

Service Learning Project:
Green Roof at The Summit United Methodist Church
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Introduction

The purpose of this report is to provide information on various green roof systems, the maintenance involved, and how to secure funding for the implementation of a Green Roof at The Summit United Methodist Church.

We have done a site analysis, a client interview, and talked with various third party suppliers. As a group, we recommend no particular system, but can share learned facts that will help the owner make an educated decision.

Without a structural analysis to ensure the weight bearing load, it's assumed this green roof will be a non-accessible, extensive system which will be cost effective as well as meet the environmental objectives stated by Catherine Girves: energy efficiency and storm water management. Ms. Girves also requested the final report include a maintenance plan, pricing options and phases, and realistic means for grant funding.

We have outlined our written report to include:

1. General Benefits of a Green Roof
2. Benefits of comparable modular tray systems
 - a. Live Roof
 - b. Green Roof Block
 - c. Carlisle/Green Grid Systems
3. Maintenance Plan
4. Rainwater collection feature
5. Green Wall option
6. Cost
7. Alternatives to a green roof
8. Funding
9. References

1. General Benefits of a Green Roof

- Reduce summer air conditioning cost
- Reduce winter heat demand
- Reduce storm water runoff
- Community and volunteer outreach program
- Increase green space by up to 3000 sq ft (includes 250 sq ft of Green Wall)
- Reduce carbon dioxide impact
- Lengthen new roof life by 2-3 times
- Provide grey water storage
- Increased biodiversity

There are many benefits to constructing a green roof. These benefits affect maintenance and efficiency costs, community involvement, and the environment.

First, installing a green roof decreases the heating and cooling load required by the building. This is achieved by increasing the thermal resistance value of the roof and, in the summer, cooling the roof by evaporation. By reducing the heating and cooling load the building requires, utility costs will decrease.

Another benefit to building a green roof is that it more than doubles the life of the roofing membrane. This happens by protecting the membrane from harmful UV rays, punctures, and extreme temperature fluctuations that cause severe damage. By not having to replace the roofing membrane as often, reduces the building's maintenance cost significantly.

Green roofs effect the environment by reducing the amount of storm water runoff from a building's roof. The materials absorb the rain water and release it over the course of several hours. According to a Michigan State University study, the amount of water a green roof can retain is 60 to 100 percent of the storm water they receive. Also, the plants filter pollutants from the storm water, creating cleaner run off. Green roofs help support local wildlife by growing local plants.

By having a green roof, lost vegetative space is regained increasing the habitat areas of a neighborhood and encouraging biodiversity in an otherwise analogous environment.

By having community volunteers help in the construction and maintenance of the green roof, an outreach program can be implemented within the church. This will build a sense of pride within the neighborhood and feeling of self-worth in the volunteers.

Finally, the visual impact a green roof has on the building often increases the value of the property. Green roofs create an inviting atmosphere that also helps a non-residential property blend into the surroundings of a residential community better.

2. Benefits of comparable modular tray systems

Modular green roof systems provide much the same environmental, aesthetic and social benefits as traditional benefits. For instance, green roofs can reduce the urban heat island effect that results from solar radiation being absorbed by dark surfaces decreasing the lifespan of a roof, decrease HVAC system efficiency and overall air quality; reduce storm water runoff, which causes local flooding and soil erosion, by 90% or more annually; has the potential of reducing indoor noise by 40 decibels, which would provide noticeable sound reduction of aircraft, traffic or rainfall (moderate rainfall ~50 dB). The primary benefit of modular systems over traditional green roofs is that they are inexpensive to install and can be relocated if roof maintenance is required, and require less site preparation.

The financial benefit possibilities, according to LiveRoof, include the cost savings of extending the life of a roof membrane by 200-300%, reducing indoor temperatures 6-8 degrees during warm/hot weather and decreasing air-conditioning costs by 25-50% in a single story building.

There are numerous modular green roof suppliers in the area; the following systems are simply recommendations to determine design options.

a. LiveRoof

LiveRoofs is unique among modular green roofs because they resemble traditional green roofs in that there are no visible grids. The vegetation by LiveRoofs is also advertised to stay greener, and fuller than many other systems throughout the year. While this design provides for a continuous appearance, the trays are easily separated if needed for roof maintenance. Continuous vegetation also absorbs more water and prevents any UV radiation from damaging the underlying roof media (Prevegetated).



The LiveRoof system also has various design options and features available such as elevated concrete walkways that could be installed for maintenance purposes, supplementary irrigation, roof edge for gutters and other drains. If after a structural analysis is performed it is determined the roof is only able to carry a limited load, the LiveRoof system is available in lite, standard and deep weighing 15-17psf, 27-29psf and 40-50psf fully saturated, respectively (Prevegetated).

According to the LiveRoof sales representative for Franklin County, some site preparation will be required before installation. In addition to the existing roof, an additional membrane is required to protect the existing roof during installation and provide a root barrier. It is recommended that a 0.045 EPDM rubber membrane be used (Cartell). According to an online rubber sheeting supplier rubber sheeting could add an additional \$1/sf to the cost of the system (Rubber). The remainder of the system including installation would cost approximately \$18-\$22/sf (Cartell). This would translate to a total project cost of approximately \$19,836-\$24,012 for stage 1 and \$30,400-\$36,800 for stage 2.

Maintenance for LiveRoof is minimal, which is common for many green roof systems. Annual maintenance primarily consists of soil testing and fertilization, which includes maintaining appropriate pH of 6.5 to 8.0 and applying fertilizer at 20lb per 1000sf. Seasonal watering may also be required during hot weather such that the roof receives sufficient water when there is less than 1" of rainfall over 2 to 4 weeks of temperatures greater than 75 degrees F. The manufacturers are not specific on the amount or frequency of watering because necessity is case

by case. During Spring and Fall growing seasons, regular weeding, approximately every 2 weeks, to prevent weeds or trees from becoming abundant and releasing seeds, and trash and leaves from smothering the plants. Pesticides and deicing agents are strongly discouraged, while mowing is acceptable to maintain 2" of vegetation growth. Total maintenance is expected to cost approximately \$0.15 to \$0.30 psf annually and are expected to behave much like living mulch.

According to the LiveRoof sales representative for Franklin County, The Franklin County Courthouse is installing a LiveRoof vegetated roof in Spring 2010. While, design specification and costs associated with this project have not yet been obtained, this project would be a good reference for further cost and benefits analysis.

b. Green Roof Blocks

Green Roof Blocks offer a traditionally simple system. Prevegetated, the Green Roof Blocks are 2'x2' aluminum trays, as well as custom shapes, that are simply placed on rubber feet directly onto the roof. The rubber feet are purchased from the specific manufacturer of the roof system and are advertised as being compatible and not affect any roof warranty. The main advantage of this system is the flexibility and maneuverability for system maintenance, and is advertised as able to be installed by anybody (Green).

The Green Roof Block system also comes in a range of sizes, available in depths of 4", 8" and 12" to accommodate a variety of vegetations. The weight of this system is approximately 17psf, 34psf, and 51psf respectively. Performing a cost analysis of this system, the total cost of production, shipping and installation of this product is approximately \$25psf. The Green Roof Block System has been determined to extend the life of a roof by 200-300 % and have an expected life span of 65yrs (Green).

Maintenance of Green Roof Blocks are similar to LiveRoofs in that regular soiling testing, watering, weeding and trash removal are required during specific times of the year. While no specific data is available, maintenance procedures and costs are expected to be comparable to LiveRoof.

While the cost of modular systems may be somewhat of a turnoff, the flexibility of these systems is their greatest advantage. An alternative to installing a green roof on the entire roof would be to install any one of these systems in localized areas on the roof such as surrounding air conditioning or near windows.

c. Carlisle's GreenGrid System

Although Carlisle has a number of green roof systems, their modular/tray GreenGrid product appears to be the most appropriate for this application. Installation of the GreenGrid system consists of Carlisle Protection Fabric (CCW-200V) placed directly on to the existing membrane roof, followed by placement of the 24"x 48" or 24" x 24" preplanted, modular trays in the predetermined layout.

When the existing Carlisle SynTec Roofing System was first installed, it should have been accompanied by a manufacturer and installer *warranty*. If there are many years remaining on

that warranty, it is important that nothing is done to *void* it. However, Carlisle promotes the installation of Green Roof Gardens and, in fact, has their own proprietary systems, which they will warrant. Nevertheless, any green roof system selected to install must not impact the warranty provisions.

NOTE: It is believed the existing Carlisle roof is more than 15 years old, in which case a new roofing membrane application would need to be applied before putting this or any other green roof system on the roof. An Existing Carlisle warranty would be void if you were to install a green roof as is.

3. Basic Maintenance Plan

Routine maintenance during the 24-month establishment period is intended to insure survival of the vegetated cover and promote the development of robust and durable ground cover. (Establishment period will be less with pre-vegetated modular trays like Live Roof). It is not guaranteed that the vegetated cover will remain weed free or that all plantings will remain constant in appearance. Supplemental maintenance may be provided to satisfy the aesthetic requirements for this project. Supplemental services, if any, shall be outlined in a Green Roof Maintenance Agreement with the service contractor.

The specific recommendations of the Maintenance Plan are as follows:

a. Watering

The plants selected for a project should be drought tolerant. In fact, growing conditions for these plants will be optimum when they are exposed to episodes of media desiccation. By keeping the surface of the media dry, it will also be easier to minimize the germination of weed seeds. The media is intended to optimize the use of applied rainfall. Periodic hand watering during the establishment period may be advisable, and will be conducted at the discretion of the service contractor. Following establishment of the cover, further irrigation is discouraged. However, in conditions of sustained drought, hand watering may be undertaken at the discretion of the service provider. Frequent watering will be detrimental to the vegetated cover.

b. Fertilization

Regular fertilization of the green roof is recommended. Soil tests should be conducted each spring in order to assess plant nutritional requirements. The nutrient applications should be made in early spring and fall. Optimal soluble nitrogen levels (nitrate plus ammonium) are 1 to 5ppm. Over-fertilization can seriously disturb the green roof. [Typical nutrient applications for this type of green roof are two pounds per 1,000 square feet, using 90-day release 14-14-14 fertilizer, e.g., Osmacote® or Meister®].

c. Gardening

Two or three maintenance trips each year should be sufficient. During the 24-month establishment period a total of six visits are recommended. The principal activity will occur in mid spring and late fall, when conditions are conducive to weed germination and establishment. Thorough weed removal at these times is required. Periodic additional weeding, while not necessary, may be conducted. However, weeding more frequently than once every two months is not recommended. Excessive weeding, and the resulting foot traffic and disruption of the cover, may prove detrimental.

Patches of bare media may be covered by distributing cuttings taken from adjacent plants or by separating and transplanting healthy plants. Sedum cuttings should be at least one-inch long and should preferably include some 'air roots.' Cuttings will set best in the early spring and late fall, but can be planted at any time except when the temperature is below freezing. A light dusting of compost may accelerate growth.

Weeding should be by hand pruning or, as appropriate, chemical weeding. Immature extensive green roofs are particularly vulnerable to colonization by annual grass, especially crabgrass. A pre-emergent crabgrass treatment may be advised. Under no circumstance shall the following proscribed activities be undertaken:

- Digging or use of pointed or sharpened tools (i.e., trowels, shovels, spades, weeders, hand cultivators, etc.)
- Use of lawn staples or stakes for any purpose, including the tethering of tarps or erosion mats
- Mowing or scything

If there is any concern that damage has been done to the underlying waterproofing system as result of maintenance activities, report the nature of the event to the Installer with 24 hours.

d. Traffic

This roof is not designed for pedestrian access. Foot traffic associated with maintenance activities should be kept to a minimum.

e. Winter Maintenance

All plant varieties in the cover system are winter hardy. No special requirements apply to winter protection.

f. Drainage

As part of each maintenance visit, the drain outlets (scuppers) should be inspected to make certain that they are free from clogging or obstructions. Correct any problems and report them to your Installer. Evidence of periodic pooling of water following rainfall events or of surface runoff across the surface of the cover should be immediately reported.

g. Waterproofing

During each maintenance visit, examine exposed components of the waterproofing system,

including flashings and counter-flashings.

h. Herbicides or Pesticides:

Herbicides and/or pesticides that are not approved in advance by the installer may not be applied to the green roof.

4. Rainwater collection system

As a part of this green roof project, we have decided to incorporate a rainwater collection system. After researching a little about collection systems on the web, a decision to go with a 305 gallon tank was made. The tank is forty-six inches in diameter, forty-nine inches in height, and has an empty weight of sixty-four pounds. The tank is originally priced at \$315 per unit, but is on sale right now for \$206.

The tank specs can be found at <http://www.watertanks.com/products/0005-005.asp>.

The square footage of the building is approximately 1700 SF. A 1000 SF area with one inch of rainwater is approximately 623 gallons of water. The average rainfall in Ohio is 37 inches per year. For the sake of safe calculations, it can be assumed that an average of one inch of rainwater will be present throughout the year to be collected into the rainwater tanks. With a 1700 SF area that's approximately 1060 gallons of water at anytime. With 305 gallons per unit, 4 tanks will be required to hold the optimum amount of water to be used on the roof.

The tank weighs sixty-four pounds empty. Water weighs approximately 8.35 pounds per gallon. At 305 gallons, each tank would weigh 2610 pounds. ($305\text{gal} \times 8.35\text{lbs/gal} = 2546\text{lbs}$, + 64lbs = 2610lbs). With four tanks that's 10,440lbs total weight. It would be recommended that an engineer calculate how much weight can be added to the structure of this building. Another recommendation would be that the tanks would be installed on the ground, and have pumping systems that would carry it back onto the roof to irrigate the green roof system.

5. Green Walls

A green wall is beneficial in many ways. Similar to a green roof, it will reduce heating and cooling costs, add biodiversity, and increase aesthetics. It can also decrease the amount of storm water runoff, depending on the type of system. The wall we are proposing to be a living wall is a south facing wall that goes from the first story roof to the second story roof. It is visible from a set of windows in a meeting room upstairs. The green wall can provide for a better view from this room.

There are many options for a green wall. Here are a couple for consideration. Please refer to the attached brochures for additional information.

a. G-Sky Green Wall Panels, www.g-sky.com/GreenWallPanels.aspx

The G-Sky system is similar to a modular live roof system. The growing medium comes in modular trays that hang on mounting strips that are attached to the wall. The trays can be

removed for easy wall maintenance. A wide variety of plants can be provided. A drip irrigation system is used for watering, when necessary. The system can use reclaimed water and collect the water that drains through to the bottom, so none is wasted. This system, because of the growing medium, can hold more storm water runoff than trellis systems, but will be much heavier to mount to the walls.

b. Green Screen, www.greenscreen.com

Green Screen is a wire trellis system. The plants are planted at the base of the wall and climb up the trellis. Therefore, the choice of plant material is smaller. The trellis comes in modular units that mount to the wall with clips in a grid system. The trellis can also be freestanding. Since the plants are at the base of the wall, irrigation, when necessary, is much easier and can be integrated into the green roof irrigation system. However, a larger amount of growing medium is required at the base of the trellis system which can produce structural issues. The cost is \$9 - \$12 per square foot installed, not including the plants. (If the wall is 20' wide x 12' tall, the total cost would be \$2160 - \$2880.)

6. Cost

To reduce the initial investment, and allow additional time while new funding sources are established, it is recommended that the green roof system be divided into a multi- or bi-stage process. As illustrated by Figure 1, the roof was divided into two regions to be completed when funding is available.

The region highlighted in yellow is approx. 1160sf, with 10% of that area reserved for mechanical equipment. This area is suggested as the first stage because it has to

potential of providing the greatest benefit. As explained earlier, one of the greatest benefits of a green roof system is the reduced heat island effect that reduces the cooling efficiency of air conditioning equipment. By reducing the ambient air temperature on the roof during warm/hot weather, cooling systems are required to run less frequently and for as long.

Stage 2 of this project is recommended to cover the remainder of the first story roof, highlighted by red. The total area of this region is approximately 1600sf. The primary benefits that this project will provide will be increased energy efficiency, noise, storm water and visual qualities of the roof and the offices located beneath.



Figure 1: Proposed stage regions.

Approximate cost per square foot:

1. Modular
 - a. Live Roof- \$20/ sq ft
 - b. Green Roof Blocks - \$25/sq ft
 - c. Green Grid System (Carlisle) \$12.50 to \$ 13.00 per sq.ft
2. Conventional
 - a. Tremco - \$15-25/sq ft
 - b. Greenscapes - \$8 - \$10 per sq. ft
3. Green Wall - \$9-\$12 per sq ft
4. G-Sky wall system \$100 or more per square foot
5. Leak detection - Electronic Vectormapping \$0.75 per sq ft
6. (4) x 305 gallon water cisterns - approx. \$824 (\$206 each)
7. Reflective roof ranges from \$0.75 to \$3.00 per square foot

7. Green Roof Alternatives

Green roofs are a great way to cut cooling cost, provide extra insulation, and extend the life of a flat roof system; however they can be prohibitively expensive. When the financing is available to create a vegetative roof it is the best option because it also manages storm water run-off as well as reducing the amount of carbon dioxide in the air.

Green roofs are in a category known in the roofing industry as cool roofing. The three categories of cool roofs all work with your building to help keep your building cool in the summer. The three categories include: roofs made from cool roofing materials, coated roofs, and green or planted roofs.

For this style of project a coated roof would be the second best option if the funding for the green roof does not come through. A reflective roof coating would be applied to your existing roof and would greatly reduce the solar heat gain on your roof. The coating could even lower roof temperatures by up to 80 degrees Fahrenheit, which would have a large impact on cooling cost.

How it works

A reflective roof coating is a monolithic, fully adhered, fluid applied membrane that has elastic properties that allow it to stretch and move with the changing weather without damage. The reflective coating effectively reduces the roof heat by reflecting the sun's radiant energy back into space. It acts as a mirror for your roof, which keeps the building cool and lets you achieve a more constant temperature and comfort level inside the building.

Solar reflectance is the most important characteristic of a roof in terms of yielding the highest energy savings during the summer months. The higher the solar reflective value, the more efficient the product will reflect the sunlight and keep heat away from the building. A properly applied light or white colored roof coating can reflect 80% of the sun's rays.

Reflective coating Cost

The cost for a reflective coating can vary from \$0.75 to \$3.00 per square foot, which includes both materials and installation. They are inexpensive, easy to apply, and require little maintenance. The roof coating will lose some of its reflectance over time due to dust so an occasional cleaning and reapplication is the small amount of maintenance required.

8. Funding

- a. United Methodist Women – A Brighter Future for Children and Youth: \$4000
<http://new.gbgm-umc.org/umw/money/grants/abrighterfuture/>
- b. United Methodist Global Ministries – Outreach to Meet Human Needs: up to \$10,000
http://archives.umc.org/frames.asp?url=http%3A//gbgm-umc.org/mission_programs/cim/
- c. Tomorrow's Leaders II Scholarship Program and Recruitment: \$500,000- \$1,000,000
 - Application due Jan. 5, 2010
<http://www07.grants.gov/search/search.do;jsessionid=mLLMLW0PjtNDQjwLZc42dnT2G2Q71pxcK1LOFNK62Z0tnYvw4YGB!-1299818899?oppId=50028&mode=VIEW>
- d. Ethnic Local Church Concerns (ELLC)

http://www.umc-gbcs.org/site/c.frLJK2PKLqF/b.3743753/k.9116/GBCS_Grants/apps/ka/ct/contactus.asp?c=frLJK2PKLqF&b=3743753&en=9hIOIXOvFbKSJYOwHcJOIUOvGhKUL6MIKeKVK9PGJgKYJcPUG
- e. EPA Environmental Education Grants -- Solicitation Notice for 2010
 - Application Due Dec 15, 2009
<http://www07.grants.gov/search/search.do;jsessionid=3x1hLW2JrWxvvgwggFyH3KXjhhJnTVB3G73gvB78XbvzbCZwFfgl!-1299818899?oppId=50030&mode=VIEW>
- f. EPA 7th Annual P3 Awards: A National Student Design Competition for Sustainability Focusing on People, Prosperity and the Planet
 - Application due Jan 4, 2010
<http://www07.grants.gov/search/search.do;jsessionid=3x1hLW2JrWxvvgwggFyH3KXjhhJnTVB3G73gvB78XbvzbCZwFfgl!-1299818899?oppId=49242&mode=VIEW>

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< <http://www.greengridroofs.com/greenroofs.htm>>
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<<http://www.greenroofblocks.com>>.
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[http://www.hrt.msu.edu/greenroof/#Benefits of green roofs](http://www.hrt.msu.edu/greenroof/#Benefits_of_green_roofs)
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<<http://www.asha.org/public/hearing/disorders/noise.htm>>.
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<<http://www.liveroof.com/>>.
7. Rubber Sheet Roll. 27 Nov. 2009
<<http://rubbersheetroll.com>>
8. LiveRoof Sales Representative for Franklin County:

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