Greenroofs:
A Proposal for the University of Maryland

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Cover Photo: Greenroof on the City Hall Building in Chicago Illinois
1. Introduction

1.1. Overview

1.1.1. The Problems of Urbanization

As the world population grows and cities around the world expand, the environment is forced to pay a heavy price. Open spaces and undisturbed land are being sealed with concrete and asphalt and as a result there is an increase in storm water pollution and runoff. Also, in cities, dark rooftops and pavement absorb and store the sun’s energy during the day and reflect it at night. According to a CNN article, “during the summer months, the temperature of a conventional flat roof can soar up to 140 degrees Fahrenheit—hot enough to fry an egg.” This is leading to what is know as the urban heat island effect—rising temperature differences between urban and green spaces.

This is affecting the planet on a global scale. In 2001, Time magazine reported that the global mean temperature is expected to rise between 2.5 and 10.4 degrees in the next 100 years. Also in 2001, the UN weather agency reported that the Earth’s average temperature for that year was the second highest on record since the records began 140 years ago. Not only is the planet getting warmer as a result, in part, of hot flat city roofs, but it is also hard to keep these buildings cool resulting in an increased demand for energy.

1.1.2. Greenroofs as a Solution

One way that we can help curb many of these problems is by converting flat conventional roofs into greenroofs. Often referred to as rooftop gardens, a greenroof is a type of roof cover that replaces typical roofing options such as tiles, shingles or gravel with a living, vegetative space. A greenroof is made up of a waterproofing layer, soil and plants. They are designed to contrast non-porous roof choices by using what is usually considered forgotten space to extend roof life, improve building aesthetics, absorb and filter rainwater, reduce ambient air temperature and cut energy and utility costs. According to greenroofs.com, greenroofs could “potentially [be the] ideal architectural union of aesthetics, economics and ecology.”

1.1.3. Proposal

The purpose of this proposal is to recommend designing a project at the College Park campus of the University of Maryland which would create a greenroof on the North Woods dining hall. Although one greenroof may not be enough to significantly curb the detrimental effects of urbanization, this would be a step in the right direction. As its status as one of the top twenty research universities in the country, a greenroof project at the University of Maryland would carry significant weight in the research community. Thus, learning more about the benefits of greenroofs would be truly helpful in sparking an interest in greenroofs in surrounding areas.
1.2. History of Greenroofs

1.2.1. Greenroofs Then

The integration of plants and architecture is a concept that has been around since recorded times. The earliest representations of greenroofs exist in the Fabled Hanging Gardens of Babylon. These gardens are thought to have been built between the eighth and tenth centuries B.C. Greek geographer Strabo wrote that gardens wrote “consisted of vaulted terraces raised one above the other, and resting upon cube-shaped pillars. These [were] hollow and filled with earth to allow trees of the largest sizes to be planted.”

There has also been evidence found of tree and shrub covered sloped walls in designs of ziggurats—temples common in the Mesopotamian valley built around 2100 BC.

Also, Earth-sheltered huts dating from the Viking era which have been found in England and Ireland and sod covered roofs which were used in Iceland and Scandinavia around 1000 A.D are other examples of age old greenroofs.

Grass roofs were introduced in Canada and the US by early 19th century settlers. In more recent times, modernist architects such as Frank Lloyd Wright and Le Corbusier incorporated greenroofs into their designs and talked of their benefits.
1.2.2. Greenroofs Now

Today, greenroofs are gaining popularity in Europe and around the world. Germany has taken the lead in the movement of greenroof development as “there, greenroofs have evolved through trial and error, the repeated testing of materials, and ultimately the development of industry standards and codes.” Currently, it is estimated that Germany has over 800 greenroof projects.\textsuperscript{12}

*Figure 3 Greenroof on Chicago’s City Hall*\textsuperscript{13}  

With the development of new waterproofing and root barrier technology, acceptance of greenroofs spread to the larger European marketplace. In the 90s, these technologies began to make their move across the Atlantic and since then, greenroof technology has been gaining popularity in the US.\textsuperscript{14}

As greenroofs become more and more popular, new technologies are being designed to make greenroof projects easier and more successful. There are companies of all different kinds who specialize in greenroof products. One company, Elevated Landscape Technologies produces a pre-grown greenroof system. Their product also incorporates the waterproofing and root barrier membrane as well as the storm water retention system. They claim that their system is lightweight, easy to install and customizable.\textsuperscript{15} Technologies like these are making it easier and more feasible for builders to incorporate greenroofs into their designs as well as for individual homeowners to add their own greenroofs to their homes.

2. What is a Greenroof?

2.1. A Definition

Rooftops are often considered forgotten space but rather than ignoring this space and totally replacing the natural environment with the built environment, it is possible to intertwine the two “so that each can help sustain the other.”\textsuperscript{16} Often referred to as rooftop gardens, a greenroof is a type of roof cover that replaces typical roofing options such as tiles, shingles or gravel with a living, vegetative space. A greenroof can change a typical flat roof into a net producer of energy, clean water and air, as well as a part of a healthy human and biological community.\textsuperscript{17} Greenroofs are designed to contrast non-porous roof choices by using forgotten space to extend roof life, improve building aesthetics, absorb and filter rainwater, reduce ambient air temperature and cut energy and utility costs.
2.2. The Types of Greenroofs

There are two different types of greenroofs—intensive and extensive greenroofs.

2.2.1. Intensive Greenroofs

Intensive greenroofs are typically designed for recreational access. They are much heavier than extensive greenroofs and support a much wider variety of plants, shrubs and trees. They require a minimum of one foot of soil and require irrigation and regular maintenance. Intensive greenroofs add about 80 to 100 pounds per square foot of additional weight to the roof and so it is very important to ensure that the existing roof structure be modified to account for the extra weight.\textsuperscript{18}

\textbf{Figure 4} Intensive greenroof in Manhattan

2.2.2. Extensive Greenroofs

Extensive greenroofs on the other hand, are lightweight and only support the heartiest of plants. They have very low maintenance requirements and require no irrigation. Extensive greenroofs are not designed to be used as outdoor spaces and typically have access for maintenance only.\textsuperscript{19} The typical extensive greenroof incorporates between one and five inches of soil at the most. They are thus much lighter and can only support plants with limited root systems. In general they add about 15-50 pounds per square foot of additional load to the roof.\textsuperscript{20} Extensive greenroofs must be checked semi annually to look for invasive weeds, disease, stray tree seedlings, etcetera.\textsuperscript{21}

\textbf{Figure 5} ELT greenroof project in Harris, New York\textsuperscript{22}

This proposal will focus on the extensive greenroof.
2.3. Components of an Extensive Greenroof

A greenroof consists of:
- A waterproofing layer
- A drainage and filter layer
- Soil and
- Plants

Figure 6 Layers of a greenroof

2.3.1. Waterproofing Layer

The lowest layer of a greenroof is the waterproofing layer. This layer prevents water collected by the roof from penetrating the roof and leaking into the building on which the greenroof is planted. There are many options in terms of the best materials to use for the waterproofing layer.

Many of the oldest greenroofs achieved waterproofing through the use of mastic asphalt. According to greenroofs.com, mastic asphalt is composed of limestone aggregates which are bound together by the tar like substance bitumen to make a dense material. It is then spread on a roof surface to create a something that is fully waterproof and does not degrade as a result of weathering. Newer chemically engineered membranes are becoming more popular however. One such option is Ethylene Propylene Diene Monomer rubber (EPDM). EPDM is a single ply rubber membrane made up principally of ethylene and propylene containing compounds which form a flexible rubber matrix when a small amount of diene is added. This rubber matrix forms a waterproof seal on the rooftop in a way very similar to that of the mastic asphalt.

Depending on the type of waterproofing layer used, a root barrier may also be required. When an organic waterproofing layer is used, roots from the plant layer could attempt to penetrate the layer in search of water and nutrients. This would disrupt the integrity of the waterproofing layer. Root resistance can also be achieved by applying a laminated upper layer such as copper or by adding chemicals to the waterproofing layer.

Of all the layers of a greenroof, it is most imperative that the waterproofing layer is installed correctly. This is ensured by learning as much as possible about roofing
procedures before beginning a project and then by conducting a water permeability test immediately following the installation of the waterproofing layer. Companies such as Roofscapes Inc. perform waterproofing tests which will ensure that a complete seal has been made.\textsuperscript{28}

2.3.2. Drainage and Filter Layer

The next layer of the green roof is the drainage and filter layer. This layer is essential to carry away excess water collected by the roof as well as to filter impurities out of the collected rain water. The drainage layer is applied over the entire roof and works to direct water to water retention areas for long term water supply of the roof as well as to rainwater outlets. When rainwater passes through the other layers of the greenroof, it hits the drainage layer and enters channels which direct it to the rainwater outlets typically at the edges of the roof.

![Figure 8 Greenroof drainage materials graphic](image)

Often combined with the drainage layer is the filter layer. This layer is necessary to hold the soil layer in place and to prevent soil and debris from entering and clogging the drainage system. While permeable to water, the filter layer does not allow soil and other particles to pass through it. The filter layer is typically made up of lightweight polyester fiber mats which are relatively inexpensive and can be easily found at most home improvement stores.\textsuperscript{30}

2.3.3. Soil Layer

The next layer is the soil layer—the plant support layer. In addition to supporting the plant life on the greenroof, the soil layer also works to filter impurities out of the rainwater and thus serves to purify runoff as if the rain were falling on natural green space. In choosing the correct soil there are many options ranging from engineered factory mixes specifically designed for greenroofs to do-it-yourself mixes. Ordinary topsoil is not typically recommended for use on greenroofs because of the potential of introducing pathogens and weeds to the greenroof.

A typical mixture contains a soil native to the area made more greenroof friendly with organic and mineral additives such as peat, humus, woodchips, sand or expanded clay. Recommended proportions for greenroof soil are about 75-80\% inorganic matter such as expanded slate or crushed clay and then 20-25\% organic matter (humus and clean topsoil). These proportions should provide “essential drainage and soil air capacity, and sufficient organic nutrients for the shallow-rooted plants.”\textsuperscript{31} In terms of depth
requirements for the soil, the more shallow the layer, the higher the demand on the plants of the roof. Typically a depth of 3 inches is suggested for do-it-yourself homeowners who mix their own soil.

2.3.4. Plant Layer

Perhaps the most important layer of the greenroof is the vegetative plant layer. Selecting the plants to use in the project is crucial to the survival and effectiveness of the greenroof. Emory Knoll Farms, a leading supplier of plants for extensive greenroof systems, suggests plants that exhibit the following characteristics:

- Low growth height
- Rapid growth / spreading
- High drought tolerance
- Fibrous root as opposed to tap roots to protect roofing membranes
- No special irrigation or nutritional requirements
- Low maintenance - trimming, weeding, feeding
- Plants shouldn't generate airborne seeds in order to prevent the green roof plants invading other landscaping.

In most areas, plants should be low growing plants and capable of storing water for a long period of time. The most common plants used are succulents (plants with thick, fleshy, water-storing leaves or stems) and other low growing plants such as creeping thyme or phloxes. All of these adapt well to conditions with little soil, no water, high winds and sun exposure—the conditions of a greenroof.

![Figure 9](image-url) Different succulent types for use on greenroofs

Many of the factors affecting plants are related to the climate of the region in which the greenroof is being planted. For example, in an area where you get a frost, it is important that the soil layer is deep enough to protect roots from frost damage. To get a good idea of what plants to use it is advisable to check the USDA’s Hardiness Zone’s Map which indicates a plant’s tolerance for cold.
The American Horticultural Society has also done work on classifying plants based on where and in what conditions they grow best. They provide such information such as a Plant Heat Zone Map which divides the US into zones based on average number of days a year where the temperature gets above 85 degrees F and provides information on which plants thrive in which zones. Another good resource in searching for greenroof plants is to contact your local transportation or highway authority for information on the types of plants it plants in medians and along highways. These plants are typically native to the area and are capable of surviving with no irrigation, little maintenance, and in harsh conditions.

2.4. Maintenance of an Extensive Greenroof

In terms of maintenance, most of the maintenance for an extensive roof is required in the initial stages of the greenroofing process. Plants must be watered initially until they are fully established. Usually this means that they should be watered about once a week for about six months. Occasional weeding in the early stages is also required. Once the greenroof has been established, semiannual checks should be done to ensure that things are going well. Also, it is a good idea to use a slow release fertilizer twice a year to ensure that the plants are getting the required nutrients.

3. Why greenroofs?

3.1. Flat Roof Problems

When examined in the context of what makes a good roof, traditional flat roofs fail. As compared to sloped roofs, flat roofs have many more issues and cannot be considered good roofing options.

3.1.1. Sustainability

Flat roofs are not known to last very long and are certainly not known to last as long as a typical home. In fact, according to the roof contractor Schindler Roofing, “the notion of having to replace a flat roof on a commercial building every 10 years seems to be acceptable to most contractors, and therefore, building owners.”

One reason for their short life span is that, often, flat roofs must be installed using different roofing options than those used for traditional sloped roofs. Traditional shingle systems do not work on flat roofs. “Shingles work in conjunction with gravity to keep the inside of the building dry as water runs down the roof and over the top of shingles. Flat roofs need a gravity-proof roofing solution.”

To deal with this gravity-less scenario, flat roofs tend to use a material that can be poured or spread over the roof surface and create the effect of a single shingle—a continuous area that has few seams and no overlapping areas where water could leak in. Most of these flat roofing materials, such as asphalt, tarpaper or a tar and gravel mix, have relatively short life spans of ten to twelve years. This is compared to sloped roof options
such as asphalt shingles which can last thirty-five years and many well-made slate or metal roofs which can last a hundred to a hundred and fifty years.\textsuperscript{40}

This short life span is due in part to the coupling of the cheap materials with the stresses that roof systems face. As a flat roof is exposed to water it is constantly moving through a cycle of getting wet and drying out. Also taxing the roof are constant changes in temperature from the extreme heat of the day to the cooler night (this heat difference is exacerbated in climates where snow and ice collect on a flat roof). These different cycles the roof goes through on a regular basis lead to the surface of the roof expanding and contracting. The traditional cheap materials such as tar and gravel used for flat roofs are not designed to withstand these changes for very long and eventually the structure of the roofing material breaks down leading to cracks in the surface. These cracks can rend a flat roof useless and, unless the roof is constantly monitored and repaired, the damaged roof typically it must be replaced.

\textbf{Figure 10} Cracked flat roof surface\textsuperscript{41}

3.1.2. Leaks

Flat roofs are also known to leak. As mentioned, traditionally, flat roofs use a gravel and tar based surface which should be sufficient to prevent leaks. However, in areas where there is significant rainfall, pooling of water in certain areas tends to become a problem which leads to an increased risk of water penetrating the roof surface. Also, in colder climates, ice and snow can build up and cause what are known as ice dams which prevent water from flowing off the roof\textsuperscript{42}—again causing pooling and creating leaks. Another problem is created when water pools in the winter in cold climates. In addition to ice dams, you can get snow and ice building up on the roof which causes the flat roof surface to sag and actually create a convex space where water collects and slowly seeps through into the building. Not only does pooled water leak into the building in the winter, it can also find its way into roof seams and refreeze. When it freezes it expands and threatens the integrity of these seams and reduces the effectiveness of the roof at preventing water from leaking into the building in even normal rainy conditions.
3.2. Environmental Problems

The growth of cities around the world has lead to an increase in concrete and asphalt surfaces as natural green spaces are taken over to provide space for buildings. These areas are impervious to water and also add to the area’s heat gain.

3.2.1. Runoff

In metropolitan areas, storm water runs directly off of asphalt and concrete surfaces and back into rivers and streams. Only fifteen percent of water that falls in metropolitan areas ever reaches plants and soil—seventy five percent becomes surface runoff. This runoff water is usually directly drained into open water bodies. As it runs through cities, this water picks up pollutants and is never cleaned by any kind of natural filter. This increased runoff is polluting rivers and streams.

Figure 11 This illustration depicts the water cycle. It shows the different processes through which water is recycled in the natural environment. In urbanized areas where most surfaces are impervious to water, the process of evapotranspiration and infiltration are significantly reduced. Without these processes, more water directly runs and flows directly into the body of water.

Figure 12 Figure from a University of Colorado study on the effects of urbanization on runoff. The Y-axis shows discharge in cubic meters per second while the X-axis represents time in hours. The graph shows that the amount of runoff increases after urbanization.
3.2.2. Rising Global Temperatures

Because they are typically made of dark materials and because they lack any slope which would prevent them from being directly hit by the sun’s rays, flat rooftops are exposed to all of the sun’s heat and light. They absorb and store the sun’s energy during day and reflect it at night. An article published by CNN.com, noted that because of the dramatic absorbance of flat roofs, “during the summer months, the temperature of a conventional flat rooftop can soar up to 140 degrees Fahrenheit – hot enough to fry an egg.” This leads to what is known as the urban heat island effect or the drastic difference in temperatures noted between urban spaces and green space.

This is all contributing to the drastic changes in world temperatures that have been noticed within the recent years. In 2001, Time Magazine reported that the global mean temperature is expected to rise between three and 10 degrees Fahrenheit within the next 100 years. And the UN weather agency reported that Earth’s average temperature in 2001 was the second highest recorded global temperature since recording began over 140 years ago.

Figure 13 This graph, taken from the Goddard Institute for Space Studies (GISS), a division of NASA, illustrates the rising average global temperature.

Table 1 Again from GISS, this table represents the same data presented in the previous table.
3.2.3. Increased Energy Usage

Hot flat roofs not only heat the air around the building but also warm the interior of the building. With the air inside the building being warmed by the intense heat on the roof, the demand on the air conditioning system rises in the summer months. This added demand on the building to maintain a livable air temperature drives up the amount of energy that the building is using along with the cost of running the building. As the need for energy to cool the building increases, the amount of pollution generated in producing that electricity increases.

In part as a result of dealing with rising temperatures and also with the growth of cities, humans are now consuming natural resources 20% faster than nature can renew them. In the last thirty years, America's demand for electricity has been steadily growing and increased more than 130% between 1970 and 2000. And although electricity usage is becoming more and more efficient, by the year 2020 it is projected that America's electricity demand will increase by another forty percent.

![Electricity Demand 1970 - Projected to 2020](image)

*Figure 14* Energy usage in the US for the last 30 years
4. Greenroofs As the Solution

Greenroofs, which cannot get hotter than about 77 degrees Fahrenheit\textsuperscript{52} can be used as integral parts of solutions to these and many other problems.

4.1. Extending roof life

Greenroofs shield existing flat roof materials from the harm that they normally incur from heat and water damage. When the sun hits a greenroof, it does not directly reach the roofing materials.\textsuperscript{53} This greatly reduces the heat stress put on the roof. As a result, the roof materials do not go through the drastic cycle of heat and cold and expanding and contracting. This causes them to last much longer. A typical greenroof extends the life expectancy of a flat roof from about 10 years to upwards of 40 years.\textsuperscript{54}

4.2. Preventing Leaks

Greenroofs also combat the problem of leaks associated with flat roofs. Because the soil layer uniformly absorbs water, there is no pooling of water on greenroofs. Also, when greenroofs are installed, one of the major layers is the waterproofing layer. When installed correctly, this adds another layer of impermeability to the roof even further reducing the chance of water getting into the building.

4.3. Combating Runoff

Greenroofs have the potential of reducing storm water runoff by fifty percent. When water hits the greenroof, it is absorbed and held by the plants and soil on the roof. From here, the water is directly returned to the water cycle as it evaporates from the roof without running right off the building.

The rain water that does drain from the roof has the benefit of being filtered. As the rain passes through the soil and plant layer, impurities are filtered out and do not return to bodies of water.\textsuperscript{55} Heavy metals and nutrients found in storm water are taken by the soil instead of being discharged into the groundwater or streams or rivers. According to a paper published by the London Ecology Unit, over 95% of cadmium, copper and lead and 16% of zinc can be taken out of rainwater by greenroofs.\textsuperscript{56} Greenroofs have also been shown to substantially reduce levels of nitrogen.\textsuperscript{57} This same process by which impurities are removed from rain water has the added benefit of recycling the nutrients in the water and returning them to the natural cycles.

4.4. Reducing Urban Heat Island Effect

One of the most important aspects of a greenroof is that, as was mentioned before, it cannot get hotter than 77 degrees Fahrenheit. This is due to the process of evapotranspiration. As water reaches the greenroof, it is absorbed by the soil. When this gets heated by the sun, plants use the energy from the sun to transform the water and
carbon dioxide into useable energy and oxygen. In using the heat that hits the plants, this process reduces the ambient air temperature surrounding the greenroof.\textsuperscript{38}

This reduction in temperature above the building aids in the vertical mixing of air. The air above the greenroof is cooler than the hot air rising from the surrounding surfaces. As the hot air rises it is replaced by the cooler air from the vegetation. This cycling of air can work to reduce city temperatures.

4.5. Reducing Energy Demands

Greenroofs can also aid in the reduction in energy usage. Because they are much cooler than traditional flat roofs, greenroofs reduce the amount of heat that is transferred into the building. This reduces the amount of energy that is needed to cool the building in the summer months. According to an article from the Environmental News Network, "a three to seven degree temperature drop translates to a 10\% reduction in air conditioning requirements. For a one-story structure with a green rooftop, cooling costs can be cut by 20 to 30\%."\textsuperscript{59} The Weston Design Consultants recently conducted an energy study for the city of Chicago which estimated that it would be possible to save $100,000,000 in saved energy annually with the greening of all of the city's rooftops.\textsuperscript{60}

Also, greenroofs add a layer of insulation to buildings and reduce the amount of heat that escapes the buildings in the winter. Again, this reduces the amount of energy that is used by the building by reducing the costs of heating the building. Not only are costs reduced by cutting the amount of energy that is needed to maintain livable temperatures in buildings, but also, the amount of pollution as a result of using less energy.

4.6. Aesthetics

Another benefit of greenroofs that cannot be downplayed is the improved aesthetic quality that comes from adding vegetation to the typical flat roof. Because roofs are not the focus of builder’s plans, they are typically the least aesthetic part of the building’s design. Typically this is not a problem because often rooftops cannot be seen. However, as cities grow and expand, neighboring buildings are built and often have windows that look out over the rooftops of other buildings. By adding a greenroof to the design of a building, you can greatly improve the view from above and add an element that is not only functional but also can be quite beautiful as well.

5. A Proposal for the University of Maryland

5.1. The University of Maryland Master Plan

In the fall of 2000, University of Maryland President, C. D. Mote appointed a Facilities Master Plan Steering Committee to develop a master plan to meet the Maryland Higher Education Commission and Board of Regents requirements and to define the principles and lay the foundation for the “orderly development and growth of the campus over the next twenty years.”\textsuperscript{61} This plan recommends the actions that should be taken to ensure
proper growth and expansion of the University in the years to come and stresses what it refers to as “thoughtful stewardship of the built environment.” One of the notions present in the plan is the desire to create a campus which both “teaches and exemplifies concern for the natural environment.” The plan lays out four principles and goals:

- Plan the built and natural environment in a way that preserves the beauty of campus while protecting the environment
- Reduce the number of automobiles on campus and eliminate vehicular congestion
- Reinforce campus’s role as a good neighbor in the community
- Preserve architectural heritage and enhance it with community spaces

These goals which in turn guide the goals of the University for the future are consistent with the concepts of the “Smart Growth” initiative. This is a program initiated at the state level to provide guidance for new development and community expansion in order to protect natural resources as well as rural areas.\(^{62}\)

5.1.1. Environmental Stewardship at the University of Maryland

The plan also seeks to work within the Environmental Stewardship Guidelines as prepared by the Environmental Stewardship Committee, an advisory committee to the University of Maryland Facilities Council. The purpose of these guidelines is to encourage the University to embrace a leadership role in the areas of environmental research and education and to practice environmental stewardship. In the University Master Plan, in accordance with these guidelines, the University sets out that it is “committed to minimizing its negative impact on local, regional and global environment and [is] striving toward environmental sustainability beyond standard regulatory compliance.”\(^{63}\)

Under these guidelines, the University has established some specific goals as well as recommended actions, many of which could be aided by building greenroofs on campus. Some selected goals of the Master Plan follow:\(^{64}\)

- **Goal:** Preserve and reinforce regional ecological connections.
  - Recommended Actions:
    - Establish greenways.
    - Manage invasive species.
    - Protect streams and wetlands.
    - Protect existing specimen trees.
    - Restore and enhance forest cover.

- **Goal:** Restore the natural hydrologic cycle.
  - Recommended Actions:
    - Manage storm water run-off more effectively
    - Improve discharge water quality and promote water reuse.
    - Improve water quality.
• Identify and reduce volume and improve quality of storm water runoff

○ **Goal:** Foster ecological stewardship.
  Recommended Actions:
  • Develop specific policies and goals to reduce consumption of non-renewable resources.
  • Minimize hazardous and toxic materials.
  • Promote environmentally responsible procurement of goods and services.
  • Adopt a waste reduction goal for the campus.
  • Incorporate energy conservation measures and renewable energy production.
  • Implement "green" architecture

○ **Goal:** Reduce Energy consumption
  Recommended Actions:
  • Implement energy conservation programs
  • Review new building design proposals to identify opportunities to reduce utility and consumption

Greenroofs have the potential to help the University achieve many of these goals. By creating a program on campus for the implementation of greenroofs, the University will be moving towards the Environmental Stewardship that it seeks to embrace. In planning new buildings for the expansion of the University, roof design should be a priority. Designing greenroofs in at the beginning of the design process allows for much more flexibility in the implementation of green architecture.

5.2. North Woods Greenroof

Greenroofs can and should become a part of campus even without expansion of the University. There are many flat roofs on campus none of which are contributing positively to the environment. One specific roof where significant improvements could be made is the roof of the North Woods Diner. Three residence halls overlook this building and the flat roof is not a nice view. Not only would a green roof significantly improve the aesthetics of the space, but it would also work to cut energy costs and deal with many of the afore-mentioned environmental problems posed by flat roofs.

*Figure 15* A picture of North Woods Diner from Easton Hall
5.2.1. A Project for Students and Faculty

Another of the goals of the Environmental Stewardship Guidelines states that “students should assist campus departments and the Environmental Stewardship Committee by identifying and participating in campus activities and leaning opportunities that support the campus Environmental Stewardship Approach.” This proposal suggests designing a student and faculty research project around the building of a greenroof on North Woods. A team could be created that could design, build and monitor the greenroof. Data could be taken to see what, if any, the actual benefits of building a greenroof are. If the project is successful, other greenroofs on campus could be built and monitored in a similar way. In discussing or publishing the results of this project, hopefully other universities or agencies would recognize the benefits of building greenroofs and other projects would be started up.

5.2.2. Building a Greenroof

There are many ways to go about actually creating the greenroof from designing the project from scratch to having a team come in and build the roof. A somewhat middle of the ground answer would be to select and buy a pre-grown greenroof that would be laid by members of a team interested in working on the project.

There are a few companies that specialize in this kind of technology. One such company is Elevated Landscapes Technology. They are based out of Canada but do projects in the US and are currently working on a greenroof project in New York. They have a product called the ELT Easy Green™ Roof. They describe it as an “interlocking green roof tile” which you can order pre-grown and can customize with the plants that you would like on your roof. Their extensive greenroof system consists of the water retention and drainage layer, the root barrier, soil and vegetation.

The soil is fewer than six inches deep and ways about eight pounds per square foot. The system is lightweight and can be ordered and installed easily. These pre-grown panels are 100cm by 100cm and cost $75 each. Panels that do not include soil and vegetation are priced at $45 each.

Figure 16 Layers of the ELT Easy Green™ Roof system

Figure 17 Installation of the ELT panels
5.2.3. Funding

Funding for this project could come from a variety of different sources. First, there are many different organizations and foundations in the area all with interests in promoting environmental protection. In its master plan, the University has already listed potential groups with whom collaborations could be formed in working towards their goals of Environmental Stewardship. In their list they include:

- Anacostia Watershed Restoration Committee
- Center for Watershed Protection
- Chesapeake Bay Foundation
- Maryland Department of the Environment
- Maryland Department of Natural Resources
- Maryland Native Plant Society
- Sierra Club (Maryland Chapter)

The Maryland Energy Administration (MEA) is another place to look for aid in funding a greenroof project. The MEA has a loan program for State agencies called the State Agency Loan Program (SALP). Established in 1991, this program uses funds from the Energy Overcharge Restitution Fund and provides loans for expenses incurred in the installation “cost-effective energy efficiency improvements in State facilities.” The University is currently making use of the SALP program for campus-wide lighting upgrades. The projects in the SALP program must have simple payback within a reasonable time period typically within 10 years or less. In order to get funding under the SALP program, an energy study would need to be carried out to determine costs and savings from a potential greenroof project. This could also be a part of a student faculty initiative which would work to further define the specifics of this proposed project.

6. Conclusion

The University of Maryland has declared itself as committed to moving towards a more ecologically friendly and environmentally conscious university. A project to design, build and monitor a greenroof on the College Park campus would help the University take a step towards meeting its goals. And though it may seem that a single greenroof may not be enough to noticeably affect global temperature patterns or significantly reduce energy consumption, a North Woods greenroof would only be the beginning. The University of Maryland has been rated as one of the top twenty research universities in the country and the work done here is well respected in the research community. Therefore, to learn more about the benefits of greenroofs would bring the concept into the public discourse and would be instrumental in extending the greenroof movement beyond the limits of campus.
7. Endnotes


7. Ibid.

8. Velazquez


10. Velazquez


12. Yocca

13. Velazquez

14. Velazquez


16. “Greenroofs 101”

17. Ibid.


19. Ibid.

20. Scholz-Barth

21. “Green Roofs 101”

22. “ELT Easy Green™: Green Roof Systems”


24. “Greenroofs 101”


27. “Greenroofs 101”

28. “Green Technology for the Urban Environment”


30. Ibid.

31. “Greenroofs 101”


33. Ibid.

34. “Green Roof Products”


37. Scholz-Barth

