

## Vegetated Roofs

### What is a Vegetated Roof?

A vegetated roof or green roof is a living roof system composed of vegetation in a lightweight growing medium atop a drainage layer, root barrier and waterproof membrane (Figure 1). This layered system enables the roof to retain precipitation on and within the planting bed and on the surface of the vegetation.<sup>1</sup> Vegetated roofs can provide many environmental benefits such as decreased stormwater runoff and reduced energy use. In addition, vegetated roofs can absorb air pollutants, provide a habitat for beneficial insects and birds, serve as a sound barrier, and mitigate the urban heat island effect.

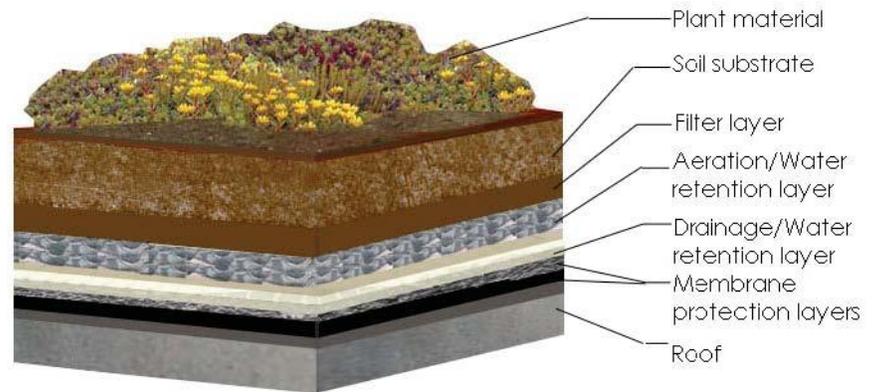


Figure 1: A basic cross-section of a vegetated roof (Source: New York City Department of Design & Construction [Cool and Green Roofing Manual](#))

### How to Incorporate a Vegetated Roof

There are many pre-engineered green roof systems available on the market but green roof designs are often customized to achieve a project's specific performance objectives. A design professional should be consulted and the development of the green roof should be integrated with the development of the building's structure and systems. The roof strength must be able to hold 10-25 pounds per square foot above the requirements of a basic roof.<sup>2</sup>

There are two primary categories of vegetated roofs: extensive and intensive. Extensive vegetated roofs are lightweight systems with shallow soil depths usually less than 6 inches.<sup>3</sup> Extensive vegetated roofs require less structural support than an intensive system and are planted with a limited palette of hardy plants adapted to extreme environments that need little maintenance. Intensive vegetated roofs have deeper soil typically more

<sup>1</sup> NJ Stormwater Best Management Practices Manual – Chapter 2: Low Impact Development Techniques. [http://www.njstormwater.org/bmp\\_manual/NJ\\_SWMP\\_2\\_print.pdf](http://www.njstormwater.org/bmp_manual/NJ_SWMP_2_print.pdf) (accessed April 30, 2011).

<sup>2</sup> City of Portland. <http://www.portlandonline.com/bes/index.cfm?c=50816&a=261074> (accessed April 30, 2011).

<sup>3</sup> Miller, Charlie. WBDG. "Extensive Green Roofs." June 11, 2010. <http://www.wbdg.org/resources/greenroofs.php> (accessed July 30, 2010).

than 6”, are heavier than extensive vegetated roofs, and can support a greater variety of plants. Intensive systems require more maintenance and a higher initial investment than an extensive roof.<sup>4</sup>

Vegetated roofs require subsystems that provide:

- Drainage - drainage design needs to maintain optimum growing conditions in the growth medium and manage heavy rainfall
- Plant nourishment and support – the planting medium needs to meet requirements for grain-size distribution, void ratio, moisture retention, etc. and
- Protection of underlying waterproofing systems - green roof assemblies need to protect the underlying waterproofing system from human activities (including the impact of maintenance).<sup>5</sup>

A variety of plant species can be included on a vegetated roof but typical vegetated roof plants include drought-tolerant species such as hardy succulents, sedums, and perennials. Consider New Jersey species that are able to live in shallow soil and that require little maintenance. For a list of species indigenous to the Northeast, see [NYC Greenbelt Native Plant Center](#) or [List of NJ Native Plants by County](#).

Like any roof a vegetated roof requires some maintenance such as watering during the plant establishment period and occasional weeding. Grasses and annual plants may need to be cut back or cleared out occasionally so that combustible material does not accumulate on the roof. The components of the roof’s drainage system such as gutters, underdrains and downspouts should be inspected and maintained regularly.<sup>6</sup>

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<sup>4</sup> US EPA. “Reducing Urban Heat Islands: Compendium of Strategies- Green Roofs.” <http://www.epa.gov/heatisland/resources/pdf/GreenRoofsCompendium.pdf> (accessed July 30, 2010).

<sup>5</sup> Whole Building Design. Extensive Green Roofs. <http://www.wbdg.org/resources/greenroofs.php> (accessed December 18, 2010).

<sup>6</sup> NJ Stormwater Best Management Practices Manual – Chapter 2: Low Impact Development Techniques. [http://www.njstormwater.org/bmp\\_manual/NJ\\_SWMP\\_2\\_print.pdf](http://www.njstormwater.org/bmp_manual/NJ_SWMP_2_print.pdf) (accessed April 30, 2011).

## Example

### The Geraldine R. Dodge Foundation Green Roof, Morristown, NJ

The Foundation's 2,000 square foot vegetated roof is planted with native plant species; provides a home for many bird and butterfly species; and absorbs 98% of rainfall.



Figure 2 - The Geraldine R. Dodge Foundation headquarters green roof in Morristown, NJ (Source: [Wild New Jersey](http://wildnewjersey.tv/2009/05/28/wild-new-jersey-exclusive-green-roof-offers-native-habitat-at-dodge-office-on-morristown.aspx))

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## Benefits

### Reduced stormwater runoff

A vegetated roof can reduce stormwater runoff, capturing up to 50% of the annual precipitation that falls on it through retention and evapotranspiration. Evapotranspiration describes the transport of water into the atmosphere from surfaces such as soil and vegetation.<sup>7</sup> Any rainfall not retained by a vegetated roof is slowed by the system, resulting in reduced peak flows in a watershed.<sup>8</sup>

### Reduced urban heat island effect

The evapotranspiration provided by vegetated roofs reduces both the temperature of the roof and the surrounding air temperature. While conventional roof surfaces can be up to 90 degrees Fahrenheit higher than air temperatures during the summer, vegetated roofs can remain cooler than ambient air temperatures.<sup>9</sup> One study found that vegetated roofs reduce roof surface temperatures by up to 38%.<sup>10</sup> Several vegetated roofs in the NYC region are being monitored to collect data about vegetated roofs and the urban heat island effect. Examples of green roof monitoring can be found through the [Columbia University's Center for Climate Systems Research](http://www.columbia.edu/~ce1002/).

<sup>7</sup> The Encyclopedia of Earth. <http://www.eoearth.org/article/Evapotranspiration> (accessed January 16, 2011).

<sup>8</sup> US EPA. "Green Roofs for Stormwater Runoff Control" February 2009. <http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf> (accessed July 30, 2010).

<sup>9</sup> US EPA. Heat Island Effect: Green Roofs. <http://www.epa.gov/heatisland/mitigation/greenroofs.htm> (accessed May 25, 2010).

<sup>10</sup> New York City Department of Design and Construction. *DDC Cool & Green Roofing Manual*. [http://www.nyc.gov/html/ddc/downloads/pdf/cool\\_green\\_roof\\_man.pdf](http://www.nyc.gov/html/ddc/downloads/pdf/cool_green_roof_man.pdf) (accessed July 30, 2010).

### Reduced Air Pollution

Green roofs serve as a carbon sink, helping to offset carbon emissions. Vegetation traps dust and particulate matter as well as other contaminants such as nitrogen oxides.<sup>11</sup>

### Energy conservation

The multiple layers of a vegetated roof provide excellent insulation. By increasing a building's thermal mass, vegetated roofs can help keep temperatures low in hot weather and warmer during the cool season. This means less energy spent on climate control for the building.<sup>12,13</sup> Green roofs are shown to reduce the cooling load by 25% or more in the summer and can therefore reduce energy consumption at times of greatest energy cost.<sup>14</sup>

### Increased Wildlife Habitat

As the roof system matures, a mini-ecosystem, which supports a variety of beneficial insects, butterflies and birds can develop.<sup>15</sup> This increases biodiversity and provides habitat for native wildlife.

### Improved Quality of Life

Like other urban greenery, vegetated roofs provide many intangible benefits for people. Installing a vegetated roof can be a method for integrating more green space into the site and the community. Also, neighboring buildings may gain increased views of nature if located near a vegetated roof.

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<sup>11</sup> Oberndorfer, Erica et. al. 2007. Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. *Biosciencemag.org* 57, no. 10. <http://www.aibs.org/bioscience-press-releases/resources/11-07.pdf> (accessed May 25, 2010).

<sup>12</sup> Ecospecifier.org: Knowledge Base Technical Guides. *6.0 - The 'Green Roof' Revolution*. [http://www.ecospecifier.org/knowledge\\_base/technical\\_guides/thermal\\_mass\\_building\\_comfort\\_energy\\_efficiency](http://www.ecospecifier.org/knowledge_base/technical_guides/thermal_mass_building_comfort_energy_efficiency) (accessed June 10, 2010).

<sup>13</sup> Center for Environmental Innovation in Roofing: Knowledge Center. *Energy Efficient Roofs > Cool Roofs > Cool Roofing Option 2*. <http://roofknowledge.org/main/energyefficientroofs/coolroofs/coolroofingoption2> (accessed June 11, 2010).

<sup>14</sup> Email correspondence with Tad Radzinski, President, Sustainable Solutions Corporation, April 6, 2011.

<sup>15</sup> Whole Building Design Guide. Extensive green roofs. <http://www.wbdg.org/resources/greenroofs.php> (accessed May 25, 2010).

## Costs

While the initial installation cost of a vegetated roof is higher than that of a conventional roof, a vegetated roof typically lasts twice as long. Costs for a vegetated roof range from \$10 to \$15 per square foot and can be higher for intensive systems.<sup>16</sup>

Changing temperatures and UV rays decrease the quality and life of a roof. Vegetated roofs protect rooftops and its structure, decreasing maintenance. Long-term savings from reduced heating and cooling costs and reduced maintenance can help offset the short-term capital costs.<sup>17</sup>

## Resources

New Jersey Stormwater Best Management Practices Manual – Chapter 2: Low Impact Development Techniques

[http://www.njstormwater.org/bmp\\_manual/NJ\\_SWBMP\\_2\\_print.pdf](http://www.njstormwater.org/bmp_manual/NJ_SWBMP_2_print.pdf)

US EPA Reducing Urban Heat Islands: Compendium of Strategies- Green Roofs

<http://www.epa.gov/heatiland/resources/pdf/GreenRoofsCompendium.pdf>

US EPA- Green Roofs for Stormwater Control

<http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.pdf>

US EPA – Green Roofs – Heat Island Effect

<http://www.epa.gov/heatiland/mitigation/greenroofs.htm>

Whole Building Design Guide

<http://www.wbdg.org/resources/greenroofs.php>

Center for Neighborhood Technology - Green Values Calculator

<http://greenvalues.cnt.org/national/calculator.php>

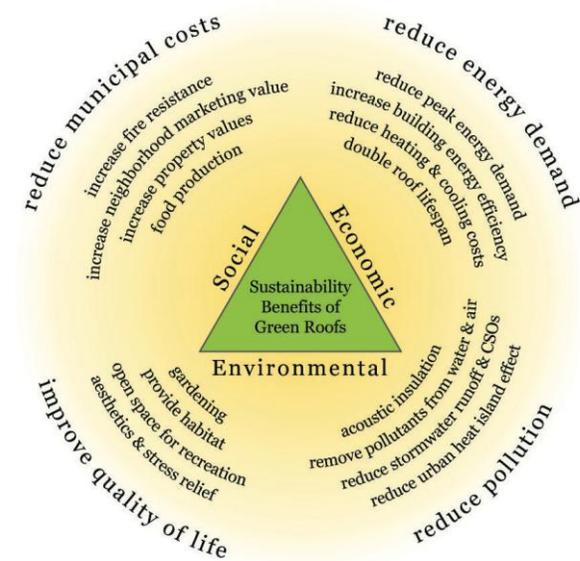


Figure 3 – Benefits of Green Roofs (Source: Hartman, Danielle. Poster presentation, ESRI International User Conference, San Diego. July 2009).

<sup>16</sup> City of Portland. <http://www.portlandonline.com/bes/index.cfm?c=50816&a=261074> (accessed April 30, 2011) and email correspondence with Tad Radzinski, President, Sustainable Solutions Corporation, April 6 2011.

<sup>17</sup> City of Portland. <http://www.portlandonline.com/bes/index.cfm?c=50816&a=261074> (accessed April 30, 2011).

Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services  
<http://www.aibs.org/bioscience-press-releases/resources/11-07.pdf>