



**GREEN ROOFS**

**Deconstructing Green Roofs**  
Plant Selection  
Roof Design



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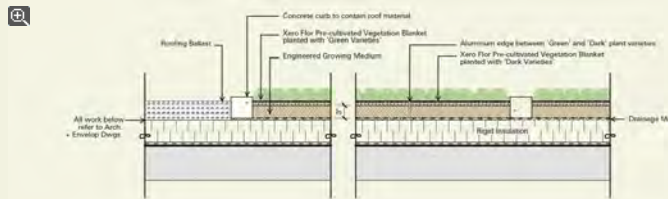
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**Deconstructing Green Roofs**  
Gardens in the Sky

Green roofs are vegetated areas installed as an addition to a conventional rooftop. The structure of a green roof can take a number of forms, but always includes a handful of key components: high quality waterproofing and root barrier, a drainage layer, filter cloth, a mineral-growing medium and plants. Root barriers are absolutely essential as they ensure that roots do not penetrate the roof membrane—one of the major fears about installing green roofs. While typical green roof plants do not have aggressive rooting, root barriers are installed as a precaution should any weed species such as cottonwood or alder trees sprout up.



Credit: Danny Singer, 2009

**“Intensive” vs. “Extensive”**

Crossing Vancouver’s Cambie Street bridge, if you look out across the Millennium Water development, you’ll see trees growing up from the rooftops of the buildings. What you’re seeing is referred to as intensive roof gardens. Intensive green roofs feature deeper soil (over 8 inches) and can support a wider variety of plant types. Intensive green roofs are often more labour-intensive than extensive green roofs, which are thinner and lighter, characterized by a light layer of vegetation and growing medium (2-6 inches on average). The plants chosen for extensive green roofs are usually drought-tolerant varieties that, once established, do not require irrigation.

These are five key elements of a green roof:

- Root-resistant layer – a root barrier deters roots from penetrating or damaging the roof membrane
- Drainage layer – drainage mats are used to remove excess water from the growing medium and channel it to drains
- Filter layer – a textile material prevents fine particles from being washed out of the growing medium and impacting stormwater quality
- Growing medium – up to six inches in depth, the mineral-based growing medium has the basic physical, chemical and biological properties needed for plant growth requiring minimal long-term maintenance
- Vegetative layer – plants that can be sustained in a very shallow growing medium (for plant list, see below)

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Credit: Danny Singer, 2009

### Benefits of Vegetated Roofs

People are buzzing about green roofs, likely because green roofs are one of the most visible and easily recognizable green design features on a building. Aside from adding visual appeal, green roofs offer a number of potential social, economic and environmental sustainability benefits.



Credit: Danny Singer, 2009

### Beating the Heat

The "heat island effect" is an urban phenomenon, wherein the temperature in a city is a few degrees higher than its surrounding area. Heat islands occur when materials in our built environment (asphalt, concrete) absorb solar radiation, and re-radiate it as heat into the surrounding area. According to the US EPA, cities can be 1-3 degrees Celsius warmer in the daytime and up to 12 degrees Celsius warmer at night. Heat islands can have an adverse effect on air quality.

Green roofs help beat the heat by instead using the sun's energy to conduct photosynthesis – effectively transforming light energy into food – and cool the air through evaporative cooling.

### Energy Efficiency: Turn off Your A/C!

Green roofs lower a roof's temperature in two ways: by providing shade and by removing heat from the air through evapotranspiration – the process by which plants and soil absorb and release water into the atmosphere. The interior temperature of the building is in turn affected by the green roof's ability to moderate the roof's surface temperature, helping to keep the interior cooler during hot summer months. Green roofs also help moderate the temperature of the roof membrane, buffering it from hot and cold extremes. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 50 degrees Celsius warmer than the air temperature.

### Life-Cycle Value

Reducing the roof's exposure to temperature extremes can prolong the life of the roof membrane, thus reducing the cost, energy, waste and material use associated with re-roofing. Green roofs protect the roof's membrane by blocking exposure to ultra-violet rays; by reducing thermal stresses associated with temperature fluctuation (expansion and contraction); and by reducing physical stresses such as exposure to wind and materials that may wear the surface.

### Habitat: Birds and Critters

A vegetated roof is an oasis in an urban desert, offering wildlife a refuge from the asphalt and concrete that characterize the built environment. Plants attract birds and bees, and the soil becomes a habitat for small insects. At the Olympic Village, soil on the extensive green roofs is relatively shallow. While the shallow soils will not support a wide range of animal life, it is still a welcome habitat addition for creatures who make their homes in an urban environment.

### Social Benefits: Looks Matter!

From the point of view of human health and sustainability, the aesthetic qualities of green roofs have a positive effect on people's psyche. At the Olympic Village, people will look out their windows and see roofs and courtyards planted and designed to look friendly and inviting. Research shows that access to views of nature is associated with improving people's health: boosting productivity and reducing absenteeism in offices and reducing the average length of stay among hospital patients.

### Stormwater Management

By capturing and storing rainwater in their soils, green roofs can help reduce the rate and quantity of stormwater outflow. Stormwater volumes are reduced and flow rates diminished by slowing down the water via soil percolation. Green roofs are most effective for stormwater management in climates with regular, moderate rain patterns. In rainy climates like Vancouver, green roofs essentially reach capacity (saturation) early in the season, and thus their contribution to stormwater management is less significant than in other climatic zones.

## PLANT SELECTION

### Viewed from Above, a Sea of Green

Choosing plants for green roofs is not an easy feat. Extensive green roofs call for drought-tolerant plants, to limit or eliminate the need for irrigation. Another challenge is that climatic conditions on a rooftop are more extreme than on the ground. Plants must be hardy and able to endure high winds and drought. "In Vancouver, it's always a challenge to find plants that are drought tolerant when you know you're going to drown them in the winter," says Jennifer Stamp, landscape architect at Durante Kreuk who was responsible for plant selection.

"A critical component in plant selection is choosing plants that will look good in drought conditions. From this perspective, Mediterranean plants are ideally suited for roof gardens," says Stamp. This approach can conflict with LEED's green roof credit requirement, which specifies the use of "native and/or adaptive plants." "As long as they're not invasive in any way, [many non-native] plants meet the adaptive requirement," says Stamp. Other characteristics that drive plant selection include maintenance, appearance, habitat value and edible fruit.

## ROOF DESIGN

### Over 287,000 Square Feet of Green Roofs

The Millennium Water design team was charged by the City of Vancouver with the requirement that 50 percent of total roof area be vegetated. This requirement was a first for the developer, who was concerned about the appearance of the green roofs, visible from many of the residential units. While green roofs generally enhance the view in an urban environment, if they are not properly maintained they can dry up or grow unwieldy, detracting from the appearance of the urban environment.

Durante Kreuk, landscape designers for the Olympic Village, did their best to create lasting, attractive landscapes. "When you're on the site, the complexity of roof forms and spaces is really interesting – and unique for Vancouver. Each garden is quite a wonderful place," says Peter Kreuk. The team added visual interest to the plantings by arranging them into giant motifs of Olympic athletes (see image). These will remain as a legacy of the neighbourhood's role as the Olympic Village.



Durante Kreuk, landscape architects for the Olympic Village development, were playful in their approach to green roof design. In this aerial view of the rooftops of the Olympic Village, plants were placed into shapes showing motifs of Olympic athletes playing hockey, curling and competing at luge. The Olympic athlete figures are created with different plant types, colours and textures, and are outlined within a metal border. Credit: Durante Kreuk, 2009

As for the long-term appearance of the roofs, the role of the landscape architect has its limitations. "After we've designed and installed the roof gardens, they are handed over to the strata councils," says Kreuk. "The landscape should look better in five years, but it's up to the residents to maintain."

Choosing the right type of green roof system can help ensure that the plants require little maintenance and will maintain their appearance. The majority of the extensive rooftop area is covered with a blanket of sedums, provided by Xero Flor, a German company specializing in green roof design and installation for 40 years. Sedum is a succulent plant tolerant to extremes in temperature that survives with little or no irrigation while requiring very little maintenance. These "blanket" systems are cultivated at ground level, then rolled and transported to the rooftop as a complete system on pallets or by crane.



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