

# “Making Green Roofs Happen” in Toronto

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POLICY ANALYSIS



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# “Making Green Roofs Happen” in Toronto: Policy Analysis

A Master’s Report to the School of Urban and Regional Planning  
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## EXECUTIVE SUMMARY

Green Roofs appear as an innovative solution for city-wide environmental issues and concerns in the City of Toronto. Recognizing benefits of green roofs based on empirical researches, the City established its green roof policy. As part of the policy, the Toronto Green Roof Bylaw is the first mandatory bylaw for green roof installation in North America. In addition, the Eco-Roof Incentive Program was launched as a direct financial incentive being integrated into the policy.

Despite the seven years of policy implementation, there is a lack of understanding around the influence and effectiveness of the policy. Relatively few policy reviews and evaluation reports, including the *2016 Eco-Roof Incentive Program Review Report* by Lura Consulting & Cardinal Group Inc. (2016), are publicly available, however, there is a need for further investigation of the policy implementation.

Therefore, the study's key objective is to identify strengths and weaknesses of the policy as well as provide a deeper insight into how the policy promotes green roof implementation. The following research questions below were designed to achieve the objectives of the study:

- What are the strengths and weaknesses of the City's green roof policy? and
- How can the policy encourage more developers and property owners to install green roofs on their buildings?

A combined qualitative research method approach was used in response to these questions. One of the two methods used was a policy analysis by conducting the review of policy documents, staff reports, and other academic and industry documents pertaining to the Toronto green roof policy. Additionally, domestic and international cities were used as cases to allow for comparative analysis of different policy tools for green roofs. The other method was face-to-face interviews with eight key informants. The interviews strongly influenced and guided the study by allowing in-depth perspectives of the key informants on realistic impacts of the policy.

On the basis of the overall findings and results, the study concludes with a series of recommendations for policy improvement as follows:

1. Perform inspection and research in partnership with green roof experts and institutions;
2. Enforce certain maintenance practices for long-term performance of green roofs;
3. Consider the provision of various incentives; and
4. Improve public awareness through better education.

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# 1.0. INTRODUCTION

## 1.1. STATEMENT OF PROBLEM

A green roof is defined as a form of green infrastructure that delivers environmental benefits, particularly with stormwater management and the mitigation of urban heat island effects, and it increases green spaces across the City of Toronto (City of Toronto, 2016a). The City's increasing interest in green roofs contributed to the enactment of a green roof policy comprised of the Toronto Green Roof Bylaw and financial incentives delivered from the Eco-Roof Incentive Program. Adopted in May 2009, the Bylaw is the first mandatory bylaw for green roof implementation in history of North America, especially with Toronto being the first municipality. While the Bylaw makes green roofs mandatory for all public and private new developments, the Program incentivizes voluntary, retrofit green roof projects on existing buildings (City of Toronto, 2017b).

Although the Bylaw has been in place to increase green roof coverage within the City over the past seven years, further investigation is needed to determine its strengths and weaknesses. Neither official measurements about the effectiveness of the policy nor report evaluating whether the policy is a key factor for successful implementation of green roofs have been publicly available (Van Dyck et al, 2015). Although the only available resource is the *2016 Eco-Roof Incentive Program Review Report* (Lura Consulting and Cardinal Group Inc., 2016), there is no certain explanation for the lack of additional evaluation on the green roof policy. It implies the need for further investigation necessary to raise public awareness with respect to the policy. Hence, this report mainly focuses on how the policy has facilitated the implementation of green roofs across the City.

## 1.2. RESEARCH OBJECTIVE AND QUESTIONS

The primary objective of this report is to examine how Toronto's planning decision regarding green roofs has been implemented to promote the inclusion of green roofs on new developments, as well as existing buildings. In particular, this report explores the strengths and weaknesses of the City's green roof policy, which are used to provide a set of recommendations for future policy improvement. Ultimately, this report supports a better understanding of how the policy has facilitated the implementation of green roofs.

In response to the objective, research questions that will guide this report are:



- What are the strengths and weaknesses of the City's green roof policy?
- How can the policy encourage more developers and property owners to install green roofs on their buildings?

### 1.3. SCOPE OF RESEARCH

This report primarily focuses on the Toronto's green roof policy, specifically the Green Roof Bylaw, incentives, and guidelines, which include the *Toronto Green Roof Construction Standard Supplementary Guidelines*. This report examines how the policy has been in effect for green roofs on new residential, commercial, institutional, and industrial developments since January 31, 2010, as well as on existing and newly constructed buildings that are not subject to the Bylaw (City of Toronto, 2016c).

For further investigation of the policy, this report reviews green roof policies employed by international municipalities. These cases are selected because of the information available on the implementation of and impact of policy. Even though not all these cases have mandatory green roof policy like the City of Toronto, the cases are key information sources for the City's policy analysis.

### 1.4. ORGANIZATION OF REPORT

This report is organized into 5 chapters. Chapter 1 has introduced the statement of general issue and research objectives, outlining the purpose of the research. Chapter 2 includes a literature review with respect to green roofs and Toronto's green roof policy development. Chapter 3 describes the methodology employed for data collection and analysis, and information sources utilized for the study. Chapter 4 presents the results in two sections: the first section summarizes the results from a comparative policy analysis with cases, while the other provides a summary of information gathered from interviews. Chapter 5 offers discussion of the results and recommendations for the City's green roof policy improvement and concludes the study with a brief summary of the results.

## 2.0. LITERATURE REVIEW

This chapter presents a review of literature on background information in regards to green roofs. The intention of this chapter is twofold: 1) to explain why the City of Toronto chose green roofs among features of green infrastructures, and 2) to highlight how the City has established its unique policy with respect to this feature. Thus, this chapter is comprised of two sections. The first section describes the composition and benefits of green roofs, as well as barriers that the City found to implement green roofs. The second section presents the City's green roof policy development process.

### 2.1. GREEN ROOF SYSTEM

The City's increasing interests in environmental sustainability motivated to adopt green roof system as an innovative form of green infrastructure across the City. Replacing impervious surface of a conventional roof, the components of a green roof ultimately mitigate environmental problems as listed in Figure 1.

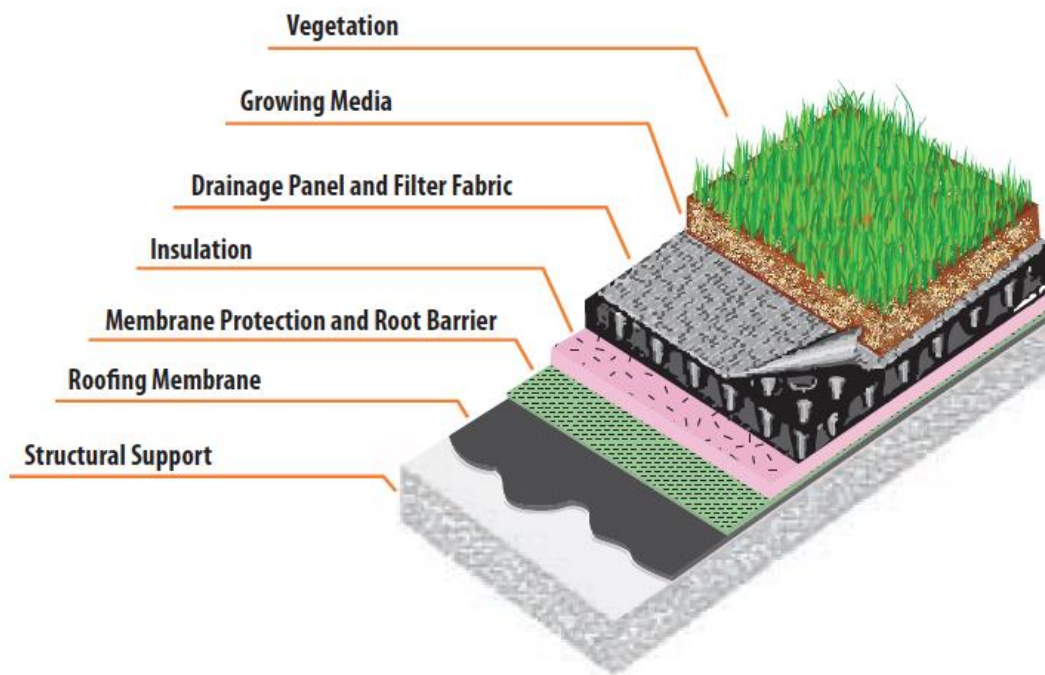


Figure 1. Typical components of a green roof. City of Toronto, n.d.

Each of the components performs a different function and comes together as a whole to mimic natural ecosystem. The components and their functions are described below (City of Toronto, n.d.; Theodosiou, 2009; Vijayaraghavan, 2015).

- **Vegetation layer** is the uppermost layer covered by plants, ranging from low-rise plants to trees.
- **Growing media**, also referred to as growth substrate, is the engineered rooting layer for the plants.
- **Drainage panel** controls the moisture of the soil, while allowing proper drainage. For example, the panel helps to expel surplus water from the roof during rain period, and, in some cases, serve as a water reservoir for the green roof during dry periods.
- **Filter fabric** is geotextile that separates the growth substrate from the draining layer to prevent the penetration and accumulation of plant debris or fine soil into the drainage layer for the long-term efficiency of the drainage layer.
- **Root barrier** protects the roofing membrane from any root penetrations and soil microbes or organic material, which could cause damage to the waterproofing membrane.
- **Roofing membrane** resists hydrostatic pressure and provides protection against water ingress.

### 2.1.1.1. TYPES OF GREEN ROOFS

The design, function, and cost of a green roof vary largely depending on the depth of the growing medium. In academic journals and industry literature, green roofs are generally classified into three types: extensive, semi-intensive, and intensive green roofs. Although these types are not followed in strict adherence to technical definitions, key characteristics of these roofs are visually distinguishable, as shown in Table 1 (Cooper, 2014).

Characteristics	Extensive	Semi-Intensive	Intensive
<b>Growing Medium Depth</b>	6" (15cm) or less	25% of the green roof area above or below 6"	More than 6"
<b>Accessibility</b>	Often inaccessible	May be partially accessible	Usually accessible
<b>Purpose</b>	Functional; stormwater management, thermal insulation	Varies	Functional and aesthetic; increased living space
<b>Irrigation required</b>	Little or no irrigation	Varies	Often required
<b>Fully saturated weight</b>	10-35 lb./ft <sup>2</sup>	30-35 lb./ft <sup>2</sup>	35-300 lb./ft <sup>2</sup>
<b>Plant Diversity</b>	Low	Greater	Greatest
<b>Cost</b>	Lowest	Varies	Highest
<b>Maintenance</b>	Lowest	Varies	Highest

Table 1. General characteristics of three main green roof types. GRHC, n.d.; Oberndorfer et al, 2007.

### 2.1.1.1. EXTENSIVE GREEN ROOFS

Extensive green roofs are the most basic, simple form of green roof systems and are generally for functional purposes, especially being ideal for stormwater management (Oberndorfer et al, 2007; Theodosious, 2009). Their growing medium is typically less than 6 inches in depth, which can accommodate relatively low-rise plants, such as grasses, mosses, and succulents, as Figure 2 illustrates (Ngan, 2004; Vijayaraghavan, 2015). The shallow growing medium contributes to the need for relatively low capital cost and minimal maintenance compared to the other types of green roofs.



Figure 2. Extensive green roof on Sherway Garden Shopping Centre. Greenroofs.com, 2014.

Given these characteristics, extensive green roofs are most commonly used in North America, evidenced by Green Roofs for Healthy Cities' (GRHC) *North American annual industry surveys* (Cooper, 2014). As shown in Figure 3, the latest survey demonstrated the continued trend that extensive green roof installation has been preferred over intensive or semi-intensive green roofs over the last several years (GRHC, 2015).

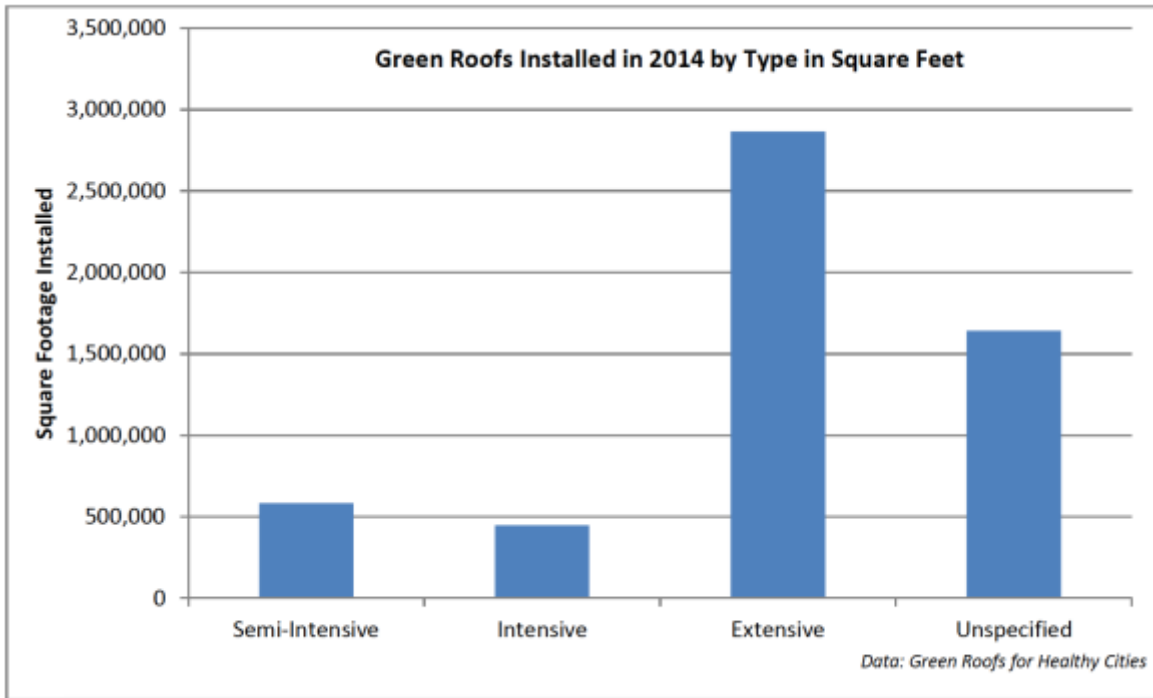


Figure 3. Types of green roofs installed across North America in 2014. GRHC, 2015.

#### 2.1.1.2. INTENSIVE GREEN ROOFS

Intensive green roofs, also known as “roof garden”, are generally designed for public amenity or recreational space, making themselves fully accessible (Figure 4) (Lawlor et al, 2006; Theodosiou, 2009). The depth of growing medium often goes beyond 6 inches, thick enough to support “increased vegetation size and diversity”, offering great potential for aesthetic expectations and food production (Oberndorfer et al, 2007; Theodosiou, 2009). Compared to the other two types, these roofs provide a broader range of benefits such as increased flexibility in design. However, these roofs are expensive among the three green roof types in terms of construction and maintenance, as irrigation system and frequent maintenance are required to ensure the sustainability of these green roofs (Lawlor et al, 2006; Theodosiou, 2009).





Figure 4. intensive green roof of the Fairmont Royal York. White, 2010.

#### 2.1.1.3. SEMI-INTENSIVE GREEN ROOFS

Semi-intensive green roofs are neutral, combining extensive and intensive green roof systems (Figure 5). These roofs have a moderate depth of growing medium, with 25% of green roof area either above or below 6 inches. The moderately thick substrate layer allows more possibilities for design and greater variety of vegetation, such as herbaceous plants and small shrubs, than an extensive green roof (GRHC, n.d.; Vijayaraghavan, 2015). These roofs demand for higher costs for both construction and maintenance, but less than intensive green roofs.



Figure 5. Semi-intensive green roofs of Robertson Building. Less Mess, 2013.

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### 2.1.2. PUBLIC AND PRIVATE BENEFITS

The components of green roofs, including vegetation and growing medium, provide private and public benefits that cannot be resulted from a conventional rooftop. A comprehensive list (Table 2) of private and public benefits of green roofs based on a wide range of literature helps to understand environmental, economic, and social considerations for green roof implementation.

Public Benefits	Private Benefits
Reduces the urban heat island effect	Aesthetic improvement
Improves air quality	Increases energy efficiency
Reduces greenhouse gas emissions	Improves solar panel efficiency
Improves stormwater management – quality and quantity	Extends life of conventional roofs (Increases roof membrane durability)
Facilitates new recreational opportunities	Increases property value
Improves community health and well-being	Food production
Increases urban habitat and biodiversity	Noise reduction
Increases tax revenue	Improves marketability
Decreases municipal infrastructure costs	Energy savings

Table 2. Typical public and private benefits of green roofs. GRHC, n.d.; Shepard, 2010; Theodosiou, 2009.

For the City of Toronto, some of the benefits, particularly public benefits, are identified as key motivation for green roof implementation. The City of Toronto expected that green roofs would “mitigate impacts on stormwater quality and quantity, improve buildings’ energy efficiency, reduce the urban heat island effect, improve air quality and additionally, beautify the City, provide natural green spaces in built-up areas, hold grounds for gardening, food production and horticultural therapy, and increase passive recreational space in densely-populated neighborhoods” (City of Toronto, 2009).

The City also insures that the green roof implementation would support the achievement of city-wide environmental objectives of the Climate Change, Clean Air and Sustainable Energy Action Plan and the Wet Weather Flow Management Master Plan (City of Toronto, 2009).

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### 2.1.3. BARRIERS AND CHALLENGES

Prior to the establishment of a green roof policy, the City identified key barriers to green roof development through public consultations with green roof stakeholders during its policy development process, which is discussed in Section 2.2. These barriers were publicly presented in a staff report to the

Roundtable on the Environment in order to suggest potential solutions for green roof implementation (City of Toronto, 2005).

#### 2.1.3.1. COSTS

Based on results of the consultations, cost was highlighted as the biggest barrier. Although the costs of green roofs vary with their types and designs, the stakeholders expressed concerns about capital cost of green roof projects, especially retrofit projects, due to “the implications of increasing loading capacity of an existing building” (City of Toronto, 2005; Van Dyck et al, 2015). In addition, the City found practical concerns regarding long-term operating costs and maintenance issues, including: 1) establishing responsibility for maintenance and its costs; 2) finding labour with the appropriate skills for green roof maintenance; and 3) practicalities of preparing buried components such as the waterproof membrane. As a potential solution to budgetary barrier, the provision of financial (e.g. subsidies or grants) and procedural (e.g. density bonus and levee fees for stormwater runoff) incentives were suggested (City of Toronto, 2005).

Additionally, Ngan (2004) emphasizes the need of a cost-benefit analysis to support a better understanding of economic benefits, such as energy savings, while simultaneously persuading developers and property owners to implement their green roofs. With the foregoing purpose, the City initiated its cost-benefit study with Ryerson University (Refer to Section 2.2.4).

#### 2.1.3.2. LACK OF PUBLIC AWARENESS

The City also highlighted a general lack of public awareness and knowledge about green roofs and their benefits. The City found that many developers and property owners did not have enough information on benefits from green roof owners (City of Toronto, 2005). This lack is also likely to create “uncertainty and doubt” about whether a green roof is a viable option in Toronto (Shepard, 2010). Improved publicity and education were strongly suggested to provide a clear information with respect to green roofs and their benefits and support a positive attitude towards these roofs.

#### 2.1.3.3. LACK OF STANDARD AND WARRANTY CONCERNS

Another barrier was the lack of clear standards for green roof installation, which “can ensure warranty, liability, and insurance for green roofs” (City of Toronto, 2005). Prior to the inception of



Toronto's Green Roof Bylaw, none of the Canadian cities had detailed design guidelines and clear, generally-accepted standards for green roofs (City of Toronto, 2005; Ngan, 2004). According to Shepard (2010), the standards help to regulate and meet expectations, while reducing the perceived risks and uncertainties that make people hesitate to install green roofs.

#### 2.1.3.4. THE APPROVAL PROCESS AND LACK OF SUFFICIENT INFORMATION, SKILLS, AND EXPERIENCE

As green roofs were considered the “new innovation” in Toronto prior to the time of when the policy was developed, the City raised concerns on how an application for green roof would proceed through the approval process. The lack of experience and knowledge of staff of the approving agency in dealing with the application could provide potential conflicts with the Ontario Building Code (OBC). Additionally, the need for appropriate knowledge and experience with Toronto's local conditions and issues were identified.

## 2.2. TORONTO'S GREEN ROOF POLICY DEVELOPMENT

The Toronto's green roof policy is the result of a consensus-based, progressive approach where the City followed six phases of the *2006 Green Roofs: A Resource Manual for Municipal Policy Makers* of the Canadian Mortgage Housing Corporation (CMHC) (Lawlor et al, 2006). The six phases are: 1) Introductory and awareness; 2) Community engagement; 3) Action plan development and implementation; 4) Technical research; 5) Program and policy development; and 6) Continuous improvement. The City did not accomplish each phase in order, however, it addressed each phase to ensure the green roofs implementation was more accessible, feasible, and practical to the public, more specifically property owners and developers (Figure 6).

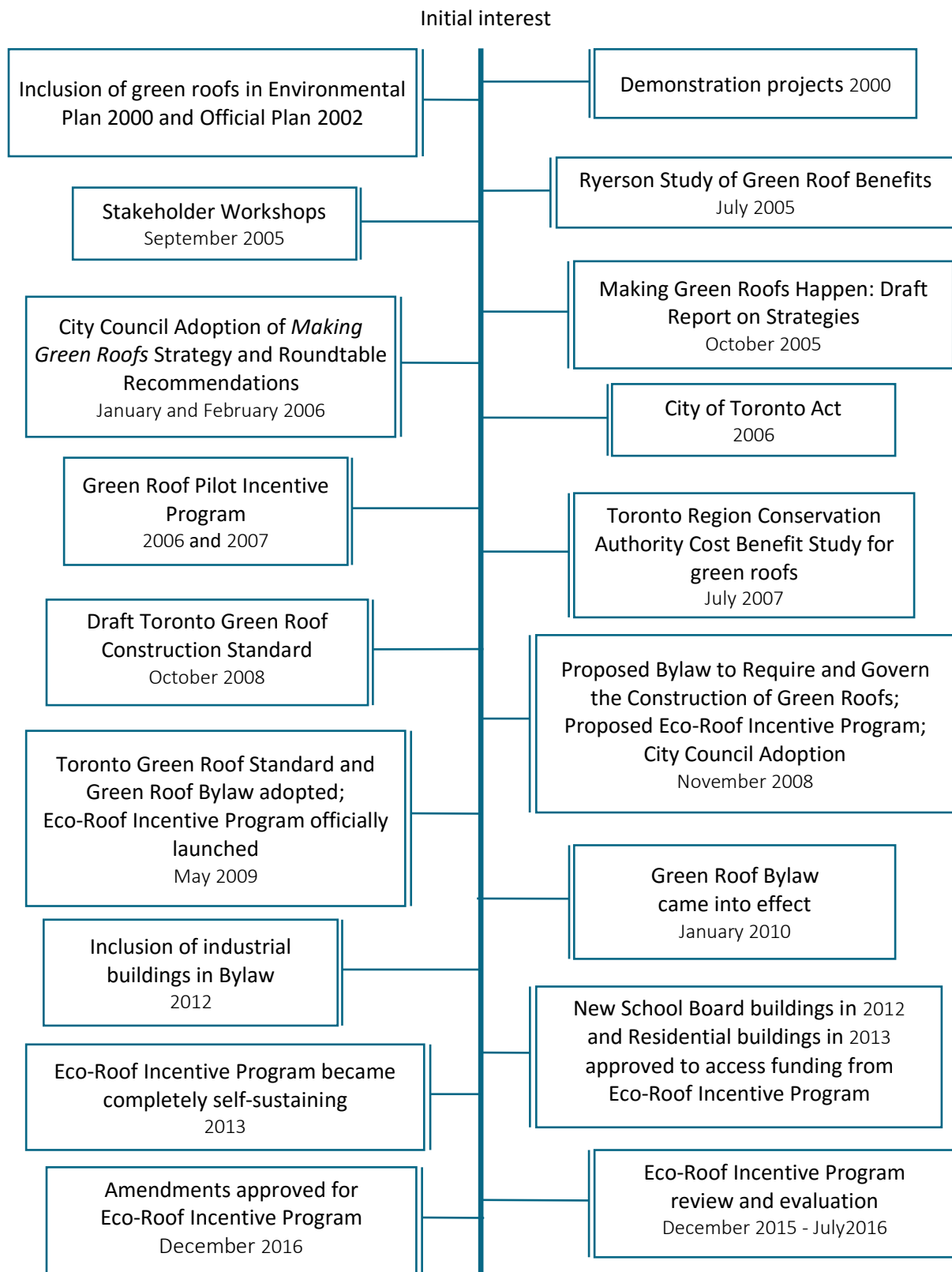


Figure 6. Timeline of Toronto's green roof policy development. Revised Loder, 2011.

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### 2.2.1. INTRODUCTORY AND AWARENESS

The City's formal interest in and recognition of green roofs were introduced in three planning and environmental policies: The 2001 Environmental Plan, the Toronto's Official Plan, and the 2000 Wet Weather Flow Master Plan (Banting et al, 2005; Lawlor et al, 2006). The first formal interest in green roofs was found in the Environmental Plan, which suggested "the need for a strategy to encourage green roofs and rooftop gardens" (Lawlor et al, 2006). Furthermore, the City's Official Plan and the Wet Weather Flow Master Plan highlighted the use of green roofs as an innovative solution to address urban heat island effect and stormwater management. The interest as a starting point facilitated a series of public consultations and a cost-benefit study associated with green roofs.

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### 2.2.2. COMMUNITY ENGAGEMENT

The City held a series of public consultations with green roof stakeholders to consider and outline consensus-based recommendations for steps in phase 5. The stakeholders included green roof suppliers, architects, landscape architects, designers, developers, builders, and property owners and managers. The participants provided a variety of ideas and suggestions for green roof construction, while identifying possible opportunities and constraints. The consultations largely contributed to the development of a Green Roof Bylaw for the City based on the findings of studies, including a cost-benefit study.

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### 2.2.3. ACTION PLAN DEVELOPMENT AND IMPLEMENTATION

This phase includes two green roof demonstration projects on the podium of City Hall and the roof of the Eastview Community Centre in 2000. The main purpose of the projects was to determine the technical, financial, and educational feasibility of green roofs in the City (Bantings et al, 2005). In partnership with the Green Roofs for Healthy Cities (GRHC), the City participated in the projects to monitor and evaluate green roof thermal performance and environmental benefits (Bantings et al, 2005; City of Toronto, 2005).

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### 2.2.4. TECHNICAL RESEARCH

In this phase, the City of Toronto investigated and quantified city-wide benefits of green roofs through a cost-benefit study entitled *the Environmental Benefits and Costs to Green Roof Technology* (Bantings et al, 2005). The study measured economic benefits of implementing green roofs in Toronto

based on assumptions. The assumptions were that green roofs would cover at least 75% of flat roof area above 350 square metres in size. The estimated total available green roof area was 5,000 hectares (50 million square metres), which is 37% of the total building roof area in Toronto.

On the assumption that 100% of available green roof area will be used, the study summarized that green roof implementation in Toronto would provide significant economic benefits to the City, particularly in the areas of stormwater management, the urban heat island effect reduction, and energy use for cooling (Table 3). The findings of the study led directly into phase 2 (Community Engagement), as the basis for stakeholder consultations.

Category of benefit	Initial cost saving	Annual cost saving
<b>Benefits from stormwater flow reduction</b>		
▪ Alternate best management practice (BMP) cost avoidance	\$2.8 to \$79 million	
▪ Pollutant control cost avoidance	\$14 million	
▪ Erosion control cost avoidance	\$25 million	
<b>Combined Sewer Overflow (CSO)</b>		
▪ Storage cost avoidance (reduced requirement for underground water storage)	\$46.6 million	
▪ Reduced beach closures		\$750,000
<b>Air Quality</b>		
▪ Impacts of reduction in greenhouse gas (CO, NO2, O3, PM10, SO2)		\$2.5 million
<b>Building Energy</b>		
▪ Savings in annual energy use		\$21 million
▪ Cost avoidance due to peak demand reduction	\$68.7 million	
▪ Savings from CO2 reduction		\$563,000
<b>Urban Heat Island</b>		
▪ Savings in annual energy use		\$12 million
▪ Cost avoidance due to peak demand reduction	\$79.8 million	
▪ Savings from CO2 reduction		\$322,000

Table 3. Summary of municipal level environmental benefits of green roof implementation in the City of Toronto based on the assumption that green roof coverage of 5,000 hectares. Bantings et al, 2005.

An additional study on private benefits and costs to buildings, *An Economic Analysis of Green Roofs: Evaluating the costs and savings to building owners in Toronto and surrounding regions* (TRCA, 2007), was conducted by the Toronto and Region Conservation Authority’s Sustainable Technologies Evaluation Program. The study calculated the average life cycle costs and savings associated with having green roofs in the Greater Toronto Area. The findings offered a package of key recommendations, including the provision of direct financial incentives. The study stated that the incentive of \$4 to \$7 per

square foot would decrease capital costs enough to install green roofs, and ultimately encourage green roof implementation across the City (TRCA, 2007).

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#### 2.2.5. PROGRAM AND POLICY DEVELOPMENT

This phase can significantly be broken into two: 1) the development and implementation of a green roof strategy, “Making Green Roofs Happen”, and 2) the City of Toronto Act’s new authority.

The City’s planning department combined and submitted the findings of stakeholder consultations and the 2005 cost-benefit study as a discussion paper, *Making Green Roofs Happen*, to its advisory Roundtable on the Environment (Lawlor et al, 2006). Approved by the Toronto City Council on February 1, 2006, a three-year green roof strategy – Making Green Roofs Happen – implemented its four components: a pilot incentive program, the installation of green roofs on City-owned facilities, the use of the development approval process, and publicity and education (City of Toronto, 2009; Mitrovic, 2010).

Funded from the Toronto Water, the pilot incentive program financially supported 16 green roof projects in 2006 and 46 in 2007 (Lawlor et al, 2006; Shepard, 2010). Due to the effectiveness of the pilot program, the City Council adopted the incentive program – the Eco-Roof Incentive Program – in 2008, and officially launched in May 2009 (City of Toronto, 2016). In terms of the development approval process, the City approved 14 zoning by-law amendments and site plan control applications for residential, commercial, and condominium developments to achieve green roofs.

Despite these outcomes, the Ontario Building Code Act restricts the legal ability of Ontario’s municipalities, including Toronto, to require green roofs, which exceeds the requirements of the Building Code (City of Toronto, 2008; City of Toronto, 2009). However, new authority under section 108 of the City of Toronto Act (COTA) granted the City an exception to the Ontario Building Code Act. In other words, the COTA authorized the City to pass a mandatory bylaw for green roof construction.

The City conducted two rounds of stakeholder consultations in late 2008 and early 2009 to discuss on a draft proposal of the Bylaw and establish a framework and construction standard for the Bylaw (City of Toronto, 2009). The consultations resulted in a series of recommendations on the standard, including green roof coverage requirements, target types of developments, and incentives.

As a result, the Toronto Green Roof Bylaw (*Toronto Municipal Code Chapter 492: City of Toronto, 2013c*), as the first bylaw in North America for green roofs, was added as an applicable law under the

Ontario Building Code, and was an additional chapter to the Toronto Municipal Code, under the authority of COTA (City of Toronto, 2009).

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#### 2.2.6. CONTINUOUS IMPROVEMENT

Currently, the City has continued to evaluate the impacts of its green roof policy and evolve the policy with many amendments. Approved amendments were integrated into the Bylaw, such as the inclusion of industrial buildings, to further support green roof implementation.

For the Eco-Roof Incentive Program, amendments were issued through stakeholder consultations in 2012, 2013 and 2016. The City further evaluated the Program to identify recommendations, which potentially increase participation and application of eco-roofs. The *2016 Eco-Roof Incentive Review Report* by Lura Consulting & Cardinal Group Inc. was completed between December 2015 and July 2016. It presented the results of best practices research, stakeholder engagement, and a financial life-cycle analysis of eco-roofs. The recommended amendments based on input from stakeholder consultations have been approved to increase program participation and encourage the implementation of green and cool roofs, known collectively as “eco-roofs” (City of Toronto, 2016).

## 3.0. METHODOLOGY

This chapter describes in detail a mixed research methods approach employed in this study, in attempt to gather data with regard to the Toronto's green roof policy. The approach is broken down into two sections: policy analysis with cases and face-to-face interviews.

### 3.1. POLICY ANALYSIS WITH CASES

This analysis is to review and analyze the City's green roof policy, based on a wide range of policy documents and resources. These include the thematic policy documents such as the Toronto Green Roof Bylaw (City of Toronto, 2013c), Toronto Green Roof Construction Standard Supplementary Guidelines (City of Toronto, n.d.), Guidelines for Biodiverse Green Roofs (City of Toronto, 2013a), and Toronto Green Standard version 2, staff reports, and web-based municipal documents. These documents and resources are available online.

Additionally, based on academic literature including master's reports, this analysis used domestic and international cases as examples and best practices to identify policy tool types, such as direct and indirect incentives and technology and performance standards employed by each municipality. The use of these cases guided supplementary information to demonstrate the differences between and the impacts of such tools. Some of the tools that are not part of Toronto's green roof policy were analyzed to support a comprehensive understanding of the policy, while setting out a series of recommendations.

### 3.2. INTERVIEWS

Two sets of interviews aim to: 1) address how the City's policy analyzed in the former approach has been put into practice, 2) determine the policy's practical strengths and weaknesses, and 3) address how the policy can better help green roof implementation in the future. Face-to-face interviews were conducted with a total of eight key informants over a 2-month period from February to March 2017. Six of them were distributed into three groups of two, while the other two key informants were independently interviewed.

The interviews were conducted in a slightly different manner due to my hearing disability. A dictation software was used during interview sessions to minimize miscommunication with the key

informants instead of audio-recording. The dictation software automatically and immediately transcribed what the key informants said and helped with immediate responses with additional questions.

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### 3.2.1. SURVEY INSTRUMENT

The sets of interviews were semi-structured with open-ended questions to obtain as much information as possible. Even though interview questions vary for each set, they are content-focused (Dunn, 2010). Samples of questions, attached in Appendix A, were created with the purpose of reaching the research objectives. The questions were designed to directly guide various perspectives from different key informants with respect to green roof implementation through the policy. The questions for the first set aim at highlighting the practical implementation of the policy, while the other set was asked with questions of how the policy influenced the decisions of developers and property owners to implement green roofs. Additional questions were created depending on different positions.

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### 3.2.2. SAMPLING KEY INFORMANTS

The first set of interviews includes four city planning officials and 2 individuals working in the field of green roof industry to provide points of view of policy makers and/or actors on the policy. These participants were found at the City of Toronto's Green Roofs, Eco-Roof Incentive Program, and Green Roofs for Healthy Cities (GRHC) websites that are devoted to dissemination of green roof information.

The other set features a group of two property owners of retrofit green roof projects, with the initial purpose of providing their feedback on their green roof installation through the policy. Their green roof projects were posted on a website entitled *Green Roof Project Database* ([www.greenroofs.com](http://www.greenroofs.com)). As all the key informants in both the sets are heavily involved in green roof projects across the City of Toronto, they were considered the best candidates for interviews. All but one key informant are identified by their names with consent through the Information Letter and Consent Form (Appendix B). The one is identified by their employment position, instead of a name.

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### 3.2.3. SURVEY RESULT ANALYSIS

The transcribed data was analyzed through an inductive analysis approach, which helps to identify, analyze, and report themes observed throughout the interviews (Thomas, 2006). In comparison with some other approaches, this approach draws summary of interview responses in a more simple,



straightforward way (Thomas, 2006). During the analysis, specific themes were developed, depending on the core messages reported by the key informants. Using direct quotations, the analysis developed high level of reliability in the results derived from the interviews, while generating a coherent narrative about the policy, as well as its strengths and weaknesses.

### 3.3. LIMITATIONS

The study has several limitations. Although the study initially intended to gain the perspectives of developers and property owners whose projects are subject to the Bylaw, none of them were interviewed. This limitation is resulted largely from the limited information of green roof projects to which the Bylaw applied.

At the same time, only the group of two property owners, who installed two green roofs on their buildings at 401 Richmond Street West and 215 Spadina Avenue prior to the inception of the Bylaw, participated instead. Although their projects were predated the Bylaw, the property owners provided further information associated with their green roofs and the Eco-Roof Incentive Program. The participation of additional developers and property owners would have fostered a more comprehensive perspective on practical issues of the green roof policy.

Another limitation is with the technical errors of the dictation software, such as the lack of accuracy, misinterpretation, and malfunction. The software sometimes did not accurately transcribe the overall speeches of the key informants. Not only that, the software stopped working during an interview session with one of the key informants for some unknown cause. Some of the key informants, thus, spent additional time and work to write their responses instead.

Despite these limitations, the findings gathered and analyzed in this study brings useful insight to the green roof policy in Toronto and supported establishing recommendations.

## 4.0. RESULTS

This chapter provides a detailed account of the findings from the mixed methods approach introduced in the previous chapter (Chapter 3). Accordingly, this chapter is structured into two sections; the first part will be on the findings from policy documents and examples of green roof policies in domestic and international municipalities and the second one will focus on the analysis of the interviews.

### 4.1. TORONTO'S GREEN ROOF POLICY ANALYSIS WITH CASES

Toronto green roof policy is comprised of a legal instrument and a financial incentive. In studies by Carter and Fowler (2008), Mees et al (2012), and Ngan (2004), legal instruments generally include technology and performance standards, while the components of incentive policy are direct and indirect financial incentives.

In the phrase of Bemelmans-Videc et al (1998) and Mees et al (2012), the City of Toronto has employed its technology standard – the Toronto Green Roof Bylaw - as a “stick”, while simultaneously supporting green roof projects through a direct incentive - the Eco-Roof Incentive Program - as a “carrot”.

#### 4.1.1. TECHNOLOGY STANDARDS

Technology standards or technology-based regulations, such as building code requirements, enforce green roof installation over all or part of a building's rooftop (Carter & Fowler, 2008; Ngan, 2004). While many municipalities around the world, for instance Basel, Switzerland and Tokyo, Japan, have employed mandatory green roof use on various types of development, the Toronto Green Roof Bylaw is unique among North American cities (Shepard, 2010).

Under the Bylaw, Toronto has a certain construction requirement for green roof coverage depending on the size of the building, as summarized in Table 4. The City specifically targets all new developments with a minimum gross floor area of 2,000 square metres being required to comply with the Bylaw. For example, a building with a Gross Floor Area (GFA) ranging from 2,000 to 4,999 square metres is legally required to install a green roof covering 20% of the available roof space. Commercial, institutional, and residential buildings can use a graduated coverage ranging between 20% and 60% of available roof space, while industrial buildings have lower coverage requirements being the lesser of 10% of available roof space or 2,000 square metres.

Gross Floor Area (Size of Building)	Coverage of Available Roof Space (Size of Green roof)
2,000 – 4,999 m <sup>2</sup>	20%
5,000 – 9,999 m <sup>2</sup>	30%
10,000 – 14,999 m <sup>2</sup>	40%
15,000 – 19,999 m <sup>2</sup>	50%
20,000 m <sup>2</sup> or greater	60%

Table 4. Green roof coverage requirements for new developments in *City of Toronto Municipal Code Chapter 492, Green roofs*. City of Toronto, 2013c.

The Bylaw came into effect in January 2010 for all new commercial, institutional, and residential buildings and was expanded to include industrial developments since April 30, 2012. Furthermore, the Bylaw offers a cool roof approach as an alternative to the green roof requirements applicable only to industrial buildings. This approach helps achieve a similar performance level to a green roof, while addressing issues and concerns associated with industrial buildings (City of Toronto, 2011). The approach also enables industrial buildings to avoid green roof installation if a cool roof for 100% of the available roof space is installed instead, in compliance with specific stormwater management performance targets (City of Toronto, 2013c).

Non-compliance with the Bylaw is penalized with a fee of up to \$100,000 as per sections 20 and 21 of the Bylaw, however, there are exceptions to the Bylaw that exist in some cases as defined in section 5. Small development projects, such as buildings with a GFA of less than 2,000 square metres and all residential buildings less than 6 storeys or 20 metres in height, are exempted from the green roof requirements. In addition, the existing buildings are excluded from the enforcement of the Bylaw for retrofit projects.

However, all available areas cannot be greened in compliance with the coverage requirement for some reasons. Thus, an application for an exemption or variance is allowed to be made under section 11 of the Bylaw. This application can contribute to a smaller amount of green roof than is required or the entire space required for green roof, through an approval from the Chief Planner and a cash-in-lieu payment of \$200 per square metre of exempted roof surface.

#### 4.1.1.1. TORONTO GREEN ROOF CONSTRUCTION STANDARD (TGRCS)

The Toronto Green Roof Construction Standard (TGRCS), as *Article IV of the Green Roof Bylaw*, provides a set of minimum requirements for green roof design and construction. The TGRCS functions

alongside the Bylaw to ensure that all green roofs, regardless of whether a green roof installation is voluntarily or obligatorily, are constructed in conformity to the City's minimum requirements for green roof construction and the Ontario Building Code (OBC) requirements for the building as a whole (City of Toronto, 2009).

Section 8 of the Bylaw notes that the TGRCS acts as an “acceptable solution” for green roof design and construction in compliance with parts 3 to 12, Division B, of the OBC for safety reasons. The TGRCS sets out several areas of considerations for safety and performance associated with green roofs, such as fire safety, gravity loads, and water retention, to ensure that every green roof is suitably and safely built on both new and existing buildings.

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#### 4.1.1.2. GUIDELINES

Toronto has the *Toronto Green Roof Construction Standard Supplementary Guidelines* and the *City of Toronto Guidelines for Biodiverse Green Roofs* as supplementary guidelines for green roof design and construction. These guidelines provide recommendations and considerations on how to optimize green roof design, rather than prescriptive requirements of the construction standard (City of Toronto, 2009). These guidelines describe and illustrate best practices to assist designers, architects, and landscape architects to design and construct green roofs in accordance with the TGRCS (City of Toronto, 2009; City of Toronto, 2013a). The former guidelines allow for flexibility in design of green roofs, while providing engineering recommendations associated with the structural aspects of green roofs, such as growing media and drainage panel.

Produced in 2013, the *Guidelines for Biodiverse Green Roofs* further supplement green roof implementation in conjunction with the *TGRCS Supplementary Guidelines*. The guidelines provide landscape architects a comprehensive list of plants suitable for green roofs, as well as recommendations and ideas for creating habitat for specific species. The implications of the guidelines were further reflected by Calvet (2013). The guidelines enhance the impact of the Bylaw in compliance with policies of the Toronto Official Plan pertaining to natural ecosystems: to protect, restore, and improve the health of natural ecosystem, and support biodiversity.

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#### 4.1.1.3. STRENGTHS AND WEAKNESSES

Ismail et al (2012) and Ngan (2004) claim that a mandatory bylaw is “by far the most effective way” of implementing green roofs, especially in new developments to address many environmental concerns of the City at the same time. Largely due to the Bylaw, 300 new green roofs have been installed, with over 250,000 square metres of green roof area coverage between February 1, 2010 and March 1, 2015 (Figure 7).

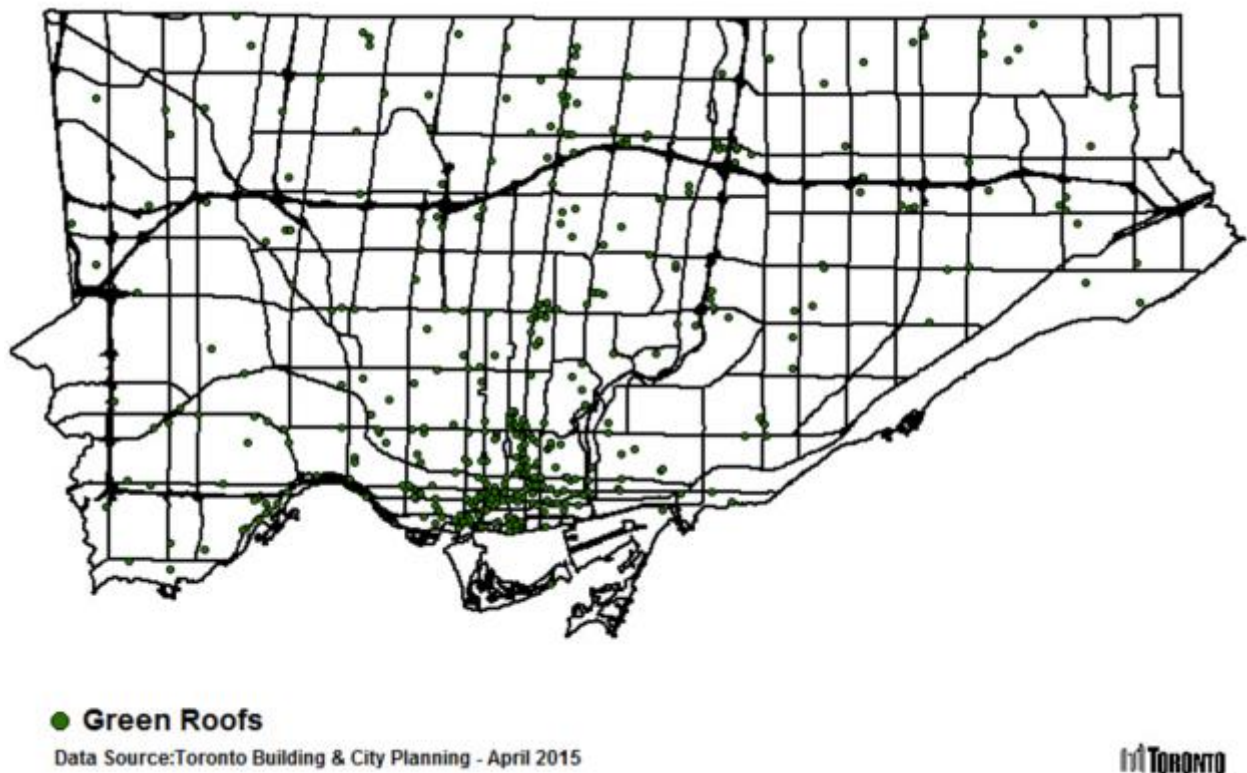


Figure 7. Map of green roofs in Toronto. City of Toronto, 2017b.

As a result, Toronto has been the only Canadian city to be ranked in the top 10 of North American Cities’ rankings in square feet of green roofs installed over the past several years (Figure 8). Furthermore, the City has ranked the second for the last two consecutive years (GRHC, 2015; GRHC, 2016).

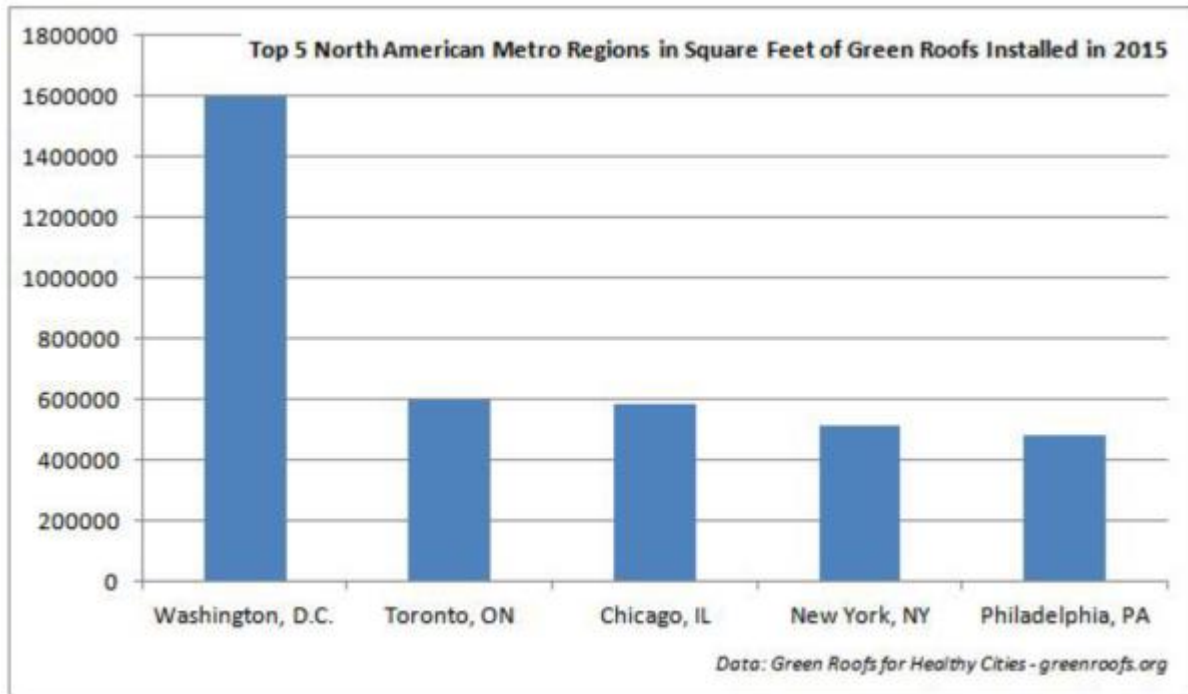


Figure 8. Top 5 North American cities in square feet of green roofs installed in 2015. GRHC, 2016.

The Bylaw has advantages, as well as limitations. The technology standards can block “innovation and application of other technologies” (Carter & Fowler, 2008; Cooper, 2014). The concerns over the Green Roof Bylaw were expressed through media sources, especially newspaper article of Belford (2009) and Mordant (2009), following the adoption of the Bylaw. The Bylaw was believed to limit choice and opportunities for other building features or technologies that help achieve environmental benefits. However, the Bylaw allows for flexibility in substituting a cool roof for a green roof on industrial buildings. Flexibility of the Bylaw is further detailed in section 4.2.2.2.

Another limitation occurs in terms of food production associated with green roof installation. The Bylaw with the TGRCS is not supportive of urban agriculture, as the green roof requirements make it difficult to use available spaces for food production (Kaill-Vinish, 2009; MacRae et al, 2010). The use of an intensive green roof could be a viable option, but increased load and financial burden for developers or property owners can be a deterrent to construct these type of roofs (Kaill-Vinish, 2009).

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#### 4.1.2. DIRECT FINANCIAL INCENTIVES

Direct financial incentive policies financially support developers and property owners with short- and long-term subsidies or grants to address budgetary barriers associated with green roof

implementation. In this regard, the Eco-Roof Incentive Program is primarily intended to motivate developers and property owners to voluntarily install their own green roofs, particularly retrofitting roofs (Lura Consulting and the Cardinal Group Inc., 2016). The Program provides grants of \$100 per square metre for eligible green roof projects that are not subject to the requirements of the Bylaw, including:

- 1) Existing residential, industrial, commercial, and institutional buildings;
- 2) All new buildings with a gross floor area of less than of 2,000 square metres;
- 3) All new Toronto Public and Separate School Board Buildings of any size; and
- 4) All new construction projects by organizations incorporated as not-for profit corporations

(City of Toronto, 2016; 2017c).

To qualify for the grants, a green roof must be “designed, constructed, and maintained in conformance with the requirements of the [TGRCS]” and the coverage requirements based on its building size (City of Toronto, 2017c).

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#### 4.1.2.1 AMENDMENTS & IMPROVEMENT

The current eligibility criteria listed above are the result of how the Program has been constantly upgraded and improved through amendments. Following the City’s decision to adopt the amendments, the incentive has increased to \$100 per square metre from the previous value of \$75 per square metre to better achieve the original goals of the Program. Based on the 2016 Eco-Roof Review Report by Lura Consulting and the Cardinal Group Inc., on average, the previous incentive level of \$75 per square metre offered from the Program covered 23% of the total project costs, a figure is so far below 50%, which is the original goal of the Program. The percentage of project costs offset by this incentive level varied significantly, but ranged between 10 and 25%.

For the reason, Washington, D.C. and New York City, New York were considered best practices and inspiration for the improvement of the Program to increase the amount of the incentive (Lura Consulting & the Cardinal Group Inc., 2016). Incremental costs for an extensive green roof built in Toronto is approximately \$182 per square metre as of October 2016, while the average cost of green roofs was 371 per square metre based on six case studies of retrofit projects developed in Toronto. Thus, the increased incentive of \$100 per square metre is anticipated to reduce “the initial ‘sticker shock’ posed by the costs”, by covering a higher percentage of costs required for green roof (City of Toronto, 2016).

However, the value of \$100 per square metre is still less than the incentive offered by the RiverSmart Rooftops Rebate in Washington, DC (\$143 to \$214 per square metre CAD), while New York City’s CoolRoofs Program covers nearly 100% of green roof project costs, with its incentive ranging from \$74.56 to \$214 per square metre CAD.

Another amendment to the Program is the provision of Structural Assessment Grant (SAG) to address a significant barrier associated with structural assessment costs for retrofit projects. Green roof costs are generally higher for existing buildings than new developments due to structural modifications. “As one of the first steps in determining whether to install a green roof”, a structural analysis is necessary to determine an existing building’s structural load-bearing capacity and check for any damage associated with the additional load of green roof (Lura Consulting & the Cardinal Group Inc., 2016). The completion of structural assessment by a professional engineer typically costs up to \$3,000. In response to this, the RiverSmart Rooftops Rebate Program in Washington, D.C., which offers a maximum grant of \$250 (approximately \$330 CAD) for a structural analysis, motivated the Eco-Roof Incentive Program to establish the SAG (Department of Energy and Environment, 2016). As a result, the additional funding up to \$1,000 for structural assessments, enforced since 2016, is likely to offset approximately a third of a typical structural assessment cost.

The Program has additionally expanded its eligibility criteria for grants. New and existing Toronto Public and Separate School Board Buildings have been eligible for the Program since 2012, residential building sector since 2013, and not-for-profit corporation buildings since 2016 (City of Toronto, 2016). The inclusion of residential buildings into the eligibility criteria for funding is applauded as “positive response to the 2013 program amendment” (Lura Consulting & the Cardinal Group Inc., 2016). As shown in Table 5, a sharp increase in green roof installation on residential buildings (32%) is reported, behind commercial or mixed-use commercial sectors (44%) in most installation among all eligible building types.

Year	Industrial	Institutional	Commercial	Mixed Use – Commercial/ Residential	Residential
2009		5	10	4	N/A*
2010		1	2	1	
2011			2		
2012	1	1	1		
2013		2	1		3
2014		1	1		8
2015		1			4
2016**					1
<b>Total</b>	<b>1</b>	<b>11</b>	<b>17</b>	<b>5</b>	<b>16</b>
<b>Percent of Total</b>	<b>2%</b>	<b>22%</b>	<b>34%</b>	<b>10%</b>	<b>32%</b>

\*The residential sector became eligible for Eco-Roof Incentive Program funding as of 2013.  
 \*\*as of September 30, 2016.

Table 5. Completed green roof projects by building type. City of Toronto, 2016.



Finally, the removal of funding cap for green roof projects was approved to encourage larger green roof projects. The Program previously funded eligible green roofs to a maximum of \$100,000, which deterred the applicants from maximizing the amount of available roof space being greened (City of Toronto, 2016). A typical example is a new high school at 2850 Eglinton Avenue East that installed its green roof in a smaller size, approximately half of the originally proposed size of 2,812 square metres, to prevent the cap being exceeded.

#### 4.1.2.2. RESULTS

Despite significant progress of the Program in establishing eco-roof space between March 2009 and October 2016, the number of approved cool roof projects far outweighed the green roof projects (City of Toronto, 2016). The Program has approved 56 applications for green roofs with the total area of 25,497.81 square metres, of which 50 projects were completed, while 222 cool roof projects with total area of 567,391.43 square metres approved (Figure 9). This can be attributed to high upfront costs for green roof projects, compared to cool roofs, as a significant barrier to install green roofs. However, the 2016 program amendments are expected to more offset upfront costs, by offering the SAG and increased incentive of \$100 per square metre.

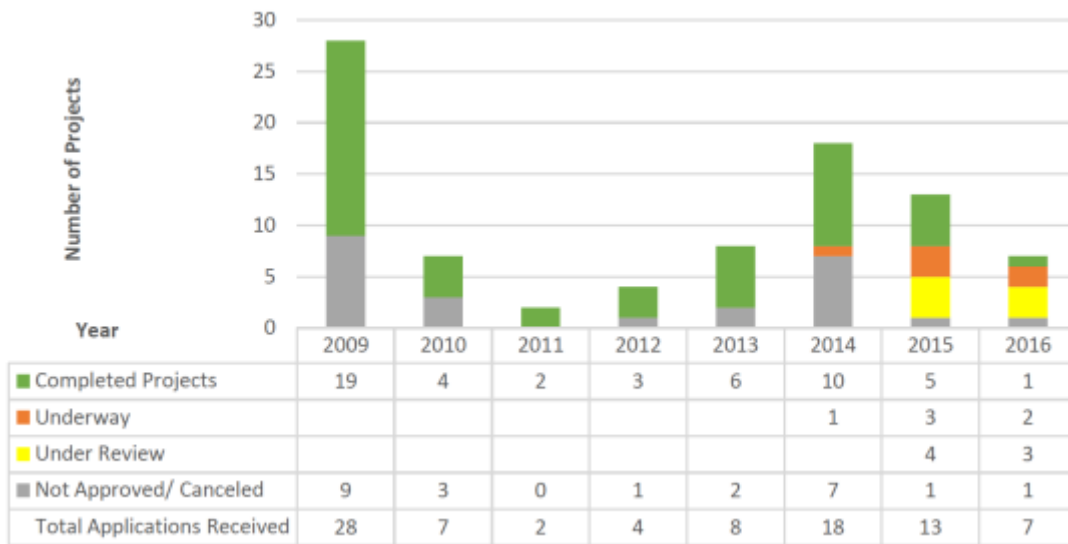


Figure 9. Green Roof Applications between March 2009 and October 2016. City of Toronto, 2016.

Nevertheless, a concern is with the financial responsibility of the Program. The Program is completely “self-sustaining” with contributions from the cash-in-lieu policy under the Green Roof Bylaw. As a result of the 2012 amendments to the Program, a discretionary reserve called the Eco-Roof Financial

Assistance Reserve Fund was established, instead of the termination of the Strategic Infrastructure Reserve that dedicated funding to the Program between 2009 and 2012 (City of Toronto, 2013b). Since 2013, funds from cash-in-lieu policy collected in the Reserve Fund have been funneled into approved green and cool roof projects. Ongoing approval of such projects depends on the availability of the funds from cash-in-lieu policy collected in the Reserve Fund (City of Toronto, 2016). However, as shown in Figure 9, the number of approved green roof projects annually has been falling since 2014 and remains compared to the four-year period prior to the amendments.

Thus, this draws a concern on how the Program not only encourages more green roof projects, but also ensures its long-term capacity for adequately incentivizing green and cool roof projects with only cash-in-lieu contributions. In the event that applications for an exception or variance decline, there is a greater chance for budgetary challenges to occur to adequately support green roof projects. In response to this, other financial sources may be necessary to adequately support the long-term implementation of the Program and prevent the termination attributed to budgetary deficit (Carter & Fowler, 2008; Ngan 2004). As such, Berlin already experienced the termination of its green roof subsidy program, which offered residents approximately 50% of green roof construction costs, in 1997 (Carter & Fowler, 2008; Shepard, 2010).

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#### 4.1.3. MAINTENANCE

The maintenance of green roofs is “a key concern and challenge” although every green roof is required to be maintained in accordance with the maintenance plan under section 3 of the Bylaw (City of Toronto, 2016). The plan is primarily intended to assess and monitor the performance of green roof components and address necessary replanting issues, however, it is not with the purpose of “large-scale research” on green roof performances in Toronto (Van Dyck et al, 2015). In addition, Loder (2011) stated that “it is still unclear as to whether the City has resolved the maintenance issues around the upkeep of green roofs”. He mentioned one of the demonstration projects remained ongoing maintenance issues as such green roof had been neglected as an “eyesore”.

Based on consultations with program participants, including roof professionals and property owners, costs for maintaining green roofs remain one of main significant barriers, although the costs vary considerably for green roofs depending on “roof-specific details”, such as the location, size, and technology used (City of Toronto, 2016). As maintenance costs average approximately \$1,250 per year,

the need for funding or strategies to reduce financial stress associated with ongoing maintenance is necessary, as suggested by the participants.

Another drawback is the lack of awareness and education in relation to the maintenance of green roofs. Many program participants noted that they were not aware of the long-term upkeep of maintenance that is needed, and they lacked the necessary skilled labourers with proper knowledge to maintain green roofs, including specific seasonal tasks such as weeding and watering. Given these concerns, the participants suggested the support of the City for maintenance.

While the City of Toronto has the combination of only the technology standard and the direct incentive, green roof leaders have employed several tools, including performance standards and indirect financial incentives. Both performance-based regulations and indirect financial incentives were explored, to identify strengths and challenges for being part of the Toronto's green roof policy. Both have the advantage of being voluntary, favoring those owners who can install green roofs in a cost-effective manner based on their site conditions. They can apply to both new construction and retrofit situations (Carter & Fowler, 2008).

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#### 4.1.4. PERFORMANCE STANDARDS

For some municipalities, green roofs are a measure for achieving environmental goals such as stormwater management (Mees et al, 2012). Performance standards are likely to be more effective in achieving specific performance targets and maximizing the benefits of green roofs than the construction requirements (Cooper, 2014; Ngan, 2004). Examples of the standards include stormwater retention and roof reflective capacity. For example, the Energy Conservation Code in Chicago standardized a minimum solar reflectance required for all new and retrofit green roofs (City of Toronto, 2005; Farahmandpour & Waterston, 2002). In the case of Toronto, an alternative for industrial building sector specifies the amount of stormwater retention, which may be met through the use of cool roof, instead of providing no options.

Furthermore, Toronto has the Toronto Green Standard (TGS), a two-tier set of performance measures for sustainable site and building design (City of Toronto, 2017a). The TGS mandates achieving Tier 1 building standards for all new constructions, whether they have a green roof or not, while offering developers who voluntarily choose to meet Tier 2 performance standards a development charge refund as a financial incentive. The Green Roof Bylaw function in conjunction with the TGS, as the TGS recognizes

green roofs as a primary way to reduce urban heat island effect, one of environmental priorities to the City. The TGS also complements the Leadership in Energy and Environmental Design (LEED) rating system, as achieving TGS performance measures contribute towards the LEED certification (CaGBC, 2014).

A performance rating system is another typical performance standard. Banting et al (2005), Lawlor et al (2006), and Ngan (2004) emphasize the significance of the rating system to address one of the main concerns with green roof policy, which is to ensure that green roofs help performance goals and are continually achieved over long periods of time. The rating system helps to evaluate and determine whether a green roof achieves its performance goals and performs its ecological functions (Lawlor et al, 2006). The mandated installation of green roofs potentially helps earn up to 11 LEED building credits in Canada by meeting performance goals, including stormwater management, energy saving, heat island effect reduction, and wildlife habitat and other environmental benefits (Cooper, 2014; Lawlor et al, 2006). However, as the LEED accreditation is attributable to a synthesis of sustainable design features, including green roofs, with the ultimate purpose of reducing environmental impacts of a building (Cooper, 2014; Shepard, 2010).

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#### 4.1.5. INDIRECT FINANCIAL INCENTIVES

Other than direct monetary inducements, indirect financial incentive policies come in many forms, such as stormwater utility fees, tax abatements, density bonusing (Carter & Fowler, 2008; Shepard, 2010). Many U.S. municipalities have various types of incentives to offer financial rewards to developers and property owners in requital of installing and maintaining their green roofs, while none of these policies are included in Toronto's green roof policy (Shepard, 2010). Developers and property owners in Toronto shoulder the entire costs of their green roofs in compliance with the Bylaw without any compensation. In contrast, the Clean River Rewards Stormwater Discount Program in Portland, Oregon offered up to a 100% discount on the on-site stormwater management charges to property owners, while property owners in the City of New York received a one-year property tax abatement of \$4.50 (USD) per square foot (City of New York, 2017; City of Portland, 2017; Shepard, 2010).

The need for the indirect incentives for green roof projects, especially stormwater fee discount based on decreases in impervious surfaces, in Toronto was reflected by Saxe (2015). She mentioned the cases of three municipalities in Ontario which are Kitchener, Waterloo, and Mississauga. Although these municipalities do not have any regulations associated with green roofs, they offer financial incentives to property owners in compensation of stormwater management benefits. In Kitchener and Waterloo, the

Stormwater Utility and Credit Program provides property owners with stormwater credit up to 45% of stormwater utility fee portion for their properties in compensation of reducing the amount of stormwater runoff (City of Waterloo, 2015; Saxe, 2015). Additionally, the City of Mississauga adopted its stormwater charge based on impervious surfaces for residential, multi-residential, and non-residential properties in effect since January 2016. Saxe (2015) raised a question why Toronto does not have political will to establish a similar form to reward for replacing impervious surfaces with green roofs.

Compared to other incentive programs, a density bonus is not a monetary inducement, but provides additional benefits associated with green roofs. A density bonus allows developers to increase the density of a particular development to provide services or amenities necessary for the population. The additional density can contribute to the increase in profit of the development associated with additional functional, green space (Shepard, 2010).

A Floor Area Ratio (FAR) bonus in the building code of Portland, Oregon encourages developers to earn a bonus ranging from 1 to 3 square feet of additional floor area based on the amount of their green roof coverage, while Chicago, Illinois offers a FAR bonus for developments including a green roof that covers 50% or 2,000ft<sup>2</sup> of the roof area (Carter & Fowler, 2008; Report to roundtable, 2005),

Toronto uses section 37 of the *Ontario Planning Act* to grant increases in density of development for community benefit contributions (Mitrovic, 2010). However, green roofs, as well as green roof buildings, are not officially regarded as a “public good” that qualifies density bonus (Cooper, 2014; Loder 2011; Mitrovic, 2010). Under section 5.1.1 of the Toronto’s Official Plan, a particular development is eligible for density bonus in return for community benefits (or “public good”), such as additional parkland and community facilities, which provide community services and facilities necessary for the additional population. Mitrovic (2010) noted that provision of a green roof alone would not achieve the desirable community services, however, alluded the possible utility of density bonusing with the intention of providing benefits to the City. As the City progressively works to implement TGS, further consideration for density bonusing through Section 37 would encourage green roof construction. In this regard, Mitrovic (2010) suggested that a Section 37 agreement between the City and a developer or property owner should be circumspectly proceeded on a purpose basis. For example, the use of Section 37 should be limited to situations where the impetus for providing the density bonus in the first place was for another purpose. In addition, the clarity about responsibility for green roof maintenance should be added in the agreement to secure such green roofs.

## 4.2. INTERVIEWS

This section builds upon the identified major themes from interview findings. The following sections highlight and compare different perspectives of key informants according to each theme. The findings include individual perspectives, while the three groups of two key informants were in general agreement.

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### 4.2.1. IMPLEMENTATION

One of the main themes was how the green roof policy implements green roofs across the City of Toronto. A group consisting of an environmental planner and J. Welsh (personal communication, March 3, 2017), both of whom work with the Bylaw, defined the Green Roof Bylaw as a “very prescriptive requirement”, which applies to most building types. They mentioned that although every roof environmentally affects the City, they have certain types of buildings where the Bylaw is difficult to impose because:

“...some have different constraints than others. For example, residential buildings have a variety of requirements placed on them through the planning process such as outdoor amenity space and consideration for those had to be made when developing the requirements.” (Environmental planner and J. Welsh, personal communication, March 3, 2017).

Furthermore, the City “provide[s] an alternative to a green roof for industrial buildings only” due to the very large roofs being required to be greened with higher costs compared to other building types (Environmental planner and J. Welsh, personal communication, March 3, 2017).

In addition to the requirements of the Bylaw, the City offers supplementary guidelines for green roof installation. Another group made up of A. Baynton and U. Ho (personal communication, February 24, 2017), both working in the Eco-Roof Incentive Program, they referred to the *Guidelines for Biodiverse Green Roofs* which illustrate best practices for enhancing biodiversity with specific plant species adjusted for the City of Toronto.

“Resources offered by the City to help with green roof projects include the Green Roof Construction Standards and the Design Guidelines for Biodiverse Green Roofs. Use of native and diverse plant species help enhance biodiversity in the urban city, and can also help ensure chosen plants are more naturally resilient to Toronto’s growing climate.”

During both the pre-application and Site Plan application process, all applicants are told that their developments are subject to the Bylaw, according to environmental planner and J. Welsh (personal communication, March 3, 2017). In addition, A. Baynton and U. Ho (personal communication, February 24, 2017), and the environmental planner and J. Welsh (personal communication, March 3, 2017) altogether expressed a similar view in terms of information accessibility. They mentioned that the applicants have their access to further information regarding green roof installation and application.

J. Welsh (personal communication, March 3, 2017) took continuous improvement of the current policy for granted in order to further achieve what the City aims for. However, she believed that the City implements its policy, a combination of the Bylaw and the Eco-Roof Incentive Program, in the right direction.

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#### 4.2.2. STRENGTHS

In perspectives of the many key informants, the Green Roof Bylaw and the Eco-Roof Incentive Program have several strengths in implementing green roofs. These strengths are distributed into three themes: 1) Encouragement; 2) Flexibility; and 3) Benefits.

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##### 4.2.2.1. ENCOURAGEMENT

Some of the key informants agreed that the Bylaw is designed as a very clear requirement that is relatively easy to implement green roofs. The Bylaw provides “a set of basic construction requirements, that is pretty explicit how green roofs need to be implemented from a building technical point of view” (K. Govers, Personal communication, February 21, 2017), while assisting an understanding of how and what needs to be done with a clear intention for green roof installation (environmental planner and J. Welsh, personal communication, March 3, 2017).

The use of the Bylaw as construction standard has another strength in achieving the city-wide benefits, in comparison with a form of performance standards, as highlighted by the environmental planner and J. Welsh:

“Because with a Bylaw requirement, you get much greater number of green roofs installed than you would with a voluntary performance measure. Voluntary approaches only encourage the industry leaders or those with a personal interest, they do not in this case achieve the widespread adoption of green roofs that is required to achieve many of the city-wide benefits that are possible from green roofs” (Personal communication, March 3, 2017).

They also highlighted that the use of Bylaw has greater ability to ensure that green roofs are safely built to achieve multiple environmental benefits in accordance with the regulated coverage standard and safety considerations.

In addition, the environmental planner and J. Welsh (personal communication, March 3, 2017) mentioned that the TGS “sets out the environmental priorities to the City” and “establishes performance measures in most cases to address those priorities for a development site”. In the perspective of J. Welsh (personal communication, March 3, 2017), although the Bylaw is not suitable for performance requirements including the TGS, “green roofs have been identified as priority for the City” to address these priorities listed in the TGS. In addition, other performance requirements that the City has, such as for stormwater management, do not influence the Bylaw, but “may influence the type and design of green roof provided” (Environmental planner and J. Welsh, personal communication, March 3, 2017).

With respect to another form of performance standards, the perspectives of the environmental planner and J. Welsh (personal communication, March 3, 2017) on the LEED rating system are consistent with the discussion of the LEED in Section 4.1.4. They remarked that the LEED rating system “encourages green roofs as one option to meet urban heat island reduction targets” and other targets if needed, but “does not ensure the performance and ecological function” of green roofs. Additionally, they noted that the rating system “provide[s] a number of options that do not guarantee a particular project will provide a green roof”.

As to financial incentives, A. Baynton and U. Ho (personal communication, February 24, 2017) applauded the Program as a key supporter for eco roof projects in bringing cool and green roofs “more mainstream rhetoric” for residents in Toronto. They believed that the grants with newly approved amendments in December 2016 enable applicants to promote green roofs, especially larger projects, as sustainable options helping increase overall environmental and social benefits in Toronto.

“Green roof funding has been approved for a new construction project by a not-for-profit corporation. Schools were included for funding through the Program in 2012... Large green roof projects have requested Council approval for funding in excess of \$100,000 (the previous funding cap). This alleviates the financial burden, and in fact acts as an incentive for anyone looking to install a large green roof, which would in turn provide greater environmental and social benefits to the community.” (A. Baynton and U. Ho, personal communication, February 24, 2017).



In the perspectives of those working in green roof industry, including K. Govers (personal communication, February 21, 2017) and S. Peck (personal communication, March 14, 2017), the performance of the Program is admired for encouraging voluntary green roof implementation.

“The Program pays for roughly a third of the construction cost of the typical green roof...it’s an incentive for the developers actually trying put as much green roof as possible. However, when they cannot meet the requirement, the fee pays for installation of equivalent green roof space on buildings where voluntary green roofs are added. The Program has worked to a certain extent to incentivize voluntary green roof implementation.” (K. Govers, personal communication, February 21, 2017).

“The main benefit of the Eco-Roof Incentive Program is to buy down the higher costs of a green roof compared to [a] regular roof...” (S. Peck, personal communication, March 14, 2017).

Furthermore, H. Black and M. Zeidler (Personal communication, March 2, 2017) mentioned that one of their buildings, the Gladstone Hotel, was financially supported from the Program, although the building is a heritage building that was not subject to the Bylaw to install a green roof. They remarked the Program as “certainly part of the impetus” to voluntarily construct a green roof on the hotel.

“...the Gladstone was able to take an advantage of the Incentive Program - it paid for half of the [construction cost of the green roof], I think so...” (M. Zeidler, personal communication, March 2, 2017).

Along with newly adopted amendments, the Program has continued its support in retrofit projects. Although the amendments, including Structural Assessment Grants (SAG), have been implemented over only a few months since the adoption, the amendments seem to be a positive response to the increase in retrofit projects.

“Green roof projects have applied and been approved for Structural Assessment Grants. Property owners have cited this as an enabling factor in their pursuit for a green roof.” (A. Baynton and U. Ho, personal communication, February 24, 2017).

A. Baynton and U. Ho (personal communication, February 24, 2017) stated that the SAG not only financially offset the costs up to \$1,000 for a structural assessment of a property, but also further encouraged property owners to personally participate in green roof installation through the cooperation of certified, professional engineers. They believed that this cooperation supports a better understanding of green roof installation process, by “helping provide additional knowledge, local context, and advice specific to their needs and property”.

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#### 4.2.2.2. FLEXIBILITY

The minimum requirements for green roof construction and design provide a certain amount of the flexibility for developers and property owners. According to the environmental planner and J. Welsh (personal communication, March 3, 2017), the Bylaw does not mandate 100% of a roof area to be greened, rather sets a maximum roof coverage of 60%, which allows for some flexibility in green roof installation. Many key informants agreed that the Bylaw does not restrict the decisions of developers and property owners in considering what goals they would like to achieve, as long as their green roofs meet both the coverage requirement and the minimum requirements of the TGRCS in the Bylaw.

“...the applicant can choose where the green roof is located and what type of design strategy they want to employ...there is flexibility in type of green roof that is constructed (plant species, depth of growing medium, etc.)” (Environmental planner and J. Welsh, personal communication, March 3, 2017).

“[The Bylaw] does not deal with biodiversity requirements, that is up to the individual property owners to determine how biodiverse they want to make...It does not spell out how it is to be constructed or the plantings, just the building standard requirements.” (K. Govers, personal communication, February 21, 2017).

As mentioned above, the flexibility exists in terms of creative innovation as opposed to the perspectives of Carter and Fowler (2008) and Cooper (2014) discussed in Section 4.1.1.3. The environmental planner and J. Welsh (personal communication, March 3, 2017) highlighted that the TGRCS ensures that every green roof is designed and constructed with considerations for safety and security, such as structural and fire safety, while allowing for creativity of designers.

In addition, the Bylaw provides another flexibility for those who cannot meet the amount of green roofs required under the Bylaw for certain reasons. The environmental planner and J. Welsh (personal communication, March 3, 2017) noted that applicants obligatorily install their green roofs in compliance with the Bylaw, but they could choose an exemption or variance with cash-in-lieu payments. However, they mentioned that the applicants “often choose to install the green roof[s]” because installing a green roof is actually cheaper than the cash-in-lieu payments and can contribute to additional value to their buildings. As a result, there have been 400 green roofs required with only 35 applications with cash-in-lieu payments for exemptions and variances since 2010.

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#### 4.2.2.3. BENEFITS

The main intent of the policy is environmental benefits. Empirical evidences of benefits derived from green roofs play a prominent role in encouraging green roof installation. H. Black and M. Zeidler (personal communication, March 2, 2017) were supporters of the policy, as they believed that having a green roof is beneficial for the City and its property owners, based on their experience in green roof projects at 401 Richmond Street West and 215 Spadina Avenue. In addition, the environmental and J. Welsh (personal communication, March 3, 2017) remarked that the green roof cost-benefit study by Banting et al (2005) “served as basis for the green roof policy initially.”

Although “the benefits to [a] building depend largely on how [a] green roof is designed” (Environmental Planner and J. Welsh, personal communication, March 3, 2017), almost all of the key informants stated that the expected benefits have been addressed through the policy. The benefits include improved stormwater management, improved energy efficiency, improved air quality, reduced greenhouse gas emissions, reduced urban heat island effect, and enhanced green spaces and potential for biodiversity.

As A. Baynton and U. Ho (personal communication, February 24, 2017) refer to the *2016 Eco-Roof Incentive Program Review and Update Report*, these benefits derived from the 50 completed green roof projects between March 2009 and October 2016 are quantified in Table 6.

Area of Concern	Outcomes
<b>Stormwater management</b>	Approximately 10.5 million litres of stormwater diverted from sewers annually. Stormwater diversion by completed green roofs results in a minimum cost saving of \$100,000.*
<b>Energy efficiency</b>	Average of 221,055 kilowatt hours per year in energy savings primarily from reduced need for air conditioning. Total electricity savings: \$135,462 per year.** The total savings were attributed to the combination of the average of 221,055 kWh/year from 50 completed green roofs and the average of 841,390 kWh/year from 190 completed cool roofs.
<b>Greenhouse gas emission reductions and air quality</b>	Average of 43.6 tonnes of greenhouse gases avoided annually.
<b>Green space enhancement and biodiversity</b>	More than 20,095 square metres of green roofs will help increase green space in the urban environment with the potential to enhance biodiversity.
<b>Economic development</b>	Minimum of 12 person-years of new employment generated to date due to green roofs through this Program.***
<b>Urban heat island reduction</b>	Widespread implementation of green roofs can reduce local ambient air temperature 1.5 to 2°C, with a direct 4-5°C temperature roof surface cooling effect.****
* Based on Toronto’s Wet Weather Flow study. ** Values are based on Toronto Hydro’s average rate of 12.75 cents per kWh. *** Based on green roof benefits as per Living Architecture Monitor, Summer 2013. **** Not measured directly as a result of the Eco-Roof Incentive Program. Based on research for widespread implementation, as per MacIvor et al, 2016.	

Table 6. Measureable outcomes of Toronto’s Eco-Roof Incentive Program based on 50 completed green roof projects between March 2009 and October 2016. City of Toronto, 2016.

In addition, they highlighted other unquantifiable benefits cited from participants of the Eco-Roof Incentive Program:

“Participants often cite increased occupant comfort (i.e. from lowered temperatures, from views of green roof); a sense of joy (i.e. from viewing green roof); and a sense of inspiration and benefit to the neighborhood (i.e. inspire others to install green or cool roofs, give tours, neighbors get to enjoy roof from below). And reduced noise and annoyance issues from vegetation absorbing noise.” (A. Baynton and U. Ho, personal communication, February 24, 2017).

In the perspective of property owners, H. Black and M. Zeidler (personal communication, March 2, 2017) knew about environmental benefits of green roofs, including reduced urban heat island effect and reduced stormwater runoff and absorbed CO<sub>2</sub>, although their green roof at 401 Richmond Street was built by “accident” by a building manager mainly for private enjoyment of their tenants. They believed that their roof garden functions as a small-scale park on the rooftops surrounded by mostly concrete and asphalt area, which “was the formerly an industrial district”. Being accessible for the tenants, the roof garden serves as “a nice quiet place up on the roof surrounded by plants that they can have their lunch or meeting or just work”.

K. Govers (personal communication, February 21, 2017) mentioned another benefit of green roofs in terms of functional, green spaces.

“...a lot of visual green spaces being added to map and you look at the City through Google Earth. 10 years ago, you would have seen a few little spots here and there. Now there are several million square feet across Toronto.” (K. Govers, personal communication, February 21, 2017).

Regarding economic benefits, K. Govers (personal communication, February 21, 2017) described green roofs as “a long-term investment”. In addition, S. Peck (personal communication, March 14, 2017) cited a study of Bloomquist (2016), which demonstrated that green roofs on condominiums in Portland, Oregon contributed to an increase of 5.5% in property investment from 2000 to 2011 (Figure 10). More specifically, closer proximity to green infrastructure including green roofs significantly correlated with higher sale prices, among many other factors such as square-footage, and building age, and proximity to amenities.

“New green roofs generate benefits...that are conferred upon the building owners and they can also make more money if the people in the building have access to the green roofs.” (S. Peck, personal communication, March 14, 2017).

However, both K. Govers and S. Peck highlighted that not all developers and property owners are realistically aware of such financial gains of having a green roof.



Figure 10. A case study of Portland, Oregon. Bloomquist, 2016.

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#### 4.2.3. WEAKNESSES

Many shortcomings of the Bylaw and the Program were also identified on the basis of the perspective of the key informants.

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##### 4.2.3.1. COSTS

High upfront costs of green roof projects remain one of significant barriers to green roof installation, as demonstrated by the 2016 Eco-Roof Incentive Program staff report in Section 4.1.2.2. A. Baynton and U. Ho (personal communication, February 24, 2017) gave supplementary explanations on the great disparity between green and cool roofs in cost.

“Due to the nature of the project, green roofs typically cost more upfront. In large part this can be understood by contemplating the additional materials and expertise required for the project compared to cool roofs. For example, green roofs require soil/growing medium, a selection of plant species, waterproof membrane, and a drainage layer.” (A. Baynton and U. Ho, personal communication, February 24, 2017).

Given the reasons, the Program has been expanded in December 2016 to further support green roof implementation through increased incentive of \$100 per square metre, removal of \$100,000 funding cap, and provision of the SAG. However, the Program offers grants only for installing green roofs and does not provide additional financial support for maintaining the green roofs (A. Baynton and U. Ho, personal communication, February 24, 2017).

#### 4.2.3.2. LACK OF COMPENSATIONS

Another limitation in terms of costs was observed from H. Black and M. Zeidler (personal communication, March 2, 2017). Due to their green roofs at 401 Richmond Street West and 215 Spadina Avenue completed prior to the inception of the Bylaw, they “did not receive any benefits” from the City or the Program. However, these green roofs have been “prime examples” along with very few green roofs, including Mountain Equipment Co-op and Ryerson University at the time of the policy development. They noted that they advocated the policy, especially the financial incentives. In their perspectives, it would be cheaper for the City to give out financial incentives as it would be used towards green roofs rather than for new sewers because green roofs are better alternatives for present and future references to stormwater management in the City. In this regard, their speech indirectly implies the need of indirect financial incentives discussed in Section 4.1.5 in return for stormwater management stems from having green roofs.

“Just the fact that we won’t have as much stormwater building up in sewers after large rainfalls would help prevent flooding – if they were to have green roofs or more green everywhere in the City that could absorb more water then we wouldn’t have these issues of the water overflowing and backing up into buildings – which is a current problem (it happened here at 401 several times last summer). The City is going to have to build new sewers now because so much has been covered in asphalt – it would probably be cheaper to cover all the roofs (I don’t know if anyone has done a study but if we covered all the roofs it could retain the water as opposed to it running off into the streets or sewers).” (H. Black and M. Zeidler, personal communication, March 2, 2017).

#### 4.2.3.3. MAINTENANCE

There are different perspectives and viewpoints associated with the maintenance and upkeep of green roofs. However, no clear regulation in terms of the maintenance of green roof is identified as one of the main deficiencies by many key informants. Although the submission of the maintenance plan is part

of the requirements under the Bylaw, the maintenance plan does not practically take effect. A. Baynton and U. Ho explained the purpose and process of the maintenance plan submission, as follows:

“Maintenance of roofs is as per the responsibility of the property owner. We do ask applicants to submit a maintenance plan as part of the grant approval process to ensure their roofs function as they should, and will be well-maintained. This step also helps property owners work out the logistics of maintenance before commitment/construction, and use the maintenance plan as a reference document for their ongoing purposes.” (A. Baynton and U. Ho, Personal communication, February 24, 2017).

Another story with respect to the responsibility of property owners in the upkeep of green roofs was drawn from H. Black and M. Zeidler (personal communication, March 2, 2017). They noted that they monitor their roof at 401 Richmond, except the one on 215 Spadina which was sold a few years ago, all the time. They currently have had technical issues with their 4,000-square-foot extensive green roof on the 401 Richmond despite the demand for minimal maintenance requirements on this particular roof. The roof replacement beneath this roof is required, and they explained their plan to work on that one the summer of 2017. They are assisted by experts, including a landscape architect or people from the University of Toronto to deal with such issues. Although their green roofs do not have legal validity to be maintained through the maintenance plan under the Bylaw, they believed that developers and property owners probably “[insist] on certain maintenance practices” to ensure that “their investment [associated with a green roof] is not destroyed”.

However, the environmental planner and J. Welsh (personal communication, March 3, 2017) acknowledged the limitation of the maintenance plan. Although the plan sets out information and strategy necessary for property owners to maintain their green roofs, “it is difficult for the City to make sure that the details are followed after construction”.

S. Peck (personal communication, March 14, 2017) shared similar thoughts as to the maintenance plan. The provision of a maintenance plan alone is insufficient to ensure that green roofs are maintained over the long-term, as the Bylaw “uses the building permitting process after the final examination of [a] property”. Additionally, K. Govers (personal communication, February 21, 2017) suggested the need for enforcement of maintenance standard and a lot of education for property owners and operators.

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#### 4.2.3.4. LACK OF INSPECTION

One of the disadvantages is that the Bylaw does not have regular inspection of green roof state and performance on new developments, while the Eco-Roof Incentive Program already has (K. Govers, Personal communication, February 21, 2017).

“One of the big drawback in new construction...is that there is no ongoing inspection of the state of the green roofs. There is no enforcement and inspection in the Bylaw as it is currently written...the Eco-Roof Incentive Program has a provision for regular inspection of the performance of the green roof and as a result the quality can be monitored.” (K. Govers, Personal communication, February 21, 2017).

The environmental planner and J. Welsh (personal communication, March 3, 2017) noted that they are trying to find ways to inspect the state of green roofs using aerial photograph on the basis of complaints. They did mention that Eco-Roof Incentive Program is in duty to examine and ensure that green roofs are built and maintained since the Program is provided with money to do this.

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#### 4.2.4. EDUCATION/PUBLIC AWARENESS

The environmental planner and J. Welsh (personal communication, March 3, 2017) stated that the City offers an online source – municipal website of Green Roofs – as “the primary means of communication information on benefits” and “it is up to the applicants to seek out the information” on the website.

Additionally, A. Baynton and U. Ho (personal communication, February 24, 2017) noted that there are various examples of communication, marketing, and education regarding green roofs. These include Live Green Toronto, the Volunteer Program, green living shows, roofing exhibitions and green building conferences.

At the same time, H. Black and M. Zeidler (Personal communication, March 2, 2017) said that they gained information from experts in green roofs – professors at the University of Toronto and a landscape architect. In addition, they voluntarily educated themselves to maintain their roofs, by attending conferences held by the Green Roofs for Healthy Cities (GRHC) and reading lots of materials associated with green roofs. They gave comment about the works they do to educate others. They have a group of students from the University of Toronto currently doing a project on the potential of their roof. They mentioned that “a lot of things like that take place” which they do voluntarily, or “when people approach [them] with something”.



However, some of the key informants noted the lack of education and public awareness. Education regarding green roofs, especially the benefits of pursuing green roofs, is needed, as suggested by S. Peck (personal communication, March 14, 2017). Citing the case study of Oregon (Bloomquist, 2016) again, he highlighted that there is a lack of research regarding financial benefits of having an accessible green roof.

“I think the City could try to work with more developers to explain to them that there are financial benefits from designing condominiums that provide accessible green roofs...I think that’s a mistake for the City...and for the developer because if they made green roofs accessible...they would be able to generate higher amounts of money for those units...I don't think the developers in Toronto all realize.” (S. Peck, Personal communication, March 14, 2017).

## 5.0. RECOMMENDATIONS AND CONCLUSION

### 5.1. RECOMMENDATIONS

Based on all findings collected from the policy analysis and interview responses, a series of recommendations for the green roof policy were created so that the City of Toronto could utilize and encourage more developers and property owners in green roof implementation.

#### 5.1.1. PERFORM INSPECTION AND RESEARCH IN PARTNERSHIP WITH GREEN ROOF EXPERTS AND INSTITUTIONS

Although the Eco-Roof Incentive Program performs regular inspections on green roofs, the enforcement of the inspection is suggested by only one out of the eight of the key informants. The Program provided only the profiles of 56 approved green roof projects that the Program financially supported, and furthermore, no evaluation of approximately 400 required green roofs were publicly available.

Given the lack of green roof knowledge, further research and studies are needed to be conducted to support a better understanding of the benefits associated with green roof installation. Especially, studies regarding economic benefits, such as the values added to green roof projects in the Canadian context, would promote green roofs as a valuable asset for most types of buildings, particularly residential properties (e.g. condominium buildings). The findings of research and studies would be useful for education and awareness that are another recommendation discussed in Section 5.1.4.

As it is not easy for the City to conduct regular inspection on all required roofs, the City should encourage the creation of partnership with roof professionals and inspectors. As two of the key informants mentioned, the involvement of professors and students from the University of Toronto is an example. Academic institutions, including the University of Toronto and Ryerson University, can utilize partnership opportunities to assist the City in invaluable inspection and research through post-secondary curriculums (Shepard, 2010).

#### 5.1.2. ENFORCE CERTAIN MAINTENANCE PRACTICES FOR LONG-TERM PERFORMANCE OF GREEN ROOFS

Another recommendation based on the findings is the enforcement of long-term maintenance of green roofs being part of the green roof policy to address maintenance issues and concerns. The enforcement provides great potential to enhance public awareness of the upkeep of green roofs, while establishing responsibility of the green roof owners for their voluntary duties in maintaining their green roofs.

The active participation and responsibility of the City in the maintenance and monitoring is also recommended to ensure long-term performance and function of green roofs.

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### 5.1.3. CONSIDER THE PROVISION OF VARIOUS INCENTIVES

According to one of the key informants, the current policy, comprised of the Bylaw and the Program, is a step in the right direction to implement green roofs across the City without any additional incentives. However, budgetary barriers remain one of significant deterrent to green roof implementations, especially for voluntary projects. In addition, there is neither the financial resources dedicated to the Program, nor a form of compensation or reward for obligatory achievement in integrating the green roofs into new constructions. Thus, it is recommended that the City incurs additional financial responsibility to provide several incentives, rather than depending only on the direct financial incentive with cash-in-lieu contributions. Having other financial sources may guarantee its availability for incentivizing more green roof projects, while deducting construction costs required for these projects.

Various types of incentives motivate and attract different stakeholders including developers and property owners, as they “have different interests and motivations for green roof” projects (Shepard, 2010). The creation of indirect financial incentives is necessary to provide additional funding to both new and retrofit green roofs.

Having a similar form in incentivizing environmental benefits, particularly stormwater management, would further encourage green roofs as a feasible option of reducing charges of stormwater runoff. This form would promote the voluntary implementation of green roofs, and consequently achieve more benefits to the City, but also green roof owners in saving money. As for the density bonus, the City may encourage voluntary additional green roof coverage than required with a certain purpose of providing benefits to the public through a prudent agreement between the City and an applicant.

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### 5.1.4. IMPROVE PUBLIC AWARENESS THROUGH BETTER EDUCATION

The final recommendation is to better inform and educate individuals who are involved in the green roof projects about green roofs. Despite a variety of education and training provided, increased awareness would bring more to the development process, which in turn would bring down costs of green roofs through increased competition, as suggested by one of the key informants. Understanding true economic benefits based on the findings of research would promote competition, as discussed earlier. Increased amount of inspection and research regarding these benefits associated with green roofs would be a stimulus for those who are hesitant about costs for green roof construction and maintenance.

In addition, education on the upkeep of green roofs is recommended for green roof owners to gain skilled labour and knowledge with respect to maintenance of their roofs. As part of the enforcement for maintenance practices, this education may enhance the responsibility of green roof owners, as well as help their understanding in the need for long-term maintenance.

## 5.2. CONCLUSION

The study primarily aimed to examine how Toronto's planning framework for green roofs encourages or limits green roof developments. Through the review and analysis of literature, policy documents, and interview responses of the key informants, the study gave insight into the strengths and weaknesses of the Toronto's green roof policy, while providing a series of recommendations.

Over the last 7 years, the combination of regulations in new developments and incentives for existing properties has increased the green roof coverage in Toronto. Largely due to the Bylaw, the City has seen the city-wide environmental benefits stem from green roofs, and become the only Canadian city among North American cities in terms of green roof development. The planning framework for green roof in Toronto is unique, as the COTA granted the authority to Toronto to establish a mandatory bylaw, which other municipalities are limited to. The Bylaw encourages developers and property owners to implement their green roofs with its clearly standardized minimum requirements, allowing for a certain level of flexibility in a way. The Bylaw guides green roof installation as desired, in conjunction with the supplementary guidelines, rather than limit choices or opportunities in terms of types or designs of the green roofs. In this respect, the Bylaw enforces the green roofs to be built on all new developments, where any forms of performance standards cannot apply with voluntary performance measures.

Although the Bylaw has succeeded in increasing green roof coverage in the City of Toronto, maintenance, inspection, and costs for long-term performance of green roofs remain as ongoing challenges. The newly amendments of the Eco-Roof Incentive Program, including increased incentive and the SAG, are expected to further support eco-roof projects.

Following a series of the recommendations discussed above, the continuous improvement of the policy is anticipated to address the issues and concerns associated with the policy in achieving green roofs, while improving the City's ability in green roof implement as a Canadian green roof leader or a precedent for other Canadian municipalities to promote green roofs.

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# APPENDICES

## APPENDIX A: SAMPLE INTERVIEW QUESTIONS

### For city planning officials and planners

- 1) What are the expected benefits of the City of Toronto's Green Roof Policy (e.g. the Toronto Green Roof Bylaw and the Eco-Roof Incentive Program)?
  - a) Why does the bylaw mandate green roofs on specific building types, such as new residential, commercial, institutional, and industrial buildings?
- 2) How does Toronto's Green Roof Policy administer the implementation of green roofs?
  - a) Do you provide developers and property owners with information and education regarding green roofs and their potential benefits?
  - b) Do you inform developers and property owners of the minimum requirements for green roof construction and design under the bylaw? And do you provide developers and property owners with information about the City's green roof guidelines (i.e. the Green Roof Construction Standards Supplementary Guidelines and the Guidelines for Biodiverse Green Roof)?
  - c) Do the minimum requirements for green roof construction and design allow for a certain level of the flexibility for developers and property owners in the decisions they make regarding the installation of a green roof?
- 3) What are some of the advantages of the policy?
  - a) What are the benefits of the Green Roof Bylaw, which may influence the decision to install a green roof?
  - b) What are the benefits of the Eco-Roof Incentive Program, which may influence the decision to install a green roof (especially in the case of any buildings that are not subject to the bylaw)?
- 4) What are some of the drawbacks and limitations of the policy?
- 5) Have any variances or exemptions been granted from the green roof requirements? If so, why?
- 6) Since every green roof, both voluntarily and obligatorily installed, must be maintained in accordance with a Maintenance Plan under the bylaw, how does the policy ensure that every green roof is monitored and properly maintained?
  - a) In your opinion, are Maintenance Plans effective in ensuring the upkeep of green roofs?
- 7) In your opinion, what incentives and tools should be added to the Green Roof Policy in order to encourage more developers and property owners to incorporate green roofs into their building design and construction?

### For developers and property owners

- 1) Why did you construct a green roof?
  - a) Was it a mandatory or voluntary decision to build a green roof?
  
- 2) To what degree has the City of Toronto's Green Roof Policy (e.g. the Toronto Green Roof Bylaw and the Eco-Roof Incentive Program) been supportive of your decision to install a green roof?
  - a) Have you received adequate information and education regarding green roofs and their potential benefits before the installation of your green roof?
  - b) Have you received adequate information and education on the bylaw (e.g. the minimum requirements for green roof construction and design)? And how did you gain information about the City's green roof guidelines (i.e. the Green Roof Construction Standards Supplementary Guidelines and the Guidelines for Biodiverse Green Roof)?
  - c) Have these minimum requirements facilitated the flexibility in deciding what type of goals you would like your green roof to achieve?
  
- 3) What are the advantages of the policy?
  - a) Do you receive any benefits and/or financial incentives from the City of Toronto in regards to installation of a green roof?
  
- 4) What are the disadvantages of the policy?
  - a) What are some of the difficulties or conflicts that you have experienced to install your green roof in accordance with the requirements under the bylaw?
  - b) If you did not receive any grants for your green roof project from the Eco-Roof Incentive Program, please explain why?
  
- 5) In your opinion, are the Maintenance Plans required by Toronto's Green Roof Bylaw effective to maintain the upkeep of green roofs?
  
- 6) In your opinion, does the policy ensure proper maintenance of your green roof?
  
- 7) In your opinion, what incentives and tools should be added or improved in the policy to encourage more developers and property owners to build green roofs onto their buildings?

## APPENDIX B: LETTER OF INFORMATION AND CONSENT FORM

### Dear (potential research participant's name):

This letter is an invitation to participate in a Master's research study titled "Making Green Roofs Happen in Toronto: An Analysis of Green Roof Policy". The study is being done by Joanne Lee under the supervision of Dr. John Meligrana from the School of Urban and Regional Planning at Queen's University in Kingston, Ontario.

The purpose of the research study is to examine how Toronto's current green roof policy, including the Green Roof Bylaw and the Eco-Roof Incentive Program, has been implemented to promote the inclusion of green roofs in the City. In particular, the information from the study will guide the in-depth exploration of advantages and disadvantages of the policy, and will be used to provide a set of recommendations for future policy improvement.

Due to the researcher's hearing loss, an interview will be conducted in a slightly different way. The interview will not be audio-recorded; rather, it will be immediately transcribed through a dictation software on the researcher's laptop. Using the dictation software is the best option for both the researcher and you to save time and minimize miscommunication. A set of interview questions is attached for you to read in advance. The in-person interview will take approximately 30-45 minutes.

You may wish to permit the researcher to include your name in any publications that may come of the study. If this is not your wish, your confidentiality will be protected to the greatest extent possible. It is important to note, however, that given the small number of people working in this field, there is a possibility that your identity could be revealed through a direct quote, and thus your confidentiality cannot be completely guaranteed.

Data collected from the interview will be stored on a password-protected electronic file, and will be accessible by only the researcher and the research supervisor. All data will be destroyed after five years. Quotes from your interview will be sourced as confidential, unless you agree to include your name.

Your participation in the interview is completely voluntary. Your signature on the attached consent form indicates your agreement to participate in the interview. Please note that you are free to withdraw from participation in the interview at any time by advising the researcher through the contact information provided below. You may also withdraw the study within 28 days after your interview, and the data collected will be destroyed. During the interview, you are not obliged to answer any questions that you find objectionable or make you feel uncomfortable.

The results of the interview will be incorporated into a master's report of Joanne Lee that will be evaluated by the research supervisor, Dr. John Meligrana, and will be distributed to participants who request a copy.

In the event that you have any questions or concerns about the study, you may contact the researcher by email at [15yjl@queensu.ca](mailto:15yjl@queensu.ca) or the research supervisor at [jmeligra@queensu.ca](mailto:jmeligra@queensu.ca) or at 613-533-6000 ext. 77145.

If you have any ethical concerns, you may contact the General Research Ethic Board (GREB) at [chair.GREB@queensu.ca](mailto:chair.GREB@queensu.ca) or at 1-844-535-2988 (Toll-free in North America).

Thank you for taking your time in reading this letter, and your interest in participating in the interview will be greatly appreciated.

Your Sincerely,  
Joanne Lee  
M. Pl. Candidate  
School of Urban and Regional Planning  
Queen's University  
Email: [15yjl@queensu.ca](mailto:15yjl@queensu.ca)

Name (please print clearly): \_\_\_\_\_

1. I have read the Letter of Information about the research study, "Making Green Roofs Happen in Toronto: An Analysis of Green Roof Policy," and have had any questions answered to my satisfaction.
2. I understand that I volunteer to participate in a 30 to 45-minute interview conducted by Joanne Lee from the School of Urban and Regional Planning at Queen's University under the supervision of Dr. John Meligrana. I understand that the interview is designed to gather information that will be incorporated into a master's report.
3. I understand that I may withdraw participation in the interview at any time by advising the researcher, and I am unable to withdraw from the study beyond 28 days following my interview. If I feel uncomfortable in any way during the interview session, I have the right to decline to answer any questions.
4. I understand that the interview will be conducted in a slightly different way due to the researcher's hearing loss. I understand that the interview will not be audio-recorded; rather, will be immediately transcribed through a dictation software. Data collected from the interview will be securely stored.
5. I understand that my confidentiality as a participant in the study will remain secure unless I give the researcher permission to use my name to identify quotes. I understand that confidential\_quotes will be included in any publications that may result from the study.
6. I understand that if I have any questions or concerns, I may contact the researcher, Joanne Lee, at [15yjl@queensu.ca](mailto:15yjl@queensu.ca); the research supervisor, Dr. John Meligrana, at [jmeligra@queensu.ca](mailto:jmeligra@queensu.ca) or at 613-533-6000 ext. 77145; or the General Research Ethic Board (GREB), at [chair.GREB@queensu.ca](mailto:chair.GREB@queensu.ca) or at 1-844-535-2988 (Toll-free in North America).

**Please check all that apply:**

I give permission for my name to be included in publications resulting from the study.

OR

I DO NOT give permission for my name to be included in publications resulting from the study, and acknowledge that any of my quotes will be referred to in generic terms (e.g., Developer A, Planner B, etc).

I wish to receive a copy of the results from the study.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\* Please keep a copy of this letter for your records.