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Urban Consortium
Energy Task Force of
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City of Austin

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Green Habitat Learning Project A Green Builder Model Home Project

Environmental and Conservation
Services Department

Doug Seiter, Program Manager

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URBAN CONSORTIUM

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CITY OF AUSTIN

**GREEN HABITAT
LEARNING PROJECT**

**A GREEN BUILDER
MODEL HOME PROJECT**

**URBAN CONSORTIUM
ENERGY TASK FORCE**

**Environmental and
Conservation Services Department**

Doug Seiter, Program Manager

December 1995

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Background

URBAN CONSORTIUM

Public Technology, Inc. (PTI), is the non-profit technology organization of the National League of Cities (NLC), the National Association of Counties (NACo), and the International City/County Management Association (ICMA). PTI's mission is to bring technology to local governments. Through collective research and development efforts in its member jurisdictions, PTI creates and advances technology-based products, services, and enterprises for all cities and counties.

Four active task forces, each composed of members of PTI's Urban Consortium (UC)—which represents fifty of the nation's largest and most progressive cities and urban counties—drive PTI's research and commercialization efforts. One of these task forces is the Urban Consortium Energy Task Force (UCETF), which was established to address critical energy needs of urban America.

THE URBAN CONSORTIUM ENERGY TASK FORCE

The UCETF is the nation's most extensive cooperative local government program to improve energy management and technology applications in local governments. Its membership is composed of local government officials from America's large urban centers. The four major goals established by UCETF members are to:

1. Pursue collaborative solutions to interrelated energy, environment and economic development issues at the local level;
2. Improve energy efficiency, reduce costs and develop revenue from local energy assets;
3. Promote practices and efforts at the local level to assure that energy and environmental considerations are broadly integrated into local decision-making, and to address the interrelationships between energy, environment and economic policies; and
4. Act as the implementation arm for NLC and NACo policies.

Under an annual program partly funded by the U.S. Department of Energy (USDOE), a number of city and county projects propose to meet UCETF objectives. Projects selected for each year's program are organized in thematic units, such as Utilities/Buildings, Transportation, Sustainable Communities, and Technology Transfer, to assure effective management and ongoing peer-to-peer exchanges. The results of these research projects are documented in reports such as this one, and made available for broad dissemination among other local governments through PTI.

The research and studies described in this report were made possible by grants from the MUNICIPAL ENERGY MANAGEMENT program of the Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy.

The statements and conclusions contained herein are those of the grantees and do not necessarily represent the official position or policy of the U.S. Government in general or USDOE in particular.

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CHAPTER 1: OVERVIEW OF THE GREEN BUILDER MODEL HOME PROJECT

ABSTRACT

The purpose of the Year 14 UCETF project was to design and construct a residential structure that could serve as a demonstration facility, training site, and testing and monitoring laboratory for issues related to the implementation of sustainable building practices and materials. The Model Home Project builds on the previous and existing efforts, partially funded by the UCETF, of the City of Austin Green Builder Program to incorporate sustainable building practices into mainstream building activities.

The Green Builder Program uses the term "green" as a synonym for sustainability. In the research and analysis that was completed for our earlier reports in Years 12 and 13, we characterized specific elements that we associate with sustainability and, thus, green building. In general, we refer to a modified life cycle assessment to ascertain if "green" building options reflect similar positive cyclical patterns found in nature (i.e. recyclability, recycled content, renewable resources, etc.). We additionally consider economic, human health and synergistic ecological impacts associated with our building choices and characterize the best choices as "green." Our ultimate goal is to identify and use those "green" materials and processes that provide well for us now and do not compromise similar benefits for future generations.

The original partnership developed for this project shifted during the year from a project stressing advanced (many prototypical) "green" building materials and techniques in a research and demonstration context, to off-the-shelf but underutilized "green" materials in the practical social context of using "green" technologies for low income housing. That project, discussed in this report, is called the Green Habitat Learning Project.

The Green Habitat Learning Project features a core partnership between Austin Habitat for Humanity, the American Institute for Learning, and the City of Austin Green Builder Program. Funding support for the actual construction of the "green" home came from several corporate contributors and private foundation support. This partnership combines three agendas, and consists of *"at-risk" and drop-out youth* serving as constructors of a *green home* for a *low income family*.

The Green Builder Program performed the coordinating functions for the project along with the following specific tasks: design, material and other "green" specifications, and funding support. The American Institute for Learning provided the selection, supervision, and training of the workers as well as supervision of the construction of the home and project financial management. Habitat for Humanity provided logistical support in securing the property, selected the family for ownership, and aided in funding solicitation.

The demonstration aspects of the project have been served well despite the fact that, since it is privately owned, the home cannot be an ongoing demonstration. The combined social and environmental benefits of this project have created considerable media attention, as well as interest from the national office of Habitat for Humanity, city officials, and corporations. Additionally, a high quality educational video has been produced about the project.

PROJECT PURPOSE AND BACKGROUND

The concept of sustainable or "green" building as expressed by the Green Builder Program was formally introduced to the citizens of Austin in early 1992. The concept presented in the *Green Building Guide* (a product of the Year 12 UCETF grant) was well-received primarily due to the proactive environmental sentiments of a large number of Austin citizens. However, practical understanding of what green building actually is and how to accomplish it needed more attention. The initial step we took in that regard was to create a reference and technical manual for building professionals. This was done in the Year 13 UCETF project and was called the *Sustainable Building Sourcebook*.

During the Year 13 Project (*Sourcebook*), we recognized that further real world information and promotion would still be necessary for both the building professionals and potential homebuyers of green homes. Similarly, we felt it was important to ascertain for ourselves (in order to be most accurate in our information on green building) the logistical realities of building a green house within our existing building supply and service system. At the same time, we felt that we could influence the supply situation by creating a demand and dialogue with building material suppliers around the needs of a green demonstration project. Thus, the goals of the project were:

- 1. Demonstrate the design and material strategies that can be incorporated into a green home.*
- 2. Select underutilized or new-to-the-region materials that demonstrate resource efficiency and potentially stimulate local economic development.*
- 3. Educate building professionals and the public through tours, media events, and written and video documentation.*

Austin Habitat for Humanity expressed interest in collaborating on a project partly because the Habitat national office wished to become more considerate of the resource impacts of building homes. Due to their large volume of activity and resultant environmental impacts, Habitat for Humanity is currently the fourth largest builder of homes in the United States and expects to be number one within a couple of years. Additionally, skyrocketing lumber prices were affecting the costs of building Habitat homes. The idea that "green" homes could use less wood was attractive.

The catalyst for forging the partnership came when representatives of the American Institute for Learning contacted the Green Builder Program to discuss their interest in developing a youth training and educational program by building an environmentally responsible home for Habitat for Humanity. The American Institute for Learning is an alternative school for disadvantaged and at-risk youth with award winning programs already established in numerous experiential learning areas. All three organizations responded positively about joining together and the resulting collaboration was titled **The Green Habitat Learning Project.**

The partnership expanded the original purpose of the green demonstration house by integrating with the social and educational goals of both Austin Habitat for Humanity and the American Institute for Learning. Thus, in addition to the goals listed above, the project encompassed the following:

- 1. Construct the home for the use of a low-income family.*
- 2. Fit into the established budget and basic design parameters used for low-income homes built by Habitat for Humanity.*
- 3. Use at-risk youth as constructors of the project and provide them with training and understanding of the environmental rationale of the project.*

REPORT ORGANIZATION

This report presents the development of a green demonstration home that is constructed with available materials and technologies.

Chapter 2 presents the rationale of the value of this project. The "green" technological concepts used in the project, the energy savings, and the Green Builder Program rating are described and contrasted to a conventional Habitat home that would have been constructed on the site.

Chapter 3 describes the construction process and the features of the house.

Chapter 4 presents lessons learned in the project, the costs, and issues regarding transferability.

In the Appendix, we present the specifications used in the project.

CHAPTER 2: FORGING THE GREEN HABITAT LEARNING PROJECT

SOMETHING FOR EVERYONE

Partners' Profile

Austin Habitat for Humanity builds low cost homes for needy families. Families who apply for Habitat homes build up "sweat equity" by participating in the building of other Habitat homes. At the time of this project, there was no operating building budget based on income from previously built homes. Austin Habitat has constructed 13 homes since 1987 through 1993, using volunteer labor and money for materials from donations, fund-raisers, and, predominantly, sponsors. The families have been able to purchase the homes for about \$35,000 at no interest for 20 years.

Recent cost increases and the price volatility of lumber has caused Austin Habitat to increase their 1994 homes' costs to \$39,750. Accompanying this change, Austin Habitat has realized that buildings totally dependent on wood framing will probably see more cost increases as the sustainability of our wood resources receives increasing scrutiny from environmental considerations. Nevertheless, the idea of incorporating green features into the homes interested Austin Habitat not only for cost stability but also for health associated with indoor air quality, durability and maintainability, and the sense of environmental responsibility in accord with their mission of serving human needs.

The *American Institute for Learning* (AIL) employs a teaching philosophy that uses project-based learning as an opportunity to reach young people disenfranchised from a sense of belonging and meaning in their lives. The AIL commenced operations in 1978 and operates four program tracts targeted at helping needy youth through education, empowerment, the AIL Casa Verde Program and job training. The AIL perceives within

a project that involves the building of a house a chance to teach a "giant math problem" integrated with a responsible community action that helps their students recognize their part in the bigger picture. AIL states that their aim is to change kids from being or becoming liabilities in their communities to being rebuilders of the community while attaining marketable skills and attitudes. The fact that high standards of environmental responsibility are incorporated in the project is in total accord with their goal of instilling responsibility and understanding in their students.

For this project, the AIL had the means to support some of the costs associated with training stipends for the students. However, they had no additional funds to support the costs of buying materials for a house.

The *Green Builder Program* was entering its second year of formal existence at the time of this project's initiation. Up to that time, most of the effort of full-time staff in the program was to develop the Program's conceptual underpinnings and a resource manual. Staff members from the existing HERS (Home Energy Rating System) program of the City of Austin, the Energy Star Program, assisted part-time in trying to market the program. Membership and interest in the program had been growing steadily, not only locally but nationwide. An international award from the United Nations in 1992 also bolstered the Program's credibility. As the national media focused attention on sustainability, it became evident that an exponential growth in interest was imminent. The reputation and knowledge of the Green Builder Program coupled with the strength of the social appeal of the partners formed a strong partnership for funding solicitation.

Expanding the Team

Seeking additional partners that could provide funding for the material costs of the house became a central priority. The Green Builder Program took the initiative to seek corporate partners and develop a conceptual profile for the project that the other partners (Austin Habitat and AIL) could use for their contacts. We all felt confident that we had funding appeal since each partner individually had been able to attract support and interest in their organizations. As a partnership, we felt that we were stronger than ever.

The Home Depot, Inc., provided the project with a \$15,000 line of credit. They stated that the project met their philanthropic goals: low income housing, at-risk youth, and the environment. Shortly thereafter, Motorola and IBM joined the team with significant contributions. With a strong foundation from these corporate sponsors, other companies and suppliers began contributing as well as they could afford.

Simultaneously to contacting potential corporate sponsors, we applied jointly for a grant from the State of Texas using oil overcharge funds. Green Builder Program personnel wrote the proposal emphasizing the multi-tiered benefits of the partnership. An additional benefit was the establishment of a training program for low income homeowners that would allow them to operate and maintain their homes in the most resource efficient manner. Homeowner manuals would be developed using the AIL students as principal authors. The proposal also called for building a total of three homes to serve as green building demonstrations to be occupied by low income homeowners. The State of Texas favorably reviewed the proposal based on the integrated features and benefits of the project coupled with the energy efficiency goals associated with the proposal. They subsequently recommended funding at the time of final review by the U. S. Department of Energy (DOE).

By early summer 1993, the project had evolved into a core partnership of Austin Habitat for Humanity, the American Institute for Learning, and the Green Builder Program employing the name, Green Habitat Learning Project. Additional corporate partners and the State of Texas became part of the team to build a total of three green demonstration houses over a two year period. The project partners were sorely disappointed when this [DOE] funding was dropped for all Texas projects in late Fall 1993, after all indications and preparations were in place for acceptance with significant work already completed.

DESIGN CRITERIA

The Green Builder Program assumed responsibility for developing plans and specifications for the project. The Green Builder Program already provides a list of green building options in four resource issues of *Water, Energy, Building Materials*, and *Solid Waste* that

are suitable for the Austin region. When the list was compiled, cost information was considered to be in a state of flux for many items. This is due to the fact that as green options become more desirable, the price of implementing them starts to respond to market-based demand in a competitive manner rather than as a specialty item. An initial task was to look at the list of green items and identify those with established market demand and use these as a starting point since we had to fit within a low budget. Concurrently, we had to look at building design issues not only for cost cutting improvements but to achieve enhanced energy performance.

Building Design

Upon review of the conventional Austin Habitat home plan, we ascertained that the plan needed to be improved in some key areas:

The standard plan could not accommodate passive energy design features without considerable modification.

Mechanical equipment was inadequate for comfort (too hot in the summer and too cold in the winter). We visited some existing homes and saw that window air conditioners were universally being added. The utility bills also indicated that electrical demand increased significantly in cold snaps probably due to electric space heaters.

All Habitat homes had been cost driven in regards to material selections; toxicity in adhesives, paints, and finishes were not addressed.

We established a goal to make the home reflect a design-based strategy for space conditioning, use durable, minimal-maintenance materials, improve comfort levels, and not impact negatively on indoor air quality. A design team was established with an architect providing drawing services, two staff persons from the Green Builder Program, and the construction supervisor for the project (who was also the former construction supervisor for Habitat for Humanity and now worked for the AIL).

Passive design strategies require site knowledge and, as a result, are ascribed primarily to custom building. Although it is possible to build a custom low-income home, in the interest of replicability it was necessary to develop a design that could be easily adjusted to different sites. This led to the development of a square house plan.

The reasoning behind the square house plan is that the interior floor plan, if properly designed, can be adapted to achieve the best relationship with the sun for passive heating and cooling. Since the cooling season is the prime factor in energy use in Austin, we also recognized that additional shading should be introduced. A porch on the west side of the house in this location could similarly rotate (as the floorplan does) in response to conditions at different sites. The porch also added (unconditioned) living space, giving the occupants the opportunity to use the favorable outdoor conditions for much of the year without additional energy costs. Additionally, a usable porch that faces the street connects the occupants with the community and helps enhance security and community spirit.

Overhangs were developed to a distance that will keep summer sun out of the south windows (there are more south windows in this design to receive the winter sun and favorable prevailing summer breezes). The overhangs accommodate continuous soffit venting that tie into the continuous ridge vent at the peak of the roof to enhance ventilation under the roof surface during the summer. The overhangs are cantilevered out over the wall so that the attic insulation does not interfere with the attic ventilation.

The fact that temperatures during much of the year in Austin fall within the comfort range led to the goal to make the house easily ventable. Natural and enhanced ventilation strategies became a central facet of the project and were incorporated into design considerations.

A major design strategy was to reduce temperature fluctuations in the house. Thermal mass was incorporated into the normally lightweight Habitat home in the form of a concrete slab foundation and floor and special wall material. In this approach, winter solar gain will be absorbed for later use and provide earth contact and thermal flywheel benefits for summer cooling.

Since daylighting decreases with the increased depth of the house due to the square plan, the ceiling height was raised, sloping toward the peak in the living/dining and kitchen areas. This allowed *indirect* lighting from energy efficient fluorescents to be placed so that

the rooms could be illuminated inexpensively. An early strategy to add a "Sunpipe" skylight (a non-heat-producing style) in the kitchen was found to be unnecessary since adequate natural light easily reflected through the space.

A review of costs associated with these design-based strategies indicated that we would be primarily shifting, not adding, costs and making the home more energy efficient.

Additional Energy Strategies

Although the home was designed to remain as cool as possible in the summer, perhaps eliminating the need for air conditioning, it could not be assured that the future home occupants would tolerate the few inevitable times that temperatures would be uncomfortable. To handle this possibility and to make space heating inexpensive and equally distributed in the house, we added a duct system (small due to the size of the house and the square plan) that would reflect the highest standards in safe and efficient installation.

The mechanical system is a high efficiency natural gas combination ("combo") system, which uses a gas water heater as heat source for the forced air furnace. The air handler also holds a cooling coil which can be connected to a high efficiency air conditioner. This replaces the standard, less efficient gas wall furnace and the need to use less efficient window air conditioners. By selecting a higher efficiency gas water heater, domestic water heating costs are also reduced.

Ceiling fans and a whole house fan were added to enhance ventilation, a key strategy for keeping cool in our area. Conventional Habitat homes provide these fans as well. However, due to security concerns, homes were not opened up at night to use the whole house fans. We added security screen doors and security bars on key windows to permit night ventilation to be used safely. Cooling the thermal mass in the home with the whole house fan is expected to greatly enhance the cooling performance of the design.

Insulation levels in our plan were increased in the attic area. We also added a radiant barrier in the attic, coupled with ridge and soffit venting to reduce high attic temperature.

In making these energy improvements, there were some additional costs in the combo/duct system (partially offset by a utility rebate), but no increase in insulation costs due to the special wall material. The ventilation costs would be higher in our plan due to the added cost of security doors. We felt that by avoiding higher operational costs, these expenses would be justified. (In the next chapter, we present a comfort and energy profile on the demonstration house versus the conventional house that would have been built there.)

Water Conservation

Improvements in water conservation could be attained without difficulty since fixtures and flow devices that exceed code are readily available at conventional costs. Also, putting in a water conserving landscape could be similarly accomplished. We initially hoped that we could demonstrate rainwater harvesting but found that the payback would be unacceptable in this application. Instead, we decided to gutter the house and direct rainwater into swales (recessed areas) in the landscape that can allow extra absorption of the rainwater (avoiding runoff) and support shade-producing plants in those areas.

Building Materials

With escalating wood prices affecting the costs of their homes, Austin Habitat was very interested in alternatives to wood-dominated structures that could still be built by volunteers. We selected a permanent wall form, recently introduced from Europe, to eliminate the need for exterior framing. It uses a waste wood fiber bound with cement into a block that appears similar to a standard concrete block. The blocks are stacked without mortar, and concrete and steel reinforcing fill the cores. The costs of this material in its completed structural application is comparable to wood framing and combines insulating qualities, fire and termite resistance, and thermal mass. This wall form material offers interesting economic development possibilities since it uses waste materials.

For interior framing, we selected steel studs. These are made from recycled steel, are easy to recycle, provide termite and fire resistance, and demonstrate consistent quality (causing less waste from unusable studs). Steel studs are also less costly than wood studs.

For floor coverings, our strategy was to use the slab as a finish floor for a large portion of the house. This would, of course, eliminate the costs and maintenance of carpeting in that area as well as allow the thermal mass to function as a thermal flywheel. In other areas, we selected recycled-content carpeting (bedrooms) and natural linoleum (kitchen and bath). Natural linoleum (which was also used for countertops) was more expensive but was used for demonstration value since it was donated.

The use of flyash (a coal combustion byproduct) in concrete allows reduced use of energy intensive portland cement. We elected to use flyash to a high workable level in all the concrete used in the project. Although flyash is cheaper to the ready mix plants than portland cement, these savings are generally not passed on and the concrete costs the same, with or without flyash. The flyash we would use is readily available and comes primarily from our own coal electrical power plant.

The balance of our material selections hinged on their impact on indoor air quality. Items such as glues, paints, and cabinet materials were chosen to be the least toxic. Very little cost impact was expected from this approach due to ready availability.

Solid Waste

Habitat projects recycle everything possible from construction waste, diverting usable materials to the Habitat Thrift Center. In our demonstration home, we wanted to also add features to the home that would make recycling convenient for the home occupants. By using a portion of the pantry as a recycling area and providing a compost system, the homeowners could significantly reduce their landfill waste. The rationale behind this feature was that recycling needs to be routine to be successful, and the built-in feature can allow this to happen. The costs associated with this change were considered minimal.

CALCULATED ENERGY SAVINGS

In this section, the results of a DOE 2 simulation are presented comparing the demonstration house and the conventional Austin Habitat home that would have been built on the site.

The Site

The home site is a corner lot with strong solar exposure on the south and west and a lack of any nearby trees that can provide shade to the house. A neighboring single story rectangular house sits close to the east side. It is oriented on an east west axis and provides little shade to the site.

The house is elevated from the streets due to the natural grade gaining approximately five feet at the point where the house stands. (Most of the ten other homes on this street that Austin Habitat has constructed are shaded to varying degrees by large trees.) Both the demonstration house and the conventional Habitat models, have three bedrooms, one bath, and approximately 1,050 square feet. The Habitat model is rectangular with a small overhang over the front entryway. The entry (narrow end of the house) would face south on this lot - a typical placement according to the Habitat staff. The demonstration house is square shaped with the entry and large porch facing west.

Habitat Home

The conventional Habitat home in the calculation uses a wall heater in the living room and window air conditioners in the living room and in a bedroom, with large windows on the unshaded southwest corner. This home satisfies City of Austin Energy and Building Code requirements. The wall heater is typical of all Habitat homes. We have added two

*Habitat for Humanity Conventional Model Floorplan
(South is toward the bottom of the page)
(Figure 2.1)*

window air conditioning units. This reflects what is done in other Habitat homes along this street after the residents move in. (Habitat does not provide air conditioning.)

The Habitat home floor plan has a central entryway on the south side entering the house between two bedrooms. A living room on the west half opens into a dining room on the north end of the house. The kitchen adjoins the dining room on the west side. The east side consists of the bathroom, a bedroom on the northeast side, as well as the bedroom on the southeast side. (See Figure 2.1.)

The energy consumption of the Habitat home in KWH, KW, and MBTU of natural gas is shown below on a monthly basis and with a total amount indicated for one year.

MONTH	KWH	KW	MBTU
JAN	701	2.43	4.008
FEB	651	3.09	2.729
MAR	748	3.23	3.754
APR	765	3.44	3.308
MAY	985	3.76	3.082
JUN	1345	4.03	2.806
JUL	1502	4.01	2.9
AUG	1403	4.00	2.9
SEP	1299	3.94	2.823
OCT	860	3.45	3.075
NOV	701	3.45	2.999
DEC	692	2.78	3.565
TOTAL	11652	4.03 PEAK	37.95

Energy Use in a Conventional Habitat for Humanity Home Built at the Demonstration Site
(Figure 2.2)

The comfort factors in separate zones in the standard Habitat home are discussed below. This critical review indicates that the house on this site will have extreme temperatures in parts of the house that are not directly connected to the wall heater and two air conditioners. The analysis indicates that additional air conditioners and space heaters would likely be used. (The energy use figures in Figure 2.2 do not account for additional

air conditioners other than the original two.) From these indications, we should assume that if comfort is desired by the residents, energy use will be higher than what is shown above. According to how the occupants choose to accomplish this, the increase could be significant if additional window air conditioners and electric space heaters are used.

Comfort Levels in the Habitat Home during the Cooling and Heating Season.

These are described below by zones ("degrees" expressed in Fahrenheit). Zones are identified due to temperature fluctuation characteristics from the lack of a centralized HVAC system. The number of hours in designated zones in all temperature ranges are noted in Figure 2.3.

	Living Room ¹	Bedroom ²	Dining Room/ Entry/Kitchen ³	Bedrooms/ Bathroom ⁴
Above 85 Degrees	0	0	0	3712
81-85	0	0	24	1211
76-80	3889	5853	3795	1037
71-75	2473	1493	2500	908
66-70	2165	967	2200	1193
61-65	233	335	241	545
Below 60 Degrees	0	112	0	154

Number of Hours in Temperature Ranges in the Conventional Habitat for Humanity House
(Figure 2.3)

- 1 Living Room has air conditioner and wall heater.*
- 2 Bedroom on Southwest side has air conditioner.*
- 3 This area is treated as one zone bordering living area.*
- 4 This area is treated as one zone fairly isolated from living area with only doorway connections. It is located along the east wall of the house.*

The Habitat home exhibits extreme temperatures in the bedrooms/bathroom zone of the home which are not served directly by air conditioners or the heater. This situation would likely cause the owners to acquire additional air conditioning and possibly heating. This is primarily due to the long side of the home facing east and west and the poor distribution characteristics of the window air conditioners.

Green-Habitat Learning Project Demonstration Home

The demonstration home has a "combo" system that uses a high efficiency water heater and 12 SEER air conditioner. The owners will acquire the home without air conditioning as per the rules of Austin Habitat for Humanity. We have added the high efficiency unit in our calculations since it can be acquired at the same cost as the code required 10 SEER due to a utility rebate and the "combo" system is prepared to accommodate it with a cooling coil

*Floorplan for Green Demonstration Home
(South is to the right)
(Figure 2.4)*

connection already in the air handler. The floorplan of the demonstration home is shown in Figure 2.4 and the energy use in Figure 2.5.

MONTH	KWH	KW	MBTU
JAN	717	2.39	4.52
FEB	609	2.55	2.526
MAR	674	2.58	3.022
APR	648	2.90	2.213
MAY	769	3.34	2.623
JUN	1088	3.60	2.382
JUL	1244	3.56	2.462
AUG	1129	3.56	2.462
SEP	1053	3.55	2.388
OCT	674	3.00	2.544
NOV	665	2.97	2.897
DEC	697	2.33	3.8
TOTAL	9967	3.60 peak	34.296

Energy Use in Green Habitat Learning Project Demonstration Home

(Figure 2.5)

Comfort Levels in the Demonstration Home. All areas of the home are within the comfort zone during most of the heating and cooling season due to the central "combo" system and the home's energy design features. This is shown in Figure 2.6.

Temperature	Hours
Above 85 Degrees	0
81-85	0
76-80	3518
71-75	2268
66-70	2630
61-65	344
Below 60 Degrees	0

Temperature ranges in the Demonstration House

Figure 2.6

Energy Use Comparison

The two homes' electrical usage have been compared as if air conditioning was added. First, in the Habitat conventional model, two window units were considered in the manner typical of other Habitat homes in the area. In the demonstration model, it assumed the owner would add a 12 SEER central unit since the home has a central distribution system. (We assume that a 12 SEER unit would be used since the City existing rebate program allows its purchase at the same price as a code required 10 SEER.) If we do not assume air conditioning is used in the comparison, the electrical energy loads would, of course, be significantly reduced.

In our analysis, the demonstration home is calculated to use 1,685 fewer KWH and will peak at 0.43 KW less than the Habitat model. KW demand is also consistently lower in the green demonstration model. Additionally, we must also question whether the residents would accept the discomfort they will experience in the cooling season and not add more air conditioning, further increasing the difference in the homes' energy performances.

Figures 2.7, 2.8, and 2.9 provide a graphical comparison of the two homes' energy consumptions by month.

Comparison of Energy Use in Green Habitat vs. Standard Design

(Figure 2.7)

Comparison of Energy Demand in Green Habitat vs. Standard Design

(Figure 2.8)

Comparison of Natural Gas Use in Green Habitat vs. Standard Design

(Figure 2.9)

The year round use of natural gas is lower in the demonstration house (by 3.654 MBTU's) and the home is again more evenly and consistently comfortable than the Habitat model. The discomfort in the Habitat conventional home may encourage the use of auxiliary heaters (probably electric, which have been used by other Habitat residents) and increase energy consumption.

GREEN BUILDER PROGRAM RATING

An underlying goal for the Green Builder Program was to have this project present as many green features as possible within the Habitat budget. There are also energy savings related to green features which are not documented in the operating energy simulation discussed above. Energy savings by using recycled materials and byproducts can be expected in the following examples: flyash instead of portland cement, recycled fiber carpet instead of virgin carpet material, recycled steel in the interior studs and roofing, recycled aluminum in window frames, recycled paint primer, and recycled wood in the wall form material.

The City of Austin Green Builder Program Rating System developed for the Year 12 UCETF project rates homes in four resource areas: *water, energy, building materials, and solid waste*. The rating system accounts for variables in building options such as overall resource conservation, operating energy, embodied energy, environmental impacts, recyclability and the use of recycled material, durability, maintainability, economic impact, and health impacts. This rating system is discussed in the UCETF Year 12 report, *Sustainable Systems Rating Program, Marketing Green Building in Austin, Texas*.

Figure 2.10 summarizes the results of rating the conventional Habitat model and the demonstration model of the Green Habitat Learning Project. The scoring is summarized in overall point totals in each of the four resource areas which is converted to a One, Two, Three, or Four Star ranking. The stars translate to Fair (One Star), Good (Two Stars), Excellent (Three Stars), and Superior (Four Stars). The final overall ranking of the house summarizes the four resource area Star rankings. (Specific features associated with this rating are discussed in the next chapter.)

Conventional Habitat Home			Green Habitat Learning Project Home		
	POINTS	STARS		POINTS	STARS
WATER	4	0	WATER	30	4
ENERGY	23	1	ENERGY	96	3
BUILDING MATERIAL	36	1	BUILDING MATERIAL	86	3
SOLID WASTE	3	0	SOLID WASTE	22	4
OVERALL		0	OVERALL		3

Green Builder Program Rating of the Demonstration Home and the Conventional Habitat Model
(Figure 2.10)

The Green Builder Program rating for this demonstration home is among the highest for any home built so far in Austin. The high ranking makes this a strong demonstration of the feasibility of using "green" strategies in conventional, low-cost housing.

CHAPTER 3: BUILDING THE DEMONSTRATION HOME

INTRODUCTION

Design work commenced in April, 1993, and was nearly complete in June on a high visibility site selected by Habitat for Humanity. The site, however, was involved in foreclosure proceedings since April, 1993. The most suitable alternate sites were also involved with the same proceedings.

The American Institute for Learning hired a construction supervisor and started processing potential crew members in June. When the land situation was unresolved by mid-July, students that were prepared to participate started to drop out. The site title was cleared and conveyed to Habitat for Humanity in late July and the AIL proceeded with the project with the corporate donations and their own resources.

A logistical arrangement for handling project financial transactions was established immediately. The AIL assumed the role of constructors and the Green Builder Program assumed the role of designer/specifier. Habitat for Humanity started processing potential homeowners and played a mostly passive role with regard to the actual building.

FROM THE GROUND UP: BUILDING FEATURES

The features that follow relate to specific items recognized by the Green Builder Program as positive green building options. Each of the underlined items included in the house are taken from the list of green building options found in the *Green Building Guide*.

Comments on these features include our present thoughts about them and suggestions for improvements.

Slab-on-Grade

Unstable soil conditions endemic to that part of Austin posed a challenge to the strategy of increasing thermal mass in the house by using a concrete slab. A structural engineering firm volunteered to design the slab which would become a main facet of the thermal flywheel. A slab design incorporating beams running in both directions was presented as solid enough to withstand expansion and contraction of the clay soil at the site.

The slab incorporated a 40% flyash content for replacement of portland cement. The normal amount used in concrete work is 25%. The concrete supplier, a former flyash sales person, felt there would be no problem with 40%. This was corroborated by a University of Texas researcher who stated that 40% is probably a maximum amount to use before significantly different workability characteristics of the concrete will occur.

The slab design called for compacted fill to be used under the slab. When the work crew prepared the site for concrete work, they excavated the underneath portion of the future slab to undisturbed soil. The undisturbed soil turned out to be over 5 feet below. This resulted in large mounds of excavated dirt (old fill) around the site and a large amount of compacted fill to be placed in the site. The fill was placed and compacted and the beams for the slab were then dug out by hand to the undisturbed soil. This turned out to be a costly approach in time and money. To dig the beams five feet deep by hand made them quite broad, wide enough for a person. This resulted in needing a lot of concrete to fill them. The effort to make the slab took four weeks (twice as long as planned) and resulted in twice the amount of concrete than was anticipated.

In a review of how to handle the situation better for the future, we noted the following points:

1. Unstable soil conditions will require extra reinforcement to the slab that can increase costs.

2. Untrained workers or volunteers would be better suited to more routine concrete work found in better soil conditions.

3. The beams could have been dug first with sandbags lining the trenches and then fill added. That technique would have used less fill and avoided moving a lot of dirt. The compacting of the fill would be more delicate due to having to work around the trenches.

In our view, because of its positive energy impact, the use of thermal mass in a similar project (poor soil conditions) is still warranted but in a different application, such as adding a brick face to an interior wall(s) and/or brick pavers over a portion of the floor.

Water Features

Copper piping used for potable lines. Copper is readily recycled and recyclable. It offers outstanding durability, and when used with lead-free solder is a safe conduit for water. This is also standard practice according to code. The use of no-lead solder is stressed in highlighting this building feature.

Water Fixture Flow Exceeds City of Austin (COA) Code. The COA has stringent water conservation standards. This house exceeds the conservation requirement in showers, faucets, and toilet. This is not difficult to achieve since the materials are readily available at competitive prices. The code requirements, at this writing, have been changed to be in line with what we used.

An Indoor Water Budget is Provided to the Owners. The Water Budget gives the owners an advance understanding of what their water consumption should be. If water use varies greatly from the budget, the owners are alerted to check for problems. This information is given to homeowners in the spirit that to be a truly resource efficient home, the owners must know how the systems operate, how the home is constructed, how to maintain the home, and what to expect from the home. A fairly good analogy to this approach is in effective car ownership and operation. Unfortunately, we do not equip homeowners with similar information, knowledge, and requirements.

Buffalo grass is used in sunny turf areas. This is the best drought resistant grass available and is a native grass. After an establishment period, it does not require watering to stay alive. Since outdoor water requirements can consume 45% of our water use, this type of turf makes the most sense. The site is very sunny and any other turf grass would require extensive watering.

Site Graded to Direct Water to Harvest Areas. Rainwater from the roof is directed into the landscape to areas that can absorb water through plants placed there. This approach requires gutters which the owners could use at a later time for directing water into cisterns. The payback for putting rainwater into cisterns as part of this project was unacceptable because the house is too small to capture enough water for all the occupants and the landscape. Since city water would be needed to back up the rainwater system, there is no cost savings from hookup (tap) fees that could be deferred into rainwater system components. However, if the rainwater can be retained on the site, the owners can benefit from increased landscape vibrancy and reduced watering.

Xeriscape techniques are used. Along with appropriate turf areas and material (buffalo grass mentioned above), the other landscape plants are native or adapted drought-tolerant species. Proper organic soil preparation featuring "Dillo Dirt" (compost from municipal sludge) and mulches are also used. The availability and costs for xeriscape plants and planting techniques are competitive with water-intensive options. This type of landscape provides multiple benefits, through proper placement for shading and the opportunity for some food production.

Outdoor water budget is provided to the owners. Water schedules for plant establishment and maintenance is supplied to the owners. The amount of water estimated to be used is also provided to the owners as in the Indoor Water Budget mentioned previously.

Energy Features

Continuous ridge and soffit venting. Reducing attic temperatures is essential to maintaining comfort in a house. The ridge and soffit venting approach used in the house

offers the best performance and does not require added energy. This is the approach most strongly advocated for attic ventilation by the City of Austin.

One Star Energy Rating. The City of Austin Energy Star Program has used a computer energy analysis program called BETA to ascertain the energy performance of new homes. The BETA (Building Energy Thermal Analysis) computer analysis of the demonstration home predicts that it will perform 6% better in heating than a comparable home built to the COA energy code. The BETA Program also showed that the house will perform 27% better in cooling compared to the comparable house built to code. (This is assuming that a 12 SEER cooling system as specified would be used if cooling is added to the demonstration house.) The analysis reviews energy equipment, lighting, overhangs, roof colors and more. (A DOE 2 analysis of the home is discussed in Chapter 2 with additional information on the home's energy performance.)

Good natural ventilation through windows. Double-hung windows used in the house can enhance natural ventilation by opening the top sash to exhaust hot air (which naturally rises). Their placement also enhances cross ventilation in the house. Passive ventilation is preferred to active strategies using electrical energy.

Roof radiant barrier. A radiant barrier (aluminum film) is draped beneath the roofing. The airspace under the roofing and above the radiant barrier connects the lower soffit vent with the upper ridge vent. The heat from the roof is blocked by the radiant barrier and exhausted by the ridge and soffit system. The combination of ridge-and-soffit venting with radiant barrier is considered an ideal system for reducing attic temperatures.

Computer simulation data ascribes little value to radiant barrier in the attic of this house due to the attic's high insulation level. (This analysis did not account for high temperature impacts on the attic ductwork.) The radiant barrier was chosen because (1) the ductwork is in the attic, (2) it would provide value as a demonstration, and (3) the material was donated.

Passive solar design features. Thermal mass in the house, such as the finished concrete floor (discussed above), is designed in conjunction with window placement and roof overhang to allow heating benefits from the low angled winter sun and protection from the summer sun. The thermal mass in the floor and walls will help keep the house cooler in

summer. The large porch on the west end protects the house from the summer sun, while natural ventilation is enhanced by window placement.

Passive solar design is the primary influence in the design of the house. The need for a design that was replicable and did not require design services every time to achieve proper solar orientation led to the development of a square plan. The square plan also had to meet lot size/setback requirements. Since the square footage of the house is small (1,156 square feet), this can be done in a 50 foot standard lot. On this size lot, a 6 foot deep porch in the narrower configuration of the lot will help protect the house on the west or east and still allow for required setbacks. However, in lots narrower than 50 feet, the square plan may not be suitable.

The elevated ceiling in the living/dining and kitchen areas allows good air movement from the ceiling fans, beneficial stratification when needed, better light from natural and artificial lighting, and some feeling of grandeur in the small house. There is a tradeoff with this feature in regards to increased volume for conditioned air. This will be considered in monitoring the energy consumption.

Ceiling fans throughout the house. Air movement across the body is a primary cooling strategy in a hot humid climate. Ceiling fans are effective at accomplishing this for low energy costs, as long as the spaces are occupied. The City of Austin residential energy conservation programs advise homeowners that air conditioning thermostat settings can be 5 degrees higher while operating ceiling fans, with the same comfort level and less energy. This house includes five ceiling fans, effectively located in all major living areas. The fans are also fitted with fluorescent lights.

Keep reflective or heat absorbing materials away from the house. Landscaping and proper driveway placement reduce heat gain to the house. The entry sidewalk on the west end of the home is the only paved area near the house. A tree was planted to shade the sidewalk.

Whole house fan with winter insulation. A whole house fan draws cooler nighttime air through open doors and windows of a house by pulling house air into the attic and exhausting it to the outdoors. In this house, the doors and certain windows are protected with security bars so they can be left open safely. Research of existing Austin Habitat homes already equipped with attic fans disclosed that, for security reasons, the fans were

not operating because the homes were closed up. It was noted that most homeowners needed some education regarding the fans' operation and benefits.

An insulated fan covering in the attic is designed to insulate the fan opening in the wintertime when it is not needed. The regular shutters for closing the fan opening are not sufficient for preventing excessive heat loss during the winter.

Setback thermostat. To conserve energy, a programmable thermostat automatically adjusts winter and summer setpoints when the house is unoccupied or people are sleeping. This type of thermostat can be intimidating to some homeowners who fear it is too complex. The importance of instructing the homeowners on how to use the thermostat cannot be overstated.

High quality duct system. Research and monitoring of buildings with ductwork have shown that faulty HVAC duct installations prevail in the building industry on a nationwide basis, and that problems associated with low quality duct installations create energy losses (25% and greater) and potentially harmful indoor air quality. This has become a central concern being addressed by all of the City of Austin energy conservation programs. The duct system in this home demonstrates the latest strategies in safe, energy-efficient duct installation.

Along with assuring a leakproof duct system, water-based mastics were specified as opposed to the more toxic solvent-based mastics.

The closet in the center of the house runs from the hallway to the kitchen. (See the floorplan in Figure 2.4.) The duct that serves the kitchen, living room, and the center northside bedroom runs through the upper portion of the closet partially inside the conditioned space. This is the safest and most efficient location for ductwork since attic temperatures are avoided and any leaks in ducts do not contribute to unwanted depressurization in the home.

Energy conserving landscape/Cool Communities strategies. This project serves as a monitoring site for the Cool Communities Program. Cool Communities is organized by the American Forests Association in partnership with the United States Environmental Protection Agency and Department of Energy. The program's goal is to reduce the urban heat island effect (the characteristic of urban areas to absorb heat through the exposed

concrete and asphalt, causing more cooling energy to be expended). This house uses the following strategies in this regard: light colored roof and walls; trees planted to keep paved areas shaded; trees and plants located to shade east and west sides of the house.

Two large shade trees are planted on the southern and western portions of the lot. The burr oak on the southeast part of the lot will overhang the adjoining neighbor's driveway and Nile Street. This tree will not have a significant effect on the heat gain in the south windows during the winter since it is offset to the east and is deciduous. A pecan tree on the west side will grow to provide additional protection from the summer west sun and is located between two existing trees already located on that side. Of the existing trees on the west side, one is short-lived and the other is damaged and may also have a shortened life span. By starting the larger tree now, sufficient size for shading will have been reached when the other trees are gone. All utilities are underground in this area so the trees will not create a maintenance problem around phone or electric lines.

An existing American elm tree protects the northeast portion of the house from the summer sunrise. On the east side of the house, the neighbor's garage also provides summer shade.

The HVAC system's air handler can accommodate air conditioning if the owners choose to add it. The Owners Manual recommends placement of the compressor on the north side of the house in the shade of the existing American elm tree for most efficient operation.

Light interior colors. Light interior colors reduce the need for artificial lighting through enhanced reflectivity. This is generally preferred in most homes already.

Energy efficient lighting. Fluorescent indirect and direct lighting are combined with lighting placement for optimum results. The outdoor porch light is a fluorescent with photo and motion sensor. In the main living area, fluorescent tubes are concealed behind a valance on the back wall that directs the light upward onto the sloped high ceiling. The reflected light from the light colored ceiling provides effective general purpose lighting throughout a large area.

Fluorescent light kits for the ceiling fans were difficult to locate initially. However, with them in place, all the provided lighting for the house is fluorescent except for closet lights.

Reduced electro-magnetic fields (EMFs). Negative health impacts have been associated with electric and magnetic fields created by electricity. Although the reasons and understanding regarding health impacts are not thoroughly understood, there is ample evidence warranting action in a manner that does not entail excessive financial costs. The term for this strategy is "prudent avoidance." In this project, the meter and service entry panel (sources of high EMFs) for the home are placed on a closet wall giving adequate distance from sleeping individuals. The wiring runs vertically in each wall to the attic area to the maximum extent possible which keeps the fields farthest from the occupants.

The electric utility will charge more to run the power to a meter if the meter is not located at the shortest distance. In this case, the best location added a slight amount to the distance (4 feet) and avoided trenching directly under an existing tree. This situation, however, can be a costly difference in many homes if the best location for the meter is not the shortest distance. This adds an additional consideration in the design and layout of homes when reducing EMF exposure to the occupants.

Daylighting strategies are used. Each room is sidelit with windows sized to provide adequate lighting. The high ceiling in the main living area enhances the sidelighting impact. Initially, a skylight (featuring small aperture, stovepipe-type lightwell, and minimal heat gain) was planned for the kitchen, since a deep porch on the west side adjoined the kitchen with only one window. However, the natural light levels proved to be adequate, perhaps because of the high light colored ceiling.

A gas combination system. The conventional Habitat homes in Austin use a gas wall furnace with blower as the source of space heat. For reasons noted earlier in this report in regards to effectiveness of the wall furnaces, a central heating system was installed using the water heater in the dual role of space heater and water heater. We selected a high efficiency water heater (0.60 Energy Factor and 80% Recovery Efficiency) to further improve the system efficiencies in the space heating and water heating modes. The higher efficiency model also included a "turbo" feature which effectively prevents sediment buildup in the bottom of the tank by keeping the water agitated.

The water heater is centrally located in a closet with an air handler situated above it in the attic. The combustion air comes from the attic. The water heater was installed on the main living area level, rather than the attic, for easier service and seasonal adjustments. The seasonal adjustments are recommended to further optimize the system efficiency. The water

heater is set at 140 degrees during the heating season (the temperature needed for effective space heating) and reduced to 120 degrees during the non-heating season in this case.

Building Materials

All wood structural material is southern yellow pine in engineered products. Yellow pine is an indigenous wood for Texas. The intent in stressing this type of resource reflects the sustainability tenet that endorses decentralized resource acquisition, application, and management. This approach seemingly conflicts with current resource commodity economics (that is, the market should determine what is used, where, and at what price). However, the decentralized perspective does not mean that market economics is excluded. It can offer improved opportunity to assign external values to resources such as forests in regard to local economics, ecological roles, aesthetic values, etc.

Engineered materials such as the roof trusses reduce on-site waste (the manufacturer can also effectively recycle larger quantities of waste compared to job site amounts). Smaller dimension wood can be used, reducing the need for harvesting the largest trees without sacrificing performance and quality.

Reinforced flyash concrete in the floor and walls; recycled-content permanent wall form product. Flyash is a coal combustion byproduct of one of the City of Austin's power plants. It reduces the need for portland cement (the production of portland cement is a very high energy process).

The selection of a permanent wall form material reflects Austin Habitat's interest in reducing wood dependency. The selected product, in this case, also presents interesting economic development potential which will be discussed further in this report. The use of a permanent wall form in the exterior walls requires no structural wood. The wood cement wall form (made from mineralized waste wood and concrete) is drystacked and the cores are filled with reinforced flyash concrete. The walls offer exceptional strength and durability, and will not burn or support termites or mold.

The use of higher percentage flyash content within the wall forms does not pose any workability problems as in the finished slab. A 40% flyash substitution for portland cement was used in both the walls and finished slab.

A portion of the slab foundation also serves as the finish floor. This allows a better thermal flywheel effect in the house (along with the mass in the walls) to help keep the house cooler in summer and warmer in winter. This approach additionally eliminates the environmental and economic investment in floor coverings. There are a variety of patterned finishes that can be applied to finished slabs. In this case, the work crew scored the concrete with a saw and dyed it for an attractive tile-like appearance.

Least-toxic termite protection. Chemical treatment for termites should be maintained and monitored in a similar manner to non-chemical approaches. In this project, there are few materials that termites can damage. Aside from wood trim on windows and doors, the only wood is in the roof trusses. Special attention was given to the foundation to prevent termites by making sure no cracks were present. Water from the house roof is diverted away and the land slopes away from the house. Keeping water and wood scrap away from the building is important. The owners also received guidance on how to monitor the building for termites.

Recycled-content carpet pad. A major source of indoor air pollutants comes from foam carpet pads. There are recycled foam pads available; however, for the best indoor air quality, a product made from woven recycled carpet fibers was selected. There will be no outgassing qualities to this product which was used in all the carpeted bedrooms.

Recycled-content carpet. Ideally, it would be best to avoid using carpet. Cleaning requirements, dust mites, and outgassing are a few of the problems associated with carpeting. Nevertheless, it is desired for its comfort and acoustical qualities. A recycled-content carpet made from recycled plastic (from soft drink containers) was used in the bedrooms. The outgassing qualities are reduced in this product and an extensive selection is available.

Natural linoleum is used in kitchen and bathroom, and for counter material. Natural linoleum is made predominantly from cork. Cork is produced from the stripped bark of the cork tree which regenerates new bark. This highly durable product is a prime example of

renewable resources used effectively in a practical application. It is more costly than sheet vinyl but was donated for demonstration purposes.

Regional brick is used for part of the siding. Brick made partially from recycled coal bottom ash is used around the lower portion of the house. Brick offers outstanding durability and easy maintenance but is generally considered cost prohibitive for low income homes. (It was done here because it is required by covenant in this particular neighborhood.) A light colored brick was selected and installation was provided by adult volunteers with assistance from the regular work crew.

Wall surfaces. Both the interior and exterior of the permanent wall forms are coated with cement stucco. A white portland cement in the stucco permitted the stucco to remain unpainted. On the gable ends of the house, a fiber cement siding is used. This type of material provides outstanding durability. It can remain unpainted and not degrade. This is an advantage for a low income family for whom maintenance may need to be deferred.

Steel framing used in the inside walls. Steel framing systems are beginning to be promoted for residential applications in the Austin region. The steel studs are significantly less costly than wood studs and contain 25 to 28% recycled content. They will not rot or suffer from insect attack. However, we feel they are most appropriate for interior applications in most cases. Parallel path correction factors for steel exterior framing show that the conductivity through the steel will reduce the walls thermal efficiency significantly. A recent analysis (published in *Energy Design Update*, May, 1994) submitted for inclusion in an addendum to ASHRAE 90.2 showed that a 2 x 8 steel framed wall with R-25 insulation achieved less than a R-10 performance.

In this project, the work crew found that the installation of steel interior framing was not difficult to do quickly and wiring and piping was easy to run along the walls due to the existing holes in the studs. It is important to remember that if copper piping and steel studs touch each other, a galvanic reaction can occur; the crew carefully protected against that hazard.

Interior doors are made from reconstituted wood. Reconstituted wood products make more efficient use of wood resources. Very little of a tree is wasted in the chipping process used to make the wood particles for this type of product.

An exterior-grade glue is used to bind the wood particles in this type of door, reducing negative indoor air quality impacts. Reconstituted wood doors are already commonly used by the building industry.

Cabinets are sealed to prevent outgassing. Cabinets made from particleboard and hardwood plywood will outgas VOCs. The cabinets in this project have particleboard sides and backs which were sealed with a water-based sealer to encapsulate the VOCs. Sealing was done on all surfaces including edges.

Roofing is recycled content metal. Metal roofs are provided as a standard feature in Austin Habitat homes. This type of roofing offers outstanding durability and will cool down rapidly in the evening, helping reduce the attic temperatures. Steel roofing, like steel studs, will contain 25 to 28% recycled content. This material is more costly than composition shingles but is estimated to last 40% longer in Austin's conditions.

Low toxicity and recycled paints and adhesives are used. The City of Austin recycled exterior primer, "Old Paint," was used on the exterior of the building. The VOC level of this primer is not extraordinarily low but the recycled feature is positive and it is only used outdoors (paint collected at the City's Household Hazardous Waste Collection Facility is reformulated for this purpose).

In the interior, materials were noted that could outgas during occupancy, leading to the selection of a zero VOC paint for all the interior needs. The paint is commonly available from a major paint manufacturer and was competitively priced.

An adhesive product made by another major supplier which contained no solvents was used for construction adhesives. In applications where there was no specific "environmentally friendly" offering, such as floor covering adhesive and duct mastic, water based adhesives were used exclusively with the understanding that there will be less outgassing with water-based products than with solvent-based ones. Water-based products also clean up without hazardous substances, an added benefit.

Recycled content attic insulation. The original intent for the project was to use cellulose insulation in the flat portions of the attic and cotton insulation in the sloped vaulted section. Cellulose insulation is made from recycled newspaper and cotton insulation is made from recycled cotton, cotton mill waste, and low grade cotton.

Cotton insulation was used throughout due to a misunderstanding by the work crew. The cotton insulation in batts does not provide as thorough a coverage as loose fill insulation. However, it also caused a greater problem when it caught fire and could not be extinguished. The resulting fire destroyed the roof/attic portion of the building with water damage further damaging the interior. Rebuilding is in progress, with rockwool instead of cotton insulation in the attic. Rockwool is made from recycled steel slag and will not burn. (Test data and samples of the cotton insulation showed it to be self extinguishing with a Class A or I fire rating. Further analysis and review of the product is pending.)

Solid Waste

A built-in recycling area is included in the utility room. This approach allows recycling to be convenient and routine rather than an afterthought. The Green Builder Program encourages this feature as a primary strategy to reduce residential solid waste headed for landfills.

Construction waste is recycled as much as possible. Austin does not presently offer a highly developed secondary market for construction waste materials. This is an important goal for the Green Builder Program and is necessary before effective construction waste recycling can be accomplished. In light of this fact, the primary strategies to reduce construction waste are:

- Use prefabricated engineered products when possible. (The roof trusses fit this strategy.)

- Order material quantities carefully to fit the job requirements.

- Recycle cardboard packaging.

- Recycle steel studs and roofing scraps.

- Provide any reusable materials to the local Habitat for Humanity Thrift Center.

- Store excess usable materials for the next job.

- Grind up sheetrock waste and use it as a soil amendment at the site.

- Select a location for cleaning out concrete trucks where the material can be possibly useful.

Enlist conserving site husbandry practices. The site had concrete piers from an earlier building and a large number of young trees growing in the location of the future home. Since the site was sloped, we were able to use the former piers as reinforcement for landscape terraces. At the end of the job, the piers were faced with loose stone. The small trees that needed to be removed were chipped for mulch at the site. The larger existing trees at the site were protected from damage during construction by avoiding compaction of the soil around them and keeping equipment away from them.

A compost system is provided. Organic yard and household materials can be composted at the home. This eliminates their landfill impact and provides useful fertilizer.

CHAPTER 4: TRANSFERABILITY ISSUES

INTRODUCTION

A common complaint associated with environmental initiatives is the seeming exclusion of socioeconomic considerations. Although one can successfully argue the full range of benefits associated with an environmental agenda, that full understanding is mostly overlooked, and oversimplifications such as "owls versus jobs" define public perception. The Green Habitat Learning Project bridges this false dichotomy.

Empowering troubled youth with skills, knowledge, understanding, and involvement plus providing housing to the needy are important positive socioeconomic strides that this project addresses. This varied approach stresses values such as satisfying work, sense of community, equal opportunity, good personal health, and a healthy environment. This is the goal of the programs operated by the American Institute for Learning in their efforts to help at-risk youth, and is incorporated into this project.

With the environmental agenda as a part of this process, a deeper connection between people and the earth becomes possible. Fundamental change on either the socioeconomic or environmental fronts can best occur within this type of conscious integration. This type of project can help redefine values associated with well-being and wealth, useful for a meaningful, productive life for individuals and a complementary relationship with the natural world. Forming an integrated agenda among the partners was key to this project's successful influence and is discussed further in this chapter.

Several economic considerations can be valued in green building. These include energy, water, and solid waste savings through conservation measures. The economic development potential for green building in the materials sector is positive on several levels. Since a primary component of green building pertains to using recycled content materials,

the potential to close the "recycling loop" exists with vertical integration of recycled content product manufacturing. The benefits in this activity can include the following: reduced landfill disposal; higher value as well as incentive for recyclables; increased jobs; decentralized production and marketing, thereby fostering an economic multiplier effect.

The wall material used in this project is a good candidate for economic development evaluation. The material uses wood chips that can be produced from any type of wood; the wood fibers are bound with cement and molded into shapes. The wall material used in our project was shipped in from Georgia. Due to the interest in the project and through our Program outreach, the Texas distributor for the material has generated enough regional interest to justify setting up a manufacturing operation in Texas. That prospect is pending at this time. The potential of this type of product is one example of the economic development potential inherent in many recycled content material applications. Waste wood is plentiful in all urbanized regions and the need for building material is similarly greatest in these areas.

FORMING PARTNERSHIPS

In this project, a partnership was formed with organizations (Austin Habitat for Humanity, the American Institute for Learning) that have strong records in community relations, high visibility, positive image, and established programs. Habitat for Humanity is an international organization with hundreds of affiliates in the United States, strong name recognition, and numerous corporate sponsors. The American Institute for Learning has developed award winning programs over the past twelve years in Austin and enjoys support and interest from local government and school officials as well as the general community. Nevertheless, the key to forming effective partnerships is the willingness among the partners to compromise and accommodate different agendas. All the partners in this project proved to be committed and flexible.

To successfully construct a demonstration building within the City, the experience that Habitat could provide in acquiring lots, organizing labor, financing, getting materials and

material money, and processing permits was considered extremely valuable to the Green Builder team.

Habitat expressed interest in participating in the project primarily because it needs to provide housing. At the time of our initial contact Habitat was in the process of increasing production from three units per year to six units, and twelve for the following year. The Green Habitat Learning Project was a chance to gain another unit toward their goal.

The volatility of wood prices was an added incentive for Habitat. The possibility of reducing wood dependence and material cost as proposed in this project was attractive. At the same time, the national Habitat office was indicating to the Habitat affiliates that the volume of housing constructed by Habitat has a significant impact on resources, and that environmental stewardship in this regard should become a priority (see Habitat Project Interface Summary Chart in Figure 4.1).

The American Institute for Learning (AIL) develops experiential learning programs for youth that have dropped out of school and wish to attain high school diplomas and/or job skills. Existing programs orient the students activities in various trades, arts, computer skills, and environmental initiatives toward the goal of applied learning. A program based on learning construction skills was identified as an area in which the AIL could provide additional services to the youth.

The AIL staff envisioned the construction skills program as a means to involving the youth in building community as well as buildings. With an expansive view toward how the construction skills program could work, the AIL contacted Austin Habitat for Humanity and the Green Builder Program for assistance. They wanted their program to emphasize environmental husbandry and social justice components that would better prepare the youth to positively address important contemporary issues.

By building green homes for low income families, AIL staff envisioned an opportunity for youth to play a constructive role on the social and environmental front, coupled with practical skills and academics (see AIL Project Interface Summary Chart in Figure 4.2).

The Green Builder Program entered the project with the intent of encouraging green building practices through gaining a high profile throughout the process of constructing the

<p><u>Summary of Project Interface Factors for Austin Habitat for Humanity</u></p>
<p>Habitat for Humanity Agenda</p> <p>Provide a home for a low income family. Meet the targeted number of units. Identify alternatives to high levels of wood dependence in their homes. Introduce cost saving measures for their homes' owners.</p>
<p>Habitat's Attributes to Project</p> <p>Experienced builder. Established positive rapport with many potential corporate and private donors. Building lots available from the City. Perform a valuable public service.</p>
<p>Habitat's Potential Shortcomings</p> <p>Concerned about providing a home meeting only basic needs. Does not have direct funding to contribute.</p>

Figure 4.1

home and having it available as an ongoing open house. A previous partnership for the Year 14 project featured a partner who had the money to construct a house. When the timeline of that project became extended beyond the Urban Consortium's grant period, partners were sought that could monetarily and logistically get a house constructed.

<u>Summary of Project Interface Factors, American Institute for Learning</u>
<p>American Institute for Learning Agenda:</p> <p>Provide training opportunity for youth. Assist in defining environmental building standards for their program. Gain support for their programs through high profile projects.</p>
<p>AIL's Attributes to Project</p> <p>Positive community image. Established successful track record in developing innovative programs. Source of labor and trained supervision. Strong commitment to project success and environmental agenda.</p>
<p>AIL's Potential Shortcomings</p> <p>Program operation is untested. No funds for materials, but can provide labor.</p>

Figure 4.2

Habitat for Humanity was considered as a self-vested organization with money for building homes. However, we discovered that they need to raise the money for every home they construct, primarily through sponsorships with churches, large builders, and some civic organizations. Nevertheless, from our viewpoint, they offered fundraising attractiveness and logistical elements necessary for actual building (lots, permit processing experience, labor organizing capabilities). Raising funds for the house in a partnership with Habitat, seemed plausible due to the positive community interest in supporting their work. It was not ideal that the completed home would be immediately occupied but it was felt that

adequate exposure could occur during the building process to serve our demonstration requirements.

<u>Summary of Project Interface Factors for the Green Builder Program</u>
<p>Green Builder Program Agenda</p> <p>Demonstrate green building in a real project Identify pitfalls and advantages in the current state of green building. Build momentum and interest for green building. Fulfill UCETF proposal requirements.</p>
<p>Green Builder Program's Attributes to Project</p> <p>Growing positive community image. Association with the City bureaucracy Technical expertise in green building. Strong networking connections with suppliers.</p>
<p>Green Builder Program's Potential Shortcomings</p> <p>Unable to control financing, scheduling, workmanship. No funds for material.</p>

Figure 4.3

The AIL contacted the Green Builder Program with their vision for involvement with Habitat at about the same time Habitat was approached by Green Builder to complete the project for the Urban Consortium grant. AIL offered the labor and supervision to build the home and, as with Habitat, they had positive community relations that could add high profile and possible funding support for the project. They required and desired strong direction from the Green Builder Program in order to build a green home.

In the initial proposal to the UCETF, Green Builder was to take on the role of coordinator for a project that would have green features designed by our partner. Additional partnerships and funding would be solicited to strengthen the project. In the new project configuration, the Green Builder Program function was greatly expanded to take the lead role in raising funds for the project and developing the design and specifications (see Green Builder Program Project Interface Summary Chart in Figure 4.3).

PROJECT LOGISTICS

The Green Builder Program incurred primary responsibility to design, develop specifications, and raise money for the house. Funds for the house were solicited from local and national corporations, with The Home Depot responding first with a \$15,000 line of credit. Local branches of Motorola and IBM soon followed with cash contributions. (A full list of donors is found in the acknowledgements.)

The fundraising requirements consumed staff time throughout the project, and included identifying the appropriate contacts; making phone contact; forwarding a written description of the project (pointing out positive benefits of involvement for the potential donor); follow-up calls; inviting the donors to project media events; and providing written "thank you" notes. Over 30 potential donors were contacted.

Considerable time was spent by the program staff in developing a grant request to receive oil overcharge funding from the State of Texas. The project in the State grant included three phases - each a different green house. After considerable delays, it was announced in December, 1993, that no grant awards in that cycle would be forthcoming. This event impacted on the budget of the first house because the AIL needed the support for their training component of the project. More time was required of program staff to assist in obtaining support for the AIL at that point.

The design process involved the formation of a team that consisted of Green Builder Program staff, the construction supervisor from the AIL, and a local volunteer architect. The conceptual design was developed through weekly meetings over a two month

period. The process began by studying the existing Habitat plan and evaluating improvements. The final design (explained earlier in this report) was markedly different in shape but included the same elements desired by Austin Habitat. The architect took responsibility to put the conceptual design into drawings. The drawings were presented to the Habitat construction committee and other local builders for review. It is important to involve the construction supervisor during the design stage so that practical construction details are developed and the job supervisor is intimate with the project (especially due to its new features).

The architect endorsed green building and gained valuable experience through the process. She played an active role throughout the entire period of construction. Her presence at the job site and positive rapport with the trainees bolstered the trainees self-image and contributed to their dedication to the project. The use of a licensed architect in a demonstration project can also help resolve trepidation or misunderstanding with building safety officials.

The process of specification development became the sole responsibility of the Green Builder Program staff as they were the only ones with the needed knowledge. This process required verifying availability and/or factoring the demonstration values of importing certain materials. For instance, a permanent wall form material manufactured and distributed from Georgia was specified since it was made from a recycled material (wood) readily common to our area. The performance and workability characteristics also seemed particularly appropriate to our region. In the interest of introducing this useful product to the region, we selected it despite the shipping issue. The manufacturer, in the interest of being involved in a demonstration project, also provided a discount on the material. (This occurred with several suppliers.) As hoped, increased demand for the product has ensued and the technology transfer development of establishing a Texas manufacturing facility is planned pending final financial arrangements.

The specification process also gave us a chance to identify commonly used materials and apply them to the project. In doing this, the project reinforces many positive choices already being made by local builders. This has the impact of making the transition to "green" building seem attainable. Commonly used materials included wood trusses, metal roofing, aluminum windows, and many others.

We also specified certain materials that local builders were just starting to use. This, again, reinforced their decision to try something new, a necessary attitude for green building since most builders are very conservative about trying new things. An example of this is the fiber cement siding used in the project. This type of siding is gaining acceptance among several large building firms.

One of the more difficult logistical elements of the project was the translation of the design and specifications to implementation. Despite the fact that the construction supervisor was involved in the conceptual design process, and bi-weekly meetings of the design team were held throughout construction, follow-through was occasionally problematic, as when the supervisor was off site (getting materials, doing administrative work, out of town, etc.) and less knowledgeable individuals were in charge. Examples of problems include extending the steel framing on the gable ends where fingerjointed wood was to be used; using cotton insulation throughout the attic when cellulose was to be used on the flat portions; using the wrong type of sheathing; putting unspecified additives in the concrete.

The role of consistent, knowledgeable supervision at the site cannot be minimized in this type of project. In this case, there were multiple agendas being implemented and priorities can be misplaced in the view of one or another partner. The agenda of Austin Habitat was to get a family into a house as soon as possible. The goal of the AIL was to assist at-risk youth in developing vocational, social, and educational skills. A fall-out of this dynamic was that the job supervisor would give overly optimistic forecasts for completion to Habitat. Failure to meet completion deadlines was largely due to the newness of building a house with trainees who did not have the vocational or motivational elements common to most Habitat volunteer construction crews. Habitat's goal was compromised by the length of time the project was taking, and the AIL was unable to increase their speed of construction by not being able to work longer hours/days or cut back significantly on the educational training component of their program. The logistical element of scheduling and completion timing in a multiple partnership project is probably the most critical for maintaining good rapport and value of the project among the partners.

Promoting the green agenda was the easiest logistical element of the project. Each partner in this project acknowledged strong value in promoting the "green" element. Several political/media events were organized during the project with each partner contributing significantly.

Video documentation was conducted during the course of the project. It has served as an easy and effective tool to spread information about the project. The video was done by AIL trainees with edit control by Green Builder Program staff. The final version, not complete at this writing, is expected in Fall 1994. The footage of the video shooting will be available to develop multiple levels of presentations including those for specific topic technical shorts, child-level programs, and general audience. A general audience, 28 minute video will be the first product. This video will convey the project's goals in a simple format. A quality video is being developed without major involvement of the Green Builder staff due to the competence and professionalism of the AIL video group. It was also relatively inexpensive due to its training component.

THE COSTS

A goal of the project was to construct a green low income home for as close as possible to the normal costs of a Habitat for Humanity low income home. We were challenged, however, with the temptations to include donated materials that we realized would be more expensive if they had to be purchased. We elected to include some of these materials to reflect the demonstration aspects of the project. This created a slight difficulty for Habitat for Humanity since it raised the home's value beyond their former homes or subsequent homes they would be able to construct, and they were concerned over the issue of fairness. (Unfortunately, the added benefits of extra value to the family were offset by the delay in moving into the home due to the construction time period and fire damage repair.)

The material costs for the standard Habitat for Humanity home run approximately \$23,000. The selling price of homes for Habitat for Humanity in 1993 was \$37,500. This price includes material and subcontractor costs, land cost, fees and permits, and overhead for Habitat supervision and administration.

The green demonstration home material costs (including donated items) totaled \$27,650. As mentioned earlier, the slab foundation on the demonstration house proved costly due to the extraordinary amount of fill at the site and cost \$3,500 more than estimated. This extraordinary cost plus the added value of some special donated items (i.e.

natural linoleum, brick pavers) account for a large portion of the difference in the project material costs.

The demonstration house provided a duct system with a high efficiency water heater serving the role of a furnace and water heater (called a combination or "combo" system). The incremental cost for this system over the standard water heater and wall heater used in the conventional Habitat homes was \$800. The gas usage is projected to be over 14 MBTU's less in the demonstration house with improved comfort levels over the Habitat model. This is presented in the energy savings discussion in Chapter 2.

Although it is possible to reduce the costs of the demonstration model in regards to the slab expense (by eliminating the slab), it is important to recall that the slab was considered an important contributor to thermal stability in the house energy design and served as a finish floor for part of the house. The conditions at the site that caused the increased slab costs could be repeated in other locations, particularly in the neighborhood where the home is located, since fill from a nearby dam construction project was distributed over a wide area on top of already poor building soil (expansive clay). Thus, to keep the same passive energy design, the added cost for the slab would have to be incurred and the cost of the house will be subsequently higher. This issue will have to be further evaluated for future use of this model. The results may prove that this model (with a slab foundation) is competitive only in better soil conditions.

LESSONS LEARNED

The Green Habitat Learning Project has mobilized additional support for the precepts of sustainability. Due to the positive nature of the partnership with agencies addressing social issues, we attracted strong public visibility and attention from public officials and businesses. This helped generate momentum that led to a City Council resolution in February, 1994, that called for the development of sustainable guidelines for all municipal buildings, and encouraged additional incentives that involve at-risk youth in endeavors associated with sustainable building. The strength of the partnership that links environmental and social issues is probably the most positive feature of this project. As a

result, we will continue to align our environmental agenda as much as possible with positive social causes. We recommend this approach to others in similar endeavors.

The goal of demonstrating green building in this project continues to be an evolutionary process. Although the project showed several green alternatives, their full value is still being evaluated in regards to performance, life cycle cost, and commercial viability. Nevertheless, even in a preliminary state, as we presently develop specifications for City of Austin low income housing, we have better information on economic and labor-related issues.

A successful aspect of demonstrating green building in this project is occurring with the start of a regional manufacturing facility for the recycled-content wall form we installed in the house. The economic development opportunities associated with green building were recognized quickly in this case and are a side benefit from this project that we did not anticipate would happen so soon. Other suppliers of materials that we used in the project have strengthened their commitment to alternative products as well. We now have ready access to floor covering alternatives from several suppliers and two regional building material suppliers are starting to specifically appeal to green buyers with new product offerings. This type of economic activity could well be expected in other regions with the stimulus of a relatively high profile demonstration. Through the many contacts we continue to receive about our program and this project, we recognize the increased momentum on a worldwide basis toward the environmental sensitivity found in green building and the economic implications associated with it.

The most difficult aspect of the project involved the fundraising and the prototypical nature of the building process. We expected to receive a grant that would have provided the bulk of the project's funding needs. When this grant fell through, it took a large amount of time and effort to identify and arrange new sources at a time when project technical and logistical details needed attention. This is an obviously critical area that needs early attention in attempting any demonstration project. As a result of not receiving the grant we expected, our original plan to construct three demonstration models with the grant support has been cut to one. This change in scope to the project has not negatively affected the benefits we have derived but has limited our capacity to directly stimulate the green building movement by presenting additional technologies we feel are viable.

The building process, in this case, involved a new program (the Casa Verde Builders of the American Institute for Learning) that was inexperienced in actually constructing a house. We are pleased to have been able to help the program get established. It caused the building timetable to be significantly extended, however. The experience factor will be a consideration in subsequent projects and we will better gauge our expectations and know how to influence the quality and timing of the work. For others considering a similar endeavor, the experience factor of using a trainee-based building crew should not be a deterrent. However, plan on additional monitoring of the project for adherence to specifications and timetables. This monitoring will assist a new program in honing its expertise in green building, and will help organize their operation logistically for best results.

There are various scenarios for becoming involved in a demonstration project. We feel that this project offered many benefits to us partly due to the depth of our relationship with it. In this project, we ended up with direct control of the scope (specifications and design). In addition, we had a strong influence on the timing (schedule) of the project. Along with financing, these two elements make up the central requirements for implementing a successful demonstration project. This amount of control involved many staff hours and, without specific staff available and funded to monitor the project, we would advise careful consideration of this type of project's impact on regular workloads.

The project suffered a catastrophe when the house caught fire just days before the family was to move in. The fire-rated roof insulation was accidentally ignited by a plumber's torch and could not be extinguished. The fire necessitated a rebuild of the interior and roof. The exterior walls of the home suffered no damage and actually have served to promote the fire effectiveness of the wall form product used. The transfer of ownership to the family had already occurred and they chose to have a specialty contractor rebuild the damaged areas. Despite this tragic event, the project was able to accomplish our aims to stimulate and demonstrate green building. We have noted no negative repercussions in our area toward green building.

The Casa Verde youth program has also been able to build positively on their project experience despite the fire. In 1994, they received YouthBuild funding from US Department of Housing and Urban Development to construct more green low income houses and train and assist up to fifty more youth. Additionally, they are now registered with the City of Austin as a housing contractor and funded to construct eight green low

income homes. The Green Builder Program will continue to assist these projects with specification and design assistance. The success of the Casa Verde Program in being able to build on this partnership has exceeded all of our expectations.

Austin Habitat for Humanity, at the time of the initiation of the project was cautious about being involved in a green demonstration project. The fire created an additional setback to their commitment to be a leader in the field of green building. However, they have subsequently chosen to take an evolutionary approach and will introduce more green features to their existing models. In terms of the four levels of green building, they will strive to attain a two star ranking (four being highest). Although we would like to see them be more proactive, we are pleased at their willingness to phase in more green features. It is important to consider the conservative or liberal nature of the governing boards in partnerships of this type in order to avoid potential strained relations. Since Austin Habitat's primary goal is to create affordable housing for needy families, a more conservative scope to our project would have been preferable to them and would have increased their enthusiasm.

CONCLUDING REMARKS

The value of presenting green building in a real project that couples the environmental agenda with important social issues cannot be overstated in terms of benefit and influence. The project and crew were visited by all City Council members (some several times), print and TV media, school groups (elementary through college), State officials, various visiting dignitaries, local builders and architects, City staff, neighbors, and many others. The project has generated many inquiries from individuals and organizations around the country who are drawing inspiration from this project. The National Habitat office is now developing green projects in Georgia, and many other affiliates are seriously attempting to use green building approaches.

The momentum toward environmental stewardship in our community has been positively affected by this project. The importance of integrating an expanded social agenda within this type of green initiative reflects the same value of holism promoted by green

building and sustainability. It is our hope that many other communities will be able to reach this synergy and help move the nation and world toward a sustainable future.

APPENDIX A

Green Builder Program Logo and Photos

*Figure A-1
Green Habitat Learning Project in mid-construction*

*Figure A-2
Students from the American Institute for Learning constructing the
Green Habitat Learning Project*

Figure A-3
Project near completion, before landscape plants

Figure A-4
Green Builder Program Logo

APPENDIX B

Specifications for the Green Habitat Learning Project

SPECIFICATIONS FOR GREEN-HABITAT LEARNING PROJECT -

DIVISION 1 - CONTRACT REQUIREMENTS

01030 SPECIAL PROJECT PROCEDURES

One of the objectives of this project is to produce a healthful house, free of toxic fumes and materials. Another project goal is to build a quality structure with minimal impact on the local and global environments.

PRODUCT SUBSTITUTION / ALTERNATES

Use specified or approved products only. Products and materials that are needed but not mentioned in the specifications must be approved prior to purchase.

FORBIDDEN PRACTICES

Smoking is prohibited on the building site except for in one area designated by the construction supervisor. All smoking materials must be properly disposed of and ultimately removed from the site. No tobacco products shall be buried or discarded on site.

Toxic substances (such as pesticides and noxious cleaning products) are forbidden. Consult architect for non-toxic alternatives.

Gasoline powered generators may not be placed inside the building at any stage of construction.

No construction debris may be disposed of on site unless it is organic matter approved for use as compost or mulch.

GENERAL CLEANUP

Sort construction debris for recycling or proper disposal as follows:

- Metals - recycle
- Appliances - recycle
- Wood - reuse whenever possible; recycle (nails & other foreign object removed); properly dispose of any treated wood debris
- Gypsum board - recycle and/or contact architect
- Organic material - compost
- Cardboard - recycle
- Recyclable paper - recycle
- Brush / yard waste - pile on site for chipping and use as mulch after landscape has been installed
- Glass - recycle
- Non-recyclable, non-compostable debris - dumpster

Follow City of Austin Clean Builder requirements:

- Identify recycling and trash areas
- Empty containers before they overflow
- Clean up trash and debris at the end of each work day
- Remind truck drivers to remove excess mud from truck tires before leaving site
- Prepare area for use of leftover concrete per Division 3
- Inform subcontractors about applicable Clean Builder requirements
- Post Clean Builder signs

Protect finish materials from potentially damaging cleaning solutions. During construction, protect floors and other surfaces from spills and damage.

Use natural, non-toxic, cruelty-free cleaning products only. Consult with architect as needed.

All spills during construction to be cleaned up immediately and disposed of properly.

01040 COORDINATION

The contractor shall be responsible for the coordination of all subcontractors and for any special training required to properly install healthful products using healthful building techniques.

01400 QUALITY CONTROL

The contractor shall maintain, with the use of healthful products and procedures, at least the same standard of quality expected in standard building practices.

DIVISION 2 - SITE WORK

02050 - DEMOLITION

Concrete piers from previous building are to be rolled to side away from construction area for future landscape integration as per landscape design.

Concrete footings, sidewalks, and slabs from previous building must be cleared from site into dumpster unless an alternative recycling option is found. The recycling option should then be used.

Appliances or other metal refuse from site should be recycled. Appliances can go to Ecology Action diversion center at entrance to City Landfill. Metal refuse is retained separately for later recycling along with construction waste metal.

02200 - EARTHWORK

Selectively remove healthy American Elm trees into containers. Select those that are standing alone to get adequate root ball. Place removed trees in safe area for replanting and provide water as needed to trees.

Trees that are grouped or intertwined with concrete should be removed and chipped. Chipped material should be retained on-site away from construction activity for integration into landscape.

Incorporate existing trees when locating structures and powerlines, allowing room for them to grow if they are not at mature size.

Protect trees from damage during construction with clearly visible fencing located below the outermost branches (see Figures 1 & 2) and flags in overhanging branches. See illustrations for where to locate fences.

Wooden slats attached to tree trunks will not provide adequate protection. (Much of the damage that occurs to trees during the construction process is due to soil compaction from

heavy equipment and materials being driven or stored under trees. Roots which extend out far beyond the trunk are damaged when soil becomes compacted. This will cause trees to go into a gradual decline, and eventually die.

Figure #1 Tree Protection Fencing

Figure #2 Plan View of Tree Protection Fencing

Filling or cutting in tree root areas will also kill trees.

Avoid trenching in tree root zones; try tunneling instead, if needed.

Never dump paints or solvents near trees. These cause plant death and soil contamination. Dispose of all waste materials properly. (NO paints or solvents can be disposed of on site.)

Collect and stockpile the topsoil for future use on the site. Other soil removed from foundation excavation is stockpiled separately for future use.

Place erosion control devices such as haybales or erosion control fencing in all areas where construction disturbs the soil or soil is piled.

Excavation, drainage design, fill and compaction are carried out per the directions of the structural engineer and best judgment of the site supervisor to ensure a dry foundation and floor slab. A sand bed under slab will be used rather than poly.

No chemical termite treatment is permitted. Structural termite control plan is provided by termite consultant.

02513 - ASPHALT CONCRETE PAVING

Avoid asphalt paving. Use concrete or gravel. Pervious pavers are preferred.

Coordinate paved areas with landscape design.

02710 - SUBSURFACE DRAINAGE

Piped underground utilities should slope away from the house foundation and trenches compacted to avoid water wicking through excavated trenches to the foundation.

Strategies for drainage away from foundation as provided by the engineer will be used.

02900 - LANDSCAPING

A landscape plan will be provided. The plan incorporates xeriscape, permaculture, edible landscape principles. The plan will be shared with the Cool Communities initiative as part of their demonstration efforts and support for the project. The Water Conservation Division Xeriscape Program will develop the plan and the Green Builder Program will serve as liaison with Cool Communities and the City Forestry division.

Areas of landscape requiring watering will be located on south and west sides of the house below the level of the foundation so no water can migrate to the foundation.

Trees that are required by the landscape plan can be obtained through the City Forestry division.

Landscape planting will be conducted by Becker Elementary School's Green Classroom Program. Contact is Carla Marshall, 440-7216, or Green Builder Program.

Existing turf that must be removed will be done by solarization. No synthetic chemicals are permitted to be used on the site.

Landscape design will incorporate retention areas for rainwater from the roof of the house and prevent runoff from the property.

DIVISION 3 - CONCRETE

03300 - CAST-IN-PLACE CONCRETE

Structural engineer's design will be incorporated for all concrete work.(John Steinman, 474-9094).

Concrete will be flyash-based for foundation, slab, and walls (40% substitution for portland cement). Reinforcing steel will be recycled content.

Excess concrete will be used in making pavers or into future paved areas as per discretion of the site supervisor.

Finished concrete will be used as final floor in living/dining areas. Scoring pattern to concrete will be provided by architect.

Coloring of concrete will be coordinated with architect and site supervisor. Test areas will be done in future carpeted rooms first.

Form boards will be used untreated and saved for additional uses.

Fiber cement permanent wall forms will be used for exterior walls. The material is nonflammable, rot and mildew proof, and not subject to insect attack. The wall form material will be stacked dry starting in a mortar bed. The material will be stacked 4 feet high before filling cores with concrete and rebar as specified by structural engineer.

Concrete porch steps and landing will be fabricated on-site.

No admixtures used in the concrete without approval of engineer and Green Builder Program.

Protect finished concrete floor with scrap cardboard taped together with masking tape. (Cardboard available from furniture suppliers.)

DIVISION 4 - MASONRY

04200 - UNIT MASONRY

04210 - Brick Masonry

Brick will be bottom ash based content in lighter colors as selected by the architect.

No admixtures used in mortar.

Cleaning of brick will be by steel brush and water.

Wall ties are to be 3/16 wire ties.

DIVISION 5 - METALS

Fasteners will be recycled content metal with corrosion resistance. Adhesives are to be water-based or specified "least-toxic" by supplier.

Steel window guards as supplied will be used on windows designated by drawings and will have interior release mechanism for emergency egress. Color to be black.

Security steel screen doors will be used on two primary entries.

DIVISION 6 - WOOD & PLASTIC

06100 - ROUGH CARPENTRY

Gable end walls will use fingerjointed yellow pine 2x4 construction.

Frame rough-in materials for window and door openings and miscellaneous uses will be #2 yellow pine. No structural wood material greater than 2x10 will be used.

Sheathing material will be recycled fiber content, with foil face. Sheathing will be used only on gable end walls. Foil facing toward attic space on east end.

06192 - PREFABRICATED WOOD TRUSSES

Roof trusses will be yellow pine species engineered by manufacturer. Trusses will carry over walls 2.5 feet, perpendicular to the plane of the walls. 1x3 fingerjointed yellow pine purlins will be used over trusses.

Radiant barrier will be draped between roof rafters to permit air movement from soffit vents to ridge vent.

06700 - WOODWORKING

Interior trim materials will be fingerjointed. No tropical hardwood material can be used unless certified "sustainably managed."

Shelving will be non-formaldehyde MDF. (Medex) Any materials that can outgas VOC's are to be avoided or completely sealed. Salvaged high quality solid wood can also be used for shelving as a substitute for MDF.

Porch materials, posts, stiles, and rails, will be fabricated from regional cypress or cedar material.

Kitchen cabinets will be fabricated with domestic hardwood faces using formaldehyde-free MDF for tops and shelves. Alternative is to use hardwood shelves. All hardwood plywood must be completely sealed to prevent outgassing. Non-solvent based wood glue is to be used for fabrication.

DIVISION 7 - THERMAL & MOISTURE PROTECTION

07175 - WATER REPELLENTS

Least-toxic products as approved by architect will be used to seal concrete where needed.

07200 - INSULATION

Roof insulation over sloped areas will be cotton batt insulation (R-19 within base chord cross-lapped with R-11). Blown cellulose insulation will be used in flat portion to 9 inch depth (unsettled). Attic floor section will be raised above bottom cord 3.5 inches by 2x4 sleepers to allow adequate insulation depth.

Gable end insulation will be cotton batt insulation (R-19).

Any rigid insulation required on-site must be CFC/HCFC-free material (expanded polystyrene).

07460 - SIDING

Horizontal fiber cement lap siding in colonial texture will be used. Siding will be installed unpainted unless scratched badly during handling. If painting is required, consult architect and Green Builder Program. All wood trim pieces for siding will be primed regional cypress or cedar with COA recycled paint primer. Final paint and color to be selected by architect.

Soffit material will be fiber cement soffit material. Fascia material will be site-ripped fiber cement smooth siding material. The fiber cement fascia will mount over 2x yellow pine structural fascia to permit water protection from gutter overflow.

07600 - FLASHING AND SHEET METAL

Unpainted 26 gauge 20 year warranty galvalume channel drain roofing made from recycled metal will be used.

07800 - SKYLIGHTS

The Sunpipe skylight product will be used in the kitchen as per drawings. The skylight will be placed on the north slope of the roof and its reduced size and design will not contribute problematic heat gain to the house.

07900 - JOINT SEALERS

All sealers are to be clear silicone. If painting will occur at location of sealant, use 50 year siliconized acrylic sealant.

DIVISION 8 - DOORS & WINDOWS

08100 METAL DOORS & FRAMES

Metal exterior doors to be insulated with CFC-free Expanded Polystyrene (EPS) or approved alternate.

08200 WOOD DOORS

Wood interior doors to be made of urea formaldehyde-free medium density fiberboard or to be solid wood panel doors.

08500 METAL WINDOWS

Aluminum (recycled content preferred) windows to have insulating glass.

08700 WEATHERSTRIPPING

Use felt strip bound with metal or a hard vinyl strip at all exterior doors and water heater closet door.

DIVISION 9 - FINISHES

09200 - PLASTER

Basecoat to be wood fiber plaster, sanded up to 100 lbs. per cubic foot, and applied directly to wallform. Finish coat to be float finished with texture selected by architect. Plaster walls to be painted with same paint as rest of interior.

09260 - GYPSUM DRYWALL

Gypsum wallboard to be 5/8" firecode with paper faces. Water-resistant wallboard ("green board") to be 5/8" firecode. Joint compound shall be free of asbestos, formaldehyde and other volatile substances and be low-biocide.

09665 - Resilient Sheet Flooring

Natural linoleum to be used in kitchen and bathroom.

09680 - CARPETING

Carpet shall be made from 100% recycled plastic (post-consumer PET). Carpet pad shall be recycled carpet fiber. Use wood tack strips to fasten carpet to floor. Adhesives not to be used.

09900 - PAINTING

All interior paints to be low VOC or no VOC latex paints. Exterior primer to be recycled latex paint as produced by the City of Austin Environmental and Conservation Services Department. Exterior finish coat to be low VOC latex paint. Semi-gloss enamel will be used throughout the interior.

DIVISION 10 - SPECIALTIES

10200 - LOUVERS AND VENTS

Transoms above bedroom doors will be used. Architect will provide details.

DIVISION 11 - EQUIPMENT

Water heater is natural gas 40 gallon size (or a different size as determined by mechanical contractor) with energy factor 60% or greater and recovery efficiency at 80% or greater.

Stove will be natural gas with pilotless ignition.

DIVISION 15 - MECHANICAL

15050 - MECHANICAL BASIC MATERIALS AND METHODS

Mechanical system components and installation require highest degree of safety consciousness and precision. All solder will be lead-free. MADAIR standards established by the COA ECSD will be adhered to. The mechanical system will be tested upon completion to insure installation quality.

15250 - MECHANICAL INSULATION

R 6 minimum is required.

15410 - PLUMBING PIPING

15415 - Water Distribution System

Type L copper pipe will be used for water lines.

15440 - PLUMBING FIXTURES

Plumbing fixtures must meet the following flow rates:

toilet - 1.5 GPF or less

showerhead - 2.5 GPM or less with cutoff feature

faucets - 2.0 GPM or less

15750 - HEAT TRANSFER

A combination system designed by HVAC contractor employing Manual J will be provided. All system components will have ready access for servicing and offer strong warranties of performance.

15880 - AIR DISTRIBUTION

MADAIR standards must be followed.

Sizing of the ductwork is calculated using Manual D. A short form Manual D is available from the City of Austin which permits rapid duct sizing.

Air duct calculator or "ductalator" sizing is acceptable when all other guidelines herein are adhered to.

The correct friction loss must be used based on the total equivalent length of each duct run.

Doors in the house need undercut and additional opening area above doors to maintain equal pressure throughout house. See drawings for above door ventilation details.

Flex duct should have a foil exterior reinforced with fiber scrim or a listing approving installation exposed to UV light.

Air flow through a flex duct is greatly restricted due to the convoluted interior surface. This must be accounted for in the system design.

Use duct that is insulated to at least R-6, with a reflective outer surface.

Ductboard is not permitted with fiberglass interior exposed to airstream.

The proper sealing of plenums, air handlers, and ducts is key to eliminating leaks in a duct system. Duct mastic is a preferred *flexible sealant* that can move with the expansion, contraction, and vibration of the duct system components. It is often strengthened with fiberglass strands for increased strength. Mastic is not a substitute for mechanical fastening of duct system components. Choose water based products that are the least toxic and easier to clean up.

If a gap exceeds 1/4 inch, reinforce mastic with fiberglass mesh tape. This tape is similar to drywall fiberglass tape but is wider and is treated to reduce smoke development. Conventional duct tape should not be used in a duct system except to seal the joints on access doors.

The application process for mastic requires all duct connections be mechanically fastened with screws, rivets, or, when using flex duct, with metal bands. The area to be joined should be wiped clean with a dry rag. The mastic is then applied with a trowel or brush (according to its viscosity) and spread one inch beyond the opening. For 1/4 to 1/2 inch openings use fiberglass mesh tape under the mastic. A larger gap needs a rigid material covering.

If tape is used for sealing ducts, the tape should be *U.L. 181 tape*. The tape rating must be stated on the tape and must meet U.L. 181 A-P. However, mastic is preferred over tape.

All connections (splices, Y's, T's, and boots) must be sealed. Additionally, boots should be sealed to the sheetrock (a wire can be used to keep it from pulling loose). Penetrations into the plenum must be sealed. Flex duct inner and outer linings need to be sealed (do not extend the duct liner through the wall of the plenum to the interior of the plenum).

The air handler closet and air handler itself must be sealed, including sealing the air handler to the platform. Next, the return plenum should be lined on the interior with duct board (foil face in) and sealed. The support platform should be sealed on all sides. Penetrations into the plenum, such as refrigerant lines, must be sealed.

Return air grills should be sealed at the point of penetration through the walls. Any structural cavities also must be sealed. Place duct board (cut to fit) on all four sides with the foil sides facing in and seal them in place.

Seal boots to sheetrock with non CFC polyseal or alternate.

DIVISION 16 - ELECTRICAL

16100 - Wiring Methods

Wire will run through PVC conduit set in wall forms. There will be minimal horizontal wire runs within the living areas' walls. This will reduce EMF exposure.

16130 - Wiring Connections

Use romex for interior wire. This will create less EMF's.

16405 - Service Entrance

Service entry will be on the closet wall exterior between bedrooms 2 and 3. This will reduce EMF exposure to bedroom occupants.

An electrical plan is provided for wire runs.

16500 - LIGHTING

16515 - Interior Lighting Fixtures

A lighting schedule is provided emphasizing fluorescent fixtures strategically located for indirect and direct lighting.

16520 - Exterior Lighting Fixtures

A fluorescent light with photo and motion sensor will be used adjoining the two doors.

SUSTAINABLE COMMUNITIES

AUSTIN, TX - Sustainable Systems Rating Program

The city of Austin, long a pioneer in sustainable research planning and practice, developed a sustainability rating system that can be used as a marketing tool to encourage high levels of resource conservation, appropriate usage, and economic development through residential building.

91-302. \$15.00

PTI - How to Save Thousands - Even Millions of Dollars Through Energy Efficiency (Video)

Looking for ways to save energy and money? This Urban Consortium Energy Task Force Video shows several cost-conscious and earth-minded methods to do so. Examples include how Phoenix saved \$32 million through retrofitting and how New York City built a natural-gas-powered fleet to comply with the Clean Air Act.

92-402 FREE!

SAN JOSE, SAN FRANCISCO, CA, & PORTLAND, OR - Sustainable Energy for Local Governments

With scarce resources and environmental concerns mounting, how can local governments move toward a sustainable system? This practical workbook identifies key components of sustainable energy.

Call Conservation and Renewable Energy Inquiry and Referral Services(CAREIRS) at 1-800/523-2929 for a copy.

SEATTLE, WA - Coordination of Energy and Air Quality

Learn how Seattle City Light (SCL) worked with industry to reduce air pollution emissions with positive economic effect. The study conducted during 1991 and 1992 resulted in a working relationship between two agencies (Seattle City Light and the Puget Sound Air Pollution Control Agency) with the same objective - to improve air quality and reduce energy consumption. Read about some of the difficulties encountered and lessons learned by SCL in accomplishing energy conservation among residential and commercial customers.

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TUCSON, AZ - Tucson Solar Village—Project Management

The City of Tucson's 820-acre Solar Village project seeks to provide a sustainable community for up to six thousand residents, using solar energy to reduce energy needs by 75%, water conservation methods to reduce usage by 65% per capita, and recycling programs to reduce landfill solid waste.

91-304. \$12.00

TUCSON, AZ - Local Government Involvement in Long Term Resources Planning for Community Energy Services

Tucson has also developed a program to coordinate government research, utility, and business energy saving efforts. Results show that by taking a state-wide perspective on resource planning, additional savings and environmental benefits can be achieved through conservation and demand management.

91-313. \$20.00

ALSO AVAILABLE:

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Building professionals obtain guidance through this technical support document for Austin's Green Builder Program, aimed at changing conventional building practices.

92-311. \$18.00

MONTGOMERY COUNTY, MD - Energy Efficient Building design: A Transfer Guide for Local Governments

A proven "how to" guide for local governments and the private sector on the implementation of energy efficient construction programs.

91-317. \$7.50

SAN FRANCISCO, CA - Energy Management Action Plan

The City/County of San Francisco has developed a methodology for local government energy

ABOUT THESE PUBLICATIONS

These publications were produced through research conducted by the Urban Consortium Energy Task Force (UCETF) of Public

Technology, Inc. Many of the research projects were funded through a grant from the U.S. Department of Energy.

The task force was established to address critical energy needs of urban America. The UCETF acts as a laboratory to develop and test solutions and share the resulting products or management approaches with the wider audience of both large and small local governments, states, and local authorities around the world.

UCETF membership includes elected officials, management, and technical professionals from urban cities and counties. It links through the Urban Consortium and PTI to national organizations, such as the National Association of State Energy Officials (NASEO), the National League of Cities, the National Association of Counties, and the International City/County Management Association to ensure the widespread exchange of information and technology.

For more information about the Urban Consortium Energy Task Force (UCETF) or these guidebooks, contact Jack Werner, PTI Business Director, at 202/626-2421.

offices to use in designing Energy Management Action Plans (EMAP). The guide walks readers through the process of creating an EMAP: identifying barriers; researching a setting for the project; and generating ideas to remove specific barriers. Help create more effective facilities in your jurisdiction via a holistic methodology.

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DETROIT, MI - *Energy Optimization of Water Distribution System*

Looking to cut your water transmission costs? An energy optimization project, such as that developed by Detroit, may help your jurisdiction cut one of its highest expenditures. Development of a computer program used to develop energy strategies and planning guidelines helped Detroit minimize power consumption and improve pumping efficiency at its pumping facilities. A guidebook identifying the transferable methodology used to develop the computer program will assist you in developing an energy optimization program for your municipality.

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CONEG - *Refueling Alternatives Fuel Vehicles: Lessons Learned from the Marketplace*

A study supported by DOE, public officials and energy companies has been conducted by the Coalition of Northeast Governors (CONEG) Policy Research Center, Inc. The findings conclude that information and refueling are two critical needs if fleet managers are to operate alternative fuel vehicles. The study surveyed fleet operators in Northeast states. This report provides useful quantitative information for decision makers to make preliminary assessments of potential market demand for the development of refueling infrastructure to serve alternative fuel vehicles.

Copies of the report are available from CONEG at (202)624-8450 for \$50 for the two volume set, \$20 for Volume I and \$40 for Volume II.

HOUSTON, TX - *Compressed Natural Gas Fueled Vehicles: The Houston Experience*
A feasibility study with additional focus on refueling infrastructure.
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Promote compressed natural gas vehicle use in your municipality's fleet. In this report, based on the City of Long Beach's experience, market barriers as well as an econometric model for the implementation of a CNG infrastructure are addressed. This transferable model may help your municipality effectively address issues associated with the implementation of such an infrastructure.
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- Improve Energy Efficiency
- Create Sustainable Communities
- Enable Practical Energy Management
- Reduce Pollution
- Save Money

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Task Force Members: Albuquerque, NM; Austin, TX; Chicago, IL; Columbus, OH; Denver, CO; Hennepin County, MN; Houston, TX; Memphis, TN; Metro-Dade County, FL; Montgomery County, MD; Orange County, FL; Philadelphia, PA; Phoenix, AZ; Norfolk, VA; San Diego, CA; San Francisco, CA; San Jose, CA; Seattle, WA; Washington, DC.

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For additional information on the process and the results of the work described in this report or for information on the overall energy management programs in the City of Austin, TX, please contact:

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