



Recommendations for Municipalities **Focus: Construction of Green Roofs**



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CELA Publication No 1486
ISBN #978-1-77842-007-8

BENEFITS OF GREEN ROOFS

STORMWATER MANAGEMENT

Impervious surfaces including concrete sidewalks, paved roads, and parking lots cover urban landscapes and decrease water absorption into land. One of the benefits of a green roof is that rainwater is taken up and retained by the vegetation, thereby reducing both runoff and flooding. In the summer, green roofs can retain 70% to 90% of the water they receive, while in winter this number declines to between 40% and 50%.¹

Other benefits relating to stormwater management include decreased sewer overflow and decreased erosion due to runoff. A report on the environmental benefits of green roofs in the City of Toronto found that annual savings from combined sewer overflow could amount to \$750,000 per year with widespread implementation.² The same report found that implementing green roofs could save \$25 million in erosion control measures.³

REDUCED ENERGY USAGE

Green roofs act as insulators thereby reducing energy demands. Green roofs decrease heat penetration in the summer and interior heat escape in the winter. One study researched the effect of a rooftop garden on energy consumption in Singapore and found that its installation on a five-story, commercial building had the potential to reduce annual energy consumption by 0.6-14.5%.⁴ This acts as a climate mitigation measure by reducing fossil fuel combustion for energy.

When comparing energy usage, green roofs can be more environmentally friendly than white roofs in colder climates. Due to their reflective properties, white roofs may result in increased energy usage for heating in the winter months.⁵ To reduce fossil fuel combustion year-round, the implementation of green roofs, as opposed to white roofs, is recommended for the province of Ontario.

REDUCED URBAN HEAT ISLAND EFFECTS

Green roofs influence micro-climate by reducing ambient temperatures through evapotranspiration. One scientific study found that the evaporative cooling effect of a roof garden reduced heat flux by 50% in the rooms below it.⁶ The report on the environmental benefits of green roofs in Toronto determined that widespread implementation would reduce ambient local air temperature between 0.5 and 2 degrees Celsius. By reducing the urban heat island effect, city-wide implementation of green roofs could result in annual energy savings of approximately \$12 million per year.⁷

This benefit is especially important as heat waves are expected to increase in intensity, frequency, and length as a result of climate change. In fact, an analysis of the heat-related

¹ Banting, D., Doshi, H., Li, J., Missios, P., Au, A., Currie, B. A., & Verrati, M. (2005). Report on the environmental benefits and costs of green roof technology for the city of Toronto. *City of Toronto and Ontario Centres of Excellence—Earth and Environmental Technologies* at page 17.

² Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page iii.

³ Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 51.

⁴ E. Wong, "Green Roof and The Environmental Protection Agency's Heat Island Reduction Initiative," in Proceeding of 3rd North American Green Roof Conference: Greening Rooftops for Sustainable Communities, Washington, DC. 4-6 May 2005, 2005.

⁵ Business Insider, "The Benefits and Controversy of White Roofs" (March 26, 2012), online at: <https://www.businessinsider.com/the-benefits-and-controversy-of-white-roofs-2012-3>

⁶ Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 9.

⁷ Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 58.

deaths in Quebec in July 2018 found that most decedents lived in an urban heat island, such as Montreal.⁸ Green roofs can act as a climate adaptation measure to save lives during these extreme heat events. Please see CELA's recommendation on Extreme Heat for more information.

REDUCED AIR POLLUTION

Vegetation on green roofs can improve air quality by sequestering pollutants including carbon dioxide. This is both a climate mitigation and a climate adaptation strategy. Green roofs can also reduce carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, and particulate matter.⁹ The economic value of air quality benefits resulting from pollutant reductions was estimated to equal approximately \$2,500,000 per year if green roofs were to be constructed on buildings across Toronto.¹⁰

RELEVANT AUTHORITIES

Municipal Act

The Municipal Act, 2001, S.O. 2001, c. 25 grants specific power to municipalities to construct green roofs or alternative roof surfaces.

97.1 (1) Without limiting sections 9, 10 and 11, those sections authorize a local municipality to pass a by-law respecting the protection or conservation of the environment that requires buildings to be constructed in accordance with provisions of the building code under the *Building Code Act, 1992* that are prescribed under that Act, subject to such conditions and limits as may be prescribed under that Act. 2017, c. 10, Sched. 1, s. 5.

97.1 (3) Without limiting sections 9, 10 and 11, the power described in subsection (1) includes the power to require the construction of green roofs or of alternative roof surfaces that achieve similar levels of performance to green roofs. 2017, c. 10, Sched. 1, s. 5.

At section 8(1), the Municipal Act confirms the broad approach to the interpretation of municipal powers.

"The powers of a municipality under this or any other Act shall be interpreted broadly so as to confer broad authority on the municipality to enable the municipality to govern its affairs as it considers appropriate and to enhance the municipality's ability to respond to municipal issues"

The Municipal Act also includes several provisions which provide broad powers to address climate change and environmental health including section 10(2), 11(2), and 226.1.

Jurisprudence

The jurisprudence has conferred broad powers on municipalities to address environmental concerns. The Supreme Court of Canada (SCC) in *SprayTech v Hudson*, [2001] 2 SCR 241 confirmed at paragraph 3 that the protection of the environment requires action by the

⁸ Center-Sud-de-l'Île-de-Montréal Integrated University Health and Social Services Center, "Heat Wave: July 2018 – Montreal Preliminary Assessment", online:

https://santemontreal.qc.ca/fileadmin/fichiers/actualites/2018/07_juillet/BilanCanicule2018VF.pdf

⁹ Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 9.

¹⁰ Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 55.

government at all levels. Additionally, the SCC in *United Taxi Drivers' Fellowship of Southern Alberta v Calgary (City)*, 2004 SCC 19 affirmed the broad and purposive approach to the interpretation of municipal powers at paragraph 6.

MODEL GREEN ROOF BY-LAW

CELA recommends that municipalities enact a green roof by-law requiring the construction of green roofs on new and existing buildings with a minimum gross floor area of 2,000 m².

WHEREAS under section 97.1 (1) of the Municipal Act, 2001 S.O. 2001, c. 25, a local municipality may pass a by-law respecting the protection or conservation of the environment that requires buildings to be constructed in accordance with provisions of the *Building Code Act, 1992*, subject to such conditions and limits as may be prescribed under that Act.

AND WHEREAS under section 97.1(3) of the Municipal Act, 2001 S.O. 2001, c. 25, a local municipality may pass a by-law to require the construction of green roofs or of alternative roof surfaces that achieve similar levels of performance to green roofs.

AND WHEREAS section 425 of the Municipal Act, 2001 authorizes a municipality to pass by-laws providing that a person who contravenes a by-law of the municipality passed under that Act is guilty of an offence.

Definitions

1. In this By-Law

"Applicant" means the owner of a building or property who applies for a permit or any person authorized by the owner to apply for a permit on the owner's behalf.

"Green roof" means extension of an above grade roof, built on top of a human-made structure, that allows vegetation to grow in a growing medium and which is designed, constructed and maintained in accordance with the Green Roof Construction Standard.

"Gross floor area" means the total area of each floor level of a building, above and below average grade, measured from the exterior of the main wall of each floor level, including voids at the level of each floor, such as an atrium, mezzanine, stairwell, escalator, elevator, ventilation duct or utility shaft, but excluding areas used for the purpose of parking or loading.

"Industrial building" means a building or a building addition exclusively used or designed or intended for use for or in connection exclusively with the manufacturing, producing or processing of goods, warehousing or bulk storage of goods, self-storage facility, distribution centre, truck terminal, research and development in connection with manufacturing, producing or processing of goods, and includes office uses and the sale of commodities to the general public where such uses are accessory to and subordinate to an industrial use.

Green Roofs on New Builds:

2. Green roofs must be constructed on new builds:

- a.** New commercial, institutional and residential development with a minimum gross floor area of 2,000 m²
- b.** New additions to commercial, institutional, and residential development where the new gross floor area added is greater than 2,000 m²
- c.** Industrial buildings greater than 2,000 m² gross floor area.

Retrofitting with Green Roofs:

3. Existing commercial, institutional, and residential buildings with a minimum gross floor area of 2,000 m² shall be retrofitted with a green roof within five years of the date of the by-law coming into force if:
 - a. The building can reasonably hold the weight of the green roof while conforming with the Ontario Building Code
 - b. Otherwise, the Applicant shall make a payment of cash-in-lieu of construction of a green roof which shall be deemed to be \$200.00/m² which will be directed to the City’s Eco-Roof Incentive Program.

Permit Required

4. No person shall construct, or cause to be constructed, a green roof required pursuant to this bylaw unless a permit has been obtained from the Chief Building Official.

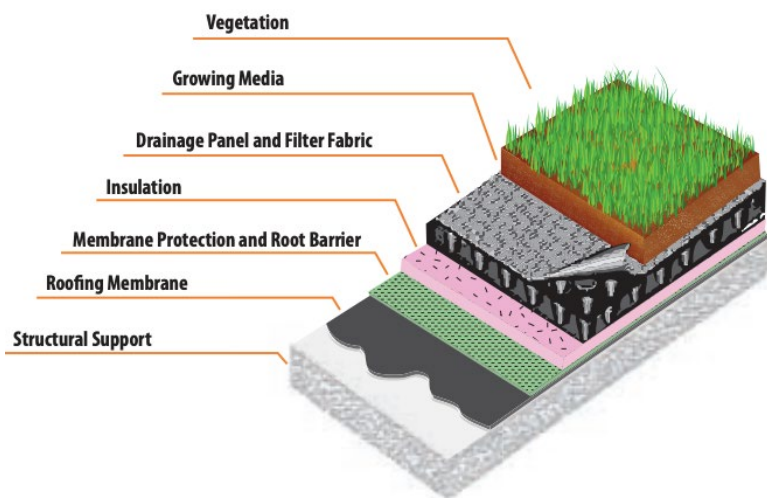
Conformity with the Ontario Building Code

5. Green roofs shall be constructed in accordance with the Ontario Building Code requirements.

MODEL GREEN ROOF STANDARD

Please utilize this model green roof standard to ensure conformity with the Ontario Building Code (OBC). If these standards are followed, the construction of the green roof will not conflict with the OBC. This standard was adapted from Toronto’s Green Roof Construction Standard.

Typical Components:¹¹



Standards	OBC and Other Relevant Requirements
Gravity Loads	OBC Division B, Part 4.1 Structural Loads and Procedures. Other OBC requirements in Division B 4.1.1.3.(1), Division B 4.1.4.1.(b) and (e), Division B 4.1.3.2.(7), Division B 5.1.4.1, Division B 9.4.1.1, Division B 9.4.3.1, Division B 9.26.11, Division B 9.23.4.5, Division B 9.23.15.7, and Division B 11.4.3.2.

¹¹ Toronto Green Roof Construction Standard, Supplementary Guidelines, online: <https://www.toronto.ca/wp-content/uploads/2017/08/7eb7-Toronto-Green-Roof-Construction-Standard-Supplementary-Guidelines.pdf> at page 2

Slope Stability	<p>Minimum slopes for roof coverings are specified in Table 9.26.3.1 in the OBC which requires a minimum of 2% for modified bitumen and 2% to 4% for built-up roofing.</p> <p>Maximum slopes are specified in the same table.</p>
Parapet Height and /or Overflow Scupper Locations	<p>The OBC gives direction on how to design green roofs to resist water accumulation from rainfall in Division B part 4 and 7.</p> <p>Analysis to be done in conformance with OBC Division B 4.1.6.4(4).</p>
Wind Uplift	<p>OBC requirements in Division B 4.1.7.1.(4) and in Division B Part 5 5.1.4.1.</p> <p>Division B - Part 4 of the OBC requires that the design can resist blow-off by wind.</p> <p>Applicants must submit a report, stamped by an engineer, providing wind uplift pressures being designed for (including a description of how the pressures were determined), and describing how the design addresses these pressures.</p>
Fire Safety	<p>The Ontario Fire Code, section 2.4.2.1 states that “combustible materials should not be stored on a roof or adjacent to any building so as to create a fire hazard to the building or its occupants.”</p> <p>The OBC provides its requirements in Division B 3.1.15.1, Division B 3.1.15.2, and Division B 11.3.3.2.</p> <p>The FLL Guideline for the Planning, Execution and Upkeep of Green Roof Sites considers a green roof to have enough fire resistance if: (1) the soil substrate has a minimum depth of 30 mm, (2) the vegetation planted constitutes a “low fire load”, and (3) a distance of at least 50 cm exists between the green roof and any penetration in the roof.</p>
Occupancy and Safety	<p>The OBC lays out its requirements in Division B 9.8.8.1, and Division B 3.3.1.17.</p> <p>The Applicant must state the use of the roof and whether it will be accessible to the public.</p>
Waterproofing	<p>The OBC lays out its requirements in Division B 9.26.1.1, Division B 9.26.2, Division B 5.6.1.1, Division B 5.1.4.2(1), Division B 5.1.4.2.(3), and Division B 9.26.4.</p>
Drainage	<p>The OBC lays out its requirements in Division B 9.26.3, Division B Part 7 (General), Division B 7.4.10.4.(1), and Division B 7.4.10.(2).</p> <p>The Applicant must conduct a leakage testing protocol.</p>
Vegetation Performance	<p>The OBC does not have any requirements that specifically address vegetation performance.</p> <p>Municipalities may follow the FLL Standard Section 9 for guidelines for the composition and performance of different growing mediums.</p>
Irrigation	<p>The OBC lays out its requirements in Division B 7.6.2.2.</p>
Maintenance Plan	<p>The applicant shall develop a maintenance plan which must define programs of routine maintenance and inspection to ensure that the green roof performs its required functions.</p> <ul style="list-style-type: none"> • The maintenance plan must address the requirements of the specified growth media and vegetation for vegetation survival.

	<ul style="list-style-type: none"> • The maintenance plan must address re-planting if re-planting becomes necessary. • The maintenance plan must be submitted with the application for a green roof permit.
Water Retention	<p>There is no OBC requirement that specifically addresses water retention.</p> <p>Water retention mats or their equivalent shall be employed as required to promote vegetative growth.</p>

OTHER CELA RECOMMENDATIONS FOR MUNICIPALITIES

CELA additionally recommends the following for green roof construction:

SUBSTRATE MATTERS. Studies conducted in Germany have shown that green roofs using a mix of mosses and sedum with a substrate depth of 2 to 4 cm can retain 40% to 45% of annual received rainfall. By increasing substrate depth to 10 to 15cm and using a mixture of sedum, grasses, and herbs, 60% of annual received rainfall is retained.¹²

SPECIES MATTERS. Alpine species are recommended as they can resist extreme conditions of heat, cold, high winds, extreme sun exposure, and long drought periods.¹³ Succulents are an example of an alpine specie that have a high capacity to store water in their leaves and roots and do not require a high substrate depth for establishment.¹⁴

PROTECTION MATTERS. The City of Toronto recommends that protection is provided to the growing media after seeding until the vegetation is fully established.¹⁵

¹² Banting et al, Report on the environmental benefits and costs of green roof technology for the city of Toronto, at page 18.
¹³ Toronto Green Roof Construction Standard, Supplementary Guidelines at page 11.
¹⁴ Toronto Green Roof Construction Standard, Supplementary Guidelines at page 11.
¹⁵ Toronto Green Roof Construction Standard, Supplementary Guidelines at page 11.