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GREEN ROOFS AS STORMWATER BEST MANAGEMENT PRACTICES

EVALUATION OF EFFECTIVE GREEN ROOF PERVIOUSNESS

SAMPLE ANALYSIS MID-ATLANTIC STATES

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Background:

Roofmeadow offers green roof runoff simulation using the RWS computer model. The RWS model requires rainfall information on 5-minute intervals and information seasonal potential evapotranspiration (PET) rates. It is typically run for a 12-month climatic cycle. This specialized software was developed for projects in Germany, but provides reliable predictions for temperate areas in the US. Its usefulness is limited to green roof systems with existing analogues in Europe for which calibration data exists. For most designs this does not pose a significant problem. The output from the simulation program includes the peak rate attenuation for every storm in the rainfall record as well predictions of annual and seasonal runoff reductions. Detailed summaries of runoff vs. rainfall for individual storms can also be generated.

By intercalating artificial design storms we can provide output that can be used directly in site-wide stormwater runoff computations. Effective rational runoff coefficients and NRCS curve numbers can be back-calculated for specified storm magnitudes. Therefore, we can assign conventional runoff properties to green roofs so that they can be included in standard stormwater management programs (TR-20, SWMM, HEC, etc.). For instance, clients or regulatory agencies may ask for values such as the NRCS runoff curve number, **RCN**, or the rational method runoff coefficient, **C**. Since these coefficients were developed to describe *surface runoff*, they are not ideal descriptors of green roof performance

which is based on the physics of *percolation*. As a consequence, a value of **RCN** or **C** provided for a particular green roof system will only apply for the specific design storm for which it has been determined. Coefficients predicted using this method will be conservative for rainfalls with smaller magnitudes than the design events.

Objective:

The objective of this analysis was to compare the performance of a proposed on-structure landscape to open-space for the purposes of evaluating the effective imperviousness ratio for the development. The design storm selected for making this comparison was the standard NRCS 10-year return, 24-hour duration event with Type II rainfall distribution.

Approach:

Two types of green roof profiles were considered.

1. Profile A: 9.8-inch thick system on a level roof or structure, and incorporating flood irrigation methods.

2. Profile B: 13.8-inch thick system on a level roof or structure, incorporating flood irrigation methods.

Both profiles are based on our Roofmeadow® *Meadow* assembly that includes two types of lightweight media. The maximum weight of these two assemblies would be 66 psf and 93 psf, respectively. The design of the *Meadow* assemblies involves installing a basal layer of coarse granular material and an upper layer of finer grained media. The cover system will be installed on a level deck. In this case, the maximum distance from any part of the green roof to a roof drain will be 30 feet.

The two assemblies were simulated using rainfall data and PET (potential evapotranspiration) data from a nearby recording weather station for the years 1990 and 1991. The annual statistics for these records were:

Year	Annual Rainfall (in)	Annual PET (in)
1990	34	36
1991	29	38

When the two green roof profiles were simulated using this climatic data, the gross runoff versus rainfall ratio associated with each profile was:

Runoff: Rainfall Ratio	**Profile A**	**Profile B**
Dec thru Feb	30%	16%
Mar thru May	11%	7%
June thru Aug	10%	4%
Sept thru Nov	5%	0%
Total Annual	**14%**	**7%**

Two design storms were introduced into the actual rainfall records. These were summertime rainfall events corresponding to the 10-year, 24-hour return frequency storm (NRCS Type II distribution), and a 'cloud-burst' of 1 inch occurring over a 1 hour time period. The total rainfall volume associated with the 10-year storm was 5.2 inches. The rainfall for the 1-inch event was distributed in a triangular distribution with a peak rate of 2.2 in/hour occurring over a 10-minute interval.

To compensate for the fact that green on-structure landscape would have some impervious tributary area, we increased the effective rainfall rates in the simulation by 22%. Therefore, the results should be representative of conditions where the overall area under consideration is 22% impervious.

No measurable runoff was produced during the 1-inch storm for either profile.

The results for the 10-year storm, including the calculated **RCN** runoff coefficient, are as follows:

	Rainfall Peak in/15 min	Runoff Peak in/15 min	**RCN**	Runoff Volume Ratio
Profile A	1.6	0.93	65	58%
Profile B	1.6	0.79	60	38%

Therefore, both profile types perform as high quality open space for storms up to and including the 10-year, 24-hour storm event. Without further analysis it is not possible to predict performance for larger events.