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Sedums Over Baltimore: How a Green Roof Made a Rehabilitated Building More Sustainable

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SEDUMS OVER BALTIMORE

How a green roof made a rehabilitated building more sustainable. By Theodore Eisenman

In May 2004, two years after planting, Katrin Scholz-Barth stands on the 20,000 square-foot extensive green roof she designed for the Montgomery Park Business Center in Baltimore.

CONSTRUCTED IN 1925 to receive and dispatch trainloads of merchandise up and down the East Coast, the 1.3-million-square-foot Montgomery Ward Catalog Building in Baltimore thrived for decades as a regional distribution center. Like many of its industrial counterparts, however, the building fell into disuse, and it stood abandoned for 25 years.

GREEN ROOF CASE STUDY

Now, this massive structure and 28-acre site have undergone adaptive reuse as part of the new Montgomery Park Business Center. A central design feature: its 30,000-square-foot green roof. Installed in August 2002, a 3-inch-thick extensive green roof encompasses 20,000 square feet on the main building and another 10,000 square feet on an adjacent warehouse. Designed and installed under the supervision of Katrin Scholz-Barth, a Washington, D.C.-based civil engineer and expert on green roof technology, Montgomery Park won a 2003 Award of Excellence in the "extensive retrofit" category from Toronto-based Greening Rooftops for Sustainable Communities.

The idea for a green roof came from a proposal by local developer Himmelrich Associates in response to an RFP from the Maryland Department of the Environment (MDE), which was searching for a new headquarters office to house over 850 employees. Among other things, MDE was concerned about reducing nonpoint-source stormwater pollution into the Chesapeake Bay. Under conventional practices, stormwater is collected from impervious surfaces such as parking lots, roads, and roofs and channeled to the nearest body of water. This can degrade aquatic health by contributing pollutants, causing combined-sewer discharge, and increasing the volume and velocity of flow.

Stormwater management was of particular concern at this mostly impervious site. Once the roof is fully vegetated, it is expected to reduce runoff by 50 to 75 percent. (It should be noted, however, that the green roof is only 18 percent of the total building roof area and one component of an integrated stormwater management system.) The remaining roof runoff, along with parking lot runoff, is collected in a 30,000-gallon underground cistern and reused for flushing toilets. Other stormwater interventions include recycled porous pavers and two vegetated bioretention areas in the parking lot.

Himmelrich Associates was already planning to redevelop the Montgomery Ward site and saw an opportunity to immediately

ALL PHOTOS AND DRAWINGS BY KAI-HENRIK BARTH

lease 20 percent of the building. The developer submitted a proposal that addressed many of the ecological design concerns articulated in the RFP, including a green roof. The proposal subsequently qualified for a $92,000 EPA Section 319(h) Clean Water Act grant to facilitate implementation of the roof.

One of the functional constraints of retrofitting a building with a green roof is the weight-bearing capacity of the existing roof structure. For this reason, lightweight extensive green roofs (usually two to four inches thick) are becoming increasingly popular for their ability to capture stormwater, insulate buildings and conserve energy, prolong roof life, and lower surrounding temperatures.

Montgomery Park's green roof also serves as an educational demonstration project. Prominently featured on the roof of what used to be the central loading dock for trains, the green roof is visible from seven floors on three sides and offers a pleasing view from two glass-backed elevators. This location exposes the green roof to more than 1,000 people per day, but it also increased the cost of the project by necessitating structural retrofits to allow for two new skylights, to meet building codes for snowdrift, and to accommodate the added weight of the green roof soil. It is therefore difficult to ascertain the exact cost of the roof. According to Scholz-Barth, green roof vegetation and planting media alone cost roughly $8 to $12 per square foot.

The roof, able to support 15 to 25 pounds per square foot when saturated, consists of a single-ply PVC liner, which serves as the waterproof membrane, covered with a 2.5-inch-thick insulation board, followed by two geotextile layers that keep soil from migrating through the profile and washing out. The roof is double pitched and slopes 7 percent to either

The green roof installation, June 2002: The growing medium is lifted onto the roof and distributed in a uniform three-inch-deep layer *(top)*. Tiny green roof plant plugs are being installed *(middle)*. A roof section with completed planting *(bottom)*.

side, providing enough gravity flow that no drainage layer is necessary. According to Scholz-Barth, no additional root-protection layer was needed because PVC acts simultaneously as a waterproofing and root-protection layer. In contrast, the petroleum-based asphalt used on conventional roofs is an organic material that plants can break down, so it requires an additional root-protection layer. And while conventional roofs use gravel ballast to hold the waterproof liner in place, the plants and soil on a green roof serve as ballast.

The planting medium consists of 75 to 85 percent inert expanded slate with 15 to 25 percent organic material. At Montgomery Park, the organic matter is a composted mushroom substrate that comes from a nearby organic mushroom farm. The expanded slate, which puffs up like popcorn when heated in a rotary kiln, was mined and transported from North Carolina. This inert material is important to the long-term success of the green roof. Over time, the organic matter will decompose and erode. When this occurs, a durable lightweight substrate is essential to prevent compaction and maintain the necessary void space for water retention and healthy plant roots.

According to Ed Snodgrass of Emory Knoll Farms, the nursery that provided the plants, the substrate is an important consideration. "Green roofs are a long-term investment, and you don't want to design something that will require ongoing maintenance, like replenishing soils and plants," says Snodgrass.

The green roof, *above* and *below,* covers the former train-shed roof of the old Montgomery Ward Catalog Building. Building occupants and visitors can see the roof from seven stories above and while riding in the glass elevators.

A compelling economic argument for green roofs is that they prolong the life of conventional roofs by protecting them from ultraviolet radiation and extreme temperature fluctuations—the two primary sources of roof membrane degradation. On a conventional asphalt roof, for example, annual temperatures may fluctuate 170 degrees. Green roofs, on the other hand, dramatically reduce this temperature differential. In a study using infrared thermometers, the Chicago Department of Environment found that on a 100-degree day, the surface temperature of a blacktop roof reached 165 degrees Fahrenheit, while a green roof was only 85 degrees. Not only do green roofs save money by lengthening the life span of roofing

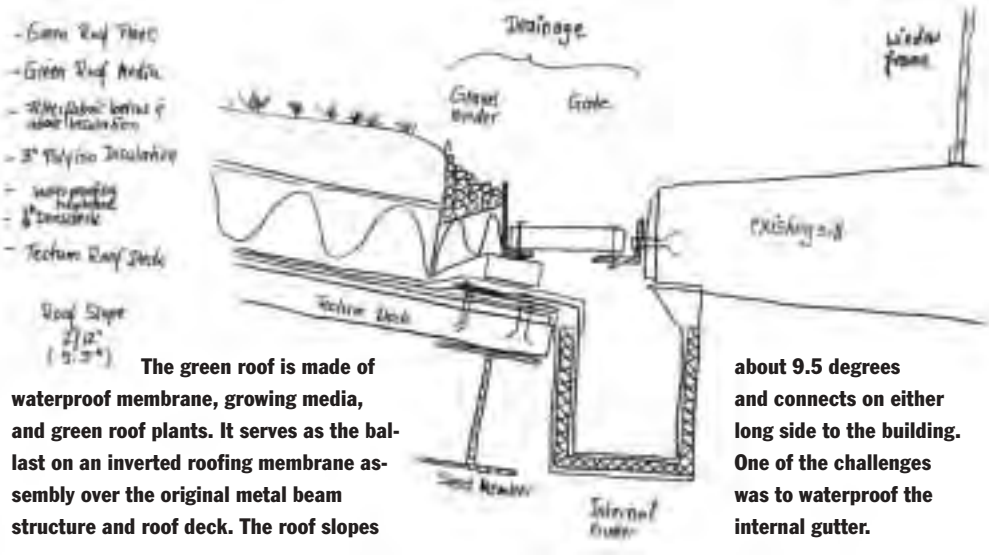
membranes multiple times, they also yield short-term savings by insulating buildings and reducing energy use. Research shows that green roofs can cut energy costs in half in summer and by 25 percent in winter.

From his nursery north of Baltimore, Snodgrass has been testing and cultivating green roof plants for the past five years. "The Germans have been testing and building green roofs for the past few decades," says Snodgrass. "But their climate is milder than ours, and some plants that succeed in Germany often wither under the hot summer conditions here in the United States."

Together with Scholz-Barth, Snodgrass specified the soil and selected the plant palette for the Montgomery Park roof. Because the roof is visible from seven floors on three sides, certain plants were selected for their aesthetics and year-round interest. However, the overarching variable guiding plant selection was long-term viability. Seventeen species of plants were selected from the sedum, rosularia, and sempervivum families, and roughly 61,000 plugs were installed at two plants per square foot.

The installation process presented challenges stemming from construction staging and roof repairs. The roof membrane was left unprotected for several months, and during this time new glass panes were installed into the original window frames seven floors above the roof. Falling debris and glass damaged the membrane, which had to be repaired, so even though the plants were delivered to the site in April as originally scheduled, they had to be stored on an adjacent warehouse roof before being installed in June. This prolonged staging

Plants form a dense vegetation cover two years after planting. *Top:* white flowering *Sedum album, Sedum floriferum* 'Weihenstephaner Gold' with dry flower pods, *Sedum spurium* 'Fuldaglut', and yellow flowering *Sedum sexangular. Middle: Sedum spurium* 'John Creech', *Sedum spurium* 'Fuldaglut', *Sedum kamtschaticum, Sedum album,* and pink flowering sedum rose carpet. *Bottom:* a cluster of white flowering *Sedum album* with sempervivum and *Sedum dasyphyllum* in the center.



The green roof is made of waterproof membrane, growing media, and green roof plants. It serves as the ballast on an inverted roofing membrane assembly over the original metal beam structure and roof deck. The roof slopes about 9.5 degrees and connects on either long side to the building. One of the challenges was to waterproof the internal gutter.

caused the plant plugs to endure significant stress from drought, near-hurricane winds, and high sun exposure. Some plants even went into temporary dormancy.

The plants also endured difficult conditions during planting. The weather was hot and dry, and the dark surface of the slate radiated the heat back to the plants, requiring temporary irrigation with tripod sprinklers. Ideally, green roof plants should be installed during mild periods that have frequent natural precipitation, typically spring or fall, so that roots can get established without supplemental irrigation. At Montgomery Park, irrigation was used to help plants gain a foothold but was disconnected in September 2002, after just three months. Despite less-than-ideal staging and installation conditions, the plants were resilient and had about an 85 percent survival rate.

In February 2004, the vegetative cover was somewhat thin. However, a visual review in June—only the second growing season—showed vigorous growth approaching complete cover. *Sedum album* and *Sedum sexangular* were displaying their white and yellow flowers, as were *Sedum ewersii* and *dasyphyllum* and some of the sempervivum. *Sedum floriferum* 'Weihenstephaner Gold' blooms in April and May and had already finished flowering. The roof ridge, where the water drains most quickly, is currently thinly vegetated, but the sempervivum, a very slow-growing plant, is expected to eventually cover it.

Construction complexities and insufficient communication between the various contractors also led to monitoring and evaluation difficulties. In an effort to determine the green roof's actual temperature and stormwater reduction capacity, a state environmental monitoring agency implanted subsurface temperature loggers in the soil substrate and installed water gauges in the existing building gutters. However, well-meaning construction workers mistook the water gauges for debris and removed them. Likewise, the temperature loggers were unknowingly marked with the same flags that the landscape contractor later used to place plants, and the flags were unintentionally removed during planting.

Despite the initial failure of monitoring efforts, new loggers were later reinstalled to measure temperature: one on top of the green roof surface, another in the green roof substrate, and a third on a conventional roof on the main building as a reference point. Over 7,400 data points were recorded between May and October 2003. But 2003 was not a typical year. Rainfall exceeded the average by 30 percent, and the summer was not as hot and dry as usual. In addition, the dark surface of the Montgomery Park green roof substrate is not representative of most extensive green roofs. Nevertheless, the green roof measurements showed a lower temperature fluctuation and a lower maximum temperature almost throughout the entire monitoring period, which is consistent with monitoring data from other green roof projects.

The green roofs are just one strategy in a comprehensive sustainable design approach at Montgomery Park. In addition to stormwater reduction strategies, interior design features include waterless urinals, high-efficiency light fixtures and automatic light sensors, recycled carpeting, and recycled materials for workstation panels and desks. During construction, roughly 80 percent of all removed materials were recycled, and the adaptive reuse of the building itself responds to Maryland's "smart growth" efforts to reduce urban sprawl by encouraging urban infill and redevelopment. Over 60 bus lines serve the location, which connects to light rail by shuttle. As the south anchor of Baltimore County's urban renewal plan, Montgomery Park is now the region's largest employment center, housing more than 5,000 workers who see the new green roof every day. LAM

Theodore Eisenman is principal of Environmental Design & Communications. He was a finalist for the 2000 international design competition for the Dr. Martin Luther King Jr. National Memorial, and he is currently managing a USDA Forest Service Living Memorials project.

Resources

- "A Grass-Roots Movement," May 1998, and "Meadows Above," September 2000, both *Landscape Architecture.*
- Green Roofs for Healthy Cities, *www.greenroofs.ca.*
- Katrin Scholz-Barth Consulting, *www.scholz-barth.com.*