

Use of Vegetated Roof Covers in Runoff Management

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The effectiveness of green roofs in reducing runoff impacts, especially in densely developed areas, is one of the principal reasons that they are so popular with city engineers in Germany. In Germany alone, more than 20 million square feet of new green roof are installed every year. Many cities require green roofs for buildings in districts that are plagued by chronic runoff-related problems.

Runoff Control Using Thin Vegetated Covers

A critical aspect of using vegetated roof covers is to clearly identify the management goals and develop suitable design criteria. It has been demonstrated in Germany that the 3-inch vegetated roof cover has the highest benefit to cost ratio. A properly designed 3-inch vegetated roof cover will provide a durable, low maintenance system that can achieve the objectives of moderating temperature, reducing runoff, and prolonging the life of the underlying waterproofing materials. Furthermore, these systems can be added to most existing buildings, often without having to reinforce or otherwise alter their structural design.

The value of green roofs in reducing the rate of runoff depends upon the design rainfall events that are considered. For communities where runoff rates are computed using the rational method (which emphasizes the impact of intense short-duration rainfall events), thin vegetated covers can typically satisfy runoff management goals for the 10-year return rainfall event, and in some cases even larger storms. Where design storms are based on 24-hour events, it is generally possible to demonstrate control of runoff to pre-development levels for storms up to several inches in magnitude (i.e., a two-year storm magnitude in southeastern Pennsylvania). It is also helpful to keep in mind that in southeastern Pennsylvania 24-hour storms with magnitudes of less than 1.5 inches contribute more than 90 percent of all rainfall.

In Germany the standard design event for urban runoff management is one inch of rainfall falling in 15 minutes. This would be a 10-year return frequency event in southeastern Pennsylvania. In our opinion, the runoff requirements for urban areas that are undergoing redevelopment should be based on the type of the storm that is linked to chronic runoff-related problems (e.g., nuisance flooding, combined sewer overflow, TMDL exceedances). By-and-large these are summer downpours. Therefore, runoff abatement programs should focus on these storms. Green roofs are a powerful tool for achieving this benefit.

Deep Vegetated Covers and Zero Discharge Installations

A typical 14-inch deep green roof can be relied on to reduce total annual runoff by 85 to 95 percent in temperate climates. In combination with other water management techniques, zero discharge is a readily attainable goal. The following are excellent examples of the integration of a variety of techniques to eliminate off-site discharge of rainfall runoff. These techniques include green roofs, cisterns, facade planters, reflecting pools, infiltration beds, and utility water recycling systems. Unfortunately, all of the information concerning these systems is in German. However, we have summarized some of these in English. The important points to remember are that: 1) these integrated building systems are a reality in Germany and that 2) a variety of techniques must be deployed in unison to achieve the goal. Although factors such as climate and geologic conditions will influence the design, there will always be a way to achieve the objective.

Cross Savings Bank (Kreissparkasse) in Weilburg

This building occupies a 3,250 square-foot area. The management system utilizes a combination of green roof landscapes, ranging in size from 2 to 6 inches in thickness. Cisterns are used to capture excess runoff for reuse in irrigation during dry periods.

Europe Park (Europapark) in Rust

This project also has a footprint of 3,250 square feet. Green roofs in combination with cisterns and low-head irrigation pumps, powered by photovoltaic panels, characterize this project.

New Convention Center (Neue Messe) in Munich

The Convention Center is a 409,000 (9 acre) square-foot complex. This is a very exciting project that integrates many management techniques. Green roofs are an essential part of the zero-discharge design and are responsible for up to 85% of the reduction in runoff. The remaining runoff reduction is accomplished by recycling runoff for utility uses and by infiltration. The Optigrün RWS computer simulation program was used to estimate the efficiency of the green roofs so that the other practices could be properly sized.

Transportation and Warehousing Center in Bondorf

This is a 40-acre development with zero runoff discharge. This stringent requirement was the result of the inability of the local wastewater treatment plant to absorb additional water from runoff. Fully 70 percent of the total area is covered with impermeable surfaces. In addition to green roofs and water recycling, this project relies on large infiltration galleries and landscape pools to infiltrate water.

These are all Optigrün projects. The designers and installers of these systems can be contacted through Roofmeadow.

The following projects are also noteworthy.

Prisma building in Nurnberg

The water management system for this project incorporates green roofs, cisterns, façade planters, water-curtain climate control, gray water recycling, and infiltration. Water management is made part of an overall artistic statement. This project was described recently in the *ASLA Professional Interest Group Water Conservation*, Vol. III, No. 1, 1999.

Pottsdamer Platz in Berlin

While not strictly an example of zero discharge, this ultra-urban development points the way to the possibilities of integrated runoff design. The design beautifully integrates extensive green roofs (2 to 3 inches) with reflecting pools, created wetlands, cisterns, and water recycling. The primary limitation of this project was the deliberate decision not to treat runoff from roads and main thoroughfares. Infiltration opportunities were also very limited due to the high water table on the floodplain of the river Sprey.

National Bank of Baden-Württemberg (Landesbank) in Stuttgart

This is another Optigrün project, which involves covering half of the 43,000 square-foot site with green roofs. A very lovely and diverse roof landscape is used to eliminate all but about 5% of annual runoff. Profiles range from 4 to 16 inches in depth.

Roofmeadow has benefitted from the assistance and technical support of Optigrün International AG. Optigrün is the world's leader in the installation of vegetated roof covers. Optigrün operates a research station at Göggingen, Germany where the performance of new materials and designs are continuously being investigated.

Data from this research was used to develop the empirical Optigrün-RWS computer simulation program, which can reliably predict the rate of stormwater runoff from a range of vegetated roof covers.

The following table summarizes output from the RWS computer simulation program for a 3.25-inch thick proto-type installation for the Fencing Academy of Philadelphia. This simulation utilized a one-year, 5-minute digital rainfall record. Two standard design storms were also inserted into the rainfall record. The predictions of the simulation were verified by field observation of the proto-type. The output illustrates that this thin green roof is much more effective in controlling brief rainfall events than long-duration storms. However, significant runoff rate suppression was achieved for all storm events. Similar analyses can be conducted as part of the feasibility phase of other projects.