RESEARCH HIGHLIGHT

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Green Roof Infrastructure Workshop

INTRODUCTION

Green roofs are a potential component of any strategy to address many of the environmental challenges facing our cities over the course of the next century. They could reduce the urban heat island effect through evapotranspiration of plants as well as the amount of heat radiated from roofing membranes. Less energy would be required for cooling buildings. Heat stress and the severity of smog episodes could also be reduced.

Replacing impermeable surfaces with vegetation also limits storm water runoff, while the plants and the soil act as filters, thus improving the quality of the runoff. In providing space for vegetation in urban areas, green roofs can increase wildlife habitat and play a role in preserving biodiversity.

To encourage a market for green roofs, the National Research Council of Canada (NRC), in partnership with Environment Canada, Canada Mortgage and Housing Corporation (CMHC) and Green Roofs for Healthy Cities, organized a *Green Roof Infrastructure Workshop* held in Ottawa in 2001. The workshop provided technical information on the implementation and benefits of green roofs, and it offered an opportunity to discuss green roof research and develop potential research collaborations. The workshop was held just prior to an international conference, which enabled international participants to exchange information with Canadian colleagues on this technology.

The workshop included presentations, a tour of NRC's new green roof research facility and three breakout sessions, one on aggregate research (urban heat island, stormwater modeling and air quality), a second on facility research and the third on policy instruments that encourage green roofs, how they work and what else needs to be done.

OBJECTIVES

The sponsors established five objectives for the workshop:

1. Introduce architects, developers, government officials and other interested parties to the design, implementation, marketing and benefits of green roofs.
2. Profile NRC's Rooftop Garden Field Research Facility in Ottawa and North American and European research on green roofs.
3. Provide an opportunity to continue to develop and refine research protocols established at a 2000 workshop and explore the potential for new research areas.
4. Test "how to" basics in designing and marketing green roofs for the architectural profession and expand knowledge of design features and related benefits.
5. Establish an international network of interested parties on green roof design, implementation and research.

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PRESENTATIONS

Boyne River Outdoor Education Centre:

In his presentation, "Green Roofs I Didn't Know I Knew" CMHC researcher Doug Pollard spoke about examples of planted roofs, where plant life is supported by a planting medium on an impenetrable structural layer without damage to the supporting structure. "Every parking garage of every highrise that extends beyond the edge of the building has one. It just happens to be at grade," said Mr. Pollard.

He then described a green roof project at Boyne River, the Toronto Board of Education's Outdoor Education Centre near Shelburne, Ontario. The system has an elastomeric membrane sandwiched between two layers of rigid insulation, which keeps the membrane protected while allowing drainage through open joints in the upper layer. This protection had the benefit of extending the life of the membrane because it was isolated from both extreme thermal variation and UV degradation. The next layer has 15.24 cm (6 in) each of mixed soil and granular, for a total depth of 0.3 m (1 ft).

Although the building was on a stable slope, there were some legal concerns about soil sliding off, and a retention blanket was applied, such as those used for highway embankments.

While an effort was made to locate a blanket made entirely from natural materials, a sudden rain shower resulted in vegetation sprouting on the roof, eliminating the need for any further seeding. Everything growing on the roof was either already in the soil or deposited by wind, bird or insect. The growth on the roof has been noticeably superior to wildflower blankets growing in swales at the back of the building, because of better solar exposure.

A curb was installed around the edge, again to allay unfounded concerns about soil slippage. Many grass roofs exist without a curb, including ones built with the soil coming to a knife-edge point.

Green roofs work by creating a thermal lag effect. The soil warms before the roof does, and evaporating moisture from the soil draws heat from the building shell, thus cooling it. The lag is such that the roof membrane only begins to warm at the end of the day and very little heat gets into the building itself. As nighttime temperatures fall, the soil loses its gained heat, and by morning, the cycle begins again.

> "When we make a scar on the earth's surface with a building, we simply put back on top of it what we removed so that the balance of the ecosystem is maintained and so we can continue to benefit from that balance . . . For free."

The green roof requires no operating budget, and after eight years, flowers continue to grow, some as high as 1.8 m (6 ft). The building continues to heat and cool itself, and the roof provides an aesthetically pleasing breathing surface that is habitat to a number of small birds and insects.

Designing Green Roofs:

Presenter Monica Kuhn discussed the layers, types, history, design considerations and benefits of green roofs, as well as some possible incentives. A green roof involves adding layers on top of a traditional roofing system. From the bottom up, these layers include the roof structure, a membrane, with insulation either above or below, a drainage layer, filter/landscaping cloth, a growing medium and plants. Green roofs can be intensive, extensive or a combination of both.

Extensive green roofs have less weight than intensive ones and involve less capital cost and maintenance. Intensive green roofs weigh more due to greater soil depths, and they have more plantings and higher maintenance requirements. Other differences between the two, and the general benefits of this technology, are outlined in another CMHC Research Highlight, *Greenbacks from Green Roofs: Forging a New Industry in Canada.*

Use, location (height, orientation, overlook, shadow, building type), access and regulatory approvals are just a few of the design considerations. Roofing, new types of membranes, leak detection, maintenance and insurance are some of the other factors to be taken into account. The type of plants selected depends on soil depth and the amount of maintenance and irrigation required.

Among the proposed incentives that could be used to encourage green roofs are tax credits, utility or infrastructure credits, density bonuses, development approvals and one-time design and installation grants.

Green Roof Selection and Maintenance:

Kaaren Pearce, a specialist in green roof technology, discussed development of green roof systems and their maintenance. The criteria for developing these systems can be guided by the following questions:

1. What is the space to be used for: views, aesthetics, education, as an amenity space for people, stormwater retention, heating and cooling effects, habitat, agriculture, etc?

2. What is the load bearing of the roof? This influences design, as weight increases with soil depth, and depth increases the variability of species that can be used. Loads generally vary from 18 to 72.8 kg per m^2 (40 to 160 lbs per ft^2).

3. What are the plant considerations? Plants naturally found in alpine, prairie or scree conditions are better suited to green roofs.
4. What plant materials are available and where?
5. What are the pros and cons of the specialized green roof systems currently available?
6. What are the pros and cons of specialized soil mixes used in these systems?

Creating and maintaining green roofs require extensive experience. Practitioners should have formal training in horticulture, a minimum of 15 years of practical experience, a solid understanding of ecosystems and microclimates, and extensive practical experience with perennial plants and specialty turf. They need good taxonomy skills, with the ability to identify undesired species. They also need to understand various manufacturers' systems and the basic components of an irrigation system.

The amount of time needed for maintenance depends on whether the roof system is new or an existing one. Establishing a green roof involves care and maintenance over the entire growing season in the first year, about a 21-week period from late May to mid-October. Weekly inspections are required for the first eight weeks to ensure healthy root development, followed by biweekly inspections for the next eight weeks, and then weekly inspections again for the final five weeks of the season. An established extensive system requires, as a minimum, maintenance four times a year-in early spring, early summer, early fall and late fall.

Pest control is not likely to be an issue, although common weeds can be a nuisance. They can be stopped if early spring and summer maintenance periods are followed. Tree seedlings are likely to be the most problematic "weed." While irrigation on extensive systems is not likely to be required, it can be helpful during periods of low rainfall. An installer's warranty, maintenance manual and schedule, and monthly reports complete the maintenance requirements.

Any roof repairs under planted areas should be done with an aim to minimize root damage. For example, the lifted area might be slid onto a plywood sheet with folding legs and set aside. A soaked burlap bag under the lifted area will help retain moisture. If possible, the section should be lifted and returned during the cooler parts of the day.

WORKSHOPS

The workshop on aggregate research needs noted a couple of key barriers to overcome in encouraging more widespread use of green roofs. First, there is a significant lack of data on the benefits of green roofs in North America. While green roofs are common in Europe, considerably more research needs to be done to prove their validity in North American cities and their cost benefit. Developers and property owners need to be shown that they can justify the cost of installing a green roof. Second, tax incentives could be used to encourage property owners to use this technology.

Another workshop on facility research looked at a research plan for two potential field monitoring projects in Toronto, one at Toronto City Hall and the other at a community centre. The parameters to be measured included temperature profile, heat flow, soil moisture content, solar reflectance, relative humidity and stormwater retention. Other potential research projects include:

- monitoring green roofs in different cities across Canada;
- studying the effects of different components (soil depth and types, plant types, configuration of garden components) in order to maximize such benefits as energy efficiency, stormwater retention and runoff quality; and
- studying the benefits of green roofs on sloped residential roofs, and developing a lightweight growing medium, a special anchoring system and low-cost, easy-to-install components for residential housing applications.

The policy workshop noted the importance of linking with partners to undertake projects and with cities that are likely to be willing to commit to green roofs. Participants suggested an inventory of existing green roofs be created and other buildings identified that would be good candidates. The supply side should be assisted in promoting green roofs, and public accessibility is important.

CONCLUSION

The infrastructure workshop successfully demonstrated that green roofs work and that they are not so foreign as we may have thought. Green roofs reduce stormwater runoff; lower heating and cooling costs; prolong roof membrane life; improve air quality; and when used extensively in an urban area, they can help to reduce urban heat island effects.

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Research Report: *Proceedings of the Green Roof Infrastructure Workshop,* 2001

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Housing Research at CMHC

Under Part IX of the ***National Housing Act***, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

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