

AN EXPLORATION OF GREEN ROOFS

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Introduction

A green roof system is an extension of an existing roof which involves a high quality water proofing and root repellent system, a drainage, filter cloth, a light weight growing medium and plants (GRHC, 2011). The exploration of green roofs is a way in which businesses of commercial, industrial, institutional, and residential buildings, new or existing, can benefit by obtaining a green roof. For example,



Figure 1: View of Extensive Green Roof at ESRI Canada's commercial building, part of the Eco-Roof Incentive Program Case Study.

through exploring the fundamentals of green roofs by discussing the main types of green roofs – Extensive and Intensive, the benefits and costs in comparison to alternative roofs, maintenance and liability of green roofs, management solutions, as well as information of Bylaws and case studies of incentive programs offered in Canada. Also, green roofs can contribute points for the Canadian certification of LEED (Leadership in Energy and Environmental Design) for new and existing buildings (CaGBC, 2011). The process of making policy and programs, including incentive programs, for green roofs would vary according to every municipal/city's needs and requirements.

Management Solutions by Green Roofs

Environmental Impact: Green roofs reduce air pollution, smog, and "Heat Island Effect" (increase of surrounding temperature) in urban areas. (Nutmeg, 2010 & ecomii, 2011).

Applicability to Canadian Climate: Green roofs reduce heating in hot weather and cooling in cold weather, and also lower hazardous greenhouse gases. (Centre for Architectural Ecology, 2009; Nutmeg Homes; Sandink & MacLeod, 2009).

Quality of Runoff: Green roofs reduce the harmful effects, i.e. heavy metals, pollutants, pesticides, etc, of regular roofs' urban rainfall/storm runoff into the water areas (VanWoerta et al., Sept 27, 2004). Green roof runoffs can be re-used for landscape irrigation, custodial uses, and restrooms (LUO, 2011). Green roofs runoffs help in storm water management (Berndtsson, 2010) as can be seen in Figure 2.

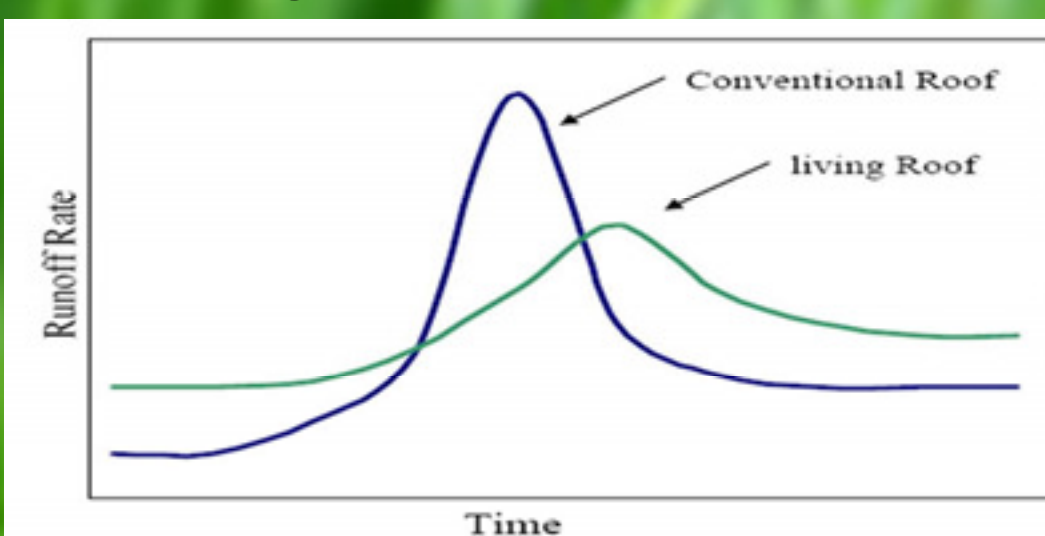


Figure 2. There is better quality and delayed, reduced quantity of runoff from green roof (living roof, green line) as compared to conventional roof (blue line). Green roofs take in the water. Green roof runoff lowers the effects on the drainage/sewage system in peak loads, water areas, and habitats. Obtained from: <http://www.furbishco.com/Stormwater2.html>

Toronto Green Roof By-Law

In the city of Toronto, a Green Roof Bylaw was enforced on January 31, 2010, and since then, has generated an area of 1.2 million square ft. of green space on commercial,



Figure 3: View of Extensive Green Roof at Gladstone Hotel (Toronto, ON), on commercial building, part of the Eco-Roof Incentive Program Case Study.

institutional, and multi-unit residential developments across the city. There are approximately 135 green roofs established around the city. Toronto's Bylaw applies to new building permit application for residential, commercial, and institutional buildings, and will soon apply to new industrial development as of April 30, 2012. Toronto's Incentive Programs, spread interest in green roofs in Canada. Figures 1, 3, and 7 are case studies of Toronto's Eco-Roof Incentive Program (ERIP) which have extensive or intensive green roofs on commercial or institutional buildings. (GRHC, 2011)

Effectiveness (Advantages & Disadvantages)

Green roofs are beneficial for various reasons which essentially provides several motives to want to install a green roof over a standard conventional roof. More specifically, public, private and construction-based benefits are obtained as a result (GRHC, 2011). Figures 4 and 5, illustrate the benefits of extensive and intensive green roofs respectively.

EXTENSIVE	INTENSIVE
<ul style="list-style-type: none"> •Light layer of vegetation that does not usually require reinforcement (less structural support) •Low maintenance (can leave vegetation to grow spontaneously) and longer life-span •Less cost •Suitable for large areas. •More self-sustaining; less technical expertise needed •Often no need for irrigation and specialized drainage systems •Looks natural •Easier for planning authority to demand as a condition of planning approvals. <p>However,</p> <ul style="list-style-type: none"> •Low plant diversity; limited on plant choice •Stressful conditions for plants •Usually no access for recreation or other use •Unattractive to some especially in winter. •Less energy efficient and storm water retention benefits. 	<ul style="list-style-type: none"> •Provides good insulation properties •More energy efficiency and storm water retention capability •Longer membrane life •Wide variety of plants •Supports a variety of landscape design and growth; high plant and habitat diversity •Can stimulate a wildlife garden on the ground •More favourable condition for plants •Accessed and used as recreational spaces •Interactions can be made between humans and nature •Can be made visually attractive <p>However,</p> <ul style="list-style-type: none"> •More maintenance & cost •More weight load on roof •Need for irrigation and drainage systems requiring energy, water and materials •More complex system and need for expertise •Low progress and general use of intensive as it relies on deep soil, irrigation/fertilization to support traditional landscape plants

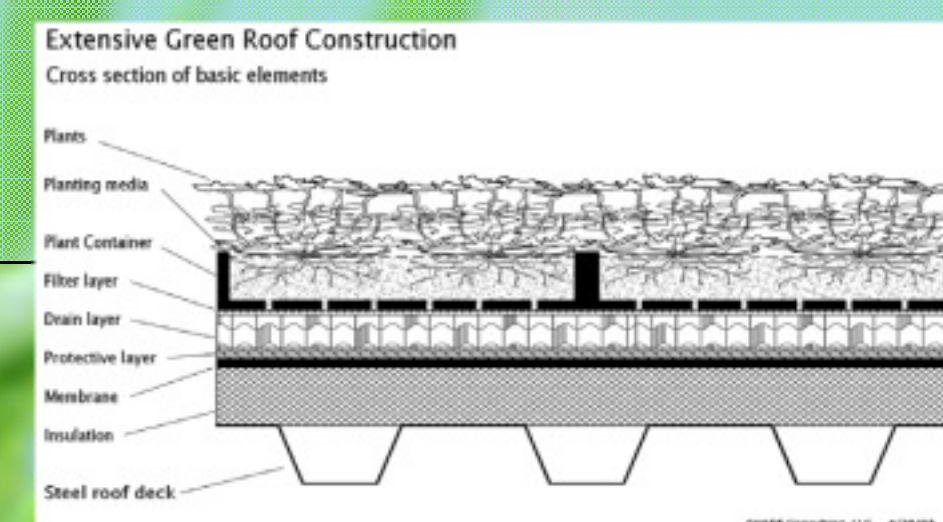


Figure 4: A detailed diagram illustrating the basic construction of extensive green roof

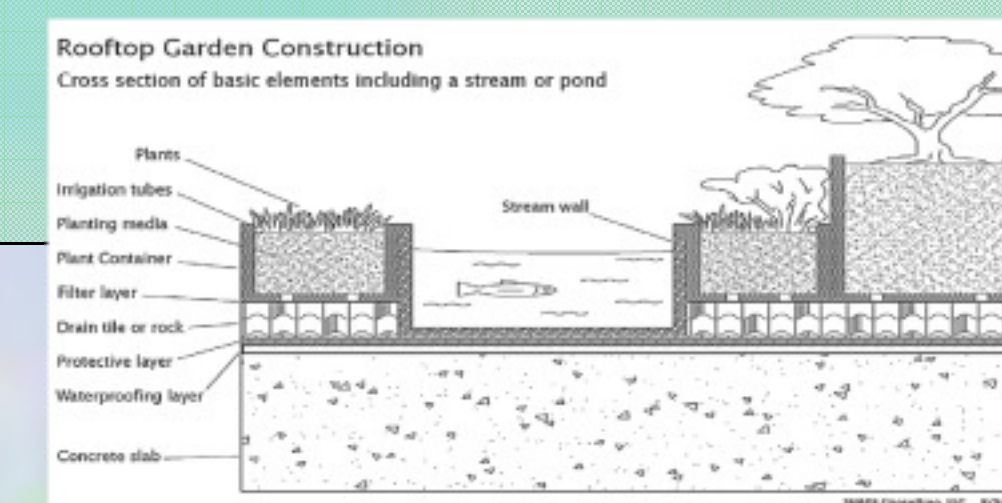


Figure 5: A detailed diagram illustrating the basic construction of a "rooftop garden" or intensive green roof

Cost & Expenses

The expenses incorporated with green roofs can be categorized into three main subtopics- installation and labour, building modification, and maintenance. Although green roofs are initially higher in cost than the standard conventional roof, green roofs allow for long-term financial savings. It is important to note that the cost may fluctuate throughout the installation of a green roof. It is reported however, that the average Canadian cost to install a green roof ranges between \$6.00 to \$21.00 per square foot (not including the base roof). This price varies depending on factors including size, complexity, building height and structure, local and technological material and labour availability, as well as the addition of any safety and aesthetic features (Toronto and Region Conservation, 2007).

Maintenance

Many green roofs will need a little irrigation for up to 90 days for it to get established. Those that already established will need regular moisture checks for the first few weeks. Winds are usually stronger higher up, as there is not as many things to block them from the wind, thus the drying effect will be greater and will draw moisture away from the plants rapidly. Also, it is key to include an irrigation system when installing green roof. Companies that install green roofs also make note of the fact that it is a necessity to keep gutters and drains clean and in good repair. (Green Roof Plan, 2011).

Liability

To reduce liability when installing/maintaining...

- 1) Communication and Contract are vital
- 2) Going through GRP - Green Roof Professionals, who are more highly qualified in North America's green roof industry
- 3) Engineers/architects take responsibility for liability if possible. (Consilienceblog.org, 2009; GRHC, 2011; & Buholzer and Wark, 2006).

Conclusion

Extensive or Intensive Green Roof systems can be divided into the categories of Complete Systems, Modular Systems, or Pre-cultivated Vegetation. The advantages gained from installing a green roof carry much more value than the traditional-installation of a regular roof. The expenses involved in the installation of a green roof are initially much higher in comparison to a conventional roof; however, long-term, it is observed that financial cutbacks are attained as a result. Green roofs last longer than regular roofs and increase the real estate value of the building. Maintenance is dependent on several factors including time, fertilization, water, and weather conditions. The liability issues can be reduced for green roofs' installation and maintenance by various beneficial ways via communication, contract, GRP professionals, and having engineers/architects give their responsibility for liability issues, if possible. Management solutions by green roofs are implemented in environmental impact, applicability to Canadian climate, and quality of runoff. Canada's first green roof regulation was established by Port Coquitlam, British, Columbia and the Council took in the Zoning Bylaw amendment on December 11, 2006 requiring all buildings over 5000 metres squared to have green roofs for environmental benefits for the City (Greenroofs.com). Figure 6 shows B.C.'s green roof. Toronto Bylaw and case studies/incentive programs from Toronto, ON and Port Coquitlam, B.C. have increased interest for green roofs across Ontario and Canada. Further research and information are required to ensure successful long-term continuation for green roofs.



Figure 6: Green Roof on Walmart store, City of Port Coquitlam, B. C.

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Figure 7: View of Metro Canada, YMCA, Intensive Green Roof, on institutional building, part of the Eco-Roof Incentive Program Case Study.

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