

Summary of Findings from Green Roof Technology Stakeholder Workshops

In order to facilitate the development of a strategy for implementing green roofs in Toronto, two workshops were held for stakeholders with knowledge and experience related to green roof development to receive their input on possible green roof policies. The following summarizes participants' answers to questions³ falling under three categories: What is a green roof? What are the barriers to the development and construction of green roofs in Toronto? What are the solutions to the barriers?

Defining Green Roofs

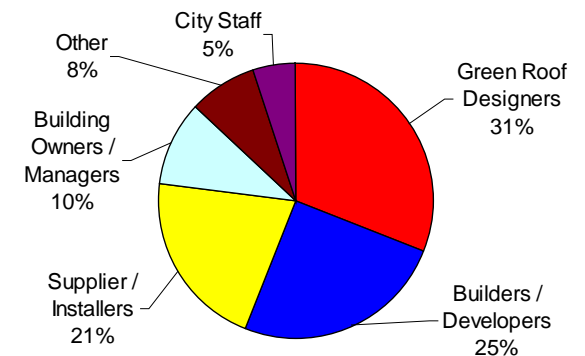
The term "green roof" has been used to describe different types of arrangements of vegetation on a roof top. There are intensive, or active, green roofs, which are typically accessible, highly maintained areas that function as gardens or amenity space. They have relatively deep substrates to accommodate diverse plants, often including trees and shrubs. Alternatively, there are extensive, or passive, green roofs, which have shallower growing media, and typically grow low maintenance plants like varieties of sedum and grasses. They may not be accessible.

The *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto* assumed in its calculation of benefits that extensive green roofs would usually be implemented because they are far less expensive to construct and maintain, are lower in weight, and are generally a more practical option for many buildings than intensive roofs. Since there is variation even amongst extensive green roof systems, the study made other assumptions, for example about the depth of growing media, to derive the projected benefits. These assumptions formed the basis of recommendations of the minimum criteria necessary for green roofs to produce the projected level of benefits for the City.

Based on the study's findings, participants were asked to respond to seven criteria⁴ as minimum requirements for a green roof for the purposes of a City policy to encourage green

Section THREE

Composition of Workshop attendees



³ The main source of the findings described here are the answers participants wrote in their workbooks. 61 workbooks were submitted. Facilitators also took notes on the discussions at each table, and those notes also inform the findings.

⁴ Criteria 4 and 5 are closely related, so they are addressed together in the summary below.



Multi-level green roof (unspecified location in the U.S.).

Photo courtesy of Bakor

roof development. A recurring comment was that the City should be careful not to place unnecessary limits in its green roof policy that would prevent less conventional but equally beneficial designs from being implemented – i.e. focus on performance.

1. Extensive (passive) green roofs should have continuous coverage of growing media over at least 75% of the roof footprint of the building.

- 33 Participants stated objections to this criterion. 15 Participants agreed.
- Many were concerned that 75% is impossible for many retrofits, due to structural limitations. More agreed with the 75% minimum requirement for new construction, although even then some participants - particularly developers - expressed concern, due to competing uses of roof space (mechanical equipment, perimeter buffer, amenity space, solar panels, etc.).
- There was a suggestion that the required coverage should only ever apply to one level or segment of the roof at a time (roof renovations are often done one segment at a time).
- Some warned that the danger in setting a minimum requirement too high is that it could *discourage* green roof construction on the many buildings which can't accommodate 75%.
- Some suggested that an incentive program should use a sliding scale to provide rewards proportionate to coverage. Some thought the sliding scale should not have a minimum coverage requirement, since "any coverage is better than none". Others thought there should be a minimum, but it should be lower – perhaps 50% (which is the LEED requirement)⁵.

2. Green roofs should be installed over "flat roofs" (with a slope of up to 2%) as a priority. Where roofs are dead flat with zero slope, green roof systems should be designed to drain water away from the roof.

- Many participants thought that the 2% slope limit was too low, because green roof technology can be effective and beneficial on gently sloped roofs⁶.

⁵ 12 participants suggested 50% as the minimum requirement for coverage.

⁶ Many participants said that 2% was too low but did not specify alternatives. However, some suggestions were received, including 12%, 20% and 30% slope.

- Some stated that pitched green roofs can be equally effective in managing stormwater if runoff is captured, stored, and used to irrigate the green roof as necessary.
- Some argued that specifying slope is less important than setting performance standards in ensuring that green roofs deliver the desired benefits.

3. The green roof system should have a maximum runoff coefficient of 40% based on annual average rainfall retention of 60% for Toronto conditions.

- Most agreed with setting the maximum runoff coefficient of 40%⁷. Many liked that this criterion was more “performance-oriented” in measuring the desired benefits.
- Some clarified that 40% should apply to the roof system as a whole, since processes on the roof to capture, store, and re-use water are important in reducing runoff to the sewer system.
- Some noted that a green roof’s effectiveness in controlling runoff should also consider *retention time*, since slower runoff also helps to reduce peak flows through storm sewers.
- There was a suggestion that, if the City implements an incentive program, it should employ a sliding scale, with a maximum runoff coefficient and additional rewards for even less runoff.

4. In general and where possible, a green roof should have a depth of at least 150mm (6 inches) to permit flexibility in the type and variety of vegetation that can be incorporated, and to ensure greater survivability of plants. For retrofits of existing buildings, a structural analysis should be conducted to determine the thickness of growing media that can be accommodated. There is often flexibility for new buildings at the design stage with regard to the structural design.

5. A green roof with a growing medium thickness as low as 75 mm (3 inches) can provide some of the benefits of deeper roofs, and should be considered acceptable where structural loads on existing building would not permit a deeper green roof. Manufacturers of such systems should be required to submit test data attesting to the performance of these systems with respect to water runoff.



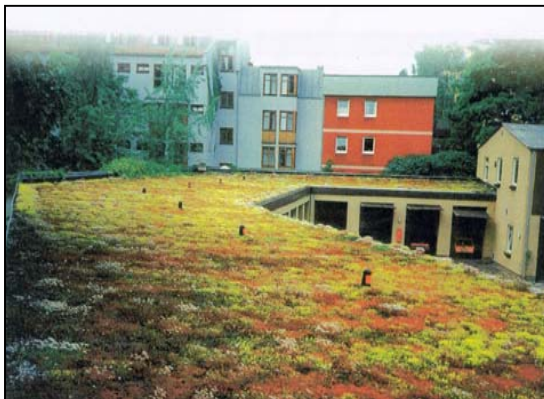
A sloped green roof on a commercial building in Kassel, Germany.
Photo courtesy of Brad Rowe

⁷ Several participants noted that less runoff than 40% is quite feasible.

- There was no consensus on these criteria. Some stated that 6 inches is not necessary (Mountain Equipment Co-op's roof has a 4-inch medium), and even 3 inches can sometimes be sufficient. Several agreed that 6 inches is the appropriate minimum depth⁸, but others stated that 6 inches is too little for a roof to provide all the desired benefits.
- Some stated that site specific circumstances determine which plants are appropriate and the necessary depth.
- Several participants agreed with the need for site specific assessment.
- There was general agreement that new buildings and retrofits need to be treated differently. Some stated that more emphasis should be put on retrofits, since they cover far more area in Toronto, and do not need planning approvals or permits.
- Some noted that if criteria were "performance-based", minimum depth would be irrelevant.

6. Green roofs should be installed over air-conditioned spaces that are heated and cooled. Green roofs that are not installed over heated and cooled spaces (e.g. over underground parking garages) will not provide all the benefits. In general, green roofs should be excluded where public and/or vehicular access would be possible from the grade level.

- Most (47 participants) disagreed with this criterion.
- Many noted that green roofs on unheated and uncooled buildings still have many benefits.
- Excluding buildings without air conditioning would disqualify many otherwise appropriate buildings, like many school and multi-unit residential buildings, which would benefit from the temperature moderating effect of a green roof.
- Some disagreed with excluding at-grade green roofs, since they also have many benefits⁹.



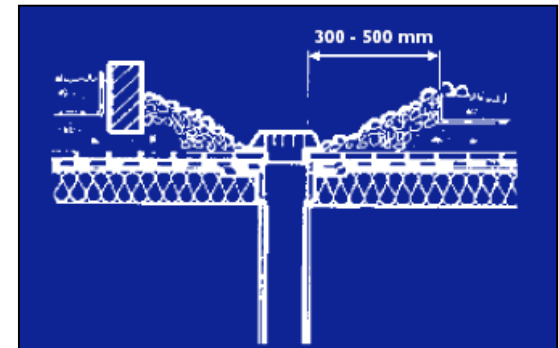
A garage in Germany with a green roof.
Courtesy of Behrens Systementwicklung GmbH.

⁸ About 15 participants made comments indicating that they thought that 6 inches was the appropriate minimum depth.

⁹ Some noted that consideration should be given to building height, since a green roof on a tall building with a small foot print would be less effective than on a low rise with a large foot print. Some recommended that the City should especially target "big-box" and industrial developments, where green roofs are likely to have more significant benefits.

7. Green roof systems should be designed and installed according to manufacturers' recommendations.

- There was a sharp split in opinion over this criterion. About 17 participants agreed with it without obvious conditions. They thought it is essential in ensuring good quality, and to allow manufacturers to provide warranties. About 12 disagreed with it. They stated that green roof design depends on many variables, including microclimate and the building's characteristics, which require materials to be used flexibly.
- Some noted that manufacturers' recommendations continue to change, as this is a developing field.
- Some noted that green roof construction involves a variety of components. Some agreed that the inanimate components of a green roof system should be installed according to manufacturers' recommendations, but argued that decisions about organic components, like plants and growing medium, are better left to landscaping experts.
- Many emphasized the roles of professionals other than manufacturers involved in green roof design and installation, including professional engineers, architects, and horticulturalists, noting that following their professional advice may be as, or more, important as following the manufacturers' recommendations.



Sample from Peck and Kuhn (2004) *Design Guidelines for Green Roofs*. Canada Mortgage and Housing Corporation.
Courtesy of Green Roofs for Healthy Cities
www.greenroofs.org

Barriers to Green Roofs

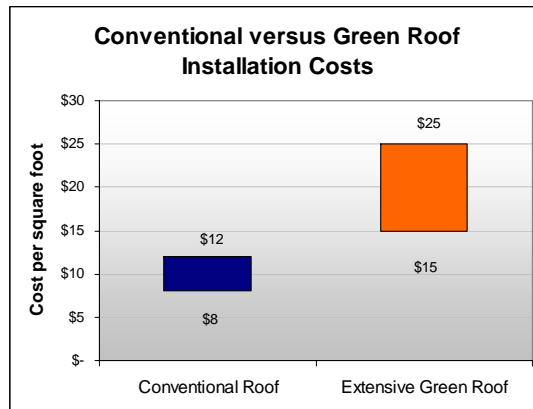
There was far-ranging and detailed discussion on the barriers to green roof development in Toronto. This summary draws on the main, recurring themes¹⁰.

Cost, Structural Concerns, and Maintenance

Cost was ranked by 79% of participants¹¹ as either the biggest or second biggest barrier to green roof development. Cost was often broken down into capital and operating costs, which are closely related to structural and maintenance concerns, respectively.

¹⁰ Some of the barriers have been categorized together because they are closely related.

¹¹ Amongst those who mentioned cost as a barrier, the rankings are as follows: 36 participants ranked it as the top barrier; 12 ranked it second; 5 ranked it third; 2 ranked it fourth; 4 ranked it fifth.



Figures based on background literature review and discussions with industry professionals

Capital/Initial Costs and Structural/Loading Capacity

- There was more concern about capital costs for retrofits than for new construction, because of the implications of increasing loading capacity of an existing building. Many participants specifically identified “structural concerns”¹² as a barrier, and this was often related to concerns about initial capital costs. However, there are also many practical difficulties in increasing the loading capacity of an existing building – such as increased complexity of design, or steel decks on many low-rises that cannot take much weight.
- There was still some concern about the higher capital cost of green roof installation on new construction, for additional expertise and non-standard roofing materials.

Operating Costs and Maintenance Issues

Many participants identified long-term operating costs or maintenance¹³ issues as a barrier. Amongst the maintenance issues, ongoing cost is often part of the concern¹⁴.

There were also practical concerns about maintenance, including:

- Establishing responsibility for maintenance and its costs in condo developments;
- Finding labour with the appropriate skills for green roof maintenance;
- Practicalities of repairing buried components, like the waterproof membrane.

Ability to Finance, Lack of Standards, and Warranty Concerns

Difficulty financing a green roof¹⁵ is obviously a result of higher costs as compared to a conventional roof, but it is also related to two other barriers identified by workshop participants: lack of generally-accepted professional standards for green roof technology¹⁶, and lack of clarity about responsibility for failure and its impacts, including issues of warranties, liability and insurance¹⁷. As long as there are no clear standards for green roofs, and as long as it is difficult to get a warranty for a green roof, green roofs will be considered

¹² Amongst those who mentioned structural issues as a barrier, the rankings are: 3 ranked it as a top barrier, 3 ranked it second, 10 ranked it as third, 5 ranked it fourth, and 2 ranked it fifth.

¹³ Amongst those who mentioned maintenance as a barrier, the rankings are: none ranked it as a top barrier; 12 ranked it second; 8 ranked it third; 8 ranked it fourth; 2 ranked it fifth.

¹⁴ There was disagreement about how much maintenance is needed, with some participants stating that green roofs need to be designed to require little maintenance if they are to be viable.

¹⁵ Amongst those who mentioned ability to finance as a barrier, the rankings are: 3 ranked it as the top barrier; 6 ranked it second; 1 ranked it third; 2 ranked it fourth; 1 ranked it fifth.

¹⁶ Amongst those who mentioned lack of standards as a barrier, the rankings are: 4 ranked it as the top barrier; 6 ranked it second; 1 ranked it third; 4 ranked it fourth; 4 ranked it fifth.

¹⁷ Amongst those who mentioned concerns about warranties, liability and insurance as barriers, the rankings are: 2 ranked it as the top barrier; 0 ranked it second; 0 ranked it third; 3 ranked it fourth; 4 ranked it fifth.

risky, and developers and building owners will be more hesitant to invest in them, and will find it more difficult to access funding for them.

The Approvals Process and Lack of Sufficient Information, Skills and Experience

Because green roofs are a relatively new innovation in Toronto, barriers can often be raised at almost every stage in the planning and installation of a green roof.

- Some were concerned about how an application for a development with a green roof would proceed through the approval process¹⁸. They were concerned that a green roof application would not be a standard approval, and may conflict with parts of the Ontario Building Code.
- Some were concerned about delays if staff in the approving agency did not have experience dealing with applications with green roofs.
- Some mentioned that there is a shortage of building professionals, labourers, and maintenance workers with appropriate knowledge and experience with local conditions and issues.
- Some mentioned that there is a shortage of materials that are locally appropriate.¹⁹

Lack of Awareness about Green Roofs

Many said that there is a general lack of public awareness about green roofs and their benefits²⁰. Also, many developers and building owners have not seen enough information about the local costs and benefits to green roof owners to convince them that green roofs are a viable option in Toronto.

Possible Solutions to Overcome Barriers

The following categorizes the solutions participants proposed to the barriers they had identified.

¹⁸ Amongst those who mentioned the approval process as a barrier, the rankings are: 3 ranked it as the top barrier; 1 ranked it second; 4 ranked it third; 3 ranked it fourth; 2 ranked it fifth.

¹⁹ A few participants stressed the importance of local research and development, so that lighter and more effective materials and more suitable local plants will become available, and it will be possible to develop local standards for green roof design and installation.

²⁰ Amongst those who mentioned lack of awareness as a barrier, the rankings are: 5 ranked it as the top barrier; 4 ranked it second; 9 ranked it third; 1 ranked it fourth; 5 ranked it fifth.



Frankfurt International Airport, Germany.
Photo courtesy of Linda S. Velazquez
www.greenroofs.com



Schiphol International Airport in Amsterdam.
Photo courtesy of Brad Rowe

Incentives

Incentives – both financial and procedural – were the most widely supported suggestions. It was noted that some inspection may be necessary to ensure that once a green roof is built, it is maintained properly.

Financial Incentives

Suggestions included (in approximate order from most to least commonly suggested):

- Property tax reduction or rebate for the implementation of a green roof.
- Short- and long-term subsidies or grants to help owners or developers cover the initial and ongoing costs associated with a green roof. Some recommended following the Green\$aver and EnerGuide program²¹ model in conjunction with a grant program. There was a suggestion that the City set aside the amount of money it has been estimated it would save (in the Green Roof Technology Study) for a fund to support a green roof incentive program.
- Reduction in development charges for developments with green roofs.
- Rebates from utilities like Toronto Hydro and Toronto Water per a demonstrated and specified amount of savings of energy use or reduction in stormwater runoff.
- Low-interest green loan program.

Several participants stated that they believe it is important that any incentive program be scaled to the amount of benefits (in reduction in runoff, energy use etc.) that a green roof produces.

Procedural Incentives

- Density bonuses for buildings with green roofs.
- Fast-track building applications with green roofs.
- Reduce stormwater management requirements for developments with green roofs.
- Levee fees for stormwater runoff and exempt buildings with green roofs.
- The City should be more flexible with zoning and/or building code requirements for developments with green roofs.
- Allow green roof space to be included as part of parkland dedication if it is an accessible and maintained amenity space.

²¹ Green\$aver provides home audits for a small fee to identify how to improve home energy efficiency to qualify for incentives offered by the federal EnerGuide program.

Education and Marketing

Participants saw enormous scope for education to encourage green roof development in Toronto. Some believe increased awareness would bring more green roof development, which in turn would bring down costs of green roofs through increased competition. Participants noted that, to be effective, promotion should target specific sectors.

General Public

- Widespread distribution of information brochures.
- Use a website to promote green roofs and disseminate information.
- Advertising in various media.
- Require green roofs on all new municipal buildings and, where possible, on roofs due for replacement. This would bring publicity to green roofs, provide leadership to the development industry, and jumpstart the green roof industry. It would also allow the City to showcase successful systems on its own buildings.

Developers and Building Owners

- Provide a list of legitimate contractors, suppliers, and systems.
- Produce sector-specific information brochures.
- Provide a cost-benefit analysis of green roofs from a building owner's point of view.
- Provide manuals on proper maintenance of green roof systems.
- Make presentations and hold or sponsor industry-targeted workshops.
- Designate a City green roof resource person, to provide information on funding, approvals, resource materials, etc.

City Staff

- A common suggestion was that the City train all staff that deal with any element of building applications to deal with green roof applications quickly and effectively.
- Some also urged the City to consider green roofs as one element in green building design, rather than a stand-alone feature.

Professional and Labour²²

- Provide green roof workshops.

²² Participants generally recognized that some of these solutions might need to come through industry and professional associations.



Ford truck assembly plant in Dearborn, Michigan. Recognized in 2004 by Guinness World Records as world's largest green roof (454,000 sq feet). Wm McDonough & Partners, ARCADIS Photos courtesy of www.greenroofs.org





Almeida Theatre, London.
Source: Dusty Gedge,
www.greenroofs.org

- Educate professionals on the approval process for buildings with green roofs.
- Provide sector specific technical bulletins.
- Reach out to (and possibly partner with) building industry associations.
- Showcase systems that are functioning successfully.
- Provide certification for professionals and labourers.
- Provide training on green roof maintenance.

Development Approval Process

Many stated that the approval process for buildings with green roofs needs to be standardized and streamlined to encourage green roof development.

Further Research & Development

Suggestions about research and development included:

- Produce information about costs and benefits of green roofs to Toronto building owners.
- Assist in research and development of green roof materials to make green roofs more effective and viable for more buildings.
- “Lobby” for green roof standards (especially concerning fire, wind and water absorption), or choose existing standards, like LEED, to follow.

Warranties

It was suggested that the City deal with Tarion Warranty Corporation before any implementation of City programs²³.

Regulation

A few participants suggested that the City should require green roofs through regulation.

²³ An initial discussion has been held with Tarion, which is responsible for administering the *Ontario New Home Warranties Plan Act*. This Act outlines the warranty protection that builders must provide to new home and condominium owners. It does not seem that there would be any concern in providing warranties on buildings with green roofs, as long as those buildings were in compliance with the Ontario Building Code.