

Appendix **D**

Example Short Technical Report: The Benefits of Green Roofs

ABSTRACT

Green roofs are becoming a popular choice for many cities and corporations. The purpose of this report is to discuss the benefits of green roofs. A typical green roof section includes structural support, a roofing membrane, insulation, a root barrier, drainage medium, filter fabric, a growing medium, and vegetation. The two types of green roofs are intensive and extensive. Intensive roofs are characterized by a shallow growing medium and shorter plants, while an extensive roof contains a deeper growing medium and can support a wide range of plant life. The advantages of green roofs include: improved stormwater runoff management, improved air quality, reduced heat island effect, thermal and acoustical insulation, reduced HVAC costs, extended roof life, potential food production, and community social, health, and emotional benefits. Issues that must be kept in mind when considering green roofs are initial costs, maintenance costs, and drainage and irrigation. Green roofs have the potential to address a myriad of urban issues. Given the benefits, all cities should promote the use of green roofs. Green roofs are particularly suited to public buildings and corporate entities with a long-term commitment to their projects.

INTRODUCTION

Green roofs are becoming a popular choice for many cities and corporations. They have many benefits. The purpose of this report is to discuss the benefits of green roofs. The background section contains information on the basic components of a green roof system and explains the two main types of green roofs. The discussion

section outlines the benefits of green roofs and briefly explains a few considerations that must be addressed. The conclusion reiterates the benefits of green roofs and explains who realizes each of those benefits. The recommendations include those who should strongly consider the use of green roofs.

BACKGROUND

Most roof assemblies contain structural support, a waterproof roofing membrane, and thermal insulation. However, a green roof assembly requires additional components not used in conventional roof assemblies. Like a conventional roof, a typical green roof section includes structural support, a waterproof roof membrane, and thermal insulation. In addition, a green roof requires a root barrier to protect the roof membrane, a drainage medium, a filter fabric, a growing medium, and vegetation. There are several products available that can be used to fulfill these functions. Figure 1, Green Roof Assembly, from American Wick Drains (American Wick Drains)

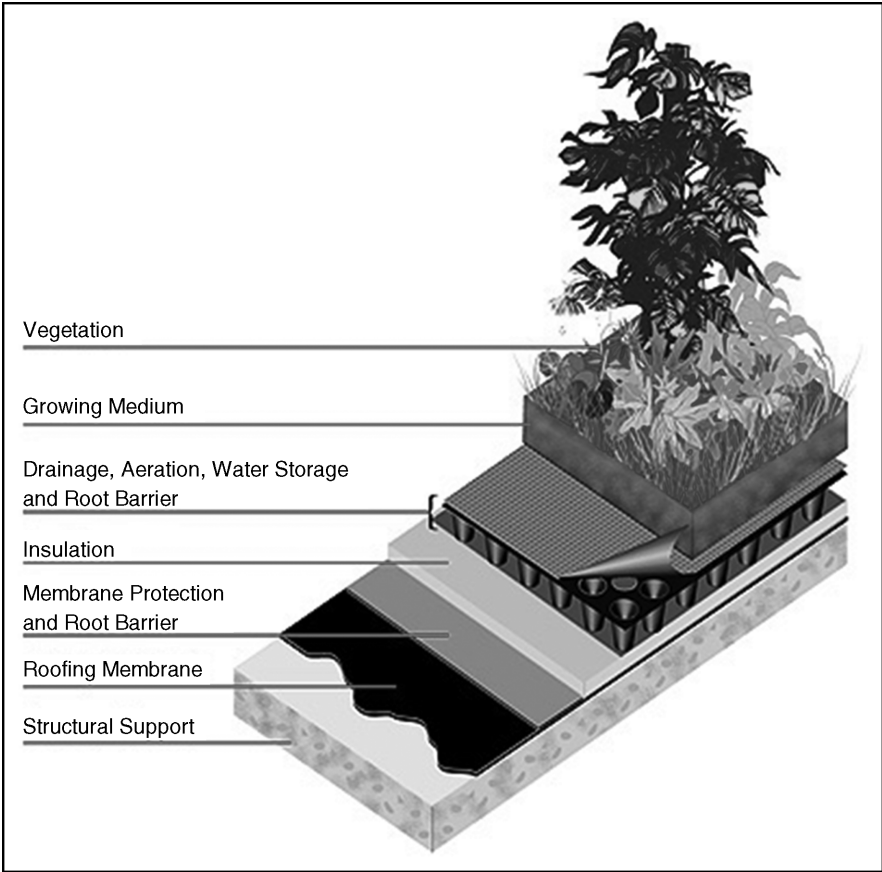


Figure 1 Green roof assembly

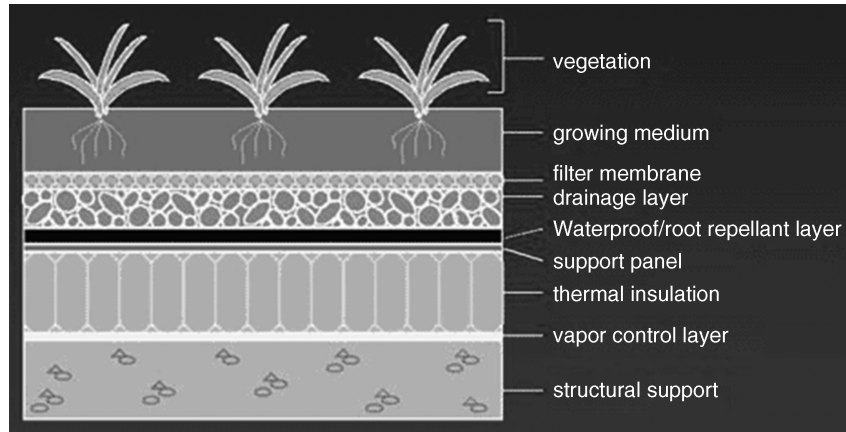


Figure 2 Green roof technologies

and Figure 2, Principle Green Roof Technologies, from National Research Council, Institute for Research in Construction (Green Roofs for Healthy Cities), show the basic components of a green roof assembly.

There are two primary types of green roofs, intensive and extensive. Extensive roofs are characterized by shallow soil depth and low-growing plants. Soil depths are usually less than 8 inches with plantings reaching heights up to 36 inches (Garden the Planet). They are lighter and lower maintenance. They provide habitat for flora and fauna. Intensive roofs can resemble parklike spaces. They are characterized by soil depths up to 4 feet and can support a wide range of plant life (Garden the Planet).

DISCUSSION

Green roofs have many advantages over conventional roofing systems. These advantages include:

- Improved stormwater runoff management
- Improved air quality
- Reduced heat island effect
- Thermal and sound insulation
- Reduced HVAC costs
- Extended roof life
- Potential food production
- Community social, health, and emotional benefits

One of the most touted benefits of green roofs is the ability to substantially reduce stormwater runoff from the buildings they cover. The planting medium absorbs much of the rainwater reducing the load on municipal storm drainage systems. The

flow water that is not absorbed is delayed. This delay assists in reducing peak flows and preventing sewage overflows and flooding that often occur during peak flows. A study by North Carolina State University demonstrated reductions in runoff up to 63 percent for a 3-inch-deep green roof. This same study showed peak flow reduction of up to 87 percent (Tokarz) for 0.6 inches of rainfall. Milwaukee, Wisconsin is another city using green roofs to assist in managing stormwater runoff. After the 2003 installation of seven green roofs, Milwaukee conducted a modeling study that showed the volume of stormwater runoff sent to sewer treatment plants was reduced 31 to 37 percent and peak flows were reduced between 5 and 36 percent (Environmental Protection Agency).

Another benefit of green roofs is improved air quality. Studies have shown that green roofs can absorb particulates. According to Green Roofs for Healthy Cities, a 10-squarefoot grass roof can remove as much as 4.4 pounds of particulate matter per year with the proper plantings (Green Roofs for Healthy Cities). Some of the pollutants that can be removed from the air include “nitrogen oxides, sulfur dioxide, carbon monoxide, and ground-level ozone (Massachusetts Department of Environmental Protection). The plant life associated with green roofs also removes carbon dioxide and produces oxygen. Green Roofs for Healthy Cities states 10 square feet of uncut grass on a green roof can generate enough oxygen for one person for a year (Green Roofs for Healthy Cities). This also serves to improve air quality, which has become an important issue for many cities facing increased air pollution and its associated health issues.

Green roofs also mitigate the effects of urban heat islands. Green spaces tend to be cooler than typical urban hardscape areas. This is also true of roofing areas. During the summer months, temperatures of conventional roofs can be substantially higher than ambient temperature reaching 130° F (Holladay) or more. Green roofs have been shown to lower the temperature of the roof areas. For instance, the City of Chicago found that the green roof of City Hall measured a range of 91 to 119° F, while the adjacent conventional roof measured 169° F on a day with a 90° F temperature during the month of August. Figure 3 illustrates the temperature differences between a conventional and a green roof (Environmental Protection Agency).



Figure 3 Temperature difference between a green and conventional roof

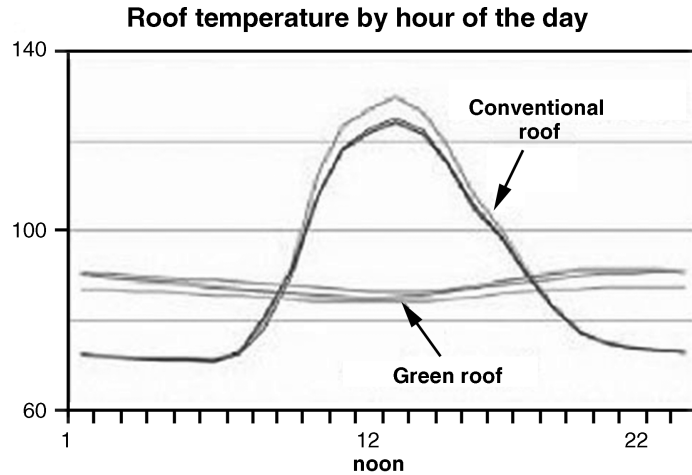


Figure 4 Roof temperature by hour

Figure 4 was developed by the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., and shows how the temperature of a green roof compares to a conventional roof throughout typical a day. The green roof temperature is more consistent and lower overall, reducing the heat radiated into the surrounding area.

Green roofs also act as additional thermal and sound insulation. They stop heat from moving through the roof. In her report titled “Energy Efficiency in Green Roofs,” Karen Lui states, “The growing medium and the plants enhanced the thermal performance of the rooftop garden by providing shading, insulation and evaporative cooling. It acted as a thermal mass, which effectively damped the thermal fluctuations going through the roofing system.” In addition to thermal insulation, green roofs provide sound attenuation. According to Green Roofs for Healthy Cities, a 4.7-inch substrate has the ability to reduce sound levels 40 decibels, and a 7.9-inch substrate may reduce sound by up to 50 decibels.

The potential for reduced HVAC costs is another benefit of green roofs. By lowering the heat gain and heat loss associated with heat transmission through the roof, the demand for air conditioning can be reduced. In a study performed by Lui, a 6-inch extensive green roof demonstrated a 95 percent reduction in heat gain and a 26 percent reduction in heat loss when compared to a reference roof (Green Roofs for Healthy Cities). The decreased heat load may allow for a reduction in mechanical equipment for the building. It also decreases the energy consumption used to heat and cool the building. Chicago’s City Hall realized savings of up to 30 percent in their energy costs after the installation of their green roof (Garden the Planet).

The list of benefits continues with prolonged roof life. The plants and planting medium provide protection from UV rays and thermal extremes that deteriorate conventional roofing membranes. It also provides physical protection from wind, hail, fireworks, and vandalism (International Green Roof Association). It’s estimated that

this protection doubles the life of the roof membrane. This, in turn, reduces reroofing expenses and landfill materials.

The potential for food production is another benefit of green roofs. Intensive roofs can support a broad spectrum of plant life, including herbs and vegetables. The Fairmont Waterfront Hotel in Vancouver planted an herb and vegetable garden on their green roof. The roof garden produces \$30,000 per year of produce that is used in the hotel's restaurant (Green Roofs for Healthy Cities). The idea can be expanded and has the potential to create food sources close to living centers. This could, in turn, reduce transportation environmental impacts as well by reducing the shipping distances for some food items.

Although much more difficult to quantify, green roofs provide communities with social, emotional, and health benefits. The EPA states, "An increasing number of studies suggest that vegetation and green space—two key components of green infrastructure—can have a positive impact on human health. Recent research has linked the presence of trees, plants, and green space to reduced levels of inner-city crime and violence, a stronger sense of community, improved academic performance, and even reductions in the symptoms associated with attention deficit and hyperactivity disorders. One such study discusses the association between neighborhood greenness and the body mass of children. (Environmental Protection Agency).

The benefits of green roofs continue. However, there are some issues that must be accounted for when considering a green roof. These include:

- Initial costs
- Maintenance costs
- Drainage and irrigation

Green roofs require more materials to build and therefore are more expensive than conventional roofs. In addition, the structural capacity of the roof must be sufficient to support the additional weight of the plants, planting medium, and human activities. According to Green Roofs for Healthy Cities and the EPA, green roofs cost \$10 to \$24 per square foot. While more than conventional roofs, the long-term savings in energy and maintenance costs should be considered.

Maintenance is an important consideration for green roofs. The EPA estimates maintenance costs to be about \$0.75 to \$1.50 per square foot. Care must be taken to keep woody plants from overgrowing and potentially damaging the roof membrane.

Although the planting medium absorbs much of the rainwater, drainage must still be provided and maintained. Gutters and downspouts must be kept clean and free of debris to avoid roof damage. Provisions for providing irrigation to plant life must be considered as well.

CONCLUSION

The benefits of green roofs cannot be ignored. Green roofs have many long-term benefits. They have the potential to address a myriad of urban issues. Many

municipalities are turning to green roofs to address issues of stormwater runoff management, urban air quality, and the effects of urban heat islands. Building owners benefit from the reduced energy costs and extended roof life. Community members gain social, health, and emotional benefits. Green roofs are a long-term investment in community well-being.

RECOMMENDATIONS

Given the benefits of green roofs, all cities should promote the use of green roofs. With the initial costs associated with green roofs, they may not be an appropriate choice for speculative developers who are concerned with keeping initial costs low. However, green roofs are an excellent choice for public buildings and corporate entities with long-term commitment to their projects and who will be able to reap the long-term benefits.

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