03D145I - DDB-D033-41

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April 30, 2003

Mr. Gordon Hargrove
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36 Wall St.
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Dear Mr. Hargrove:

Please find enclosed our project proposal entitled “Green Building Design.”

We hope these recommendations will be useful to you in building your new facility.

Thank you for your time and consideration.

Sincerely,

Michael Baker Anna Foss

Anthony Gillet Roy Medeiros

Green Building Design

An Interactive Qualifying Project

submitted to

Friendly House and Wadsworth and Associates

and to the Faculty
of the

Worcester Polytechnic Institute

April 30, 2003

by

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Abstract

A green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Friendly House is a social services building located in the city of Worcester, MA. Friendly House needs an upgraded facility to better serve the community, and a "green" building can both serve the environment and allow them access to funding that would otherwise be inaccessible. This study provides Friendly House with appropriate, well-informed decisions about their new building that will allow them to build the most environmentally friendly facility they can given their specific needs and budget.

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Executive Summary

A green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Friendly House is a social services building located in the city of Worcester, MA. Friendly House is an invaluable asset to the community, providing services such as outreach programs, and food, health, and social services to the city. This study was conducted for the purpose of redesigning Friendly House's 31-year-old facility using "green" ideas. Their building has far exceeded its life span and their spatial needs have eclipsed what it can provide them. Friendly House wishes to construct a new building in an environmentally friendly manner for three reasons: to give them access to multiple sources of funding that would not be available otherwise, to illustrate the message of energy conservation to their clientele and neighbors, and to build responsibly and enjoy the benefits of occupying an environmentally sound facility.

To accomplish our goal of providing Friendly House with appropriate, well-informed decisions for their new building, we utilized archival research and case studies to gather data. We interviewed other owners of green buildings and architects who have designed them. We also interviewed the staff of Friendly House to see what aspects of the new building were most important to them. We identified and evaluated those "green" techniques that promised to have the best cost-to-benefit ratio, and to meet other selection criteria related to maintainability, durability, and energy efficiency. The United States Green Building Council has developed an official standard for Green Building

Design, called LEED certification, and we used this as a guide to determine what techniques will impact the "greenness" of Friendly House the most. We recommended specific green building design products, technologies, and approaches in each of four general categories: materials and recycling, water efficiency, energy efficiency, and indoor air quality.

The materials and recycling category includes building products that incorporate recycled substances, and general ideas for incorporating "green" materials into Friendly House's new building. Specific recommendations include:

- Durisol: An insulated concrete form that incorporates recycled wood and cement with integrated insulation, and is comparable in price to traditional concrete blocks and insulation.

In the water efficiency category, we list products that will help Friendly House save a large amount of money on their water bills, as well as conserve fresh water. Recommendations include:

- Waterless Urinals: These fixtures use absolutely no water and require little maintenance – the traps must be changed periodically, but this is a small price to pay for the benefit of using no water whatsoever.
- Low-flow fixtures: Low-flow pluming and showerheads can save a great deal of water, with only minimally greater startup costs.
- Vegetation: Choosing indoor and outdoor vegetation carefully, such as using only native plants and minimal lawn can save money by requiring less water to keep the plants alive. Rain barrels can also be incorporated

into the outdoor building design to catch rainwater for use in watering vegetation.

The category of energy efficiency details cutting energy costs through more efficient lighting, renewable power sources, and heating and insulation. Recommendations in this area include:

- Compact Fluorescent Lightbulbs: These bulbs consume ¼ the energy of regular light bulbs, and run at far cooler temperatures as well.
- Solar Panels by Powerlight: We determined that solar panels are probably the method that would best suit Friendly House if a renewable power source is needed for their new building, and Powerlight is a company that can provide them with good quality solutions.
- Burnham Boilers: Burnham is a company that makes outstandingly energy efficient boiler systems that are Energy Star approved.
- Nu-wool: A spray-on insulation solution that is made up of 100% recycled fibers and covers walls better with fewer air pockets, resulting in far better insulation than traditional solutions.

Finally, the indoor air quality category includes options for heating and cooling using advanced ventilation systems. One of the biggest concerns for the new building was proper air management and cooling, and these recommendations can aid in that area:

- Fantech: Fantech is a company that produces energy star approved advanced ventilation systems for large scale uses such as Friendly House.

- Rheem: Rheem manufactures environmentally friendly central heating and cooling units. Their units are also Energy Star approved.

We also recommend a number of ways that Friendly House can communicate the message of energy awareness to their neighbors, by placing clearly marked recycling bins and informative signage about the various "green" techniques in the building in highly trafficked areas. We have described techniques that will have the greatest potential impact on Friendly House's "greenness," and in using these techniques, Friendly House will be able to become a LEED certified building. This document will allow them to make decisions for their new building that best suit their needs and budget.

1. Introduction

"Green" buildings have recently come into mainstream use as an excellent method of conserving energy and reducing a building's overall impact on the environment. A green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner (USGBC, 2003). Traditionally, buildings have been designed using hazardous substances, with little regard to the harmful effects of materials, energy conservation, or reduction of pollution. Green buildings go beyond simply avoiding commonly known harmful materials. They are designed to meet objectives such as protecting occupant health and improving employee productivity, as well as helping the environment. They are built using recycled materials and rely on clean power sources such as solar energy. Because one must take into consideration cost, materials, power sources, the people that inhabit the building, location, and countless other variables, designing a green building can be extremely challenging; however, whether directly or indirectly, we are all able to reap the benefits of a cleaner and more energy efficient building.

The social services organization, Friendly House, located in Worcester, MA, helps families in need with basic services like food, clothing, and shelter. Friendly House's current facility was originally designed for a 20-year lifespan. That was thirty-one years ago. It was repainted and endured numerous renovations, but it is far too small for Friendly House's purposes. The current building does not support the staff in a way that they can most effectively serve their clientele. The building is very small, and while Friendly House's spatial needs have continued to grow, the building has become more

and more cramped. One issue is that the staff must now decide which programs "deserve" to use the limited storage space even though each program is vital to the success of the organization. Friendly House's goal for this project is to design a new building using "green" ideas.

Building "green" is something that Friendly House wants to do to encourage grants from organizations that fund green buildings, and promote the critical need for energy conservation to their neighbors. However, Friendly House needs a compilation of the green building options available to them, and that is a main objective of this project. Assessing green building technologies for maintainability, efficiency, cost effectiveness, and durability according to what is feasible for Friendly House is another objective. An example of a feasible technology is something that would stand up to a lot of wear and tear and has a cost-to-benefit ratio appropriate considering the budget. A building that is low maintenance, relatively inexpensive, energy efficient, and durable is important to Friendly House because the building will be heavily used for many different activities and as a non-profit organization, Friendly House does not have any money to spare. After crossing several hurdles in attempts at fundraising due to competing agencies, the poor economy, and the difficult fundraising climate following the September 11th tragedy, Friendly House now sees green building technologies as not only a way to embrace the benefits of an energy conscious facility, but also an excellent avenue to raise interest and funds to support their much needed building. There is a great deal of funding available for green buildings, and Friendly House wants to take advantage of that opportunity. The Massachusetts Technology Collaborative (MTC) has already provided

$20,000 to support the costs of this early stage feasibility study. Friendly House is dedicated to helping those in need and the new facility will represent this by not only helping their staff and clientele but also helping the environment.

Because green building design is such a new field, a relatively small number of case studies have been done. Also, because there is no one user-friendly "manual" of green design methods, the information is not in one easily accessible place or is geared to a more non-technical audience. This project aims to gather specific green building design recommendations that are relevant to Friendly House and present it in a clear, concise, and effective manner. Friendly House wishes to do a complete green building – energy regulation, materials, and electrical sources, so that they can effectively communicate their message of conservation to the community, help the environment, and perhaps most importantly move into a larger, better designed building to meet their needs. To do so, they need to obtain knowledge about the specific options they have in the field of green buildings so that they can implement this technology in the best way possible for their needs. Because Friendly House has a lot to do with a limited number of resources it would be difficult for them to research and obtain this information themselves; this project will provide it to them. We worked with John Wadsworth, a local architect who is working for Friendly House, and together we can assist Friendly House in the new building endeavor.

This project was performed and delivered through interviews, archival research, case studies, and careful analysis. Our research provides Friendly House with a document

that describes the state of the art technology available to them, so that they can create a green building that will fit in with their neighborhood, maximize available space, create an environment that their staff and clientele will enjoy using, and at the same time help the environment. More than simply providing Friendly House and John Wadsworth with this information, the project analyzed which of the options available to them could best suit their needs and budget. Although this project was geared toward Friendly House specifically, it can be used as a manual for green building design around the world, so that others can realize the benefits green buildings in their own neighborhoods.

Chapter 2 describes the background research that was conducted to gather information on green building design. Chapter 3 deals with the various methodologies used in the project. It includes the techniques we used to acquire information, such as interviews, case studies, archival research, and cost-benefit analysis. Chapter 4 describes the results of the project and the recommendations we have provided; the information we have gained through our research, and how it is applicable to Friendly House. Chapter 5 is our conclusion.

2. Background and Literature Review

The main goal of the project was to provide examples of the most effective technologies and methods for the new Friendly House building. The following sub-sections of the background chapter briefly describe the direction of the project, what Friendly House is all about, key aspects of green building designs, and applicable technologies.

2.1 Friendly House

2.1.1 Core Philosophy

"Friendly House helps people to help themselves, generate self-reliance and increase their quality of life. The strengthening of the finest family standards and the highest American ideals is the underlying educational purpose of Friendly House. Friendly House provides opportunities for individuals to realize his or her potential for a full life through self-direction and growth."

2.1.2 Past

Friendly House opened its doors to serve the public in 1920 with funding and support from the Worcester Civic League (Friendly House, 2002). Friendly House's intent was to promote neighborhood health and welfare for the betterment of Worcester. The main focus was to further the interests of Worcester's immigrants by introducing them to customs and traditions of their new home and helping them to become an integral part of civic life. A clubroom, kitchen and dental room made up the settlement house.

Classes in housekeeping, cooking, nursing, dressmaking, basketry and millinery were offered for girls. Boys had manual training each week. Social gatherings at the settlement house were regularly planned and well attended for the children to mix. A small dental care program was also in operation for children (Friendly House, 2002).

In the early 1920's Friendly House was forced to relocate due to spatial needs and shortly after, in 1928, the Junior League assumed control of Friendly House and once again moved to a bigger and better facility in order to meet its needs. Responsibility and funding of the Friendly House exchanged hands several times and underwent numerous changes. The 1930's were a decade of growth and constant challenge for Friendly House. During the Depression, Friendly House for the first time became involved in government-supported programs. Friendly House was in great demand and found itself fulfilling its primary purpose as a Settlement House. Friendly House quickly became the first place for neighbors to turn when in need. The coming of the 1940's brought World War II, and as a result, settlement houses were faced with severe staffing shortages. Men and boys went to the armed forces and women opted for higher paying defense positions. At that time Friendly House focused their attention on programs for school-aged children. The Friendly House Nursery School was filled to capacity during the War years and young teenagers served as recreational leaders. After the wars years, the primary focus of Friendly House continued to be the school age recreational programs (Friendly House, 2002).

The turbulent 60's presented a radical challenge for Friendly House. The rediscovery of poverty in neighborhoods throughout the country, the Vietnam War, and

the Civil Rights movement made this decade particularly challenging to settlement houses. The war on poverty and anti-poverty programs changed the programming, services and direction of Friendly House. In 1966, Friendly House received its first major federal grant from the Office of Economic Opportunity. The grant provided social services to 2,000 seniors, teens and needy families. This was the turning point in the kind of services Friendly House provided. The once small, single purpose agency was being transformed into a multi-service community center. Then in 1972 ground was broken for their new and current building (Friendly House, 2002).

2.1.3 Present

Today, Friendly House survives solely on donations and funding from members of the community. They are staffed with many qualified social service agents and volunteers, who are a key to their success. Their philosophy remains the same as in the past, but with newly added programs such as childcare, housing services, and emergency services. They are equipped with a food pantry that supplies those in need with a food basket once a month. In addition, they also provide free clothing, emergency furniture, notary services, immigration attorneys, utility assistance, and holiday food and toy distribution (Friendly House, 2002).

The childcare and youth recreational programs include YoutHoop Basketball, After School Program, Teenage Program, and Workreation (Friendly House, 2002). The YoutHoop program is an instructional program for boys and girls ages eight to fourteen, which is divided up into three divisions by age groups. Once the teams are established each team has one practice and one game per week. The After School Program is for

children grades K – 6 and includes programs of physical education, arts and crafts, board games, a homework center, a school vacation program, and even birthday parties. The Teenage Program includes such activities as a homework center, teen counseling, cooking, seminars, as well as arts and crafts. Lastly, Workreation is for children ages 12 to 15 and combines work with recreation in order to show teens the world of work while having fun.

Each of these programs allows children to obtain the opportunity to experience various activities that they might not be able to at home. During the school year each child is provided an after-school snack while participating in these programs. At the start of the summer, Friendly House operates on a full time basis. Each day the children are taken to a state park or lake, and every so often they go on a field trip, such as Six Flags or whale watches. During the summer the children are provided with breakfast, lunch, and an afternoon snack.

The Friendly House also directs and maintains several Housing Assistance buildings located throughout the Worcester area. One such building, the Francis Perkins House, is a long-term, transitional housing program for homeless women and their children. Located on Cottage Street, the Perkins House is capable of housing eight to ten families at a time. Another Housing Assistance program is the Friendly House Shelter, located on Elm Street. Since the shelter has opened its doors to the homeless, it has often operated at full capacity and provides a safe, stable shelter for families in time of need. Friendly House also operates at yet another housing facility, Foundations, which is located on Fairfield Street and has a maximum stay time of two years. Both the Francis Perkins House and Foundations require assessment, application, and release forms.

2.1.4 Future Outlook

With the increasing poverty in the Worcester area and the necessity for social services on the rise, Friendly House has come to a crossroad. The Friendly House is at a point where their current facility has seen its last days of use. Thus, the necessity for a larger and more user-friendly facility is in great need, but the funding is scarce. With the constant competition for funding among the many non-profit organizations in Worcester, the Friendly House needed a new edge for their funding.

As a result, Friendly House intends to utilize green building design to construct a building on the same location that is environmentally friendly and energy efficient. There are many grants available for construction projects if Friendly House decides to build "green," and they have chosen to seize the opportunity. By applying environmentally friendly design and resource-efficient techniques, Friendly House will strive to build a new home that will suit its staff and clientele.

An important impediment to this goal is that the Friendly House is entirely dependent on public donations and contributions to their project. They have been guaranteed six to seven million dollars by the City of Worcester, but the project is expected to be in the ten to twelve million-dollar range. The Friendly House has started to campaign to raise the necessary funds to complete construction, but they will need all they help that they can get. Therefore, in order to entice those individuals and organizations that provide funding, they intend to maximize their efforts through green building design (Friendly House, 2002).

2.2 Green Building Design; Technologies and Approaches

Sustainable design or building "green" is a way to use natural resources efficiently while creating healthier buildings (USGBC, 2003). It provides cost savings to all through improved human health and productivity, lower cost building operations, and resource efficiency. It also moves us closer to a sustainable future.

A green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as improving employee health by promoting good indoor environmental quality. Increased fresh air filtration amplifies health and well being at every level. High regard for air quality issues also encourages improved building operations and maintenance (CEPA, 2000, chapter 1). Also, green buildings are designed to use less energy, conserve water, and use resources more efficiently. Green buildings reduce the overall impact to the environment (USGBC, 2003).

2.2.1 Reduction of Environmental Impact

The impact of buildings on the environment is staggering. Every year building construction (CEPA, 2000):

- consumes 25% of global wood harvest,
- consumes 40% of the materials entering the global economy,

- consumes 3 billion tons of raw materials, for foundations, walls, pipes, and panels,
- consumes 50% of the copper used in the USA, and
- generates 50% of the global output of greenhouse gases and the agents of acid rain.

Buildings affect their neighboring and surrounding areas, sometimes creating unwanted impacts on residents and communities. For example, traditional buildings use a lot of local resources and create a less clean environment but building with sustainability in mind can dramatically lessen negative impact.

2.2.2 Energy Efficiency

Energy efficiency is one way to help lessen negative impacts on a society. By using less energy or implementing a new, more cost effective, and environmentally friendly technique, new buildings are more likely to be welcomed into neighborhoods. Passive design strategies can dramatically affect building energy performance (CEPA, 2000). These include building shape and orientation, passive solar design, and the use of natural lighting. Installing high-efficiency lighting systems with advanced lighting controls, including motion sensors tied to dimmable lighting controls, and implementing task lighting, which reduces general overhead light levels, are all ways of saving on energy (ETEC, 1997). Using a properly sized and energy-efficient heating/cooling system in conjunction with a thermally efficient building shell, maximizing light colors for

roofing and wall finish materials, and minimizing glass on east and west exposures are also great ideas for “green” buildings. A few other technologies to consider are alternative energy sources such as photovoltaic and fuel cells that are now available in new products and applications. Renewable energy sources provide a great symbol of emerging technologies for the future (ETEC, 1997).

Building with energy efficiency in mind decreases the need to expand utility plants, which ultimately saves more money. Less energy demand reduces air emissions, contributing to better air quality not just locally. Energy-efficient buildings cost less to operate, and in the larger scope, the less energy we use, the less the U.S. is dependent on foreign energy sources

2.2.2.1 Passive Solar Design

A passive solar building provides cooling and heating to keep the building comfortable without the use of mechanical equipment. This style of construction results in buildings that respond to the environment. For passive heating and cooling, the plan of the building, careful site selection, construction materials, building features and other aspects are designed to collect, store, and distribute the sun's heat in winter and to block the sun's rays in summer. Passive solar building designs can be constructed in any architectural style and in any part of the country.

Energy efficiency minimizes the need for heating, cooling, electricity, solar, or otherwise. Designers of solar buildings use insulation levels that are higher than those found in typical construction and also utilize energy efficient appliances and lighting.

The new advances in window design allow for up to twice as much resistance to heat loss as compared to those used in conventional construction. Air infiltration is also reduced by carefully sealing and caulking around window and door openings and under sill plates.

Since Friendly House is a non-profit organization and budget is a major concern, passive solar design is a relatively inexpensive means to obtain efficient lighting and effective heating and cooling. The current situation with Friendly House's lighting, heating, and cooling allows for maximum improvements since their equipment barely meets code regulations, and passive solar design is a simple approach to this problem. The outer areas of Friendly House's building, which includes the windows and doors, are in poor condition and increase heating cost in the winter. Furthermore, since Friendly House has no existing cooling system, passive solar design would drastically reduce the effect of the sun during the summer months. Lastly, the positioning of the building and windows will allow effective lighting throughout the building and help cut back on costs as well.

2.2.2.2 Geothermal Systems

Geothermal systems, also known as geoexchange systems, use the energy stored within the earth to heat and cool buildings, as well as provide hot water. The earth absorbs about 47% of the sun's energy which is more than 500 times more energy than man needs every year. These systems are designed to take advantage of the buildup of energy and use this energy to heat buildings in the colder months and return it during the warmer times (Geothermal Heat Pump Consortium, Inc., 2002).

Geothermal heat pumps are different from traditional heat pumps for many reasons. Geothermal heat pumps use energy from under the earth's surface. The temperature of this soil stays relatively constant throughout the year. Soil at a depth of six feet maintains a temperature between 45F and 70F. This is why well water maintains a cool temperature throughout the summer (Geothermal Heat Pump Consortium, Inc., 2002). Geothermal heat pumps use less energy due to the moderate temperatures from which they extract heat, as compared to traditional heat pumps. Traditional heat pumps use the outside air. This air can vary greatly depending on the time of year. Heat is produced using much less energy when starting from a ground temperature at about 50F than a traditional heat pump that uses an air temperature that may be below zero. This is also true throughout the summer. Geothermal heat pumps allow the relatively cool ground to absorb excess heat from inside a building. Traditional heat pumps use much more energy to utilize the warm outdoor air to cool inside a building (Geothermal Heat Pump Consortium, Inc., 2002).

There are two types of geothermal systems. The open-looped system circulates water from a well, lake, or pond. The closed-loop circulates a confined liquid through a horizontal or vertical grid of flexible plastic piping (Ameren Corporation, 2003).

2.2.2.3 Power Sources

2.2.2.3.1 Solar Energy

Solar energy, also known as sunlight, can be used for many purposes including generating electricity and providing hot water. Other purposes for sunlight include heating, cooling, and providing light for buildings (US Department of Energy, 2003). Sunlight is converted into electricity through semiconducting materials. These materials absorb the sunlight, causing them to lose electrons which then flow through the material producing electricity (National Renewable Energy Laboratory, 2002).

2.2.2.3.2 Photovoltaic Systems

Solar cells are typically combined into modules that hold about 40 cells. These modules are then typically arranged in a group of about 10, into what is called a PV (Photovoltaic) array. PV arrays can be used to produce electricity for a single building (US Department of Energy, 2003). These arrays are usually placed facing south. In addition, they can be mounted on a single-axis track such that they follow the sun throughout the day. Also available are two-axis tracks that allow the system to follow the path of the sun throughout the day as well as change the horizontal angle due to the different positions of the sun throughout the year (Northeast Sustainable Energy Association, 2001). Sometimes they can be designed to operate with concentrated sunlight. These systems use lenses to focus the light onto the solar cells (National Renewable Energy Laboratory, 2002).

Three main items basically make up a solar electric system: modules, inverters, and sometimes batteries. Modules convert sunlight into electricity. Inverters convert that electricity from the modules into alternating current so the electricity can be used with most appliances. Batteries are used to store excess electricity for backup and nighttime power and are often used when the solar electric system is situated in remote locations. Other smaller components that make up this type of system are wiring, circuit breakers, and support structures (National Renewable Energy Laboratory, 2002).

PV systems can be freestanding units. However, building integrated systems have also been developed. These systems may be used in place of other building materials. Solar roof shingles, for instance, have been developed to look like traditional shingles but perform the duties of the shingles as well as a solar module. The use of such a product can save money due to the fact that less of the traditional material needs to be purchased. Other such products include photovoltaic awnings used above windows for shades and opaque glass photovoltaic facades (Northeast Sustainable Energy Association, 2001).

2.2.3 Green Building Materials

Materials used in buildings are one of the main causes of negative environmental impacts of buildings. The removal of raw materials damages ecosystems and degrades water quality. These raw materials, through the manufacturing process, are transformed into finished materials, and the manufacturing process generates waste and pollution. After these finished materials are installed in the building, they require maintenance. Thus, the cleaning of them can produce toxic waste and health hazards. The materials themselves can release toxic gases as well. Further, many of the materials do not last

throughout the complete life cycle of the building (Santa Monica Green Building Program, 2000). Because of the need to replace them, the process of gathering raw materials, manufacturing them into a product, and then providing maintenance begins all over again. Although this is true with most construction projects, "green materials" are now being produced keeping these harmful results in mind and, in turn, trying to minimize their effects as well as providing longer lasting products (California Integrated Waste Management Board, 2003).

2.2.3.1 Materials Containing Recycled Content

Many materials that are produced are made partially or fully out of recycled content. Materials that are made of post-consumer waste or recovered materials are available. These materials allow the greatest benefit on the environment due to the fact that landfills are not being filled and a greater amount of raw materials is not being used unnecessarily.

In-plant recycling is also beneficial. In-plant recycling involves using waste that is created when manufacturing products and then reusing this waste in the creation of future products. Many of these products have benefits that the original product does not have. For example, lumber is sometimes made with waste plastics, which can allow it to withstand the weather better when used for outdoor purposes. Many new uses are still being investigated (CEPA, July 2000). Table 1 shows some materials that typically contain different types of recycled material.

Table 1 **Typical Building Products Made With Recycled Content**	
Acoustical tile	Gypsum board
Aluminum and steel products	Mineral filled and plastic composite panels
Carpet and carpet pad	Plastic Insulation
Cellulose insulation	Plastic lumber
Ceramic tile containing glass	Recycled asphalt
Fiberglass insulation	Remanufactured wood products
Fly-ash concrete	Roofing tile and siding, cement/paper
Geo-textile fabrics	Rubber tile and mats

(Santa Monica Green Building Program, 2000)

Many traditional products are made of recycled materials. Knowledge about these products should be gained through manufactures. One such product is drywall in which the backing paper is 100 percent recycled (CEPA, July 2000).

Choosing such sustainable materials can benefit the project at hand as well as the community. Using these materials prevents pollution as well as preventing waste generation. Moreover, using these types of materials creates a need for new recycling industries throughout the community. In addition, companies can benefit through an enhancement of their image (CEPA, July 2000).

With all the benefits mentioned through the use of recycled materials, an important concern for many people is where to locate information about these recycled products. There are many guides and directories that can be found. However, most of these guides and directories do not contain price and availability data due to the fact that these aspects are frequently changing. Many of these guides can be accessed over the Internet (CEPA, July 2000).

2.2.3.2 Barriers Involved With Recycled Materials

The use of recycled materials has not, as of yet, become a widespread practice. Therefore, availability, options, and knowledge about such products are not readily available or well understood. In the following, these barriers will be discussed.

In regard to availability, quantity is of main concern. If engaging in a large project, one must contact suppliers and find if they are capable of manufacturing the specified quantity and how long it would take (CEPA, July 2000). The time limit is important due to project schedules that must be followed.

Options are also limited when dealing with recycled materials. Typical options include colors, sizes, and other features. Purchasers can obtain lists of material options to see what is available. As the market for these recycled products expands, the options available with these products will grow as well (CEPA, July 2000).

Cost is a major barrier when discussing recycled materials. People believe that recycled materials have a higher cost. However, many of the materials can be cost-competitive and sometimes less expensive than traditional building materials. Conversely, some of these materials are more expensive than traditional materials. In these cases, the life-span of the product is important (CEPA, July 2000).

Finally, some people perceive recycled products as a lower quality material. With the new technology and quality control, this is becoming less of an issue (CEPA, July 2000). Nevertheless, one should make sure that products have been tested and meet industry standards.

2.2.3.3 Reuse and Recycling of Materials

One of the most effective ways of limiting new material use is through the salvage of parts that remain in an already existing structure. This accomplishes two tasks. First, it cuts down on the waste and disposal of materials from the old building. This cuts down on the overall cost of the project. Secondly, harmful effects can result from the manufacturing of a product. One negative effect this process has is when these products are being manufactured, the materials are often milled to their final shape producing waste. This waste is usually discarded when it can and should be recycled. Through the reuse of materials, there is less of a need to manufacture new products (LEED Green Building Rating System, pg. 39).

Table 3 provides a list of materials that can be recovered from a typical jobsite. The table is divided into new construction and demolition/remodeling projects. As is clearly shown, many materials can be reused and recycled throughout the process of construction. This can be very beneficial in allowing a project to stay within a given budget.

Table 2
Types of Materials Typically Recovered Successfully
(Sorted by Construction Phase)

New Construction Site	Demo/Remodel Project Site
• Asphalt • Brick and aggregate material • Land-clearing debris	• Asphalt • Concrete • Land clearing debris • Brick • Rebar • Scrap metal
Construction Phase • Cardboard • Ferrous metal • Nonferrous metal • Wood • Form wood • Pallet • Plastics	***Construction Phase*** • Cardboard • Electrical—wire and metal • Framing • Insulation • Plumbing fixtures and piping • Formed wood • Pallet
Finishing Phase • Cardboard • Carpet and pad • Drywall • Pallets • Plastic/films	***Finishing Phase*** • Appliances • Cabinets • Cardboard • Doors • Heating ducts • Millwork • Siding • Windows—glass and frames • Wood flooring
Site Operation • Glass • Aluminum beverage cans • Cardboard • Office paper • Plastic	
Note: The type and volume of recyclable materials will vary during the life of the project.	

(CEPA, July 2000, pg. 137)

Many materials can be recycled during the construction and demolition of a project. Some of these materials are listed in Table 4 shown below. Many benefits are associated with this practice (South Carolina Department of Health and Environmental Control, 2003). Cost savings from avoided landfill disposal fees is one benefit of recycling materials during the construction and demolition process. Further, recycling materials conserves valuable landfill space and protects the environment.

Table 3
Typical Recycled Construction and Demolition Debris

Aluminum (including siding)	Masonry
Asphalt roofing materials	Paving materials
Bricks	Plastics
Concrete	Pluming fixtures
Corrugated cardboard	Rocks
Drywall	Shingles
Electrical materials	Soil
Glass	Steel
Insulation	Tree stumps
Lumber	Vinyl siding

(United States Environmental Protection Agency, 2000)

Waste estimates due to construction have been determined through various organizations. One such organization is the North American Home Builder's Association, or NAHB. The NAHB has collected data nationally. With this information they have determined average costs and volume estimates on construction wastes. NAHB found that an average homebuilder pays $511 per house for construction waste disposal. Further, they found, of that waste, 85-90 percent was recyclable (CEPA, July 2000, pg. 114).

2.2.4 Recycling

Integrated waste management encompasses prevention of waste whenever possible, reuse or recycling whenever practical, disposal only of what is left, and buying products made out of materials people recycle (CEPA, 2000). Materials reuse and recycling boasts these benefits (CEPA, 2000):

- Prevents pollution and waste generation
- Saves money through prevention
- Creates new recycling industries
- Reduces landfill disposal and expansion, and where it is used for disposal, waste incineration and its associated air pollution.

Recycling will help keep our earth young. That is to say recycling will lessen the negative impacts on environment, especially in the United States because we use so much of so many resources and have such a large market for production. Being able to use a product for one purpose and then, instead of throwing it away, manufacturing it into something totally different is an insight that needs to be highly practiced in the world. Reducing, reusing, and recycling are some of the keys to a happy, healthy, and clean earth.

2.2.5 Water Efficiency

There are three main approaches to water efficiency in a green building: water efficient landscaping, wastewater and storm water management, and overall water use reduction (USGBC LEED rating document, 2002, 16). Water efficient landscaping can

be achieved by using high-efficiency irrigation techniques to water the surrounding plants, or by using rainwater or recycled water from on-site, to reduce the overall potable water consumption. Using native plants that require little water and minimizing lawn space will contribute as well (EPA Laboratory Brochure, 2001). The EPA New England Regional Laboratory is an excellent example of a water efficient building, as it touches on all three of these issues (*Figure 1*).

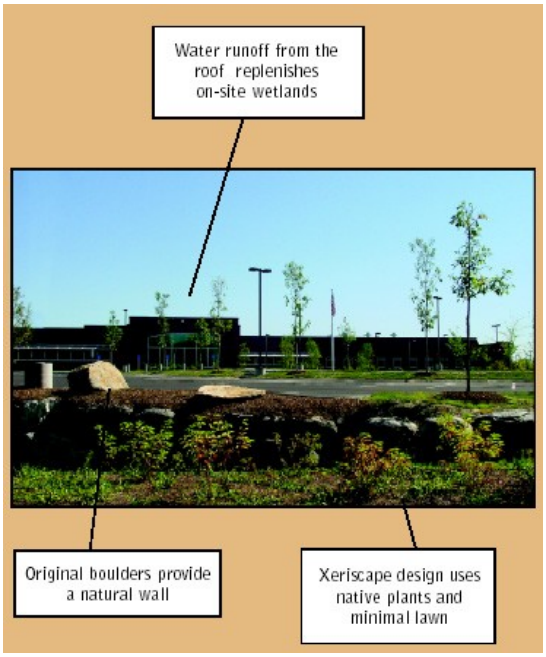


Figure 1: A green building with water efficiency techniques implemented. Xeriscape is an organization that promotes water efficient landscaping.
(EPA New England Regional Laboratory Brochure, 2001)

Wastewater and storm water management entails reducing the overall use of municipal sewage or eliminating its use by recycling wastewater in the facility. This also

relates to site sustainability. It aids the site in being self-sufficient, not having to rely on public water disposal means (USGBC LEED rating document, 2002, 18).

Water use reduction is simply maximizing the facility's water efficiency in order to reduce the strain on public water systems (USGBC LEED rating document, 2002, 19). This can be done through the use of high-efficiency fixtures, or by using recycled water to fuel the fixtures. Dry fixtures such as composting toilets can be used as well (USGBC LEED rating document, 2002, 19).

2.2.6 Indoor Air Quality

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in buildings. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the building. High temperature and humidity levels can also increase concentrations of some pollutants (EPA Website, 2003).

There are many sources of indoor air pollution in any building. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products. There are also building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for building cleaning and maintenance, personal care, or hobbies; central heating and cooling systems and humidification devices. Then there are the outdoor or environmental sources

such as radon, pesticides, and outdoor air pollution. The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as how old the source is and whether it is properly maintained are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted (EPA Website, 2003).

Some sources, such as building materials, furnishings, and building products like air fresheners, release pollutants more or less continuously. Other sources, related to activities carried out in the building, release pollutants intermittently. These include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in building-keeping. High pollutant concentrations can remain in the air for long periods after some of these activities (EPA Website, 2003).

If too little outdoor air enters a building, pollutants can accumulate to levels that can pose health and comfort problems. Unless they are built with special mechanical means of ventilation, buildings that are designed and constructed to minimize the amount of outdoor air that can "leak" into and out of the building may have higher pollutant levels than other buildings. However, because some weather conditions can drastically reduce the amount of outdoor air that enters a building, pollutants can build up even in buildings that are normally considered "leaky" (EPA Website, 2003).

Outdoor air enters and leaves a building by infiltration, natural ventilation, and mechanical ventilation. In a process known as infiltration, outdoor air flows into the building through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors. In natural ventilation, air moves through opened windows and doors. Air movement associated with infiltration and natural ventilation is caused by air temperature differences between indoors and outdoors and by wind. Finally, there are a number of mechanical ventilation devices, from outdoor-vented fans that intermittently remove air from a single room, such as bathrooms and kitchen, to air handling systems that use fans and duct work to continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the building. The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase (EPA Website, 2003).

Another effective means to promote healthy indoor air quality is through the use of breathing walls. A Breathing Wall naturally diffuses air and water between the interior and exterior. By absorbing and releasing moisture they stabilize the interior humidity and thereby preventing mold, rot and other problems. In addition breathing walls are solid form structures so that there is no place for insects, rodents, or termites to live and thus reducing pesticide use. Breathing walls are also constructed in many cases with high pH levels so as to inhibit mold and bacteria growth and use natural materials to reduce usage of petrochemicals, volatile organic compounds, and other toxic materials (EPA Website, 2003).

2.3 Integrating Green Building Design into Friendly House

2.3.1 Costs of Green Buildings

Technologies and materials used for green buildings can be costly. Some green buildings cost more up-front but save money through lower operating costs over the life of the building. The green building approach applies a project life cycle cost analysis for determining the appropriate up-front cost. Some benefits, such as improving occupant health, comfort, productivity, and reducing pollution and landfill waste are not easily measured. Careful planning and well thought-out additions can aid in developing a reasonable budget. For this reason, builders must consider setting aside a portion of the building budget to cover costs associated with less tangible green building benefits. The cost-savings potential of green building strategies can only be fully realized when they are incorporated from the beginning of design construction, with the assistance of an integrated team of people. This is important because if a budget is set from day one without considering the less tangible aspects of a green building. Then when the opportunity comes along for a service that will provide potential savings, the budget manager is less likely to add it in. When buildings are "greened" from start to finish, the potential for monetary savings is enormous.

2.3.2 Standards for Green Buildings

It is useful to examine what the accepted "standards" are for green building design. There exist many official standards developed by cities, states, and organizations

in the field of green building design that concisely define what experts in the field believe makes up a truly "green" building.

Perhaps the most widely known and respected standard is the Leadership in Energy & Environmental Design (LEED) Green Building Rating System. This rating system represents the U.S. Green Building Council's national standard for what constitutes a "green building." The rating system aims to improve occupant well-being, environmental performance, and economic returns of buildings using established and innovative practices, standards, and technologies. To receive LEED certification, an applicant must fill out an extensive form and submit multiple documents about the project. Projects then receive points from each section that add up to a final total. Depending on the total, one of four levels of certification is awarded. Sections include:

- Sustainable sites (i.e., erosion and sediment control, choice of building site, storm water management, heat and light pollution)
- Water efficiency (i.e., water efficient landscaping, wastewater innovations, water use reduction)
- Energy and atmosphere (i.e., energy performance, renewable energy sources, CFC reduction, green power)
- Materials and resources (i.e., recycling, building and resource reuse, construction waste management, use of local materials)
- Indoor environmental quality (i.e., tobacco smoke, CO_2 control, ventilation, emission and pollutant control, use of daylight, aesthetic appeal of layout)
- Innovation & design process.

Some of these, mainly site sustainability and materials and resources, will be taken into consideration in one way or another in the design of Friendly House (USGBC-LEED Document). LEED certification, though difficult to achieve, is an excellent gauge to measure the various "green" aspects of a building.

LEED certification is something many environmentally friendly and energy efficient buildings try to achieve. One main reason for becoming LEED certified is directly related to fundraising. There are associations, such as the Massachusetts Technology Collaborative, which provide grants to organizations, like Friendly House, for feasibility studies and start-up costs for new green buildings.

Cities and states across the country have established guidelines for environmentally friendly building design. The city of Santa Monica, California has adopted standards for all building projects within its city limits as part of its Santa Monica Green Building Program. The city provides plenty of resources for understanding exactly how to meet the guidelines, without putting too much financial strain on builders. Many of the measures that Santa Monica recommends do have an associated initial cost, but some of them can actually reduce the initial costs and in turn the operating costs of the facility. All of them will increase the overall value of the building (Santa Monica Green Building Program, 2001, Introduction). In fact, the entire state of California has passed mandates concerning Green Building Design. While not as strict as LEED certification or Santa Monica's mandatory requirements, California does have excellent standards for energy efficiency, indoor air quality, materials efficiency, and water

efficiency (California Integrated Waste Management Board, 2002, Policy and Law Section).

With more and more cities adopting Green Building policy, environmentally safe buildings are *en vogue* at the moment. Green practices indicate a company's commitment to the future of both their facility and our planet as a whole, and Friendly House's place in the community as a social services building fits extremely well with such a commitment.

2.3.3 How Green Building Design Relates to Friendly House

It is clear that Friendly House needs a new facility. They have far outgrown their needs and their current building is falling down around them. Green building design is an excellent choice for them. Their new building will not only benefit the environment, but it gives them a great opportunity to raise much needed funds for construction, and it also communicates to their employees, clientele, and neighbors the desperate need for energy conservation.

Friendly House is a non-profit organization and therefore cost savings in an important issue for them. With an estimated budget of 10-12 million dollars there is a lot of fund raising to be done. To make the most of every dollar raised by and granted to Friendly House, choosing the most cost-effective materials and technologies is a must. Determining which materials and technologies would be the most appropriate for Friendly House through careful research was a large part of this project. The cost effectiveness of materials and technologies that were evaluated was only one of the qualifiers we used to determine the appropriateness of a particular material or technology.

Maintainability, durability, and energy efficiency were the other qualifiers used to determine the appropriateness of a green building material or technology.

This project provides Friendly House with the necessary research needed to make a decision on how to implement green building design into their new facility. We used the techniques outlined in the following chapter to compile a list of options available to them so that they can make an informed, intelligent decision that best suits their needs.

3. Research Methods

3.1 Introduction

The main goal of this project is to suggest to Friendly House methods and technologies that will be the most appropriate methods and techniques of green building design. "Appropriate" methods and techniques for Friendly House are ones that can be easily maintained, are energy efficient, durable, and cost effective. Using these four characteristics as our main qualifiers, we have been able to judge what green building techniques should and may not work for Friendly House.

There are a number of methods available for researching green building design, but only some of them are applicable to this particular project. The primary research methods that we utilized for researching green building design are case studies, interviewing, archival research, and cost benefit analysis. In reviewing case studies we have evaluated which methods and technologies for green building worked best in past green buildings. Archival research is the use of available resources to develop our knowledge of green building design and allowed us to review a broad scope of technologies and establish a platform for more detailed analysis. After organizing the green technologies and methods gathered though archival research and case studies we then analyzed the costs and benefits of the materials and products chosen. This allowed us to evaluate the technical and economic feasibility of the green building technologies we found to be most appropriate. Interviewing has allowed us to question the Friendly House staff and the Grafton Hill community members, along with the architect, John

Wadsworth, on what would best apply to this project. We have become familiar with the operations, staff, and clientele of Friendly House and organized their input on how the new building and its green technologies will affect them. Throughout the research process we have also kept in mind that our unit of analysis for each method will be buildings, thus providing the necessary data and results that will be most suitable for Friendly House's situation and satisfy their new facility.

3.2 Case Studies

Case studies allow researchers the opportunity to see how theoretical concepts are applied to real life situations. These concepts can then be analyzed and compared to find the most useful applications for our project (WPI IQP Handbook, 2001, ch. 9). In green building design, different materials and practices may appear very beneficial, but they may not be economical or feasible due to such factors as location or availability. Location was the primary basis for choosing the case studies we did. By looking at these different case studies, many questions have been answered.

The concept of a green building is still relatively new. Therefore, research in this area is also new. By analyzing current green buildings, their failures and achievements can be observed. If, for instance, an energy source was put in one house and found to be a complete failure, one would probably want to avoid this product in future buildings. However, questions must be asked as to why such a failure occurred and if anything has been done to correct the product. For our project, we visited the Conservation Law Foundation (CLF) located in Boston, MA. The CLF is the oldest and largest regional environmental advocacy organization in the United States (Conservation Law

Foundation, 2003). They are a non-profit, public interest group based in New England with five locations. Their attorneys, scientists, economists, and policy experts' work on the most significant threats to the natural environment of the region and its residents. We used their current, recently expanded building designed with green ideas in mind to see if any of the materials, methods, and technologies they have used will be beneficial and available to use with the Friendly House. The CLF building consists of offices as well as conference rooms in which some ideas can be incorporated into the new Friendly House. Similarly, we looked at a feasibility study for an organization called Alternatives Unlimited, Inc. located in Whitinsville, MA. They are a social services provider offering a wide range of residential, vocational, and transportation services to people with developmental and psychiatric disabilities (Alternatives Unlimited, Inc., 2001). Alternatives Unlimited, Inc. plans on renovating their old building and redesigning it using green techniques. Beals and Thomas Inc. compiled the feasibility study for Alternatives Unlimited, Inc. and provided options for different materials and technologies that would be appropriate in a new design for their facility.

Both of these case studies that we researched provided us with excellent examples and guidelines as to what we wanted to accomplish. Particularly, we implemented several ideas that the Alternatives case study used, such as the LEED certification checklist and several products as well. The Conservation Law Foundation was another outstanding source of information and ideas. By being able examine the layout of there building we were able to reference and apply similar lighting and passive solar design techniques. In addition, there use of composting worms in the basement is an easy and effective way to reduce scrap food waste and overall trash disposal. After researching the

many ideas covered in both of these case studies, we were then able to apply them according to their appropriateness for Friendly House's needs.

Information gained through reliable sources is important for accurate results. Energy savings, amount of materials reused from a previous structure, amount of recycled material contained in the products, and the sum of money saved by utilizing these techniques over time are all examples of quantitative values that can be gathered and then examined. After gathering this information from several projects, we have analyzed the benefits and drawbacks drawn from the results.

3.3 Interviews

In order to determine the proper interviewees we first had to take a look at the goals of this project and the major objectives that were to be researched. The goals of Friendly House and green building design have been mentioned in chapters prior to this. The primary concerns were environmentally friendly materials, energy efficiency, indoor air quality, water efficiency, lighting, and of course costs. One particular purpose of our interviews was to obtain specific information that could be analyzed for the general population, not simply applicable to a single respondent. By doing so we gained an understanding of the general consensus of the Friendly House staff and their clientele, and not just what one particular individual wants or needs in the new building.

When conducting our interviews it was important to avoid some common misinformation such as biases, leading questions, extreme views, and atypical people who did not represent Friendly House or their clientele. In order to obtain the correct sample we limited our list of interviewees to the Friendly House staff and their clientele

that they serve. Throughout our interviewing process we basically used the face-to-face interviewing method. By utilizing this method of interviewing we were able to eliminate such answers as "I don't know" or "no answer" by asking follow up questions. Before each interview we sat down as a group and collectively developed questions. For the most part each set of questioning pertained to the development of the new Friendly House, energy efficiency, water efficiency, indoor air quality, and how the development would affect each individual.

Our interviews at Friendly House included the directors of social services, food services, recreation, maintenance, and the head director as well. Diane Mikulski, the director of food services, was very informative and gave us a quick tour to show us the layout of her storage areas, refrigerators, and freezers. Josephina, the director of social services, gave us a good understanding of the social serves aspect of the building and their needs in a new building. The director of recreation, Jim Williams, expressed a great need for a new gym floor, equipment storage areas, and classrooms that are equipped for the different activities that are run throughout the year. An example of classrooms needs would be an arts and crafts room supplied with tables or work areas so that the children have enough space to work and perhaps sinks for easy clean up. We also spoke with Gordon Hargrove on several occasions and he gave us plenty of information on the background and history of Friendly House, as well as the general concerns of the public and the Friendly House personnel.

Outside of Friendly House we talked with several different individuals who are familiar with green building design and the current technologies. In the early stages of our research we went to the NESEA's sustainable energy conference and talked with

many sales representatives from a wide variety of companies. Although these were not formal interviews and no set questions were established before hand, they were still helpful in obtaining an understanding of some of the products we had researched. We also visited the Conservation Law Foundation (CLF) in Boston and talked with an employee there. The CLF is a green building and we were fortunate enough to have a tour around the building in order to see what technologies and products they implemented into the design of their building.

Upon completion of all the necessary interviews, we were then able to process and analyze the obtained data. By analyzing similar opinions, needs, and desires of each individual we could then examine which techniques and products would be feasible and effective for Friendly House and its patrons. In addition, each of these products was further analyzed for pricing options, efficiency, life span, durability, and which would best suit a New England climate and environment.

3.4 Archival Research

Perhaps the most important method we utilized was archival research. A great deal of information is available about green building design from internet sources, electronic journals, research publications, and books. Since we did not develop our own specific green techniques, but merely suggested existing options to Friendly House, we needed to analyze the previous research of others to compile the list of possibilities.

The procedure for our archival research was fairly straightforward. Utilizing the tools available to us at WPI's library, searching for books and electronic journals relevant

to Green Building Design was made easy through the Gordon Library's online search feature. It is sometimes difficult, however, to find results using online searching tools, so it was necessary to make searches as broad as possible so as to generate the most results. It is also important to keep the results relevant. The same problem arises while performing internet searches. With the millions of websites available, finding valuable content is somewhat of a chore. Specific keywords other than just "green building" were used to find results that could be listed under a different name, such as "environmentally friendly", "energy efficient", and "site sustainability". We looked at abstracts of green building design documents to find commonly used words, and these were the ones we concentrated on when searching. The term "green building" is a relatively new phrase, considering the overall lifespan of environmentally friendly construction, and as such it is not ubiquitously used to describe the technology as of yet.

We compiled the techniques for green building design that we found into five main categories of power sources, building materials, water efficiency, energy efficiency, and air cleanliness. Organizing them into categories helped us assess the viability and benefits of the various green techniques we found. Through the research, we constructed a context of current green technologies, and with this context we were better able to begin to evaluate and analyze them with respect to Friendly House. We looked at features, benefits, availability, and cost of the various materials and technology that currently exist, and used these as basic qualifiers to construct a list of the best possible options for Friendly House specifically. That is, the techniques that are the "greenest" and most budget-effective were listed first, and techniques that make less environmental difference and are expensive were listed last. More than just this list of technologies, however, we

also researched less tangible ways to promote green ideas, such as recycling bins and energy-conscious signage that Friendly House could use in their building to communicate their message of energy conservation to the neighborhood. This analysis is covered in more detail in the results section.

We also researched Friendly House itself quite a bit. Their history was an important part of the project, because we needed to determine exactly how they use their current facility, and what they are looking to get out of the new one. We obtained documents from both their website and from our contacts on-site, and used those to construct a detailed history of their inner workings, so we could better understand what type of building would suit them best. Friendly House's website provided a great deal of specific information about their history as a settlement house and their mission to the community. We also met with their director, Gordon Hargrove, on multiple occasions to discuss Friendly House.

In this field as with others, finding valid, respected research can be difficult among the myriad of useless information that is out there. We validated information sources in two ways: by looking at the sources that the source itself used, and by looking for references to that source in other places. If a source cited many respected sources in their research, that source was in turn most likely valid, and if other sources referenced the source in a favorable way, this indicates that others believe the source to be valid. Another way we validated sources was to compare information from multiple sources. If many sources agree or capture the general idea of a particular issue, the data is more likely to be valid. For example, one source we found to be extremely useful was the U.S. Green Building Council (USGBC)'s website. They not only offer extensive information

on LEED certification, which is an excellent standard for green building design, but they have countless building summaries and construction plans for green buildings across the country. Because the USGBC is such a respected member of the green community, their information did not have to be considered for validity in the least, and as such this information was an invaluable component of our research.

3.5 Cost Benefit Analysis

Building an environmentally friendly and energy-efficient building will help Friendly House to interest environmentally cautious people and organizations, such as the Massachusetts Technology Collaborative, in donating money. Budget is always a concern when designing a new building and therefore building "green" is something the Friendly House is using not only to reap all the environmental and energy-saving benefits but also to gain an angle in fund-raising. The environmentally friendly and energy efficient methods and techniques we have suggested to Friendly House will not only raise money for the construction of the building but also save money through lower operating costs when the new green building is in utilized. Friendly House has made it clear that money has been and continues to be the biggest problem they face in their endeavor to build a new facility.

Being a not-for-profit organization, Friendly House has no money to spend on themselves and therefore is relying fully on grants and donations. To make the most of the budget our project team will use cost-benefit analysis in the green building design project. This will allow us to compare a number of different materials, energy sources, and other green construction ideas on the basis of their costs and benefits.

Cost-benefit analysis is one way to research which materials, power sources, and other resources to use in order to design the best building within a budget. Cost benefit analysis is used frequently in planning, decision support, program evaluation, evaluating proposals, and other activities (Babbie, 2002). However, the term itself has no precise definition beyond the implication that both positive and negative impacts are going to be summarized and compared (Solution Matrix, 2000).

Because the term "cost-benefit analysis" does not refer to any specific approach or methodology, the researcher who is asked to produce one should take care to find out what is expected or needed. Cost-benefit analysis includes several varieties of research analysis, such as (Solution Matrix, 2000):

- Return on Investment Analysis, which is used to evaluate the investment potential by comparing the magnitude and timing of expected gains to the investment costs;
- Financial Justification, which is used to justify spending money;
- Cost of Ownership Analysis, which is designed especially to find the lifetime costs of acquiring, operating, and changing something in the building.

We have made use of the internet and company brochures to gain the information needed to analyze the benefits of different products with respect to their costs. We have collected data from such sources and examined the prices of certain materials, power sources, and services. We then learned each of their pros and cons.

We carefully selected only those websites that contain relevant information from reliable sources. Looking for official seals or referenced cites was our main focus with

validating internet use. We found green building companies online and set up a tour of an existing green building.

The cost of the total project is estimated to be between 10-12 million dollars. This project has not taken into consideration all the costs of a new building but has thoroughly researched the green aspect of possible materials and technologies. Saving money through cost avoidance, careful selection of green building materials and technologies, and lower operating costs has been one of our biggest goals with this project.

At times it was not possible to obtain prices for certain materials. The costs of materials and technologies are shown in the templates which follow in chapter 4.

4.0 Results

4.1 Basis for Analysis and Evaluation

A green building cannot be built using only one technology or material. A green building needs a combination of different methods and ideas to really work in an energy efficient and environmentally friendly manner. The following chapter details different green materials, technologies, methods and personal practices that together will provide Friendly House with a green building that meets the standards for LEED certification. Implementing only a few of the following technologies would still result in a more energy efficient and environmentally friendly building than would be attainable with traditional materials and technologies. However, to meet Friendly House's goal of building the greenest building possible for them, each of the materials and technologies in this chapter should be considered.

There are many aspects of green building design that do not involve advanced technology or actual "green" materials. In fact, many LEED points come from observing energy efficient habits and practices. Building shape and orientation along with the use of energy saving appliances and fixtures are important approaches to green building design. These ideas, in combination with the technologies outlined in the templates described in the next paragraph, are all techniques we recommend that Friendly House and their architect, John Wadsworth, consider implementing in the new Friendly House building.

Despite the fact that green building design is a fairly new technology our project group was fortunate enough to attend a conference at the beginning of our research and obtain a fairly large amount of literature on different building techniques and materials. After reading through this literature we narrowed down which materials and technologies to further evaluate. We eliminated materials based on their feasibility for Friendly House. Because Friendly House is in an urban area on a limited amount of land we eliminated technologies such as wind power and large storm water treatment systems. Many of the companies whose literature we reviewed had feasibility maps of different locations in New England where their technology would work best. This also helped eliminate products that would not be practicable for Friendly House.

After we narrowed down the technologies and materials into a group that would most likely work for Friendly House we constructed a template to further evaluate them. Using the template of material and technology feasibility to construct a small database of researched materials and technologies, we established a rating system, which allowed us to evaluate their suitability for Friendly House. Each qualifier- -maintainability, durability, cost effectiveness, and energy efficiency- -was given individual scores and then tallied to produce a total score for one material or technology. Based on a scale of 1-5, 1 being the worst and 5 being the best, each qualifier had its own set of standards for receiving a numeric score.

To make sure that the score of each qualifier would be understood by both the evaluators and the reader we constructed a rubric. This rubric describes in detail what each of the different scores, 1-5, represents. Because all of the materials and technologies being evaluated were pre-selected from a larger sample, their total scores

are all relatively high. This rubric is not meant to be definitive as to whether or not to use each of the detailed products, but rather to show characteristic comparisons between them.

There are some considerations on a few of the technologies and materials that could not be portrayed in any of the four qualifying categories. For this reason we have added both an "advantages" and "disadvantages" section in the templates. Please note that any issue not captured in the scores can be found in either the "advantages" or "disadvantages" section. The scoring for the rubric can be found in the boxes on each of the templates in this chapter.

The standard rating system, or rubric, we established for each of the four qualifiers is as follows:

MAINTAINABILTY

1=POOR

A score of 1 indicates that this material or technology, while it may be environmentally friendly in some manner, has extremely high upkeep costs or a low overall lifetime. Because Friendly House is seeking materials that will last a long time and provide them with an easily maintainable building, these materials will not be recommended.

2=ACCEPTABLE

A score of 2 indicates that this material or technology could be used, but the drawbacks outweigh the benefits. These technologies are similar to traditional technologies and could be maintained, but require time and effort for Friendly House.

3=AVERAGE

A score of 3 indicates that this material or technology has equal maintainability as traditional materials and technologies. Friendly House would have to spend no extra time maintaining these materials and technologies than traditional ones.

4=GOOD

A score of 4 indicates that this material or technology's maintenance benefits outweigh its drawbacks. This material or technology can be maintained more easily than traditional materials and will be recommended to Friendly House.

5=EXCELLENT

A score of 5 indicates that this material or technology is exceptional in the category of maintainability. It has a longer than normal lifespan, is easily maintained, and its startup costs are not prohibitive. As far as maintainability is concerned, these products definitely fit Friendly House's needs.

ENERGY EFFICIENCY

1=POOR

A score of 1 in the energy efficiency category indicates that a material or technology uses more energy than traditional material or technology. Because energy efficiency is a large part of what Friendly House is looking for in a new building, materials and technologies that receive a 1 in this category will not be considered.

2=ACCEPTABLE

A score of 2 for energy efficiency indicates that the material or technology conserves the same amount of energy as traditional materials. Although these may be relatively feasible, Friendly House is looking to reduce costs and conserve energy, so a score of 2 would not be advisable.

3=AVERAGE

A score of 3 indicates that the material or technology is more energy efficient than similar, traditional materials and technologies. Although there are benefits to using these materials, drawbacks exist as well. These materials would be recommended over traditional technologies, but only if their other scores are favorable as well.

4=GOOD

A score of 4 in the category of energy efficiency means that the material or technology is more energy efficient than traditional techniques, and has few drawbacks. These materials are very likely to be recommended to Friendly House, because of the importance they place on energy efficiency.

5=EXCELLENT

A score of 5 in the energy efficiency category indicates a material or technology that conserves a significant amount of energy compared to traditional materials or technologies. Products and technologies with a rating of 5 in this category will most likely be recommended to Friendly House.

COST EFFECTIVENESS

1=POOR

A score of 1 in the cost effectiveness category indicates a material or technology that is not cost effective at all and in some cases could be relatively expensive. Since Friendly House is a non-profit organization cost is a major aspect of this project and a score of 1 would not be feasible.

2=ACCEPTABLE

A score of 2 indicates that a material or technology has relatively expensive startup costs compared to traditional materials or technologies, or takes an extremely long time to pay itself off. Items with scores of 2 would not be recommended for the Friendly House because of the emphasis placed on cost in this project.

3=AVERAGE

A material or technology that receives a score of 3 in cost effectiveness is more cost effective than traditional, non-green techniques. It may have drawbacks in other areas, but it pays its initial costs off within a reasonable time span. These materials would probably be recommended as long as their other scores reflect quality as well.

4=GOOD

A material or technology that receives a score of 4 in this category shows financial benefits over time through energy efficiency and has a relatively small start-up cost. The materials or technologies in the "good" category have similar start-up costs to traditional ones. These materials and technologies will most likely be recommended to Friendly House providing they have high scores in the other qualifying categories.

5=EXCELLENT

A material or technology that receives a score of 5 in this category is either cheaper than regular materials and is environmentally friendly or it is extremely "green" and has a pay off over time.

DURABILITY

1=POOR

A score of 1 in the durability category indicates a material or technology that is fragile and can be worn with relatively little use. These materials and technologies would need to be replaced every year. A material or technology of this nature would be not advisable for the Friendly House due to the heavy use of their facility.

2=ACCEPTABLE

A score of 2 in the category of durability indicates that a material or technology is no more durable than regular, non-green techniques and lasts approximately 10 years. These materials would only be recommended for Friendly House if their other merits were numerous, because durability is very important for such a heavily trafficked facility.

3=AVERAGE

A score of 3 in the durability category indicates a material or technology that is "green" and durable. An "average" product would not need to be replaced for a significant amount of time (15 years) and would most likely have an average score in the maintainability category.

4=GOOD

A score of 4 in the category of durability indicates a material or technology would not need to be replaced for 25 years. These materials and technologies would be appropriate for Friendly House due to the heavy use of the building.

5=EXCELLENT

A score of 5 in the category of durability indicates that the given material or technology has a life span 30 years or more and can withstand heavy traffic and continual usage. Materials and technologies listed as excellent would be perfect for Friendly House, since their building receives thousands of people in and out each day.

4.2 Assessment of Green Building Technologies

The following technologies, methods, materials, and ideas are separated into four different sections. The sections are materials and recycling, energy efficiency, water conservation, and indoor air quality.

4.2.1 Materials and Recycling

Materials and recycling are both important aspects of green building design. The following templates illustrate some of the various approaches and techniques that are available and effective for Friendly House. For example, Durisol, pg. 52, is an insulated concrete forming system that is made entirely of recycled material and provides a durable and long lasting alternative to regular concrete and insulation. Another means of recycling and waste management would be through the use of worm composting systems. Worm composting systems, pg. 53, are relatively inexpensive, easily maintained, and could be used as an educational device for the children.

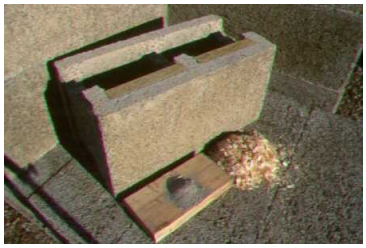
4.2.1.1 Use of Locally Produced Building Materials

Buying materials and utilizing the services of local construction companies is recommended because the closer the materials originate from, the less smog-forming pollutants are allowed to enter the air from transportation vehicles. Materials from local companies will probably be more cost effective as well overall, because shipping costs will be lower. In addition to putting funds into the local economy, there are two LEED points possible for the patronization of local businesses.

The following templates detail Durisol and a worm composting system.

Durisol®

Insulated Concrete Form



Durisol is an insulated concrete forming system. It is "made of recycled waste wood bonded together with standard Portland Cement, dry stacked and filled with concrete and reinforcing steel."

Advantages: Durisol has a great number of advantages over traditional concrete forms. It is lightweight, fire resistant, sound absorptive, termite resistant, and free draining. It is easily cut to shape. Because insulation is integrated into the wall form, no insulation has to be installed, allowing drywall or other finishing materials to be applied directly, resulting in better durability of the wall. Friendly House has large problems with wall durability, and with directly applied finishing materials, wall durability is greatly increased. Durisol is made of recycled wood, and Durisol itself can be recycled it as well. It does not produce off-gases. Finally, while slightly more expensive, it is comparable in cost to regular concrete and insulation.

Disadvantages: There are really very few disadvantages to this excellent product. A price for Durisol could not be obtained without knowing how many forms Friendly House will need. The only foreseeable issue would be that the company is based in Canada, and availability could be a problem, but the area is close to being within 500 miles of Friendly House.

Maintainability:	5
Durability:	5
Cost Effectiveness:	4
Energy Efficiency:	5

Summary: This product comes with our highest recommendations. Countless advantages over the traditional approach crossed with insignificant disadvantages make for an exceptionally easy to recommend product. Barring any issues with availability, this should be an essential part of the Friendly House project.

Contact information

67 Frid Street,
Hamilton, Ontario, Canada L8P 4M3
tel: 905-521-0999 fax: 905-521-8658
http://www.durisol.com

Worm Factory

Worm Composting Systems

Composting is a process by which microorganism, bacteria, mold, yeast, fungus, and protozoa break down the food into simpler compounds by enzyme action, producing 100% natural organic fertilizer. In full operation the Worm Factory will house about 10,000 - 12,000 worms. They will consume 5 to 8 pounds of food a day, allowing you to harvest a full tray of castings each month. It will take 6 to 9 months to reach this level.

Advantages: Each Worm Factory comes with full instructions and everything you need to get started. The Worm Factory is made in the U.S.A., constructed from high quality recycled plastic, with a limited 5-year warranty on materials and workmanship. It is very simple to assemble and can be stored in or outside. It will not only serve as a means of composting and waste reduction for Friendly House, but could also serve as an educational tool for the children.

Disadvantages: Maintenance of the worm compost will have to be done regularly, but there is little mess involved.

Maintainability:	4
Durability:	5
Cost Effectiveness:	4
Energy Efficiency:	NA

Summary: Worm composting is an efficient and effective method of waste reduction and is also useful for the indoor and outdoor vegetation at the new Friendly House. The Worm Factory itself is relatively inexpensive and takes up little space as well. The prices range from $100-110 for a 3-5 tray system. There is free shipping in the United States. Worms are available through www.yelmworms.com and come in boxes ranging from 1-50 pounds and cost between $20-$637 dollars.

Contact information
2370 W. Hwy 89A #11-156, Sedona, AZ 86336
tel: 800-767-5549
fax: 561-760-2447
http://www.neatitems.com/worm_bins.htm

4.2.2 Energy Efficiency

Energy efficiency is the largest section in our assessment of green building technologies for Friendly House. This is because the most outstanding characteristic of

the ideas, methods, and technologies we researched was that they were energy efficient. There are templates for solar panels and reflective roofing in this section and Friendly House will not be implementing them both. We recommend that Friendly House first consider the Powerlight solar panels, described on page 63, because the Massachusetts Technology Collaborative requires that a building receiving grant money implement at least one renewable energy source. If solar panels are not used on the roof, then the Sarnafil, pg. 62, reflective roofing system would certainly conserve enough energy to significantly lower Friendly House's electric bill.

4.2.2.1 Passive Solar Design

One way that virtually any building project can save on energy costs is to employ passive solar design. As described in the background, passive solar design involves the use of the sun to provide heat and light throughout the building. What follows is a description of how Friendly House can apply passive solar design to their building.

4.2.2.2 Passive-Solar-Friendly Building Materials

Any internal material that is able to absorb light energy and convert it to heat is considered passive-solar-friendly. Dark tiling should be used in any area that is exposed to sunlight. Darker tiles absorb 40 to 95 percent of incoming solar radiation from the sun, depending on their color—darker colors typically absorb a greater percentage than lighter colors. This is why solar-absorber surfaces tend to be dark colored. Bright-white materials or objects reflect 80 to 98 percent of incoming solar energy.

Bright-white materials can have their advantages, however. Sarnafil roofs have developed an all-white roofing system that reflects a great deal of the sun's rays, therefore eliminating urban heat islands. Having a white roof would allow Friendly

House to stay much cooler in the summer, and with the use of darker, heat absorbing materials on the inside of the building, heating potential would not be greatly affected in the winter. Sarnafil's technology evaluation can be found in the technical section of this chapter.

Good insulation is extremely important for effective passive solar design. Without proper building insulation, heat gained by solar radiation can be lost extremely quickly. Specific insulation products will be mentioned in the heating and cooling section, but it is important to remember insulation in the context of passive solar design as well.

4.2.2.3 Southern Building Orientation

An essential part of passive solar design is that the building faces the south.

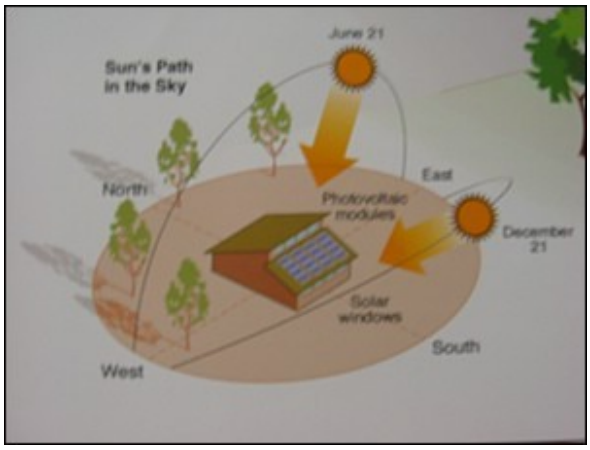


Figure ???? – Building Orientation (taken from Velux Brochure)

As shown in this diagram, a building receives the most sun if it faces the southern sky. The diagram also shows how the sun's placement in the sky differs in the summer and the winter. Most of a building's windows should be on the south side to take advantage of the sun's rays. Windows should be designed with overhangs or awnings such that they allow less light to come in during the summer, therefore keeping out unwanted heat and

lowering cooling costs; during the winter, windows will then allow more light to penetrate when the sun is lower in the sky, allowing more heat to enter, and saving overall heating costs.

The initial sketches of the new building made in 1995 describe Friendly House's new building running east-west, like the old facility, rather than north-south. It was unclear at the time of this project whether it would be possible to design the building facing the south, because of concerns with the lot and many other unknowns in the early stages of the project. If at all possible however, Friendly House should face the south and have as many windows as possible on that side.

4.2.2.4 Windows and Skylights/Light Tunnels

Passive solar design can be much more effective with the right type of windows. All windows should be coated with a special glazing material made of transparent or translucent glass. This allows solar radiation (light) to pass through, but the glass then in turn absorbs the infrared radiation (heat), and the heat is distributed to other parts of the building. The solar radiation that passes through can then be absorbed by building materials to further distribute heat throughout the building (US Department of Energy, 2002).

Windows should be double layered and operable. Double layered windows insulate far better than single pane windows. Operable windows simply refer to windows that can be opened. Windows that are double layered and operable are more expensive, but the payoff seems to be worth it in the long run. Windows should also have one continuous piece of weather stripping whenever possible; a continuous piece reduces

chance of installation errors, and is important to reduce nighttime heat loss. Also, Energy Star© offers certification for windows, and wherever possible, Energy Star© windows should be used. Energy Star© is an organization that certifies energy efficient products.

Skylights and or light tunnels are an excellent way of lighting rooms during the day. Natural sunlight is vastly preferable to any other type of light, and it is of course provided free of charge by the sun. Skylights are generally only useful on the top floor of a building, however. We have researched a product called a light tunnel that uses highly reflective tubing to funnel outside light into hallways or lower floors. Electrical lighting fixtures can then be installed inside these tunnels to provide light on cloudy days or at night. The company that developed these light tunnels is named Velux, and their technology evaluation can be found in the technical section of this chapter on page 61. Skylights would be very useful in Friendly House's gym.

4.2.2.5 Electrical Lighting

The use of compact fluorescent light bulbs, or CFLs, can greatly benefit any building. They use one quarter the amount of energy that regular light bulbs use and run at only 100F compared to 300-500F for regular light bulbs, reducing unwanted heat generation. Dimmers, timers, and sensors should also be used. This will save energy and cost. Dimmers are used when the full brightness is not necessary or when natural light is present. Timers and sensors allow lights to be turned off when the room is not in use. A template for CFL's can be found on page 66.

4.2.2.6 Kitchen and Cooking Ideas

The kitchen is an area in a building that usually uses a great deal of energy. Stoves, microwaves, and ovens can consume a great deal of electricity if energy efficient models are not chosen. Because the south side of the building will get the most sunlight, therefore becoming warmer than the north side, the kitchen should be located in the north side of the building. This will generate heat in the winter and keep the southern side cooler in the summer.

Cooking with natural gas is cheaper than cooking with electricity if the option is available. Choosing a gas oven/range with electronic ignition instead of a pilot light will cost half as much to operate as an electric oven/range. Friendly House's current facility uses electrical heat in the kitchen and switching to gas will save money. By utilizing the following procedures, Friendly House can further increase energy efficiency in the kitchen:

- Self cleaning ovens have higher insulation levels which result in lower energy use
- Gas ovens with new electronic pilotless ignitions reduce gas usage by 30% as compared with a constantly burning pilot light
- Preheat oven only when necessary
- Do not lay foils on the rack
- Use glass or ceramic pans in the oven
- Keep range-top burners and reflectors clean
- Match the size of the pan to the heating element
- Use smaller kitchen appliances instead of oven/range when appropriate
- When boiling water in a pan, always use a cover

Signs can be posted in plain view for the cooking staff to encourage these ideas.

The following templates detail different products that we recommend Friendly House consider for conserving energy.

ACUMENTRICS

Solid Oxide Fuel Cell Power

Acumentrics is a company that provides Solid Oxide Fuel Cell Power using an array of solid-state ceramic tubes. The SOFC remote power unit is fueled by natural gas, propane, ethanol, or hydrogen.

Advantages: One benefit of this system is that it is easy to site on a facility. It also can operate from many different fuels such as propane, natural gas, methane, ethanol, and many other hydrogen-rich fuels. This gas can be stored on-site or delivered at normal line pressures with no pressure boosting. There are also no engine or oil changes, lubrications, or other tune-ups which reduces maintenance costs. This system is environmentally clean due to the direct electrochemical process that does not combust the fuel. The system has lowered CO_2 levels and has negligible NO_x and SO_x emission. The peak efficiencies of this system are between 40-50% and can exceed 75% with waste heat recovery. The machine runs very quietly as well.

Disadvantages: The air filter and sulfur filter must be serviced annually or as conditions warrant which has to be done with most power systems anyways. The initial cost might be an issue for the Friendly House, however, no sales representative could reached for a price quote.

Maintainability:	4
Durability:	4
Cost Effectiveness:	3
Energy Efficiency:	4

Summary: This can be used at the Friendly House and should be considered as a backup energy source. Having a back up system would eliminate the possibility of a power outage at Friendly House. It is not necessary to have a back-up system if Friendly House's funds don't allow it. This system comes with a one year warranty

Contact information
20 Southwest Park, Westwood, MA 02090
tel: 800-332-0277 fax: 781-461-1261
http://www.Acumentrics.com

VELUX®

Roof Windows and Skylights

Nothing transforms a space like natural light and fresh air. The beauty that natural light brings into surroundings is a quality that no artificial light source can imitate. Providing 30% more light than vertical windows and enhanced air circulation, VELUX® Roof Windows and Skylights, and sun tunnels deliver a constant source of natural elements. Westfield State College used Velux skylights in their dining common.

Advantages: Velux windows protect against solar heat gains and interior fading. They resist condensation twice as long as clear glass and promote energy efficiency through the use of natural light which saves on utility bills. The tempered safety glass would be durable for places such as the Friendly House gymnasium. Velux offers 5, 10, and 20 year warranties. Natural lighting is more pleasing and the more of it there is the less energy will be used through light bulbs. Velux also manufactures devices called Sun Tunnels that allow outside light to be funneled through highly reflective tubing to parts of the building such as hallways or lower floors, that would not normally receive sunlight.

Disadvantages: Initial costs of double layered glass might be expensive, however pricing schemes for Sun Tunnels are unknown at this time.

Maintainability:	4
Durability:	4
Cost Effectiveness:	3
Energy Efficiency:	4

Summary: Skylights would be a good option for areas of the building where natural light would work best, as in the gym, and the tempered safety glass would be durable. The use of natural light in addition to passive solar design will work very well for Friendly House.

Contact information
www.veluxusa.com
Many dealers located in Worcester
5 Installers located in MA
FAQ's on website

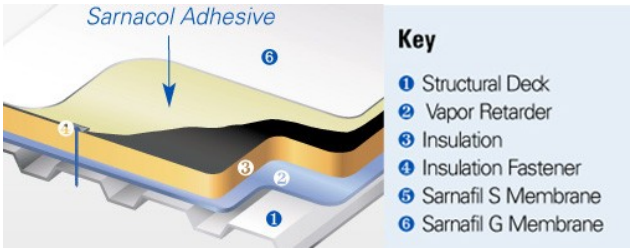
Sarnafil Division

Reflective Roofing

Dark colored roofs absorb a tremendous amount of solar radiation and become extremely hot. In most geographic areas, an air temperature increase translates into an air quality decrease. Highly reflective roofs diminish this condition and have recently been identified as the environmentally preferable roofing solution. Sarnafil's EnergySmart Roof® is designed to help alleviate oppressive urban air temperatures, which will in turn slow the reaction of smog forming pollutants. Sarnafil's EnergySmart Roof® has a highly reflective, dirt-resistant surface that can reduce the amount of energy required to maintain comfort in an air-conditioned building by decreasing heat flow through the building envelope. The picture on the right is John Hancock tower in Boston.

Advantages: This product saves energy through lower cooling costs. It reduces air pollution because it stops the roof temperature from getting too high and smog forms at high temperatures. Sarnafil has superior weatherproofing though either of their flat roof methods; the adhered system shown below or the adhered felt back system which can be seen at their website www.sarnafilus.com.

Disadvantages: Initial startup costs may be high but a sales representative was unable to give us general price quotes.



Maintainability:	4
Durability:	4
Cost Effectiveness:	3
Energy Efficiency:	4

Summary: Reflective roofing system. White colored "roofing membrane" reduces urban heat islands and saves energy by reflecting almost 83% of sunlight. If Friendly House decides not to go with solar panels this roofing idea will provide cost savings through lower cooling costs.

Contact information
100 Dan Road
Canton, MA 02021
Tel. 781-828-5400
800-451-2504
Fax 781-828-5365
http://www.sarnafilus.com

POWERLIGHT
SOLAR ELECTRIC SYSTEMS

Solar Electric Power Products

Powerlight is a company that deals in solar energy products, namely solar cells and solar arrays. Because a renewable energy source is a must for Friendly House to make sure they receive the most grants, solar energy has been determined to be the most feasible, and Powerlight can provide the products needed. Their PowerGuard system is perfect for flat roofs like the one at Friendly House, and is unobtrusive, so as to not stand out too much in the neighborhood.

Advantages: Powerlight is a leader in the field of solar power; their technology is top-of-the-line. Their products carry a twenty year warranty. They have products designed especially for the type of roof found on Friendly House. The solar cells will protect the roof from UV degradation for years as well.

Disadvantages: Initial startup costs for solar power are high, which presents a big hurdle, but solar power does pay off over enough time. Concerns were expressed that solar panels could be damaged by children throwing rocks, however, a fiberglass or plastic covering could be placed over the cells to protect them. Also, because the system will be on a flat roof, they will not be extremely noticeable.

Maintainability:	3
Durability:	4
Cost Effectiveness:	3
Energy Efficiency:	5

Summary: If solar power is indeed chosen as Friendly House's renewable energy source, Powerlight is an excellent company to provide it for them. The twenty year warranty is a definite plus, and the solar cells could be protected for comparatively negligible costs.

Contact information
2954 San Pablo Avenue, Berkeley, CA 94710
tel: 510-540-0550 fax: 510-540-0552
http://www.powerlight.com

America's Boiler Company

The OPUS line of hydronic heating equipment represents innovative design, ultimate energy efficiency, and superior performance. In fact, the word 'OPUS' itself is synonymous with a masterpiece, a creation, and a composition. Developed by Burnham Corporation, an industry-leading manufacturer of hydronic heating equipment, OPUS performance heating equipment incorporates 21st century innovation with 145 years of experience.

Advantages Opus systems are a newly developed line of Burnham boilers that are energy star approved for their high efficiency. These boilers are also equipped with an energy management control center (EMC^2). The EMC^2 automatically adjusts the supply water temperature of the G_1 based on outdoor air temperature giving maximum comfort and efficiency. It also simplifies installation and set-up by having a pre-wired, easy-to-program control panel.

Disadvantages: Since Opus boiler systems are cutting edge technology there are no set warranties at this time or that which we found through our research. Similarly, since these systems are so far advanced as opposed to competitors, pricing and start up costs may tend to be on the higher end of the spectrum but no set price was available to us.

Maintainability:	4
Durability:	4
Cost Effectiveness:	3
Energy Efficiency:	5

Summary: As previously mentioned, energy efficiency is the number one priority to Friendly House. Therefore, the Opus boiler system may be an excellent choice as a heating source. Despite the fact that start up cost may be pricey, the efficiency rating is 88% to 99%, which is outstanding by any measure.

Contact information
tel: 717-397-4701
http://www.burnham.com

Manufacturer of WALLSEAL®, a spray-in-place cellulose insulation

Nu-Wool Cellulose insulation is an energy-saving insulation product made from recycled newspapers. Nu-Wool Cellulose Insulation, with its thermal and air infiltration properties, is installed in both attics and walls of residential and commercial buildings. The Nu-Wool WALLSEAL system is a spray-in-place cellulose insulation product that is applied to the wall cavities of new construction. Nu-Wool WALLSEAL is sprayed in place, eliminating the voids and air pockets common with other insulation materials.

Advantages: Nu-Wool Cellulose Insulation has an excellent value and return on investment for buyers due to its ease of installation, low material cost, proven performance, and energy savings. Studies have shown that there is no breakdown of Nu-Wool Cellulose Insulation over time in terms of fire resistance, moisture absorption, mold growth, corrosive action or paper degradation. Nu-Wool would work extremely well for Friendly House since all of the previously mentioned aspects are of great importance to them.

Disadvantages: After researching Nu-Wool technology there seem to be no limitations with this product. One possible area that may be of some concern would be pricing and proper installation. A sales representative was unable to give us pricing for this product. Installation may be an issue because if not properly installed Nu-Wool will not reach its maximum potential.

Maintainability:	5
Durability:	5
Cost Effectiveness:	4
Energy Efficiency:	5

Summary: Nu-Wool is by far an excellent choice for Friendly House. It is made from 100% recycled fibers and is environmentally friendly. Nu-Wool offers homebuyers a three year guarantee on the amount of energy bills when it is properly installed by a certified contractor and may save as much as 40% on heating and cooling bills.

Contact information
50 Depot St., Belchertown, MA 01007
tel: 1-800-748-0128
http://www.nuwool.com

LUMATECH

Compact Fluorescent Lights

Lumatech is merely one of many companies that specialize in Compact Fluorescent Lights (CFL's). CFL's use a different, more advanced technology than incandescent light bulbs and come in a range of styles and sizes based on brand and purpose. CFL's have been manufactured for over 20 years, and have come a long way. They now provide warm, inviting, and lasting light without the flicker or hum of older fluorescent lamps.

Advantages: With ENERGY STAR qualified CFL's you enjoy the same amount of light as standard bulbs, but use less energy. By using less energy, you reduce pollution. In addition, ENERGY STAR CFL's last 6 to 10 times as long, saving time buying and replacing bulbs as well as energy and money. All ENERGY STAR qualified fixtures follow National Fire Protection Association (NFPA) guidelines for fire safety. CFL's are much cooler to the touch than incandescent or halogen bulbs. In fact, compared to incandescent lighting, ENERGY STAR qualified lighting produces up to 90 percent less heat

Disadvantages: After examining the pros and cons of CFL's there seems to be few disadvantages with this product. CFL's are a little more costly than your average light bulb at $12/bulb, but the pay back drastically outweighs this cost. Secondly, CFL's contain small amounts of mercury and if broken must be safely disposed of.

Maintainability:	5
Durability:	5
Cost Effectiveness:	4
Energy Efficiency:	5

Summary: CFL's are another excellent choice for Friendly House to cut back on energy costs, while maintaining quality lighting for their personnel. CFL's are low maintenance, durable, energy efficient, and long lasting; all of which Friendly House is seeking in technologies for their new building.

Contact information

41636 Enterprise Circle North, Unit C Temecula, CA 92590
tel: 800-932-0637
fax: 800-345-5862
http://www.carpenterlighting.com/lumatech/lumatech_home.asp

Excel Dryer, Inc.

Excel Dryer, Inc. manufactures hand dryers and hair dryers. For more than 38 years, Excel's full line of American-made hand dryers has provided cost-effective hand dryers and hair dryers. They are headquartered in East Longmeadow, Massachusetts.

Advantages: The XLERATOR hand dryer dries hands in 10 to 15 seconds. They use 80% less energy and have a 90% cost savings versus paper towels. This product is GREENSPEC approved. It also promotes hygiene through its no-touch feature.

Disadvantages: The initial cost is higher than regular hand dryers. The white hand dryer costs $549.00 and the chrome hand dryer costs $599.00.

Maintainability:	3
Durability:	4
Cost Effectiveness:	4
Energy Efficiency:	4

Summary: This is definitely an option for Friendly House but initial cost may be an issue.

Contact information

357 Chestnut Street, East Longmeadow, Massachusetts 01028
tel: (413) 525-4531 Fax: (413) -525-2853
http://www.exceldryer.com/Products/xlerator.asp

4.2.3 Water Efficiency

Although water is the world's most abundant resource it is still important to protect it. Being smart about water use takes little effort and offers energy and water saving benefits.

4.2.3.1 Water Conservation

An extremely important issue in green building design and LEED certification is the water efficiency of a building. Many points are available towards certification for buildings that manage their water effectively. The following list of water-conscious ideas can help Friendly House score these points.

Toilets installed prior to 1994 use 3.5 to 7 gallons of water per flush and as much as 20 gallons per person per day. In addition, an average of 20% of toilets leak wasting up to 200 gallons a day. Friendly House can save a significant amount of water and reduce their utility, wastewater, and water bills by doing the following:

- Install ultra-low flow toilets that require only 1.6 gallons per flush and waterless urinals
- Consider a pressurized model for optimal performance when installing low-flow toilets
- Check toilets periodically and repair them promptly
- Reduce tank capacity by placing a one gallon plastic jug of water or gravel, or two one-quart bottles in the tank
- Install a "dam" that partitions off a section of the tank so that it can't fill with water

- Do not use the toilet as a trash can

Friendly House plans to make showers available to their employees and clientele. There are many showerheads available that comply with the new 2.5 gallon flow rate required by the Federal efficiency standard. Various brands offer different levels of improved shower quality, flow rate, and performance characteristics. When choosing new showerheads, take these suggestions into consideration to save money.

- Choose showerheads that comply with the new 2.5 gallon flow rate
- Since public water from an older municipal system is available for Friendly House, select a brand specifically designed to maximize satisfaction with low-pressure water output
- Signs can be posted to encourage people to take quick showers, this can save an average of 20 gallons of water per day
- Do not drain the hot water heater completely with each shower, or energy savings gained through the new efficient showerhead are wasted
- Replace showerheads that fill a one-gallon bucket with water in 20 seconds or less
- Install aerators on kitchen and bathroom faucets
- Repair leaky faucets and showerheads promptly

4.2.3.2 Indoor/Outdoor Vegetation

An element of green building design that should not be overlooked is the vegetation used in and around the building. Being selective with the plants used can increase the LEED ranking of the building by making the indoor air quality better and conserving water.

Plants used inside the building should be low maintenance. They should not require a large amount of water or grooming. If at all possible, recycled water should be used to water them. Having plants inside the building helps process carbon dioxide into oxygen, thus improving the quality of air in the building.

Outside the building, only native plants should be used. Exotic vegetation requires more maintenance to survive, and often more water. The lawn surrounding Friendly House should be kept as small as possible so as to not require an irrigation system. If the lawn can be watered simply by rainfall, LEED points are available for the exclusion of an outdoor irrigation system. Shade over walkways and other paved areas should be provided by trees, to reduce the heat generated by the sun being absorbed by the dark pavement.

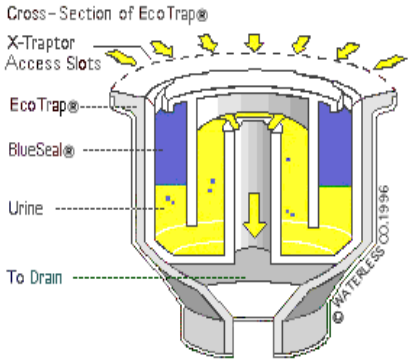
The following template is a water saving product that is recommended for use in a new Friendly House.

WATERLESS NO-FLUSH™ URINALS

Waterless Co. is a recognized leader in water conservation for urinal fixtures. They are affiliated with the Sustainable Buildings Industry Council (SBIC) and are a member of the U.S. Green Building Council (USGBC).

Advantages: Waterless No-Flush Urinals work completely without water or flush valves. The cost of these no-flush urinals is only about $1 per 1000 uses which is cheaper that conventional urinals. They are cleaned the same as regular urinals and hook up to conventional 2" waste lines. The no-flush feature promotes hygiene. Further, dry surfaces inhibit bacteria growths and the absence of water reduces sewer line encrustations. The urinal consists of BlueSeal and an EcoTrap. The BlueSeal eliminates odors and is biodegradable. The BlueSeal is located inside the EcoTrap which is recyclable.

Disadvantages: The BlueSeal in these urinals must be replaced after approximately 1500 uses. The EcoTraps must be replaced one to six times per year depending on the traffic. Fiberglass may be more prone to chip than porcelain but the fiberglass can be repaired more cheaply.



Maintainability:	3
Durability:	4
Cost Effectiveness:	5
Energy Efficiency:	5

Summary: When Friendly House chooses fixtures for the bathroom, Waterless No-Flush Urinals should definitely be considered. This fixture allows for immediate cost savings and comes with a three year warranty. Water urinals cost roughly $438.50 each.

Contact information
1050 Joshua Way, Vista, CA 92083
tel: 1-888-NOFLUSH fax: 858-793-5661
http://www.waterless.com

4.2.4 Indoor Air Quality

Indoor air quality is an important issue these days, especially with increases in energy efficient methods and technologies. Energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising indoor pollutant levels. Some basic approaches to solving this ongoing problem are presented in the following section.

4.2.4.1 General Heating and Cooling Ideas

Heating and cooling are an important part of designing a building. The climate in Worcester varies quite a bit throughout the seasons, from extremely hot to bitter cold. To manage these climate changes without excessive costs, the actual heating and cooling systems must work efficiently. Fantech, pg. 75, and Rheem, pg. 74, are examples of such systems. Furthermore, to take advantage of effective heating and cooling, a building must be well insulated. Nu-woo, pg. 65, is a company that provides spray-on insulation that reduces air pockets in insulated areas. Durisol is a concrete form that has integrated insulation. Further information on these companies can be found in the templates provided in the report.

Another idea is to place heat-producing rooms on the north side of a building. This area receives the least amount of sunlight and is therefore the coolest part of a building. The kitchen for instance produces a great deal of heat through the stove and appliances. Therefore, the kitchen should be placed in the north section of the building. Systems such as air conditioning should be placed on the north for opposite reasons, to allow them to run more efficiently and at a cooler temperature.

The following templates detail products that would save energy and add to indoor air quality.

Rheem Commercial Solutions

Heating and Cooling Systems

Rheem Manufacturing has been a trusted name in the United States for many years. One of the world's leading manufacturers of central heating and cooling products, Rheem distributes its full line of residential and commercial products around the globe. Since Friendly House is a commercial building, the products offered by Rheem are more than sufficient for their needs.

Advantages: Rheem is a partner in Energy Star. Products with the Energy Star label are the most energy efficient choices you can make as a consumer. By participating in the Energy Star, Rheem is helping to differentiate between standard-efficiency and high-efficiency products. Using these products helps you save money on your utility bills and works to protect the environment by conserving energy.

Disadvantages: Rheem's heating and cooling systems only have a one-year warranty and specific parts of the product itself are excluded from this one-year warranty. However this warranty can be extended to what they call Protection Plus. How much extra cost would be involved is uncertain. Secondly, with the size of the proposed Friendly House, they might need several units to effectively heat and cool the building, which may be costly as well.

Maintainability:	3
Durability:	3
Cost Effectiveness:	4
Energy Efficiency:	5

Summary: Although start up costs and extension of the warranty may be costly in the beginning, the pay off on utility bills and conservation of energy with these heating and cooling systems will out weigh the negatives. Also, Rheem can provide package units, which are used for both heating and cooling and will cut down on space, maintenance, and costs. There are two units, 15 tons and 20 tons, which cost $5634 and $7652, respectively.

Contact information
5600 Old Greenwood Rd, Fort Smith, AR 72908
tel: 1-800-548-Rheem
http://www.rheemac.com

Fantech

Your Ventilation Solutions Company

For more than two decades Fantech has dominated the air movement and ventilation markets. Fantech provides several different models. One particular system is the HRV. The Heat Recovery Ventilation system allows for effective air exchange while minimizing heating and cooling costs. Therefore, improved ventilation will not only cut down on indoor pollutants in Friendly House, but it will also cut down on heating and cooling costs.

Advantages: Fantech products have a guaranteed warranty of five years and are among the top of the line producers of ventilation systems. During the heating season heat recovery models allow the incoming fresh air to be preheated by the outing stale air without contaminating the fresh air, and vice versa for the cooling season as well.

Disadvantages: Initial startup costs for Fantech ventilation systems might be somewhat expensive due to the flow capacity of a single unit. A single unit costs $1945. A unit can only properly ventilate two to three rooms, and therefore Friendly House would need several systems in order to ventilate the building in an effective manner.

Maintainability:	4
Durability:	3
Cost Effectiveness:	3
Energy Efficiency:	4

Summary: Although Friendly House would be required to use several units so that the building is properly ventilated, the fact that they would be using HRV systems would reduce heating and cooling costs, as well as pollutants and would eventually pay off over time.

Contact information

1712 Northgate Blvd., Sarasota, FL 34234
tel: 800-747-1762: 941-309-6000
fax: 800-487-9915: 941-309-6099
http://www.fantech.net

4.3 Recommendations for Energy Conservation Awareness

Placing recycling bins in easily accessible places in and around Friendly House will encourage its occupants to recycle. Items such as cardboard, paper and newspaper, plastic bottles, glass, and tin and aluminum cans can be recycled. Clearly marked bins in high traffic areas will allow staff and clientele to recycle without little added effort in comparison to throwing all "trash" into one receptacle. Placing signs on and around the areas of the recycling containers will educate people about the benefits and facts about recycling. Interesting statistics about how different materials can be broken down and reused will encourage occupants to turn their trash into recyclable material. Some possible statistics for the signs include:

- Twenty years ago it took 19 aluminum cans to make one pound, but today, aluminum beverage cans are lighter and it takes 29 cans to make a pound.
- Americans throw away enough aluminum every three months to rebuild our entire commercial air fleet.
- Every minute of every day, an average of 123,097 aluminum cans are recycled. Today, the national average of aluminum can recycling is two out of every three cans.
- Tossing away an aluminum can wastes as much energy as pouring out half of that can's volume of gasoline.
- Making new aluminum cans from used cans takes 95 percent less energy and 20 recycled cans can be made with the energy needed to produce one can using virgin ore.

- Recycling one aluminum can saves enough energy to keep a 100-watt bulb burning for almost four hours or run your television for three hours.

- While recycling has grown in general, recycling of specific materials has grown even more drastically: 42 percent of all paper, 40 percent of all plastic soft drink bottles, 55 percent of all aluminum beer and soft drink cans, 57 percent of all steel packaging, and 52 percent of all major appliances are now recycled.
- 1% of America's current waste stream is equal to about 2 million tons of trash each year.
- There are 3,091 landfills in America. 75% of these landfills have less than ten years left before they are filled to capacity.
- The average office worker generates about a pound of recyclable paper each day.
- Recycling one aluminum can saves enough energy to run a television for three hours.

Saving some "trash" such as soda bottles, egg crates, and tin cans may prove to be a good thing. These items could be used by the children in a number of different craft projects and can turn trash into art.

To show the Friendly House community the importance of energy efficiency and environmentally friendly techniques, signs and posters illustrating what materials, techniques and methods are implemented in their building should be posted. These signs and posters should show information and diagrams of the various green techniques installed in Friendly House, how they work, and why they are energy efficient. The signs and posters should be colorful and easy to understand, to help the staff and other occupants of Friendly House better understand how their new green building works.

4.4 Integration of Technologies

It can be confusing when simply looking at some of the different templates and not having an explanation of how some of these power systems, heating and cooling systems, and ventilation systems integrate together.

We recommend the use of a renewable energy source. Through our research we have found that the most appropriate option for the Friendly House is solar power due to their location. If solar power will not be used we recommend the use of Sarna roofing material which will help on energy savings. We also recommend a backup source of energy if the Friendly House feels this is necessary. For this task we recommend the use of fuel cell power.

Heating and cooling systems are important for the design of a new Friendly House as well. Rheem is recommended as a source for heating and cooling the building. This provides Friendly House with the opportunity for air conditioning throughout the summer months. Burnham is a boiler company that could be use by the Friendly House as a source of hot water for the building. If air conditioning is not a major concern for the Friendly House, Burnham boilers are used for heating a building as well. Ventilation systems are an important part of several rooms in a new facility. The areas we recommend the use of Fantech are in the kitchen, bathrooms, and possibly the boiler room. The use of Fantech products will lower hearing and cooling costs as well.

The use of these products will surely result in an environmentally friendly and energy efficient building.

5.0 Conclusion

It is apparent that Friendly House needs a new building due to the condition and size of the current facility. Green building design provides a great opportunity for them. It not only allows Friendly House a different avenue for receiving funds for a new building, but it will allow them to better service the community with a new, energy efficient building, and also serve as an example of green building design in the Worcester area.

Our methods used in compiling the results of our research were useful. Interviewing helped us realize the needs and uses of Friendly House. Further, interviewing has allowed us to talk to people from other green buildings and gain information about the materials and techniques they have integrated. Case studies of these buildings allowed us to see different technologies and how effective they have been for them such as the Conservation Law Foundation. A summary of what we learned from the CLF can be found in Appendix A of this report. We learned about different materials and technologies through archival research using the internet and company brochures. After gathering information on these materials and technologies, we attempted to do a cost/benefit analysis to see the benefits of using these products in a new Friendly House. However, contacting representatives from the different companies was difficult and only a few price quotes could be found.

We recommended specific green building design products, technologies, and approaches that we divided into four general categories. The materials and recycling category includes products such as Durisol, an insulated concrete form that uses recycled wood and built-in insulation. We recommend waterless urinals and low-flow fixtures in

the water efficiency category. The category of energy efficiency details cutting energy costs through better lighting systems, passive solar design, and the use of energy efficient systems. Finally, the indoor air quality category includes options for heating and cooling using advanced ventilation systems.

Through all of our research we have provided Friendly House with well-informed recommendations that can be implemented in a new facility. With all these materials and techniques combined, Friendly House will have a very energy efficient and environmentally friendly building. A more functional and enjoyable space will also be created through the design of a new Friendly House building.

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Appendix A: Interviews

Friendly House Interviews

Diane Mikulski – Director of Food Services

Our interview with Diane provided some valuable information, but she was not well informed on the green building aspect or was unsure of what would be necessary. Diane was kind enough to give us a tour of the building and a look at the layout of where the food storages are located. The tour showed that the storage areas for the food services are scattered throughout the building and creates problems. During summer hours when they serve nearly 1200 people a day there is little to no room to store all the food products necessary to feed such quantities of people. Another problem is that as of now the deliveries come in through the gym and is quite a task for her to store all the food in different areas of the building. She would like to see a centralized area for all her storage needs and possibly a loading dock for deliveries. Another idea is to have recycling bins distributed around the building and separate dumpsters out back to organize the recyclables. As for ventilation, air conditioning, and appliances there is room for major improvements. First of all Friendly House doesn't have air conditioning and in the summer the kitchen is an unbearable working environment. Secondly, the ventilation and appliances only meet code so that they can keep the kitchen in use. So improved ventilation and appliances would cut back on costs and conserve energy and water.

Jim Williams- Recreational Director

We met Jim when he gave us a tour of Friendly House on our first trip there. We later set up an interview with him when he gave us a lot of valuable information about Friendly House and what he sees in a new building. He wasn't well informed on green building design techniques but when we gave him a few examples he seemed interested and excited to see them implemented in a new building. We mentioned skylights in the gym, fire-proof materials, chemically safe, and solar power to Jim. He told us a lot about the gym and how they need more lighting and a floor that won't hurt people's feet but also doesn't get slippery when wet. Jim also mentioned having padded walls and more equipment storage space. He mentioned that the children need something along the line of lockers to put their book bags and winter coats in. These lockers should be able to lock so that children will be able to keep their belongings secure. He would also like to have an office that is in a central location so he doesn't need to run around so much. Jim mentioned a place to sell food during games. Jim would also like to see each classroom designated for a particular activity such as arts and crafts and computers.

Josephina Velez – Director of Social Services

We began our interview with Josephina like the other interviews – we asked what she liked about the current Friendly House and what she would like to see in a new one. Josephina firmly reinforced the information gleaned from interviews with Jim and Diane, that space is a huge issue and that Friendly House cannot function to its full potential without a facility upgrade. Their social services department provides invaluable services to the community, and without space and privacy for their work, they simply are not doing everything they could. Their clients are forced to tell their stories in front of anyone who is in earshot because of the lack of private offices. Social services really needs their own separate unit from everything else, especially separate from the hundreds of kids that come and go every day. When asked about green building design, Josephina did not have much to add, but she did agree with suggestions for techniques that we are currently exploring, such as recycling bins and energy conscious signage, and a vastly improved ventilation system. Her main concern was definitely with space though. Her passion for getting this project in motion and desire for more space to better serve the community does not directly concern green building design, but if nothing else, it further supports the dire need for Friendly House to rebuild their building.

Conservation Law Foundation Interview

Jocelyn Leveille - Facilities Manager and Information Systems Technician

On Monday, April 7, 2004, we went on a tour of the Conservation Law Foundation in Boston, Massachusetts. Jocelyn Leveille took us on a tour of the recently expanded building and showed us the many offices and conference rooms. He mentioned the use of different sensors in the rooms used to control the lights. One type of sensor used is a motion sensor; when the room is not in use, the lights shut off. The other type of sensor is used in the outer rooms of the buildings that had windows. This sensor dimmed the lights based on the amount of sunlight entering through the windows. Also used in these tall windows is a reflector that directs the sunlight into the room allowing the building to have more natural light. The ventilation system throughout the building is electronically controlled allowing the building to maintain a constant, comfortable temperature. This system can also be shut off when the building is not in use such as on weekends and at night. Jocelyn Leveille also mentioned that the building recycles eighty-two percent of its waste. The CLF recycles many objects such as cans, plastic, paper goods, and batteries. They also recycle food through the use of worms in the basement. The worms convert the food into compost which members of the CLF can then use for themselves.

Appendix B: LEED Certification Checklist

This appendix is a list of all 69 LEED Certification credits, and whether through our research we have determined them to be possible. Points that receive zeroes are required credits and do not count towards the certification total. Attached at the end of this chart is the LEED document itself, that details the requirements needed for these points.

Key:	Y = Definitely capable of achieving N = Definitely incapable of achieving M = Maybe, has a 50/50 chance ? = Insufficient information to answer

	Y	M	N	?
Sustainable Sites	14 Possible Points			
Prereq 1 **Erosion & Sedimentation Control** Required		0		
Credit 1 **Site Selection**	1			
Credit 2 **Urban Redevelopment**	1			
Credit 3 **Brownfield Redevelopment**				1
Credit 4.1 **Alternative Transportation**, Public Transportation Access				1
Credit 4.2 **Alternative Transportation**, Bicycle Storage & Changing Rooms	1			
Credit 4.3 **Alternative Transportation**, Alternative Fuel Vehicles			1	
Credit 4.4 **Alternative Transportation**, Parking Capacity	1			
Credit 5.1 **Reduced Site Disturbance**, Protect or Restore Open Space				1
Credit 5.2 **Reduced Site Disturbance**, Development Footprint				1
Credit 6.1 **Stormwater Management**, Rate and Quantity				1
Credit 6.2 **Stormwater Management**, Treatment			1	
Credit 7.1 **Landscape & Exterior Design to Reduce Heat Islands**, NonRoof				1
Credit 7.2 **Landscape & Exterior Design to Reduce Heat Islands**, Roof	1			
Credit 8 **Light Pollution Reduction**	1			
Water Efficiency	5 Possible Points			
Credit 1.1 **Water Efficient Landscaping**, Reduce by 50%		1		
Credit 1.2 **Water Efficient Landscaping**, No Potable Use or No Irrigation		1		
Credit 2 **Innovative Wastewater Technologies**				1
Credit 3.1 **Water Use Reduction**, 20% Reduction	1			
Credit 3.2 **Water Use Reduction**, 30% Reduction		1		
Energy & Atmosphere	17 Possible Points			
Prereq 1 **Fundamental Building Systems Commissioning** Required	0			
Prereq 2 **Minimum Energy Performance** Required	0			
Prereq 3 **CFC Reduction in HVAC&R Equipment** Required	0			
Credit 1 **Optimize Energy Performance** (10 Possible Points)	3	5	2	
Credit 2.1 **Renewable Energy**, 5%	1			
Credit 2.2 **Renewable Energy**, 10%	1			
Credit 2.3 **Renewable Energy**, 20%		1		
Credit 3 **Additional Commissioning**				1
Credit 4 **Ozone Depletion**	1			
Credit 5 **Measurement & Verification**			1	
Credit 6 **Green Power**		1		

Materials & Resources	13 Possible Points			
Prereq 1 **Storage & Collection of Recyclables** Required	0			
Credit 1.1 **Building Reuse**, Maintain 75% of Existing Shell			1	
Credit 1.2 **Building Reuse**, Maintain 100% of Shell			1	
Credit 1.3 **Building Reuse**, Maintain 100% Shell & 50% Non-Shell			1	
Credit 2.1 **Construction Waste Management**, Divert 50%	1			
Credit 2.2 **Construction Waste Management**, Divert 75%		1		
Credit 3.1 **Resource Reuse**, Specify 5%	1			
Credit 3.2 **Resource Reuse**, Specify 10%		1		
Credit 4.1 **Recycled Content**, Specify 5% (p.c. + 1/2 p.i.)	1			
Credit 4.2 **Recycled Content**, Specify 10% (p.c. + 1/2 p.i.)	1			
Credit 5.1 **Local/Regional Materials**, 20% Manufactured Locally	1			
Credit 5.2 **Local/Regional Materials**, of 20% in MRc5.1, 50% Harvested Locally		1		
Credit 6 **Rapidly Renewable Materials**				1
Credit 7 **Certified Wood**				1
Indoor Environmental Quality	15 Possible Points			
Prereq 1 **Minimum IAQ Performance** Required				0
Prereq 2 **Environmental Tobacco Smoke** (ETS) **Control** Required	0			
Credit 1 **Carbon Dioxide** (CO_2) **Monitoring**		1		
Credit 2 **Ventilation Effectiveness**				1
Credit 3.1 **Construction IAQ Management Plan**, During Construction				1
Credit 3.2 **Construction IAQ Management Plan**, Before Occupancy		1		
Credit 4.1 **Low-Emitting Materials**, Adhesives & Sealants	1			
Credit 4.2 **Low-Emitting Materials**, Paints	1			
Credit 4.3 **Low-Emitting Materials**, Carpet	1			
Credit 4.4 **Low-Emitting Materials**, Composite Wood	1			
Credit 5 **Indoor Chemical & Pollutant Source Control**	1			
Credit 6.1 **Controllability of Systems**, Perimeter	1			
Credit 6.2 **Controllability of Systems**, Non-Perimeter		1		
Credit 7.1 **Thermal Comfort**, Comply with ASHRAE 55-1992				1
Credit 7.2 **Thermal Comfort**, Permanent Monitoring System	1			
Credit 8.1 **Daylight & Views**, Daylight 75% of Spaces	1			
Credit 8.2 **Daylight & Views**, Views for 90% of Spaces			1	
Innovation & Design Process	5 Possible Points			
Credit 1.1 **Innovation in Design**		1		
Credit 1.2 **Innovation in Design**		1		
Credit 1.3 **Innovation in Design**		1		
Credit 1.4 **Innovation in Design**		1		
Credit 2 **LEED**. **Accredited Professional**	1			
Totals:	**27**	**20**	**9**	**13**

LEED Ranking	Req'd Points	Can Friendly House do it?
Basic LEED Certification:	26-32 points	Without Question
Silver	33-38 points	Very Possible
Gold	29-51 points	Difficult, but still possible
Platinum	52-69 points	Nearly impossible given current research

If these recommended materials and techniques are integrated into a new Friendly House building, the standards of LEED certification can definitely be met by Friendly House. Friendly House can definitely receive 27 points which would allow them to get the basic LEED certification. A silver ranking can very possibly be reached if some of the questionable methods and technologies are used such as having no irrigation system which is Credit 1.2 of the LEED Document. A total of 47 points can be achieved if all questionable methods and technologies are implemented which would give them a gold ranking. A total of 9 points cannot be accomplished by the Friendly House do to their location and capabilities. We had insufficient information to answer 13 of the credit points.

Appendix C: LEED Document

LEED™

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Green Building Rating System

For New Construction & Major Renovations

(LEED-NC)

Version 2.1

November 2002

Revised 3/14/03

Introduction

The Leadership in Energy and Environmental Design (LEED™) Green Building Rating System represents the U.S. Green Building Council's effort to provide a national standard for what consistitutes a "green building." Through its use as a design guideline and third-party certification tool, it aims to improve occupant well-being, environmental performance and economic returns of buildings using established and innovative practices, standards and technologies.

Consistent with USGBC policy for the continuous improvement of LEED, Version 2.1 is an administrative update of the LEED 2.0 Rating System for new commercial construction, major renovations and high-rise residential buildings. Its purpose is to address concerns raised by USGBC members and other LEED users by providing technical clarifications and streamlining the documentation requirements for LEED certification. These improvements are expected to simplify the documentation process for project teams and to reduce the costs of documenting LEED credits while retaining the stringency and integrity of the LEED Version 2.0 standards. An approval vote by USGBC membership is not required for Version 2.1 because performance levels have not been altered. Version 2.1 was created through the generous volunteer efforts of the LEED Technical Advisory Groups and with the guidance of the LEED Steering Committee. This document represents general consensus, not unanimous agreement. USGBC gratefully acknowledges the contributions of its committee members.

The new LEED Letter Template is a central component of the Version 2.1 improvements. It is a dynamic tracking and documentation tool that must be used by Version 2.1 project teams in preparing a complete LEED certification submittal. For each credit, the Letter Template prompts LEED practitioners for data, indicates when documentation requirements have been fulfilled adequately for submittal, and serves as a formatting template for the project's initial submittal. Additional support documents will be requested during the certification assessment's audit phase.

This Rating System document states the basic intent, requirements and documentation submittals that are necessary to achieve each prerequisite and voluntary "credit." Projects earn one or more points toward certification by meeting or exceeding each credit's technical requirements. All prerequisites must be achieved in order to qualify for certification. Points add up to a final score that relates to one of four possible levels of certification. See the LEED Checklist for a summary of credit topics and point values. A short description of technologies and strategies is included for each credit to briefly inform those who are unfamiliar with the particular topic. The LEED Reference Guide for Version 2.1—the technical companion to the Rating System and Letter Template—provides further background, explanations and instructions.

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Project Checklist

Sustainable Sites

14 Possible Points

Y			Prereq 1	**Erosion & Sedimentation Control**	Required
Y	?	N	Credit 1	**Site Selection**	1
Y	?	N	Credit 2	**Urban Redevelopment**	1
Y	?	N	Credit 3	**Brownfield Redevelopment**	1
Y	?	N	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Y	?	N	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
Y	?	N	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
Y	?	N	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
Y	?	N	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
Y	?	N	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
Y	?	N	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
Y	?	N	Credit 6.2	**Stormwater Management**, Treatment	1
Y	?	N	Credit 7.1	**Heat Island Effect**, Non-Roof	1
Y	?	N	Credit 7.2	**Heat Island Effect**, Roof	1
Y	?	N	Credit 8	**Light Pollution Reduction**	1

Water Efficiency

5 Possible Points

Y	?	N	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
Y	?	N	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
Y	?	N	Credit 2	**Innovative Wastewater Technologies**	1
Y	?	N	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
Y	?	N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere

17 Possible Points

Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
Y	?	N	Credit 1	**Optimize Energy Performance**	1–10
Y	?	N	Credit 2.1	**Renewable Energy**, 5%	1
Y	?	N	Credit 2.2	**Renewable Energy**, 10%	1
Y	?	N	Credit 2.3	**Renewable Energy**, 20%	1
Y	?	N	Credit 3	**Additional Commissioning**	1
Y	?	N	Credit 4	**Ozone Depletion**	1
Y	?	N	Credit 5	**Measurement & Verification**	1
Y	?	N	Credit 6	**Green Power**	1

Materials & Resources

13 Possible Points

Y			Prereq 1	**Storage & Collection of Recyclables**	Required
Y	?	N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
Y	?	N	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
Y	?	N	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
Y	?	N	Credit 2.1	**Construction Waste Management**, Divert 50%	1
Y	?	N	Credit 2.2	**Construction Waste Management**, Divert 75%	1
Y	?	N	Credit 3.1	**Resource Reuse**, Specify 5%	1
Y	?	N	Credit 3.2	**Resource Reuse**, Specify 10%	1
Y	?	N	Credit 4.1	**Recycled Content**, Specify 5% (p.c. + 1/2 p.i.)	1
Y	?	N	Credit 4.2	**Recycled Content**, Specify 10% (p.c. + 1/2 p.i.)	1
Y	?	N	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
Y	?	N	Credit 5.2	**Local/Regional Materials**, of 20% in MRc5.1, 50% Harvested Locally	1
Y	?	N	Credit 6	**Rapidly Renewable Materials**	1
Y	?	N	Credit 7	**Certified Wood**	1

Indoor Environmental Quality

15 Possible Points

Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
Y	?	N	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
Y	?	N	Credit 2	**Ventilation Effectiveness**	1
Y	?	N	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
Y	?	N	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
Y	?	N	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
Y	?	N	Credit 4.2	**Low-Emitting Materials**, Paints	1
Y	?	N	Credit 4.3	**Low-Emitting Materials**, Carpet	1
Y	?	N	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
Y	?	N	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
Y	?	N	Credit 6.1	**Controllability of Systems**, Perimeter	1
Y	?	N	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
Y	?	N	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
Y	?	N	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
Y	?	N	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
Y	?	N	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Innovation & Design Process

5 Possible Points

Y	?	N	Credit 1.1	**Innovation in Design**	1
Y	?	N	Credit 1.2	**Innovation in Design**	1
Y	?	N	Credit 1.3	**Innovation in Design**	1
Y	?	N	Credit 1.4	**Innovation in Design**	1
Y	?	N	Credit 2	**LEED™ Accredited Professional**	1

Project Totals

69 Possible Points

☐ ☐ ☐ **Certified** 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Sustainable Sites

SS | WE | EA | MR | EQ | ID
Prerequisite 1

Erosion & Sedimentation Control

Required

Intent

Control erosion to reduce negative impacts on water and air quality.

Requirements

Design a sediment and erosion control plan, specific to the site, that conforms to United States Environmental Protection Agency (EPA) Document No. EPA 832/R-92-005 (September 1992), Storm Water Management for Construction Activities, Chapter 3, OR local erosion and sedimentation control standards and codes, whichever is more stringent. The plan shall meet the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation of storm sewer or receiving streams.
- Prevent polluting the air with dust and particulate matter.

Submittals

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring whether the project follows local erosion and sedimentation control standards or the referenced EPA standard. Provide a brief list of the measures implemented. If local standards and codes are followed, describe how they meet or exceed the referenced EPA standard.

Potential Technologies & Strategies

Adopt an erosion and sediment control plan for the project site during construction. Consider employing strategies such as temporary and permanent seeding, mulching, earth dikes, silt fencing, sediment traps and sediment basins.

SS | WE | EA | MR | EQ | ID

Credit 1

1 Point

Site Selection

Intent

Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Requirements

Do not develop buildings, roads or parking areas on portions of sites that meet any one of the following criteria:

- Prime farmland as defined by the United States Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5).
- Land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA).
- Land which is specifically identified as habitat for any species on Federal or State threatened or endangered lists.
- Within 100 feet of any water including wetlands as defined by United States Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state or local rule, OR greater than distances given in state or local regulations as defined by local or state rule or law, whichever is more stringent.
- Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (Park Authority projects are exempt).

Submittals

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring that the project site meets the credit requirements.

Potential Technologies & Strategies

During the site selection process, give preference to those sites that do not include sensitive site elements and restrictive land types. Select a suitable building location and design the building with the minimal footprint to minimize site disruption. Strategies include stacking the building program, tuck-under parking, and sharing facilities with neighbors.

Development Density

1 Point

Intent

Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources.

Requirements

Increase localized density to conform to existing or desired density goals by utilizing sites that are located within an existing minimum development density of 60,000 square feet per acre (two story downtown development).

Submittals

- ❑ Provide the LEED Letter Template, signed by the civil engineer, architect or other responsible party, declaring that the project has achieved the required development densities. Provide density for the project and for the surrounding area.
- ❑ Provide an area plan with the project location highlighted.

Potential Technologies & Strategies

During the site selection process, give preference to urban sites.

SS | WE | EA | MR | EQ | ID

Credit 3

1 Point

Brownfield Redevelopment

Intent

Rehabilitate damaged sites where development is complicated by real or perceived environmental contamination, reducing pressure on undeveloped land.

Requirements

Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment) OR on a site classified as a brownfield by a local, state or federal government agency. Effectively remediate site contamination.

Submittals

- ❑ Provide a copy of the pertinent sections of the ASTM E1903-97 Phase II Environmental Site Assessment documenting the site contamination OR provide a letter from a local, state or federal regulatory agency confirming that the site is classified as a brownfield by that agency.
- ❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring the type of damage that existed on the site and describing the remediation performed.

Potential Technologies & Strategies

During the site selection process, give preference to brownfield sites. Identify tax incentives and property cost savings. Develop and implement a site remediation plan using strategies such as pump-and-treat, bioreactors, land farming and in-situ remediation.

SS	WE	EA	MR	EQ	ID
Credit 4.1					

Alternative Transportation: Public Transportation Access — 1 Point

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

Locate project within 1/2 mile of a commuter rail, light rail or subway station or 1/4 mile of two or more public or campus bus lines usable by building occupants.

Submittals

❑ Provide the LEED Letter Template, signed by an appropriate party, declaring that the project building(s) are located within required proximity to mass transit.

❑ Provide an area drawing or transit map highlighting the building location and the fixed rail stations and bus lines, and indicate the distances between them. Include a scale bar for distance measurement.

Potential Technologies & Strategies

Perform a transportation survey of future building occupants to identify transportation needs. Site the building near mass transit.

SS | WE | EA | MR | EQ | ID

Credit 4.2

1 Point

Alternative Transportation:
Bicycle Storage & Changing Rooms

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

For commercial or institutional buildings, provide secure bicycle storage with convenient changing/shower facilities (within 200 yards of the building) for 5% or more of regular building occupants. For residential buildings, provide covered storage facilities for securing bicycles for 15% or more of building occupants in lieu of changing/shower facilities.

Submittals

- ❑ For commercial projects: provide the LEED Letter Template, signed by the Architect or responsible party, declaring the distance to bicycle storage and showers from the building entrance and demonstrating that these facilities can accommodate at least 5% of building occupants.

OR

- ❑ For residential projects: provide the LEED Letter Template, signed by the architect or responsible party, declaring the design occupancy for the buildings, number of covered bicycle storage facilities for securing bicycles, and demonstrating that these facilities can accommodate at least 15% of building occupants.

Potential Technologies & Strategies

Design the building with transportation amenities such as bicycle racks and showering/changing facilities.

Alternative Transportation: Alternative Fuel Vehicles — 1 Point

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

Provide alternative fuel vehicles for 3% of building occupants AND provide preferred parking for these vehicles, OR install alternative-fuel refueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.

Submittals

❑ Provide the LEED Letter Template and proof of ownership of, or 2 year lease agreement for, alternative fuel vehicles and calculations indicating that alternative fuel vehicles will serve 3% of building occupants. Provide site drawings or parking plan highlighting preferred parking for alternative fuel vehicles.

OR

❑ Provide the LEED Letter Template with specifications and site drawings highlighting alternative-fuel refueling stations. Provide calculations demonstrating that these facilities accommodate 3% or more of the total vehicle parking capacity.

Potential Technologies & Strategies

Provide transportation amenities such as alternative fuel refueling stations and carpool/vanpool programs. Consider sharing the costs and benefits of refueling stations with neighbors.

SS | WE | EA | MR | EQ | ID

Credit 4.4

1 Point

Alternative Transportation: Parking Capacity

Intent

Reduce pollution and land development impacts from single occupancy vehicle use.

Requirements

Size parking capacity to meet, but not exceed, minimum local zoning requirements AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants; OR add no new parking for rehabilitation projects AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants.

Submittals

- ❑ For new projects: provide the LEED Letter Template, signed by the civil engineer or responsible party, stating any relevant minimum zoning requirements and declaring that parking capacity is sized to meet, but not exceed them. State the number of preferred parking spaces for carpools.

OR

- ❑ For rehabilitation projects: provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring that no new parking capacity has been added.State the number of preferred parking spaces for carpools.

Potential Technologies & Strategies

Minimize parking lot/garage size. Consider sharing parking facilities with adjacent buildings.

Reduced Site Disturbance: Protect or Restore Open Space — 1 Point

Intent

Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements

On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways and main utility branch trenches, and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas in order to limit compaction in the constructed area; OR, on previously developed sites, restore a minimum of 50% of the site area (excluding the building footprint) by replacing impervious surfaces with native or adapted vegetation.

Submittals

❑ For greenfield sites: provide the LEED Letter Template, signed by the civil engineer or responsible party, demonstrating and declaring that site disturbance (including earthwork and clearing of vegetation) has been limited to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walk ways and main utility branch trenches, and 25 feet beyond constructed areas with permeable surfaces. Provide site drawings and specifications highlighting limits of construction disturbance.

OR

❑ For previously developed sites: provide a LEED Letter Template, signed by the civil engineer or responsible party, declaring and describing restoration of degraded habitat areas. Include highlighted site drawings with area calculations demonstrating that 50% of the site area that does not fall within the building footprint has been restored.

Potential Technologies & Strategies

Perform a site survey to identify site elements and adopt a master plan for development of the project site. Select a suitable building location and design the building with a minimal footprint to minimize site disruption. Strategies include stacking the building program, tuck-under parking and sharing facilities with neighbors. Establish clearly marked construction boundaries to minimize disturbance of the existing site and restore previously degraded areas to their natural state.

SS | WE | EA | MR | EQ | ID

Credit 5.2

1 Point

Reduced Site Disturbance: Development Footprint

Intent

Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements

Reduce the development footprint (defined as entire building footprint, access roads and parking) to exceed the local zoning's open space requirement for the site by 25%. For areas with no local zoning requirements (e.g., some university campuses and military bases), designate open space area adjacent to the building that is equal to the development footprint.

Submittals

❑ Provide a copy of the local zoning requirements highlighting the criteria for open space. Provide the LEED Letter Template, signed by the civil engineer or responsible party, demonstrating and declaring that the open space exceeds the local zoning open space requirement for the site by 25%.

OR

❑ For areas with no local zoning requirements (e.g., some university campuses and military bases), designate open space area adjacent to the building that is equal to the development footprint. Provide a letter from the property owner stating that the open space will be conserved for the life of the building.

Potential Technologies & Strategies

Perform a site survey to identify site elements and adopt a master plan for development of the project site. Select a suitable building location and design the building with a minimal footprint to minimize site disruption. Strategies include stacking the building program, tuck-under parking and sharing facilities with neighbors. Establish clearly marked construction boundaries to minimize disturbance of existing and restore previously degraded areas to their natural state.

Stormwater Management: Rate and Quantity

1 Point

Intent

Limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements

If existing imperviousness is less than or equal to 50%, implement a stormwater management plan that prevents the post-development 1.5 year, 24 hour peak discharge rate from exceeding the pre-development 1.5 year, 24 hour peak discharge rate.

OR

If existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff.

Submittals

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring that the post-development 1.5 year, 24 hour peak discharge rate does not exceed the pre-development 1.5 year 24 hour peak discharge rate. Include calculations demonstrating that existing site imperviousness is less than or equal to 50%.

OR

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring and demonstrating that the stormwater management strategies result in at least a 25% decrease in the rate and quantity of stormwater runoff. Include calculations demonstrating that existing site imperviousness exceeds 50%.

Potential Technologies & Strategies

Design the project site to maintain natural stormwater flows by promoting infiltration. Specify garden roofs and pervious paving to minimize impervious surfaces. Reuse stormwater volumes generated for non-potable uses such as landscape irrigation, toilet and urinal flushing and custodial uses.

SS | WE | EA | MR | EQ | ID

Credit 6.2

1 Point

Stormwater Management: Treatment

Intent

Limit disruption of natural water flows by eliminating stormwater runoff, increasing on-site infiltration and eliminating contaminants.

Requirements

Construct site stormwater treatment systems designed to remove 80% of the average annual post-development total suspended solids (TSS) and 40% of the average annual post-development total phosphorous (TP) based on the average annual loadings from all storms less than or equal to the 2-year/24-hour storm. Do so by implementing Best Management Practices (BMPs) outlined in Chapter 4, Part 2 (Urban Runoff), of the United States Environmental Protection Agency's (EPA's) *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, January 1993 (Document No. EPA-840-B-92-002) or the local government's BMP document (whichever is more stringent).

Submittals

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring that the design complies with or exceeds EPA or local government Best Management Practices (whichever set is more stringent) for removal of total suspended solids and total phosphorous.

Potential Technologies & Strategies

Design mechanical or natural treatment systems such as constructed wetlands, vegetated filter strips and bioswales to treat the site's stormwater.

Heat Island Effect: Non-Roof

1 Point

Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

Requirements

Provide shade (within 5 years) and/or use light-colored/high-albedo materials (reflectance of at least 0.3) and/or open grid pavement for at least 30% of the site's non-roof impervious surfaces, including parking lots, walkways, plazas, etc.; OR place a minimum of 50% of parking spaces underground or covered by structured parking; OR use an open-grid pavement system (less than 50% impervious) for a minimum of 50% of the parking lot area.

Submittals

- ❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, referencing the site plan to demonstrate areas of paving, landscaping (list species) and building footprint, and declaring that:
  - ❑ A minimum of 30% of non-roof impervious surfaces areas are constructed with high-albedo materials and/or open grid pavement and/or will be shaded within five years
  - ❑ OR a minimum of 50% of parking spaces have been placed underground or are covered by structured parking
  - ❑ OR an open-grid pavement system (less than 50% impervious) has been used for a minimum of 50% of the parking lot area.

Potential Technologies & Strategies

Shade constructed surfaces on the site with landscape features and minimize the overall building footprint. Consider replacing constructed surfaces (i.e. roof, roads, sidewalks, etc.) with vegetated surfaces such as garden roofs and open grid paving or specify high-albedo materials to reduce the heat absorption.

SS | WE | EA | MR | EQ | ID

Credit 7.2

1 Point

Heat Island Effect: Roof

Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

Requirements

Use ENERGY STAR® compliant (highly reflective) AND high emissivity roofing (emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surface; OR install a "green" (vegetated) roof for at least 50% of the roof area. Combinations of high albedo and vegetated roof can be used providing they collectively cover 75% of the roof area.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, civil engineer or responsible party, referencing the building plan and declaring that the roofing materials comply with the ENERGY STAR® Label requirements and have a minimum emissivity of 0.9. Demonstrate that high-albedo and vegetated roof areas combined constitute at least 75% of the total roof area.

OR

❑ Provide the LEED Letter Template, signed by the architect, civil engineer or responsible party, referencing the building plan and demonstrating that vegetated roof areas constitute at least 50% of the total roof area.

Potential Technologies & Strategies

Visit the ENERGY STAR® Web site, www.energystar.gov, to look for compliant products. Consider installing high-albedo and vegetated roofs to reduce heat absorption.

Light Pollution Reduction

1 Point

Intent

Eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments.

Requirements

Meet or provide lower light levels and uniformity ratios than those recommended by the Illuminating Engineering Society of North America (IESNA) *Recommended Practice Manual: Lighting for Exterior Environments* (RP-33-99). Design exterior lighting such that all exterior luminaires with more than 1000 initial lamp lumens are shielded and all luminaires with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification. The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property. Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary.

Submittals

❑ Provide the LEED Letter Template, signed by an appropriate party, declaring that the credit requirements have been met.

Potential Technologies & Strategies

Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Minimize site lighting where possible and model the site lighting using a computer model. Technologies to reduce light pollution include full cutoff luminaries, low-reflectance surfaces and low-angle spotlights.

SS | **WE** | EA | MR | EQ | ID

Credit 1.1

Water Efficiency

1 Point

Water Efficient Landscaping: Reduce by 50%

Intent

Limit or eliminate the use of potable water for landscape irrigation.

Requirements

Use high-efficiency irrigation technology OR use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, engineer or responsible party, declaring that potable water consumption for site irrigation has been reduced by 50%. Include a brief narrative of the equipment used and/or the use of drought-tolerant or native plants.

Potential Technologies & Strategies

Perform a soil/climate analysis to determine appropriate landscape types and design the landscape with indigenous plants to reduce or eliminate irrigation requirements. Use high-efficiency irrigation systems and consider using stormwater and/or greywater for irrigation.

SS | **WE** | EA | MR | EQ | ID

Credit 1.2

Water Efficient Landscaping:
No Potable Use or No Irrigation

1 Point
in addition to
WE 1.1

Intent

Limit or eliminate the use of potable water for landscape irrigation.

Requirements

Use only captured rain or recycled site water to eliminate all potable water use for site irrigation (except for initial watering to establish plants), OR do not install permanent landscape irrigation systems.

Submittals

❑ Provide the LEED Letter Template, signed by the responsible architect and/or engineer, declaring that the project site will not use potable water for irrigation. Include a narrative describing the captured rain system, the recycled site water system, and their holding capacity. List all the plant species used. Include calculations demonstrating that irrigation requirements can be met from captured rain or recycled site water.

OR

❑ Provide the LEED Letter Template, signed by the landscape architect or responsible party, declaring that the project site does not have a permanent landscape irrigation system. Include a narrative describing how the landscape design allows for this.

Potential Technologies & Strategies

Perform a soil/climate analysis to determine appropriate landscape types and design the landscape with indigenous plants to reduce or eliminate irrigation requirements. Consider using stormwater and/or greywater for irrigation.

SS **WE** EA MR EQ ID

Credit 2

1 Point

Innovative Wastewater Technologies

Intent

Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Requirements

Reduce the use of municipally provided potable water for building sewage conveyance by a minimum of 50%, OR treat 100% of wastewater on site to tertiary standards.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, MEP engineer or responsible party, declaring that water for building sewage conveyance will be reduced by at least 50%. Include the spreadsheet calculation and a narrative demonstrating the measures used to reduce wastewater by at least 50% from baseline conditions.

OR

❑ Provide the LEED Letter Template, signed by the civil engineer or responsible party, declaring that 100% of wastewater will be treated to tertiary standards on site. Include a narrative describing the on-site wastewater treatment system.

Potential Technologies & Strategies

Specify high-efficiency fixtures and dry fixtures such as composting toilets and waterless urinals to reduce wastewater volumes. Consider reusing stormwater or greywater for sewage conveyance or on-site wastewater treatment systems (mechanical and/or natural).

Water Use Reduction: 20% Reduction — 1 Point

Intent

Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements.

Submittals

- ❑ Provide the LEED Letter Template, signed by the MEP engineer or responsible party, declaring that the project uses 20% less water than the baseline fixture performance requirements of the Energy Policy Act of 1992.
- ❑ Provide the spreadsheet calculation demonstrating that water-consuming fixtures specified for the stated occupancy and use of the building reduce occupancy-based potable water consumption by 20% compared to baseline conditions.

Potential Technologies & Strategies

Estimate the potable and non-potable water needs for the building. Use high-efficiency fixtures, dry fixtures such as composting toilets and waterless urinals, and occupant sensors to reduce the potable water demand. Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing, mechanical systems and custodial uses.

SS **WE** EA MR EQ ID

Credit 3.2

1 Point
in addition to
WE 3.1

Water Use Reduction: 30% Reduction

Intent

Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use 30% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements.

Submittals

- ❑ Provide the LEED Letter Template, signed by the MEP engineer or responsible party, declaring that the project uses 30% less water than the baseline fixture performance requirements of the Energy Policy Act of 1992.
- ❑ Provide the spreadsheet calculation demonstrating that water-consuming fixtures specified for the stated occupancy and use of the building reduce occupancy-based potable water consumption by 30% compared to baseline conditions.

Potential Technologies & Strategies

Estimate the potable and non-potable water needs for the building. Use high-efficiency fixtures, dry fixtures such as composting toilets and waterless urinals, and occupant sensors to reduce the potable water demand. Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing, mechanical systems and custodial uses.

Energy & Atmosphere

SS | WE | **EA** | MR | EQ | ID

Prerequisite 1

Fundamental Building Systems Commissioning

Required

Intent

Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.

Requirements

Implement or have a contract in place to implement the following fundamental best practice commissioning procedures.

- Engage a commissioning team that does not include individuals directly responsible for project design or construction management.
- Review the design intent and the basis of design documentation.
- Incorporate commissioning requirements into the construction documents.
- Develop and utilize a commissioning plan.
- Verify installation, functional performance, training and operation and maintenance documentation.
- Complete a commissioning report.

Submittals

❑ Provide the LEED Letter Template, signed by the owner or commissioning agent(s), confirming that the fundamental commissioning requirements have been successfully executed or will be provided under existing contract(s).

Potential Technologies & Strategies:

Engage a commissioning authority and adopt a commissioning plan. Include commissioning requirements in bid documents and task the commissioning agent to produce a commissioning report once commissioning activities are completed.

SS | WE | **EA** | MR | EQ | ID

Prerequisite 2

Required

Minimum Energy Performance

Intent

Establish the minimum level of energy efficiency for the base building and systems.

Requirements

Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments) or the local energy code, whichever is more stringent.

Submittals

❑ Provide a LEED Letter Template, signed by a licensed professional engineer or architect, stating that the building complies with ASHRAE/IESNA 90.1-1999 or local energy codes. If local energy codes were applied, demonstrate that the local code is equivalent to, or more stringent than, ASHRAE/IESNA 90.1-1999 (without amendments).

Potential Technologies & Strategies:

Design the building envelope and systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost effective energy measures. Quantify energy performance compared to the baseline building.

CFC Reduction in HVAC&R Equipment

Required

Intent

Reduce ozone depletion.

Requirements

Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion.

Submittals

❑ Provide a LEED Letter Template, signed by a licensed professional engineer or architect, declaring that the building's HVAC&R systems do not use CFC-based refrigerants.

Potential Technologies & Strategies:

When reusing existing HVAC systems, conduct an inventory to identify equipment that uses CFC refrigerants and adopt a replacement schedule for these refrigerants. For new buildings, specify new HVAC equipment that uses no CFC refrigerants.

1–10 Points

Optimize Energy Performance

Intent

Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirements

Reduce design energy cost compared to the energy cost budget for energy systems regulated by ASHRAE/IESNA Standard 90.1-1999 (without amendments), as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11 of the Standard.

New Bldgs.	Existing Bldgs.	Points
15%	5%	1
20%	10%	2
25%	15%	3
30%	20%	4
35%	25%	5
40%	30%	6
45%	35%	7
50%	40%	8
55%	45%	9
60%	50%	10

Regulated energy systems include HVAC (heating, cooling, fans and pumps), service hot water and interior lighting. Non-regulated systems include plug loads, exterior lighting, garage ventilation and elevators (vertical transportation). Two methods may be used to separate energy consumption for regulated systems. The energy consumption for each fuel may be prorated according to the fraction of energy used by regulated and non-regulated energy. Alternatively, separate meters (accounting) may be created in the energy simulation program for regulated and non-regulated energy uses.

If an analysis has been made comparing the proposed design to local energy standards and a defensible equivalency (at minimum) to ASHRAE/IESNA Standard 90.1-1999 has been established, then the comparison against the local code may be used in lieu of the ASHRAE Standard.

Project teams are encouraged to apply for innovation credits if the energy consumption of non-regulated systems is also reduced.

Optimize Energy Performance

1–10 Points

(continued)

Submittals

- ❑ Complete the LEED Letter Template incorporating a quantitative summary table showing the energy saving strategies incorporated in the building design.
- ❑ Demonstrate via summary printout from energy simulation software that the design energy cost is less than the energy cost budget as defined in ASHRAE/IESNA 90.1-1999, Section 11.

Potential Technologies & Strategies

Design the building envelope and building systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance as compared to a baseline building.

1 Point

Renewable Energy: 5%

Intent

Encourage and recognize increasing levels of on-site renewable energy self-supply in order to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 5% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or responsible party, declaring that at least 5% of the building's energy is provided by on-site renewable energy. Include a narrative describing on-site renewable energy systems installed in the building and calculations demonstrating that at least 5% of total energy costs are supplied by the renewable energy system(s).

Potential Technologies & Strategies

Assess the project for non-polluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.

Renewable Energy: 10%

1 Point
in addition to
EA 2.1

Intent

Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 10% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or responsible party, declaring that at least 10% of the building's energy is provided by on-site renewable energy. Include a narrative describing on-site renewable energy systems installed in the building and calculations demonstrating that at least 10% of total energy costs are supplied by the renewable energy system(s).

Potential Technologies & Strategies

Assess the project for non-polluting renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.

SS | WE | **EA** | MR | EQ | ID

Credit 2.3

1 Point
in addition to
EA 2.1 and 2.2

Renewable Energy: 20%

Intent

Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 20% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or responsible party, declaring that at least 20% of the building's energy is provided by on-site renewable energy. Include a narrative describing on-site renewable energy systems installed in the building and calculations demonstrating that at least 20% of total energy costs are supplied by the renewable energy system(s).

Potential Technologies & Strategies

Assess the project for non-polluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.

Additional Commissioning

1 Point

Intent

Verify and ensure that the entire building is designed, constructed and calibrated to operate as intended.

Requirements

In addition to the Fundamental Building Commissioning prerequisite, implement or have a contract in place to implement the following additional commissioning tasks:

1. A commissioning authority independent of the design team shall conduct a review of the design prior to the construction documents phase.
2. An independent commissioning authority shall conduct a review of the construction documents near completion of the construction document development and prior to issuing the contract documents for construction.
3. An independent commissioning authority shall review the contractor submittals relative to systems being commissioned.
4. Provide the owner with a single manual that contains the information required for re-commissioning building systems.
5. Have a contract in place to review building operation with O&M staff, including a plan for resolution of outstanding commissioning-related issues within one year after construction completion date.

Submittals

❑ Provide the LEED Letter Template, signed by the owner or independent commissioning agent(s) as appropriate, confirming that the required additional commissioning tasks have been successfully executed or will be provided under existing contract(s).

Potential Technologies & Strategies

Engage the commissioning authority early in the design phases.

SS | WE | **EA** | MR | EQ | ID

Credit 4

1 Point

Ozone Protection

Intent

Reduce ozone depletion and support early compliance with the Montreal Protocol.

Requirements

Install base building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFCs or Halons.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or engineer, stating that HVAC&R systems as-built are free of HCFCs and Halons.

Potential Technologies & Strategies

When reusing buildings, inventory existing building systems using refrigerants and fire suppression chemicals and replace those that contain HCFCs or Halons. For new buildings, specify refrigeration and fire suppression systems that use no HCFCs or Halons.

Measurement and Verification

1 Point

Intent

Provide for the ongoing accountability and optimization of building energy and water consumption performance over time.

Requirements

Install continuous metering equipment for the following end-uses:

- Lighting systems and controls
- Constant and variable motor loads
- Variable frequency drive (VFD) operation
- Chiller efficiency at variable loads (kW/ton)
- Cooling load
- Air and water economizer and heat recovery cycles
- Air distribution static pressures and ventilation air volumes
- Boiler efficiencies
- Building-related process energy systems and equipment
- Indoor water risers and outdoor irrigation systems

Develop a Measurement and Verification plan that incorporates the monitoring information from the above end-uses and is consistent with Option B, C or D of the 2001 *International Performance Measurement & Verification Protocol (IPMVP) Volume I: Concepts and Options for Determining Energy and Water Savings.*

Submittals

❑ Provide the LEED Letter Template, signed by the licensed engineer or other responsible party, indicating that metering equipment has been installed for each end-use and declaring the option to be followed under IPMVP version 2001.

❑ Provide a copy of the M&V plan following IPMVP, 2001version, including an executive summary.

Potential Technologies & Strategies

Model the energy and water systems to predict savings. Design the building with equipment to measure energy and water performance. Draft a Measurement & Verification Plan to apply during building operation that compares predicted savings to those actually achieved in the field.

1 Point

Green Power

Intent

Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirements

Provide at least 50% of the building's electricity from renewable sources by engaging in at least a two-year renewable energy contract. Renewable sources are as defined by the Center for Resource Solutions (CRS) Green-e products certification requirements.

Submittals

- ❑ Provide the LEED Letter Template, signed by the owner or other responsible party, documenting that the supplied renewable power is equal to 50% of the project's energy consumption and the sources meet the Green-e definition of renewable energy.
- ❑ Provide a copy of the two-year electric utility purchase contract for power generated from renewable sources.

Potential Technologies & Strategies

Determine the energy needs of the building and investigate opportunities to engage in a green power contract with the local utility. Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources. Green power may be procured from a Green-e certified power marketer, a Green-e accredited utility program, through Green-e certified Tradable Renewable Certificates, or from a supply that meets the Green-e renewable power definition.Visit www.green-e.org for details about the Green-e program.

Materials & Resources

SS	WE	EA	MR	EQ	ID
Prerequisite 1					

Storage & Collection of Recyclables

Required

Intent

Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirements

Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics and metals.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect or owner, declaring that the area dedicated to recycling is easily accessible and accommodates the building's recycling needs.
- ❑ Provide a plan showing the area(s) dedicated to recycled material collection and storage.

Potential Technologies & Strategies

Designate an area for recyclable collection and storage that is appropriately sized and located in a convenient area. Identify local waste handlers and buyers for glass, plastic, office paper, newspaper, cardboard and organic wastes. Instruct occupants on building recycling procedures. Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste management technologies to further enhance the recycling program.

SS | WE | EA | **MR** | EQ | ID

Credit 1.1

1 Point

Building Reuse:
Maintain 75% of Existing Walls, Floors and Roof

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain at least 75% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, listing the retained elements and declaring that the credit requirements have been met.

Potential Technologies & Strategies

Consider reuse of existing buildings, including structure, shell and non-shell elements. Remove elements that pose contamination risk to building occupants and upgrade outdated components such as windows, mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

Building Reuse:
Maintain 100% of Existing Walls, Floors and Roof

1 Point
in addition to
MR 1.1

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain an additional 25% (100% total) of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, demonstrating the retained elements and declaring that the credit requirements have been met.

Potential Technologies & Strategies

Consider reuse of existing buildings, including structure, shell and non-shell elements. Remove elements that pose contamination risk to building occupants and upgrade outdated components such as windows, mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

SS | WE | EA | **MR** | EQ | ID

Credit 1.3

1 Point
in addition to
MR 1.1 and 1.2

Building Reuse: Maintain 100% of Shell/Structure and 50% of Non-Shell/Non-Structure

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain 100% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material) AND at least 50% of non-shell areas (interior walls, doors, floor coverings and ceiling systems).

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, demonstrating the retained elements and declaring that the credit requirements have been met.

Potential Technologies & Strategies

Consider reuse of existing buildings, including structure, shell and non-shell elements. Remove elements that pose contamination risk to building occupants and upgrade outdated components such as windows, mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

Construction Waste Management: 1 Point
Divert 50% From Landfill

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage at least 50% of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the credit requirements have been met.

Potential Technologies & Strategies

Establish goals for landfill diversion and adopt a construction waste management plan to achieve these goals. Consider recycling land clearing debris, cardboard, metal, brick, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area on the construction site for recycling and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that salvage may include donation of materials to charitable organizations such as Habitat for Humanity.

SS | WE | EA | **MR** | EQ | ID

Credit 2.2

1 Point
in addition to
MR 2.1

Construction Waste Management:
Divert 75% From Landfill

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage an additional 25% (75% total) of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the credit requirements have been met.

Potential Technologies & Strategies

Establish goals for landfill diversion and adopt a construction waste management plan to achieve these goals. Consider recycling land clearing debris, cardboard, metal, brick, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area on the construction site for recycling and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that salvage may include donation of materials to charitable organizations such as Habitat for Humanity.

Resource Reuse: 5%

1 Point

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 5% of building materials.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing each material or product used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of materials for the project.

Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

SS | WE | EA | **MR** | EQ | ID

Credit 3.2

1 Point
in addition to
MR 3.1

Resource Reuse: 10%

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing each material or product used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of all materials for the project.

Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

Recycled Content: 5% (post-consumer + 1/2 post-industrial) — 1 Point

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials.

Requirements

Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 5% of the total value of the materials in the project.

The value of the recycled content portion of a material or furnishing shall be determined by dividing the weight of recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total value of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, *Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)*, available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

SS | WE | EA | **MR** | EQ | ID

Credit 4.2

1 Point
in addition to
MR 4.1

Recycled Content: 10% (post-consumer + 1/2 post-industrial)

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing the impacts resulting from extraction and processing of new virgin materials.

Requirements

Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

The value of the recycled content portion of a material or furnishing shall be determined by dividing the weight of recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total value of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, *Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)*, available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

Regional Materials: 20% manufactured regionally — 1 Point

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation .

Requirements

Use a minimum of 20% of building materials and products that are manufactured* regionally within a radius of 500 miles.

* Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesmen. For example, if the hardware comes from Dallas, Texas, the lumber from Vancouver, British Columbia, and the joist is assembled in Kent, Washington; then the location of the final assembly is Kent, Washington.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of regional materials/products and showing their cost, percentage of regional components, distance from project to manufacturer, and the total cost of all materials for the project.

Potential Technologies & Strategies

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed.

1 Point
in addition to
MR 5.1

Regional Materials: 50% extracted regionally

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements

Of the regionally manufactured materials documented for MR Credit 5.1, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of regional materials/products and showing their cost, percentage of regional components, distance from project to manufacturer, and the total cost of all materials for the project.

Potential Technologies & Strategies

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed.

Rapidly Renewable Materials

1 Point

Intent

Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

Requirements

Use rapidly renewable building materials and products (made from plants that are typically harvested within a ten-year cycle or shorter) for 5% of the total value of all building materials and products used in the project.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of rapidly renewable products. Show their cost and percentage of rapidly renewable components, and the total cost of all materials for the project.

Potential Technologies & Strategies

Establish a project goal for rapidly renewable materials and identify materials and suppliers that can achieve this goal. Consider materials such as bamboo flooring, wool carpets, straw board, cotton batt insulation, linoleum flooring, poplar OSB, sunflower seed board, wheatgrass cabinetry and others. During construction, ensure that the specified rapidly renewable materials are installed.

1 Point

Certified Wood

Intent

Encourage environmentally responsible forest management.

Requirements

Use a minimum of 50% of wood-based materials and products, certified in accordance with the Forest Stewardship Council's Principles and Criteria, for wood building components including, but not limited to, structural framing and general dimensional framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers.

Submittals

- ❑ Provide the LEED Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing the FSC-certified materials and products used. Include calculations demonstrating that the project incorporates the required percentage of FSC-certified materials/products and their cost together with the total cost of all materials for the project. For each material/product used to meet these requirements, provide the vendor's or manufacturer's Forest Stewardship Council chain-of-custody certificate number.

Potential Technologies & Strategies

Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.

Indoor Environmental Quality

SS | WE | EA | MR | **EQ** | ID

Prerequisite 1

Minimum IAQ Performance

Required

Intent

Establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, thus contributing to the comfort and well-being of the occupants.

Requirements

Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality, and approved Addenda (see ASHRAE 62-2001, Appendix H, for a complete compilation of Addenda) using the Ventilation Rate Procedure.

Submittals

❑ Provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring that the project is fully compliant with ASHRAE 62-1999 and all published Addenda and describing the procedure employed in the IAQ analysis (Ventilation Rate Procedure).

Potential Technologies & Strategies

Design the HVAC system to meet the ventilation requirements of the referenced standard. Identify potential IAQ problems on the site and locate air intakes away from contaminant sources.

Required

Environmental Tobacco Smoke (ETS) Control

Intent

Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).

Requirements

Zero exposure of non-smokers to ETS by EITHER:

- prohibiting smoking in the building and locating any exterior designated smoking areas away from entries and operable windows;

OR

- providing a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, enclosed with impermeable deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least 7 PA (0.03 inches of water gauge).
- Performance of the smoking rooms shall be verified by using tracer gas testing methods as described in the ASHRAE Standard 129-1997. Acceptable exposure in non-smoking areas is defined as less than 1% of the tracer gas concentration in the smoking room detectable in the adjoining non-smoking areas. Smoking room testing as described in ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.

Submittals

❑ Provide the LEED Letter Template, signed by the building owner or responsible party, declaring that the building will be operated under a policy prohibiting smoking.

OR

❑ Provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring and demonstrating that designated smoking rooms are exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, enclosed with impermeable deck-to-deck partitions, operated at a negative pressure compared with the surrounding spaces of at least 7 PA (0.03 inches of water gauge), and performance has been verified using the method described in the credit requirements.

Environmental Tobacco Smoke (ETS) Control

Required

(continued)

Potential Technologies & Strategies

Prohibit smoking in the building or provide separate smoking rooms with isolated ventilation systems.

SS	WE	EA	MR	EQ	ID
Credit 1					

1 Point

Carbon Dioxide (CO_2) Monitoring

Intent

Provide capacity for indoor air quality (IAQ) monitoring to help sustain long-term occupant comfort and well-being.

Requirements

Install a permanent carbon dioxide (CO_2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments. Refer to the CO_2 differential for all types of occupancy in accordance with ASHRAE 62-2001, Appendix D.

Submittals

❑ Provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring and summarizing the installation, operational design and controls/zones for the carbon dioxide monitoring system. For mixed-use buildings, calculate CO_2 levels for each separate activity level and use.

Potential Technologies & Strategies

Design the HVAC system with carbon dioxide monitoring sensors and integrate these sensors with the building automation system (BAS).

Ventilation Effectiveness

1 Point

Intent

Provide for the effective delivery and mixing of fresh air to support the safety, comfort and well-being of building occupants.

Requirements

For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (Eac) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy.

Submittals

❑ For mechanically ventilated spaces: provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring that the design achieves an air change effectiveness (Eac) of 0.9 or greater in each ventilated zone. Complete the table summarizing the air change effectiveness achieved for each zone.

OR

❑ For mechanically ventilated spaces: provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring that the design complies with the recommended design approaches in ASHRAE 2001 Fundamentals Chapter 32, Space Air Diffusion.

OR

❑ For naturally ventilated spaces: provide the LEED Letter Template, signed by the mechanical engineer or responsible party, declaring that the design provides effective ventilation in at least 90% of each room or zone area in the direction of airflow for at least 95% of hours of occupancy. Include a table summarizing the airflow simulation results for each zone. Include sketches indicating the airflow pattern for each zone.

Potential Technologies & Strategies

Design the HVAC system and building envelope to optimize air change effectiveness. Air change effectiveness can be optimized using a variety of ventilation strategies including displacement ventilation, low-velocity ventilation, plug-flow ventilation such as under floor or near floor delivery, and operable windows. Test the air change effectiveness of the building after construction.

SS | WE | EA | MR | **EQ** | ID

Credit 3.1

1 Point

Construction IAQ Management Plan: During Construction

Intent

Prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building as follows:

- During construction meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, Chapter 3.
- Protect stored on-site or installed absorptive materials from moisture damage.
- If air handlers must be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill, as determined by ASHRAE 52.2-1999.
- Replace all filtration media immediately prior to occupancy. Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-1999 for media installed at the end of construction.

Submittals

❑ Provide the LEED Letter Template, signed by the general contractor or responsible party, declaring that a Constuction IAQ Management Plan has been developed and implemented, and listing each air filter used during construction and at the end of construction. Include the MERV value, manufacturer name and model number.

AND EITHER

❑ Provide 18 photographs—six photographs taken on three different occasions during construction—along with identification of the SMACNA approach featured by each photograph, in order to show consistent adherence to the credit requirements

OR

❑ Declare the five Design Approaches of SMACNA IAQ Guideline for Occupied Buildings under Construction, 1995, Chapter 3, which were used during building construction. Include a brief description of some of the important design approaches employed.

Construction IAQ Management Plan: During Construction — 1 Point

(continued)

Potential Technologies & Strategies

Adopt an IAQ management plan to protect the HVAC system during construction, control pollutant sources and interrupt contamination pathways. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile and gypsum wall board.

SS | WE | EA | MR | **EQ** | ID

Credit 3.2

1 Point

Construction IAQ Management Plan: Before Occupancy

Intent

Prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase as follows:

- After construction ends and prior to occupancy conduct a minimum two-week building flush-out with new Minimum Efficiency Reporting Value (MERV) 13 filtration media at 100% outside air. After the flush-out, replace the filtration media with new MERV 13 filtration media, except the filters solely processing outside air.

OR

- Conduct a baseline indoor air quality testing procedure consistent with the United States Environmental Protection Agency's current *Protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445*.

Submittals

❑ Provide the LEED Letter Template, signed by the architect, general contractor or responsible party, describing the building flush-out procedures and dates.

OR

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the referenced standard's IAQ testing protocol has been followed. Include a copy of the testing results.

Potential Technologies & Strategies

Prior to occupancy, perform a two week building flush-out or test the contaminant levels in the building.

Low-Emitting Materials: Adhesives & Sealants

1 Point

Intent

Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, AND all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, listing the adhesives and sealants used in the building and declaring that they meet the noted requirements.

Potential Technologies & Strategies

Specify Low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section where adhesives and sealants are addressed.

SS | WE | EA | MR | **EQ** | ID

Credit 4.2

1 Point

Low-Emitting Materials: Paints and Coatings

Intent

Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

VOC emissions from paints and coatings must not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, listing all the interior paints and coatings used in the building that are addressed by Green Seal Standard GS-11 and stating that they comply with the current VOC and chemical component limits of the standard.

Potential Technologies & Strategies

Specify Low-VOC paints and coatings in construction documents. Ensure that VOC limits are clearly stated in each section where paints are addressed.

Low-Emitting Materials: Carpet

1 Point

Intent

Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

Carpet systems must meet or exceed the requirements of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, listing all the carpet systems used in the building and stating that they comply with the current VOC limits of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program.

Potential Technologies & Strategies

Specify Low-VOC carpet products and systems in construction documents. Ensure that VOC limits are clearly stated where carpet systems are addressed.

SS | WE | EA | MR | **EQ** | ID

Credit 4.4

1 Point

Low-Emitting Materials: Composite Wood

Intent

Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

Composite wood and agrifiber products must contain no added urea-formaldehyde resins.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, listing all the composite wood products used in the building and stating that they contain no added urea-formaldehyde resins.

Potential Technologies & Strategies

Specify wood and agrifiber products that contain no added urea-formaldehyde resins.

Indoor Chemical & Pollutant Source Control

1 Point

Intent

Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality.

Requirements

Design to minimize pollutant cross-contamination of regularly occupied areas:

- Employ permanent entryway systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways.
- Where chemical use occurs (including housekeeping areas and copying/printing rooms), provide segregated areas with deck to deck partitions with separate outside exhaust at a rate of at least 0.50 cubic feet per minute per square foot, no air re-circulation and maintaining a negative pressure of at least 7 PA (0.03 inches of water gauge).
- Provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, declaring that:

- Permanent entryway systems (grilles, grates, etc.) to capture dirt, particulates, etc. are provided at all high volume entryways.
- Chemical use areas and copy rooms have been physically separated with deck-to-deck partitions; independent exhaust ventilation has been installed at 0.50 cfm/square foot and that a negative pressure differential of 7 PA has been achieved.
- In spaces where water and chemical concentrate mixing occurs, drains are plumbed for environmentally appropriate disposal of liquid waste.

Potential Technologies & Strategies

Design separate exhaust and plumbing systems for rooms with contaminants to achieve physical isolation from the rest of the building. Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building.

SS | WE | EA | MR | **EQ** | ID

Credit 6.1

1 Point

Controllability of Systems: Perimeter Spaces

Intent

Provide a high level of thermal, ventilation and lighting system control by individual occupants or specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements

Provide at least an average of one operable window and one lighting control zone per 200 square feet for all regularly occupied areas within 15 feet of the perimeter wall.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, demonstrating and declaring that for regularly occupied perimeter areas of the building a minimum of one operable window and one lighting control zone are provided per 200 square feet on average.

Potential Technologies & Strategies

Design the building with occupant controls for airflow, temperature and lighting. Strategies to consider include lighting controls, task lighting and operable windows.

Controllability of Systems: Non-Perimeter Spaces — 1 Point

Intent

Provide a high level of thermal, ventilation and lighting system control by individual occupants or specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements

Provide controls for each individual for airflow, temperature and lighting for at least 50% of the occupants in non-perimeter, regularly occupied areas.

Submittals

❑ Provide the LEED Letter Template, signed by the architect or responsible party, demonstrating and declaring that controls for individual airflow, temperature and lighting are provided for at least 50% of the occupants in non-perimeter, regularly occupied areas.

Potential Technologies & Strategies

Design the building with occupant controls for airflow, temperature and lighting. Strategies to consider include task lighting and underfloor HVAC systems with individual diffusers.

SS	WE	EA	MR	EQ	ID
Credit 7.1					

1 Point

Thermal Comfort: Compliance with ASHRAE 55-1992

Intent

Provide a thermally comfortable environment that supports the productivity and well-being of building occupants.

Requirements

Comply with ASHRAE Standard 55-1992, Addenda 1995, for thermal comfort standards including humidity control within established ranges per climate zone. For naturally ventilated buildings, utilize the adaptive comfort temperature boundaries, using the 90% acceptability limits as defined in the California High Performance Schools (CHPS) Best Practices Manual, Appendix C – A Field Based Thermal Comfort Standard for Naturally Ventilated Buildings, Figure 2.

Submittals

❑ For mechanically ventilated spaces: provide the LEED Letter Template, signed by the engineer or responsible party, declaring that the project complies with ASHRAE Standard 55-1992, Addenda 1995. Include a table that identifies each thermally controlled zone, and that summarizes for each zone the temperature and humidity control ranges and the method of control used.

OR

❑ For naturally ventilated spaces: provide the LEED Letter Template, signed by the engineer or responsible party declaring that the project complies with the 90% acceptability limits of the adaptive comfort temperature boundaries in the California High Performance Schools (CHPS) Best Practices Manual Appendix C – A Field Based Thermal Comfort Standard for Naturally Ventilated Buildings, Figure 2.

Potential Technologies & Strategies

Establish temperature and humidity comfort ranges and design the building envelope and HVAC system to maintain these comfort ranges.

Thermal Comfort: Permanent Monitoring System

1 Point
in addition to
EQ 7.1

Intent

Provide a thermally comfortable environment that supports the productivity and well-being of building occupants.

Requirements

Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and the effectiveness of humidification and/or dehumidification systems in the building.

Submittals

❑ Provide the LEED Letter Template, signed by the engineer or responsible party, declaring that a permanent temperature and humidity monitoring system will operate throughout all seasons to permit control of the building zones within the seasonal thermal comfort ranges defined in ASHRAE 55-1992, Addenda 1995. Confirm that the temperature and humidity controls were (or will be) tested as part of the scope of work for Energy and Atmosphere Prerequisite 1, Fundamental Building Systems Commissioning. Include the document name and section number where the commissioning work is listed.

Potential Technologies & Strategies

Establish temperature and humidity comfort ranges and design the building envelope and HVAC system to maintain these comfort ranges. Install and maintain a temperature and humidity monitoring system in the building to automatically adjust building conditions as appropriate.

SS | WE | EA | MR | **EQ** | ID

Credit 8.1

1 Point

Daylight and Views: Daylight 75% of Spaces

Intent

Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements

Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks. Spaces excluded from this requirement include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits.

Submittals

❑ Provide the LEED Letter Template signed by the architect or responsible party. Provide area calculations that define the daylight zone and provide prediction calculations or daylight simulation.

Potential Technologies & Strategies

Design the building to maximize interior daylighting. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high performance glazing and photo-integrated light sensors. Predict daylighting via calculations or model daylighting strategies with a physical or computer model to assess footcandle levels and daylight factors achieved.

Daylight and Views: Views for 90% of Spaces — 1 Point

Intent

Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements

Achieve direct line of sight to vision glazing for building occupants in 90% of all regularly occupied spaces. Examples of exceptions include copy rooms, storage areas, mechanical, laundry and other low occupancy support areas. Other exceptions will be considered on their merits.

Submittals

❑ Provide the LEED Letter Template and calculations describing, demonstrating and declaring that the building occupants in 90% of regularly occupied spaces will have direct lines of site to perimeter glazing. Provide drawings highlighting the direct line of sight zones.

Potential Technologies & Strategies

Design the building to maximize view opportunities.

SS | WE | EA | MR | EQ | **ID**

Credit 1

Innovation & Design Process

1-4 Points

Innovation in Design

Intent

To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Requirements

Credit 1.1 (1 point)	In writing, identify the **intent** of the proposed innovation credit, the proposed **requirement** for compliance, the proposed **submittals** to demonstrate compliance, and the **design approach** (strategies) that might be used to meet the requirements.
Credit 1.2 (1 point)	Same as Credit 1.1
Credit 1.3 (1 point)	Same as Credit 1.1
Credit 1.4 (1 point)	Same as Credit 1.1

Submittals

❑ Provide the proposal(s) within the LEED Letter Template (including intent, requirement, submittals and possible strategies) and relevant evidence of performance achieved.

Potential Technologies & Strategies

Substantially exceed a LEED performance credit such as energy performance or water efficiency. Apply strategies or measures that are not covered by LEED such as acoustic performance, education of occupants, community development or lifecycle analysis of material choices.

SS	WE	EA	MR	EQ	ID
Credit 2.1					

LEED Accredited Professional

1 Point

Intent

To support and encourage the design integration required by a LEED Green Building project and to streamline the application and certification process.

Requirement

At least one principal participant of the project team that has successfully completed the LEED Accredited Professional exam

Submittals

❑ Provide the LEED Letter Template stating the LEED Accredited Professional's name, title, company and contact information. Include a copy of this person's LEED Accredited Professional Certificate.

Potential Technologies & Strategies

Attending a LEED Accredited Professional Training Workshop is recommended but not required. Study the LEED Reference Guide. Successfully pass the LEED accreditation exam.