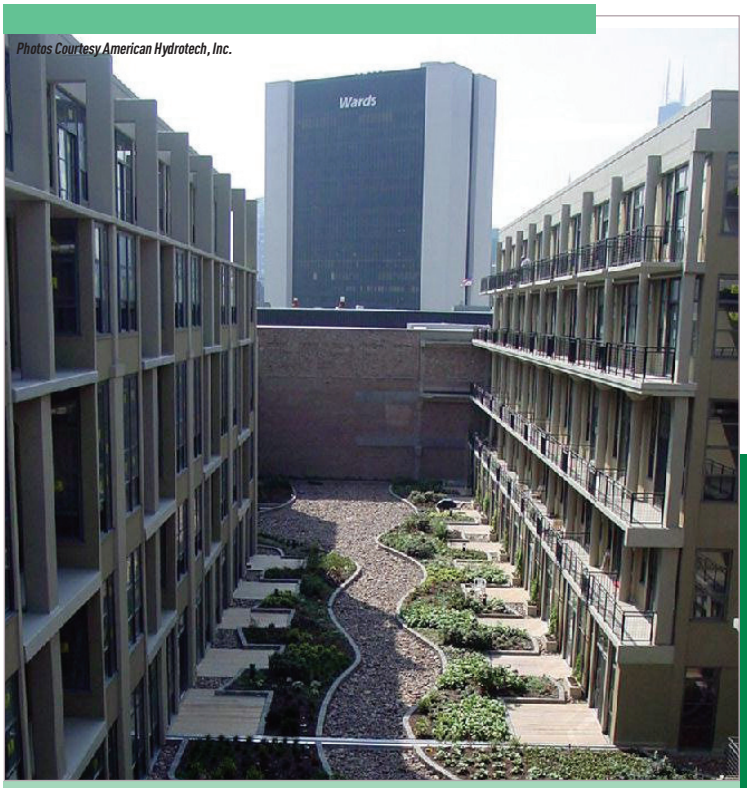
Designing with Green Roofs: Maximizing Sustainability and Stormwater Management



900 N. Kingsbury (Domain Lofts at eport) Chicago, Illinois
Architect: Pappageorge Haymes Limited
Images of the installation of this green roof on the top on an existing roof deck between two interior bays. The roof was retrofitted by the architects and provided with insulation and a seamless membrane. The garden and walking paths create a secret garden for residents who live above busy Chicago streets.

New urban roof top gardens lower energy costs and increase environmental benefits

Provided by American Hydrotech, Inc.

CONTINUING EDUCATION

Use the learning objectives below to focus your study as you read **Designing with Green Roofs: Maximizing Sustainability and Stormwater Management.** To earn one AIA/CES Learning Unit, including one hour of health, safety, welfare credit, answer the questions on page 339, then follow the reporting instructions on page 354 or go to the Continuing Education section on *archrecord.construction.com* and follow the reporting instructions.

LEARNING OBJECTIVES

After reading this article, you should be able to:

- *Identify the components of a green roof.*
- *Describe how green roofs help with stormwater management.*
- *Analyze green roofs as part of your environmental strategy.*

By Celeste Allen Novak, AIA, LEED AP

Ten stories above the Lake Michigan campus, atop Loyola University's newest learning lab in Chicago, is a rooftop prairie garden, planted on eight-inch soil beds. This urban oasis of tranquility provides a place where birds nest, amid a green outdoor environment. The Michael R. and Marilyn Quinlan Life Sciences Education and Research Center, designed by architects, SCB - Solomon Cordwell Buenz, provides stormwater detention, improves water quality, reduces the heat island effect of the city, and increases the life of the roof. Renee Euler, ASLA, landscape architect and designer of this green roof says, "It's a great view. It's a unique place for a prairie to be living and it has the potential to spread the seeds of native plants across Chicago."

These secret gardens, hidden from general view, and some very public green roofs, are a growing new trend in sustainable design and stormwater management. Green roofs maximize the buildable area of a project site and provide new places for people to go outdoors in an urban environment. Owners receive value from architects and design professionals who understand how to design, plant, specify, and construct green roofs.

Roofs are designed to keep rain and snow out of and away from a building, and support mechanical equipment. Roofs keep buildings dry and prevent heat loss. Traditional flat roofs are often unsightly, add little to building aesthetics, and represent a landscape of potential opportunities for designers. They add to the hard surfaces of the urban landscape or building site, and require stormwater mitigation.

A green roof or garden roof is a high-performance, environmental statement. Green roofs include many of the same components as conventional roofs, including insulation, waterproofing membrane, ballast, and flashing, but also contain components to provide moisture retention/drainage as well as a growing media to support the plants. building performance standards.

Types of Gardens on Roofs Require Programming Decisions

Programming a building requires knowledge of how it will be used. Green roofs can support the weight of soil, rain, snow, and in many cases, pedestrians, on top of an engineered roofing system. Manufacturers typically provide two categories of garden roofs: intensive roofs and extensive roofs. Each type of roof has different maintenance, structural, and performance criteria that must be evaluated.

Intensive Green Roof Benefits

Intensive garden roofs can be pedestrian-friendly, with walking paths, plants, shrubs, and even trees. Soil depth is determined by the programmed activity to occur on the roof. The cost of supporting pedestrians, and saturated soils, is countered by the benefits of adding additional usable tenant areas. In addition, intensive roof gardens provide new areas for infiltration and storage of stormwater.

In 2004, according to the City of Chicago Department of the Environment, more than 80 municipal and private green roofs, totaling over one million square feet, were in various stages of construction. In November 2005, spokesperson Connie Buscemi of the Chicago Department of Planning and Development said that Chicago had over two million square feet of green roofs in the city. "Chicago has become the model for meshing green roofs with development and the environment." The city encourages green roofs to be added to industrial buildings as well as single family houses by providing grants and assistance programs to developers.

Chicago initiated a program based on the principal that adding plants and trees to the urban fabric reduces Urban Heat Island effect. Cities are hot, full of heat-storing pavement. More trees and plants in a city can change the temperature and decrease the cost of air conditioning. The City of Chicago claims that it saves almost $3,600 annually from its green roof on City Hall roof through energy savings. The associate architect on this Chicago landmark is William Worn Architects and the rooftop design, completed in 2001 by Conservation Design Forum. The city is monitoring the green roof on the Chicago City Hall and tests show that when the air temperature is ninety degrees Fahrenheit, the green roof temperature is also ninety degrees, whereas the asphalt roof on the adjacent building is one-hundred and sixty degrees. Continued studies of green roof projects in the city are proving the case for green roof installations.

The City of Chicago's Department of the Environment began to promote green roofs in the mid-1990s. They provided grants for roofs, such as one for Schwab Rehabilitation Hospital, designed by Stephen Rankin Associates, to reduce the heat island effect. In July 2004, *U.S. News & World Report* named Schwab as one of the top U.S. hospitals, citing the therapeutic environment of the unique rooftop garden as one of the reasons.

Photo Courtesy American Hydrotech, Inc.

Assembly of Intensive Garden Roof.

David Rahija, Schwab's Director of Inpatient Therapy, is excited by this thriving garden, completed in 2003. He says "The garden is not only a place for patients but also a place for staff to relax." Master Gardeners, a volunteer gardening program, has volunteered to assist with plant maintenance. Above the roof membrane system, some of this roof is paved with a highly reflective concrete paver on pedestal walkway. The roof has deep planting beds, trees, and a flowing stream built up above the roof deck, accessible from the therapy rooms. Patients in wheelchairs can plant flowers in wheelchair accessible flowerbeds. Planting, weeding, and watering improve motor coordination, and manual dexterity. Therapists have designed programs for sensory stimulation and for learning relaxation techniques. Staff and patients appreciate the ability to go outside. Patients are provided with a safe outdoor space, where therapists use horticulture therapy to heal and restore well-being. This verdant garden grows benefits beyond initial costs, through spiritual healing and environmental benefits for patients and caregivers.

Extensive Garden Roofs are Worth the Effort

An extensive garden roof is usually much lighter and thinner than the intensive roof. Since it is typically not intended for additional usable space, developers question whether it is worth the effort. As land values rise, developers need to maximize building footprints. Small sites and large parking requirements leave little room for stormwater storage. The usual solution is to bury large storage tanks under the pavement for storage and filtration or to direct all stormwater to city storm systems. Shrinking stormwater infrastructures have placed more fees on developers, thereby encouraging green roofs as viable solutions.
"The more green roof you put on, the less stormwater you have to put somewhere else,"

explained landscape architect Cheryl Zuellig, ASLA, of JJR, in Ann Arbor, Michigan. Research studies at the Russell E. Larson Agricultural Research Center by Penn State University quantified a 50 percent reduction in runoff from a three-and-one-half-inch green roof. Continued studies are proving the stormwater retention of green roofs in many climates, different soil thicknesses and the type of plants. Green roof providers will help design professionals calculate the amount of storage available by design on a roof, based on climate data and required local stormwater codes.

Municipalities determine rainfall in many ways. The quantity of rain is calculated by quantifying the average rainfall, as well as the frequency and magnitude of a storm event. The most common criteria for rainfall are the amount recorded in a 100-year storm. This is defined as the amount of rainfall that has a one percent chance in any given year of being equaled or exceeded. Building codes require that developed properties should minimize stormwater run-off onto other properties, or into storm sewers. Washtenaw County, Michigan is one of many municipalities to research new stormwater infiltration systems. They are waiting for the research data to confirm what many Europeans already know: green roofs are an effective stormwater mechanism and will lead to a decrease in the cost of municipal infrastructure.

Green roofs can solve this problem, if designers understand the trade-offs involved for stormwater detention. Rainy Portland, Oregon is statistically only slightly wetter than Michigan. The difference in Portland, which allows designers a one-to-one trade-off for green roofs as stormwater detention, is that the typical storm event consists of light rainfall that falls over a longer period of time. In Michigan, a storm will flood the storm sewers quickly, requiring a larger storage capacity to accommodate potentially larger flood storage. A typical roof system in Portland can be more shallow than a roof system in Michigan.

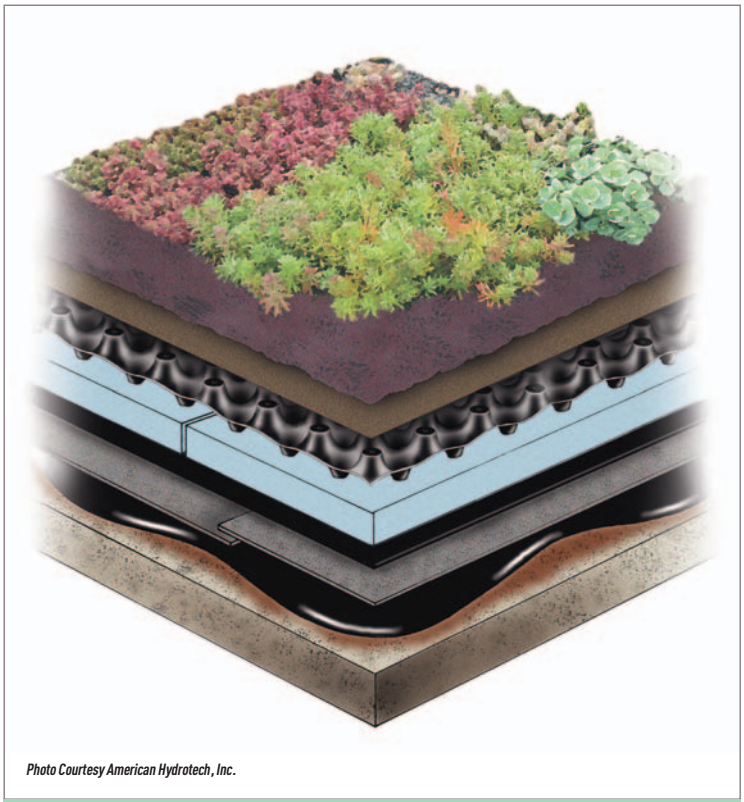
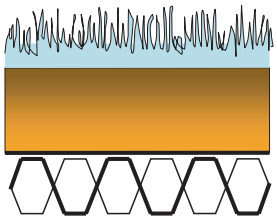


Photo Courtesy American Hydrotech, Inc.

Assembly of Extensive Garden Roof.

Green Roofs

Extensive - Green Roof Assembly (min. thickness)



	Weight (lb/sq.ft.)	
	Dry	Wet
Extensive Soil (3")	14.0	18.0
Drainage/Retention	0.3	0.9
	14.3	18.9

Courtesy American Hydrotech, Inc.

The rooftop garden at JBG Companies in suburban Maryland is an example of an extensive roof garden designed for storm water management. The site was in a community concerned with impervious surfaces and rising taxes. One of a cluster of buildings, Woodland Park One, was built on a site that had been completely paved. Jef Fuller, AIA, managing principal of DNC Architects, Inc., realized he had an opportunity to solve a stormwater problem and increase the value of the property to the developer.

In Maryland, if an architect can increase the area that can absorb rainwater by 20 percent beyond the existing development footprint, then there is a waiver of one-to-one per area for stormwater requirements. For Fuller, this meant that the building area would be increased if he could place the stormwater detention above ground, instead of burying it under the parking area. Calculations proved that the costs were identical if he put a green roof on the building, instead of burying the stormwater in an underground tank. Additionally, the green roof had the advantage of being part of the viewscape for office workers in the higher buildings, which were in the next phase. The roof was completed in 2003 and requires no irrigation, and maintenance is minimal.

Fuller demonstrated to his client, JBG, and to Montgomery County authorities that the green roof would decrease the site's impervious area from 88 percent to 40 percent. Through his calculations, the owner saved permit time, reduced underground storm storage tanks, and complied with Maryland's Smart Growth initiative for green roofs.

The Pieces Must Fit Together

The Hanging Gardens in ancient Babylon, New York City's Rockefeller Center Plaza, and earth-bermed houses of the 1970s, are built-up roof gardens using conventional heavyweight soils. New technologies provide architects with interrelated roof components, creating a lightweight viable living roof by design.

The most common deterrent to adding a green roof is the cost of the additional structure required to support the roof load. Jeremy S. Edmunds, Assoc. AIA, P.E., LEED-AP, project manager at Brownfield redeveloper Cherokee Northeast, in East Rutherford, New Jersey states, "We haven't built a green roof yet, but are studying them for several projects in the Northeast. If waterproofing and structural loading concerns are addressed, we feel green roofs will turn heat island eyesores into welcoming gardens."

Green roofs add weight, or dead load, to the roof of a structure and must be factored into its design. Besides the weight of the roof membrane and insulation, the weight of the green

Staten Island Ferry Terminal—St. George Terminal, Staten Island, NY • Architect: New York office of Hellmuth Obata + Kassabaum
This one-quarter acre extensive green roof provides rainwater collection for irrigation and stormwater retention.

roof components, growing media (soil), and plants must be taken into consideration. Of these, the soil weight is typically expressed as a saturated or wet weight. Some extensive green roofs can weigh little more than a traditional roof with ballast; however this weight can increase substantially as the thickness of the soil is increased to accommodate the wider variety of plants that can be placed in an Intensive green roof. The soil for a green roof can weigh between 5.5 to 7.5 pounds per square foot per inch of depth (wet or saturated weight), so on a typical extensive green roof, a three-inch depth of soil would add 16.5 to 22.5 pounds per square foot. This spread in weight is largely dependent on the composition of the soil, and can vary between green roof providers.

Green Roof Resources

Green Roof Resources
U. S. Green Building Council. http://usgbc.com

PENN State Center for Green Roof Research.
http://hortweb.cas.psu.edu/research/greenroofcenter/

City of Chicago. http://egov.cityofchicago.org/city/

Green Roofs for Healthy Cities:
Your Green Roof Infrastructure Industry Association
http://www.greenroofs.net/index.php?option=com_content&task=view&id=18&Itemid=30

ASTM.
http://www.astm.org/cgibin/SoftCart.exe/DATABASE.CART/WORKITEMS/WK575.htm?L+mystore+kpnj0867+1085198469

The Greenroof Directory.
http://www.greenroofs.com/resources.htm

The Guidelines for the Planning, Execution and Upkeep of Green Roof Sites, also known in Germany as the FLL standards, is the international standard for green roofs. For 35 years, Germany has been greening its roofs, and this technology is now being used in the U.S. New building codes are being developed for green roofs and testing standards are being written by the ASTM International Green Roof Task Group.

A client once phoned Frank Lloyd Wright to complain about a leaking roof over their dining room table. "Move the table," he said. Some owners may initially balk at the idea of a green roof because of a past unfortunate roof experience. Most owners want to see a roof drain completely and as quickly as possible, and the idea of actually retaining water within a green roof assembly is a foreign concept to most. Of the various components that make up a green roof, there is none more important than the roof membrane. No matter how great a green roof looks, if it leaks, the owner will not be happy. There are a number of roof membranes and assemblies available, including: built-up, single-ply, asphalt prefabricated sheet, and fluid applied, just to name a few. Not every roof membrane or assembly is designed to be buried beneath a green roof assembly, in a continuously wet environment, so it is critical that the membrane manufacturer be consulted to insure their product is up to the task.

The ideal membrane for a green roof assembly should have several attributes. The membrane must be capable of performing in a wet environment, long lasting, bonded to the substrate (making it easy to locate and repair damage if it occurs), monolithic or seamless, easy to detail, installed by an authorized trained applicator, and fully warranted. One type of roofing membrane which has performed well, with a successful 40 year track record in buried wet applications is a fluid applied rubberized asphalt membrane. This type of membrane is applied in a fabric reinforced assembly 215 mil thick, directly to the substrate, and is monolithic, and ideal for green roof applications.

Vegetation-free zones are typically incorporated around a building's perimeter edge, at drains and at other penetrations through the roof. These areas typically consist of a 12- to 18-inch-wide path of stone or concrete pavers, and protect the roof flashings from the plants roots, as well as provide ease of access to the flashings (if ever needed), a fire break, and wind uplift protection. Green roofs installed in high wind areas and on taller buildings need to be designed to accommodate the specific wind uplift forces on these roofs, especially at the corners and perimeter edges. The vegetation-free zone in these cases must be enhanced in order to accommodate these forces.

Roots are Contained by Barriers

Whether planting smaller grasses or larger shrubs, all plants have roots. The balance between protecting the membrane from damage and promoting healthy root growth and spread (not confining or killing roots) is the primary goal of a root barrier. Root barriers can vary depending on the type of plants. For species with aggressive root systems, contractors can lay asphaltic sheets with an embedded repelling agent or heavy duty plastic sheets with taped or overlapping seams to prevent root penetrations. For smaller plants with less aggressive root systems, thin polyethylene sheets are installed, again overlapped with seams. ■

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The article continues online at ***http://archrecord.construction.com/resources/conteduc/archives/0512american-1.asp***

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AIA/ARCHITECTURAL RECORD CONTINUING EDUCATION Series

LEARNING OBJECTIVES

After reading this article, you should be able to:

- *Identify the components of a green roof.*
- *Describe how green roofs help with stormwater management.*
- *Analyze green roofs as part of your environmental strategy.*

INSTRUCTIONS

Refer to the learning objectives above. Complete the questions below. Go to the self report form on page 354. Follow the reporting instructions, answer the test questions and submit the form. Or use the Continuing Education self report form on *Record's* web site—*archrecord.construction.com*—to receive one AIA/CES Learning Unit including one hour of health safety welfare credit.

QUESTIONS

1. What is the most important element of a green roof?
- **a.** A quality membrane designed for a wet environment
- **b.** Inspection chambers
- **c.** 18-inch vegetation free zone
- **d.** Insulation

2. Plants should be selected based on which criteria:
- **a.** Size
- **b.** Root system
- **c.** Drought resistance
- **d.** All of the above

3. Intensive green roofs are:
- **a.** Always 3-inches thick
- **b.** Low maintenance
- **c.** Require no irrigation
- **d.** Pedestrian friendly

4. The weight of an extensive green roof is calculated by:
- **a.** Thickness of the membrane
- **b.** Type of plants
- **c.** Thickness of the growing medium, type of plants, and the weight of the components
- **d.** None of the above

5. The benefits of green roofs are:
- **a.** Improved water quality
- **b.** Reduced impervious surfaces
- **c.** Reduce the heat island effect
- **d.** All of the above

6 Growing medium for a green roof may contain all but which of these materials:
- **a.** sand
- **b.** mica
- **c.** slate
- **d.** scoria

7. Vegetation-free zones, typically consisting of pavers at the building's perimeter edge, serve all of the following purposes except which?
- **a.** Create a fire break
- **b.** Provide ease of access to flashing
- **c.** Replace the need for drains
- **d.** Offer wind uplift protection

8. An essential part of rainwater storage on a green roof:
- **a.** Waterproofing
- **b.** Drainage assembly
- **c.** Flashing
- **d.** Ballast

9. Green roof manufacturers should:
- **a.** Provide only the roof components, not the plants
- **b.** Provide and warranty all components including the growing medium
- **c.** Provide certifications from English testing agencies
- **d.** Provide netting for geese

10. Roof pitch for an extensive green roof can be up to:
- **a.** 0 degrees
- **b.** Less than five percent slope
- **c.** Less than 45 percent slope
- **d.** Planted the same way on each side of the slope

Photos Courtesy American Hydrotech, Inc.

Currier Center for the Performing Arts, The Putney School, Charles Rose AIA, Charles Rose Architects Inc., Boston, Massachusetts
The architect for the Putney School for the Performing Arts Center was inspired by the forms of the White Mountains, creating dramatic roof lines above this energy-efficient building. The sloped green roof insulates the structure from the harsh New England winters.

Watering the Plant and Aerating the Soil is Part of the System

The delicate equilibrium between over-watering and not providing enough water can be challenging enough with common houseplants. The scale is greater on a roof top, but the issue is the same. Moisture retention and drainage panels that incorporate both a reservoir system and drainage channels are located beneath the soil, under a filter fabric, in a well-designed green roof. The drainage assembly and retention layer plays an essential part in storing rainwater that filters through the growing media. A system which looks like an egg crate works as follows: Drainage channels above and below ensures that excess water is free to drain out of the system. The profile of the components also provides water storage troughs, that retain additional water for use by the vegetation. Diffusion holes through the panels allow air circulation and water vapor to move up into the root zone. In an extensive roof where little or no additional irrigation to be provided, a moisture mat can be added to the system assembly to absorb and store additional usable water.

Dirt

Dirt is a common material, but soil is generally engineered as a growing medium for green roofs. As most gardeners will testify, dirt is heavy and often contains clay that does not allow water penetration. Soil prepared for green roofs is 30 percent lighter than ordinary soil and retains moisture, contains nutrients, and provides good drainage. These soils are blended mixes of sand and organic matter, along with lightweight aggregates such as expanded shale, slate, clay or pumice or scoria (which is the refuse from melting of metals).

Too much acidity in the soil prevents plant growth. On roofs, rain and the pollution carried by rain, will be too acidic and not have the proper pH balance for growth. The pH scale ranges from 0 (too acidic) to 14 (too alkaline), and good soil needs a pH level of about 6.5. The microclimate of the site and surrounding soils may need to be tested in order to provide the appropriate green roof soil nutrient mixes.

Plant Selection Criteria

The Loyola University roof garden is an extensive garden planted with native prairie plants and sedums. Succulent plants, sedums require little soil, can withstand long periods without water, and thrive in difficult climates. They are less than one foot tall and come in a variety of attractive colors and shapes. For these reasons, sedums are considered the perfect plant for an extensive garden roof.

Gardeners select plants based on climate conditions. Roof gardeners must understand rooftop ecology and choose plants appropriate to the level of care provided in the roof system. Since roof landscapes mimic nature, plants should be sustainable. Plants should be selected based on their size, tolerance to drought, and maintenance requirements, and by combining annuals and perennials, cool and warm season plants, and shallow-rooted wildflowers with fibrous grasses provides variety.

Intensive roofs, such as the Schwab Hospital roof, are landscaped for diversity. Plants were selected to frame the seasons, and care was taken to create a Midwest garden of native plants. Qualified landscape architects should be selected to prepare a plant list for the green roof. Plants provided for a green roof should have a tolerance for drought, have non-invasive, fibrous roots, and grow fast. The garden should be planted so it can grow for a season before winter dormancy in Northern climates.

Case Studies

Some garden roofs are sloped or even curved, such as the building for Gap, Inc. in San Bruno, California, designed by William McDonough + Partners, of Charlottesville, Virginia. "How many buildings do you know that have made oxygen lately?" William McDonough, FAIA, often asks architects. Intensive garden roofs are designed for a maximum slope of 51-to-300 millimeters (two- to twelve-inches).

Extensive garden roofs can have steeper slopes, and some green roofs have been installed up to a 45 degree slope. Design for roof slopes requires analysis of the climate, wind direction, and sun angles. The amount of snow, and rain patterns, will affect the type of plant on each side of the roof slope, depending upon the roof orientation.

Bruce Eisenberg, AIA, Director of Architecture for the New York City Department of Parks and Recreation, in Flushing, New York, is completing design in 2005 for a new green roof at the Marine Park Senior Center, in Brooklyn, with estimated completion in 2007. As the first sustainable green building designed in-house by city employees, the structure will be equipped with photovoltaic solar panels, a geothermal system, and an extensive green roof, which blends into the environment. It will reduce the heat island effect of the urban location and reduce stormwater runoff, keeping much of it on-site, while removing pollutants, thereby reducing the impact on the City's overloaded waste system. "The green roof, with an unusual round form, and rooftop photovoltaics, responds to the environment," says Eisenberg. The design team is striving for compliance with the U.S. Green Building Council's (USGBC) rating system, Leadership in Energy and Environmental Design (LEED), and a silver rating.

In 2005, Eisenberg noted, Mayor Michael Bloomberg signed legislation mandating that by 2007, 50 percent of all New York City agencies with capital projects exceeding two million dollars will be required to comply with the USGBC'S LEED program, with the goal of achieving silver ratings. This law will significantly increase interest and demand for green roofs with New York City.

Architects Pappageorge Haymes Ltd., designed the rooftop at the Domain Lofts at ePort, in Chicago, Illinois. The site was an abandoned Montgomery Ward & Company Catalog House, with a footprint too wide for rehabilitation as housing. The designers chose to remove a large swathe of interior construction building new walls and a new roof exposed to the elements. This is an example of how architects can design a new roofscape for tenants where the view to the garden is better than the view on the street.

Gardens improve the quality of life, and add quantifiable real estate value to projects and the built environment. Green roofs are a good business decision for rooftops of new mixed-use housing complexes, and hotels with rooms facing rooftop vents and gravel landscapes.

Research demonstrates that human health is improved by exposure to nature, fresh air and growing plants. In hospital and healthcare environments, views to natural landscapes enhance healing, and gardens have traditionally served as sources of respite and inspiration. The Japanese create Zen gardens for meditation.

Standards For Green Roofs

New codes are being developed for green roofs and testing standards by the ASTM International Green Roof Task Group. These standards include standard guides for selecting plants, determining dead loads and live loads, tests for water retention, wind loading, and definitions of components.

Manufacturers typically provide warranties for green roofs, and guarantee that their products will last with proper installation. Green roof suppliers should provide green roofs with the following:

- All of the components of the entire system, from waterproofing membrane to the growing medium.
- Proper considerations for wind loading and fire safety
- Material data proving that the system conforms to FLL and ASTM standards
- The total weight of the system
- Stormwater calculations for the site location
- Plant recommendations, especially for extensive roofs
- Specifications for all products
- A single source warranty for all components from the deck up
- Authorized trained installars ensure good workmanship
- A portfolio of successful projects

An Environmental Tool

Architects, owners, and contractors who care about the environment, love green roofs. They help the environment by mimicking the natural cycle of rainfall on the earth, while adding new outdoor spaces in dense urban environments. Green roofs lower heating bills by adding insulation, and extend the life of the roof by protecting it from ultraviolet rays. They create visual excitement and new uses for leftover building areas. Green roofs provide many environmental benefits to building owners and communities. Tenants living in mixed-use projects with green roofs have the advantage of a place to get some fresh air and quiet respite in urban environments.

The U.S. Green Building Council's rating system, LEED, grants points that certify a building as green. Green roofs will allow points based on the LEED 2.1 rating system. Points can be given for numerous benefits including stormwater management, since the effect of a green roof is that it decreases the impervious surface of a site. A specific credit addressing reduction of heat islands is available and green roofs qualify as long as they cover at least 50 percent of the roof surface.

In addition, some green roof manufacturers use recycled content in the waterproofing membrane, granting additional points towards certification. Green roofs can provide credits for supplying materials within a 500-mile radius of the site, and also count for the reduction of site disturbance. Innovation credits are often given to projects that incorporate green roofs. Leaders in the environmental movement know that adding a green roof contributes to the environmental qualities of a project.

"To create a garden is to search for a better world."[1]
Visions of Paradise: Themes and Variations on the Garden. Photographs: Maria Schinz, text: Susan Littlefield. New York: Stewart, Tabori & Chang, 1985

Roof gardens change the nature of the built environment. They also add to biodiversity. Reid R. Coffman, University of Oklahoma assistant professor of landscape architecture who researches green roof fauna and habitats says, "Longstanding living examples in Switzerland have shown green roofs can be viable habitats for threatened and endangered species. The wonderful part about biodiversity is the challenge designers will face with regards to context. This demand for contextualism will perpetuate a flurry of wonderful, innovative projects. These attempts, trying to connect the extremes of rooftops and viable habitats, will subsequently uncover essential knowledge in the mission of ecological design."

By providing sustainable, aesthetic and functional outdoor spaces, design professionals can plan projects with exciting new elements, added value, and significant, tangible benefits, thereby enhancing the built environment, and creating new landscapes for the 21st century.

Celeste Allen Novak, AIA, LEED AP, is an architect, environmentalist and writer in Ann Arbor, Michigan.

Source:

1. Visions of Paradise: Themes and Variations on the Garden.
Photographs: Maria Schinz, text: Susan Littlefield. New York: Stewart, Tabori & Chang, 1985