Green Infrastructure and Stormwater Management in Toronto:

Policy Context and Instruments

Centre for Urban Research and Land Development

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Table of Contents

Executive Summary

Green infrastructure (GI) includes a wide range of natural vegetative systems, green technologies and innovative approaches to development that collectively provide a multitude of environmental, economic and social benefits to people and communities. Many of these benefits relate to water and stormwater management. As jurisdictions across the globe face increased infrastructure, water and development pressures in urban centers, policy makers are trying to advance a shift from grey to green infrastructure by developing and implementing a range of policy instruments.

GI policies cross a range of traditional policy areas including land use policies, environmental policies, water policies, infrastructure policies, and planning policies.

Jurisdictions are developing and re-designing existing policies to try and support a shift from grey to green infrastructure to improve policy outcomes and enhance benefits for citizens, businesses and communities.

This report focuses on a central research question: *What policy instruments are currently being used to facilitate the shift from grey to green infrastructure related to water and stormwater management in Canada, Ontario and Toronto?*

This report presents findings related to this research question using secondary sources and government documents. It forms the descriptive and contextual foundation for a project that examines the policy context, instruments and implementation barriers associated with the policy shift from grey to green infrastructure in the City of Toronto. A journal article builds on the findings in this report and summarizes additional findings from a set of key informant interviews conducted in 2016-17.

Understanding green infrastructure policies in urban areas in Canada requires a multi-level governance approach.

This report uses this approach by outlining the policy context at the federal, provincial and municipal levels in Canada. It provides an overview of the intergovernmental policy context in which green infrastructure initiatives are embedded and the diverse range and mix of policy instruments that are associated with green infrastructure. Using the City of Toronto, Canada's largest urban center, as a case study, this report outlines the complex context and diverse set of instruments that are currently associated with green infrastructure efforts.

In addition to a focus on the City of Toronto and its various policies and agencies, this report also outlines some of the initiatives that non-government organizations and the private sector are engaged in related to green infrastructure and stormwater management in partnerships and projects across the city.

It is clear from this report, that the shift from grey to green requires a recognition of the complex mix of policy instruments involved and an increased emphasis on partnerships – between levels of government; between government agencies with infrastructure, land and water mandates; and between governments and the non-government and private sector actors and organizations.

Introduction

Green infrastructure is a concept and approach that is garnering the attention of policy makers and practitioners across the globe. With significant economic and environmental pressures facing many jurisdictions, the concept of green infrastructure has been very appealing, particularly as jurisdictions grapple with climate change mitigation and adaptation. There is a growing body of scholarly and practitioner literature on green infrastructure that spans many different disciplines. Scholars from urban planning, economics, environmental studies, public policy and public administration are particularly interested in research questions related to green infrastructure approaches, policies and tools and the feasibility of shifting planning, investments and decision making towards green infrastructure.

Green infrastructure (GI) is a broad concept and approach with scholarly and practitioner foundations in many different disciplines (Sinnett et.al. 2015). Some 20 years after the concept of 'green infrastructure' arrived in policy and scholarly discourse, the literature is now full of definitions (Allen 2012). Although it is considered a relatively new concept, it is based on the use of many old techniques. GI has been defined as an interconnected network of green space that conserves natural ecosystem values and function (Benedict and McMahon 2006). It is now considered to include all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales (Tzoulas et.al. 2007).

GI includes a wide range of natural vegetative systems and green technologies that collectively provide a multitude of environmental, economic and social benefits to people and communities (see Appendix I) It is considered an "approach to planning and design that moves beyond traditional site- based approaches towards a more holistic approach that acknowledges the complexities of social-ecological interactions" (Lennon et.al. 2016, 845) and is sometimes used interchangeably with Low Impact Development (LID) in the planning and engineering literature although GI has evolved as a broader concept to include LID.

Although there is no universal definition for GI, there are some common elements and principles. There is agreement that GI is a multi-scalar concept generally with a regional, community, neighbourhood or site-specific focus (Allen 2012, 23). Lennon et.al. (2016) summarize these key principles as: viewing GI assets as fundamental infrastructure; spatial connectivity; multi-functionality including provision of benefits for social and ecological systems; and interdisciplinary collaboration. There is also a consensus that GI provides multiple co-benefits and is part of a triple-bottom line approach to ecosystem valuation (Appendix II). This report narrows the definition of GI and its common elements to focus more specifically on GI related to water and stormwater.

From a water and stormwater management perspective, the term "green infrastructure" most often refers to natural or human-made elements that provide hydrological functions and processes for managing water"[1] (O'Neill and Cairns 2016, 1). GI has been advanced as an innovative, complementary strategy to reduce pressures on stormwater systems and secure cleaner run-off to water bodies (Chalifour, 2016). The United States Environmental Protection Agency (EPA), for example, states that "green infrastructure

1 Most definition of GI includes both natural features and systems such as parklands, gardens, forests, and wetlands and also man-made installations and technologies such as stormwater ponds, wetlands, urban forests, bioswales, permeable surfaces, green roofs and green walls. It also includes infrastructure designed to support water retention and reuse (see Appendix I).

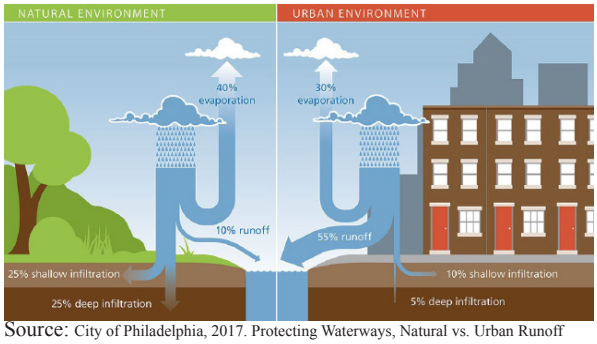
uses vegetation, soils, and other elements and practices to restore some of thenatural processes required to manage water and create healthier urban environments" (US, EPA 2017). In addition to these general principles there are specific definitions and principles related to water and stormwater management and some consensus that GI can be contrasted and differentiated from grey infrastructure.

Grey infrastructure or traditional infrastructure is the hard and impervious infrastructure to manage the water cycle and stormwater. 'Grey' is generally used in the water management literature to describe the hardscapes and systems deigned to manage water and wastewater. This includes large, vertical, below ground detention tanks, designed to capture and store stormwater during peak flow periods, relieving pressure from wastewater treatment systems and plants (Tzoulas et.al. 2007). Traditional 'grey' infrastructure systems for managing water consist of connecting residents, industries, and a wide range of users to large water and wastewater systems. Water systems take water from surface or groundwater sources, treat the water and provide it to users through a variety of pipe, treatment and distribution facilities. Sewage, or used water, is channeled through grey infrastructure to treatment facilitates and, in most cases, then to receiving bodies such as rivers and lakes.

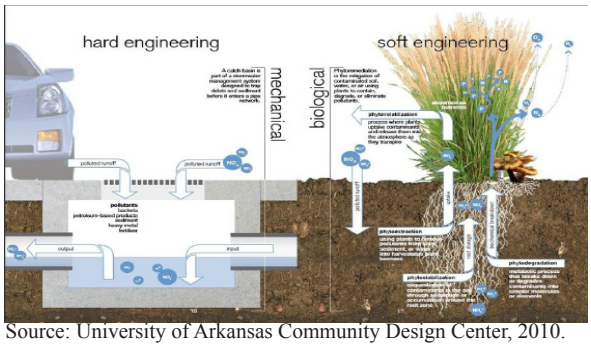
For water and wastewater management, some of the earliest studies on the benefits of GI stemmed from criticisms of conventional grey infrastructure. It is now considered a concept, approach, method of planning, and set of technologies that replace or supplement grey in many jurisdictions. There is a growing consensus that there are both benefits and limitations of GI when it comes to managing water systems. There are numerous environmental advantages to GI from both a water quantity and quality perspective. Slowing down the movement of water by reducing impervious surfaces in urban areas is something many jurisdictions are exploring. The fast, polluted runoff from large paved areas not only costs municipalities a fortune to manage, it also pollutes surface water and is a major cause of water pollution in receiving waters. Many jurisdictions are now trying to advance the use of GI but the question of whether a shift is truly feasible is being debated.

GI and storm water management policies and initiatives have been developed under a range of policy settings and circumstances.

Source: Walsh, Thomas. 2010. Plan Philly.



Source: City of Philadelphia, 2017. Protecting Waterways, Natural vs. Urban Runoff



Source: University of Arkansas Community Design Center, 2010.

In jurisdictions across the globe, GI planning tools and technologies are now being promoted through a range of government policies, instruments and programs. The environmental policy and planning literature reveals a range of tools and instruments for GI and stormwater management including regulations, subsidies, grant programs, incentive programs and stormwater utility fees. Various attempts have been made to categorize the tools that are employed by municipalities (Schilling 2008; Ellis 2013). There are also various models and tools including the US EPA's Stormwater Management Model, the Green Infrastructure Valuation Tool Kit in the UK and a wide range of tools related to modelling design and impacts of LIDs and GI (Jayasooriya, 2014).

From a public policy perspective, not all GI policy is explicitly labelled as such.

> "In Philadelphia, a comprehensive green infrastructure approach is estimated to cost $1.2 billion over the next 25 years, compared to over $6 billion for "grey" infrastructure. With this plan, 250 people are expected to be employed annually in green jobs. The city is expecting up to 1.5 billion pounds of carbon dioxide emission to be avoided or absorbed through green infrastructure each year, the equivalent of removing close to 3,400 vehicles from roadways".
> Source: American Society of Landscape Architects. 2017. Green Infrastructure: Cities.

A wide range of policy instruments have been used to try to encourage the use of GI along the classic policy instrument continuum from coercive, state-centered regulatory instruments to voluntary market-based and information instruments targeted at the private sector, non-profit sector, residents and landowners (Johns 2016). The concept of "green infrastructure" has become central in policy documents and as a multifunctional general planning tool (Lindholm 2017, 1). GI projects have most often been made possible on public lands and properties.

However, in many urbanizing contexts there are limits to this and engagement of private landowners and developers is key (Lindholm 2017, 4). Given this, it is not surprising that a wide range of land use planning instruments are an important part of the GI policy mix.

In any given jurisdiction, there are a range of policies and instruments used to promote the shift from grey to green infrastructure.

Policy Context in Canada

According to recent survey data, water is an important priority for Canadians. Water treatment facilities that maintain the quality of drinking water are viewed as the top priority with 45% of respondents to a national survey ranking it as one of the top three water infrastructure priorities in 2016 and 52% as a high priority in 2017.

When drinking water, sewage collection/ treatment and stormwater management are combined, 57% of Canadians ranked water infrastructure as the highest priority for government funding in Canada (RBC 2017). When specifically asked about priorities for government funding of water infrastructure, some 20% of Canadians surveyed rated GI as one of the top three water infrastructure priorities (RBC 2016, 43). Although this may seem low, it is an interesting finding given that GI is a relative recent addition to the policy landscape.

GI is a relatively new concept in Canada. Although the technologies associated with GI have been used in some jurisdictions for decades, GI is new to the policy discourse and policy landscape in Canada.

> "Water infrastructure consistently ranks as the second most important category of infrastructure in terms of public investment, second only to hospital and health care infrastructure."
>
> Source: Royal Bank of Canada, 2017. RBC Canadian Water Attitudes Study.

GI crosses many traditional policy boundaries including environmental policy, economic policy, and water policy. The policy context of GI must also be understood in the context of Canada being a land and water abundant nation. Until recently, water quantity issues have not been on the policy agendas of governments with the exception of some regions and localities facing water scarcity. Historically, the management of water and sewer systems has been viewed as an engineering issue rather than an economic issue (Fenn and Kitchen 2016, 27). The environment and water quality have only been public policy concerns in the past 40-50 years and have not always been high on the policy agenda. This policy history and context is important related to understanding public policy related to GI.

Historically, approaches and technologies now defined as GI have not been part of the environmental or water policy landscape. For example, while interest in water reuse in Canada emerged at least 25 years ago, and some experts consider water reuse to be the greatest worldwide challenge of the century (Asano 2002), its spread in Canada is much more limited (Exall et.al. 2004). The broader economic, social and political context, are all important for understanding why, and analyzing GI policies in Canada.

In the context of the Canadian constitution, Canada is a federal system where legal authority and powers are divided between the federal and provincial governments. The environment is not mentioned in the constitution and thus has evolved as a shared jurisdiction under several sections. Under section 92A provinces have primary jurisdiction over natural resources and water law and policy has evolved alongside of federal powers related to fisheries and navigation (Benedickson 2017). Municipal governments have no constitutional powers and are delegated authorities by provincial governments. Like the environment, infrastructure is not mention in the constitution. In practice, jurisdiction over various policy domains is shared under various Constitutional powers, intergovernmental agreements and arrangements. Policies related to GI must be understood in this legal and political context.

The federal and provincial governments own significant land and water resources. For decades water quality has also been an issue and continues to be a policy domain where despite existing laws and policies, policy objectives are not being met. In 2015, for example, some 1838 drinking water advisories were issued in Canadian communities, many of which were caused by infrastructure problems (Eggertson 2015). Governments are also significant owners of infrastructure. Provinces own 41.4% of public infrastructure while the federal government owns only 1.8% (Canadian Infrastructure Report Card 2016, 5). The remainder of infrastructure (nearly 60%) is owned, and in many cases, operated by municipalities, about 35% of which are either in fair, poor or very poor condition and in need of urgent repair (ibid 2016, 10).

In the next section, the key policy context and several key policy developments related to GI are outlined. While it is not possible to provide a detailed review of all relevant policies at the federal and provincial levels, it is critical to understand the broader policy context in order to understand GI policies at the municipal scale and in the City of Toronto.

The Federal Policy Context

The Canadian federal government does not have a national water policy or a national green infrastructure policy. The federal government does however have some jurisdiction related to environmental policy, water policy and infrastructure and provides some policy capacity and funding for provinces and municipalities related to these and other policy areas that are relevant to GI. Historically, most of the major water and infrastructure development projects have been supported with federal policies and resources in partnership with the other levels of government. For example, the St. Lawrence Seaway (MacFarlane 2014), municipal water systems and wastewater systems (Benedickson 2007) and environmental water clean-up efforts in the Great Lakes region (Johns 2017). These and other infrastructure and environmental policies across Canada have been supported by the federal government. Although scholars do not consider the federal government a leader in water policy, water infrastructure or green infrastructure, there have been some developments in the past two decades at the federal level that are important in understanding the state of GI in Canada, Ontario and Toronto.

In 2000 the federal government established two funds to enable more funding and investment in green municipal projects during a period of federal budget surpluses. In 2001 the Federation of Canadian Municipalities (FCM) published a GI guide for municipalities to guide municipalities who were eligible to receive funding and in 2004 published a report demonstrating the economic benefits of GI (FCM 2004) In 2005, two funds were combined to form the Green Municipal Fund and allocated $550 million under a funding agreement to the FCM to support partnerships and leveraging of both public and private-sector funding to reach higher standards of air, water and soil quality, and climate protection (FCM 2015, Canada OECSD 2016). The FCM has over 2000 municipal members who represent almost 90% of the Canadian population and own 56.8% of Canada's core public infrastructure such as water systems, roads and bridges, buildings, sport and recreation facilities and public transit (FCM 2016). Federal funding for GI through FCM and public-private partnerships continued after a new federal government under Stephen Harper and the Conservatives were elected in 2006.

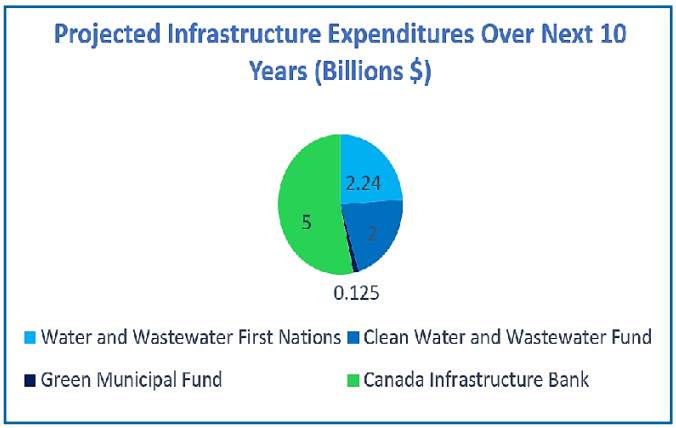
The federal government's fiscal situation changed drastically as it was faced with the 2008-9 recession. In 2008, the Harper government created Public-Private Partnerships Canada, a Crown Corporation created with a central role in infrastructure policy. In 2009, as part of a broader focus on post-recession, economic stimulus spending and infrastructure, the federal government announced the Green Infrastructure Fund with a commitment of $1 billion over 5 years (FCM 2016) in addition to the Green Municipal Fund. The 2012 federal Wastewater Systems Effluent Regulations under the federal Fisheries Act was estimated to require the upgrading of some 850 wastewater systems across Canada by 2040, with upgrades alone costing $6 billion (Canada OECSD 2016). Despite several positive reports on the Green Municipal Fund (FCM 2012a and 2012b; Canada OECSD 2016) and additional investments, the overall share of infrastructure investment in Canada has declined from 4.8% of real GDP in 2010 to 3.7% in 2015 (Demers and Demers 2017, 37).

In 2014, the Harper government announced a $14 billion, 10-year infrastructure plan under the New Building Canada Fund to fund infrastructure projects with maximum federal

contribution from 33% (Canada OECSD 2016). Although GI was not central to this new funding, by this time the concept of GI was becoming more common in policy discourse at all levels of government in Canada and became part of election campaign platforms of all the major political parties.

After the federal election in 2015, the new federal government under Justin Trudeau made infrastructure investment "a cornerstone of the newly-elected Liberal government's economic policy platform" in their first budget (Demers and Demers 2017, 30). The Liberal government's projected infrastructure expenditures over the next ten years included announcements of $120 billion, $60 billion of which constitute new spending - the largest infrastructure investment plan in Canadian history (Demers and Demers 2017, 38).

Of this funding, $2.24 billion over 5 years is to fund water and wastewater in First Nations communities and a newly created fund called the Clean Water and Wastewater Fund allocated $2 billion over 4 years to infrastructure projects with the federal government funding up to 50% of projects (Canada, Department of Finance 2016). An additional $125 million was announced for the Green Municipal Fund and was added to the Fund in 2017-18 (FCM 2017). A further $5 billion will be available for GI projects through the Canada Infrastructure Bank (Infrastructure Canada 2017) an institution established in June 2017 as "an additional tool to build new infrastructure development by attracting private sector and institutional investors to support the transformational infrastructure that Canadian communities need …including $5 billion for GI projects, including those that reduce greenhouse gas emissions, deliver clean air and safe water systems, and promote renewable power" (Infrastructure Canada 2017).



In 2015, some groups focusing on GI shifted their attention to the newly elected Liberal federal government. With significant announcements related to infrastructure funding the federal government tried to shift the focus to green funding and dedicated funding to GI (Interview 2016). "Consultations with the federal government and Minister of Infrastructure indicated that in Phase I the feds just wanted to 'get the money out the door'; the funding was unconditional with high levels of provincial discretion. The communication focused on these investments as "a lost opportunity related to green infrastructure" (Interview 2016). There was a strategy in Phase II to "try to get the feds to do it differently with three tasks:
i) consider GI first for every job;
ii) have dedicated funding for GI; and
iii) implement a GI strategy to share best practices and help municipalities."

The 2016 federal budget included a full section on Green Infrastructure that lists a wide range of infrastructure for clean energy, asset management, and water and wastewater systems (Canada, Finance 2016). According to the Federal government the new longer-term funding model under the Building Canada Plan and the permanent Gas Tax Fund have moved the federal government away from the short term, ad hoc funding of infrastructure that existed in the prior 10 years. In contrast to the unilateralism of the Harper government,

the Trudeau government adopted a more collaborative approach with other levels of government (Whitehead 2016).

Responsibility for overseeing the implementation of this project funding was transferred from Public-Private Partnerships Canada and the Department of Finance to the Department of Infrastructure and Communities - Infrastructure Canada (Demers and Demers 2017, 42) and the requirement of P3 screening before approval of projects (ibid, 46).

Federal infrastructure and green municipal funding in the past decade has been significant, and funding announced for the coming decade represents a huge investment and opportunity in the coming decade. The federal government however has no formal GI policy and continues to have a very broad approach to funding GI. No data is available on what portion of this funding has and will go to funding GI versus grey. The federal government itself does not have a GI procurement policy for its own capital projects or public-private partnership. It has a massive capital budget for public sector and public- private partnership projects across the country but no GI procurement policy.

Green procurement is not a new idea in Canada (NRTEE 1994) but it has not been used widely. Since 2006 the federal government has had an official green procurement policy that applies to all federal departments as part of the government-wide strategy and the Federal Sustainable Development Strategy (Canada PWGSC 2017). It is not however connected to infrastructure policies and programs or a condition of funding for intergovernmental transfers.

The Department of Public Works and Government Services (PWGSC) takes the lead on the development of procurement strategies and instruments for the federal government and Deputy heads of all federal departments, including Infrastructure Canada, are required to ensure that the objectives of green procurement are realized and report on each year in their department performance reports. A review of Infrastructure Canada's 2015-16 Performance Report indicates GI is not a key performance measure or priority, although there are some indicators broadly related to GI in the Sustainable Development Section of the Performance report.

With Phase 2 of Green Infrastructure Funding announced, the Canadian Water Network convened a national municipal water infrastructure roundtable with officials from Infrastructure Canada and 19 of 'Canada's progressive municipalities who collectively provide water to over 60% of Canadians' (Canadian Water Network 2016). The goal was to discuss and make recommendations related to 'future ready and adaptable water systems'. Green infrastructure, supporting projects that achieve multiple benefits, removing 'shovel ready' requirements, and funding asset management were themes in several of the recommendations. Similarly, the Forum for Leadership on Water (FLOW) has urged the federal government to make innovative and sustainable urban water infrastructure a top priority for its 10-year, $180 billion infrastructure plan (Flow 2017). The FLOW report calls for the federal government and other levels of government to take the pressure off existing grey infrastructure by using investments in living green infrastructure and capturing natural capital in municipal asset management programs (FLOW 2017, 4). However, despite these calls for a new approach to water infrastructure investments, it remains to be seen whether Phase 2 funding will better align federal infrastructure funding with GI investments.

In summary, the federal government does not currently have a major role in GI policy in Canada. It does not have a national GI policy, a national water policy or a national infrastructure policy with explicit GI goals. It does not have any GI conditions on infrastructure transfers to provinces and municipalities.

It does have several statutes related to environmental policy and water policy and commitments under international agreements such as the 2012 Great Lakes Water Quality Agreement. It also has several intergovernmental agreements that are relevant for this report. While no intergovernmental agreement exists on GI, the 2014 Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health is one important intergovernmental agreement and the 2009 Canada Wide Strategy for Municipal Wastewater Effluent developed through the Canadian Council of Ministers of the Environment (CCME) is another. The CCME agreement was reached by the 14 Ministers of the Environment in Canada to ensure that wastewater facility owners will have regulatory clarity in managing municipal wastewater effluent under a harmonized framework (CCME 2009). A Model Sewer Use Bylaw is a tool that has been developed under this intergovernmental agreement to provide guidance and best management practices to policy makers at the provincial and municipal levels. To date, these intergovernmental tools have not focused on green infrastructure and GI policies and tools fall primarily to the provincial and municipal governments under existing land use and water policies.

The Provincial Policy Context: Ontario

One of the challenges with GI from a policy perspective is that it crosses various jurisdictions and several traditional policy domains. Any assessment of GI policies must therefore be understood and analyzed in this broader policy and legal context. In the province of Ontario there are numerous statutes and policies that relate to infrastructure and water. For purposes of this paper, just the key water, planning and infrastructure policies are reviewed.

Like the federal government, the provincial government has also been investing in infrastructure, particularly following the last recession. In 2011, the Liberal government in Ontario established a Ministry of Infrastructure (Infrastructure Ontario) and invested in a wide range of infrastructure projects. The province also launched green bonds in 2014 to fund infrastructure projects but to date these have been targeted at transportation and health care capital projects, not water and stormwater projects. GI has also been recognized by the province as part of the solution to climate change. In 2015, a coalition of groups called the Green Infrastructure Coalition of Ontario (GIO) called on the Government of Ontario to change the definition of public infrastructure to incorporate GI, improve intergovernmental and interagency coordination, establish a research and development fund and incorporate GI more systematically into existing legislation, policies and programs (GIO 2015).

The provincial government also passed the Infrastructure for Jobs and Prosperity Act (2015) and released a long-term infrastructure plan in 2017 that has many policy objectives associated with infrastructure investments including, economic, environmental, and social policy objectives. It also has a Green Investment fund that has primarily targeted projects to address climate change and contribute to economic growth.

According to the Province of Ontario,

green infrastructure uses natural elements, whether already in place or developed by human intervention, to carry out ecological and hydrological functions. It can include for example, vegetation and landscaping, street trees and other urban forest elements and green roofs.

(Build Ontario Infrastructure Update 2017).

Despite formal definitions of GI in infrastructure policy and reporting documents, similar to the federal government, no data exists on how much of provincial infrastructure expenditures in general, and specifically related to water and stormwater, are allocated to grey versus green infrastructure and this is very difficult to track using current budgets and public accounts.

In addition to infrastructure policies, the province has a set of policies related to GI under the Planning Act (1990, 2017). Under this piece of legislation, the Ontario Provincial Policy Statement (PPS 2014) is the statement of the government's policies on land use planning and municipalities use the PPS to develop their official plans and to guide and inform decisions on other planning matters.

Although the 2005 PPS did not mention GI, a definition of GI is included in the 2014 PPS and several sections outline GI policy objectives. Under sections 1.6.2 "Planning authorities should promote green infrastructure to complement infrastructure" (Section 1.6.2); "Planning for stormwater management shall (d) maximize the extent and function of vegetative and pervious surfaces" (Section 1.6.6.7) and "Planning authorities shall protect, improve or restore the quality and quantity of water including subsections related to green infrastructure" under Section 2.2.1 (Ontario, PPS 2014).

Municipalities must then have their own official plans conform to the PPS and the Ontario Building Code that applies to houses, buildings or structures also addresses some aspects of stormwater management (GLSLCI 2011, 15). However, an analysis of official plans in 2016 revealed that only 18 of 103 Officials Plans in the province mentioned GI (GIO 2016).

In addition to infrastructure and planning policies, the province has several water policies that have an impact on GI (ECO2018). The drinking water tragedy in Walkerton, Ontario and the resulting Walkerton Inquiry into the province's water policies have resulted in significant policy changes across the province (Johns 2008). Several new statutes followed this Inquiry including the Safe Drinking Water Act (2002), the Nutrient Management Act (2002) and the Clean Water Act (2006). In addition, the Inquiry report (O'Connor 2002), and a subsequent report in 2005 recognized the need for change in Ontario's water and wastewater sector in terms of policy, regulation, financing, water pricing and rates (Swain 2005) yet GI was not part of the policy landscape. Despite legislative change and new provincial policies related to water management and source protection in the past 10-15 years, integration of land use and watershed planning remains a significant challenge (Plummer et.al. 2011; ECO 2018).

Many water management projects related to municipalities still fall under the longer standing Ontario Water Resources Act (OWRA) and its Certificate of Approval process that was amended following the Walkerton Inquiry. The OWRA currently governs water and stormwater in Ontario and the Ontario Ministry of Environment and Climate Change (MOECC) - since 2018 called the Ministry of Environment, Conservation and Parks - is responsible

for the legislation and regulations under this statute.

Related to stormwater, the OWRA contains provisions for regulating municipal wastewater effluent and prevents the discharge of other harmful pollutants into any waters within provincial boundaries. Section 53 of the OWRA requires new municipal sewage works, as well as expansions and alterations to existing facilities, to obtain a Certificate of Approval in order to be built, upgraded and operated. The OWRA includes stormwater facilities in its definition of sewage works, and requires that storm water infrastructure projects obtain a Certificate of Approval if storm water is discharged to surface water bodies, onto the surface of the ground, or into groundwater.

Under Section 53 of the OWRA, the MOECC also has a Stormwater Management Planning and Design Manual that was produced in 2003 based on best available science engineering knowledge from the 1990s that "promotes a conveyance and end-of-pipe approach' (GIC 2015, 18). It has been reviewed more recently to take into consideration aspects of climate change, but there have been repeated calls for this manual to be updated to incorporate GI.

In 2015 the MOECC commissioned a consultants report Runoff Volume Control Taregts for Ontario. In 2016 the Ministry started a review process realted to the 2003 design manual and many groups and stakeholders lobbied to have the revised manual incorporate GI. The province established a stakeholder review group and posted a draft Low Impact Development Stormwater Management Guidance Manual in 2017 to complement the 2003 manual. However, at the time of this report the 2003 manual had not been updated and the LID stormater manual had not been finalized.

In addition to the MOECC's mandates related to water and infrastructure under the statutes above, there are also related policy goals under the Water Opportunities & Water Conservation Act (2010); and the Great Lakes Protection Act (2015). In addition, the provincial Conservation Authorities Act (1990, 2017) delegates' important responsibilities related to flood plain management and watershed management to Conservation Authorities (CAs). There are a number of municipal and regional conservation authorities that are critical to encouraging public, private and non-profit partners to adopt green infrastructure. The Toronto Regional Conservation Authority (TRCA) and Credit Valley Conservation Authority (CVC) are local watershed management agencies with flood management and watershed responsibilities under the provincial Conservation Authorities Act. They work in partnership with all levels of government, landowners and many other organizations and are funded by a mix of municipal levies, self-generated revenues, provincial grants, federal grants and contracts (Conservation Ontario 2018). CAs such as TRCA and CVC are considered leaders in green infrastructure related to water management. Municipalities generally work with CAs on many projects related to green infrastructure to avoid duplicating efforts.

Conservation authorities have been working on Low Impact Development (LID) for several years. In 2010, CVC conducted a jurisdictional scan of jurisdictions within the United States that had implemented LID programs for stormwater management. Their report focused on best practices related to LID and stormwater management and identified some of the barriers to LID but did not make broader connections to GI (CVC 2010). This work was later used to develop guidelines for LID for both CVC and TRCA in 2012.

These Conservation Authorities are also working on source water protection, flood management and an urban water balance

Enhanced Stormwater Management Master Planning

Issue	Possible Contributing Factors	Identification
Basement flooding	• Increase in frequency of extreme weather events • Sewer failures • Home plumbing failures / installation errors	• Complaints records • Drainage plans
Urban flooding	• Increase in frequency extreme weather events • Sewer failures • Lack of overland flow route	• Complaints records • Road closures
Bank erosion	• Increase in runoff • Riparian vegetation removal	• Infrastructure failures along watercourse • Exposed utilities along watercourses • Rapidly changing channel morphology
Poor water quality	• Lack of stormwater quality BMPs • Spills and point source pollution • Urban development (ESC loading from construction) • Road operations • CSOs (combined sewer overflows) • Reduced assimilative capacity • Agricultural nutrient loading	• Stormwater audit programs • Provincial Water Quality Monitoring Network data (PWQMN)
Degraded aquatic habitat	• Changes to baseflow regime • Poor water quality issues (see above) • Riparian vegetation removal	• Stormwater audit programs • Benthic monitoring
Stormwater infrastructure failures	• Increase in frequency of extreme weather events • Development pressures exceed original design • Lack of maintenance • End of lifecycle	• Complaints records • Master drainage plan findings/ recommendations • Inspection records
Lack of stormwater infrastructure	• Development prior to modern stormwater policies	• Outfalls discharging directly to receiving waters • Other water quality and water quality issues present (see issues above)
WWTP (wastewater treatment plant) inefficiencies	• Combined sewers • I and I (inflow and infiltration)	• WWTP flow records • I and I studies
Municipal wellhead threats	• Land use within Wellhead Protection Area (WHPA) • Operations within WHPA	• Source protection plans
Municipal wellhead capacity issues	• Changes to infiltration rates • Changing demographics • Changes land use	• Source protection plans Municipal pumping records
Surface water intake threats	• CSOs • Water quality issues (see above)	• Source protection plans
Surface water intake capacity issues	• Lack of base flow • Changes to precipitation patterns	• Source protection plans Municipal water use records

Source: Credit Valley Conservation Authority 2016.

modelling tool related to GI.

Finally, the province also has the Municipal Act which provides municipalities with the authority to enact bylaws for prohibiting, regulating and inspecting discharges into connections to a sewer system. A number of Ontario municipalities have used this authority to pass sewer-use bylaws. As described below, the City of Toronto has additional powers delegated from the province under the City of Toronto Act (2006).

Combined, these various pieces of legislation and related policies result in several provincial ministries being relevant for understanding GI policies related to stormwater management. The Ministry of Municipal Affairs and Housing, Infrastructure Ontario, and MOECC are the main ones.

This is very important context for understanding GI policies and implementation at the municipal level.

Despite some progress, some significant policy challenges exist at the provincial level. The discourse or 'policy lexicon' has not incorporated GI (ECO 2011, 2016; GIO 2015), there is a lack of coordination of provincial ministries and agencies with infrastructure and water related mandates and there is no provincial funding specifically for GI. There is no baseline data or inventory of GI installations or coverage, no provincial leadership on GI policies (GIO 2015) and no provincial GI procurement policy.

A report by the Green Infrastructure Ontario Coalition (GIO) identified several barriers to province wide implementation of a green stormwater infrastructure strategy including: little knowledge and awareness of GI, resistance to change (conventional end-of-pipe conveyance approaches are entrenched), many professionals and decision makers are comfortable with the status quo; skepticism about the cost-effectiveness of GI; lack of technical knowledge and capacity, implementation complexity and regulatory hurdles (GIO 2015).

Finally, in addition to federal and provincial policies, agencies and implementation efforts there are also important intergovernmental efforts that have been advancing GI policies and projects. As noted above, national water management guidelines from CCME, efforts in the Great Lakes region, and other intergovernmental efforts are relevant for understanding the state of GI policies in Canada.

An example is Waterfront Toronto, a 'tri-government' organization that has an intergovernmental mandate and funding that is playing an important role in redeveloping waterfront lands and advancing GI projects on the waterfront in Toronto. Each government approves all its funding to Waterfront Toronto through detailed and binding contribution agreements.

Contribution agreements are based on an annual tri-government negotiated long-term funding plan, which is approved by Toronto City Council, the Ontario Minister of Infrastructure and the Federal Minister of Finance (Waterfront Toronto 2018c).

Projects like Sherbourne Common have been noted as significant examples of 'next generation infrastructure' in the city (Brown 2014, 81). In 2017-18 Waterfront Toronto received 75% of its funding from all three levels of government to fund redevelopment of waterfront lands in Toronto including $49 million from the City of Toronto related to the redevelopment of the Port Lands (Waterfront Toronto 2018a). Some of their projects include GI components related to stormwater management (Waterfront Toronto 2018b). However, Waterfront Toronto has not been part of the City of Toronto discussions on GI policy or project development.

It is in this intergovernmental context that many GI policies are being designed and implemented at the municipal level.

The Municipal Policy Context

Within Canada's intergovernmental context, municipalities can develop and implement policies related to green infrastructure. As noted above, municipalities do not have any constitutional authority related to land use, environmental policy, water policy, or infrastructure. Under the constitution, some sections like Section 92(10) grant the provincial legislatures of Canada the authority to legislate on local works and undertakings and provinces delegate powers and authorities to municipalities. However, municipal governments are responsible for many by-laws, regulations, programs and direct services provided to their residents including roads, public transportation, housing, parks, recreational facilities and water services.

In Canada there are over 5,000 municipalities of various sizes, both rural and urban (Statistics Canada 2016). Several of the largest cities in Canada have populations larger than some of the smaller provinces. By the time of the 2001 census, for example, approximately 23 metropolitan areas had a larger population than the province of Prince Edward Island and six of Canada's largest metropolitan areas each had more citizens than any of the four Atlantic provinces (Canada LOP 2006). According to the 2016 census, some 83% of Canadians live in cities (Statistics Canada 2016).

Although urbanization has made cities very important economic and service centers, the political and policy context has become increasingly difficult for municipalities because of their limited powers and authorities which are largely delegated from provincial governments.

Ontario has 444 municipalities which derived their general authorities from the Municipal Act (2001) and other statutes. However, municipalities are restricted in their ability to run a deficit budget and must obtain provincial approval before undertaking long-term budgeting (Canada LOP 2006). The political context in cities is also unique in that mayors and elected councilors are responsible for large budgets and a wide range of policies and public services. As there are no political parties, individual mayors and councilors, and coalitions of elected officials, can make a difference in terms of policy decisions.

The Federation of Canadian Municipalities (FCM) and Association of Municipalities of Ontario (AMO) have existed for some time to advocate and advance municipal issues. Infrastructure and water policy are two areas of concern for municipalities. There has been long-standing intergovernmental cooperation on some local policy areas such as housing and infrastructure. However, federal

involvement in municipal policy areas was of some concern and in 2004, all three levels of government developed some principles related to federal government involvement in municipal issues (CICS 2004). Since that time, cooperation and concerns about intergovernmental relations related to infrastructure have been increasing (Canada LOP 2006; Demers and Demers 2017). Some cities began advocating for "Charter city" status to operate under their own "stand-alone" legislation. The City of Toronto argued that it required its own legislative Charter status because of its unique position as the largest city in the country, its importance as an economic center in Canada and because it must compete with nearby North American cities and thus, it needed different tools than other municipalities (Canada LOP 2006).

As outlined below, the City of Toronto Act (COTA) was passed in 2006 making Toronto, Ontario's only city with special delegated powers, granting authorities and theopportunity for Toronto to use an additional range of policy instruments to address a variety of issues including land use, water use and stormwater management issues.

However, some of these authorities remain limited or the same in the context of provincial statutes such as the provincial Planning Act. Site plan control under COTA remained the same as site plan control under the Planning Act. Bill 68 (Modernizing Ontario's Municipal Legislation Act (2017) revisions to the Municipal Act and COTA gave authority for other municipalities to create bylaws related to GI provided they are covered in the Ontario Building Code.[2] Recent amendments under the Modernizing Ontario's Municipal Legislation Act (2017) also added some clarifications related to environmental standards and construction of buildings. Building and permitting policies do play a role related to GI in the City of Toronto.

In summary, municipalities face some constitutional, legal and financial constraints that are very important related to GI. However, GI policies are 'scalable interventions' and 'supportive, strong policies from all orders of government is critical to implementing GI" (Boudreau et.al. 2017). Combined with the major demands and pressures in urban spaces, municipalities are becoming increasingly important in public policy and this is evident related to GI.

The Greater Toronto Area and Green Infrastructure Policies

The municipality of Toronto located on the shores of Lake Ontario in the Great Lakes has a population of 2.7 million, representing almost 8% of the total population in Canada (Statistics Canada 2017). Toronto and its surrounding municipalities of Durham, Halton, Peel, and York constitute the Greater Toronto Area (GTA).

The GTA is the largest metropolitan area in Canada - home to six million people and counting. It spans an area of 7,125 square kilometers and includes the City of Toronto and the surrounding regional municipalities of (TRCA 2016, 4). The city and region are home to a diverse population and wide

> The GTA is projected to be Ontario's fastest growing region in the next 25 years with its population increasing by 42% to reach 9.6 million by 2041. The Ontario Ministry of Infrastructure has made commitments of $160 billion since 2014 to support infrastructure and public transit.

Source: Ontario Ministry of Finance 2017; Avison Young 2017

[2] The author would like to thank Jane Welsh from Toronto Planning for these additional details.

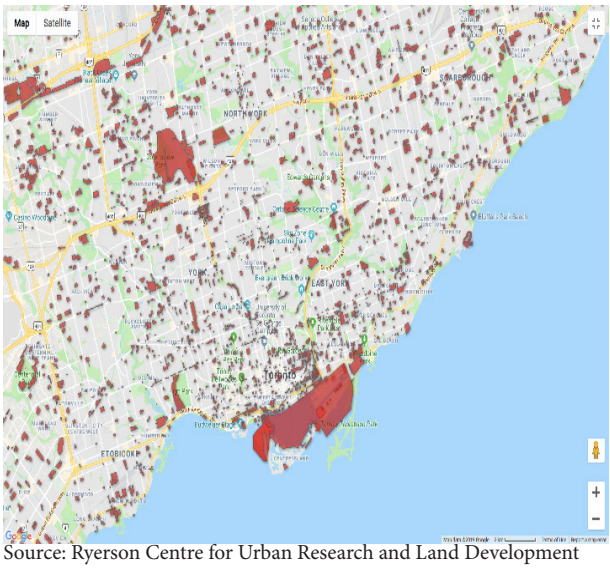
range of domestic and industrial uses of land and water. As Canada's largest and growing municipality, the city faces many infrastructure, land and water challenges.

Over time, the land and water system in Toronto has changed drastically with industrialization and urbanization. Land use is now highly urbanized and the urban built form consists of many different types of properties and land uses. These property categories include 436,000 residential; 7,668 condos/multi-family residences; 4,586 industrial and 20,093 commercial and institutional (including public sector properties such as schools, hospitals etc.) (Toronto 2015c). The city is home to thousands of roads, bridges, public utility corridors and two airports. In addition, there are more than 34 million trees and shrubs make up the GTA urban forest (TRCA 2016, 45) yet green space is declining.

While there was an estimated 8.4 ha per 1,000 people in 2011 in the greater Toronto watershed area, over the last five years, the amount of greenspace per 1,000 people across TRCA's jurisdiction has likely decreased due to population increase (TRCA 2016, 49).

In addition to urbanization and intensification of land use, it is important to note that there is significant variation in the amount of lands that are publicly or government owned. This is very important context related to green infrastructure policies.

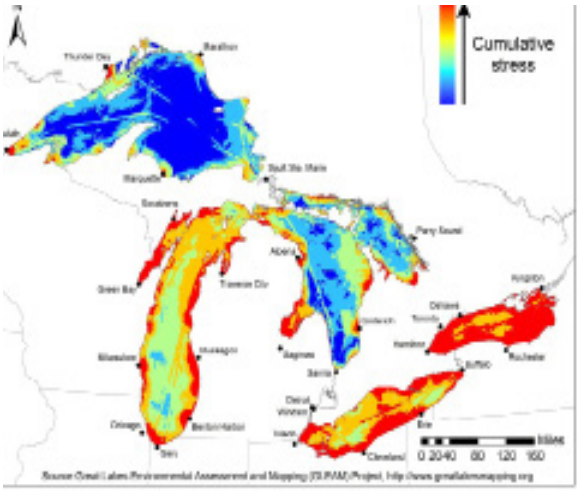
As highlighted on the map above, large tracts of waterfront lands are publicly owned. Arguably in these areas there is more potential for green infrastructure policies and installations that are government led. However, the map above also highlights

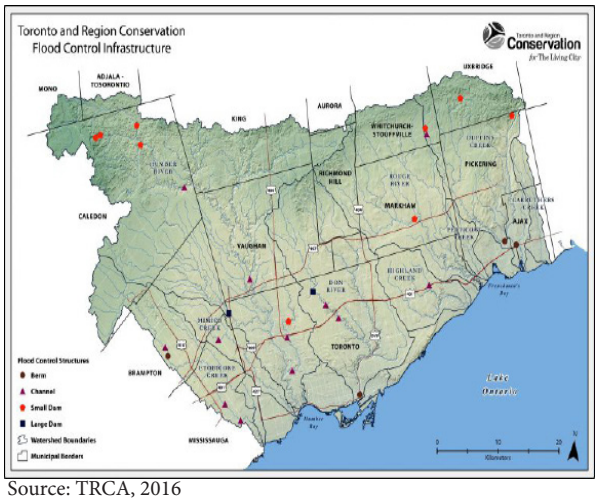


Source: Ryerson Centre for Urban Research and Land Development 2017. Greater Toronto/Hamilton Area (GTHA) Government-Owned Public Lands Inventory Web Map

that private property ownership is a critical component related to green infrastructure, water and stormwater management.

The Toronto region is also part of the Great Lakes ecosystem and has changed dramatically over time in terms of both water quality and quantity. Toronto has been designated one of the Great Lakes 'Areas of Concern' since 1987 due to poor water quality and cumulative effects of multiple water uses in watersheds in the GTA.

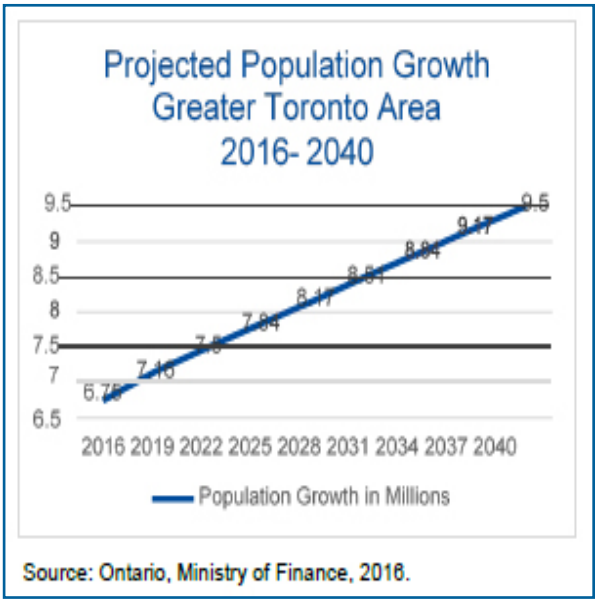




Source: TRCA, 2016

The Toronto and Region Conservation Authority (TRCA) focuses on the 2,506 square kilometers, nine river systems and The approximately 60 kilometers of the Lake Ontario waterfront in the Toronto region (TRCA 2016, 4). The map above outlines the waters within the jurisdiction of the Toronto and TRCA, including the City of Toronto boundaries.

TRCA has jurisdiction over watershed regulated areas. In accordance with Ontario Regulation 166/06, TRCA regulates areas where development could be subject to flooding, erosion or where interference with wetlands and alterations to shorelines and watercourses might adversely affect environmental features. Any of these activities within the Regulated Area may require a permit from TRCA (TRCA 2018).



Source: Ontario, Ministry of Finance, 2016.

Currently, TRCA's jurisdiction is the most urbanized and densely populated urban area within the province. According to provincial planners and TRCA, it is projected to remain one of the fastest growing areas of the province for at least the next 25 years with population growth in the GTA expected to grow to an estimated 9.5 million by 2041 (TRCA 2016, 49).

Also according to TRCA, just "35% of the urbanized areas across TRCA's jurisdiction are served by stormwater controls that help prevent flooding and manage water quality, erosion and impacts to aquatic ecosystems" and "the increase in stormwater runoff is one of the most serious environmental impacts of urban development" (TRCA 2016, 31).

Over the past five years, there have been 11 weather events for which TRCA has issued Flood Watch and Warnings. There are currently 43 clusters of flood vulnerable areas within Toronto watersheds (TRCA 2016, 35).

Both water quantity and water quality are reasons that TRCA is engaged in green infrastructure policy development, implementation and projects. Multiple uses of water by residents, businesses and industry in the GTA, combined with heavy stormwater runoff, are important concerns - not only because of the impacts to water-reliant ecosystems, but because the water,

The Toronto Flood that occurred in July 2013 cost the city an estimated $65 million in damages

Source: City of Toronto, 2013. Follow-up on the July 8, 2013 Storm Event

wastewater and stormwater management infrastructure is costly to operate and requires significant new investment to maintain, upgrade and expand.

Water quantity is now highly managed. The "water system of Greater Toronto is so split apart from its natural state that it cannot function without ever more expensive, heavily engineered systems" (Ignaczak 2015).

Many water quantity and quality issues continue to be challenges in the GTA and City of Toronto. Combined sewer overflows continue to be an issue after large-scale rain events. During heavy rains, the city's infrastructure may be overwhelmed by the volume of water and untreated wastewater flows into the lake. The management of water and stormwater through a highly developed but aging grey infrastructure is very costly.

The City of Toronto and Green Infrastructure Policies

Like many other municipalities in North America and Canada, the City of Toronto has developed a multi-faceted mix of policies to promote the shift from grey to green infrastructure broadly and specifically related to water and stormwater management over the past decade.

Table 1 summarizes the GI policy instrument mix in the City of Toronto. There are many different policies, implementation agents and actors from the public, private and non-profit sectors involved in GI in Toronto. This report focuses on those with local land and water use authorities and responsibilities in the Toronto area.

The City of Toronto is a large, complex organization. In 1998 Toronto's municipal government was amalgamated and restructured and seven large municipalities were combined to form the City of Toronto

Table 1 Summary of Green Infrastructure Policy Instrument Mix in the City of Toronto

Budget Instruments	**Revenue** Stormwater Utility Fee Development Fees Green stormwater capital investment plan	**Expenditure** Operating budget Capital budget Procurement policies
Regulatory Instruments	**Provincial** Land Use Regulations Certificates of Approval Ontario Building Code	**Municipal** [3] Official Plans - land use plans Zoning Bylaw [4] Green Roof By-law Mandatory Downspout Disconnection
Planning Instruments	**Land Use** TGS Checklist Toronto Green Standard (TGS)* Building permits Site plan control **Infrastructure** Asset Management Plans	**Water Use** Wet Weather Flow Master Plan (WWFMP) Watershed and sub-watershed plans Provincial/local source water protection plans Water Conservation Plans Service connection approvals
Subsidies and Incentive Programs	TGS Tier 2 Development Charge Refund Eco-Roof Incentive Program Free-tree Program	Basement Flooding Program
Interdivisional Initiatives	Green/Complete Streets	
Information & Behavioural Instruments	Government Reports Water Bills	Open Data

under the Mayor and 44 elected councillors who have authority to pass by-laws and manage a budget of $10.5 billion per year (larger than some of Canada's provinces). The corporation is led by the City Manager, three deputy city managers, several division heads and commissioners overseeing the work of some 34,000 employees in the Toronto Public Service (see Appendix II). Policy and project work related to GI and

[3] Both the Toronto Green Standard and Green Roof Bylaw implement Ontario provincial Official Plan policies.
[4] The 2013 version of the Zoning bylaw requires a percentage of soft landscaping for front and backyards.

stormwater management is directed by the City Council.

Excluding land, Toronto has $76 billion in physical assets, of which $29 billion are water and wastewater, by far the largest category of assets (Toronto 2015).

Given that GI is a policy domain that crosses economic, environmental, land use and water policies, there are several divisions with responsibilities related to GI.

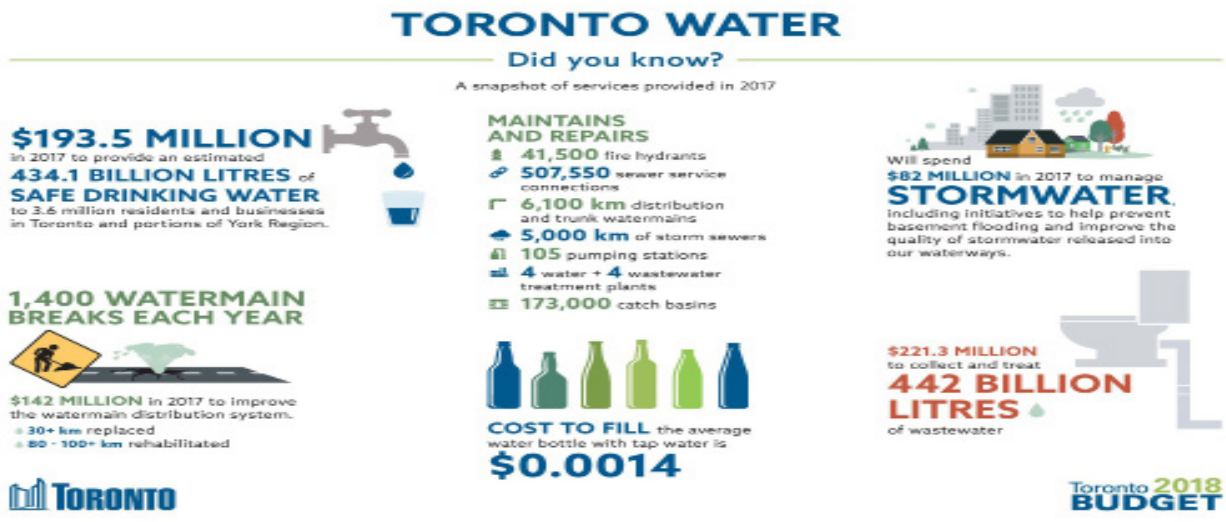
The primary departments (called Divisions in the City of Toronto) include Toronto Water, City Planning, Toronto Building, Engineering and Construction, Transportation Services, Parks, Forestry and Recreation, Corporate Finance, Financial Planning and Environment and Energy.

Of these departments, Toronto Water and City Planning have been the primary divisions engaged in GI policies related to water and stormwater with Transportation Services and other divisions also involved with GI policy and projects through several initiatives, a hybrid of funding, and a collaborative approach that is often project-focused.

Toronto Planning has primary responsibility for land use policies. It is the main division responsible for implementing provincial land use policies outlined above, and the Official Plan for the City of Toronto. This department has an annual budget of $47 million and employs approximately 370 staff,

many with urban planning and interdisciplinary backgrounds (City of Toronto 2017). The former Chief Planner & Executive Director Jennifer Keesmaat was a regular presenter at the Grey to Green conference often held in Toronto and an outspoken advocate of green infrastructure.

Staff from several units in Toronto Planning are involved with GI policies and programs including the Strategic Initiatives, Policy & Analysis Section which is responsible for city-wide planning policy development and implementation; the Urban Design section; and the Waterfront Secretariat. As will be outlined in the following sections, Toronto Planning has responsibility for many by-laws and policies related to GI. Toronto Water is the city division for all publicly owned assets that provide, transmit and distribute water, wastewater collection and treatment,



Source: City of Toronto Budget, 2018

and stormwater collection, transmission and treatment within City of Toronto boundaries. They manage these responsibilities with other divisions. For example, ditches are the responsibility of Transportation Services.

Toronto Water manages water, wastewater and stormwater through a system includes 4 water treatment plants; 4 wastewater treatment plants; 470,000 water service connections and 463,300 sewer service connections (Toronto Water 2015).

The department maintains 6000 kms of water mains; 5000 kms of storm sewers; 4100 km of sanitary sewers and 1400 kms of combined sewers (Toronto 2016a) and another 173,000 catch basins (Toronto Water 2017). Toronto Water manages and maintains assets valued at $28 billion and a reserve of $7 million (Toronto Water 2015a).

The organization serves 3.4 million residents and businesses in Toronto and portions of York and Peel. The organization employs 1,757 full and part-time employees of which 1,405 are unionized; salaries and benefits are approximately 39% of the annual operating budget (Toronto Water 2015c). The organization employs a mix of personnel but not surprisingly, many of the employees have engineering and science backgrounds.

Table 2 summarizes the various organizations in the GTA and divisions in the City of Toronto with mandates and policy implementation responsibilities related to GI.

Given the size and resources of Toronto Water it is a significant organization in terms of GI related to stormwater management. In 2017 Toronto Water had a $1.2 billion operating budget under the 'non-levy' operating budget category and City Planning had a $47 million budget (City of Toronto,

Table 2 Key Green Infrastructure Policy Implementation Organizations in Toronto

WATERFRONT TORONTO
- Created by all three levels of government in 2001 with a $500 million commitment
- has a 25-year mandate to transform 800 hectares (2,000 acres) of brownfield (mostly public) lands on the waterfront into Toronto's 'new blue edge'
- Estimated investments of $135 million in 2017-18
- 56 employees
- Funds many projects using green infrastructure

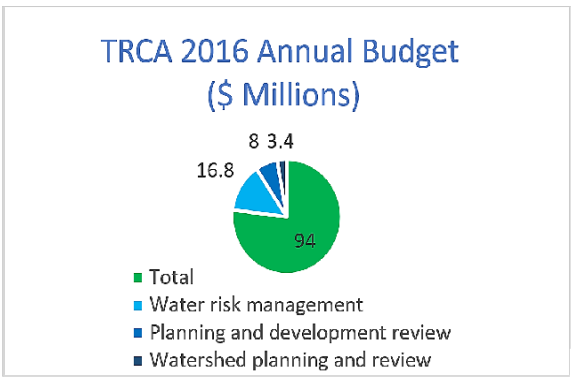
TORONTO AND REGION CONSERVATION AUTHORITY
- $94 million operating budget
- Flood management, water quality, watershed planning priorities
- 630 FTE employees; 650 supplementary staff

PLANNING DEPARTMENT
- $43 million operating budget; $59 million capital budget
- $28 million (operating) and $21 (capital) budget from development charges
- 372 employees
- The Toronto Green Standard (TGS)
- Green Roof by-law
- Green Streets Technical Guidelines
- Demonstration projects
- 40,000 building permits in 2015

TORONTO WATER
- Public utility with metered water system
- Large city department
- 1750 employees
- Owns $28 billion in assets
- collects $1 billion/year
- 6% of revenues from development charges
- $400 million annual operating budget; $750 million annual capital budget
- annual capital budget expected to reach $1b/year in each of next 5 years
- Declining water consumption 1.5% per year for past 10 years
- stormwater management capital program projected to grow from 18% of total capital program in 2015 to 40% in 2025
- 10 year capital budget plan (2016-2025) and Wet Weather Master Plan

OTHER DEPARTMENTS AND AGENCIES
- Toronto Building
- Engineering and Construction
- Parks, Forestry and Recreation
- Transportation Services
- Corporate Finance; Financial Planning
- Environment and Energy
- Build Toronto Inc. and Invest Toronto Inc.

Sources: City of Toronto 2016, 2016b, 2017; TRCA 2016, 2016b, 2017; Waterfront Toronto 2017.



Source: Toronto and Region Conservation Authority, 2016.

2017). It is important to note that Toronto Water is funded by the water rate and other Divisions are funded from municipal taxes.

It is also important to note that Toronto Water and City Planning work closely with the other organizations and departments in Table 2 on a range of land use and water policies in the city related to green infrastructure (also see organization chart in Appendix II).

Some departments however do not have GI as a key policy focus. For example, the Environment and Energy Division and the Major Capital Infrastructure Coordination (MCIC) office do not have GI as a mandate. The role of MCIC is that it acts as a hub for coordinating projects. They do not have a grey or green infrastructure focus, or any other specific policy focus, since their role is strictly to schedule and coordinate projects that involve several parties.[5] In other jurisdictions, environment and /or infrastructure departments are sometimes lead agencies on green infrastructure.

In addition to the organizations listed in Table 2, there is also an informal committee that discusses cross-divisional initiatives related to GI.[6]

These municipal divisions the City of Toronto also work with other local authorities and agencies with responsibilities related to GI policy implementation. The City of Toronto works closely with the Toronto and Region Conservation Authority (TRCA) and provides some funding for projects TRCA is working on related to green infrastructure and low impact development, particularly related to flood regulated areas and watershed protection and stewardship.

The TRCA's area of jurisdiction includes 3,467 square kilometers: 2,506 on land and 961 water-based jurisdictions over 9 watersheds (TRCA 2017).

TRCA's watershed jurisdiciton covers six participating municipalities including the City of Toronto and regions of Durham, Peel and York. TRCA has an annual budget of $94 million in 2016 of which $16.8 million was spent on water risk management, $8 million on planning and development review and $3.4 million on watershed planning and review. Some $83 million of its revenue comes from government sources ($73 from municipal sources) and the remaining $32 million it generates through various programs and services (TRCA 2017b).

Since 2013, the TRCA has prioritized GI and LID related to one of their 12 strategic directions: "Manage our regional water resources for current and future generations". In its 10 year strategic plan (2013-2023), the TRCA commits to action and partnerships related to GI: "We will remove technological and institutional barriers to Low Impact Development (LID) technology and green infrastructure techniques through research, demonstration, education and policy" (TRCA 2016, 21).

Finally, Waterfront Toronto also has some projects and intiatives related to green infrastructure. Waterfront Toronto was established by the federal government, province of Ontario and the City of Toronto in 2001, each committing $500 million in

[5&6] The author would like to thank staff from Toronto Water for for providing these additional details about MCIC and the cross-divisional committee

seed capital to enable the organization to begin the revitalization process on the waterfront. The vast majority of the land in the waterfront revitalization area is owned by the governments who gave the organization development control over their land. However, Waterfront Toronto must adhere to all City of Toronto policies.

Waterfront Toronto had an operating budget of $12.6 million in 2016-17 with revenues provided by all three levels of government, land sales and other sources. In 2016-17 it invested $33 million in waterfront revitalization projects, several of which included GI features (Waterfront Toronto 2017). For 2017-18 the organization has an estimated capital investment plan of approximately $135 million (Waterfront Toronto 2016).

GI projects on the waterfront in Toronto like Sherbourne Common have been noted as significant examples of 'next generation infrastructure' in the city (Brown 2014, 81). The City of Toronto works closely with Waterfront Toronto and has a Waterfront Secretariat (see City of Toronto Organization Chart in Appendix II) with 12 staff in the Planning department who work with Waterfront Toronto, and federal, provincial and other partners to coordinate work of other parntners and agencies related to waterfront projects.

Combined with federal and provincial government departments and agencies there are many public-sector organizations engaged in developing and implementing a range of policies related to GI. As outlined above, the City of Toronto alone has several divisions involved in developing and implementing GI policy instruments and initiatives, many of them specifically related to stormwater management. For purposes of this report, the instruments are each discussed in the following section, followed by a review of interdepartmental, non-government and private sector initiatives.

Expenditure Tools

Given that governments at all levels spend significant funds each year on water infrastructure, it is not surprising that public expenditures are an important policy instrument when it comes to GI.

As this report focuses on green infrastructure related to stormwater management, this section focuses on public sector finance (both revenue and expenditure tools) and procurement policies as important tool sets governments can use to invest in GI.

In addition, governments source many contracts with the private sector to design, build and operate water infrastructure. Many of these expenditures are channeled through public-private partnerships (P3s). Large

Source: Toronto Water, Operating Budget Notes, 2016.

municipalities like Toronto invest significant portions of their capital and operating budgets on infrastructure and stormwater management through their many divisions and in partnerships with the private sector.As noted by one interviewee for this project, 'the power of the purse is critical'.

The City of Toronto, like many municipal governments, uses expenditures to build, operate, maintain, and replace water infrastructure annually and over multi-year plans and projects. As outlined in the previous section, several Divisions across the City are involved in green infrastructure policies and

projects and have expenditure tools relate to GI. Toronto Water is funded by the water rate and other Divisions are funded from municipal taxes. Toronto Water and water infrastructure in Toronto is 100% rate funded as 'non-levy' operating expenditures (Toronto Water 2016).

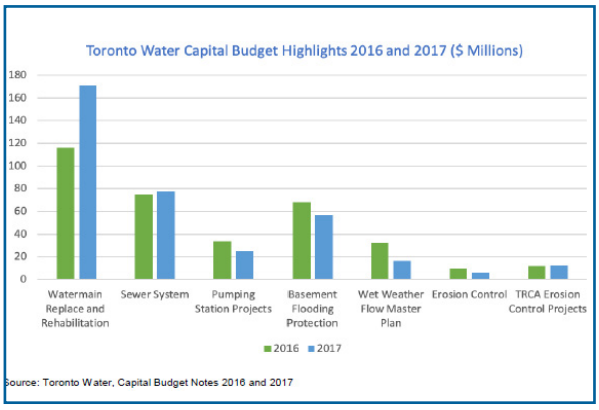
Although the City of Toronto operates its water and wastewater programs on a full-cost recovery model, recent declines in consumption, while positive, have negative implications for funding water and wastewater infrastructure and services. Moving towards a full-costing approach has occurred gradually but price increases for residential customers of approximately 70% over the 2005-2012 period and a further 50% since 2012, combined with other factors such as the installation of more efficient water technologies in the past two decades, has resulted in a decline in water consumption of 14% overall and 24% per capita (TRCA 2016, 40).

Operating Expenditures

Out of a total municipal budget of $10.5 billion, Toronto Water's total budget is $1.2 billion or 10% of the total operating budget (Toronto 2017). Toronto's water system is expensive. In 2016, the operating budget of Toronto Water was $440 million to provide water and wastewater services to 3.4 million residents and business in Toronto via over 470,000 connections (Toronto Water 2016b).

Wastewater collection and treatment is 51% of these costs, water supply and treatment 44% and stormwater management 5% (Toronto Water 2016b). The 2016 Operating Budget is predicated on a water rate increase of 8% effective January 1, 2016 and subsequent rate increases.

A significant portion of operating expenditures is for operation and maintenance costs of the city's water system



(see breakdown above), another (39%) funds the 1757 staff that work at Toronto Water. There is a Water Infrastructure Management section that is responsible for asset management, policy and program development and stormwater management. Within the operating budget there are some funds used for policy research and development and for demonstration and other projects. The City does have several people working on GI at Toronto Water and in other divisions. However, there is no specific operating budget, organizational unit or personnel with GI as their primary responsibility.

Data on the percentage of operating expenditure allocated to grey, green or a mix of grey and green water infrastructure is not available. It is thus difficult to track how much of the operating budget would be considered to be supporting GI installations, projects, operations or maintenance. This is similar on the capital budget side.

Capital Budgets and Expenditures

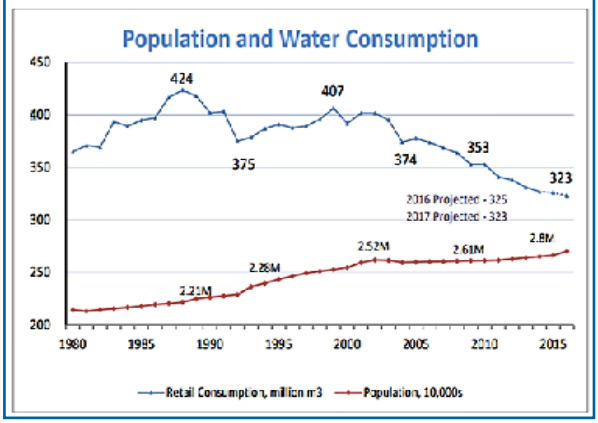
The City of Toronto has some capital expenditure on GI through collaborative projects by several divisions under the City's annual capital expenditures and multi-year capital budget and plan. On the capital expenditure side related to GI, water and stormwater management, Toronto Water has assets of $9.1 billion and wastewater assets of $19.2 billion (Toronto Water 2016).

In 2016, the capital expenditures for Toronto Water was $801 million. This funds state of good repair projects to address infrastructure renewal such as watermain replacement and rehabilitation ($116 million), the sewer system ($75 million) and pumping station projects ($34 million). In addition, there are annual expenditures related to basement Flooding Protection projects ($68 million), implementation of the Wet Weather Flow Master Plan ($32 million), city Erosion Control projects ($10 million), and TRCA erosion control projects ($12 million) (Toronto Water 2016c).

Capital expenditures can vary, for example, the Basement Flooding Protection Program was $62 million and the Wet Weather Flow Master Plan $40 Million in 2015 (Toronto 2015c).

The remaining 5% of the capital budget comes from development charges and 1% from other sources. Capital investment almost tripled from 2012-2015 (Toronto 2015c). In 2015 the capital budget increased by 27% to $780 million with $8.5 billion planned over ten years (2015-2024) (Toronto Water 2015d). For the 2016-2025 10-year planning period, the total capital budget is $11 billion (Toronto Water 2016c).

City of Toronto Population Growth and Water Consumption 1980-2015



The fastest growing portion of Toronto Water's capital budget is related to stormwater management (City of Toronto 2015b).

Toronto Water's Capital plan continues to be 100% self- sustaining, largely through water revenues, with no debenture financing and no impact on the municipal property tax levy. Water rate increases were 8% in 2016 and projected to be 5% in 2017-18 and 3% per year from 2019 forward (Toronto Water 2015c). In 2015 the average residential water cost was $894 per year – an average daily cost of $2.65 per day for all residential drinking water, wastewater and stormwater (Toronto Water 2015c, 41). With the 8% increase in 2016 that average annual water bill would go up to $966 (ibid, 43). An 8% increase would be an additional $179,000 for those large industrial water users that consume over 1 million m3 per year (Toronto Water 2015c). Commercial and industrial users with average consumptions of 100,000 m3 per year pay annual bills of $250,000-$350,000 (Toronto Water 2015c, 43).

Declining water consumption and a number of competing infrastructure priorities have placed significant pressure on the long-term capital program (City of Toronto 2015a).

A staff report in 2015, "Funding Options for Paying for the Toronto Water Capital Program" highlighted the growing needs of the stormwater management capital program, which as a portion of the total capital program is projected to grow from 18% of

the total capital program in 2015 to 40% in 2025 (Toronto Water 2016c).

Based on these projections, staff at Toronto Water began working on a report to explore the feasibility of a separate funding structure for stormwater management based on alternative parameters including per lot charges and impervious area. Many jurisdictions are already using stormwater charges or fees based on the idea that charging predicated on the amount of stormwater runoff from a property is a more equitable approach than using revenue from meter-based billing to pay for capital works associated with stormwater management. Removing the cost of stormwater management from the volumetric water rate would reduce the cost to the consumer for the consumption of water and treatment of wastewater.

City staff began reviewing various aspects associated with implementing a stormwater charge, including: a flat rate for residential properties (including detached and semi-detached homes, duplexes, triplexes, townhouses and row houses); a different flat rate for condominiums, multi-family residential, and industrial, commercial and institutional properties; and, a specific charge for each property one hectare (1ha) or greater based on the amount of runoff they contribute to the City's stormwater management system (City of Toronto 2015a).

According to a report in 2015, "the implementation of a stormwater charge will enhance business competitiveness. The preliminary impact analysis of the potential stormwater charge indicates that properties with large water consumption and relatively small impervious area contribute disproportionately towards the cost of stormwater management, and a stormwater charge based on impervious area rather than consumption will decrease their total water bill" (City of Toronto, 2015a, 11). This policy instrument is discussed in more detail below.

Procurement and Green Infrastructure

In addition to direct public expenditures, the other expenditure related instrument that some jurisdictions have used to advance GI are procurement policies. In some jurisdictions, procurement has been used as a policy instrument given the substantial volume and amount of public sector expenditures on projects and contracts. Governments at all levels procure major capital projects. In some jurisdictions procurement policies require consideration of GI options and/or supplements to grey infrastructure (IISD 2015, EC 2016). Although governments at all levels in Canada have had infrastructure investment and procurement at the top of their agendas in the past decade there has been very little use of procurement tools related to green infrastructure. A report by the Mowat Centre in 2015 focused on alternative procurement and financing models to capitalize on the 'infrastructure moment' in the Great Lakes and St. Lawrence region did not mention green infrastructure (Mowat Centre 2015).

There is no existing data on what percentage of public procurement goes to grey versus green infrastructure in Canada, Ontario or Toronto in operating or capital budgets. Like many other jurisdictions, the City of Toronto procures and purchases many goods and services from other government agencies, non-profit sector organizations ant the private sector. Some of the largest projects procured are infrastructure projects and water infrastructure projects.

As noted above, the federal government has had a formal policy on Green Procurement since 2006. Green Procurement is the

integration of environmental performance considerations into the procurement decision-making process (Canada PWGS, 2017). Green procurement requires the integration of environmental performance considerations into the procurement process including planning, acquisition, use and disposal within the context of achieving value for money (Canada PWGS 2017). Federal government departments are responsible for setting green procurement targets and including environmental criteria and specifications. As a result,suppliers have a key role to play in advancing the government's environmental agenda by providing environmentally preferable goods and services (Canada TBS 2017).

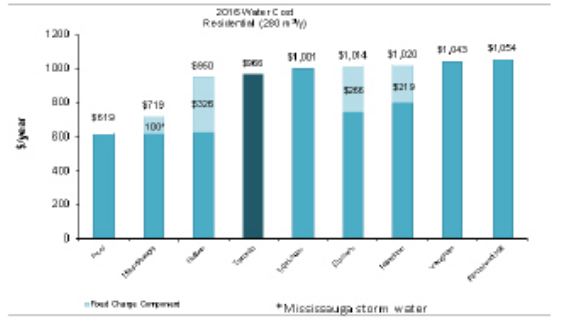
The only province that has a green procurement policy is Nova Scotia which adopted a sustainable procurement policy in 2010. Nova Scotia argues that this type of policy is broader than green procurement as it considers the health and social impacts of the goods and services being purchased and goes beyond green procurement which primarily considers the environmental impact of products or services over their full life cycle. The province of Ontario does not have a green procurement policy. In Ontario, the City of Burlington has had a greenprocurement policy since 2011 and the City of Waterloo has a green purchasing policy. These are mainly targeted at goods and services procured by these municipalities, not infrastructure.

There are no specific procurement policies related to GI in the City of Toronto. There are no requirements or incentives to consider GI or mix of grey and green when a call for proposals is posted, reviewed or as part of the procurement decision-making process. Toronto has a centralized purchasing and materials management process and evaluation criteria are included for all projects over $100,000. Toronto Water is a large purchaser of services and infrastructure and it has four dedicated buyers in the finance and procurement department.

As of 2017, procurement policies, sustainable development policies, water infrastructure and GI policies have not been brought together in the Request for Quotation (RFQ), the Request for Tender (RFT), or Request for Proposal (RFP) processes. Criteria such as quality of service, terms and specifications, and other criteria beyond cost are currently part of these processes, but sustainability and green infrastructure are not.

One interviewee reported there has been a shift in the paradigm of procurement over time. For example, there are some environmental criteria used in sourcing certified sources from a renewable source but there are no set environmental or GI criteria. The City also has a social procurement policy which according to one interviewee provides an incentive or forces suppliers to include certain criteria and deliverables in their proposals and contracts. The interviewee indicated the social procurement policy could be considered a precedent for adding procurement criteria in the GI realm.

According to the interviewee, this policy change would have to be institutional.



Source: Toronto Water 2016d, 11.

Toronto Water, Planning and the Finance Department could be involved in developing such criteria but this kind of procurement policy and approach would have to be endorsed by Council. In the social procurement case, several active councillors led this and got it passed by Council.

In summary, while operating expenditures, capital expenditures and procurement policies and processes are all very significant in terms of GI policy instruments, public sector expenditure budgets are under increasing pressures and are only part of the GI policy mix. Unlike many other city services, water is a 'rate supported program' thus the revenue side of the budget is very important in terms of understanding GI policies, as is Council's setting of divisional mandates and priorities.

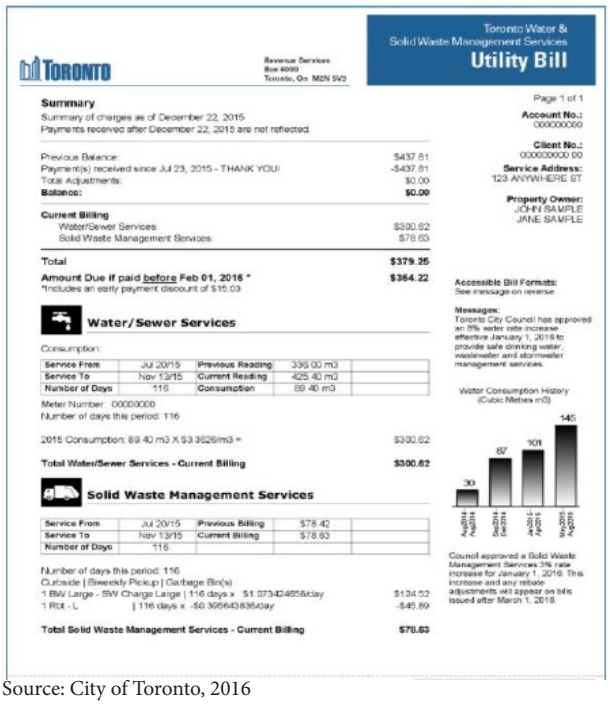
Revenue Instruments

Some jurisdictions are trying to get property owners to internalize the cost of water and stormwater management, similar to energy costs. This approach is primarily achieved by using economic policy instruments such as user fee instruments. Municipalities in Ontario all have the ability to generate revenues through fees and service charges but the City of Toronto is the only Ontario municipality with the legislative authority (City of Toronto Act, 2006) to allow it to levy taxes other than property taxes (City of Toronto 2015, 40). Revenue instruments are thus central to many policy areas, but particularly related to water, wastewater, and stormwater management.

In terms of revenue some 33% of city revenue or $3.8 billion comes from property taxes. The next highest category, $2.8 billion, is transfers from the federal and provincial governments (City of Toronto 2015). The remaining budget comes from other revenue sources such as user fees and development charges. The City of Toronto Act and other policy authorities granted by the province have been important and have aligned well with Toronto's move in the direction of cost recovery for its water and wastewater systems in the past two decades.

Although the City has several sources of revenue, it is estimated that between 2015 and 2024, it will spend $6.2 on growth related infrastructure and will collect $1.3 billion in development charges (City of Toronto 2015c). The adequacy of revenue instruments to fund water infrastructure in municipalities in Ontario have been the subject of debate for some time (Fenn and Kitchen 2016; Kitchen 2017).

Following the Walkerton Inquiry into the Walkerton tragedy and province-wide problems with water governance and management, Justice O'Connor recommended full cost recovery and that municipalities plan to raise adequate resources for their water systems from local revenue sources which could include water rates, user charges, development charges, property taxes, accumulated reserves and loans (O'Connor 2002, 302). Unlike some other municipalities, Toronto has moved in this direction and used revenue instruments and asset management plans to fund both water services and capital water projects.



TORONTO

Revenue Services
Box 6000
Toronto, On M2N 5V3

Toronto Water &
Solid Waste Management Services
Utility Bill

Page 1 of 1

Summary
Summary of charges as of December 22, 2015
Payments received after December 22, 2015 are not reflected.

Previous Balance	$437.61
Payment(s) received since Jul 23, 2015 - THANK YOU!	-$437.61
Total Adjustments:	$0.00
Balance:	**$0.00**
Current Billing	
Water/Sewer Services	$300.62
Solid Waste Management Services	$78.63
Total	$379.25
Amount Due if paid before Feb 01, 2016 *	**$364.22**

*Includes an early payment discount of $15.03

Account No.: 000000000
Client No.: 000000000 00
Service Address: 123 ANYWHERE ST
Property Owner: JOHN SAMPLE JANE SAMPLE

Accessible Bill Formats: See message on reverse.

Messages: Toronto City Council has approved an 8% water rate increase effective January 1, 2016 to provide safe drinking water, wastewater and stormwater management services.

Water/Sewer Services

Consumption:

Service From	Jul 20/15	Previous Reading	336.00 m3
Service To	Nov 13/15	Current Reading	425.40 m3
Number of Days	116	Consumption	89.40 m3

Meter Number: 00000000
Number of days this period: 116

2015 Consumption: 89.40 m3 X $3.3626/m3 = $300.62

Total Water/Sewer Services - Current Billing **$300.62**

Water Consumption History (Cubic Metres m3)

Solid Waste Management Services

Service From	Jul 20/15	Previous Billing	$78.42
Service To	Nov 13/15	Current Billing	$78.63
Number of Days	116		

Number of days this period: 116
Curbside | Biweekly Pickup | Garbage Bin(s)
1 BW Large - BW Charge Large | 116 days x $1.0734246858/day $124.52
1 Rbt - L | 116 days x -$0.3956643836/day -$45.89

Total Solid Waste Management Services - Current Billing **$78.63**

Council approved a Solid Waste Management Services 3% rate increase for January 1, 2016. This increase and any rebate adjustments will appear on bills issued after March 1, 2016.

Source: City of Toronto, 2016

Water and wastewater services and infrastructure in Toronto are primarily supported by general water rates through utility bills to residents and other water and wastewater users. Some of the water services are also funded through development charges (as described below). The city establishes its water rates on an annual basis.

The City Council-approved 2015 Water and Wastewater Rates and Service Fees staff report recommended two years of 8% increases (2015-2016), followed by two years of 5% increases (2017-2018). The advantage of using water rate increases greater than the rate of inflation for the purposes of generating revenue for the capital program is that it is administratively very simple. The disadvantage of using general water rate increases for the specific purpose of funding stormwater management projects is that they are not as equitable or transparent as a stormwater charge, nor do they incentivize large properties to manage their stormwater onsite (City of Toronto 2015b).

The basis of water funding has also changed on the revenue side. Toronto, like many other municipalities has moved away from flat rate charges to metered charges so users pay according to use of both water and wastewater infrastructure and services. In 2007 there were 72,000 flat-rate accounts and by the end of 2014, there were approximately 1,600 remaining flat-rate accounts, most of which were single-family residential homes. By the end of 2015 nearly all water users in Toronto had automated water meters installed. The City's mandatory Water Metering Program requires automated water meters in every home and business at no charge to the customer (Toronto Water 2015d).

The program has been fully in place since 2015 is now providing much more precise consumption data and will be able to provide a more accurate consumption forecast going forward, and more predictable revenues.

Over the last decade, despite the increase in population, there has been a trend towards reduced consumption showing an average decrease of 1.5% per year (ibid).

There is a clear budget paradox underpinning GI policies – what could be called the *Consumption-Green Infrastructure-Water Budget Paradox.* Slowing, conserving and decreasing water use leads to decreases in the water budget. Water consumption decreases means less revenue. However, with a growing population and development, Toronto continues to be able to fund its water operations through revenue sources. It is the capital budget that requires other revenue sources and is under significant pressure.

Water revenues have also been affected by rate reductions and rebates. In 2008, Council approved a water rebate program for low-income seniors and low- income persons with disabilities who meet the eligibility criteria as prescribed in the Municipal Code, Chapter 849.

This rebate represents a 30% reduction and is only applicable if the household annual consumption is less than 400 cubic meters, to provide assistance to those most in need. In 2014, the City processed 4,668 low income water rebate applications for a total rebate amount of $602,105 (City of Toronto 2015a).

Given this context, it is not surprising that Toronto has increasingly looked to revenue instruments and they are an important policy instrument related to GI. "The move to cost recovery policies create important financial incentives that help address environmental problems; together with planning, regulatory and education/outreach programs, they are a critical part of a broader urban water policy toolkit. User fees create a dedicated revenue stream for municipal water services, ensure a fairer assignment of costs, and create greater awareness and transparency about the costs of these services" (TRCA 2016, 40).

However as noted by the Environmental Commission in Ontario, "it has been too difficult for municipal councils to allocate the necessary funds, in competition with other priorities. Even more important, funding stormwater management out of taxes gives no incentive to public or private property owners to limit the runoff and pollution they create, and to protect the natural areas and GI that absorb stormwater. As a result, "municipalities risk sinking billions of dollars into grey infrastructure, instead of GI; and into disaster clean-ups instead of prevention" (ECO 2016, 3). The ECO recommended several provincial ministries need to make the municipal focus on revenue instruments and full cost recovery a requirement. "The Ministry of Infrastructure should require municipalities to prepare asset management plans for their grey and green stormwater infrastructure; and the Ministry of Municipal Affairs in collaboration with the Ministry of the Environment and Climate Change, should support municipalities in implementing stormwater fees" (ECO 2016, 4).

The most recent report from the provincial Environmental Commissioner indicates these challenges related to water management and full-costing remain significant issues (ECO 2018).

Stormwater Fees

Given the pressures on both the operating and capital budgets, particularly related to stormwater infrastructure, and the pressures for cost-recovery water systems it is not surprising that Toronto has considered the instrument of stormwater fees. Some 1600 municipalities in the United States and 21 cities in Canada are using stormwater fees as part of both water and GI policies (Campbell et.al. 2016). Stormwater fees, sometimes called stormwater utility fees or stormwater charges, are charged directly to property owners and are based on the amount of stormwater runoff generated by the property. They are thought to be more equitable than a property tax as each property owner is charged based on usage of stormwater services. However, it depends on how the stormwater fee is structured.

The most popular U.S. fee system is based on the average amount of impervious area for a single-family residential parcel. The second most popular fee system where every property owner pays the same stormwater fee. The next most popular fee system is the tier system which charges a fee based on a range of impervious area (Campbell et.al. 2016).

Since the volume of stormwater running off a property cannot be easily measured, some proxy measures are generally used to estimate the volume. The method most commonly used is some estimated amount of impervious surface on a property (asphalt, driveways, patios, rooftops etc.) under

the assumption that imperviousness is a very good proxy for indicating how much runoff a property contributes to the storm sewers and stormwater system. There is also some recognition that residential and non- residential properties vary in size and features and thus require different instrument designs. They are a popular policy instrument as jurisdictions can then provide incentives in the form of reduced bills for those who have more pervious or on-site stormwater management devices. The other benefit of this instrument is that a stormwater fee can be dedicated exclusively to stormwater rather than being part of the larger water supply, distribution and management system.

Stormwater management fees are allowed under the Municipal Act (2001) and the City of Toronto Act (2006). "A stormwater charge is determined based on the demands a customer imposes on the stormwater system. Generally, the more hard-surfaces (i.e., impervious area) a property has, the more stormwater runoff (rain and melted snow) it contributes and therefore the more it should be charged." (City of Toronto 2015b, 7). Some municipalities in Ontario such as Kitchener, Waterloo, Richmond Hill and Mississauga have introduced stormwater management fees (Fenn and Kitchen 2016, 45) and many others are exploring this instrument.

A report published by Environmental Commission of Ontario in 2016 (based on concern that using property taxes to fund stormwater is not a viable solution in the future) indicated only 8 municipalities in Ontario were using stormwater fees. However, some 30% of the 77 municipalities that responded to the survey indicated they are considering SWM fees (ECO 2016). Although responses were only received from 77 of Ontario's 444 municipalities in Ontario, 65% indicated they were not recovering costs for stormwater management; 85% were covering costs through property taxes; and 39% indicated they were also using development charges (discussed in the next section) (ECO 2016). Of those who reported using stormwater fees, Kitchener reported costs of $3.95-$14.92 per month for property owners using a charge structure with 13 tiers of charges. The City of Mississauga has also had stormwater charge since 2016 with 5 tiers of charges based on total roof area and hard surface area (using aerial imaging). Of 144,000 properties including all city properties in Mississauga; total collections range from $50 to $175 per year. Using a rough average of $112.50 charge per year this will generate approximately $16.2 million per year for Mississauga.

To date, Toronto has used a strategy focused on Institutional-Commercial-Industrial accounts (ICIs) with large impervious areas with a nominal storm water utility fee (effective January, 2011). In 2012 Toronto Water started to explore this policy instrument. From 2012-2015 several public consultations were held and City staff were asked to consider a range of alternatives for a stormwater fee including: a flat rate based on averageimperviousness across the city, and credits or water bill reductions for property owners who increase the imperviousness using GI installations. With 435,000 residential properties in Toronto, there is significant potential for this instrument.

In 2014-15 the City engaged in a public consultation related to funding Toronto Water's Capital program. Personnel from several environmental organizations indicated in a written submission that they were "supportive of establishing an independent stormwater rate" and "encourage City Council to adopt a fee determined by the volume of runoff generate by a property's impermeable surface". They also encouraged

city council to establish a citizen led Stormwater Innovation Council …to advise Council on innovation alternatives now ignored by Toronto Water" (ED and CELA 2015).

According to Toronto Water:

"*the incentive program that would be introduced as part of the implementation of a stormwater charge would motivate owners or managers of large properties to develop their own stormwater management solutions onsite, thereby reducing the pressure on the City's stormwater management infrastructure and increasing the number of stormwater management best practices on private property across Toronto"* (City of Toronto 2015b, 8).

Submissions were collected from many other stakeholders. A submission from the Toronto Catholic District School Board, which owns many properties and buildings in Toronto and had a water bill of $1.73 million in 2014, expressed deep concerns as a stormwater rate would almost double their bills and requested that combined water and wastewater rates be capped at a yearly increase (TDSB 2014).

A submission from the Real Property Association of Canada expressed "Real Estate Industry Concerns" from the perspective of large-scale commercial and industrial real estate. "Our members are strongly opposed to the separate stormwater charge as a potential revenue tool" (REALpac 2014). They viewed this a "policy slippery slope", that "the general municipal tax base and specific consumption water rates should be adequate funding sources", and the City not "proceed with the enacting of a stormwater charge as it has inherent and far-reaching negative economic impact on Toronto businesses" (REALpac 2014).

The Toronto Industry Network (TIN), with 24 member companies representing industry sectors such as food processing, chemicals, fuels, paper, pharmaceutical, cement, laundry and general manufacturing across Toronto, expressed a different perspective. "The City is to be commended for proposing to charge for stormwater separately from the cost of purchased water as the quantity of water purchased is generally unrelated to the quantity of stormwater discharged"; "we subscribe to the City's philosophy of making the SWC a flat rate for most residential, multi-residential and ICI properties less than one hectare"; "TIN believes the most reasonable method (for properties larger than one hectare) is based on volumetric discharges from the property and where that this is impractical could be based on the property's impervious area" (TIN 2014). Various stakeholders presented different positions related to introducing a stormwater fee and wanted more information on implementation and related implications. There was also some concern that a stormwater fee would be viewed as a rain tax and that it should be revenue neutral.

A staff report to City Council in October 2015, stated:

This report recommends that funding for Toronto Water's growing Capital Program related to stormwater management move from a water rate funded program to a dedicated stormwater charge funded program. A stormwater charge imposed upon property owners which is predicated on the amount of stormwater runoff from a property is a fair funding approach supported by the majority of stakeholders consulted to date. The establishment of a separate stormwater charge also brings more transparency to the actual costs of providing and maintaining a stormwater management system within the City.

Toronto Water developed a proposal for a stormwater charge based on dividing

properties into four categories: (i) Residential, (ii) Apartment & Condominium Buildings; (iii) Industrial, Commercial & Institutional, and (iv) Large Properties (Toronto Water 2017c). Staff developed a geographic information system (GIS) analysis to determine the hard and soft surface areas across the entire city using aerial photography (Toronto Water 2017c). Based on this analysis there are approximately 5,500 large properties (one hectare or larger) and approximately 78% of these properties are industrial, commercial or institutional. Large Properties account for only 1% of the number of properties in the dataset, but represent 42% of all hard surfaces (Toronto Water 2017c, 10).

Based on this work, Toronto Water developed a proposal for a stormwater charge and continued consultations in 2016-17. Many of the same stakeholders made submissions. The Toronto Catholic District School Board indicated the proposed stormwater charges "will significantly increase the costs of each of the four school boards' operations in the City of Toronto" (TCDSB 2016) and advised in their submission that the Minister of Education has taken a position that Section 58 of the Education Act provides school boards with an exemption to stormwater fees imposed under the Municipal Act, 2001 (TDCSB 2016). TDSB was also not supportive due to similar reasons.

The Green Infrastructure Ontario Coalition, RiverSides, Toronto Environmental Alliance, and TRCA were supportive of stormwater charges initially focused on larger properties and expanding the focus to other properties over time. They all offered feedback on different aspects of implementation. Smart Prosperity Institute was also supportive and offered comments on lessons from other jurisdictions and other comments for consideration (Toronto Water 2017b).

RiverSides was supportive of the "user-pay principles" but noted challenges related to the focus on large properties and the paradox facing the City and Toronto Water:

"as we achieve reductions in stormwater flow, Toronto Water will see reductions in revenue from stormwater charges. We see this as a significant disincentive to Toronto Waters's pursuit and promotion of cost-effective preventive measures that are designed to reduce the volume of stormwater that has to be transported, stored, and treated. Thus, if significant stormwater reductions are made, the City could become a financial victim of its own success or financially incentivized to maintain or even increase stormwater volumes rather than reduce them. RiverSides recommends a three-year timeline for inclusion of the almost 400,000-strong residential sector into a rebate or credit program for verifiable lot-level stormwater reduction" (RiverSides 2016).

Toronto Industry Network (TIN) made two submission in 2016 and 2017 was supportive of transparency and fairness in water service billing. Based on a survey of 17 of its members it submitted comments and queries related to the details of implementation and financial implications for its members and encouraged the phasing in of the program (Toronto Water 2017b). Finally, the Real Property Association of Canada (REALPAC) opposed the implementation of a stormwater charge but recommended that the maximum stormwater charge be capped at $100,000 per year if the City proceeded (Toronto Water 2017c).

In addition to the submissions from stakeholders, the City also collected considerable feedback from the public through its website (toronto.ca/stormwatercharge) and a short, four-question survey. The website had approximately

13,000 hits and resulted in more than 1,800 survey responses (Toronto Water 2017c).

According to the survey results, 74% of respondents either strongly agree or agree that upgrading stormwater infrastructure is an important investment for the City to be making (Toronto Water 2017c, 20). Respondents were asked which of two options they preferred to fund the stormwater management program. Option 1 was "pay based only on how much water I use" (i.e., the status quo), and Option 2 was "pay less for how much water I use and charge me separately for stormwater based on the average amount of hard space on properties of my size"; 43% of respondents chose Option 1, 38% chose Option 2 (Toronto Water 2017c, 20-21). The feedback staff received during public consultation made it clear that a stormwater charge would only be accepted if it was formulated from more individualized charges based on a more detailed understanding of hard surface areas on all properties across the City (Toronto Water 2017c, 24).

City staff organized 25 public consultation events, 19 of which were "pop-up" consultations at community centres, farmers' markets and the National Home Show where staff answered 550 enquiries and distributed 2,200 information cards to direct members of the public to the website to learn more and complete the survey. The other six events were public meetings held at each of Toronto's civic centres where staff delivered a detailed presentation on the stormwater charge proposal to almost 250 attendees (Toronto Water 2017c, 20).

In addition to the using GIS and hard surface analysis methods similar to those adopted in other municipalities that have implemented stormwater charges. Staff also conducted impact analysis to get a better understanding of the potential impacts of the stormwater charge model on all types of users. As noted in the report by Toronto Water, Deputy City Manager and Chief Financial Officer:

"Generalizing the results of impact analysis is complicated by the fact that there are several variables that affect the result, namely property size, property category and water consumption. Water consumption is a factor in the analysis because the stormwater charge model requires the separation of the portion paid for stormwater management currently embedded in the water rate, thereby resulting in the water rate decreasing by 20% upon implementation. At a very general level, analysis demonstrates that small properties with higher water consumption would generally have a net decrease on the water account portion of their utility bill, while large properties with low water consumption would generally have a net increase" (Toronto Water 2017c, 12).

After substantial review, study and consultation, Toronto Water decided in May 2017 not to pursue a stormwater management fee. As noted in the report to Executive Committee of Council in May 2017:

"Several issues related to the implementation of a stormwater charge were identified during the development of the implementation plan and the consultation process, the most important of which relate to: potential exemptions from the stormwater charge; no assurance that any overall reduction in a utility bill resulting from the implementation of a stormwater charge would be passed on to a tenant; strong demand from stakeholders and the public for more individualized stormwater charge formulations; and requests for incentives for homeowners. As a result of these issues, staff do not recommend the implementation of a stormwater charge at this time" (Toronto Water 2017c).

City Council directed staff instead to review the water rate structure by 2019

and assess the state of technology relevant to the viability of automated geographic information system (GIS) analysis of stormwater runoff contributions from properties across Toronto and report back during the annual budget process.

To date, a stormwater fee is not part of the revenue instrument toolbox used to support stormwater capital investments or GI projects. Some observers find City Council's decision 'perplexing' and argue the city needs to imagine the stormwater charge as a water fund that could send a positive message and support programs designed to support water literacy or incentives for green infrastructure on private lands (Boudreau 2017). By not pursuing a stormwater fee, the city remains dependent on its other revenue sources as water, wastewater and stormwater systems are not funded through property taxes. One of the other revenue tools used is development charges.

Development Charges

The Environmental Commission of Ontario's report in 2016 indicated that 39% of the 77 municipalities that responded to a survey on stormwater policy and management were using development charges to help fund their stormwater infrastructure (ECO 2016). Development charges are fees collected from developers at the time a building permit is issued and represent an important source of funding for the Capital Budget. The fees help pay for the cost of growth-related, eligible capital projects (and related operating costs). Most municipalities in Ontario use development charges to ensure that the cost of providing infrastructure to service new development is not imposed on existing residents and businesses in the form of higher property taxes. Development charges in Toronto are used to fund capital projects (Toronto 2015, 88).

As early as the 1950s and 1960s, Ontario municipalities began requiring developers to pay a portion of the costs for the hard services necessitated by new development, and shortly thereafter began requesting funding for related soft services as well. Since 1989 the province has had legislation to govern development charges and they have been increasing at dramatic rates over the past 10 to 20 years, particularly in the GTA

> Development Charges in the City of Toronto are required for land development or redevelopment projects for: constructing a new building; making an addition to alteration to an existing building that increases the number of residential units or the non-residential gross floor area; redeveloping a property or making interior alterations that result in a chance of use to all or part of a building

Source: City of Toronto, 2017h, Development Charges Overview

since 2002 (Amborski 2011, 7). In part, this is because greater financial responsibility has been placed on municipalities by the provincial government, in part because municipalities have viewed increases in development charges as more politically acceptable as opposed to other revenue sources such as property taxes and user fees and in part because of new powers making these sources available through the new City of Toronto Act (Amborski 2011,18).

Existing literature suggests that development charges, are designed to have growth pay for growth-related capital costs (Amborski 2011, 6). They are described as financial tools used by municipalities in several Canadian provinces to pay for the growth-related capital costs associated with new development or redevelopment and can influence how land resources are consumed and developments are designed (Baumeister 2012, 26). Development charges are often cited as an appropriate option to pay for infrastructure related to new growth, because

they place the onus on those who require this infrastructure, instead of the existing tax base (ibid). They are important in providing an important incentive to efficient forms of development and can provide a disincentive to inefficient forms of development (Sustainable Prosperity 2014, 3.)

Studies have found that that most municipalities were focused on the role of development charges in generating revenue to help cover their capital needs and had little interest in land use or planning implications despite the fact that the literature suggests that the way in which development charges are structured affects how land resources are consumed and how developments are designed (Baumeister 2012).

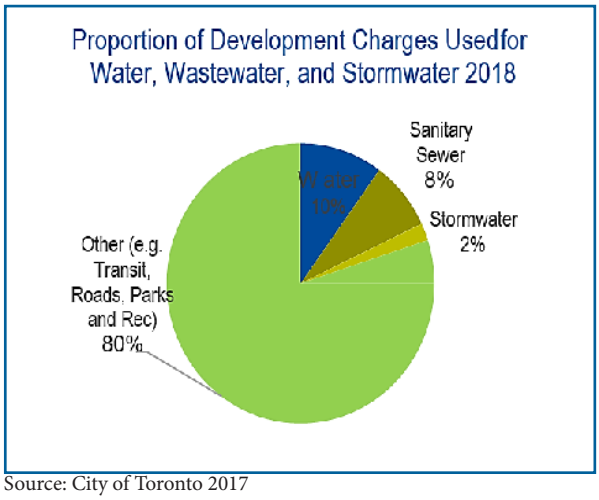
Development charges play an ever-increasing role as a revenue source in many jurisdictions, particularly in Ontario and in some municipalities (Amborski 2011). "In examining the approaches, property related services such as sewer, water, and stormwater would be appropriate to include in a development charge payment as these benefits are directly related to the property as they are essential for development. However, this does not preclude using other mechanisms to finance them (Amborski 2011, 24).

Some municipalities are willing to forgo revenue by reducing or exempting their development charges to encourage intensification, redevelopment or other development features (Baumeister 2012, 22). There is a considerable literature in urban planning about how development charges effect developments, mainly of land and density, and housing (Baumeister 2012; Amborski 2011), but very little on how development charges relate to GI or water and wastewater management.

This has led to some debate about whether development charges are a financing tool or a planning tool, and to what degree municipalities view them as policy tools. "There remains a municipal mindset that development charges are primarily intended to raise revenue and are not a policy tool" (Baumeister 2012, 26).

Up until recently, development charges were regulated under the Development Charges Act (DCA) (1997) and parts of the Ontario Planning Act. The DCA allows for development charges to cover 100% of eligible growth-related capital costs of all water services, including waste water and stormwater; and some other services (City of Toronto 2016b). Section 37 of the Planning Act was originally termed an "oversizing" levy, to reflect its use to increase the size of piped infrastructure or to expand treatment facilities. Over time, however, section 37 levies have been diverted to a range of other capital uses (Fenn and Kitchen 2016, 83). In addition, under the Ontario Planning Act, any new development requires a 5% contribution of its land as a park contribution or cash equivalent to 5 per cent of the land value. Section 37 of the Planning Act also allows for the requirement of certain standards in the development of new housing such as green roofs.

In 2013, City Council in Toronto adopted a new Development Charges Bylaw, in



Source: City of Toronto 2017

accordance with the requirements of the existing DCA and related regulations. Around the same time, the province held a development charges system review. Input and submissions were received from many stakeholders. Municipal officials had hoped that the exhaustive consultation would achieve broader improvements in support of the principle of 'growth paying for growth' and Toronto City Council urge the Province to broaden the application of development charges further by eliminating the mandatory 10 percent reduction to eligible costs, deleting the list of ineligible municipal services; and deleting the section of the draft Bill that makes development charges payable upon the first applicable building permit being issued (City of Toronto 2016b). The City of Toronto did not support development charges being payable on the first building permit as many developments that are large in scale and scope in Toronto require multiple building permits and the City has the flexibility of development charges as projects progress over time.

Input from the City of Toronto was not fully addressed when the province passed new development charges legislation in the Smart Growth for Our Communities Act (2015) which came into effect in January 2016. Most of the amendments are not in effect until the City's development charges by-law is updated or renewed. The net effect of the various amendments to the DCA on City development charge revenues is difficult to predict until a new by-law is developed in 2017-18. The implications of the new provincial development charges legislation for water, wastewater, stormwater and GI is not yet clear. In May 2017, the City initiated a Development Charges By- law review process that will be implemented in 2018 (City of Toronto 2017c, 2017g). To date, there are no specific changes anticipated in the development charges by-law related to green infrastructure.

In 2015, actual development charges were $221 million (City of Toronto 2015, 65) and in 2017 these were $189 million or 7% of capital budget revenues (City of Toronto 2017a). It has been estimated that between 2017 and 2026 development charges will be 5% of the capital budget (City of Toronto 2017a). In 2017, the City reported that development charges are used to fund a variety of municipal services. Some 80% of development charges go to transit, parks and recreation, libraries, housing, police, fire, and other municipal services (City of Toronto 2017c). The portion of development charges that go to water, wastewater and stormwater were 20 % (water 10%; sanitary sewer 8% and stormwater 2%) (City of Toronto 2017c).

Development charges as a source of revenue are important. However, they are controversial and some have argued they are an inappropriate way to fund growth related infrastructure: that shifting from development charges to full cost recovery user charges is more appropriate (Clayton 2015); that Section 37 revenues and development charges in Ontario should be re-focused on city-wide infrastructure priorities related to growth in demands on water, wastewater and stormwater systems (Fenn and Kitchen 2016); and that users, not federal and provincial tax payers and developers, should start paying directly for infrastructure (Bird and Slack 2017).

However, under the current policy regime, development charges are viewed as an important policy instrument related to advancing GI, particularly if used as incentives to encourage developers to build using GI in new or re- developments and then receive reductions in development charges as described in the section on the Toronto Green Standard below.

To date, the impact of reductions in development charges for GI installations and investments is not clear. Another issue related to GI is that development charges are only meant to cover the capital costs associated with new development and do not cover the long-term operations and management of the system. Because a development charge is an up-front, one-time fee, there is no recourse for ensuring that the GI is maintained and doing its job over the long term (O'Neil and Cairns 2016, 56).

Some have argued there also needs to be a greater understanding generally about the impact of development charges on land use decisions by having finance staff and planning staff involved in bylaw and decision-making (Baumeister 2012). If this is the case related to land use, it is even more challenging related to water use and management. Given that revenue instruments, like stormwater fees and development charges are more indirect ways of implementing GI policy objectives and investments, Toronto has also pursued other by-laws and regulations. Under some of these regulations, developers may be eligible for development charge refunds.

By-laws and Regulations

Land use regulations are one of the most common tool sets used to govern green uses of the landscapes, protecting green spaces, and for greening the built form. The current Official Plan (2015) is intended to ensure that the City of Toronto evolves, improves and realizes its full potential in areas such as transit, land use development, and the environment. Council's Strategic Plan is the broadest expression of the type of city envisioned by Council in the future, serving as a framework for several policies and strategies. "The official plan is the master policy document for all City divisions …it provides the policies and guidelines for all staff and developers" (Boudreau 2016). It is a long-term policy document that guides local development and action in a variety of contexts over the next 30 years.

The Official Plan includes many regulatory provisions for protecting the Green Space System, designations for various land uses, and regulating development in the city. Policies on intensification are meant to encourage population growth into existing areas where infrastructure already exists (TRCA 2016, 63). The most recent Official Plan consolidation of policies (2015), combined with zoning by-laws, governs land use, maximum structure size and grey coverage in the city.

Because the land use-water use interface is important related to green infrastructure, planning policies and regulations have significant implications for infrastructure, water quantity and quality management.

Other City plans and strategies such as the Environmental Plan, the Culture Plan, the Wet Weather Flow Management Master Plan, the Water Efficiency Plan, complement the Official Plan and help to implement city-building goals through by-laws, regulations and other tools.

Toronto Green Standard

A study in 2008 found that the benefits derived from green development clearly outweigh related costs (Kesik and Miller 2008) and many cities like Toronto are trying to advance the use of GI and building through policies and regulations. Some environmental groups argue that "all new development or redevelopment should integrate some level of GI and stormwater source control. Cities should build green space into new development plans and preserve existing green spaces and street vegetation" (Ecojustice 2008, 33). In some jurisdictions, regulations related to water retention have

been set. Some US jurisdictions have requirements that a minimum 1 inch (25 mm) of stormwater be managed on site (US EPA 2017). A 5mm minimum retention standard of rainfall has been recommended for local municipalities related to Low Impact Development (TRCA 2012, 35).

Studies have also been conducted related to a Minimum Runoff Volume Control Target (RCVT) for Ontario. Aquafor Beech did a jurisdictional study and analysis of rainfall in Ontario to inform the development of the Ministry of the Environment & Climate Change (MOECC) Low Impact Development Stormwater Management Guidance Manual (Aquafor Beech 2016). As noted above, at time of writing this report, Ontario's 2003 Stormwater Management Planning and Design Manual had not been updated and is a set of provincial guidelines for municipalities, not regulations.

The closest regulation that is currently required in the City of Toronto is the Toronto Green Standard (TGS) (established in 2010, updated in 2014). The Toronto Green Standard follows the discretion set in the WWFMP and related documents (described in the next section).

This section focuses on the TGS as a 'set of performance measures with supporting guidelines related to sustainable site and building design for new development" (GIO 2015, 12).

The TGS is a two-tier set of performance measures with supporting guidelines that promotes sustainable site and building design in new public and private development. Tier 1 requires 5mm water retention required for all development applications and Tier 2 is a higher, voluntary level of performance (10mm) with a financial incentive. The latest version of Tier 2 was adopted in December 2017 and put into effect in May 2018 with a requirement to meet 10mm stormwater retention in order to receive a development charge refund. If a developer goes above and beyond the minimum standard they can be refunded some of their development charges paid to the City.

The standards are designed to work with the regular development applications, approvals and inspections process. Since the City of Toronto put its Toronto Green Standard into effect in 2010, a total of 517 site plan applications have been approved that met either Tier 1 or Tier 2 requirements, including 55 low-rise residential (townhouses), 183 mid-to high-rise, and 279 industrial, commercial and institutional developments and this is a key driver of the strong growth being experienced in the Toronto green building industry (TRCA 2016, 57).

Since 2010, 1500 development applications have been required to meet Tier 1 and 22 have been certified as meeting Tier 2.

TGS are considered to be very innovative and one step above the Ontario Building Code but there is no good data on whether the city is achieving 5mm targets and whether this is sufficient in the context of average rainfalls in the city.

Green Roof By-Law

It is estimated that the percent of impervious cover in urban environments can range from 41% in high density residential areas to as high as 96% in downtown commercial settings (Bowles 2002). Of this, as much as 70% can be attributed to roof surfaces (ibid). As such, capturing rainwater that falls on roof surfaces has been an important part of the policy instrument mix for stormwater management in urban environments in some jurisdictions.

While beneficial in very dense areas with little available land, green roofs are one of the most expensive forms of GI. They manage runoff only from the roof area and buildings

must be designed to hold the weight of a green roof (GCC 2017). Nonetheless, they are an important part of the policy toolkit for the City of Toronto.

In addition to development regulations and standards, Toronto also has another regulatory tool related to GI. Toronto was the first city in North American to adopt a green roof by-law requiring large-footprint buildings to incorporate green roofs to help absorb rain water and provide other benefits. A green roof is an extension of an

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

Under Section 108 of the City of Toronto Act, green roofs are required to be installed on new commercial, institutional and high-density residential development with a minimum Gross Floor Area of 2000 m2 as of 2010 and as of 2012, requires compliance for new industrial developments. There have been 444 green roofs installed since 2010 (Toronto 2017d). As part of the Building Permit process for a Green Roof, Toronto Building staff review plans to ensure compliance with the Toronto Green Roof Construction Standard, Ontario Building Code, local Zoning Bylaws and other applicable laws.

Downspout Disconnection

The other by-law that has supported GI is the downspout disconnection by-law. By disconnecting downspouts, storm water flows during heavy wet weather events are redirected. Instead of being directed to storm sewers, the flows are redirected to lawns and garden that allow for rainwater retention and stores water underground. Toronto passed this by-law in 2010 making it mandatory for property owners to disconnect their downspouts. It comes into effect across the city in three phases: Phase 1 targeted property owners in areas served by combined sewers (stormwater and sanitary sewage carried in a single pipe) who were required to disconnect their downspouts by November 2011; Phase 2 targeted property owners in basement flooding study areas who were required to disconnect by December 2013 and; Phase 3 required all remaining properties across the City to disconnect by December 2016.

Other Planning Instruments

In addition to provincial planning policies and Toronto's Official Plan which contain regulatory instruments, a range of other planning policy instruments are used to encourage a shift from grey to GI. The Official Plan administered by the Planning and Building Departments and the Wet Weather Flow Management Master Plan (WWFMP) administered by all divisions are the most significant.

As outlined above, the PPS and Official Plan are important instruments for planning purposes. Although the planning process requires approvals and incorporates regulatory requirements, Official Plans are another planning instrument that can make significant policy statements and signal to developers that GI is a land use priority.

Amendments to the Official Plan (OPA 262) were initiated in 2014 and came into effect June 2016 with new policies to encourage GI. A set of tools and incentives, like the time it takes for application processes and approvals under the planning process are available. The planning and approval process can be designed so that those developers who use GI might receive both monetary incentives and rebates (as discussed above in the development charges, (TGS and Green Roof sections) and also other incentives such as accelerated approvals for applications

that incorporate GI. To date these types of planning instruments have not be used in support of GI by the City of Toronto.

Stormwater management plans are the most common tool used to anticipate and address stormwater infrastructure. The Wet Weather Flow Management Guidelines (2006) set performance objectives with respect to water quality, quantity control (peak runoff and flood management) and water balance (volumetric control). Toronto Water is gatekeeper for the Wet Weather Flow Management Policy and Master Plan

ENVISION Rating System Example: Natural World Category
NW2.1 MANAGE STORMWATER
INTENT: Minimize the impact of infrastructure on stormwater runoff quantity and quality
LEVELS OF ACHIEVEMENT

Enhanced	Superior	Conserving	Restorative
(4) Increase storage capacity. Project employs low impact development (LID) measures to reduce generation of storm runoff to pre-development concitions. The target water storage capacity for greyfields, 30% improvement in water storage capacity. For brownfields, 20% improvement. Greenfields site maintains 100%.	(9) Extended storage capacity. Project employs low impact development (LID) measures to reduce generation of storm runoff to pre-development conditions. The target water storage capacity for greyfields, 60% improvement in water storage capacity. For brownfields, 40% improvement. Greenfields site maintains 100%.	(17) Sustainable stormwater management. Project employs low impact development (LID) measures to reduce generation of storm runoff to pre-development concitions. The target water storage capacity for greyfields, 30% improvement in water storage capacity. For brownfields, 60% improvement.	(17) Sustainable stormwater management. Project employs substantial low impact development (LID) measures to reduce generation of storm runoff. Runoff is maintained on site and/or exceeds undisturbed climax ecosystem. Stormwater management programs and storm water handling structures are designed to capture and repurpose more than 100% of stormwater on-site as part of over water management regime.

Source: Griesbach, *The Envision Rating System*, 2014.

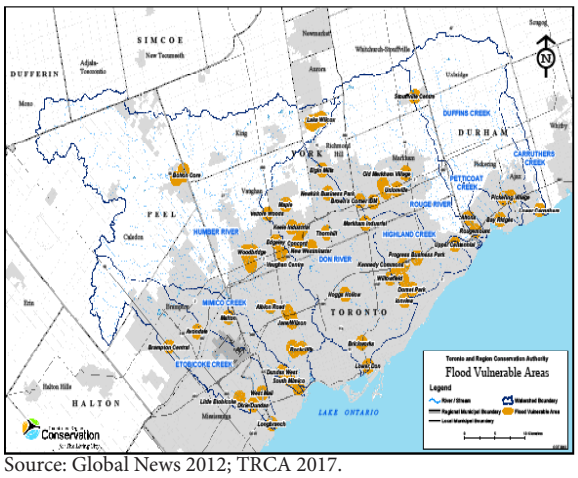
which governs and lays out storm water infrastructure for the next 25 years.

The City of Toronto's Wet Weather Flow Master Plan adopted by Toronto City Council in 2003, is a 25-year plan that identifies 170 projects to better manage stormwater, improve water quality and protect infrastructure from flooding and erosion. Projects, programs, and other initiatives have been implemented by Toronto Water and other City divisions to help achieve the WWFMP's water quality objectives based on the WWFMP's hierarchy of (i) Source Controls; (ii) Conveyance Controls; and (iii) End-of- Pipe Controls. In addition, ongoing and new initiatives within (iv) Municipal Operations have been implemented that also help to improve water quality in Toronto's watercourses and Lake Ontario waterfront (Toronto Water 2017d).

The Wet Weather Flow Master Plan was said at the time to "incorporate a new philosophy in wet weather flow management where rainwater is recognized as a resource" (D'Andrea, Snodgrass and Chessie 2004, 417). "A new philosophy was adopted in the development of the Master Plan which emphasized control of rainwater at source to minimize stormwater runoff" (ibid, 418). While some of this plan does consider GI, and the overall goal of the plan is to meet Provincial Water Quality Objectives within the City of Toronto surface waters, the plan is primarily focused on grey infrastructure. While the WWFMP views grey infrastructure as the primary policy approach, there is some recognition that GI should be considered to be part of the planning process.

In addition to the WWFMP in the City of Toronto, TRCA has also developed and used watershed and subwatershed planning related to its water quantity and quality policy objectives in its Strategic Plan 2013-2022. More recently TRCA has been actively involved in promoting LID planning and development guidelines and other planning initiatives related to GI. It has been using a new planning tool for GI called ENVISION. This tool is a rating system like ISO and Audubon certification systems. Infrastructure projects that TRCA is involved with are evaluated against criteria. For example, those that have 100% capture of rain and stormwater get maximum points. Waterfront Toronto is also exploring the possibility of using it for infrastructure projects (Waterfront Toronto 2017b).

Many municipalities in Canada are also exploring asset management plans as another important planning instrument related to water systems. Some 123 of 444 municipalities in Ontario had developed



Source: Global News 2012; TRCA 2017.

asset management plans by 2016; these were primarily developed by Finance departments in partnership with public works and sometimes water departments (Dawe 2016). Yet, many municipalities asset management plans are focused on grey infrastructure and struggle with how GI assets can be incorporated into asset management plans (Harvey et.al. 2017). A major reason why GI is not included within formal asset management frameworks for stormwater and drinking water systems is that the service it provides tends to be significantly undervalued (Harvey et.al. 2017).

Subsidies and Incentive Programs

In addition to expenditure, revenue and planning instruments many jurisdictions also have subsidy and incentive programs. In Washington, DC for example they have several different subsidies targeted at property owners to encourage the installation of green roofs, permeable pavers and rain barrels. Some of these programs are targeted at all property owners and land users, others are in targeted or priority watersheds.

In Toronto since December 2017, Tier 2 applicants in the development application process can receive a development charge refund if they meet a 10mm stormwater retention requirement.

Basement Flooding Program

In response to major flooding events in the past decades and record rainfalls in 2005 and 2013 the City of Toronto has increased its investments in grey and green infrastructure related to basement flooding. In July 2013, 126 mm of rainfall fell in just three hours (Boudreau 2015). By 2050, Toronto's maximum daily rainfall is expected to more than double, rising to 166 mm from 66 mm in 2011 (Toronto 2011). In response, the City identified flood vulnerable areas and 67 Basement Flooding Study Areas where work will be undertaken to address chronic basement flooding problems.

To assist residents, the City offers owners of single-family, duplex and triplex residential homes a financial subsidy of up to $3,400 per property to install flood protection devices including a backwater valve, a sump pump, and pipe severance and capping of the home's storm sewer or external weeping tile connection. The subsidy is available only to existing homes, not homes in the planning stages or currently under construction and current building standards include the management of stormwater on site.

In 2015, the City Council Budget Committee, requested a briefing note from Toronto Water on how to strengthen the "green infrastructure" in all basement flooding Environmental Assessments (EA) and projects. Toronto Water in its capital budget brief submitted to Council in 2015 indicated that "Green infrastructure" solutions recommended in the EA studies for basement flooding protection "have included stormwater wet and dry ponds that provide temporary storage in the storm sewer system to manage surcharges during extreme storms (i.e. end of pipe solutions). Stormwater ponds have been recommended in EAs when public open space to available to accommodate the above-ground infrastructure. This

is challenging in the City's built-up neighbourhoods. City parks are typically the only available area" (Toronto Water 2015d). The report went on to say, "Green infrastructure" within the public right-of-way can include bioswales and bioretention units (i.e. bio-retention units). These measures can help manage stormwater during smaller storms; however, they are less effective at providing basement flooding protection during larger storms. These measures also help improve stormwater quality" (Toronto Water 2015d).

In response to these queries from Council, Toronto Water indicated that GI solutions would be considered for stormwater quality improvement in EA studies that begin in 2015" (Toronto Water 2015d). However, the department noted "There are technical challenges with implementing "green infrastructure" projects within the public right-of-way. These issues include limited space, conflicts with other infrastructure, tree impacts, parking requirements, soil conditions, etc. These challenges may make implementation of "green infrastructure" not feasible. Despite these challenges, Toronto Water is committed to advancing "green infrastructure" projects and has been collaborating with City Planning to implement approved "green infrastructure" pilot projects" (Toronto Water 2015d). As of 2017 there were 67 Basement Flooding Study Areas in the city, studies for 31 areas were complete, 10 were ongoing and the remainder planned for the future (Harding 2017).

Free Tree Program

New technologies are allowing researchers to quantify the services provided by trees and confirm their value as vital GI. "Unlike conventional or "grey" infrastructure, which begins to decay and depreciate the moment it is installed, the value of a properly maintained tree increases over its functional lifespan. By all measures of urban sustainability, trees are simply a good investment" (Toronto 2017d). In 2015, the Green Infrastructure Ontario Coalition, which has united conservation authorities, environmental groups, municipal government, academia and industry to promote GI policies and programs, released Ontario's Urban Forest: Call to Action, which identifies priority actions to help protect and sustain our urban forests (TRCA 2016, 46).

Toronto, the largest city in Canada has an urban forest with an estimated 10.2 million trees covering approximately 18,000 hectares. Forty percent of this valuable resource is situated on public property, including an estimated 3.5 million trees within the city parkland system and approximately 600,000 trees on city streets. In addition to providing shade and helping to cool and clean the air, trees help prevent flooding. The City of Toronto will plant a free tree on the city-owned road allowances adjacent to private properties by residents simply requesting a free tree. This is in addition to the active tree planting program.

Eco-Roof Incentive Program

The City of Toronto also has an eco-roof incentive program. An eco-roof is a green roof that supports vegetation, or cool roof that reflects the sun's thermal energy. These installations save energy, reduce urban heat, improve air quality, create habitat and capture stormwater. To be eligible for this program, buildings must be existing buildings, located in the city with a gross floor area of less than 2000 m2. All types of buildings are eligible: residential, industrial, commercial, institutional and green roof funding is also available to all new construction projects by Toronto school boards and non- profit corporations.

Under this program eligible green roof projects will receive $100/square metre up to a maximum of $100,000 and eligible cool roof projects will receive $2-5/square metre up to a maximum of $50,000 (O'Neill and Cairns 2016, 52). Funding requests greater than $50,000 are subject to Council approval. From 2009 to 2015, the Eco-Roof Incentive program reduced the amount of stormwater that would end up in the City's sewers by 8.9 million litres (City of Toronto 2015e).

Other Incentive Programs

In addition to these incentive programs for GI installations, Toronto Water is encouraging water conservation in the commercial, industrial and institutional sectors however GI is not eligible under the Capacity Buyback Program that encourages and rewards industrial, commercial and institutional organizations that reduce water use.

Interdivisional Programs and Initiatives

While some green infrastructure policies are developed and implemented by single departments/divisions, or by Toronto Water and the Planning department together, there is growing recognition that GI for stormwater management requires involvement of a number of divisions and departments in the City. The city is made up of a number of separate divisions that operate largely independently. Many of the "B" division organizations (or hard infrastructure service providers) incorporate some degree of GI and stormwater management policies, programs, projects, and practices into their operations but there is a need for more interdepartmental collaboration on GI policies. The most promising of these initiatives have been the Green Streets and Complete Streets initiatives.

Source: City of Toronto Green Streets, 2017.

Green Streets/Complete Streets

In 2013, Toronto City Council 'directed three divisions (water, planning and transportation) to develop GI standards' (Interviews 8 and 9) and approved an inter- divisional proposal to develop green streets guidelines related to several Official Plan policies. Green streets are defined as "a right-of-way with a variety of green infrastructure design and operational treatments that manages stormwater at-source, and achieves the broad objectives of the Toronto Green Standard" (Boudreau 2015). This effort was a multi-department/ division effort with Toronto Water and the Planning Divisions taking leading roles, and the departments Parks, Forestry and Recreation; Transportation Services and Engineering and Construction Services, and in partnership with Economic Development, Energy and Environment, Toronto Parking Authority and other partners. This combined effort was based on several common drivers: i) manage rain where it falls; ii) using a watershed/natural systems approach; iii) at source, conveyance, then end-of-pipe solutions; iv) partnerships and v) citizen awareness and involvement (Boudreau and Cheung 2015).

In 2014 the City of Toronto (led by City Planning and Toronto Water) jointly hired a multidisciplinary consulting team to develop a Green Streets Technical

Guidelines document and provide advice on the integration of GI with typical street elements. The City also invested in pilot projects and demonstration projects. The Guidelines were envisioned to be a technical reference document for the appropriate location, design, construction, operation and maintenance of GI elements within the right-of-way and include detailed design drawings, construction specifications and operations and maintenance manuals.

Schollen & Co. landscape architects and consultants were awarded a contract and developed a Green Streets Technical Guidelines document under the 2014 Provincial Policy Statement, and Toronto's Official Plan, Wet Weather Flow Management Policy, and Toronto Green Standard. Based on this work the Green Streets Technical

Guidelines were developed to address a full range of locations for GI, along with a selection tool to help identify the best GI elements for a given context. The guidelines include ways to improve streetscapes by enhancing the tree canopy, reducing urban heat island effects, reducing stormwater runoff, reducing energy consumption, and reducing greenhouse gas emissions (TRCA 2016). The guidelines "are construction standards for GI in streets and other sites" (Boudreau et.al. 2017).

Various departments were involved at planning, site plan review and project implementation stages. These guidelines evolved through a series of demonstration projects focused on sustainable streets, sidewalks and projects using permeable pavers, trees, grasses, GI landscaping, and stormwater retention.

The guidelines were intended as the primary source for technical direction on green stormwater management, the foundation of demonstration projects and illustrating the co-benefits of integrating grey and green infrastructure.

They were also the foundation of a broader effort on complete streets. Based on this inter-divisional work and several demonstration projects, the City of Toronto developed and released the Complete Streets Guidelines in 2017 to provide a holistic approach to street design. As stated in the document, "Toronto's Complete Streets Guidelines should be considered in all street design projects in the City of Toronto" (City of Toronto 2017e). In addition, they contribute to water and stormwater management. As stated in Chapter 7, "Green infrastructure designed to capture rainwater is an emerging and important part of Toronto's streets. It can help minimize stormwater load on the City's sewer system, which has come under increasing pressure with the frequency and severity of storms" (City of Toronto 2017e, 116).

These inter-divisional efforts have demonstrated the value of inter-divisional collaboration and partnerships related to green infrastructure policy implementation. Green streets require numerous public, private and non-profit sector partners including university researchers for demonstration projects (Boudreau and Cheung 2015). "Policy on the ground is projects…and thinking needs to be thought through in every project" (Boudreau 2016). To meet Toronto Water's Wet Weather Flow Management Plan and Toronto Green Standard objectives to "manage rain where it falls", the city has initiated and evaluated several demonstration projects using a triple bottom line approach (Boudreau et.al. 2017). Raindrop Plaza was one of these projects using permeable paving, landscape design and rain gardens to direct stormwater runoff to temporary soil storage cells below the plaza and help irrigate newly planted large shade trees. The city, commissioned a full

evaluation to highlight the economic, social and environmental costs and benefits of the project (Impact Infrastructure 2017). Although several demonstration projects involving several city departments have been very valuable in starting the shift from grey to green, there have been challenges moving GI from special projects to broader implementation.

Chief Resilience Officer

In addition to these inter-departmental initiatives, in June 2017, Toronto hired Elliott Cappell as its first Chief Resilience Officer (CRO) - a new position created to lead city-wide resilience-building efforts to help Toronto prepare for catastrophic events and urban stresses (Water Canada 2017). This two-year position reports to the City Manager (see Appendix III) and will oversee the development of a comprehensive Resilience Strategy for the city. The chief resilience officer position is funded for the first two years by 100 Resilient Cities, a non-profit supported by the U.S- based Rockefeller Foundation. The organization will also provide Toronto as a member with access to a fund of $200 million to help fund research and consultation. "It's very important for the individual to be both a disruptor and connector…to cut through red tape and break down divisional "silos" to get results (Water Canada 2017).

Toronto's CRO will join a network of resilience officers in cities across the world who will share best practices and decide how to apply them in their own city. The City's new CRO "will be responsible for leading and coordinating all resilience building efforts, which will include planning for green infrastructure" (Boudreau et.al. 2017).

In a report in August 2017, Toronto was ranked the world's most resilient city, according to a recent report by (Grosvenor Group 2017). The report studied 50 global cities and found that Toronto, and other Canadian cities, fared well, as they were generally well governed, well planned and had good access to resources, including water and energy. The resiliency ranking was determined by assessing the cities' vulnerability to events and their ability to adapt to change and cope with adverse issues. GI is an important part of resiliency efforts in many jurisdictions.

GI is in most cases thought to be associated with resilience but it is not clear how much this new position will advance GI and there is no indication of how inter- departmental approaches will be institutionalize or advanced after this two-year position ends. At the time of writing in 2017 the Chief Resilience Officer was engaged in town halls and it was not clear if GI will be advanced through this office.

Other Inter-divisional Efforts

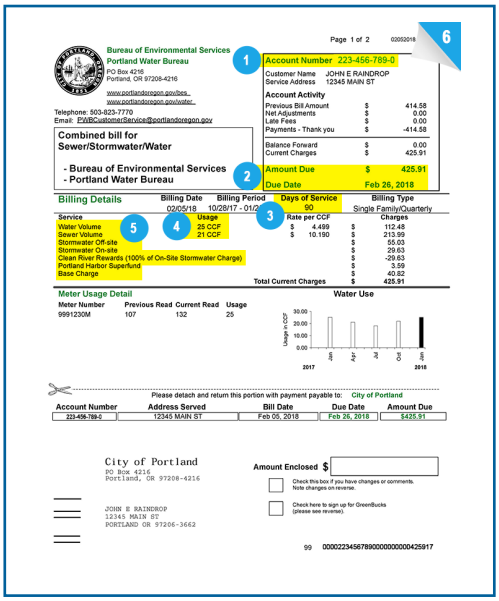
There are no current inter-divisional policies, programs or initiatives related to green infrastructure under the direction of one lead organization in the City of Toronto. As noted above, there is an informal committee in the City that discusses cross-divisional initiatives related to green infrastructure. Key informants interviewed in 2016-17 indicated that an inter-departmental/divisional initiative to establish a GI unit has been discussed as a possible proposal for consideration in the City of Toronto but nothing has developed on this front as of 2018.

As of 2017, there are no federal, provincial or municipalities in Canada that have designated GI units or programs at the central agency level that work across departments. However, some cities like Portland, Oregon have a GI unit with approximately 20 staff and dedicated resources to overcome institutional barriers and develop and implement

GI policies. New York City's Green Infrastructure Program is another example of a multiagency effort led by the New York Department of Environmental Protection. As of 2018, the city has not pursued this type of organizational unit to lead and enhance inter-divisional coordination on GI policy development and implementation and nothing has been recommended to Council.

Information and Behavioural Instruments

In addition to the other policy instruments above, government departments and agencies can use a wide range of information instruments to encourage behavioural and attitudinal change related to GI. The TRCA for example encouraging residents to help manage stormwater runoff on their properties by installing cisterns, rain barrels



Source: Portland Water Bureau, 2018.

and rain gardens to collect and use rainwater or by using permeable pavers for patios and driveways (TRCA 2016, 32), Municipalities can do a lot however, there is a lack of understanding of GI by property owners and low levels of public awareness related to GI and its benefits for the environment and water management.

The City of Toronto does have some information instruments. Some of these involve communications plans and strategies to inform the public about the existing policy instruments, including incentive programs that are available. Given all water users in Toronto are metered, there is some capacity to use information and behavioural instruments. MyWaterToronto is a program that provides citizens with water use information anytime, anywhere, from their computer or mobile device. Citizens can see their total and average water use by day, week, month or year in an easy-to-read graph or chart format. There is potential to use this kind of instrument to encourage GI installations and behaviours.

Utilities and service providers are increasingly being compelled to provide customers with personalized feedback on their water use and behaviours, similar to the manner in which information is provided by energy utilities. New data tools such as geo-spatial data and open datainitiatives in the City of Toronto may make these kinds of instruments an important part of the future policy mix.

Customer-oriented information is a data source that could be used to open a whole new tool box of GI instruments given that Toronto already has a fully metered system that can provide data for behavioural and information instruments.

Information for citizens on their water use, wastewater and stormwater contributions have been used in other jurisdictions as

the basis of stormwater fee discounts and incentives (EPA 2010). Information gives residents and property owners the option of making behavioural and site changes that can decrease their bills by encouraging retrofits, GI installations, decreasing impervious surfaces etc. Information is thus an important part of stormwater fees in many jurisdictions and one of the reasons some jurisdictions want to separate water use and stormwater charges on water bills.

Providing residents and property owners with information about the benefits of GI installations related to water quantity and quality is basic information that could improve public education about GI and water use. Information is also important for public reporting.

The City of Toronto does not currently have any GI reporting. Some jurisdictions have specific reports that include performance measures related to GI. Hamilton, for example has a 'state of infrastructure report' and although it focuses on grey infrastructure, this kind of reporting can be used to advance GI policies. Reporting using performance indicators is a very important tool set in public administration. The most common indicators related to GI policies are: i) % of impervious surface (city- wide and by property); ii) % of public expenditures on GI projects and installations; iii) % of expenditures (operating and capital) saved by GI installations and iv) volume of rainfall managed with GI (annually, by storm event or by geographic area). Some jurisdictions like Vancouver have passed a city-wide rainwater management plan and GI strategy that includes reporting and performance measures and a long-term target to capture and treat 90% of Vancouver's average annual rainfall through the implementation of GI on public and private property (Vancouver 2016). Imperviousness report cards, GI audits and reporting by the industrial, commercial, and institutional sectors are also other possible tools.

A key challenge for broader acceptance and adoption of GI is behavioural resistance by residents, businesses and developers. While governments can use a range of tools to implement GI projects on public lands and properties, implementation on private lands and properties require a different set of tools. This is important as large portions of land and the vast majority of water users are private (O'Neill and Cairns 2016). In addition to the wide range of policies and organizations involved in various public policies and implementation of policy instruments, there are also some non-government GI efforts and initiatives that can be considered.

Non-Government GI Initiatives

While the focus of this report is on GI policies being developed and implemented in the public sector, a number of non-government and non-profit sector organizations are trying to advance GI in the City of Toronto. Many of these are environmental, land use and water groups. This section is not meant to be comprehensive but includes an overview of some of the programs and initiatives being implemented by non-government organizations. Many of these non-government initiatives have been developed and implemented in the past decade.

The Green Infrastructure Foundation (GIF) was founded in 2007 to respond to the need for greater awareness and resources to promote the design, installation, and maintenance of GI in local communities. This is a membership based industry association and the leading entity for promoting the Green Roof and Wall industry in the U.S. and Canada. The Grey to Green Conference is an annual regional sustainability conference with a focus on GI implementation at an urban

and regional level hosted by Green Roofs for Healthy Cities and the Green Infrastructure Foundation.

The Green Infrastructure Foundation works with partners including the Green Infrastructure Ontario Coalition to deepen and broaden public awareness of the multiple benefits of green roofs, urban forests, and other forms of green infrastructure as part of the built environment.

In 2009 the Green Infrastructure Ontario Coalition (GIO) was established to bring industry associations together with NGOs to promote GI policies in Ontario. By pooling advocacy resources GIO has able to produce policy research reports and target both the province and federal government, particularly elected officials, to advance GI. In 2012, in partnership with Ecojustice, GIO published a report entitled *Health, Prosperity and Sustainability: The Case for Green Infrastructure in Ontario*.

Over time, GIO's advocacy has shifted from a focus on the province initially when there were opportunities related to new climate change policies to federal government because of the change in government in 2015. They have a vision that GI is the default policy approach by 2040 by advocating for governments to have a 'consider green infrastructure first policy' for infrastructure funding and having a dedicated funding stream of 15% of infrastructure funding for GI. It is also advocating for GI to be required in municipal asset management planning (GIO 2017).

In addition to GIO, there are other NGOs and think tanks working on GI policy research and advocacy. Ecojustice (2008) and CIELP (2011) have been documenting and advocating for GI for some time. Lake Ontario Waterkeepers and Ecojustice have done some good work on combined sewer problems. Some groups like Ducks Unlimited focused on wetlands as a form of GI. EcoSpark and Evergreen provide support for community gardens and projects.

Green Communities Canada (GCC) is a large NGO that has initiated and worked on GI for several years. GCC is a national association of community organizations across Canada. They have developed a Soak it Up Toolkit with 16 actions municipalities can take to implement GI, particularly related to stormwater. They have recently developed a Stormwater Scorecard that accompanies the tool kit and allows communities to conduct analysis of their existing policies, plans and programs related to GI and stormwater management (GCC 2017).

Partners in Project Green is a not-for-profit organization established in 2008 from a partnership between the Greater Toronto Airports Authority and the TRCA. These two organizations envisioned a community of like-minded businesses pulling together for the betterment of both the environment and the local economy. This organization has worked with community members to develop innovative new water projects designed to reduce the burden on the municipal stormwater and water treatment systems. In 2015, the first pilot was completed and a large rainwater harvesting installation was completed at a Scarborough furniture manufacturer. The captured water, diverted from the local storm sewer, helps to irrigate a host of newly- planted native plants, shrubs and trees on the site.

Work of the Toronto Atmospheric Fund is credited supporting the work of policy champions related to the TGS (Schwartz 2016,14-15). Work of Sustainable Prosperity, (now the Smart Prosperity Institute based at the University of Ottawa), produced a report in 2016 entitled New Solutions for Sustainable Stormwater Management in Canada as a resource for local governments

across Canada and the City of Toronto (O'Neill and Cairns 2016). They worked with Green Communities Canada to provide community workshops in 5 municipalities across Canada on stormwater fees and other tools for encouraging GI projects and are currently working with the Natural Step (an Ottawa-based NGO) to provide municipal roundtables to help staff work together to clearly identify, assess, and problem-solve key barriers to successfully implement new solutions for sustainable stormwater management. The customized sessions, organized and facilitated by Smart Prosperity Institute (SPI) and The Natural Step (TNS), engaged communities on their unique barriers to managing stormwater through user fees and green infrastructure, with the goal of developing local strategies and action plans for overcoming those barriers. The Smart Prosperity Institute also has a Municipal Natural Assets Initiative and work on green bonds as policy instruments that can be used to support GI investments.

Several other universities are also involved in GI work related to GI policies in Toronto. Research on green roofs by scholars at Ryerson University is said to have contributed to GI policy development (Banting 2005; Schwartz 2016). Some of this work is focused on science and policy research and some of it is more advocacy focused. The Centre for Urban Research at Ryerson published a policy position paper in 2014 advocating for an increase use of user charges and against the use of development fees to fund water and waste water infrastructure (Clayton 2014).

Universities are not just providing research for GI. Ryerson Urban Water working in partnership with the City of Toronto hosted a Green Infrastructure Hackathon in October 2016, bringing together students from 12 universities and colleges and more than 70 professionals from the GI sector in the GTA area who served as mentors and judges to support this student-focused event that brought together ideas and approaches from a variety of disciplines including urban planning, engineering, environmental studies, business, and public policy to form multidisciplinary teams to design GI designs. The hackathon generated 10 GI designs and 3 finalists. In addition, Ryerson has an interdisciplinary green infrastructure course that is part of the Masters in Urban Planning program.

Industry & Private Sector GI Initiatives

In addition to several non-government organizations that are active in promoting GI in the City of Toronto, there are also some active proponents of GI in industry and the private sector. Many of these private sector organizations and associations are involved in trying to promote GI in private companies and on private properties.

Green Roofs for Healthy Cities (GRHC) is a non-profit industry association working to grow the green roof and wall industry throughout North America since 1999. It develops awareness of the economic, social and environmental benefits of green roofs, green walls, and other forms of living architecture through education, advocacy, professional development and celebrations of excellence. It includes members from Canada and the US but has a strong focus on GI in Canada, particularly municipalities.

The Building Industry and Land Development Association (BILD) is a membership-based organization with 1300 member companies - Toronto having 800 members including builders, developers, renovators and trades companies (BILD 2017). The organization's roots go back to 1921 and the establishment of the Toronto Homebuilder's Association, viewed as one of the leading industry associations related to GI in the province.

There is also the green building industry. Although it is more difficult to define this sector of the economy, one indicator of the vitality of the green building industry is the number of certified green industrial, commercial, institutional and high-rise residential buildings.

The City of Toronto continues to lead the nation in the total number of certified green buildings with 253, as of September 30, 2014 (TRCA 2016, 57). Green buildings are considered to be those certified under either the Leadership in Energy and Environmental Design (LEED) Canada Green Building Rating System administered by the Canada Green Building Council, or the Building Owners and Managers Association's Building Environmental Standards (BOMA) program administered by BOMA Canada. Between 2011 and 2014 the stock of LEED and BOMA certified buildings in the Toronto region grew by an average of 39 buildings per year, to a total of 414 (TRCA 2016, 57). The Canada Green Building Council's Marketing Committee recently launched an interactive map of Ontario's green building landscape. The map features all Ontario buildings that have achieved LEED and Toronto Green Standard Tier 2 Certification.

Although government organizations are in many cases taking the lead on GI policies and projects, many of policy instruments covered in this report are implemented through public-private partnerships. In many cases, GI projects, whether large-scale or small-scale are being implemented by the public, non-profit and private sectors working together. The involvement of all three sectors, communities and citizens is very important to the policy instrument mix.

The redevelopment of the Toronto Waterfront is an important example. As outlined in the map on p.16 of this report, a significant portion of lands adjacent to Lake Ontario are publicly owned. Through an innovative partnership between all levels of government, developers, community organizations and citizens, Waterfront Toronto and Sidewalk Labs are working in partnership to bring planning, technology and community engagement together to redefine urban life in Toronto. "This joint venture called Sidewalk Toronto, aims to make Toronto the global hub for urban innovation'(sidewalklabs.com 2017). The Sidewalk project is part of a larger project in the area of the port lands on the shoreline of Lake Ontario, that covers more than 325 hectares (800 acres) and is one of North America's largest areas of underdeveloped urban land (sidewalktoronto.ca 2017).

Although green infrastructure is not an explicitly stated as central to Sidewalk Toronto, the sustainability goal is "a suite of design and infrastructure innovations that can dramatically reduce building energy consumption, landfill waste and carbon emissions – creating a blueprint for truly climate-positive neighbourhoods"

Source: Globe and Mail, Google's Sidewalk Labs, October 17, 2017.

(sidewalklabs.com 2017). This project also presents an opportunity for Toronto to become a leading jurisdiction in green infrastructure innovation related to buildings and development but also related to water and stormwater management. Indeed, this initiative, and major developments in other areas of the city (Avison Young 2017), will test the adaptability of existing land use and water policies and highlight the importance of partnerships in the shift from grey to green.

Conclusion

This report highlights that GI policies related to water and stormwater management are complex. In Canada, GI policies cannot be understood without some understanding of the political and institutional context in which they are embedded. Canada's federal system results in shared jurisdiction related to GI policies, in general and for stormwater management. An examination of the range of policy instruments in the City of Toronto related to GI reveals how many of the policies are embedded in this intergovernmental context, federal funding, and provincial legislation.

In addition, GI policies are complex in that they cross many traditional policy areas. Although policy instruments related to grey infrastructure have evolved to be managed by Toronto Water as a large municipal department, GI policies cross many policy domains and departments with mandates to implement them. In the City of Toronto, the Planning Department has taken the lead on many GI policies. Toronto Water is also important given its control over expenditure and revenue tools. Together with other divisions such as Transportation Services, there are several divisions involved in GI policies and projects. While this report has attempted to be comprehensive, it may not capture all of the GI-relevant policies and instruments being used related to stormwater management or more broadly.

The research for this report indicates that expenditure, revenue and stormwater planning instruments are an important part of the policy instrument mix related to GI in the City of Toronto but these instruments remain focused on grey infrastructure. Planning, regulatory instruments related to development, and some incentive programs, seem to have GI policy goals more front and center. However, what is also evident is that many of the policy instruments in the GI policy mix do not require regulatory foundations.

Given the need to integrate a focus on land use, water use and other policy goals, a mix of instruments is a common and necessary approach for advancing a policy shift from grey to green. This shift is challenging. The City of Toronto however is not alone in this policy terrain. The NGO and private sector are critical partners and have partnered with the City on many fronts. In some cases, these sectors are leading policy change and advancing green infrastructure policies at the community level through demonstration projects, research, design, and innovation.

One gap in the policy mix however is the focus on information and behavioural instruments and engagement of the public. Although some incentive programs exist to educate and engage citizens about the benefits of GI, there is no data on the degree to which these instruments are being use or data on citizens' knowledge and preferences related to GI. Information systems and open data are introducing new policy instrument options that are an important part of the future policy toolbox in municipalities and other levels of government. As recommended by other observers, "consistent with their public commitments to open data and data accessibility, the governments of Canada and Ontario must assume responsibility for collecting, analyzing and disseminating comparative information on water, wastewater and stormwater rates and water services plans of municipalities" (Fenn and Kitchen 2016, 17).

Finally, this report focuses on documenting and describing existing policy instruments and their implementation in the City of Toronto.The scholarly literature indicates there are range of factors that help explain the current state of GI policies and the challenges associated with their implementation. These are examined in another publication (Johns forthcoming). Only by understanding context, instruments, and barriers to implementation, will green infrastructure policies advance.

References

Allan, J.D., McIntyre, P.B., Smith, S.D., Halpern, B.S., Boyer, G.L., Buchsbaum, A., Burton, G.A., Campbell, L.M., Chadderton, W.L., Ciborowski, J.J. and Doran, P.J., 2013. *Joint analysis of stressors and ecosystem services to enhance restoration effectiveness*. Proceedings of the National Academy of Sciences, 110(1), pp.372-377.

Allen, W. 2012. "Advancing Green Infrastructure at all Scales: From Landscape to Site", *Environmental Practice*, 14(1), 17-25.

Altus Group 2011. *The Urban Infrastructure Challenge in Canada: Making Greater Use of Municipal Debt Options*, report prepared for the Canadian Home Builders' Association

Amborski, David. 2011. *Alternatives to Development Charges for Growth-Related Capital Costs*. Vaughan: Residential and Civil Construction Alliance of Ontario, http://www.rccao.com/news/files/RCCAO_March2011_REPORT-1.pdf

American Society of Landscape Architects. 2017. *Green Infrastructure: Cities*. Retrieved from https://www.asla.org

Aquafor Beech, 2016. *Runoff Volume Control Targets for Ontario*, Final Report submitted to Ontario Ministry of Environment and Climate Change.

ARUP and Sydney Water 2015. *The Future of Urban Water: Scenarios for Water Utilities in 2040*

Asano T. 2002. "Water from (waste) water – The Dependable Water Resource", *Water Science and Technology*, 45(8), 23–33.

Ashley, R. M., & Evans, T. D. 2011. *Surface water management and urban green infrastructure: a review of potential benefits and UK and international practices*.

Association of Municipalities of Ontario, 2017. *The Green Infrastructure Opportunity* https://www.amo.on.ca/AMO-PDFs/Events/16CONF/Proceedings/Concurrents/GreenInfrastructureDMartinDowns.aspx

Avison Young, 2017, *Transit Nodes of Tomorrow: Development Opportunities in the Greater Toronto Area*, November 2017.

Banting, Doug.et.al. 2005. *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto*, City of Toronto and Ontario Centres of Excellence.

Barnhill, Kathleen Barnhill, Richard Smardon 2012, "Gaining Ground: Green Infrastructure Attitudes and Perceptions from Stakeholders in Syracuse, New York", *Environmental Practice*, 14(1), 6-16.

Baumeister, M. 2012. *Development Charges across Canada: An Underutilized Growth Management Tool?* Munk Institute on Municipal Finance and Government, IMFG Graduate Student Papers, No.9, http://munkschool.utoronto.ca/imfg/uploads/201/imfg_no.9_online_june25.pdf

Benedickson, Jamie, 2007. *The Culture of Flushing: A Social and Legal History of Sewage*, Vancouver, University of British Columbia Press.

Benedict, M.A.; McMahon, E.T. 2006. *Green Infrastructure*, Island Press: Washington, DC.

Bird, Richard M. and Enid Slack ed. *Financing Infrastructure: Who Should Pay?* McGill Queens University Press (Montreal & Kingston).

Boudreau, Sheila, 2015. Toronto Green Streets, presentation at the Federation of Canadian Municipalities Sustainable Communities Conference, February 11, 2015.

Boudreau, Sheila, 2016. Infrastructure and Planning Approaches for More Resilient Systems: City of Toronto, presentation at Canadian Water Network Blue Cities Conference May 19, 2016.

Boudreau, Sheila and Patrick Cheung, 2015. Green Streets TO, presentation to Complete Streets Forum, Toronto, October 1, 2015.

Boudreau, Sheila, Patrick Cheung, Kate Nelischer and Shayna Stott, 2017. "Green Infrastructure, the Right Way for the Right-of-Way", *Municipal World*, November 2017, 19-20, 40.

Boudreau, Sheila, 2017. "Stormwater Fee Refresh: Roof tax or tool for social transformation?" *Water Canada Magazine*, November/December 2017, 42.

Bowles G. 2002. "Impervious Surface - an Environmental Indicator", *The Land Use Tracker*. 2(1).

Brown, Hillary, 2014. *Next Generation Infrastructure: Principles for Post-Industrial Public Works*, Washington: Island Press.

Brown, Rebekah R., 2005. "Impediments to integrated urban stormwater management: the need for institutional reform", *Environmental Management*, 36 (3), 455–468.

Brown, R.R. and Farrelly, M.A., 2009. "Delivering sustainable urban water management: a review of the hurdles we face", *Water Science & Technology*, 59 (5), 839–846.

Brown, R.R., Ashley, R., and Farrelly, M.A., 2011. "Political and professional agency entrapment: an agenda for urban water research", *Water Resources Management*, 25 (15), 4037–50.

Campbell, C.W. et.al. 2016. *Western Kentucky University Stormwater Utility Survey* https://www.wku.edu/engineering/civil/fpm/swusurvey/swusurvey-2016draft11-7-2016hq.pdf

Canada, *Budget 2016: Growing the Middle Class* (March 2016); retrieved from: http://www.budget.gc.ca/2016/docs/plan/budget2016-en.pdf

Canada, Department of Finance, 2017. *Budget 2017, Chapter 2, Communities Built for Chang*e, http://www.budget.gc.ca/2017/docs/plan/chap-02-en.html

Canada, Infrastructure Canada, 2017a. Canada Infrastructure Bank, http://www.infrastructure.gc.ca/CIB-BIC/index-eng.html

Canada. Infrastructure Canada, 2017b. *Investing in Green Infrastructure*, http://www.infrastructure.gc.ca/plan/gi-iv-eng.html

Canada, Library of Parliament, 2006. *Municipalities, the Constitution and the Canadian Federal System.*

Canada, Office of the Environmental Commissions and Sustainable Development, 2016. Spring Report 1: Federal Support for Sustainable Municipal Infrastructure, http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201605_01_e_41380.html

Canada, Public Works and Government Services (PWGS), 2017. *Policy on Green Procurement*, http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/politique-policy-eng.html

Canada. Statistics Canada, 2016. *2016 Census: 150 years of Urbanization.*

Canada. Statistics Canada, 2017. Municipalities in Canada with the Largest and Fastest-growing populations between 2011 and 2016.

Canada, Treasury Board Secretariat (TBS) 2017. *Policy on Green Procurement*, https://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=32573&section=html

Canadian Council of Ministers of the Environment, 2009. *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* http://www.ccme.ca/files/Resources/municipal_wastewater_efflent/cda_wide_strategy_mwwe_final_e.pdf

Canadian Infrastructure Report Card 2016, http://www.canadainfrastructure.ca/downloads/Canadian_Infrastructure_Report_2016.pdf

Canadian Institute for Environmental Law and Policy (CIELP), 2011. *Greening Stormwater Management in Ontario: An Analysis of Challenges and Opportunities*.

Canadian Water Network, 2016. *Phase 2 Federal Green Infrastructure Funding: Recommendations for Future Ready Water Systems across Canada*, 1-7.

Cettner, A. et.al. 2013 "Stormwater Management and Urban Planning: Lessons from 40 Years of Innovation", *Journal of Environmental Management and Planning*, 56(6), 786-801.

Chalifour, Nathlie 2016. "Incenting Green Infrastructure for Stormwater Management: Knowledge Mobilization for Canadian Communities", Canada Water Network, project description.

Chini, Christopher M. et.al. 2017 "The Green Experiment: Cities, Green Stormwater Infrastructure and Sustainability", *Sustainability*, 9, 105, 1-21.

Cirillo, Colleen and Podolsky, Liat. (2013). *Health, Prosperity and Sustainability: The Case for Green Infrastructure in Ontario*. Toronto, Ontario: Green Infrastructure Ontario Coalition and Ecojustice.

City of Philadelphia, 2017. *Protecting Waterways, Natural vs. Urban Runoff.* Retrieved from http://www.phila.gov/water/sustainability/protectingwaterways/Pages/default.aspx

City of Toronto, 2011. *Toronto's Future Weather and Climate Driver Study*, report prepared for the City of Toronto by SENES Consultants Limited.

City of Toronto. 2013. Follow-up on the July 8, 2013 Storm Event. Retrieved from http://www.toronto.ca/legdocs/mmis/2013/ex/bgrd/backgroundfile-62645.pdf

City of Toronto 2015. City of Toronto 2015 Financial Report, https://www1.toronto.ca/City%20Of%20Toronto/Accounting%20Services/Financial%20Reports/Files/pdf/2015/2015_FinanceAnnualReport_web.pdf

City of Toronto, 2015b. Official Plan.

City of Toronto, 2015c, City Budget Presentation to Council, https://www1.toronto.ca/City%20Of%20Toronto/Strategic%20Communications/City%20Budget/2015/PDFs/Presentations/2015%20Presentation%20to%20Council.pdf

City of Toronto, 2015d, Toronto Official Plan, Consolidated June 2015, https://www.toronto.ca/wp-content/uploads/2017/11/9048-cp-official-plan-chapter-2.pdf

City of Toronto, 2015e, *Toronto Environmental Progress Report 2015*, https://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Action%20 Plans,%20Policies%20&%20Research/PDFs/City_of_Toronto_EPR_2015_FINAL_ACC.pdf

City of Toronto, 2016a, *Fact Sheet: City Revenue*, October 2016.

City of Toronto, 2016b. *Development Charges Act Changes*, Deputy City Manager & Chief Financial Officer report. City of Toronto, 2017a. City Council Approved Operating Budget, https://www1.toronto.ca/City%20Of%20Toronto/Strategic%20Communications/City%20Budget/2017/PDFs/2017%20CN%20Approved.pdf

City of Toronto, 2017b. *Where the Money Goes* https://www1.toronto.ca/City%20Of%20Toronto/Strategic%20Communications/City%20Budget/2017/PDFs/Where%20th e%20money%20goes%202017%20CA.pdf

City of Toronto 2017c, 2017 Development Charges Bylaw Review, May 12, 2017.

City of Toronto, Environment and Energy Department, 2017d, *Every Tree Counts: A Portrait of Toronto's Urban Forest*

City of Toronto, 2017e, *Toronto Complete Streets Guidelines*, February 2017.

City of Toronto, 2017f. 2017 Water and Wastewater Consumption Rates and Service Fees. Retrieved from https://www.toronto.ca/legdocs/mmis/2016/ex/bgrd/backgroundfile-98484.pdf

City of Toronto, 2017g. 2018 Development Charges Bylaw Review: Factsheet. Retrieved from https://www.toronto.ca/wp- content/uploads/2017/10/97ab-DC-Review-Fact-Sheet-Oct-16-Final.pdf

City of Toronto, 2017h, Development Charges Overview https://www.toronto.ca/city-government/budget-finances/city-finance/development-charges/development-charges- overview/

Clayton, Frank 2014. "A New Direction for Funding Growth-Related Water and Wastewater Infrastructure in the Greater Toronto Area and Hamilton", Centre for Urban Research and Land Development, Ryerson University.

Clayton, Frank 2015. "What does the future hold for Ontario's Water and Wastewater Utilities and how they fund growth related infrastructure?", presentation at Centre for Urban Research and Land Development policy seminar, January 26, 2015.http://www.ryerson.ca/content/dam/cur/pdfs/Water_wastwater_Presentations/Clayton_Presentation_CURPolicySeminar_ Jan26.pdf

Conservation Ontario, 2018. *About Conservation Authorities: Mandate and Funding*, http://conservationontario.ca/conservation-authorities/about-conservation-authorities/

Credit Valley Conservation Authority (CVC), 2010. *Survey of Municipal Policies and Administrative Approaches for Overcoming Institutional Barriers to Low Impact Development*, http://www.creditvalleyca.ca/wp-content/uploads/2012/04/Muni_LID_Policy_withAppendix_Jan10.pdf

Credit Valley Conservation Authority (CVC), 2012. *Stormwater Management Criteria* http://www.creditvalleyca.ca/wp-content/uploads/2014/09/cvc-swm-criteria-appendices-Aug12-D-july14.pdf

Credit Valley Conservation Authority (CVC), 2016. *Grey to Green Enhanced Stormwater Management Master Planning: Guide to Optimizing Municipal Infrastructure Assets and Reducing Risk*. Retrieved from http://www.creditvalleyca.ca/wp- content/uploads/2016/01/ORGuide.pdf

Canadian Intergovernmental Conference Secretariat (CICS), 2004. Principles Underlying Federal Government Initiatives Regarding Municipalities, 16-17 September 2004, http://www.scics.gc.ca/cinfo04/860493004a_e.html

D'Andrea, Michael, William J. Snodgrass and Patrick D. Chessie 2004." Development of a Wet Weather Flow Management Master Plan for the City of Toronto" , *Water Qual. Res. J. Canada*, 39(4), 417–431.

Dawe, Matt, 2016. Presentation on asset management plans, Public Sector Digest, presentation at Canadian Water Network Blue Cities Conference May 19, 2016.

Demers, F. and M. Demers 2017, "Infrastructure Policy and Spending: An Initial Look at the Trudeau Liberal Plan", in G. Bruce Doern and Christopher Stoney, *How Ottawa Spends*, 30-85.

Ecojustice 2008. *Green Cities, Great Lakes: Using Green Infrastructure to Reduce Combined Sewer Overflows.*

Eggertson, Laura. 2015, "Canada has 1838 Drinking-water advisories", *Canadian Medical Association Journal*, 187(7): 488

Environmental Commission of Ontario (ECO), 2018. *Back to Basics: Volume 2 Clean Water* https://docs.assets.eco.on.ca/reports/environmental-protection/2018/Back-to-Basics-Volume2.pdf

Environmental Commission of Ontario (ECO), 2016. *Urban Stormwater Fees: How to Pay for What We Need*, https://media.assets.eco.on.ca/web/2016/11/Urban-Stormwater-Fees.pdf

Environmental Commission of Ontario (ECO) 2014, *Managing New Challenges, Annual Report 2013-14*, http://docs.assets.eco.on.ca/reports/environmental-protection/2013-2014/2013-14-AR.pdf

Environmental Commissioner of Ontario (ECO), 2011. Annual Report 2010-11.

Environmental Defence and Canadian Environmental Law Association, 2015. Proposal for Innovative Options for Providing Stormwater Infrastructure and Services submission to Corporate Finance, City of Toronto, https://www.cela.ca/sites/cela.ca/files/Toronto_Stormwater_Rate_Proposed_Solutions.pdf

European Commission. 2010. Green Infrastructure Implementation in Proceedings of the European Commission Conference, Brussels, Belgium, 19 November 2010.

European Commission. 2013. *Building a Green Infrastructure for Europe*, http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf

European Commission 2016. *A Handbook on Green Public Procurement*, 3rd Edition, http://ec.europa.eu/environment/gpp/pdf/Buying-Green-Handbook-3rd-Edition.pdf

Exall, Kirsten, Jiri Marsalek and Karl Schaefer 2004. "A Review of Water Reuse and Recycling, with Reference to Canadian Practice and Potential: Incentives and Implementation", *Water Qual. Res. J. Canada*, 39(1), 1–12.

Farahbakhsh, Khosrow and Christopher Despins, and Chantelle Leidl, 2009. "Developing Capacity for Large-Scale Rainwater Harvesting in Canada", *Water Qual. Res. J. Can.* 44(1), 92-102

Federation of Canadian Municipalities 2001. *A Guide to Green Infrastructure for Canadian Municipalities* https://www.fcm.ca/Documents/tools/PCP/A_Guide_to_Green_Infrastructure_for_Canadian_Municipalities_EN.pdf

Federation of Canadian Municipalities 2004. *Demonstrating the Economic Benefits of Integrated, Green Infrastructure* https://www.fcm.ca/Documents/tools/GMF/Demonstrating_the_Economic_Benefits_of_Integrated_Green_Infrastructure_ Final_Report_EN.pdf

Federation of Canadian Municipalities 2015. *About Green Municipal Fund*, http://www.fcm.ca/home/programs/green-municipal-fund/about-gmf.htm

Federation of Canadian Municipalities 2017. *Municipal Asset Management Program*, https://fcm.ca/home/programs/municipal-asset-management-program/municipal-asset-management-program.htm

Firehock, Karen, Walker, R. Andrew 2015, *Strategic Green Infrastructure Planning: A Multi-Scale Approach*, Washington DC, Island Press.

Federation of Canadian Municipalities, 2012a. *Canadian Infrastructure Report Card 2012.Volume 1: Municipal Roads and Water Systems*, https://fcm.ca/Documents/reports/Canadian_Infrastructure_Report_Card_EN.pdf

Federation of Canadian Municipalities 2012b. *Green Municipal Fund Annual Report 2011-12*, https://fcm.ca/Documents/corporate-resources/annual- report/Green_Municipal_Fund_Annual_Report_2011_2012_EN.pdf

Fenn, Michael and Harry Kitchen, 2016. *Bringing sustainability to Ontario's water systems: A quarter-century of progress, with much left to do*, Ontario Sewer and Watermain Construction Association, Mississauga ON, https://www.oswca.org/uploads/oswca_may2016_waterstudyreport_final_001.pdf

Forum for Leadership on Water (FLOW) 2017, *Smart, Strategic Investments for Urban Water Sustainability: Seizing Canada's Infrastructure Moment*.

Global News, 2012. 42 Areas in GTA at risk from serious flood, experts warn. Retrieved from https://globalnews.ca/news/598817/42-areas-in-gta-at-risk-of-flooding-during-extreme-weather-events/#map1

Globe and Mail, 2017, Google's Sidewalk Labs signs deal for 'smart city' makeover of Toronto's waterfront, https://www.theglobeandmail.com/news/toronto/google-sidewalk-toronto-waterfront/article36612387/

Great Lakes, St-Lawrence Cities Initiative, 2011. *Stormwater Management in the Great Lakes and St. Lawrence Basin: Cities Charting the Way Forward.*

Green Communities Canada (GCC), 2017. *Soak it Up! Toolkit*, Second Edition, http://www.raincommunitysolutions.ca/wp-content/uploads/2017/07/GCC-SoakItUp-Toolkit-2017.pdf

Green Infrastructure Ontario Coalition 2012. *Health, Prosperity and Sustainability: The Case for Green Infrastructure in Ontario.*

Green Infrastructure Ontario Coalition 2014. *A Green Stormwater Infrastructure for Ontario*, draft document for Stormwater Section of Green Infrastructure Ontario.

Griesbach, Ethan. 2014. *The Envision Rating System: Guide for Sustainable and Integrated Design*. Ontario Good Roads Association. Retrieved from https://www.ogra.org/files/2%20Ethan%20Griesbach_The%20Envision%20Rating%20System.pdf

Grosvenor Group, 2017. *Resilient Cities: A Grosvenor Report*

Harding, Graham, 2017. Development in the City of Toronto: Water Infrastructure Challenges and Opportunities, presentation to the Urban Land Institute Leadership Program, February 16, 2017.

Harvey, Richard M. de Lange, E. McBean, W. Trenouth, A. Singh & P. James et.al. 2017. "Asset condition assessment of municipal drinking water, wastewater and stormwater systems – Challenges and Directions Forward", *Canadian Water Resources Journal*, 42(2), 138-148.

Ignaczak, Nina, 2015. "Fractured Water: Can Urban Ontario Reconnect its Watersheds?", Building the Living City, March 11, 2015.

International Institute for Sustainable Development 2015. *How Green Public Procurement Contributes to Sustainable Development in China*, https://www.iisd.org/sites/default/files/publications/how-gpp-contributes-sustainable-development-china.pdf

Impact Infrastructure, 2017. *Triple Bottom Line Cost Benefit Analysis of Raindrop Plaza*.

Jayasooriya, V. M. and A. W. M. Ng. 2104. "Tools for Modeling of Stormwater Management and Economics of Green Infrastructure Practices: A Review." *Water, Air, & Soil Pollution* 225(8): 1-20.

Johns, C. 2008. "Non-Point Source Water Pollution Policy and Institutions in Ontario Before and After Walkerton" in M. Sproule-Jones, C. Johns and T. Heinmiller ed. *Canadian Water Politics: Conflicts and Institutions*, (Montreal and Kingston: McGill-Queen's University Press), 203-42.

Johns, C. 2016. "Green Infrastructure Policies and Water Management in the City of Toronto", presentation at the Water Centric Cities conference, University of Wisconsin-Milwaukee, April 15, 2016.

Johns, C. 2017. "The Great Lakes, Water Quality and Water Policy in Canada", in Steven Renzetti and Diane Dupont ed. *Water Policy and Governance in Canada*, Springer Publications, 159-178.

Keeley, Melissa, 2011. "The Green Area Ratio: An Urban Site Sustainability Metric", *Journal of Environmental Planning and Management*, 54(7), 937-58.

Keeley, M., Koburger, A., Dolowitz, D., Medearis, D., Nickel, D., and Shuster, W. (2013). "Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee." *Environmental Management*, 51(6), 1093–1108.

Kesik, T. and A. Miller 2008. 'Toronto Green Development Standard Cost Benefit Study', prepared by University of Toronto Planning Department for the City of Toronto, City Planning Department.

Kitchen, Harry, 2017. "Paying for Water in Ontario's Cities: Where Have We Come From, and Where Should we Go? in Richard M. Bird and Enid Slack ed. *Financing Infrastructure: Who Should Pay?*, McGill Queens University Press: Montreal-Kingston, 54 – 86.

Lennon, M. 2014. Green infrastructure and planning policy: a critical assessment. L*ocal Environment: The International Journal of Justice and Sustainability* 20 (8) , pp. 957-980.

Lennon, M. et.al. 2016. "Developing Green Infrastructure 'thinking': devising and applying an interactive group-based methodology for practitioners", *Journal of Environmental Management and Planning*, 59(5), 843-865.

Lindholm, Gunilla 2017, "The Implementation of Green Infrastructure: Relating a General Concept to Context and Site, *Sustainability*, 9(610), 1-13.

Lister, Nina Marie, 2016. Wet Infrastructure: Building Blue-Green Infrastructure: Handbook 2: Governance, https://www.ryerson.ca/content/dam/water/2016/WETInfrastructure/Governance%20Low%20Res.pdf

Lobina, Emanuele, 2012. "Water Service Governance, Technological Change, and Paradigm Shifts: A Conceptual Framework", *International Journal of Water*, 6(3/4), 155-175.

Marsalek, Jiri and Hans Schreier, 2009. "Innovation in Stormwater Management in Canada: The Way Forward", *Water Quality Research Journal of Canada*, 44(1), v-x.

Mell, I. 2010. *Green Infrastructure: Concepts, Perceptions and Its Use in Spatial Planning*. Ph.D. Thesis, Newcastle University, Newcastle, United Kingdom.

Mell, I., Allin, S.; Reimer, M.; Wilker, J. 2017. Strategic green infrastructure planning in Germany and the UK: A transnational evaluation of the evolution of urban greening policy and practice. *International Planning Studies*, 1-17.

Mowat Centre 2015. Vital Capital: Using Alternative Procurement and Financing Models to Capitalize on the Infrastructure Moment in the Great Lakes and St. Lawrence Region, University of Toronto.

National Roundtable on Environment and Economy 1994. Greening Public Sector Procurement: Role Options for the National Roundtable on Environment and Economy, http://warming.apps01.yorku.ca/library/wp-content/uploads/2013/03/NRTEE-1994-The-Greening-Public-Sector- Procurement-Role-for-the-NRTEE.pdf

Nickel, D., Schoenfelder, W., Medearis, D., Dolowitz, D. P., Keeley, M., and Shuster, W. (2014). "German experience with managing stormwater with green infrastructure." *Journal of Environmental Planning and Management*, 57(3), 403–423.

Nova Scotia, 2009. *The Path to Sustainable Procurement*, https://novascotia.ca/nse/pollutionprevention/docs/Path_to_SP_Discussion_Paper.pdf

Novotny, V., J. Ahern and P. Brown, 2010. *Water Centric Sustainable Communities: Planning, Retrofitting and Building the Next Urban Environment*, Hoboken NJ: John Wiley & Sons.

O'Connor, Dennis R. 2002. R*eport of the Walkerton Inquiry Part Two: A Strategy for Safe Drinking Water.*, Ministry of the Attorney General, Ontario.

O'Neill, Sara Jane and Stephanie Cairns, 2016. *New Solutions for Sustainable Stormwater Management in Canada*, report published by Sustainable Prosperity http://institute.smartprosperity.ca/sites/default/files/stormwaterreport.pdf

O'Neill, Sara Jane 2016. Incenting Green Infrastructure for Stormwater Management, presentation published by Sustainable Prosperity.

Ontario, Ministry of Finance. 2016. *Ontario Population Projections Update, 2016-2041*. Retrieved from https://www.fin.gov.on.ca/en/economy/demographics/projections/table10.html

Ontario, Ministry of Infrastructure 2017, BuildON Infrastructure Update 2017, https://www.ontario.ca/page/buildon-2017-infrastructure-update

Ontario, Provincial Policy Statement 2014, http://www.mah.gov.on.ca/Page10679.aspx#Infrastructure+and+Public+Service+Facilities

Pakzad, P, et.al. 2017, "Developing Key Sustainability Indicators for Assessing Green Infrastructure Performance", *Procedia Engineering*, Volume180, 146-156

Plummer, Ryan, et.al. 2011. "Probing the Integration of Land Use and Watershed Planning in a Shifting Governance Regime, *Water Resources Research*, 47, W09502.

REALpac 2014. Submission to City of Toronto Corporate Finance Re: Funding of Toronto Water's Capital Program, https://www.toronto.ca/legdocs/mmis/2015/ex/bgrd/backgroundfile-86058.pdf

Roe, M. and Mell, I. 2013. 'Negotiating value and priorities: Evaluating the demands of green infrastructure development', *Journal of Environmental Planning and Management* 56(5), 650–673.

Rowe, Amy. Ann., P. Rector and M.Bakacs, 2016. "Survey Results of Green Infrastructure Implementation in New Jersey", *Journal of Sustainable Water in the Built Environment,* 2(3), 1-6.

Roy, Allison H., et al. 2008. "Impediments and solutions to sustainable, watershed-scale urban stormwater management: lessons from Australia and the United States." *Environmental Management* 42(2), 344-359.

Royal Bank of Canada (RBC), 2016. *Canadian Water Attitudes Survey*, http://www.rbc.com/community-sustainability/_assets-custom/pdf/CWAS-2016-report.pdf

Rutherford, Susan 2007. *The Green Infrastructure Guide: Issues, Implementation Strategies and Success Stories*, Vancouver, B.C.: West Coast Environmental Law Research Foundation.

Ryerson University, Centre for Urban Research and Land Development, 2017. Greater Toronto/Hamilton Area (GTHA), Government-Owned Public Lands Inventory Web Map, http://www.ryerson.ca/cur/Research/governmentpubliclandswebmap/

Sa'adu Danjaji, Abdulrahman and Ariffin, Mariani 2017. "Green infrastructure policy for sustainable urban development", *International Journal of Environment and Sustainable Development*, 16(2), 112-127.

Seah, Harvey, 2016. Presentation on Infrastructure and Planning Approaches for More Resilient Systems: Singapore PUB, presentation at Canadian Water Network Blue Cities Conference May 19, 2016.

Schwartz, Elizabeth, 2016, "Developing Green Cities: Explaining Variation in Canadian Green Building Policies", *Canadian Journal of Political Science*, 49(4), 621-41.

Schilling, Joseph, and Jonathan Logan. 2008. "Greening the Rust Belt: A green infrastructure model for right sizing America's shrinking cities", *Journal of the American Planning Association* 74(4), 451-466.

Sinnett, Danielle, Nick Smith and Sarah Burgess ed. 2015. *Handbook on Green Infrastructure: Planning, Design and Implementation*, Edward Elgar Publishers.

Statistics Canada, 2016, Population of Census Metropolitan Areas, http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo05a-eng.htm

Swain, Harry, 2005. *WATERTIGHT: The Case for Change in Ontario's Water and Wastewater Sector*, Ministry of Public Infrastructure Renewal www.pir.gov.on.ca.

Taylor, Andre, 2008. "Ten Attributes of Emergent Leaders Who Promote Sustainable Urban Water Management in Australia", paper in proceedings of the 11th International Conference on Urban Drainage, Edinburgh, Scotland.

Toronto Industry Network, (TIN) 2014. Funding Toronto Water's Capital Program written submission to Corporate Finance City of Toronto, November 21, 2014, https://www.toronto.ca/legdocs/mmis/2015/ex/bgrd/backgroundfile-86058.pdf

Toronto Water 2015a. 2015 Water and Wastewater Rates and Service Fees, Staff Report to City of Toronto Budget Committee, January 13, 2015.

Toronto Water 2015b. Funding Options for Paying for Toronto Water's Stormwater Management Capital Program.

Toronto Water 2015c. Toronto Water Budget, presentation to Budget Committee by Lou Di Gironimo, General Manager, Toronto Water, November 6, 2015.

Toronto Water, 2015d. 2015 Capital Budget Briefing Note: Strengthening "Green Infrastructure" in Basement Flooding Environmental Assessments and Projects

Toronto Water 2015e. Funding Options for Paying for Toronto Water's Stormwater Management Capital Program, Staff Report to Toronto Budget Committee, October 29, 2015.

Toronto Water 2016a. *Toronto Water at a Glance*, https://www1.toronto.ca/wps/portal/contentonly?vgnextoid=2ee75830a898e310VgnVCM10000071d60f89RCRD&vgnextchannel=71dc5830a898e310VgnVCM10000071d60f89RCRD

Toronto Water 2016b. Toronto Water Operating Budget Notes. Toronto Water 2016c. Toronto Water Capital Budget Notes.

Toronto Water 2016d, Staff Report for Action on Water and Wastewater Consumption Rates and Service Fees, November 3, 2016.

Toronto Water 2017. Toronto Water Capital Budget Notes, https://www.toronto.ca/legdocs/mmis/2016/ex/bgrd/backgroundfile-98487.pdf

Toronto Water 2017b Stormwater Charge Proposal Attachment B: Stakeholder Written Feedback

Toronto Water 2017c. Proposed Stormwater Charge – Results of Consultation and Next Steps, https://www.toronto.ca/legdocs/mmis/2017/ex/bgrd/backgroundfile-103535.pdf

Toronto Water 2017d. 2017 Wet Weather Flow Master Plan Implementation Status Update, https://www.toronto.ca/legdocs/mmis/2017/pw/bgrd/backgroundfile-103216.pdf Master Plan Implementation Status Update

Toronto Catholic District School Board 2014, Submission to General Manager, Toronto Water re: Funding Toronto Water's Capital Program.

Toronto and Region Conservation Authority, 2012 Stormwater Management Criteria

Toronto and Region Conservation Authority 2013. *Building the Living City 10 Year Strategic Plan 2013-2022*, http://www.trca.on.ca/dotAsset/164987.pdf

Toronto and Region Conservation Authority 2016. The Living City Report Card 2016: A progress report on environmental sustainability in the Toronto region, https://trca.ca/wp-content/uploads/2017/02/3058-LCRC-2016-Final-WEB.pdf

Toronto and Region Conservation Authority 2016b. Annual Report 2016, https://trca.ca/wp-content/uploads/2017/07/3138-TRCA-AnnualReport2016-FA-WEB3.pdf

Toronto and Region Conservation Authority 2016c, Flood Control Map https://trca.ca/conservation/flood-risk-management/flood-control-structures/

Toronto and Region Conservation Authority, 2017. Flood Plain Map, https://trca.ca/conservation/flood-risk-management/flood-plain-map-viewer/#map

Toronto and Region Conservation Authority, 2017. Audited Financial Statements, year ending December 31, 2017

Toronto and Region Conservation Authority, 2018. Regulated Areas, https://trca.ca/planning-permits/regulated-area-search-v2/

Toronto Star, 2015. "Fix budget woes by hiking development charges, Toronto councillor says", December 1, 2015.

Tzoulas, K.et.al. 2007. Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review", *Landscape and Urban Planning*, 81: 167-178.

United States, Environmental Protection Agency (U.S. EPA), 2007. *Green Infrastructure Statement of Intent*, http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_intentstatement .pdf

United States, Environmental Protection Agency (U.S. EPA), 2010. *Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure*, http://www2.ku.edu/~kutc/pdffiles/Green%20Infrastructure%20Case%20Studies.pdf

United States, Environmental Protection Agency (U.S. EPA), 2013. *Green Infrastructure Strategic Agenda*, https://www.epa.gov/sites/production/files/2015-10/documents/2013_gi_final_agenda_101713_0.pdf

United States, Environmental Protection Agency (U.S. EPA), 2014. *Green Infrastructure Collaborative*, https://www.epa.gov/green-infrastructure/green-infrastructure-collaborative

United States, Environmental Protection Agency (U.S. EPA), 2016. *Green Infrastructure*, http://www2.epa.gov/green-infrastructure/what-green-infrastructure

United States, Environmental Protection Agency (U.S. EPA), 2017. *Stormwater Management and Green Infrastructure Research*, https://www.epa.gov/water-research/stormwater-management-and-green-infrastructure-research

University of Arkansas Community Design Center. 2010. *Low Impact Development: A Design Manual for Urban Areas.*

Vancouver, City of Vancouver, 2016. Administrative Report, *Rainwater Management Plan and Green Infrastructure*, http://council.vancouver.ca/20160419/documents/rr2.pdf

Van Meerkerk, I. and Edelenbos, J., 2014, The effects of boundary spanners on trust and performance of urban governance networks. Findings from survey research on urban development projects in the Netherland, *Policy Sciences*, 47 (1), pp. 3-24.

Vail, E. E., and Meyer, A. X. 2012. "Barriers to green infrastructure in the Hudson Valley: An electronic survey of implementers." New York State Dept. of Environmental Conservation, Albany, NY.

Walsh, Thomas. 2010. "SBN report tackles PWD's long-term gain vs. short-term pain." Plan Philly. Retrieved from http://planphilly.com/articles/2010/03/10/long-term-water-dept-plan-presents-short-term-private-cooperation.

Water Canada, 2017. 'Toronto Appoints New Chief Resilience Officer', http://watercanada.net/2017/toronto-appoints- new-chief-resilience-officer/

Waterfront Toronto 2016. Waterfront Toronto Corporate Plan 2017-18,

Waterfront Toronto 2017. Annual Report 2016-17.

Waterfront Toronto 2017b. Neighbourhood Sustainability, http://sr.waterfrontoronto.ca/en/social/pm1NeighbourhoodSustainability.asp

Waterfront Toronto, 2018a, Financial Statements of Waterfront Toronto, March 31, 2018.

Waterfront Toronto 2018b. Waterfront Toronto: Our Vision, Sustainability, Green Infrastructure and Stormwater Management, https://waterfrontoronto.ca/nbe/portal/waterfront/Home/waterfronthome/our-vision/environment%20and%20sustainability/green+infrastructure

Waterfront Toronto, 2018c, Waterfront Toronto: Accountability, https://waterfrontoronto.ca/nbe/portal/waterfront/Home/waterfronthome/about-us/accountability

Winz, Ines, Sam Trowsdale and Gary Brierley 2014. "Understanding barrier interactions to support the implementation of sustainable urban water management", *Urban Water Journal*, 11(6), 497–505

Worstell, C. (2013). “Green infrastructure in the State of New Jersey: Statutory and regulatory barriers to green infrastructure implementation.” New Jersey Future, Trenton, NJ.

Wright, H. 2011. “Understanding Green Infrastructure: The Development of a Contested Concept in England”, *Local Environment*, 16, 1003-1019.

Young, R. F. 2011. “Planting the Living City: Best Practices in Planning Green Infrastructure—Results from Major US Cities”, *Journal of the American Planning Associatio*n, 77(4), 368-381.

Zellner, M., et.al. 2010. Using green infrastructure to manage urban stormwater quality: a review of selected practices and state programs. Springfield, IL, USA: Illinois Environmental Protection Agency.

Appendix I: Green Infrastructure for Water and Storwater Management Glossary

Bio-swale - landscape elements designed to remove silt and pollution from surface runoff water through sloped drainage filled with vegetation or other materials

Bio-retention Cell/Area - also called rain gardens, vegetated areas that are design to collect, retain and treat stormwater runoff from adjacent lands

Blue Roof – roofs can be designed with stormwater management features that generally include rainwater harvesting

Constructed Wetland - an artificial wetland restored or created for the purpose of treating municipal or industrial wastewater, greywater or stormwater runoff.

Green roof – includes a range of solutions ranging from rooftop gardens to rooftop vegetation that include grey water recycling and plantings to reduce storm water flows; also have many additional benefits such as improving air quality, cooling, and habitat

Permeable Pavement – provide stormwater retention capabilities similar to a natural system by allowing stormwater to infiltrate directly or pass through them. Examples of permeable pavement include permeable asphalt, permeable concrete or interlocking concrete pavers.

Rain barrels – also called cisterns, collect rainwater to slow stormwater flows and for alternative uses.

Rain Garden – a landscaping feature (sometimes called a bioretention area) that includes vegetation and soils at lower elevation than surrounding lands to absorb stormwater runoff

Rainwater harvesting - the ancient practice of capturing rainwater from impervious surfaces and storing it for future use

Road Swale – shallow channels (sometimes called a stormwater drainage or vegetated swale) that contain vegetation and soils designed to trap particulate pollutants, promote filtration and reduce stormwater runoff.

Reclaimed water - treated effluent of a quality suitable for a specific reuse application

Stormwater Detention Ponds – man made or natural areas lowered in grade than surrounding lands to accommodate and retain higher than normal flows of rain water, slowing them down before they reach the storm water system

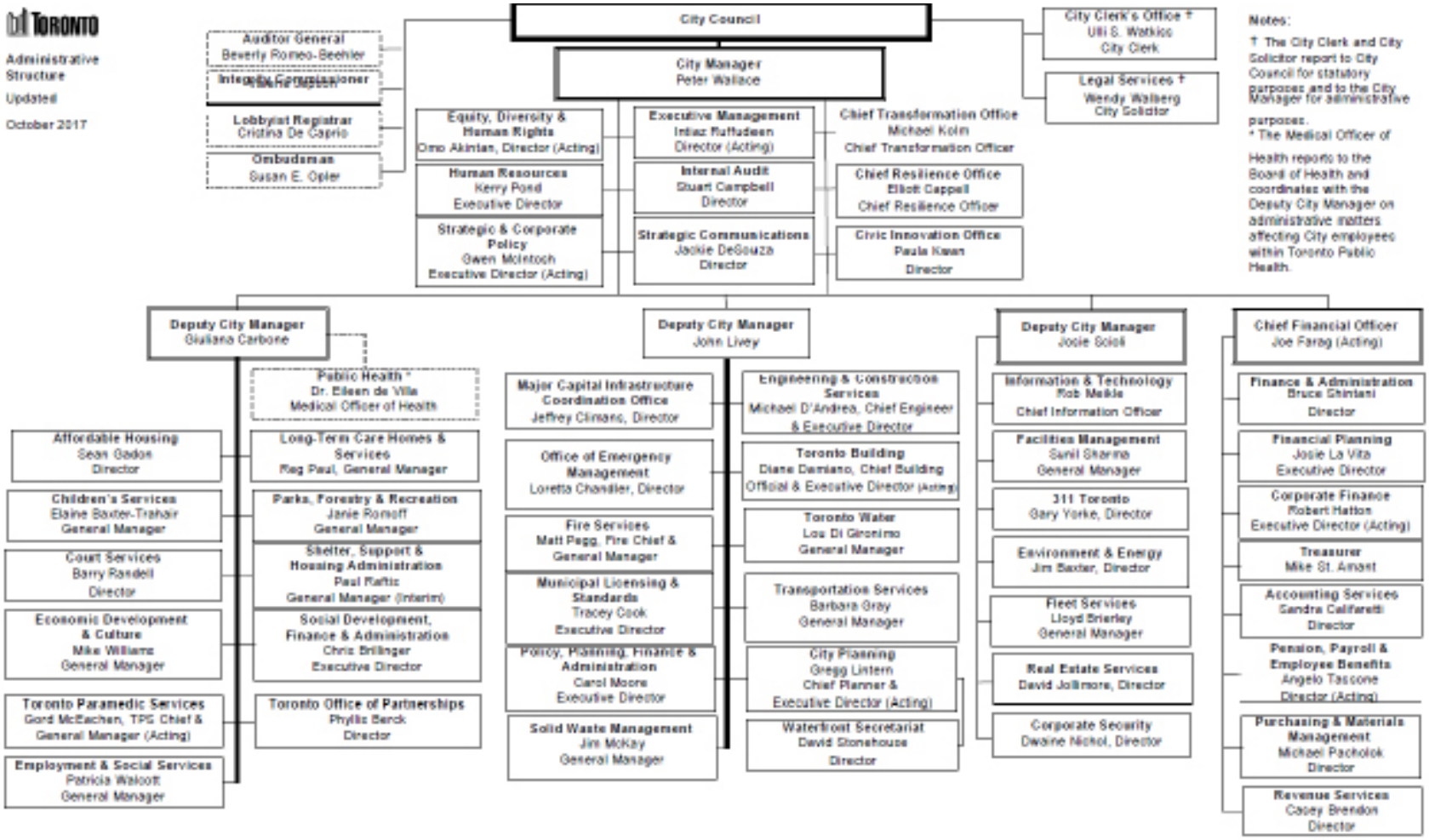
Stormwater filtration systems – systems that integrating grey and green through a natural series of filtration systems before water enters a treatment plant or receiving waters

Water Reuse/Grey Water – the use of treated wastewater for a range of other beneficial purposes; can be direct in which reclaimed water is transported to the points of reuse, or indirect reuse implies discharge of an effluent into receiving waters (surface or ground water)

Water recycling - typically refers to industrial systems, in which the effluent is recovered or treated and returned or recirculated back into the industrial process.

Glossary Sources: Exall et.al.2004; Ecojustice 2008; GCC 2017

Appendix II: City of Toronto Organization Chart 2017



Source, City of Toronto Organization Chart 2017.

https://www1.toronto.ca/divisions/pdf/org_chart.pdf