Green Infrastructure in Ottawa:
A State of the City Report

Presented by:

ECOLOGY OTTAWA ECOLOGIE OTTAWA

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Contents

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We would also like to thank our Advisory Committee for overseeing this work. The Advisory Committee was comprised of:

- Clara Blakelock, Green Communities Canada
- Adam Caldwell, sustainability consultant
- Stu Campana, EnviroCentre
- Larissa Holman, Ottawa Riverkeeper
- Paul Johanis, Greenspace Alliance of Canada's Capital
- Jesse Vermaire, Carleton University

While the representatives of the Advisory Committee played a key role in this report, the opinions expressed herein do not necessarily reflect those of the representatives or the partner organizations they represent.

2 Executive Summary

Green infrastructure – the use of natural and built systems to slow down, soak up and filter stormwater – is an exciting new area of focus for many cities around the world. Green infrastructure can be used to manage wet weather impacts in a way that enhances water quality and strengthens resilience to impacts from climate change. Ottawa has started experimenting with green infrastructure with a number of pilot programs, and has begun collecting data.

Ottawa has the opportunity to learn from other jurisdictions when considering next steps on green infrastructure. Various cities are experimenting with a range of innovative policies, from aggressive green roofs targets, to green streets policies, to urban tree canopy forest cover targets, to financing mechanisms designed to incentivize green infrastructure uptake.

The policy conversation takes place within the context of existing plans and local actors. While there is complex interplay between various jurisdictions and organizations, there is still clear room for the City of Ottawa to move forward on aggressively implementing green infrastructure at a city-wide scale. The report concludes with a list of recommendations for the city to develop green infrastructure policy and climate resilience. That list is presented below as well as at the end of this document.

3 Summary of Recommendations

What follows is a condensed list of the top five near-term actions the City of Ottawa can undertake to advance green infrastructure. A more comprehensive list of policy recommendations can be found in section 11 of this document.

1. Move beyond green infrastructure experimentation to widespread implementation, using targets and timelines to track robust implementation.
2. Develop a green roofs bylaw, following the example set by the City of Toronto.
3. Implement green streets at scale, using a "green standard" for street design and adequate funding for widespread implementation.
4. Develop and preserve Ottawa's urban forest using hard targets for reducing effective impervious areas and for enhancing urban forest canopy cover.
5. Implement low-impact development requirements for new developments and re-developments. As part of this, the City could use runoff volume control targets to manage at least the first 25 millimetres of water on site.
6. Promote on-site green infrastructure measures for homeowners through the use of a public engagement and awareness campaigns, like the one currently being piloted in the Pinecrest area.

4 Introduction

Green infrastructure[1] is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. Green infrastructure can be defined as the use of natural and built systems to slow down, soak up and filter stormwater. It can include living systems (e.g., trees, wetlands, green roofs, bioswales, rain gardens) as well as green technologies (e.g., porous pavements, rain barrels and cisterns). Whereas more traditional "grey infrastructure," such as piped drainage and water treatment systems, is designed to move urban stormwater away from the built environment, green infrastructure reduces and treats stormwater at source while delivering environmental, social, and economic benefits.

This paper will review how green infrastructure is being addressed by different Canadian jurisdictions impacting implementation in Ottawa. We will also review local case studies, best practices from other jurisdictions, and consider the local context of groups with experience, expertise or capacity in green infrastructure implementation. On the basis of this analysis, we will make recommendations for strengthening green infrastructure implementation in Ottawa.

This paper is designed as a tool for non-governmental organizations, community groups, policymakers and legislators to put Ottawa in a leadership position on green infrastructure.

5 What is Green Infrastructure?

Green infrastructure – the use of natural and built systems to slow down, soak up and filter stormwater – is a concept that has come out of relative obscurity in the past decade. It has been increasingly adopted worldwide as a means of working with natural systems to create a built environment that is resilient to the anticipated effects of a changing climate.

The types of infrastructure or features that are considered green infrastructure can vary widely, but a brief list of typical green infrastructure features could include:

- Urban forests and woodlots
- Bioswales, engineered wetlands and stormwater ponds
- Rain barrels
- Downspout extensions
- Green roofs and green walls
- Parks, gardens, turf, and landscaped areas
- Urban agriculture
- Meadows and agricultural lands
- Wetlands, ravines, waterways and riparian zones

[1] In many cases, "green infrastructure" is sometimes used interchangeably with "low-impact development," or "LID." For the purposes of this paper, we are retaining the common formal distinction between these two terms. Whereas "green infrastructure" encompasses a wide range of living and built systems, "low-impact development" is a subset of green infrastructure, and refers only to engineered systems.

FIGURE 1: EXAMPLE OF A ROADSIDE BIOSWALE

SOURCE: Flickr - Labelled for reuse. Author: University of Michigan School for Environment and Sustainability

If well-designed, green infrastructure can help build communities that are beautiful, inclusive, biodiverse and resilient. Because green infrastructure leverages, mimics, enhances and integrates natural features, in comparison to traditional infrastructure, it is fundamentally regenerative in nature. This feature stands in contrast to traditional infrastructure, which degrades in quality and condition over time.

6 Green Infrastructure – The Local Context

The application of green infrastructure is highly site-specific; solutions that may work in a warm or arid climate may not be as effective in Ottawa's colder and comparatively wet climate. Moreover, the local geography and geomorphology are important considerations in considering green infrastructure. The Ottawa Valley is dominated by the Ottawa River, and its tributaries give life and shape to the city. Much of Ottawa is dominated by water. City of Ottawa documentation describes the local geomorphology as follows:

FIGURE 2: PANORAMIC VIEW OF OTTAWA

SOURCE: G. Baranski (2009)

> *The City of Ottawa itself has four sub-watersheds with eleven minor watersheds... with an extensive network of rivers and streams… some 4,500 km of watercourses in total. These watercourses vary dramatically in size, drainage area and nature. Throughout most of the Ottawa valley, the recharge of aquifers is limited by an impervious aquitard (or confining layer) known as the Champlain Sea silt and clay layer. textbf{Natural Resources Canada has estimated that only 10% of precipitation that falls in the Ottawa area infiltrates into the ground, the rest being lost to evapotranspiration or runoff to rivers and lakes.*[2]

Collection systems conveying stormwater are classified as combined, partially separated, or fully separated, with the combined system in the core of the city, partially separated sewer systems generally found in older neighbourhoods located inside the Greenbelt. Fully separated sewers are common in most suburbs and have been a requirement for new development since 1961. Additionally, there are a total of 254 stormwater management facilities used to mitigate the impacts of increased imperviousness on receiving watercourses, including water quality treatment, flood control, runoff volume reduction and erosion control.[3]

6.1 Ottawa's Changing Climate

The growing climate crisis helps frame the importance and relevance of green infrastructure at this time. In Ottawa, climate change is making its impact felt through severe weather events. In spring 2017, Ottawa and Gatineau experienced a record flooding event that pointed to the importance of rapid action and the cost of a business-as-usual approach.

Green infrastructure is widely seen as a partial solution to one of the primary, near-term climate impacts in the Ottawa region: flooding. Climate change will bring additional water into the region, although at this time we lack sufficient data to know how much. We know that much of this additional water will come in the form of severe weather effects and more violent storms.

2 City of Ottawa (2011). Characterization of Ottawa's Watersheds: An Environmental Foundation Document with Supporting Information Base. Retrieved June 7, 2018 from: https://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/cap083402.pdf.

3 Ibid.

FIGURE 3: OTTAWA CENTRAL EXPERIMENTAL FARM

SOURCE: Wikimedia Commons – Author: cjuneau

In 2009, the Ontario Centre for Climate Impacts and Adaptation, a university-based resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation, held a workshop in Ottawa to explore the largest climate risks to the region. The final report indicated that the two largest risks to Ottawa were extreme heat and flooding that would "…test the capacity of the drainage system."[4] Other effects would include "…extreme heat (one-day event), extreme precipitation (one day event), wind, warmer winter temperatures, freezing rain (ice accumulation), climate variability, lightning and high humidity."[5] A 2017 report from the University of Waterloo-based Intact Centre on Climate Adaptation sounds a similar warning for Canada as a whole: "for seven out of eight years (2009-2016), extreme weather-related insurance payouts have exceeded $1 billion in Canada, which is atypical relative to pre-2009 insurance losses. The primary cause of claims during the seven-year period up to 2016 was flooding."[6]

Flowing from the City of Ottawa's Official Plan, a major municipal policy tool which guides the design of Ottawa over the coming decades, the 2014 Infrastructure Master Plan outlines the municipal government's near-term plans for infrastructure building and maintenance. This document provides a considerable background on weather trends, citing climate change as a "major influence on watersheds and

4 Ontario Centre for Climate Impacts and Adaptation Resources – OCCIAR (2009). Adapting to Climate Change in Ottawa. Retrieved July 3, 2017 from: http://www.climateontario.ca/doc/workshop/2009WorkshopReport/Ottawa%20Workshop%20Final%20Report.pdf.

5 Ibid.

6 Intact Centre on Climate Adaptation – University of Waterloo (2017). When the Big Storms Hit: The Role of Wetlands to Limit Urban and Rural Flood Damage. Retrieved May 2, 2018 from: https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2017/07/When-the-Big-Storms-Hit.pdf.

FIGURE 4: FLOODING ALONG THE OTTAWA RIVER

SOURCE: Site: Flickr - Author: Ross Dunn

their hydrology and on the demand for outdoor water use as well as the amount of water that enters the sewers."[7] The Infrastructure Master Plan indicates three specific trends:

1. Ottawa's average temperature is rising.
2. Precipitation in the form of rain and snow is increasing.
3. The frequency of major one-day rainfall events is increasing.

Figures 5 and 6 below show distinct trends of annual warming for Ottawa over 30 years. On average, temperatures have risen approximately +1.3°C and precipitation levels have increased overall - and especially in the warm months - over this period. Precipitation amounts have dropped precipitously in the winter.

Based on the 30-year climate trends, the Infrastructure Master Plan indicates that "trends could result in more frequent occurrence of snowmelt, combined with rainfall during the winter season" and a "distinct increasing trend than is evident in the total precipitation."[8] Moreover, the plan concludes that "Ot-

[7] City of Ottawa (2013). Infrastructure Master Plan. Retrieved January 16, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/infrastructure-master-plan.

[8] City of Ottawa (2013). Infrastructure Master Plan. Retrieved January 16, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/infrastructure-master-plan.

FIGURE 5: 30-YEAR AVERAGE TEMP °C - 100-YEAR PERIOD

SOURCE: Ottawa Infrastructure Master Plan Sec. 4.3

tawa area is experiencing more frequent multi-day precipitation events" with a "25% to 30% increase in the number of days with precipitation."[9]

Not only will Ottawa be wetter, but it will be hotter, more humid, and subject to more frequent weather events such as flooding, heat waves, and severe thunderstorms, ice storms and snowstorms. We can also expect a rise in disease vectors such as vermin, insects, and increased air pollution. Crop failures due to drought or flood will become increasingly common. This will put stress on all of Ottawa's systems, and bring considerable disruption to the community. Ottawa's Official Plan states the city must "prepare for the impacts of climate change [and] (adaptation) need[s] to be incorporated into all levels of City decision-making including the Official Plan and related Master Plans."[10]

6.2 Ottawa's Green Infrastructure Experimentation

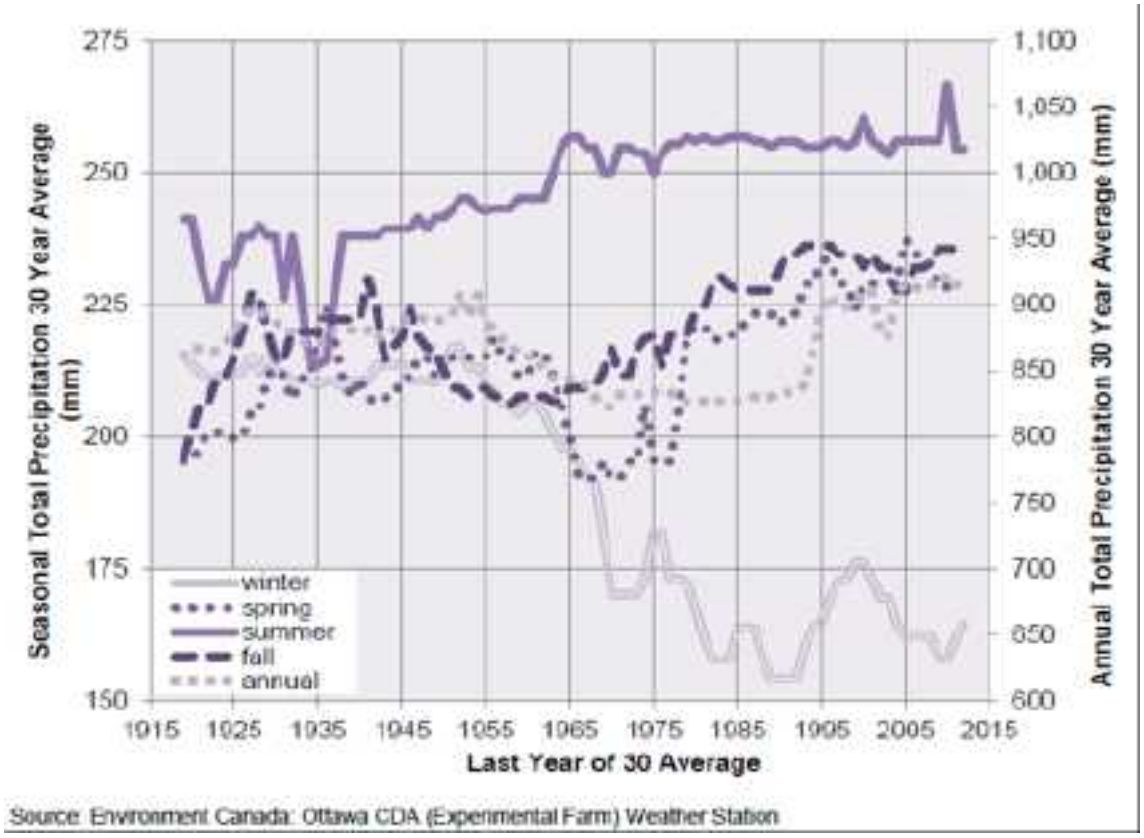
In June 2016, Ottawa City Council approved the Water Environment Strategy – a "long term strategy to protect and enhance the health of the watercourses that flow through Ottawa." [11] Growing out of the Ottawa River Action Plan (ORAP), a plan to protect the Ottawa River, the Water Environment Strategy

9 Ibid.

10 City of Ottawa (2013). Official Plan. Retrieved February 5, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/official-plan/volume-1-official-plan.

11 City of Ottawa (2016). Water Environment Strategy – Phase 2: Protecting the Health of Ottawa's Water Environment. Retrieved May 25, 2018 from: http://app05.ottawa.ca/sirepub_fr/cache/2/4va0ivl1xflq34xwbbaxyfa3/364298052520181250432 63.PDF.

FIGURE 6: 30-YEAR AVG. PRECIPITATION (MM) - 100-YEAR PERIOD



SOURCE: Ottawa Infrastructure Master Plan Sec. 4.3

marks an important shift in the City of Ottawa's response to the challenge of securing a healthy watershed. The strategy establishes 20-year goals and sets near-term (2016-2018) priorities, and addresses stormwater, wetland and groundwater issues that are not covered in ORAP.

One of the main benefits of the Water Environment Strategy cited by local experts is its contribution to coordinating the complex challenge of water management in Ottawa. This challenge is complex in part because it spans across multiple municipal departments and other stakeholders such as conservation authorities.[12]

Despite the Water Environment Strategy's explicit focus on challenges such as climate change and flooding, it lacks ambition on the subject of green infrastructure. While its 20-year objectives include "Expand the use of green infrastructure to manage stormwater" and "Explore and respond to the impacts of climate change on watercourses and watersheds,"[13] the strategy considers green infrastructure as experimental in nature. In other words, the City of Ottawa remains committed to piloting approaches rather than to implementing proven strategies at scale. This comes at a time when other cities are proceeding with more ambitious plans.

12 CBC Ottawa (2016). Ottawa's 20-year water plan to tackle 'complex problem.' Retrieved June 7, 2018 from: http://www.cbc.ca/news/canada/ottawa/ottawa-water-strategy-environment-committee-1.3581512.

13 City of Ottawa (2016). Report to Environment Committee 17 May 2016 and Agriculture and Rural Affairs Committee 3 June 2016 and Council, Submitted on May 10, 2016. Retrieved May 23, 2018 from: https://www.documentcloud.org/documents/2833681-Water-environment-strategy.html.

At the time of writing, the City of Ottawa's efforts on green infrastructure are concentrated on three experimental projects. These projects are summarized for context below.

6.2.1 Sunnyside Avenue Rain Gardens

At the time of writing, the City of Ottawa's most advanced (in terms of implementation) green infrastructure pilot is a rain garden project on Sunnyside Avenue in the central neighbourhood of Old Ottawa South. This pilot is the first of two bio-retention pilot projects designed to manage stormwater.

FIGURE 7: SUNNYSIDE AVENUE RAIN GARDENS – PROJECT STUDY AREA

SOURCE: City of Ottawa – Sunnyside Avenue Bioretention Retrofit Annual Monitoring Report.

Three rain gardens, also referred to by the City of Ottawa as Bioretention Facilities, were installed on Sunnyside Avenue at the intersections of Roslyn Avenue, Leonard Avenue and Grosvenor Avenue in 2014. The rain gardens are vegetated, shallow depressions underlain by an engineered soil mix designed to support plant and microbial growth and to achieve stormwater control objectives.[14] The vegetation, shown below, includes a diverse range of plant species.

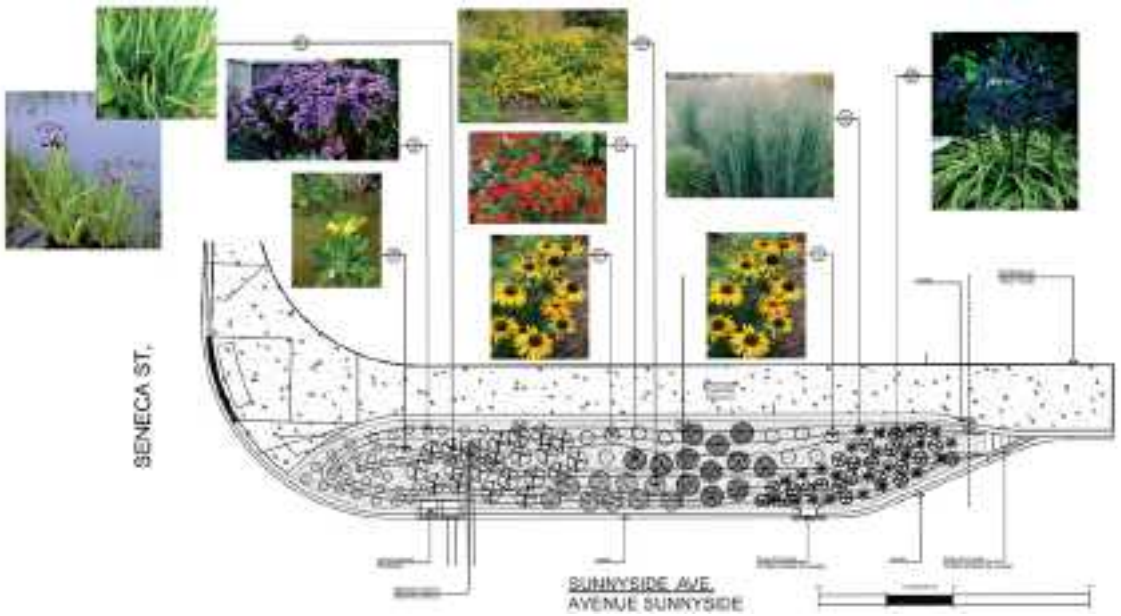
One notable element of the Sunnyside project design is its use of curb extensions or "bulb-outs." These are commonly used as traffic calming tools, allowing the rain gardens to serve a dual purpose. An image of the Sunnyside bulb-out design is below.

The rain gardens were incorporated into planned improvements stemming from a neighbourhood traffic management study, and were designed to add greenspace, enhance the streetscape and capture and treat stormwater runoff.[15]

[14] City of Ottawa (2017). Sunnyside Avenue Bioretention Retrofit Ottawa, ON Annual Monitoring Report 2017.

[15] City of Ottawa (2014). Open House: Sunnyside Avenue Traffic Calming "Green Street" Treatments. Retrieved May 25, 2018 from: https://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/sunnyside_oh2_en.pdf.

FIGURE 8: DETAIL OF SUNNYSIDE RAIN GARDEN SITE PLAN



SOURCE: City of Ottawa

FIGURE 9: SUNNYSIDE BULB-OUT DESIGN

SOURCE: City of Ottawa – Sunnyside Avenue Bioretention Retrofit Annual Monitoring Report.

At the time of writing, the City has assessed the first full year of maintenance and monitoring of the Sunnyside project. It reports that the project is largely succeeding. According to the project annual monitoring report: "Overall the rain gardens are functioning well, and in many instances exceeding design expectations for rainfall capture and infiltration rates."[16] Recommended improvements on the project focus mostly on minor monitoring and data collection issues.

The report touches on other key details from the Sunnyside project:

- Six visual inspections showed robust plant growth in the rain gardens.
- Few large maintenance issues were observed, with the most common task being hand weeding of the gardens.
- Stormwater runoff entering the Bioretention Facilities was captured and infiltrated rapidly.
- While there were data collection issues at one of the gardens, data from the other two indicated few stormwater overflow events.[17]

While initial signs are promising, the Sunnyside rain gardens project is still under analysis at the time of writing. The study period is slated to end later in 2018.[18]

6.2.2 Stewart Street Green Infrastructure Project

FIGURE 10: DETAIL OF STEWART STREET GREEN INFRASTRUCTURE PLAN

SOURCE: City of Ottawa

At the time of writing, the City of Ottawa has initiated work on Stewart Street for the purposes of an additional green infrastructure pilot project. As with Sunnyside, this is a bioretention pilot project. The City plans to integrate soil, plants and trees to manage runoff on Stewart Street between King Edward Avenue and Friel Street in Ottawa's Sandy Hill neighbourhood. This will be done by narrowing existing pavement and then extending curbs with green features.[19]

16 City of Ottawa (2017). Sunnyside Avenue Bioretention Retrofit Ottawa, ON Annual Monitoring Report 2017.

17 Ibid.

18 Old Ottawa South Community Association (2016). The Sunnyside Rain Gardens. Retrieved May 25, 2018 from: https://www.oldottawasouth.ca/green-dreamers/item/5678-the-sunnyside-rain-gardens.

19 City of Ottawa (2014). "Getting our Feet Wet" with Low Impact Development. Retrieved May 25, 2018 from: http://waterbucket.ca/rm/files/2014/12/Darlene-Conway_City-of-Ottawa_Getting-Our-Feet-Wet-with-LID_Oct-2014.pdf.

This project contains some elements of the bulb-out design that characterizes the Sunnyside project, but it is mostly focused on integrating green infrastructure elements to the sides of a street without substantial new additions.

FIGURE 11: – PHOTOS OF STEWART STREET BIORETENTION PILOT

SOURCE: Ecology Ottawa

As shown in Figure 11, the project integrates bioretention features on the north and south sides of Stewart Street. Compared with the Sunnyside project, the Stewart Street initiative is smaller in width but has been installed of the length of a road segment, rather than in three separate bioretention facilities.

The Stewart Street project has been constructed and is in the monitoring phase. No data was available for this report at the time of writing.

6.2.3 Former Canadian Forces Base Rockcliffe Low Impact Development Demonstration Project

Unlike the Sunnyside Avenue and Stewart Street projects, the Former Canadian Forces Base (CFB) Rockcliffe Low Impact Development Demonstration Project is an attempt to integrate green infrastructure solutions into a larger development. The CFB Rockcliffe redevelopment is taking place in Ottawa's east end. The City of Ottawa's stated goal with the Rockcliffe redevelopment is "to implement [low impact development] as part of development, monitor, gain experience, answer key questions and build capacity in a phased and controlled setting with a willing partner."[20]

As part of this project, the City of Ottawa has identified two main green infrastructure tools that it seeks to deploy: bioswales and permeable pavement parking lay-bys. As indicated in Figure 12, bioswales (identified as "swales" and "vegetated swales" in the legend) line several streets and occupy other areas in the southwest corner of the development area. The bioswales will perform bioretention functions while the permeable pavement additions will provide water quality enhancements, run-off detention and infiltration benefits.[21]

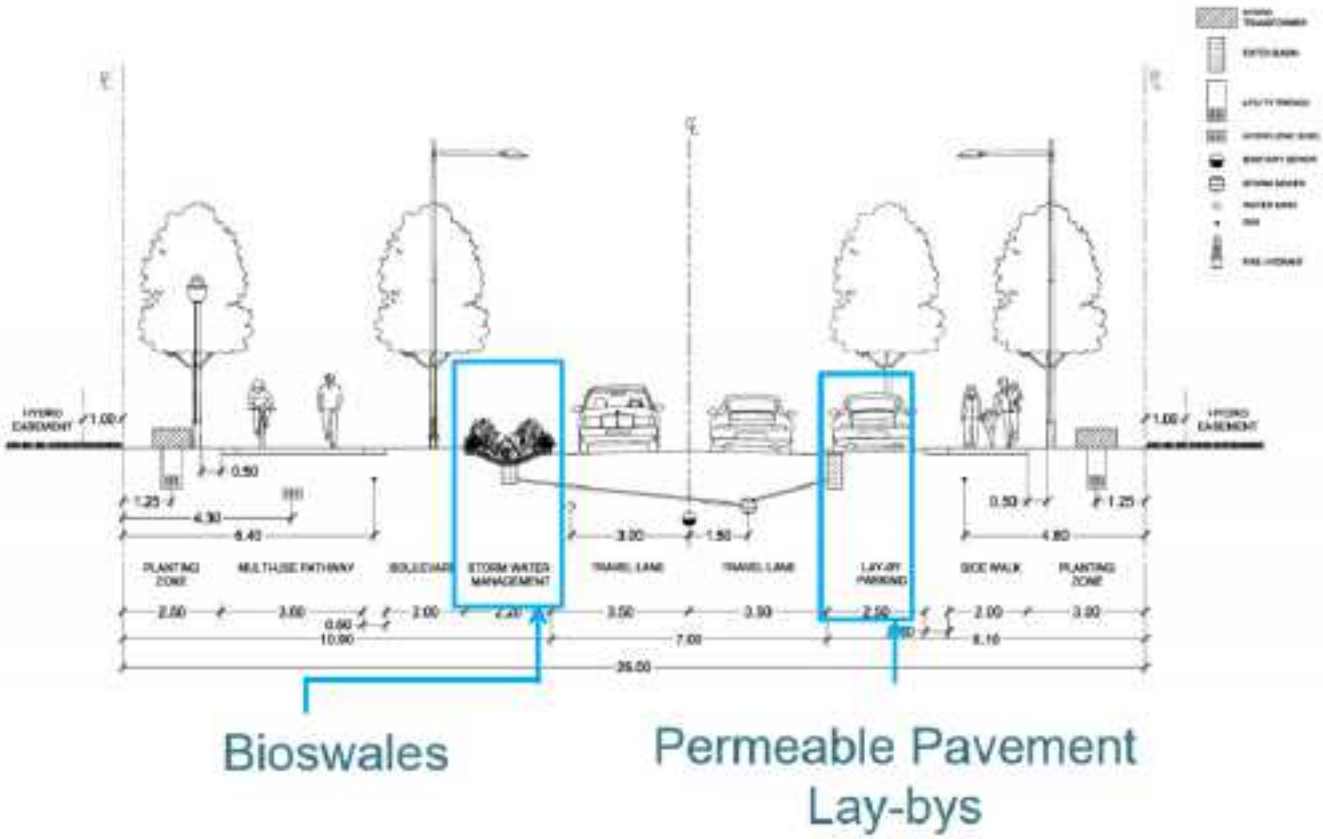
[20] Canada Lands Company (2015). Former CFB Rockcliffe Redevelopment: Stormwater Management Existing Conditions LID Pilot Project Scoping – Final Report. Retrieved June 7, 2018 from: http://ottwatch.ca/meetings/file/309602.

[21] City of Ottawa (2014). "Getting our Feet Wet" with Low Impact Development. Retrieved May 25, 2018 from:

FIGURE 12: CFB ROCKCLIFFE REDEVELOPMENT OVERVIEW.

SOURCE: Canada Lands Company

FIGURE 13: DETAIL OF CANADIAN FORCES BASE ROCKCLIFFE LOW IMPACT DEVELOPMENT DEMONSTRATION PROJECT.



SOURCE: City of Ottawa

http://waterbucket.ca/rm/files/2014/12/Darlene-Conway_City-of-Ottawa_Getting-Our-Feet-Wet-with-LID_Oct-2014.pdf.

Other project elements include front yard "soakaways" and soil amendments. Soakaways are holes filled with rubble and coarse stone to allow surface water to percolate back to the earth near to where it falls. The soakaways are being incorporated into housing developments in the Phase 1 area. Soil amendments include the addition topsoil over turf and landscaped areas.

The CFB redevelopment project will be rolled out in several phases, with the main green infrastructure piloting elements to be initiated as part of Phase 1 (with servicing in 2015-2016).

As with the Stewart Street project, monitoring is underway and no detailed information was available for this report at the time of writing.

6.2.4 Other Initiatives

Ecology Ottawa interviewed City of Ottawa staff regarding additional areas of progress in green infrastructure. Beyond the three pilots outlined above, the City is proceeding with an additional street pilot on Hemmingwood Way in the city's west end (Centrepointe).

In addition to pilots, the City has been working on a screening tool in order allow staff to more efficiently assess areas in which the addition of green infrastructure improvements would be efficient and effective. The screening tool takes account of factors such as soil condition, water levels, and demands on the urban landscape (e.g., for roads, sidewalks, etc.). The widespread use of such a tool could help the City conduct assessments more rapidly than in the past and better prioritize the use of limited green infrastructure funds to achieve optimal results and mitigate risks such as reduced water quality and erosion.

Finally, the City of Ottawa has conducted a public education and outreach initiative in neighbourhoods near Pinecrest Creek and Westboro Beach. The outreach involves information sessions, workshops on rainwater harvesting and infiltration landscaping, installation of interpretive signs along waterways, and rainscaping demonstration projects. The work is being implemented with the support of Green Communities Canada and EnviroCentre.

7 Best Practices from other Cities

As indicated above, Ottawa remains at a preliminary phase in learning from and implementing green infrastructure. Other cities have moved well beyond the experimentation phase. Below are several examples of leading green infrastructure policies from other cities.

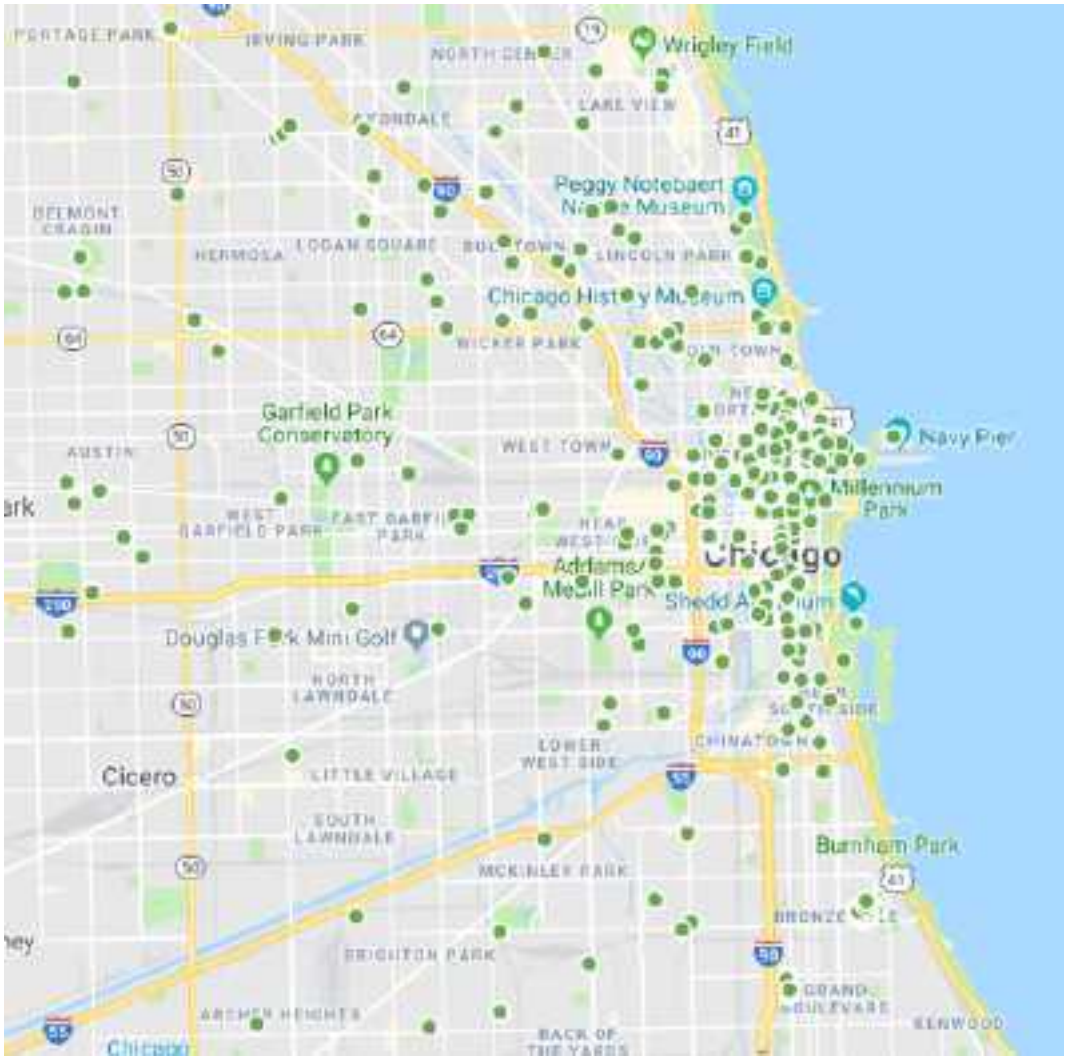
7.1 Mandated Construction of Green Roofs – Chicago, IL and Toronto, ON

The City of Chicago's climate action plan mandates construction of 500 new green roofs each year starting in 2008, with 6,000 green roofs expected by 2020. This ambitious green infrastructure plan puts Chicago in a leading position on implementation. In Chicago's case, this plan is designed to help address the urban heat island effect, which is a major problem for the city, especially as climate change worsens

over the coming years.[22]

This program involves more than a mandate. The City of Chicago has rolled out a grant program to support green roof adoption, where $5,000 grants are issued to promising projects.[23] Chicago has also committed to leading by example early on. In April 2000, the City of Chicago began construction of a 38,800 square foot green roof on top of Chicago City Hall. The project encompasses an entire city block at a total cost of $2.5 million.[24] The city hall green roof is being supplemented with dozens of other green roofs on public buildings. Yet while public property is an area of focus, the city's green roof initiative also extends to the business and residential sectors.[25]

FIGURE 14: DETAIL OF CITY OF CHICAGO GREEN ROOFS MAP



SOURCE: City of Chicago

22 World Wildlife Fund (2012). Chicago green roofs. Retrieved May 25, 2018 from: http://wwf.panda.org/?204400/Chicago-green-roofs.

23 Inhabitant (2006) Chicago Green Roof Program. Retrieved June 7, 2018 from: https://inhabitat.com/chicago-green-roof-program/.

24 Greenroofs.com (2018). Chicago City Hall. Retrieved June 7, 2018 from: http://www.greenroofs.com/projects/pview.php?id=21.

25 City of Chicago (2008). Chicago Climate Action Plan: Our City Our Future. Retrieved June 7, 2018 from: http://www.chicagoclimateaction.org/filebin/pdf/finalreport/CCAPREPORTFINALv2.pdf.

As part of its efforts in green infrastructure implementation and climate adaptation, Chicago has mapped urban heat islands with infra-red cameras. Chicago has also complimented its green roof initiative with a dataset and publicly accessible map that provides the location, satellite images and square footage of the city's green roofs.[26]

In January 2010, Toronto became the first city in North America to require the installation of green roofs on new commercial, institutional, multifamily residential and new industrial developments. This was conducted through the use of a bylaw that stipulates standards for when green roofs are required, and for how they should be built. This bylaw mandates that 60 percent of available space on roofs of large buildings must be vegetated.[27]

By 2017, Toronto's green roofs policy had resulted in more than 113,000 square meters of new green space on developments across the city. The beneficial spinoffs of this initiative included over 125 full-time jobs (related to building and maintaining the roofs), reductions of over 400,000 cubic feet of stormwater per year, and annual energy savings of over 1.5 million kWh for building owners.[28]

Figure 15 below shows potential changes that would follow from application of Toronto's green roofs requirements over the course of 10 years.

While Ottawa is home to several green roofs, the city currently lacks a green roofs policy – no green roofs are mandated by urban by-laws. Chicago and Toronto demonstrate the capacity of cities to set aggressive targets for green roofs, and to maintain a focus on adding green roofs to new and existing builds. While there are important differences between Ottawa's and Toronto's bylaw powers under provincial legislation, and while these differences have an impact on each city's capacity to enact bylaws of this sort, municipal leadership in this area is needed if Ottawa wants to begin the conversation of gaining greater municipal powers.

[26] City of Chicago (2018). Chicago green roofs. Retrieved May 25, 2018 from: https://www.cityofchicago.org/city/en/depts/dcd/supp_info/chicago_green_roofs.html.

[27] CityLab (2018). What cities can learn from Toronto's green roof policy. Retrieved July 4, 2018 from: https://www.citylab.com/design/2012/04/what-cities-can-learn-torontos-green-roof-policy/1846/.

[28] Ibid.

FIGURE 15: TRIPTYCH IMAGE OF ANTICIPATED GREEN ROOF DEVELOPMENT IN TORONTO OVER A DECADE WITH NEW POLICY.

SOURCE: CityLab

7.2 Green Streets – Philadelphia, PA

The City of Philadelphia has developed a Green Streets program and design manual to systematically incorporate green infrastructure elements into street refurbishments and rebuilds. The manual provides design standards and guidelines for developing green streets in a way that optimally manages stormwater runoff.[29]

This approach is part of an ambitious land-water-infrastructure program designed to take place over 25 years (starting in 2011) at a cost of over $2 billion USD.[30] According to the City of Philadelphia's Green City, Clean Waters plan, "Streets and sidewalks are by far the largest single category of public impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer service area. … A green street acts as a natural stormwater management system, capturing rain or melting snow (runoff), allowing it to soak into soil, filtering it and at the same time, reducing the amount of stormwater that would otherwise make its way into Philadelphia's combined sewer pipes."[31]

The City of Philadelphia's green streets tools include:

- Street trees
- Specific attention to the "pit" in which street trees are planted
- Sidewalk trenches and planters
- Sidewalk bump-outs and bulb-outs (sidewalk extensions)
- Porous pavements[32]

As part of the green streets initiative, the City of Philadelphia has been explicit in its goal of aligning green infrastructure planning with other city programs, utilities and jurisdictions (e.g., the Pennsylvania Department of Transportation). Part of the rationale for this effort is leveraging opportunities by combining work at key moments. According to the City of Philadelphia: "When both utility and road work can be done on each street at the same time, it lessens the project costs and the inconvenience to residents."[33] The City also notes, "Interagency collaboration is key to the successful implementation of green infrastructure citywide."[34] This effort allows for the City to be proactive in its effort to green streets, and to take advantage of opportunities such as routine infrastructure replacement, installation of cable, phone or gas lines, and routine repaving.

This approach has translated into delivering green infrastructure benefits at scale in Philadelphia. As of 2018, there were over 200 green street projects constructed or in design in the city.[35]

29 City of Philadelphia (2014). Green Streets Design Manual. Retrieved May 25, 2018 from: http://www.phillywatersheds.org/what_were_doing/gsdm.

30 City of Philadelphia (2011). Amended – Green City, Clean Waters. Retrieved May 25, 2018 from: http://www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf.

31 Ibid.

32 Ibid.

33 Ibid.

34 City of Philadelphia (2018). Philadelphia Water Department: Green Streets Program. Retrieved June 8, 2018 from: http://www.phillywatersheds.org/what_were_doing/green_infrastructure/programs/green_streets.

35 Ibid.

From a policy perspective, the program is interesting as it puts forward a "green standard" for all streets within Philadelphia.[36] Looking at the Ottawa policy context, the City of Ottawa has taken recent action to restructure its approach to street design. Now, as part of all street builds and refurbishments, the City of Ottawa employs a "complete streets" approach, which examines how the City can adjust the street to make it more accessible to all ages, users and abilities, as opposed to car drivers. The City of Ottawa could use the Philadelphia as a model to aggressively implement green streets at scale. Borrowing from Philadelphia's example, Ottawa could initiate a well-funded and long-term program that enforces a minimum standard and is paired with tools to facilitate rapid and adequate implementation.

FIGURE 16: VIEW OF A GREEN STREET DESIGN ELEMENT (STORMWATER PLANTER).

SOURCE: City of Philadelphia

Ottawa could also benefit from employing a proactive inter-agency and inter-departmental approach to green infrastructure. As noted by the City of Ottawa, the green infrastructure file is particularly complex and involves various city departments. The City's screening tool is an early attempt to manage this complexity, and is a step in the right direction. The next challenge is being systematic about identifying opportunities stemming from other departmental and jurisdictional initiatives. This would add additional layers of complexity but also provide numerous opportunities for action.

While Toronto has not demonstrated a green streets initiative that matches Philadelphia's in scope, it demonstrates the potential for policy learnings for Ottawa, as a nearby city operating within a similar legal context. Toronto has developed green streets technical guidelines and is currently working on an

[36] C40 Cities (2013). Case study: Green streets and alleys. Retrieved May 25, 2018 from: https://www.c40.org/case_studies/green-streets-and-alleys.

implementation strategy. The guidelines provide an overview of sustainable stormwater planning and practices, help inform the selection of appropriate green infrastructure options and seek to ensure that green street designs are attractive, functional and appropriate to their urban context. Adopting similar guidelines in Ottawa could help integrate green infrastructure into future street developments.

7.3 Developing the Urban Forest with Hard Targets, with Special Consideration of Underserved Areas – Portland, OR

While it risks going slightly beyond this paper's focus on green infrastructure as natural and built systems designed to manage water, Portland's approach to the urban forest is worth noting for three reasons: first, trees are part of green infrastructure, and so urban forestry work contributes to water management in various ways (and Portland is using trees to reduce impervious areas in this example); second, Portland's use of ambitious policy on the urban forest management file shows how hard targets can drive policy success; third, Portland's consideration of underserved areas points to the important co-benefits of well-planned green infrastructure initiatives, as well as to broader equity considerations when it comes to climate adaptation.

As part of its 2015 climate action plan, the City of Portland has embarked on a project to prioritize urban forest development with the use of hard targets.[37] To this end, Portland's climate plan sets out the objective of reducing effective impervious areas by a specified amount (600 acres) as well as enhancing urban forest canopy cover to 25% for each residential neighbourhood and 15% for central, commercial and industrial areas by 2050. This will result in an urban forest canopy that covers at least 33% of the city.[38] As part of its efforts to expand the urban forest and reduce impervious areas, the City of Portland is conducting depaving efforts and building green roofs. The City of Portland's hard targets are related to its overall greenhouse gas emissions mitigation and adaptation plan, which breaks down specific emission reduction goals by category (e.g., buildings and energy, urban form and transportation, etc.).

Portland's plan also incorporates equity considerations. Tree programs are mandated to "[f]ocus on low-canopy neighborhoods and neighborhoods with populations at higher risk of adverse outcomes and urban heat island effects."[39] The incorporation of equity concerns into the city's urban forest plan stems from an understanding of the disproportionate impacts of climate change. As the City of Portland notes:

Low-income populations and communities of color are more likely to live in areas with less greenspace and to be more vulnerable to heat-related and respiratory illnesses. Low-income populations and communities of color are more likely to be impacted by extreme weather events that occur as a result of climate change. This is due to reduced access to key information and available programs and services as a result of language, cultural, or geographic barriers. For example, community members may be unaware of the existence of resources such

37 U.S. Green Building Council (2017). Green infrastructure: Best practices for cities. Retrieved May 25, 2018 from: https://www.usgbc.org/articles/green-infrastructure-best-practices-cities.

38 City of Portland (2015). Climate Action Plan: Local Strategies for Address Climate Change. Retrieved May 25, 2018 from: https://www.portlandoregon.gov/bps/article/531984.

39 Ibid.

as cooling centers that may be open during heatwaves due to materials not being translated or available in areas that they traditionally access community information. Service boundaries and language restrictions can provide additional barriers in accessing programs and services.[40]

As part of its tree canopy expansion effort, the City of Portland rolled out a grant program to help low-income homeowners with removal and replacement of dead or dangerous trees in low-canopy neighbourhoods, partnered with schools on planting efforts, and provided training and support to enhance community ownership and protection of trees.[41] As of 2017, the City of Portland reported that it was on track at this early stage in its canopy expansion efforts, with specific canopy-related goals attached to a 2020 target date for completion.

The City of Ottawa is moving into a position where it will have the data it needs to implement a policy similar to Portland's. As part of its new Urban Forest Management Plan, the City of Ottawa will be using air surveys to map Ottawa's tree canopy, which will enable it to understand overall forest cover levels. The City of Ottawa can use this data as a baseline and then set appropriate canopy cover targets, with special consideration of underserved areas as in the Portland model. As part of the process of collecting and using data, information on soil volume is also critical, as adequate soil volume for trees is very important for their health and function as stormwater infrastructure. The next challenge in Ottawa's case is ascribing hard targets to canopy enhancement, and following through on a planning, engagement and funding strategy in order to attain those targets.

7.4 Innovative Green Infrastructure Financing – Washington, DC

The District of Columbia (DC) has created strong fiscal incentives for the development of green infrastructure through the use of its Stormwater Retention Credit Trading System. Under this system, established as part of a set of stormwater management regulations that took effect in early 2014, individuals can generate and sell Stormwater Retention Credits (SRCs) to earn revenue for projects by installing green infrastructure or removing impervious surfaces. The SRCs can then be sold to properties that have regulatory requirements for managing stormwater.[42] Under this scheme, large development sites can comply with half of their obligation to reduce stormwater runoff by buying SRCs from voluntary green infrastructure projects.

Two years after the rollout of the SRC system, DC announced a related Purchase Agreement Program that provided the additional option of selling DRCs to the DC Department of Energy Environment. This program effectively created a price floor in the SRC market, thereby providing certainty regarding return on investment.[43]

[40] City of Ottawa (2011). Characterization of Ottawa's Watersheds: An Environmental Foundation Document with Supporting Information Base. Retrieved June 7, 2018 from: https://documents.ottawa.ca/sites/documents.ottawa.ca/files/documents/cap083402.pdf.

[41] City of Portland (2017). City of Portland Oregon and Multnomah County Climate Action Plan Progress Report. Retrieved June 8, 2018 from: https://www.portlandoregon.gov/bps/article/636700.

[42] DC Department of Energy Environment (2018). Stormwater Retention Credit Trading Program. Retrieved July 9, 2018 from: https://doee.dc.gov/src.

[43] DC Department of Energy Environment (2018). DOEE announces $12,750,000 for innovative program to incen-

DC's program amounts to a substantial investment in local green infrastructure, and sets up a policy environment designed to enhance the uptake of green infrastructure projects while incentivizing private investment in projects.

8 The Policy Context

Many jurisdictions internationally have stand-alone policies that specifically address green infrastructure. Federally, Canada has no such policy, nor does Ontario or the City of Ottawa. However, there are several policies that directly affect infrastructure, land use, natural areas, biodiversity, climate change, the built environment and civic well-being. Some of these policies address these topics directly, while others address issues that are pertinent to these areas.

Figure 17 lists varying policies affecting green infrastructure in Ottawa across all three Canadian jurisdictions, in addition to the National Capital Commission (NCC). Here, federal and NCC policy impact

FIGURE 17: POLICIES GUIDING GREEN INFRASTRUCTURE IN OTTAWA – MULTIPLE JURISDICTIONS

	Federal	National Capital Commission	Provincial	Municipal
Legislation			• *Planning Act* (Provincial Policy Statement • *Conservation Authorities Act*	
Legally-binding planning document				• Official Plan • Infrastructure Master Plan • Greenspace Master Plan
Other plans and policies	The Pan-Canadian Framework on Clean Growth and Climate Change	• *The Plan for Canada's Capital 2017-2067* • *Framing our Future: A plan for Sustainability and Resiliency in Canada's Capital Region* (partnership between NCC, City of Ottawa, City of Gatineau)	Low-Impact Development (LID) Stormwater Management Guidance Manual	• Ottawa River Action Plan • *Putting Down Roots for the Future: City of Ottawa Urban Forest Management Plan 2018-2037* • Air Quality and Climate Change Management Plan

tivize cost-effective green infrastructure. Retrieved July 9, 2018 from: https://doee.dc.gov/release/doee-announces-12750000-innovative-program-incentivize-cost-effective-green-infrastructure.

policy at the provincial and municipal levels through multilateral consultation, strategic planning and development of funding opportunities. The province exerts direct regulatory control over the City of Ottawa, which in turn must follow the regulatory framework in decision-making.

While green infrastructure in Ottawa can be impacted through multiple jurisdictions, laws, master plans and other plans and policies at the provincial and municipal levels have the most direct impact. These will be covered in detail below.

8.1 Provincial Policies and Plans

8.1.1 Low Impact Development (LID) Stormwater Management Guidance Manual (Draft)

One key document affecting green infrastructure across Ontario is still in draft form. The Province of Ontario's Low Impact Development Stormwater Management Guidance Manual reflects an evolution in stormwater management in the province. According to a draft version of the document dated April 2017:

"[I]t is no longer enough to simply apply [low impact development] and [green infrastructure stormwater management] approaches as part of land planning to simply mitigate impacts. To truly protect Ontario's water resources, the natural and human environments and preserve the ecological services already provided by our existing natural systems, these practices must be integrated into everyday urban forms, into the very fabric of the community. In this way, a complete and healthy community is formed whereby the very features which support the human inhabitants (roads, parks, grassed areas, sidewalks) become the very elements that protect the existing hydrologic features and function, create habitat, and make a community more livable."[44]

The Low Impact Development guidelines are anticipated to mark a substantial change in how green infrastructure is managed in municipalities across Ontario, as it will set requirements for controlling runoff volumes and outline how new developments, redevelopments and road projects will need to maintain pre-development hydrology. Essentially, this document will elevate consideration of source controls for water runoff above the current level – something that is encouraged – towards being a key part of municipal stormwater systems.[45] At the time of writing, the document remains in draft form and its future is uncertain given the recent change in provincial government.

8.1.2 Provincial Policy Statement under the Planning Act (2014)

The Provincial Policy Statement (PPS) is Ontario's premier land use policy document. Central to its mandate is advocacy for "strong, sustainable and resilient communities" and a "clean and healthy environment."[46] The Policy Statement prioritizes managing development and population growth while

[44] Province of Ontario (2017). Low Impact Development (LID) Stormwater Management Guidance Manual (Draft). Retrieved June 8, 2018 from: http://www.municipalclassea.ca/files/7_DRAFT_MOECC_LID%20SWM%20Manual.pdf.

[45] RAIN Community Solutions (2018). Runoff volume control is coming to Ontario! Retrieved July 6, 2018 from: http://www.raincommunitysolutions.ca/en/runoff-volume-control-is-coming-to-ontario/.

[46] Provincial Policy Statement Under the Planning Act (2014). Retrieved July 6, 2018 from: http://www.mah.gov.on.ca/AssetFactory.aspx?did=10463.

protecting Ontario's natural resources and the natural environment. The Policy Statement recognizes that "natural and cultural heritage and archaeological resources provide important environmental, economic and social benefits," and must be managed sustainably to "conserve biodiversity, protect essential ecological processes and public health and safety, provide for the production of food and fibre, minimize environmental and social impacts, and meet its long-term needs."[47]

The Provincial Policy Statement is important for laying out minimum planning standards that are adhered to be other aspects of provincial and municipal policy. Areas of focus include stormwater management best practices (including low impact development), climate change adaptation through land use and development patterns, and the restoration and enhancement of diversity and connectivity of natural features.

8.1.3 Conservation Authorities Act (1990)

This Act was originally created in 1946 to authorize the formation of conservation authorities, with the aim of ensuring the conservation, restoration and management of Ontario's natural resources. Under the current Act there is no specific mention of green infrastructure policy. However, this legislation is important for some of the more technical aspects upon which relevant municipal policy is based. Conservation authorities play an important role in mapping floodplains, updating anticipated rainfall amounts and ascertaining 100-year flood standards based on climate "normals." Broadly speaking, conservation authorities play a critical role in land management and protecting biodiversity.

The Conservation Authorities Act is undergoing a very significant review process, which will include multiple opportunities for stakeholder engagement. It is expected that green infrastructure principles will be significantly incorporated into the review.

8.2 Municipal Policies and Plans

8.2.1 Official Plan (2003)

The City of Ottawa Official Plan drives all policy for the city, and there is ample support for green infrastructure principles within the plan. In its key Strategic Directions under "Maintaining Environmental Integrity," the Official Plan states that "[t]he City will preserve natural features and the integrity of natural systems by directing land use and development in a way and to locations that maintain ecosystem functions over time," and that "[g]reenspaces will be valued and protected for their environmental, cultural heritage, recreational, educational and aesthetic qualities."[48]

The City notes that policies governing the extension and upgrade of infrastructure can provide key levers for managing urban growth."[49] It would be consistent with overarching city policies that green infrastructure principles be used as a means of managing growth in a sustainable way – in other words,

47 Ibid.

48 City of Ottawa (2003). Official Plan. Retrieved July 6, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/official-plan/volume-1-of

49 Ibid.

integration of green infrastructure elements into urban design patterns is seen as a means of advancing local-level sustainable development.

8.2.2 Infrastructure Master Plan (2013)

The Infrastructure Master Plan (2013) is another key municipal policy document. Through its focus on "ensuring the long-term sustainability of the City's water, wastewater and stormwater infrastructure," the document touches on various issues relevant to green infrastructure.[50] Specifically, the Infrastructure Master Plan engages in important discussions on development charges, age and viability of infrastructure, and lifecycle assessments and lifetime servicing costs, all issues which are germane to the adoption of a green infrastructure strategy. The Infrastructure Master Plan also supports the Ottawa River Action Plan in strategically managing discharge into the Ottawa River. It is notable that the document features significant discussion on changing climate trends, and the limitations of current 100-year models and the systems that were designed using them.

8.2.3 Greenspace Master Plan (2006)

The Greenspace Master Plan is tasked with characterizing and quantifying greenspace within the capital, establishing targets for acquisition, protection and enhancement of greenspace, and developing eco-connectivity. The plan mandates the enhancement of greenspace quality and "encourage[s] public and private owners of natural lands to retain the land's natural features and functions through stewardship and design with nature principles."[51]

While the Greenspace Master Plan does not include content on green infrastructure as a conceptual tool, it touches on some elements of green infrastructure, including the use of greenery on pedestrian and cycling corridors to cleanse runoff, increase water filtration, reduce urban heat island effect and improve air quality.

8.2.4 The Ottawa River Action Plan

The Ottawa River Action Plan (ORAP) is a critical component of Ottawa's wet weather strategy, and strategies to develop and strengthen aquatic and riparian biodiversity. The plan is comprised of 17 individual projects designed to enhance the health of the Ottawa River and to protect Ottawa's overall water environment.

ORAP includes a number of projects that touch on green infrastructure. Most important among these is the Water Environment Strategy (2016), which is outlined in detail in the section "Ottawa's Green Infrastructure Experimentation" above.

[50] City of Ottawa (2013). Infrastructure Master Plan. Retrieved July 6, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/infrastructure-master-plan.

[51] City of Ottawa (2006). Greenspace Master Plan. Retrieved July 6, 2018 from: https://ottawa.ca/en/city-hall/planning-and-development/official-plan-and-master-plans/greenspace-master-plan.

ORAP also includes a Wet Weather Infrastructure Management Plan that identifies green infrastructure as a support program that enables the success of the City's plans to manage wet weather, as well as two stormwater management retrofit plans that advise the use of green infrastructure tools (e.g., rain barrels, rain gardens, stormwater management ponds, "green" streets, etc.) as long-term solutions to challenges in water quality. Notably, a 50-year time frame is suggested for implementation of the Pinecrest Creek / Westboro Stormwater Management Retrofit Study.[52]

8.2.5 *Putting Down Roots for the Future: City of Ottawa Urban Forest Management Plan 2018-2037 (2017)*

The City of Ottawa's Urban Forest Management Plan is mandated to integrate green spaces dominated by urban forest into Ottawa's Asset Management Plan. The significance of this is that the plan undertakes a broad and detailed discussion of the monetized value of ecology and the various services it provides. Indeed, a key guiding principle of the plan is that "[t]he urban forest must be recognized and managed as a valuable infrastructure asset and a positive investment."[53]

The Urban Forest Management Plan is one of the only City of Ottawa documents to specifically mention green infrastructure, and enters into a specific discussion of use of urban forests as an alternative to traditional "grey" infrastructure. Moreover, it discusses and itemizes the various services ecology provides, and their relative value. Following the discussion above touching on the unique regenerative nature of green infrastructure, the document states that "the urban forest is different from investment in grey infrastructure, which depreciates over time. As trees grow in size and their canopy and leaf area increases, the amount and value of the benefits and services they provide increases exponentially."[54]

8.2.6 Air Quality and Climate Change Management Plan (2014)

The City's Air Quality and Climate Change Management Plan indirectly promotes green infrastructure principles and discusses the value of natural system services in providing resilience against a changing climate: "Forests and wetlands provide major benefits to the community, including reduced hard infrastructure costs for water filtration and storage, additional cooling, and community livability benefits."[55]

The document argues that "adding climate change mitigation and adaptation values enriches the business case for land stewardship and securement, for the purposes of flood protection and cooling sinks, among others."[56]

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52 City of Ottawa (2018). Ottawa River Action Plan. Retrieved July 6, 2018 from: https://ottawa.ca/en/residents/water-and-environment/air-land-and-water/beaches-rivers-and-streams/ottawa-river-action-plan.

53 City of Ottawa (2017). Putting Down Roots for the Future: City of Ottawa Urban Forest Management Plan 2018-2037. Retrieved July 6, 2018 from: https://documents.ottawa.ca/sites/documents.ottawa.ca/files/final_ufmp$_en.pdf$.

54 Ibid.

55 City of Ottawa (2014). Air Quality and Climate Change Master Plan. Retrieved July 6, 2018 from: http://app05.ottawa.ca/sirepub/cache/2/oii4vxp2kr3vapmel2l353m2/19338207062018023654898.PDF.

56 Ibid.

9 Local Level Actors

Ultimately, the success of moving forward with green infrastructure in Ottawa depends on more than the municipal government alone. Developers and private sector actors, for example, play a critical role in integrating green infrastructure into their designs and benefiting from spinoff effects such as better water control and aesthetic improvements.

9.1 Conservation Authorities

Conservation authorities play an important role in managing watersheds, and are mandated to ensure the conservation, restoration and responsible management of local water, land and natural habitats through a variety of programs.[57]

Three conservation authorities have jurisdictions that overlap with the boundaries of the City of Ottawa: the Mississippi Valley Conservation Authority, the Rideau Valley Conservation Authority and the South Nation Conservation Authority. The jurisdictional ranges covered by these conservation authorities, which are designed around watersheds, are shown in Figure 18 below.

Each of the three area conservation authorities takes an active role in a variety of activities connected to furthering the "conservation, restoration, development and management of natural resources" in their respective watersheds, under authority from the Conservation Authorities Act.[58] Activities include issuing waterfront development permits, public education, monitoring and forecasting water levels and protecting drinking water.

Ottawa is also home to a variety of local, provincial, regional and national non-profit organizations that have demonstrated experience, expertise and capacity in the implementation of green infrastructure projects. These groups, along with a short description of their green infrastructure work, are listed below.

[57] Conservation Ontario (2018). Natural champions making a difference. Retrieved July 6, 2018 from: http://conservationontario.ca/about-us/conservation-ontario/.

[58] Rideau Valley Conservation Authority (2018). About Us. Retrieved July 9, 2018 from: https://www.rvca.ca/about-us.

FIGURE 18: CONVERSATION AUTHORITIES OPERATING WITHIN THE BOUNDARIES OF THE CITY OF OTTAWA

SOURCE: Conservation Ontario

9.2 EnviroCentre

Established in 1999, EnviroCentre is an Ottawa-based non-profit organization that helps residents, businesses and organizations conserve energy and reduce their impact on the environment, while saving money.[59] EnviroCentre is currently working on behalf of the City of Ottawa to conduct outreach and engagement around stormwater management projects in targeted communities.

9.3 Green Communities Canada

Green Communities Canada is a national association of community organizations that helps people go green – in their homes and gardens, on the road, at work, and in the community.[60] Green Communities Canada operates a series of water program called "RAIN Community Solutions" that involves working with municipalities, property owners and others to manage rain where it falls. Green Communities Canada has also taken an active role in working with the provincial government on its Low Impact Development guidelines.

[59] EnviroCentre (2018). About Us. Retrieved July 9, 2018 from: https://www.envirocentre.ca/about-us/.

[60] Green Communities Canada (2018). Our mission: A green and healthy future for all. Retrieved July 6, 2018 from: http://greencommunitiescanada.org/about-us/.

9.4 Ottawa Riverkeeper

Ottawa Riverkeeper is a registered charity that serves to protect and advocate on behalf of the Ottawa River rivershed. Ottawa Riverkeeper is a licensed member of Waterkeeper Alliance, an international grassroots advocacy organization.[61]

While Ottawa Riverkeeper does not currently have a green infrastructure campaign, the issue dovetails with its Sewage Overflows campaign which focuses on preventing runoff into the river during rainfall or snowfall events.

9.5 Canada Green Building Council

The Canada Green Building Council (CaGBC) is a not-for-profit, national organization that has been working since 2002 to advance green building and sustainable community development practices in Canada. The CaGBC works to change industry standards, develop best design practices and guidelines, advocate for green buildings and develop educational tools. The CaGBC is the licence holder for the LEED green building rating system in Canada. LEED 4, the latest version of the LEED rating system, focuses on buildings managing stormwater on site, replicating natural site hydrology. While it is a national-level organization, CaGBC has an office in Ottawa and conducts events and projects in Ottawa.

10 Policy Observations

As with any set of policies, there are challenges and opportunities affecting the way Ottawa approaches green infrastructure. One serious challenge facing the city is the lack of a single coherent green infrastructure policy stemming from any jurisdiction. While there are several policies and plans at every level that provide support for various tenets of green infrastructure principles, they are typically diffuse, open to a wide range of interpretations, contain no specific targets and are non-binding.

The current lack of action may be due to several reasons:

1. Lack of clarity with so many overlapping acts, policies and plans
2. Hesitation due to significant knowledge gaps and a sense that green infrastructure is an "unproven technology"
3. Lack of funding or conflicting funding budget priorities
4. Lack of a proper understanding of, or appreciation for, the urgency of the climate crisis and its deep connection to severe weather impacts such as flooding
5. Lack of political will as a result of political expedience due to perceived public opinion
6. Pressure from outside development interests, which may relate to perceived short-term cost-effectiveness of excluding or reducing green infrastructure elements from developments.

[61] Ottawa Riverkeeper (2018). About Us. Retrieved July 9, 2018 from: https://www.ottawariverkeeper.ca/home/who-we-are/our-story/.

While the policy landscape was expected to undergo positive change at the provincial level with the advent of the Low Impact Development guidelines, this process is uncertain at the time of writing (July 2018) with the recent change of government.

Despite the challenges listed above, there is still ample policy room for the City of Ottawa to lead on the implementation of green infrastructure. As noted above, the City of Ottawa already has some of the tools in place (key pieces of policy, useful data) to replicate or imitate green infrastructure best practices from other jurisdictions.

There is ample discussion of green infrastructure policy elements and tools in various plans impacting Ottawa, notably in key documents like the Official Plan and the 2014 Provincial Policy Statement. Clearly, municipal decision-makers understand the importance of green infrastructure principles in various contexts. Further, there is momentum from other jurisdictions pushing for action in this area. Based on this, there is impetus for action towards a strong green infrastructure policy or focused green infrastructure program – one that adds to existing policy language to delineate a city-wide plan of action.

One major opportunity for the City of Ottawa is to move beyond the experimentation phase in its green infrastructure projects. While data collection is important and should continue, it is also very time-consuming. At the time of writing, despite having three pilot projects underway, the City of Ottawa had only collected data for one trial (Sunnyside). It is unclear what kinds of timelines are in place for completing data collection and moving to more ambitious phase of green infrastructure roll-out.

Examples from other jurisdictions should inspire the City of Ottawa to deepen its green infrastructure ambition, even as it continues collecting and assessing data to refine its approach. Clearly, cities with similar climates and with very similar jurisdictional powers (e.g., Toronto) have been able to lead on initiatives such as green streets and green roofs. It appears the main barrier to greater ambition in Ottawa stems from political will, with attendant considerations of targets, funding and ambitious policy language.

When looking at leading jurisdictions, the importance of this political will is evident. For example:

- **Targets:** Chicago has a policy of 500 new green roofs per year, while Portland has a tree canopy cover target of 25% for each of its residential neighbourhoods. Ottawa lacks any green roof target (let alone a green roof bylaw), and has no neighbourhood-level tree canopy targets.
- **Funding:** It is clear that Ottawa's three pilot projects are much smaller in scope and in scale than leading cities. Additional funding could go towards broadening green infrastructure implementation, as well as paying for staff time to speed up analysis of pilots and hasten the delivery of the City of Ottawa's screening tool. Borrowing from the District of Columbia's example, funding could also go towards policy regimes that establish incentives for private actors to invest in green infrastructure.
- **Policy language:** Beyond developing new policy language where there is none (e.g., green roofs), the City of Ottawa could develop design standards on street re-builds that automatically integrate

green streets principles wherever feasible. This could involve adjustments to existing policies such as the Complete Streets Implementation Plan.

11 Recommendations

Below is a detailed list of recommendations for the city to develop green infrastructure policy and climate resilience.

1. Move beyond green infrastructure experimentation to widespread implementation, using targets and timelines to track robust implementation.
2. Develop a green roofs bylaw, following the example set by the City of Toronto.
3. Use existing policies to implement green streets. The city could use existing green infrastructure policy language and the Complete Streets Implementation Plan – which views all street refurbishments as an opportunity to better design streets for all ages, users and abilities – to systematically integrate natural systems into streets city-wide.
4. Develop and preserve Ottawa's urban forest using hard targets for reducing effective impervious areas and for enhancing urban forest canopy cover.
5. Implement low-impact development requirements for new developments and re-developments. As part of this, the City could use runoff volume control target to manage at least the first 25 millimetres of water on site.
6. Promote on-site green infrastructure measures for homeowners through the use of public engagement and awareness campaigns, like the one being piloted in the Pinecrest area.
7. Employ strong incentives for the use of green infrastructure at the household level. For example, Ottawa could imitate or replicate Washington, DC's Stormwater Retention Credit Trading Program, where revenue can be earned for projects that install green infrastructure or remove impervious surfaces.
8. Open dialogue with leading municipalities on transitioning older grey infrastructure to green infrastructure, based on risk, need and cost-benefit analysis.
9. Prohibit new development on floodplains. While building in floodplains is strictly against City policy, the City is still basing some of its planning decisions on the premise of new floodplain development.[62]
10. Analyze potential for leveraging development fees for green infrastructure projects and/or biodiversity enhancement.
11. Consider developing a comprehensive green infrastructure policy, with the object of consolidating green infrastructure-related initiatives within various municipal policies and setting specific goals.

[62] CBC Ottawa (2018). West-end LRT route runs through Kanata floodplain. Retrieved May 25, 2018 from: http://www.cbc.ca/news/canada/ottawa/lrt-floodplain-kanata-feedmill-1.4648477.

12. Undertake a comprehensive climate resilience risk assessment of critical infrastructure, vulnerable populations and the natural environment. As part of its membership in the Compact of Mayors, Ottawa is obligated to put forward a climate adaptation plan. Any such plan should feature a strong focus on green infrastructure, and potentially recommend green infrastructure plans or policies as a partial solution to climate vulnerability.

13. Work with conservation authorities to update flood plain maps and rainfall intensity–duration–frequency (IDF) curves. As part of this effort, Ottawa should examine if the 100-year flood basis (i.e., a 1 in 100 chance of a flood occurring in a given year) still makes sense in the context of a rapidly changing climate.

14. Work with conservation authorities to re-examine biodiversity targets and flooding and runoff requirements. The City could then use these targets as a lens affecting new developments, stormwater systems and building codes.

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