Evaluation of an Extensive Greenroof

York University Computer Science and Engineering Building
Toronto, Ontario

Development in and around urban areas continues to expand at an unprecedented pace. As ever more vegetated areas are replaced by buildings and paved surfaces, rainwater that previously infiltrated or evapotranspired runs off, carrying with it oil, grease, bacteria and other contaminants from urban pavements into streams and lakes. The larger volume of surface runoff in turn erodes channels, degrades aquatic habitats, and increases the risk of flooding and associated damage to infrastructure.

Rooftop gardens help to mitigate some of the environmental impacts of urban stormwater runoff by temporarily retaining rainwater and promoting evapotranspiration. They also help improve air quality, reduce energy use, increase biodiversity, modify summer air temperatures, and create healthier, more attractive cityscapes.

Project Objectives

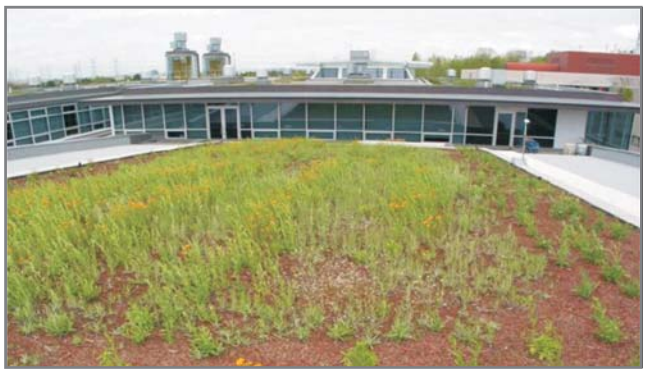
This study of an extensive greenroof was initiated in 2002 to address the growing need for research on the stormwater management and biodiversity benefits of greenroof technology within cold weather climates. Specific objectives of the study were to:

- evaluate the potential of rooftop gardens to reduce the quantity and improve the quality of stormwater runoff;
- quantify the stormwater management benefits of greenroofs at a watershed scale through scenario modelling;
- assess the potential effect of greenroofs on urban biodiversity, and
- provide recommendations on the design and maintenance of greenroofs to maximize benefits related to stormwater management and biodiversity.

Site Description

The study was conducted on the Computer Science and Engineering building on the campus of York University in the City of Toronto, Ontario. The roof is covered by two surfaces: shingles and a garden. The roof surface covered in shingles represents a typical roof and is monitored so that results may be compared to those obtained for the garden.

Both roof surfaces have a 10% slope. The garden is vegetated with wildflowers and the substrate is 140 mm thick. It was designed to be light weight, retain water and resist compaction.



Monitoring Program

Both roof surfaces were continuously monitored over three seasons (2003 to 2005) for rainfall, surface runoff quantity, air temperature, relative humidity, soil temperature and soil moisture levels. A web-based monitoring system was used for archiving and viewing monitoring data.

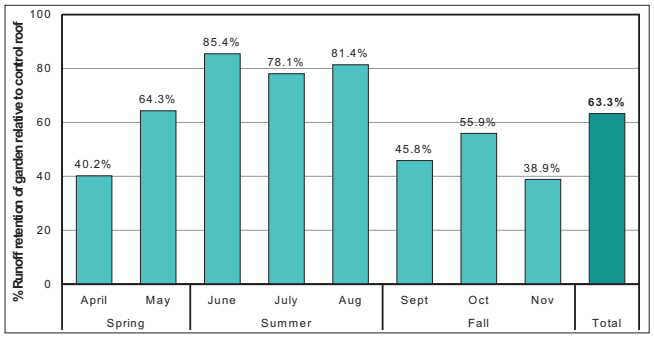
Water quality analyses of runoff from both roofs and precipitation were completed for 23 rainfall events between April 2003 to November 2004, and were supplemented by chemical analyses of several commercially available greenroof growing media to assess how the media may affect garden runoff quality.

Inventories of flora, fauna and insect species were conducted to evaluate the ecological benefits of greenroofs.

Findings

Water Quantity:

- Over the monitoring period the rooftop garden reduced runoff volumes by 63% during spring, summer, and fall events.



Average percent runoff retention of the garden by month

- The annual retention rate, assuming winter (January to March) retention rates of 5 and 25%, was estimated to be 51 and 54%, respectively. Runoff retention capacity of greenroofs during winter rainfall and snowmelt events requires further study.
- The garden's ability to retain stormwater falls as storm size and antecedent moisture content increase, and temperature decreases.
- The best retention rates occurred in the hot summer months, followed by the spring, fall and winter.

Water Quality:

The garden runoff demonstrated improved water quality in comparison to the shingled roof for several stormwater contaminants of concern. These include:

- Suspended solids
- Nitrate
- Escherichia Coli
- Heavy metals (e.g. copper, zinc, cadmium and lead)
- Polycyclic aromatic hydrocarbons

Relative to the conventional roof, the garden runoff had higher loads of constituents typically found in soil, such as potassium, magnesium, and total phosphorus.

Among the constituents with higher loads, phosphorus was the only variable to pose a threat to receiving waters. It is unknown whether this is a long term concern for all greenroofs. Phosphorus concentrations declined significantly after the first year of monitoring, and the growing medium used at York University had the second highest phosphorus concentrations of those tested. In general, growing media with high phosphorus levels or phosphorus-rich start-up fertilizers should be avoided.

Biodiversity:

- The flora survey showed an increase in native plants from 18 to 29 over two years and revealed that the greenroof could be conducive to the establishment of conservative or rare native plants of local concern.
- A total of six bird species were observed using the greenroof, two of which were breeding on site.
- The community structure of bees on the greenroof was not significantly different from that observed in similar habitats nearby, but was found to lack species that one would expect to find in similar habitats elsewhere.

Project Funding Partners:

Great Lakes Sustainability Fund
Toronto & Region Remedial Action Plan
Ontario Ministry of Environment
Toronto and Region Conservation
Region of Peel
Region of York
Seneca College
York University

For more information on this project or the Sustainable Technologies Evaluation Program (STEP), contact Tim Van Seters at 289-268-3902.

The final report for this study may be downloaded from the STEP website at www.sustainabletechnologies.ca.