source</th>
<th>Austin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Trucked to site</td>
</tr>
<tr>
<td>Distribution</td>
<td>On-site</td>
</tr>
<tr>
<td>Processing</td>
<td>Use semi-skilled labor on-site</td>
</tr>
<tr>
<td></td>
<td>Unfired</td>
</tr>
<tr>
<td></td>
<td>Low embodied energy(^{116})-comparable to adobe: 2500 BTU/brick(^{117})</td>
</tr>
<tr>
<td>Use</td>
<td>Load-bearing walls</td>
</tr>
<tr>
<td></td>
<td>Lifespan of at least 100 years</td>
</tr>
<tr>
<td>Re-use</td>
<td>Return to soil</td>
</tr>
</tbody>
</table>

Table 6. Steel

<table>
<thead>
<tr>
<th>Source</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Truck to site</td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td>Use high recycled-content steel</td>
</tr>
<tr>
<td></td>
<td>Embodied energy (non-recycled): 19,000 BTU/lb.(^{118})</td>
</tr>
<tr>
<td>Use</td>
<td>Roofs and trusses</td>
</tr>
<tr>
<td></td>
<td>Long lifespan</td>
</tr>
<tr>
<td>Re-use</td>
<td>Recycle again</td>
</tr>
</tbody>
</table>

Table 7. Salvaged Wood

<table>
<thead>
<tr>
<th>Source</th>
<th>Habitat Restore, Austin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Truck to site</td>
</tr>
<tr>
<td>Distribution</td>
<td>On-site</td>
</tr>
<tr>
<td>Process</td>
<td>Low embodied energy (virgin): 2200 BTU/lb.(^{119})</td>
</tr>
<tr>
<td>Use</td>
<td>Walkways, trellises, porch structure</td>
</tr>
<tr>
<td>Re-use</td>
<td>Can be salvaged and used again</td>
</tr>
</tbody>
</table>

\(^{116}\) The Rocky Mountain institute provides this definition, “Embodied energy is the energy needed to grow, harvest, extract, manufacture, or otherwise produce a building product...figures do not account for energy added during transportation” in *A Primer on Sustainable Building*. (Snowmass, CO: Rocky Mountain Institute, 1995), 44.


\(^{118}\) Rocky Mountain Institute, *A Primer on Sustainable Building* (Snowmass, CO: Rocky Mountain Institute, 1995), 78.

\(^{119}\) *Ibid.*
Table 8 Glass

<table>
<thead>
<tr>
<th>Source</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Embodied energy (non-recycled): 10,000 BTU/lb.\textsuperscript{120}</td>
</tr>
<tr>
<td>Use</td>
<td>Windows and solar collectors</td>
</tr>
<tr>
<td>Re-use</td>
<td>Easily recycled</td>
</tr>
</tbody>
</table>

Table 9 Flyash Concrete

<table>
<thead>
<tr>
<th>Source</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Truck to site</td>
</tr>
<tr>
<td>Distribution</td>
<td>On-site</td>
</tr>
<tr>
<td>Process</td>
<td>Embodied energy: 10,000 BTU/lb.\textsuperscript{121}</td>
</tr>
<tr>
<td>Flyash (a byproduct of electric plants) reduces the amount of cement needed and alleviates pollution\textsuperscript{122}</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>Concrete bond beams, pool, cistern</td>
</tr>
<tr>
<td>Re-use</td>
<td></td>
</tr>
</tbody>
</table>

Table 10 Pervious Pavers

<table>
<thead>
<tr>
<th>Source</th>
<th>Mesquite trees, Texas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Embodied energy: 2200 BTU/lb.\textsuperscript{123}</td>
</tr>
<tr>
<td>Otherwise Mesquite cleared away and wasted</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td>Pavers for walkways to retain water on site</td>
</tr>
<tr>
<td>Re-use</td>
<td>Biodegradable</td>
</tr>
</tbody>
</table>

\textsuperscript{120} Ibid.

\textsuperscript{121} Ibid.


\textsuperscript{123} Rocky Mountain Institute, A Primer on Sustainable Building, (Snowmass, CO: Rocky Mountain Institute, 1995), 78.
## APPENDIX B. R-VALUE CALCULATIONS

### Table 11

<table>
<thead>
<tr>
<th>R-values for walls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20 cm caliche walls with 2 cm mud plaster on the exterior and 1 cm mud plaster on the interior</td>
<td>3.80</td>
</tr>
<tr>
<td>10 cm organic bonded glass fiber insulation</td>
<td>19.60</td>
</tr>
<tr>
<td>Inside air vertical</td>
<td>.68</td>
</tr>
<tr>
<td>Outside air</td>
<td>.17</td>
</tr>
<tr>
<td>Total</td>
<td>24.25</td>
</tr>
</tbody>
</table>

### Table 12

<table>
<thead>
<tr>
<th>R-values for roof</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated steel roofing</td>
<td>.50</td>
</tr>
<tr>
<td>Radiant barrier as a reinforced sheet applied to under side of rafters which creates an air space</td>
<td>1.32</td>
</tr>
<tr>
<td>Outside air</td>
<td>.17</td>
</tr>
<tr>
<td>Inside air horizontal</td>
<td>.61</td>
</tr>
<tr>
<td>20 cm organic bonded glass fiber insulation</td>
<td>39.20</td>
</tr>
<tr>
<td>Total</td>
<td>41.80</td>
</tr>
</tbody>
</table>
APPENDIX C. HEATING CALCULATIONS

Energy Performance Worksheet for a Building in Texas\textsuperscript{124}

GENERAL INFORMATION ABOUT THE PROJECT

PROJECT: Affordable housing for artists
ADDRESS: West Seventh Street, Austin, Texas
1713 = Heating degree days at project location

GENERAL INFORMATION ABOUT THE BUILDING

12,074 = Total heated floor area in square feet
106,756 = Interior volume of building in cubic feet

INFORMATION ABOUT WINDOWS

3 = Type of windows
3 for windows that are low-e or that have three or more panes

\begin{table}
\centering
\begin{tabular}{|l|l|l|l|}
\hline
Area (square feet) & Clear percentage & U & Orientation \\
\hline
1844 & 98 & .28 & South \\
\hline
480 & 95 & .28 & East \\
\hline
840 & 95 & .28 & North \\
\hline
688 & 95 & .28 & West \\
\hline
0 & 0 & 0 & Skylights \\
\hline
\end{tabular}
\caption{Windows}
\end{table}

INFORMATION ABOUT WALLS

\begin{table}
\centering
\begin{tabular}{|l|l|l|}
\hline
Area (square feet) & R-value & Description \\
\hline
10,434 & 24.25 & Walls \\
\hline
568 & 5.00 & Doors \\
\hline
\end{tabular}
\caption{Walls}
\end{table}

\textsuperscript{124} Adapted from "Energy Performance Worksheet for a Building in Iowa" prepared by Laurent Hodges, Iowa State University Extension, BES Building, Haber Road, Ames, Iowa 50011.
INFORMATION ABOUT ROOF

Table 15 Roof

<table>
<thead>
<tr>
<th>Area (square feet)</th>
<th>R-value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8301</td>
<td>41.8</td>
<td>Roof</td>
</tr>
</tbody>
</table>

MISCELLANEOUS INPUT

0.5 = Air changes per hour
929,710 = Average daily total internal heat in BTU
3 = Amount of thermal storage (3 = high)

INFORMATION ABOUT POSSIBLE HEATING SYSTEMS

5.20 = Coefficient of performance for electric heat pump
95% = Annual fuel utilization efficiency for gas, propane, or oil-fired furnace

ENERGY PRICES

8.5 cents per kWh = Price of electricity
65 cents per therm (100,000 BTU) = Price of natural gas
79 cents per gallon = Price of propane
98 cents per gallon = Price of fuel oil

BUILDING HEAT LOSS CALCULATION

Table 16 Heat Loss

<table>
<thead>
<tr>
<th>Description</th>
<th>Square feet</th>
<th>Effective R-value</th>
<th>BTU/Degree Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>11,031</td>
<td>20.3</td>
<td>13,052</td>
</tr>
<tr>
<td>Roof</td>
<td>8301</td>
<td>41.8</td>
<td>4766</td>
</tr>
<tr>
<td>South Windows</td>
<td>1844</td>
<td>3.6</td>
<td>12,392</td>
</tr>
<tr>
<td>East/West Windows</td>
<td>1168</td>
<td>3.6</td>
<td>7849</td>
</tr>
<tr>
<td>North Windows</td>
<td>840</td>
<td>3.6</td>
<td>5645</td>
</tr>
</tbody>
</table>

AIR INFILTRATION HEAT LOSS: 23,059 BTU/Degree Day
BUILDING HEAT LOSS COEFFICIENT: 66,787 BTU/Degree Day
ESTIMATED HEATING LOAD: 189,230 BTU/hr at winter dry bulb temperature
THERMAL PERFORMANCE

Abbreviations:  
BTU = British thermal units  
DD = Fahrenheit heating degree-day  
MBTU = Million BTU

ASSUMED AIR CHANGES PER HOUR: .50
BUILDING HEAT LOSS COEFFICIENT: 66,787 BTU/DD

Table 17 Thermal Performance

<table>
<thead>
<tr>
<th></th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating DD</td>
<td>30</td>
<td>214</td>
<td>402</td>
<td>484</td>
<td>322</td>
<td>211</td>
<td>50</td>
<td>1713</td>
</tr>
<tr>
<td>Gross heat loss (MBTU)</td>
<td>2</td>
<td>14.29</td>
<td>26.85</td>
<td>32.32</td>
<td>21.51</td>
<td>14.09</td>
<td>3.34</td>
<td>114.41</td>
</tr>
<tr>
<td>Internal heat (MBTU)</td>
<td>28.82</td>
<td>27.89</td>
<td>28.82</td>
<td>28.82</td>
<td>26.03</td>
<td>28.82</td>
<td>27.89</td>
<td>197.1</td>
</tr>
<tr>
<td>Net heat loss (MBTU)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
</tr>
<tr>
<td>Solar gain (MBTU)</td>
<td>119.8</td>
<td>86.14</td>
<td>76.92</td>
<td>84.29</td>
<td>94.55</td>
<td>107.0</td>
<td>129.8</td>
<td>698.63</td>
</tr>
<tr>
<td>Solar Load Ratio</td>
<td>100</td>
<td>n/a</td>
<td>n/a</td>
<td>24.05</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Useful solar (MBTU)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
</tr>
<tr>
<td>Auxiliary heat (MBTU)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 18 Heating Summary

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary for Average Heating Season</td>
<td></td>
</tr>
<tr>
<td>Total internal heat</td>
<td>197.1</td>
</tr>
<tr>
<td>Total useful solar heat</td>
<td>3.5</td>
</tr>
<tr>
<td>Total auxiliary heat</td>
<td>0</td>
</tr>
<tr>
<td>Total heat loss</td>
<td>200.6</td>
</tr>
</tbody>
</table>

HOME HEATING REQUIREMENT: 69,268 BTU/DD
HOME HEATING INDEX: 5.7 BTU/DD-sqft
Table 19 Utility Costs for the entire community

<table>
<thead>
<tr>
<th>Type</th>
<th>Total annual heating cost</th>
<th>Average Jan. bill</th>
<th>Average utility bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric resistance</td>
<td>1.00 = COP</td>
<td>$0</td>
<td>$718</td>
</tr>
<tr>
<td>Electric heat pump</td>
<td>5.20 = COP</td>
<td>$0</td>
<td>$718</td>
</tr>
<tr>
<td>Natural gas furnace</td>
<td>95% = AFUE</td>
<td>$0</td>
<td>$718</td>
</tr>
<tr>
<td>Propane furnace</td>
<td>95% = AFUE</td>
<td>$0</td>
<td>$718</td>
</tr>
<tr>
<td>Oil-fired furnace</td>
<td>95% = AFUE</td>
<td>$0</td>
<td>$718</td>
</tr>
</tbody>
</table>
APPENDIX D. COOLING CALCULATIONS

DESIGN CONDITIONS:

Summer outside design conditions:  
Drybulb: 90 degrees F  
Wetbulb: 74 degrees F  
Wind sp: 7.5 mph  
Hour: 2 p.m. August 21

Summer inside design conditions:  
Drybulb: 78 degrees F  
Rel. hum: 50 percent

Summer drybulb air temperature difference: 12 degrees  
Summer water vapor (humidity ratio) difference: .004  
Ventilation cubic feet per minute per person: 10 cfm

Table 20 Above Grade Walls

<table>
<thead>
<tr>
<th>Wall</th>
<th>Area</th>
<th>R total</th>
<th>U value</th>
<th>UA total</th>
<th>Equiv. temp.</th>
<th>Indoor temp</th>
<th>Temp. diff.</th>
<th>Heat gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>3386 sqft</td>
<td>24.25</td>
<td>.041</td>
<td>138.8</td>
<td>100 degrees</td>
<td>78 degrees</td>
<td>12 degrees</td>
<td>3054</td>
</tr>
<tr>
<td>South</td>
<td>3133</td>
<td>24.25</td>
<td>.041</td>
<td>128.5</td>
<td>111 degrees</td>
<td>78 degrees</td>
<td>33 degrees</td>
<td>4241</td>
</tr>
<tr>
<td>West</td>
<td>1987</td>
<td>24.25</td>
<td>.041</td>
<td>81.5</td>
<td>121 degrees</td>
<td>78 degrees</td>
<td>43 degrees</td>
<td>3505</td>
</tr>
<tr>
<td>East</td>
<td>1687</td>
<td>24.25</td>
<td>.041</td>
<td>69.2</td>
<td>100 degrees</td>
<td>78 degrees</td>
<td>22 degrees</td>
<td>1522</td>
</tr>
</tbody>
</table>

Above grade walls total heat gain: 12,322 BTUH  
(No below grade walls)

Table 21 Windows in Sun and Shade. (Windows are 1/4 inch, argon-filled, double pane, low-e coated)

<table>
<thead>
<tr>
<th>Window</th>
<th>Area</th>
<th>U</th>
<th>Temp. diff.</th>
<th>UxAT</th>
<th>SCO</th>
<th>SCI</th>
<th>SHG</th>
<th>CLF</th>
<th>Heat gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>209.9</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.0</td>
<td>.88</td>
<td>32</td>
<td>.7</td>
<td>5,245</td>
</tr>
<tr>
<td>South</td>
<td>485.2</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.0</td>
<td>.88</td>
<td>116</td>
<td>.7</td>
<td>37,234</td>
</tr>
<tr>
<td>West</td>
<td>172.7</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.0</td>
<td>.88</td>
<td>150</td>
<td>.7</td>
<td>16,811</td>
</tr>
<tr>
<td>East</td>
<td>119.9</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.0</td>
<td>.88</td>
<td>32</td>
<td>.7</td>
<td>2,996</td>
</tr>
<tr>
<td>North</td>
<td>626.6</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.2</td>
<td>.88</td>
<td>32</td>
<td>.7</td>
<td>5,777</td>
</tr>
<tr>
<td>South</td>
<td>485.2</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.2</td>
<td>.88</td>
<td>116</td>
<td>.7</td>
<td>9,495</td>
</tr>
<tr>
<td>West</td>
<td>516.3</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.2</td>
<td>.88</td>
<td>150</td>
<td>.7</td>
<td>12,267</td>
</tr>
<tr>
<td>East</td>
<td>359.8</td>
<td>.44</td>
<td>12</td>
<td>5.28</td>
<td>1.2</td>
<td>.88</td>
<td>32</td>
<td>.7</td>
<td>3,317</td>
</tr>
</tbody>
</table>

Windows total heat gain: 93,142 BTUH
Table 22 Roof

<table>
<thead>
<tr>
<th>Roof</th>
<th>Area</th>
<th>R total</th>
<th>U value</th>
<th>UA total</th>
<th>Equiv. temp.</th>
<th>Indoor temp.</th>
<th>Temp. diff.</th>
<th>Heat gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horiz.</td>
<td>8301</td>
<td>41.8</td>
<td>.024</td>
<td>198.6</td>
<td>126</td>
<td>78</td>
<td>48</td>
<td>9532.8</td>
</tr>
</tbody>
</table>

Roof total heat gain: 9533 BTUH

VENTILATION:

Table 23 Sensible Ventilation

<table>
<thead>
<tr>
<th>No. people</th>
<th>CFM/person</th>
<th>CFM total</th>
<th>Temp. diff.</th>
<th>CFM x ΔT</th>
<th>Times</th>
<th>Heat gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>10</td>
<td>200</td>
<td>12</td>
<td>2400</td>
<td>1.08</td>
<td>2592</td>
</tr>
</tbody>
</table>

Table 24 Latent Ventilation

<table>
<thead>
<tr>
<th>No. people</th>
<th>CFM/person</th>
<th>CFM total</th>
<th>Water diff.</th>
<th>CFM x water diff.</th>
<th>Times</th>
<th>Heat gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>10</td>
<td>200</td>
<td>.004</td>
<td>.8</td>
<td>4842</td>
<td>3873.6</td>
</tr>
</tbody>
</table>

Air enthalpy heat gain: 6467 BTUH

INTERNAL LOADS GAIN:

PEOPLE HEAT GAIN:
20 people x 500 BTUH = 10,000 BTUH

LIGHTING HEAT GAIN:
2769 sqft. x .5 watts/sqft. x 3.412 BTUH/watt = 4724 BTUH

EQUIPMENT HEAT GAIN:
12,074 sqft x 1 watt/sqft x 3.412 BTUH/watt = 41,196 BTUH

Internal loads total heat gain: 55,920 BTUH

BUILDING HEAT GAIN SUMMARY:

Above grade walls in sun and shade: 12,322 BTUH
Windows in sun and shade: 93,142 BTUH
Roof in sun and shade: 9533 BTUH
Ventilation: 6467 BTUH
Internal loads total: 55,920 BTUH
Worst hour total heat gain: 177,384 BTUH

One day: 5 hours x 177,384 BTUH = 886,920 BTUH

Storage capacity of mass: 15,781 cuft x 50 lb/cuft = 789,050 lb

\[ 789,050 \text{ lb} \times 0.2 \text{ BTU/°F-lb-hr} \times 0.8° = 1,262,480 \text{ BTUH} \]

The mass can handle all of the heat gain.
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“Housing Maverick.” Architecture, August 1997, 44.


