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Case Study

Vancouver, Canada
May 31 – June 3, 2017/ *Mai 31 – Juin 3, 2017*

EFFICACY OF AN EXTENSIVE GREEN ROOF IN COMBINATION WITH STORAGE IN RUNOFF MANAGEMENT FROM STORMS OF VARYING INTENSITIES

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1 Project Overview

Provision of green roofs in an urban environment can have several benefits including reduction of urban heat island effect, energy savings through insulation, and reduction in stormwater runoff. In this study, rainfall and outflow data were collected between April to September for a 10 cm extensive green roof installed at the A. Alfred Taubman Student Services Center of Lawrence Technological University (LTU), Southfield, Michigan, USA. During this period, data from seven rainfalls with depth ≥ 1.65 cm that produced measurable runoffs for the green roof was used to develop and calibrate a simple mass balance model for the prediction of green roof retention and outflow.

2 Innovation

The performance of a green roof is significantly impacted by its properties as well as its geographic location. While green roofs may be effective in controlling runoff from small low intensity storms, their efficacy in runoff management for higher intensity storms may be limited. Thus provision of additional storage can increase its effectiveness for stormwater management. In this study, the efficacy of the 10 cm extensive green roof in combination with varying storage capacity was evaluated for runoff management from storm of recurrence intervals varying between 2 – 100 years in the Windsor Essex/ Southeast Lower Michigan Region. Design storms were simulated using NRCS Type II rainfalls with storm period of 24 hours and recurrence intervals of 2 - 100 years. A simple mass balance model previously developed and tested for the same green roof was used to simulate runoff control by the green roof.

3 Lessons Learned

For design storms of 2 – 100 years, the calculated peak runoff without and with green roof and pre-development peak flows are presented in Table 1. The results show that despite runoff retention of 13 – 25% and reduction in peak flow, the simulated green roof peaks for 2 - 100 years storm are always higher than the corresponding pre-development flows. Green roof by itself therefore is not deemed to be an effective stormwater BMP. The model was used to simulate the effect of green roof plus additional storage on runoff retention and reduction of peak flows. Different additional storage values, starting from 10 m^3 were used in model simulations and the results are presented in Figure 1. Using Figure 1, the storage values required to limit the 2 to 100 year storms post-development peaks to corresponding pre-development levels as well as complete retention were calculated and presented in Table 2.

Table 1: Effect of green roof on peak flows and flow retention for storms of varying recurrence intervals

Storm Recurrence Interval (years)	Peak Flows $m^3/1000\ m^2/sec$			Green Roof Flow Retention (%)
	Conventional Roof	Green Roof	Pre-development	
2	0.0068	0.0040	0.0017	25.1
5	0.0083	0.0051	0.0025	20.6
10	0.0094	0.0058	0.0032	18.2
25	0.0108	0.0067	0.0041	15.8
50	0.0120	0.0074	0.0049	14.2
100	0.0131	0.0081	0.0057	13.1

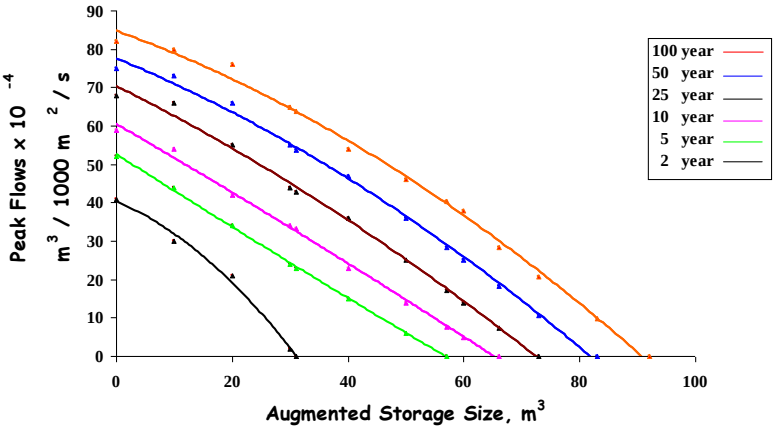

Figure 1: The effect of additional storage on simulated green roof peak flows

Table 2: Augmented storage requirements with green roof to achieve pre-development peak flows or complete retention for storms of varying recurrence intervals

Storm Recurrence Interval (years)	Augmented Storage (m^3)	
	Pre-development Flow	Complete Retention
2	22	31
5	29	57
10	32	66
25	34	73
50	38	82
100	40	90

The results show that stormwater retention by the green roof was not sufficient to reduce the peak runoff to pre-developmental levels or lower for any of the 2 – 100 year storms. However, the green roof in combination with varying amounts of additional storage can be effectively used to achieve different stormwater runoff management targets. For an area of 1000 m^2 in the Windsor Essex Region, a 10 cm extensive green roof in combination with an additional storage of 40 m^3 can reduce the peak flow to pre-developmental levels for all of 2 – 100 year storms. Increasing the additional storage to 90 m^3 can allow for retention of the entire stormwater runoff from storms of up to 100 years recurrence interval. The captured runoff can be beneficially reused for alternate uses such as toilet flushing or landscape irrigation, which also reduces the need of municipal water supplied.